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Canada

CANADA'S 8th NATIONAL COMMUNICATION AND 5th BIENNIAL REPORT

Canada's Eighth National Communication on Climate Change and Fifth Biennial Report

Cat. No.: En1-63E-PDF
ISSN: 2371-6924
EC22068

Environment and Climate Change Canada
Public Inquiries Centre
12th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Telephone: 819-938-3860
Toll Free: 1-800-668-6767 (in Canada only)
Email: enviroinfo@ec.gc.ca

Aussi disponible en français

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Minister's Message

As the Minister of Environment and Climate Change, I am pleased to submit Canada's *Eighth National Communication and Fifth Biennial Report* to the United Nations Framework Convention on Climate Change (UNFCCC).

This Report shows the progress that Canada is making thanks to our accelerated climate action in recent years, reflecting the scientific and economic need for action. It shows us how far we have come and how far we still must travel in the country-wide transition toward a prosperous, net-zero emissions future. Lastly, it shows that Canada continues to be a constructive and progressive partner in the global fight against climate change.

Since the last *Biennial Report* to the UNFCCC in December 2019, Canada has faced the public health and economic challenges resulting from COVID-19, as well as a global energy crisis that has changed the emission and energy outlook of all nations. In its 2022 annual report, the International Energy Agency forecasts that the global energy crisis could accelerate the transition away from fossil fuels and towards renewable sources of energy.

In this context, Canada's resolve to fight climate change and transition away from fossil fuels has only grown stronger. The 2019 *Biennial Report* projected that Canada would reduce emissions to 588 million tonnes by 2030, a reduction of 227 million tonnes from the 2015 *Biennial Report*.

I am happy to report that the 2022 report shows that Canada is on track to reduce another 97 million tonnes by 2030—a 16 percent drop from the 2019 projections. This is the result of the measures we have announced since the last *Biennial Report*, and highlights that we have made major strides towards our greenhouse gas reduction targets. This also reflects Canada's strengthened position as a reliable and trusted global energy and clean technology supplier.

Canada has been focused and relentless in pursuing climate action since 2015. A series of major environmental policy plans—starting with the Pan-Canadian Framework in 2016—began to correct the alarming upward trajectory of Canada's emissions profile. Since the 2019 *Biennial Report* to the UNFCCC, Canada published a strengthened climate plan, *A Healthy Environment and a Healthy Economy*, in December 2020, which included 64 strengthened and new federal policies, programs and investments to cut pollution and build a stronger, cleaner, more resilient and inclusive economy. We adopted the *Canadian Net-Zero Emissions Accountability Act* in June 2021, enshrining in law Canada's enhanced new target to reduce emissions 40 to 45 percent below 2005 levels by 2030 and our commitment to achieve net-zero emissions by 2050. We have also implemented and strengthened a national pollution pricing system in Canada that is at the same time helping with Canadians' affordability challenges. Canada also became the first country to commit to reducing methane emissions in the oil and gas sector by at least 75 percent below 2012 levels by 2030.

In March 2022, Canada released its *2030 Emissions Reduction Plan: Canada's Next Steps for Clean Air and a Strong Economy*, the most comprehensive emissions reduction plan in Canada's history. This plan includes $9.1 billion in new investments, and reflects economy-wide measures such as pollution pricing and clean fuels, while also targeting actions ranging from buildings to vehicles to industry and agriculture. In December 2022, we published draft regulations for a regulated zero-emission vehicle sales target, the first regulations to come out of the *2030 Emissions Reduction Plan*.

More measures are coming in 2023, including taking steps to become the first major oil and gas producer to put in place a cap on oil and gas sector emissions—a significant measure that is not yet included in Canada's 2030 UNFCCC emissions modelling.

A cleaner, healthier, more efficient and affordable net-zero future for Canada is within our reach. Canada will continue to work with provinces and territories, municipalities, Indigenous Peoples, the financial community, innovators, and businesses, as well as the international community, to ensure that it is on good footing to achieve all of the many benefits that come with its 2030 target, and puts us firmly on the path to net-zero by 2050.

The Honourable Steven Guilbeault,
Minister of Environment and Climate Change

Chapter 1: Introduction and Executive Summary

Canada is pleased to present its *Eighth National Communication* and *Fifth Biennial Report* to meet its reporting requirements under the United Nations Framework Convention on Climate Change (UNFCCC). Canada has prepared these reports in accordance with adopted guidelines and other guidance for National Communications and Biennial Reports.

The following Introduction and Executive Summary provides an overview of *Canada's Eighth National Communication* and *Fifth Biennial Report* to the UNFCCC.

1.1. National Action

Canada has taken significant steps to address climate change since its last report to the UNFCCC. In addition to being one of the first Parties to the UNFCCC to sign and ratify the Paris Agreement, Canada has followed through on its Paris commitments over the past seven years by taking action, investing over $120 billion to reduce emissions, protect the environment, spur clean technologies and innovation, and help Canadians and communities adapt to the impacts of climate change. Building on the *Pan-Canadian Framework on Clean Growth and Climate Change* (2016), in 2020 the Government of Canada released its strengthened climate plan, *A Healthy Environment and a Healthy Economy,* to deepen emissions reductions across the economy, create new, well-paying jobs, make life more affordable for households, and build a better future.

This was followed in 2021 by implementation of the *Canadian Net-Zero Emissions Accountability Act*, which enshrines in legislation the Government of Canada's commitment to achieve net-zero greenhouse gas emissions by 2050. The Act also establishes the 2030 greenhouse gas emissions target as Canada's Nationally Determined Contribution (NDC) under the Paris Agreement, an emissions reduction target of 40 to 45 percent below 2005 levels by 2030. It also holds the federal government accountable by establishing a transparent process to plan, report on, assess, and adjust the Government's efforts to achieve Canada's national targets, which are set based on the best scientific information available, and provides for periodic examination of the Government's actions by the Auditor General of Canada. As well, the Act established a Net-Zero Advisory Body in legislation, to provide independent advice to the Government of Canada.

As an early deliverable under the *Canadian Net-Zero Emissions Accountability Act,* Canada published the first Emissions Reduction Plan (ERP) in 2022. The *2030 Emissions Reduction Plan* lays out the next steps to reach Canada's 2030 emissions reduction target, providing greater certainty and improving transparency and accountability on the way to net-zero. The 2030 ERP includes a suite of new mitigation measures and strategies, $9.1 billion in new investments, and builds on the foundation set by Canada's existing climate actions across sectors. The plan also reflects input from thousands of Canadians, businesses, and communities, as well as submissions from Indigenous partners, provinces, territories and the Net-Zero Advisory Body. Additional measures continue to be developed, both to ensure Canada reaches its 2030 target and to support deeper reductions beyond 2030. Progress under the plan towards Canada's 2030 target will be reviewed in progress reports produced in 2023, 2025, and 2027. Additional targets and plans will be developed for 2035 through to 2050.

As climate impacts continue to intensify, the Government of Canada recognizes that a more ambitious, strategic and collaborative approach is required to adapt and build resilience to the impacts of climate change. This is why the Government of Canada released for final comment in November 2022 Canada's first National Adaptation Strategy—*Canada's National Adaptation Strategy: Building Resilient Communities and a Strong Economy*. Developed by working closely with provincial, territorial and municipal governments, Indigenous Peoples and other key partners and stakeholders, the Strategy establishes a shared vision for climate resilience in Canada, identifying key priorities for increased collaboration, and establishing a framework for measuring progress at the national level.

1.2. International Action

At the international level, Canada is taking strong action to demonstrate its commitment to advancing international adaptation policies and supporting the international clean growth economy.

Canada is continuing to mobilize climate finance to support the international community in mitigating and adapting to climate change. After fully delivering on its 2015 commitment to provide $2.65 billion in climate finance to developing countries by fiscal year 2020-21, the Government of Canada committed in 2021 to provide $5.3 billion over five years to continue helping developing countries affected by climate change transition to sustainable, low-carbon, climate-resilient, nature-positive, and inclusive economies. This commitment dedicates a minimum of 40 percent of funding towards adaptation, and increases the proportion of grant contributions to 40 percent, from 30 percent previously. In line with Canada's Feminist International Assistance Policy, Canada will ensure that at least 80 percent of projects will integrate gender equality considerations.

Through its efforts with the Local Communities and Indigenous Peoples Platform and beyond, Canada has demonstrated leadership on enhancing the engagement of Indigenous Peoples on international climate action. From 2019 to 2022, Canada provided funding to establish an Indigenous Peoples Focal Point within the UNFCCC Secretariat to support the work of the Local Communities and Indigenous Peoples Platform. These efforts are essential to supporting diverse perspectives across climate action leadership, and will continue to be a major focus of Canada's international action.

Canada continues to work with international partners to advance and promote climate action, research, and capacity-building. For example, as a founding member of Mission Innovation (MI), Canada regularly collaborates with international partners to strengthen global cooperation on clean energy innovation in order to advance affordable and reliable clean energy solutions that will revolutionize energy systems across the world. Canada has demonstrated leadership in supporting the first phase of MI and announced that it exceeded its target to double public spending on clean

energy research, development, and demonstration. In June 2021, Canada joined other MI members in launching MI 2.0 with the intent to strengthen cooperation on pioneering clean energy solutions. In addition, Canada will continue to advance gender as a key priority in international climate change efforts. Between 2018 and 2021, Canada supported the delivery of five capacity-building workshops for women negotiators (one in the Caribbean and four in francophone Africa), in partnership with France and the Organisation internationale de la Francophonie. Through these workshops and by providing funding to support women negotiators' travel and participation in UNFCCC sessions, the Government of Canada is supporting meaningful representation, diversity, and inclusion at the UNFCCC. This commitment is also reflected in Canada's own delegation to the UNFCCC, by prioritizing diversity and inclusion, including of Indigenous Peoples.

1.3. National Circumstances

Canada's unique geographic, demographic, and economic circumstances influence its GHG emissions profile. For example, while Canada has a relatively small population, it also has one of the largest landmasses in the world, most of it located in the northern half of the northern hemisphere. These factors contribute to heavier energy and transportation use than in smaller and/or more densely populated countries.

Canada's population remains the smallest among G7 countries but is rapidly growing, mostly through international migration. With 38.2 million inhabitants in 2021, it is anticipated that Canada's population could reach between 43.6 and 57.7 million by 2050. Two-thirds of Canada's population and urban centres are located within 100 kilometres of the Canada—U.S. border, leaving large parts of the country sparsely populated. The large distance between metropolitan areas and low population density generates high emissions from the Transportation Sector making it the second largest contributor of GHG emissions in Canada.

Canada experiences a wide range of climate conditions, with most of the inhabited regions seeing distinct seasons—in particular very warm summers and very cold winters. Heating and cooling have a significant impact on energy use and GHG emissions. Canada's climate has been increasingly warming over the last several years. Northern regions are the most affected, and extreme events such as drought, heat waves, forest fires, floods and severe thunderstorms are happening more frequently. The cost of associated disasters is rising as a result.

Although climate and geography contribute to making Canada a heavy energy user, energy efficiency has improved in recent years. In addition, 82 percent of Canada's total electricity is produced from non-GHG emitting sources, with hydroelectricity comprising most of this production. The share of renewable power from sources other than hydro has been increasing steadily since 1990 while the supply generated from coal has decreased substantially over the same time period. The *Clean Electricity Regulations* will be part of a suite of federal measures to help drive progress towards a net-zero electricity grid by 2035, while maintaining system reliability and electricity affordability for customers.The COVID-19 pandemic had a notable impact on the Canadian economy. GDP had a negative growth of -5.2 percent in 2020, but recovered by 2021 to 4.6 percent (the highest growth rate since 2007).

While Canada's economy is primarily driven by the Service Sector, its Manufacturing, Construction, Mining, Oil and Gas, and Forestry Sectors still represent almost 30 percent of the economy, which is unique among industrialized countries. These emissions-intensive sectors contribute significantly to Canada's emissions. However, Canada's abundant natural resources, skilled workforce and competitive business environment also provides opportunities to grow its cleantech and low-carbon economy, including through clean fuels, nature-based solutions, and critical minerals development and battery production, to help support not only Canada's but the world's net-zero future.

1.4. Canada's Greenhouse Gas Inventory

Canada's *National Inventory Report* is prepared and submitted annually to the UNFCCC and includes estimates of carbon dioxide equivalent (CO_2 eq) in the following five sector categories, as defined by the Intergovernmental Panel on Climate Change: Energy, Industrial Processes and Product Use, Agriculture, Waste, and Land Use, Land-Use Change and Forestry (LULUCF).[1] Canada also reports estimates of historical emissions and removals according to the following economic sector categories: Electricity; Transportation; Oil and Gas; Heavy Industry; Buildings; Agriculture; and, Waste and Others.

In 2020, Canada emitted 672 Mt CO_2 eq, a net decrease of 69 Mt in total emissions (or 9 percent) from 2005 emissions.[2] The Energy Sector (consisting of Stationary Combustion Sources, Transport, and Fugitive Sources) continues to account for the majority of Canada's emissions, at 80 percent or 540 Mt. Other emissions are generated from the Agriculture Sector (8 percent), the Industrial Processes and Product Use Sector (7.5 percent), and the Waste Sector (4 percent). Alberta continues to have the highest emissions among Canadian provinces, primarily due to expanding oil and gas operations.

Similar to other industrialized countries, carbon dioxide is the largest contributor to Canada's GHG emissions and accounted for 80 percent of Canada's emissions in 2020. Other emissions include methane (14 percent), largely from fugitive sources in oil and natural gas systems, agriculture and landfills, and nitrous oxide (5 percent) from agricultural soil management. Combined, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3) contributed less than 2 percent of Canada's emissions.

1.5. Policies and Measures

1.5.1. Institutional Arrangements

Within the Government of Canada, the Minister of Environment and Climate Change is responsible for domestic and international climate change policies. However, as the environment is a shared jurisdiction in Canada, and given the cross-cutting nature of climate change, several federal, provincial and territorial ministries work together to address this issue. At the federal level, most climate change regulations are developed under the authorities of the *Canadian Environmental Protection Act, 1999* (CEPA).

In 2016, the Government of Canada developed the *Pan-Canadian Framework on Clean Growth and Climate Change* in collaboration with provinces and territories, and with input from Indigenous partners. Building on this national effort, the Government of Canada released its strengthened climate plan, *A Healthy Environment and a Healthy Economy*, in December 2020, to deepen emissions reductions across the economy, create new, well-paying jobs, make life more affordable for households, and build a better future.

In 2021, the Government of Canada enacted the *Canadian Net-Zero Emissions Accountability Act*. The Act sets legal requirements for current and future governments to plan, report, and course correct on the path to net-zero emissions by or before 2050. It commits Canada in legislation to achieving its 2030 Nationally Determined Contribution under the Paris Agreement of 40 to 45 percent below 2005 levels, as well as committing Canada to setting national targets for the reduction of GHG emissions every five years from 2030 with the objective of attaining net-zero emissions by 2050. The Act provides a durable framework of accountability and transparency to

deliver on this commitment. As an early deliverable under the Act, Canada published the *2030 Emissions Reduction Plan* in 2022, providing a plan for how Canada will reach its 2030 target. The first progress report on the 2030 Plan must be completed by the end of 2023.

Moreover, in September 2022, the Government of Canada released *Faster and Further: Canada's Methane Strategy*. The Strategy provides a pathway to further reduce methane emissions from across the economy while supporting Canadian technology and creating good-paying jobs.

Federal, provincial and territorial Ministers continue working together through longstanding inter-ministerial fora, such as the Canadian Council of Ministers of Environment and the Energy and Mines Ministers Conference, to implement and report on emissions reductions efforts and to align priorities for collaboration on adaptation.

1.5.2. Policies and Measures to Reduce Emissions

Based on Canada's *National Inventory Report*, Canada's emissions fell by 9.3 percent from 2005 levels by 2020. In addition to this, the LULUCF accounting contribution in 2020 would contribute an additional 24 Mt (or 3 percent) of reduction in 2020. Official information on the net purchases by Québec of international credits is not yet available, but preliminary estimates suggest about 11 Mt. With these contributions, Canada's emissions would fall by about 14 percent from 2005 levels by 2020. Furthermore, significant efforts have been made to establish funding, programs, and accountability and transparency frameworks to support the accelerated reductions required to meet Canada's 2030 reduction targets and to achieve net-zero emissions by 2050.

A number of key cross-cutting measures are planned or in place to reduce emissions across Canada. For example, every jurisdiction in Canada has had a comparable price on carbon pollution in place since 2019, and strengthened benchmark criteria were announced in 2021 that all carbon pollution pricing systems will need to meet from 2023 to 2030 .

Under the Pan-Canadian Framework, the Strengthened Climate Plan and the *2030 Emissions Reduction Plan*, federal, provincial and territorial governments are working to target emissions across all sectors of the economy. For example:

- Carbon pricing is the cornerstone of Canada's approach to climate action—since 2019, every jurisdiction in Canada has had a comparable price on carbon pollution.
- The Government of Canada is supporting the Electricity Sector move to net-zero by 2035 and continues to phase-out the use of coal-fired electricity generation and increasing funding for non-emitting electricity.
- Under the Strengthened Climate Plan, *A Healthy Environment and a Healthy Economy,* the Government of Canada has launched the $8 billion Net-Zero Accelerator to support the decarbonization of Canada's largest industrial emitters, scale-up clean technology and accelerate Canada's industrial transformation across all sectors.
- To decarbonize the Transportation Sector, all new light-duty cars and passenger truck sales must be zero-emission by 2035, and the federal government committed to permanent public transit funding of $3 billion per year beginning in fiscal year 2026-27.
- Canada's *2030 Emissions Reduction Plan* included several initiatives that will reduce emissions within the Buildings Sector, such as the Canada Greener Homes Grant (supporting homeowners making their homes more energy-efficient) and the Green and Inclusive Community Buildings (providing $1.5 billion funding to improve energy efficiency in community centres, sport facilities, and cultural spaces).

Key investments and new innovations will play an important role in reaching Canada's emissions reductions goals. The Government of Canada announced in the *2030 Emissions Reduction Plan* and in Budget 2022 that it will expand the Low Carbon Economy Fund by investing an additional $2.2 billion over seven years (starting in fiscal year 2022-23). Advances in clean technology and innovation are also anticipated to make Canada a global leader in supporting the transition to a lower carbon future. In 2021, Export Development Canada facilitated $6.3 billion-worth of business for cleantech—a 39 percent year-over-year increase from 2020.

1.6. Projections

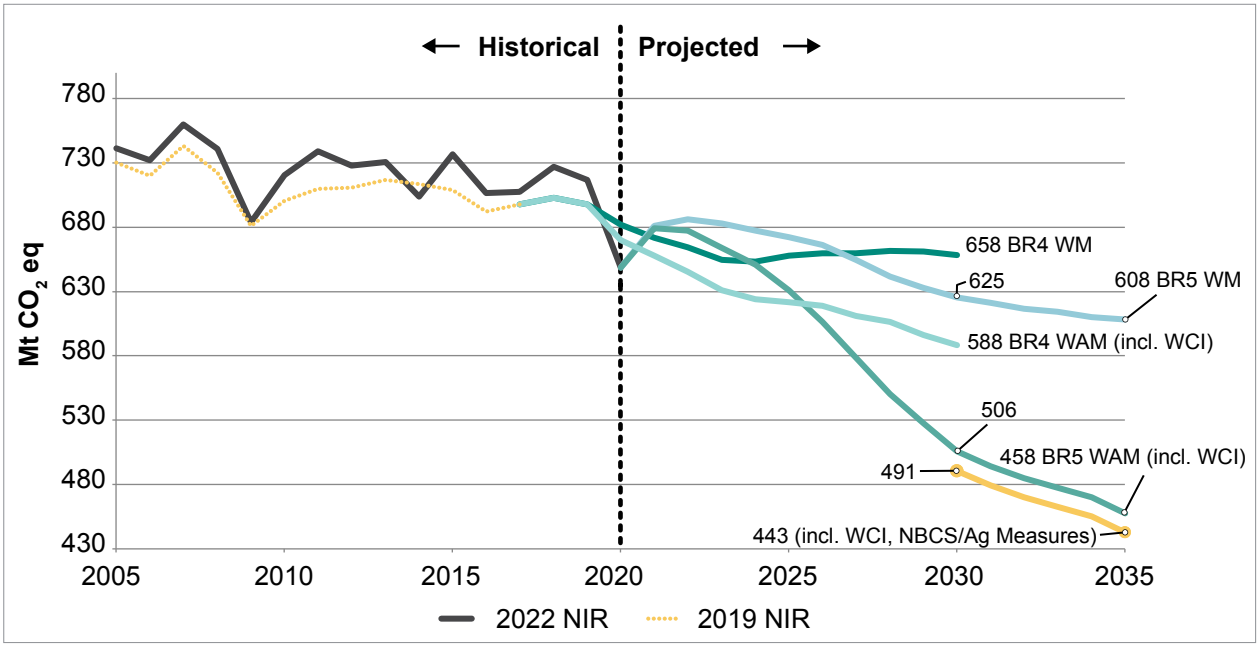
Projections provide important insight into the expected impacts of the suite of existing measures and can be a valuable tool when identifying where more effort is needed. Canada's GHG projections are derived using a detailed bottom-up simulation model where energy data is allocated to individual subsectors using the North American Industrial Classification System. These subsectors are then aggregated into the economic sectors presented in this report. Projections are based on ECCC's Energy, Emissions and Economy Model for Canada (E3MC), which is internationally recognized and incorporates external data from consistent sources. ECCC consults extensively with other government officials, selected experts and provinces and territories on annual emissions projections.

For its *Eighth National Communication and Fifth Biennial Report*, Canada has presented projections that include both a "with measures" scenario (WM) and a "with additional measures" scenario (WAM, both outlined in Section 5.2).

- The WM scenario builds on the WM projections presented in the *Fourth Biennial Report*, and now includes all policies and measures funded, legislated and implemented by federal, provincial and territorial governments over the last three years, up to November 2022.
- The WAM scenario accounts for those additional policies and measures that are under development but have not yet been fully implemented, some of which were announced as part of the 2030 ERP (e.g., Clean Electricity Regulations, strengthened methane regulations in the oil and gas sector targeting 75 percent reduction by 2030 and proposed landfill gas regulations). This scenario is provided for the purposes of representing progress to Canada's 2030 target and to better demonstrate the full impact of Canada's climate policies.

Under the WAM scenario, emissions in 2030 decline to 491 Mt Including contributions from Land Use, Land-Use Change and Forestry (LULUCF), Nature-Based-Climate Solutions (NBCS) and Agriculture Measures and credits purchased under the Western Climate Initiative (WCI). This is 97 Mt below the 2030 WAM projection in the *Fourth Biennial Report*. Post-2030, the WAM scenario sees emissions continuing to decline, reaching 443 Mt in 2035. Figure 1 shows the "with measures" and "with additional measures" projections, as well as the projections presented in Canada's *Fourth Biennial Report*.

Figure 1-1: Scenarios of Canadian Emissions (Including LULUCF) to 2035 (Mt CO_2 eq)



While every effort is made to be as complete as possible in what is included in the model, there will always be measures that are not included. This includes the aforementioned federal measures that have not been sufficiently developed to support inclusion, such as the oil and gas cap on emissions, elements of the Green Buildings Strategy, as well as additional mitigation measures that could be implemented by the provinces and territories between now and 2030. Emissions reductions from additional future actions will be assessed as new measures are implemented.

Uncertainty is an inherent and unavoidable aspect of any model that is generating long-term projections. The current global context further complicates the development of projections given the extent of global change in recent years, notably due to the COVID-19 pandemic, the worsening impacts of the climate crisis including large scale flooding and heat waves, and the emerging and related dual inflation and energy supply crises in 2022. The scenarios presented reflect recent events that could impact future emissions, using expert and data driven forecasts. These forecasts can change dramatically from year to year, driven by global conditions. A notable change in 2022 has been global energy prices, which are forecast to drive higher natural gas production in Canada's energy sector, which is a shift from the natural gas price and demand forecasts in recent years.

The uncertainty inherent in projections is addressed via modelling and analysis of alternate cases that focus on variability in: future economic growth, population projections and oil and natural gas production and prices. The sensitivity analyses generated through these alternate cases are used to identify a range of possible emissions projections. Under the WM scenario, emissions reductions in Canada are projected to be 625 Mt in 2030. Through the sensitivity analysis, emissions reductions in 2030 under the WM scenario are projected to range from between 612 and 664 Mt. Environment and Climate Change Canada also updates emissions projections annually, reflecting the latest historical data and up-to-date future economic and energy market assumptions.

1.7. Vulnerabilities

Recent extreme events in Canada have caused billions of dollars in damages, displaced thousands, and disrupted supply chains. Projections also indicate that today's record-breaking events will be tomorrow's new normal. Impacts are building upon each other and leading to additional effects such as increased demand for emergency assistance, loss of biodiversity, reduced food and economic security, and increased demands on physical and mental health services. Climate change often worsens existing inequalities and vulnerabilities, leaving some people living in Canada more exposed than others.

Building on the Pan-Canadian Framework, Canada released its first National Adaptation Strategy for final comment in November 2022. The Strategy establishes a shared vision for climate resilience in Canada, identifies key priorities for increased collaboration, and establishes a framework for measuring progress at the national level. The Strategy offers the opportunity to scale up ongoing actions and advance new initiatives and leadership through the help of shared priorities and collaborative action. Through the National Adaptation Strategy, the federal government is committed to continued collaboration and partnerships with jurisdictions and organizations to support stronger adaptation action. Adaptation efforts must respect the jurisdictions of local, provincial, territorial, national, and Indigenous governments, and act to accelerate and build upon their existing efforts.

Canada has advanced adaptation efforts by making substantial, successive funding commitments. The Government of Canada earmarked $2.2 billion from Budgets 2021 and 2022 to support a number of federal adaptation policies and programs, including the co-development of an Indigenous Climate Leadership Agenda with Indigenous Peoples, a top-up of the Disaster Mitigation and Adaptation Fund (established in 2017), enhancing wildfire preparedness, and completing flood maps for high-risk areas. To show how the Government of Canada plans to contribute to achieving the proposed targets, goals and objectives laid out in the National Adaptation Strategy, Canada released the *Government of Canada Adaptation Action Plan* in November 2022. The Action Plan includes a total of 68 federal actions across 22 departments and agencies, illustrating the depth and breadth of action being taken. The November 2022 announcement also included $1.6 billion in new federal funding commitments to help protect communities from coast to coast to coast.

The Government of Canada is also continuing to support Indigenous and northern communities in adapting to climate change impacts through a number of targeted programs. This includes support for risk assessments, adaptation planning, implementation of structural and non-structural adaptation measures, and the co-application of scientific and Indigenous Science and Knowledge for community-based climate monitoring.

In support of climate resilience, Canada developed the *Emergency Management Strategy for Canada*, an official emergency management and disaster risk reduction strategy. Through this Strategy and its iterative action plans, federal, provincial and territorial governments are working on a number of important initiatives, including the National Risk Profile, which will create a forward-looking national picture of disaster risk and emergency management capabilities. Governments will also review the Disaster Financial Assistance Arrangements, an important federal disaster relief program.

While governments and communities have made significant progress to strengthen their response and resilience to climate change, additional efforts are required to effectively prepare for projected impacts. Strategic partnerships and investments will be critical to improve decision-making, build the capacity and skills needed to adapt, and support community-led projects.

1.8. Financial, Technology, and Capacity-Building Support

Canada is committed to supporting developing countries to obtain clean and reliable sources of energy and enhance resilience, particularly the poorest and most vulnerable countries, in their fight to adapt to the impacts of climate change. Between 2015 and 2021, Canada fully delivered on its commitment to provide $2.65 billion in climate finance to support developing countries in their transition to low-carbon, climate-resilient economies.

Between 2019 and 2020, nearly $965 million from Canada's $2.65 billion climate finance pledge was delivered through bilateral, multi-bi, and multilateral channels, as well as to the organizations and financial mechanisms of the UNFCCC. These channels include the Green Climate Fund, the world's largest international climate fund dedicated to supporting developing countries pursue climate action, and the Global Environment Facility, through which Canada is able to support developing countries implement multilateral environmental agreements and priorities such as biodiversity, land degradation, and sustainable forest management.

In 2021, Canada committed to provide $5.3 billion over the next five years to continue its international climate action support. A minimum of 40 percent of this funding will be earmarked for adaptation, another 40 percent for grant contributions, and 20 percent will fund projects that either leverage nature-based climate solutions or contribute biodiversity co-benefits. In line with Canada's Feminist International Assistance Policy (FIAP), at least 80 percent of projects will integrate gender equality considerations. Canada's sub-national governments are also making meaningful contributions to scaling up Canada's climate finance, including Québec's $3 million contribution to the Adaptation Fund in support of the Paris Agreement goals.

Export credit agencies such as Export Development Canada (EDC) and FinDev Canada are playing an important role in supporting investments for climate activities. For example, EDC has been issuing green bonds since 2014, resulting in more than $2 billion to fund environmental protection and climate change mitigation. In 2021, FinDev Canada committed to increase its climate finance allocation to 35 percent by 2025 and launched its *Climate Change Strategy* to outline how FinDev's climate change policy would be implemented.

Canada recognizes the essential role that clean, affordable and accessible technologies play in mitigating and adapting to climate change, and will continue its efforts to engage with international partners and share Canadian technologies and expertise. For example, Canada has provided knowledge, science-based carbon budget models, mentoring and guidance on forest GHG emissions mitigation and forest management to Belize, Chile, Colombia, Czech Republic, Ecuador, the European Union, Honduras, India, Ireland, Italy, Mexico, Mongolia, Nicaragua, Korea, Peru, Poland, Uruguay, and the United States. Canada continues to support the International Energy Agency's research through the Clean Energy Transitions Programme and the Technology Collaboration Programme. In 2019, Canada joined the International Renewable Energy Agency to support the promotion and adoption of renewable energy globally.

1.9. Research and Systematic Observation

In Canada, climate science research and monitoring approaches involve federal, provincial, municipal, academic and private sector partners.

In December 2020, Canada released the *Climate Science 2050: Advancing Science and Knowledge on Climate Change* report to strengthen the coordination and development of mitigation and adaptation science. Work is now underway to develop an associated plan, titled *Climate Science 2050: Canada's Climate Change Science and Knowledge Plan*, to identify priorities for new research, and the synthesis and mobilization of existing knowledge, to inform action towards achieving net-zero emissions in Canada.

The three major research funding agencies in Canada, known together as the Tri-Councils, continue to provide funding for climate science research programs and fostering innovation between academia, non-governmental and community partners, and Canadian companies. For example, in 2022 the Natural Sciences and Engineering Research Council of Canada issued a new call for proposals to the Alliance Mission Grants with a nominal budget of $22 million to support research related to net-zero GHG emissions targets.

Systematic climate observations are essential for understanding the mean states of various climate components over time and the natural variability around these means, for detecting changes in means and extremes, and for attributing these changes to specific causes. The long-term systematic collection, quality assurance, and dissemination of climate system data is an important aspect of systematic observations, and Canada is working with the World Meteorological Organization to share data openly and freely, as well as to address global and regional observation network gaps.

Canada is a significant contributor to the Global Climate Observing System, including by providing monthly climatological datasets and support for the World Meteorological Organization's Climate Normals and the Global Ocean Observing System, and the Global Terrestrial Observing System. In 2024, Canada will take on the Presidency of the Committee on Earth Observations Satellites, prioritizing the role of Earth observations for protection of biodiversity and climate action.

A growing area of research is the use of remote sensing methods to derive methane emissions on global and regional scales. Canadian industry leads the world in Fourier Transform Spectrometer (FTS) technology and is currently advancing it to better observe atmospheric gases from space, including critical gases such as carbon dioxide (CO_2) and methane (CH_4) that are leading causes of climate change.

1.10. Education, Training, and Public Awareness

Across Canada, all levels of government and numerous non-governmental organizations have undertaken a range of activities to broaden public awareness of climate change and encourage collective action.

In 2021 and 2022, Environment and Climate Change Canada launched an advertising campaign titled *Our Healthy Environment and Economy*, with the goal of raising awareness and increasing the uptake of Canada's various environmental programs and incentives. Post-campaign surveys revealed that two-thirds of respondents intended to increase their personal efforts to protect the environment within the next six months.

The Canadian Centre for Climate Services, launched in 2018, plays a key role in providing credible, useful, and timely climate data, information, and tools for Canadians. The Centre incorporates information from federal departments, provincial and territorial governments, and climate science experts to provide training and guidance on using climate data and to develop new products as needed. The Centre also houses several climate data portals, include climate model projections, a climate atlas that combines climate science, mapping, and Indigenous Knowledge, and advanced analytic tools for academia.

The Office of Energy Efficiency within Natural Resources Canada provides accessible information for Canadians to make informed decisions on consumer products and renovations, such as a handbook for homeowners on how to make their homes more energy efficient. The Office also supports the EnerGuide and ENERGY STAR program, two major labelling programs, which provide useful information on household appliances, heating and cooling products, and light-duty vehicles.

In June 2022, the Government of Canada launched the Regional Energy and Resource Tables to identify and pursue opportunities for economic growth, energy transformation, and sustainable job creation in each region of the country. This collaborative initiative will involve close partnerships between federal, provincial and territorial governments, a tailored approach to engagement with Indigenous governments and groups and a process to seek input from municipal governments, experts, industry, labour, non-profit organizations and others. As of November 2022, nine provinces and territories have launched their Tables. Efforts from this initiative will culminate in the development of comprehensive place-based economic strategies that consider pathways to achieving economic growth opportunities and the enabling conditions such as building the workforce needed to advance these opportunities.

References

1 The most recent report entitled *National Inventory Report 1990-2020: Greenhouse Gas Sources and Sinks in Canada* is available online at: https://unfccc.int/documents/461919.

2 This figure excludes LULUCF emissions and removals.

Chapter 2: Canada's National Circumstances

This chapter outlines national circumstances within Canada that contribute to observed trends in greenhouse gas (GHG) emission levels and removals. For the purposes of this report, Canada defines a national circumstance as a relatively inflexible characteristic of a nation, not easily shaped by government policy, which significantly influences its GHG emissions.

Canada's unique geographic, demographic, and economic circumstances influence its GHG emissions profile. For instance, Canada has a highly variable climate that contributes to higher energy use for space heating and cooling in the Buildings Sector compared to some other industrialized countries. Canada also has a large landmass, with a low population density that contributes to longer travel times and higher demand for freight transportation than in smaller and/or more densely populated countries. Canada has a resource-based economy and has seen sustained economic growth, as well as faster than average population growth relative to other Organisation for Economic Cooperation and Development (OECD) countries. Canada is also a net exporter of energy and has an energy-intensive Industrial Sector.

While Canada represented only 1.56 percent of total global GHG emissions in 2019, it is one of the highest per capita emitters due to its size, its climatic conditions, and its energy-intensive, resource-based economy.[1] However, since 1990, the level of emissions per unit of real gross domestic product (GDP) has fallen 37 percent, reflecting more efficient industrial processes, a shift to a more service-based economy, and lower emitting energy generation through fuel switching.[2]

2.1. Governance Structure

Canada is a geographically large federation composed of a central federal government, 10 provincial governments, and three territorial governments. The Canadian Constitution and convention assign different powers to each level of government.

Protection of the environment is not specifically addressed under the Constitution. It has become an area of shared jurisdiction as governments have taken action according to their respective authorities. Constitutional jurisprudence continues to evolve in this area.

Federal environmental laws are based on federal constitutional powers such as international borders, international relations, trade and commerce, navigation and shipping, seacoasts and fisheries, criminal law, and the power to legislate in the national interest.

Provincial environmental laws are based on provincial constitutional powers, which include municipalities, local works and undertakings, property and civil rights, provincially owned (public) lands and natural resources. Territorial governments exercise delegated powers under the authority of the Parliament of Canada. The devolution of powers, or the transfer of province-like responsibilities from the federal government to territorial governments, is ongoing.

The Government of Canada has implemented a number of key pieces of climate change-related federal legislation in recent years. These include the *Greenhouse Gas Pollution Act* (GGPPA) in 2018 and the *Canadian Net-Zero Emissions Accountability Act* (CNZEAA) in 2021. These Acts are described in more detail in Chapter 4: Policies and Measures. A number of provincial, territorial, and municipal governments have made net-zero-by-2050 commitments, including net-zero legislation from Nova Scotia and Prince Edward Island.

Every jurisdiction has an environmental ministry or agency, but climate responsibilities can be widely shared within each government. Within the federal government, for example, several departments and agencies have mandates that have a significant climate component: Environment and Climate Change Canada, Fisheries and Oceans Canada, Natural Resources Canada, Agriculture and Agri-Food Canada, Transport Canada, Health Canada, Parks Canada Agency, the Impact Assessment Agency of Canada, Finance Canada, Infrastructure Canada, and Innovation, Science and Economic Development Canada.

In addition, many of the federal Ministers leading these departments have formal mandate letter commitments to work with Environment and Climate Change Canada in addressing climate change. For instance, in the most recent ministerial mandate letters (December 2021), the Minister of Natural Resources was asked to work with the Minister of Environment and Climate Change to cap oil and gas sector emissions at current levels and ensure that the sector makes an ambitious and achievable contribution to meeting the country's 2030 climate goals. The Minister of Environment and Climate Change was also tasked to work with the Minister of Public Safety and the President of the King's Privy Council for Canada and Minister of Emergency Preparedness, with support of the Minister of Natural Resources, Minister of Innovation, Science and Industry and the Sustainable Finance Action Council, to develop a climate data strategy to ensure that the private sector and communities have access to data to inform planning and infrastructure investments. Given the many different federal departments with varying responsibilities with respect to climate change-related action, a Deputy Ministers' committee was established to oversee the implementation of climate change-related action across government, facilitating coordination and promoting coherence across different departments. As well, implementation progress of federal actions to address climate change is tracked to inform senior management governance committees, Ministers and the Prime Minister.

Natural resources, including energy, fall mainly under provincial jurisdiction. Provincial governments own the resources within their boundaries and have broad responsibility for managing resource development activities, except on some federal lands (e.g., National Parks, north of the 60th parallel, offshore) and some Indigenous lands (e.g., lands managed by an Indigenous government established through a land claim). Provincial governments manage resource ownership, royalties, land-use planning and allocations as well as exploration, development, conservation and use of natural resources within their boundaries.

The federal government has responsibility for interprovincial and international trade, and the Canada Energy Regulator regulates interprovincial/international pipelines and energy exports and imports. The federal government conducts environmental assessments of major projects with the greatest potential for significant adverse environmental impacts.

Given that the environment is an area of shared jurisdiction between the federal and provincial or territorial governments, powers between the federal and provincial/territorial jurisdictions often overlap with regard to particular environmental issues. To that end, several multi-level governance mechanisms ensure close collaboration in policy and regulatory development and implementation, from the Canadian Council of Ministers of the Environment and issue-specific councils and working groups, to equivalency and other types of agreements between federal environmental authorities and their provincial and territorial counterparts.

As well, First Nations, the Métis Nation, and Inuit are the Indigenous Peoples of Canada, with their own distinct, rights-bearing communities with their own histories. Canada's constitutional and legal order recognizes the reality that Indigenous Peoples' ancestors owned and governed the lands which now constitute Canada prior to the Crown's assertion of sovereignty. The special relationship between Indigenous Peoples of Canada and the Government of Canada, including existing Aboriginal and treaty rights, is recognized and affirmed in Section 35 of the *Constitution Act, 1982*. Section 35 contains a full suite of rights, and holds the promise that Indigenous nations will become partners in Confederation on the basis of a fair and just reconciliation between Indigenous Peoples and the Crown.

All of Canada's relationships with Indigenous Peoples are based on recognition of this fact and supported by the recognition of Indigenous title and rights, as well as the negotiation and implementation of pre-Confederation, historic, and modern treaties. Many modern treaties include environmental provisions. In June 2021, Canada passed the *United Nations Declaration on the Rights of Indigenous Peoples Act*, which affirmed that the Declaration applied to Canadian law, and provided a framework for implementing the Declaration in Canada.[3]

Indigenous Peoples demonstrate climate change resilience in the face of unique and diverse circumstances that include being among the most vulnerable to climate change. First Nations, Inuit, and Métis continue to be guardians and stewards of the environment. Foundational to Canada's approach to climate change is a commitment to support and partner with Indigenous communities as they take action and exercise their right to self-determination.

As the federal, provincial, and territorial governments take action on climate change, Canada will move forward while recognizing and respecting the rights and self-determination of Indigenous Peoples, including through robust, meaningful engagement that draws on Indigenous Knowledge. A key priority remains strengthening the collaboration between federal, provincial, and territorial governments and Indigenous Peoples on mitigation and adaptation actions, based on recognition of rights, respect, cooperation, and partnership. Indigenous Peoples are important leaders and partners in developing real and meaningful climate action. The Government of Canada has continued collaborative engagement with Indigenous Peoples through three distinctions-based, senior, bilateral tables, in accordance with joint commitments made by the Prime Minister and National Leaders of the Assembly of First Nations, Inuit Tapiriit Kanatami and the Métis National Council. These forums seek to ensure First Nations, Inuit and Métis are full and effective partners in advancing clean growth and addressing climate change based on the recognition of rights, respect, cooperation and partnership, and consistent with the *United Nations Declaration on the Rights of Indigenous Peoples*.

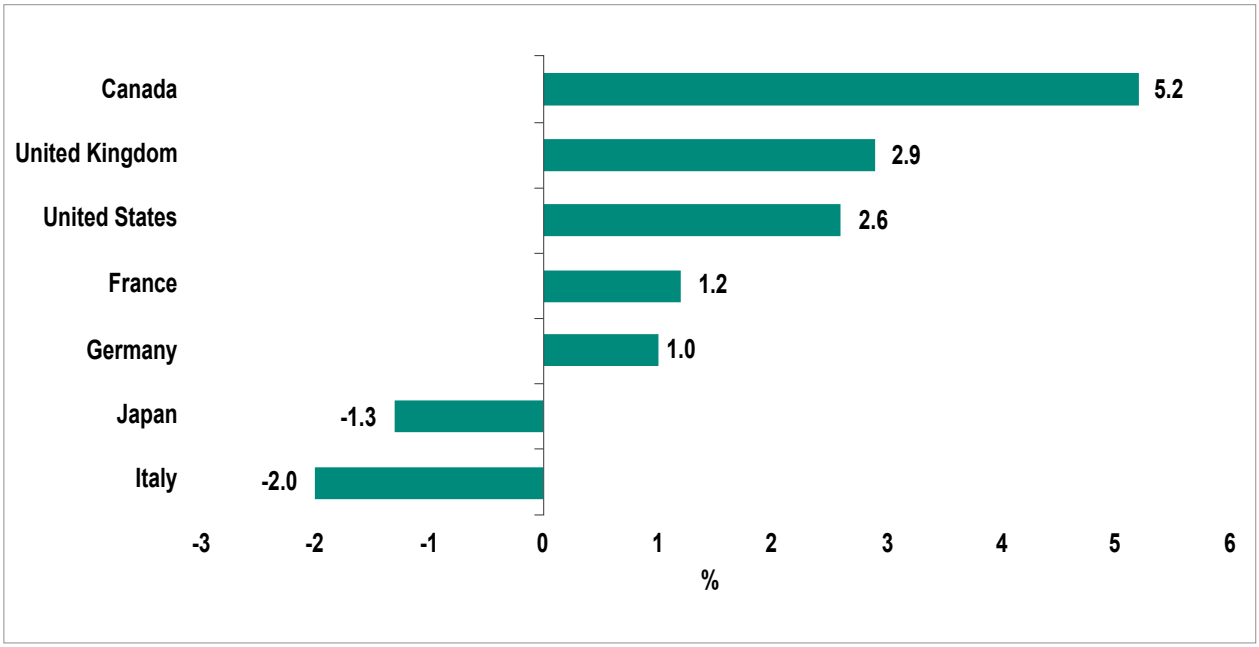
2.2. Population Profile

In 2021, Canada's population was 38.2 million.[4] While the Canadian population remains the smallest among G7 countries, its population grew at almost twice the rate of every other G7 country from 2016 to 2021, rising 5.2 percent from 2016 to 2021. Although the onset of the COVID-19 pandemic in 2020 slowed Canada's rapid population growth, it continued to be the fastest among G7 countries.[5] Immigration was responsible for nearly four-fifths of the population increase from 2016 to 2021. It is projected that there will be between 43.6 and 57.7 million people in Canada by 2050.[6]

Canada's population is not spread evenly across the country. The southern part of Canada is home to a large number of urban centres, leaving the northern and rural regions of the country much less populated. In 2021, over one-third of Canadians (13.1 million people) lived in the three largest metropolitan areas of Toronto, Montréal and Vancouver.[7] Moreover, in 2021, most of Canada's population lived in urban areas, while 18 percent lived in rural areas.[8]

Canada has 41 metropolitan areas (where the population is greater than 100,000), many of which have large distances between them (e.g., approximately 450 kilometres between Ottawa and Toronto, Ontario).[9] In 2021, Canada's population density was estimated to be 4.2 people per square kilometre, compared with 36 people per square kilometre in the U.S.[10] Large distances between Canada's widespread metropolitan areas and a low population density contribute to high energy demand (and GHG emissions) related to the transportation of people and goods.

Figure 2-1: Population Growth Rate (in percent) of G7 Countries, 2016 to 2021



Source: Statistics Canada. 2022. Chart 1, Canada's population is growing at the fastest pace in the G7 and ranks seventh in the G20. Available at https://www150.statcan.gc.ca/n1/daily-quotidien/220209/cg-a001-eng.htm.

2.3. Economic Profile

As of 2021, Canada was the world's 9th largest economy with a GDP of $2.0 trillion.[11] On a GDP per capita basis, Canada ranks 23rd in the world.[12]

In 2020, during the COVID-19 pandemic, GDP had a negative growth of -5.2 percent.[13] By 2021, GDP growth had recovered to 4.6 percent—the highest growth rate since 2007.[14] The population grew by 2 percent between the start of 2020 and late 2022.[15] Over the last 20 years, the economy has remained steady, despite the contractions in 2009 and 2020.[16]

Canada's economy is driven by the services-producing sector, comprising 71.5 percent of GDP in 2021.[17] Goods-producing industries, led by manufacturing, mining and oil and gas, and construction, comprise the remainder.[18] Many of Canada's goods are produced for export. In 2021, the value of total exports of goods and services was $646 billion.[19]

As a resource-rich economy, Canada is a net exporter of agriculture, energy (electricity and oil and gas) and many resource-based commodities such as pulp and paper, mined metals and aluminum. In 2021, Canada's exports of energy, extracted resources, and agricultural commodities were valued at $213 billion.[20] However, because of a significant increase in manufactured imports coupled with the impact of the economic downturn, Canada has been in an overall net import position between 2009 and 2021 on an annual basis.[21]

Canada's international trade is highly concentrated on its shared border with the U.S., with 73 percent of its exports and 61 percent of its imports devoted to its southern neighbour in 2021.[22] In recent years however, China has been an increasing source of imports (8 percent in 2021) and exports (4 percent in 2021).[23] In May 2017, Canada ratified a free trade agreement with the European Union (EU), its second largest trading partner. Between 2016 and 2020, the value of Canadian exports to the EU increased by 20 percent.[24] Other important trade partners include Japan, Mexico, South Korea and India.[25]

Table 2-1 below describes Canada's employed population by source of employment. The services-producing sector in Canada employed 79 percent of the working population in 2021.

Table 2-1: Canadian employment by industry

North American Industry Classification System (NAICS)	2017	2018	2019	2020	2021
	Persons (x 1 000)				
Total, all industries	18 281.10	18 568.00	1 9896.33	17 999.20	18 865.40
Goods-producing sector	3 879.50	3 949.80	3 974.90	3 770.80	3 884.60
Agriculture	286.6	284.7	292.3	279.4	251.8
Forestry and logging and support activities for forestry	49	53.1	49	52.3	50.7
Fishing, hunting and trapping	17.4	16.8	17.3	18.3	17
Mining, quarrying, and oil and gas extraction	258.8	270.6	266.5	236	256.9
Utilities	132.1	145.2	140.3	138	140.8
Construction	1 407.90	1 442.90	1 469.40	1 373.80	1 432.30
Manufacturing	1 727.80	1 736.30	1 740.20	1 672.90	1 735.10

North American Industry Classification System (NAICS)	2017	2018	2019	2020	2021
Services-producing sector	14 401.60	14 618.20	15 010.70	14 228.50	14 980.90
Wholesale and retail trade	2 794.10	2 785.10	2 824.70	2 684.00	2 819.60
Transportation and warehousing	936.1	989	1 037.10	950.2	989.9
Finance, insurance, real estate, rental and leasing	1 161.90	1 169.00	1 202.80	1 233.90	1 299.90
Professional, scientific and technical services	1 429.70	1 450.60	1 537.30	1 528.40	1 673.90
Business, building and other support services	748.2	764.9	768.1	702.8	707.7
Educational services	1 267.20	1 311.70	1 358.90	1 337.50	1 452.10
Health care and social assistance	2 366.10	2 396.00	2 496.20	2 438.30	2 558.60
Information, culture and recreation	773.9	769.7	762.4	681.5	721.8
Accommodation and food services	1 201.90	1 232.10	1 209.80	941.9	957.7
Other services (except public administration)	767.8	795.3	812.5	737.3	734.1
Public administration	954.7	954.9	1 000.70	992.5	1 065.50

Source: Statistics Canada. 2022. Table 14-10-0023-01: Labour force characteristics by industry, annual (x 1,000). Available at https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410002301.

Table 2-2 describes the GDP output related to each industry in Canada. The significant contributions to Canada's economy include real estate, manufacturing, mining and oil and gas extraction as well as construction and finance.

Table 2-2: Gross Domestic Product at Basic Prices, by Industry (Annually)

North American Industry Classification System (NAICS)	2017	2018	2019	2020	2021
	Canadian Dollars (x 1 000 000)				
All industries	1 895 902	1 950 424	1 989 633	1 887 451	1 982 308
Goods-producing industries	560 918	577 653	579 594	545 393	566 923
Agriculture, forestry, fishing and hunting	40 201	40 046	40 970	41 409	38 650
Mining, quarrying, and oil and gas extraction	148 951	155 552	154 153	141 172	150 704
Utilities	41 917	42 865	43 738	42 683	42 161
Construction	139 395	143 481	144 595	141 952	149 565
Manufacturing	192 637	198 531	198 494	179 447	187 791
Service-producing industries	1 333 437	1 371 229	1 407 629	1 339 366	1 412 026
Wholesale trade	97 529	100 724	104 295	101 356	106 911
Retail trade	97 142	99 751	101 788	98 860	105 431

North American Industry Classification System (NAICS)	2017	2018	2019	2020	2021
Transportation and warehousing	85 903	87 535	90 329	73 456	75 430
Information and cultural industries	61 607	64 275	68 438	67 198	69 748
Finance and insurance	130 081	133 331	136 837	142 804	149 787
Real estate and rental and leasing	240 876	246 930	253 627	257 621	266 451
Professional, scientific and technical services	110 087	115 223	120 345	116 905	124 808
Management of companies and enterprises	8 984	6 734	5 410	3 805	2 803
Administrative and support, waste management and remediation services	50 403	51 975	52 668	45 736	47 567
Educational services	99 762	103 291	105 054	99 751	105 875
Health care and social assistance	130 536	134 866	137 657	133 200	144 860
Arts, entertainment and recreation	15 056	15 354	16 127	9 371	9 666
Accommodation and food services	41 582	42 526	43 900	27 812	31 484
Other services (except public administration)	38 017	38 611	38 803	32 715	35 563
Public administration	126 567	130 651	133 164	131 243	137 795

Source: Statistics Canada. 2022. Table 36-10-0434-03: Gross domestic product (GDP) at basic prices, by industry, annual average (x 1,000,000). Available at https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610043403.

2.4. Geographic Profile

Canada is a country of physical extremes and contrasts, spanning 41 degrees of latitude and 88 degrees of longitude. Its surface area is 9,984,670 km², with land accounting for 9,093,507 km² and fresh water accounting for 891,163 km².[26] The country extends 5,300 kilometres east to west, the distance between Paris and New York, and 4,600 kilometres north to south. It is the second largest country in the world and encompasses six time zones. Canada also has the longest coastline of any country, spanning 243,042 kilometres along the Atlantic, Pacific and Arctic Oceans.[27]

Canada has more lake area than any other country in the world, with lakes that are among some of the largest. The Great Lakes, which straddle the southern Canada–U.S. boundary, contain 18 percent of the world's fresh lake water.[28] Large rivers also stretch across Canada, with many situated north of 60 degrees latitude. For example, the Mackenzie River is over 4,000 kilometres long and is the country's largest river. Wetlands cover about 14 percent of the land area of Canada and approximately 60 percent of Canada's fresh water drains to the north.[29]

Approximately 36 percent of Canada is covered by forest, and 25 percent by arctic tundra.[30] Additional land cover in Canada includes grassland, shrubland, mixed forest, cropland, deciduous forest, water, snow, ice, and urban and built-up land.[31] Wetlands and terrestrial and offshore Arctic

permafrost are of particular concern as they store huge amounts of organic carbon and can be both natural sinks and sources of greenhouse gases. Emissions of methane from permafrost and from the abundant number of wetlands, lakes, and rivers located in boreal and arctic regions are expected to substantially increase this century due to rapid climate warming and associated permafrost thaw, changing moisture regimes, wildland fire frequency and severity, successional changes and ecozone boundary shifts.

Canada is divided into fifteen terrestrial ecozones, which each represent a large and generalized area of land characterized by interactive and adjusting abiotic and biotic factors. These ecozones range from the Arctic Cordillera Ecozone where the environment is dry and cold and is covered by vast polar ice fields and alpine glaciers, to the Pacific Maritime Ecozone, with ecosystems ranging from humid coastal rainforest to cool boreal and alpine conditions at higher elevations. In contrast, the Boreal Shield Ecozone, the largest of Canada's ecozones, presents a continuous stretch of trees, water bodies, and bedrock and is characterized by long cold winters and short warm summers.

These geographical contrasts present different challenges when assessing climate resilience and mitigating climate change impacts. For instance, coastal erosion, reduction in ice cover, and thawing permafrost increase risks to critical infrastructure, health, and food security in Canada.

2.5. Climate Profile[32]

Canada has a wide range of climatic conditions: Canada's Pacific coast is relatively mild year-round, while the Prairie Provinces (in the central western portion of the country) have greater extremes (cold winters and warm summers). Those ranges are expected to intensify by 2030.

Average annual temperatures are expected to differ considerably from region to region throughout the country. Toronto, Ontario, located in the south of the country, is expected to have an annual average daily temperature of about 10°C which will contrast with the approximate -13°C annual average daily temperature for Resolute, Nunavut in Canada's Arctic. Halifax, Nova Scotia, on Canada's Atlantic coast, will average about 8°C, while Vancouver, British Columbia, on the Pacific coast, will average about 12°C.[33]

In most regions in Canada, summer and winter temperatures dictate both heating and cooling needs, which impact energy use. For example, Montréal, Québec, is expected to experience an approximate annual average of 440 cooling degree-days (number of degree days accumulated above 18°C in a selected time period) and approximately 3,873 heating degree-days (number of degree days accumulated below 18°C in the selected time period) by 2030.[34]

Canada is also expecting considerable regional variation in precipitation. On Canada's Pacific Coast, some locations will average approximately 3,262 millimetres (mm) a year, contrasted with the much drier Prairie Provinces where some locations will see as little as 370 mm a year. In the far north of Canada, precipitation totals are expected to be generally less than 300 mm a year; for example, by 2030, Resolute, Nunavut is anticipated to see an average of 226 mm of annual precipitation.[35]

In addition to variable temperature and precipitation, Canada also experiences extreme weather events including droughts, floods, high winds, tornadoes, snow and ice storms, and severe thunderstorms, which are expected to intensify as the climate continues to change.

Information on vulnerabilities, impacts and adaptation measures is presented in Chapter 6: Vulnerability Assessment, Climate Change Impacts and Adaptation Measures.

2.6. Energy

Canada has an abundant and diversified portfolio of energy resources. In terms of hydrocarbon resources, Canada is a major global producer and exporter. Canada is also a leader in clean electricity, with 82 percent of its power generation coming from non-GHG emitting sources in 2019, ranking first among the top energy-generating countries. In terms of renewable energy, Canada ranks seventh globally for renewable energy production.[36]

Energy: Canada's Position in the World

- 3rd in hydroelectricity production
- 4th in uranium production and 6th in exports
- 4th in crude oil production and 3rd in exports
- 5th in natural gas production and 6th in exports
- 8th in wind energy capacity

Sources: International Energy Agency, Natural Resources Canada, World Nuclear Association

In 2020, the Energy Sector accounted for 8.1 percent of Canada's GDP in current prices (nominal GDP), and directly employed about 293,000 people. Canada is also a major exporter of energy products. In 2020, 80 percent of Canada's production of crude oil was exported. Canada's energy exports mostly go to the U.S., with the exception of coal and uranium.[37]

Table 2-3: Canada–U.S. Energy Trade in 2020

Resource/product	Exports to the U.S.			Imports from the U.S.
	percent of Canadian production	percent of U.S. imports	percent of U.S. consumption	percent of Canadian consumption
Crude oil	79	60	21	25
Petroleum products	29	26	3	7
Natural gas	42	98	8	20
Coal	1	10	0.1	19
Uranium	56	28	25	–
Electricity	9	93	2	2

Source: Natural Resources Canada. 2021. *Energy Fact Book 2021-2022*. Natural Resources Canada. Available at https://www.nrcan.gc.ca/sites/nrcan/files/energy/energy_fact/2021-2022/PDF/2021_Energy-factbook_december23_EN_accessible.pdf.

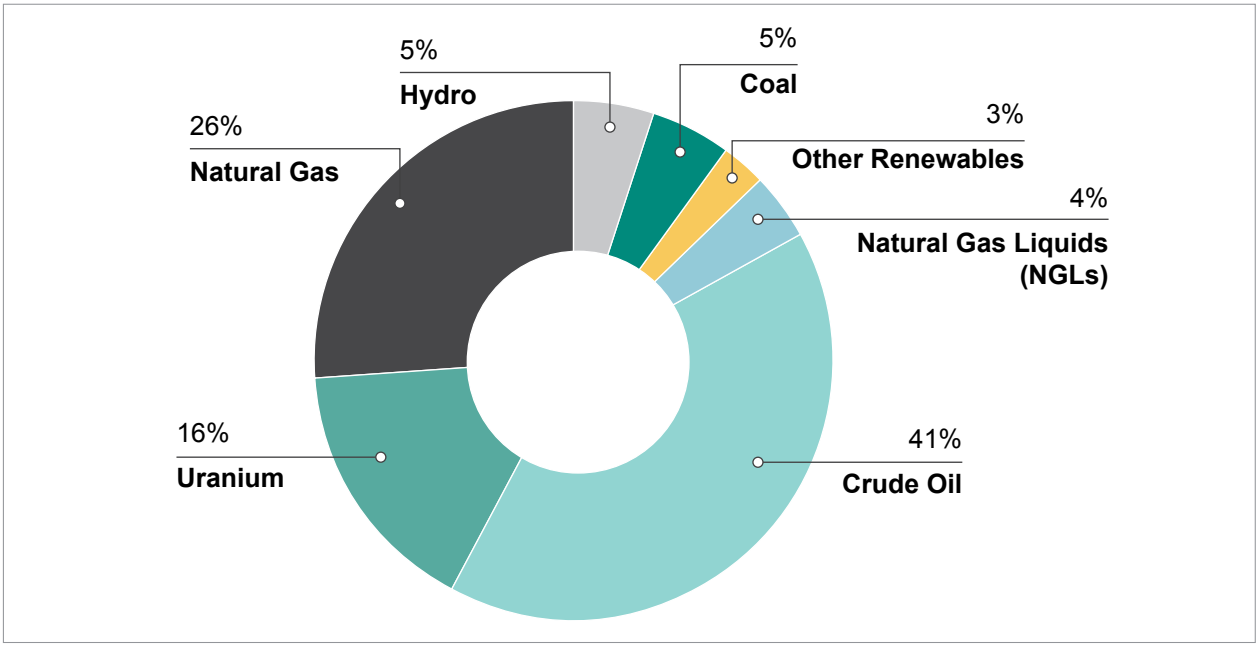
In 2020, annual capital expenditures by the Energy Sector totalled $60 billion. This amount is a decrease of 49 percent from a peak in 2014.[38] By 2020, capital investments in Canada's oil sands sector to date reached $332 billion, including $7.4 billion in 2020.[39]

Canada's provincial governments are the direct managers of most of Canada's natural resources and have responsibilities for energy resource management within their borders.

2.6.1. Energy Reserves, Production, and Trade

In 2019, 67 percent of Canada's primary energy production was in crude oil and natural gas, down from over 75 percent in 2014.[40] Western Canada is a producer of crude oil and natural gas, which it exports across Canada and to the U.S.[41] Eastern Canada imports crude oil and gas and has some refining facilities.[42]

Figure 2-2: Canada's Primary Energy Production by Source, 2019



Source: Natural Resources Canada. 2021. *Energy Fact Book 2021-2022*. Available at https://www.nrcan.gc.ca/sites/nrcan/files/energy/energy_fact/2021-2022/PDF/2021_Energy-factbook_december23_EN_accessible.pdf.

2.6.1.1. Crude Oil

Canada has 10 percent of the world's proved reserves of crude oil, or approximately 172 billion barrels, and 97 percent of Canada's proven reserves are located in the oil sands.[43] Crude oil production in Canada has grown steadily over the past two decades, up from 1.7 million barrels per day in 1990,[44] to 4.5 million barrels per day in 2020.[45] In 2020, 63 percent of Canada's oil production came from the oil sands.[46]

In 2020, 79 percent of total Canadian production was exported to the U.S.[47] Canadian crude oil represented about 60 percent of all U.S. crude oil imports and 23 percent of U.S. refinery crude oil intake in 2020, making Canada its leading foreign supplier of crude oil.[48]

2.6.1.2. Natural Gas

Canada is the fifth largest producer and sixth largest exporter of natural gas in the world. Canada is part of a fully-integrated North American market where natural gas moves from supply basins to demand centres via an extensive pipeline network. As of 2020, Canada has 71 trillion cubic feet of proven natural gas reserves.[49]

In 2020, Canadian natural gas production averaged 16.1 billion cubic feet per day (Bcf/d) of marketable natural gas. Unconventional gas production, including shale and tight gas, now accounts for over 84 percent of Canadian production. In 2020, 42 percent of Canadian production was exported to the U.S. and Canada imported 2.2 Bcf/d of natural gas from the U.S. Canada's current production of natural gas is below its mid-2000s peak of 16.6 Bcf/d, reflecting very low natural gas prices and a reduced U.S. dependence on Canadian natural gas exports.[50]

2.6.1.3. Coal

Canada ranks 16th in the world in proven coal reserves with about 10.7 billion tonnes, and Canada's 2020 coal production was 46 Mt, down from 62 Mt in 2015.[51] 69 percent (32 Mt) of the 2020 production was exported. The majority of exports were destined for Asian markets, with China, Japan, and South Korea receiving 64 percent of total exports. Canada is both an importer and an exporter of coal; however, Canada's imports of coal have declined by more than 50 percent since peaking in 2003. In 2020, Canada imported about 6 Mt of coal, of which 69 percent came from the U.S.[52]

2.6.1.4. Electricity

In 2019, Canada produced 635 terawatt-hours of electricity, generated from a mix of sources. Currently, 82 percent of Canada's electricity is produced from non-GHG emitting sources, principally hydro (59 percent) and nuclear (15 percent). In 2020, Canada had the fourth largest installed capacity of hydropower in the world.[53] Since 2005, renewable power production from wind and solar has been increasing and now makes up over 5 percent of total production.[54] The share of electricity supply generated from coal decreased from almost 17 percent in 1990 to 7 percent in 2019.[55]

In 2020, Canada exported 67 terawatt-hours of electricity to the U.S., which represented about 2 percent of total U.S. consumption.[56] In 2020, Canada imported 2 percent of its electricity consumption from the U.S.[57]

2.6.2. Energy Consumption

Canada's economy is becoming increasingly less energy intensive. From 2000 to 2018, Canada's energy intensity per dollar of GDP declined 17 percent.[58]

Over the 2000 to 2018 period, energy use on a per capita basis decreased by 2 percent.[59] Canada's per capita consumption of oil products, natural gas, and electricity is higher than in most other industrialized countries, reflecting the energy use of industries such as mining, pulp and paper, and petroleum refining.[60] Other key factors include long distances between communities and a relatively cold climate.

The share of renewable energy of Canada's total primary energy supply was 16 percent in 2019.[61]

2.7. Transportation

Transportation is critical to the Canadian and global economy. As a trading nation, Canada relies on a Transportation Sector that is globally competitive. In 2021, the broader transportation industry contributed 3.6 percent to Canada's GDP.[62]

Despite improvements in emissions intensity, transportation remains the second largest source of GHG emissions in Canada. From 2005 to 2019, Canada saw a 15 percent growth in transportation emissions due to an increase in on-road freight transportation activity, an increase in the overall number of vehicles on the road, and a shift in personal vehicle ownership from cars to light trucks.[63] In 2020, transportation emissions had decreased to 2005 levels, due in part to the global COVID-19 pandemic.

2.7.1. Road Transportation

Road transportation is the largest source of passenger and freight transportation emissions, and is also the most important in terms of the value of goods traded between Canada and the U.S. Canada has more than 1.13 million km of two-lane equivalent roads, roughly 38,000 km of which make up the National Highway System.[64] Canada's road network is shared by different users, including approximately 22 million light passenger vehicles, 1.05 million medium and heavy trucks, 91,000 buses, and 720,000 motorcycles and mopeds.[65] In 2021, more than 25.4 million road motor vehicles were registered in Canada.[66] Between 1990 and 2020, the total number of vehicles in Canada increased by 81 percent.[67] The stock share of electric vehicles (EVs) has increased from 0.1 percent of motor vehicles in 2016 (approximately 29,000 EVs) to 1.2 percent in 2021 (approximately 301,000 EVs).[68]

On-road freight accounts for 32 percent of the Transportation Sector's share of GDP. In 2016, over 55 percent of Canadian exports to the U.S. were transported by trucks, representing $218 billion of goods, while 72 percent of imports from the U.S. ($200 billion) were similarly transported.[69] Between 1990 and 2020, GHG emissions from freight trucks increased by 240 percent.[70]

2.7.2. Aviation

With 37,073 civil aircrafts, Canada has the second largest civil aviation aircraft fleet in the world.[71] Its commercial sector ranges from international scheduled services to small, single aircraft charter companies and business aircraft operators. In 2021, airports in Canada handled 1.3 million tonnes of cargo from domestic and foreign carriers, a 5.1 percent increase from 2020. However, the yearly average remains 11.5 percent below 2019 levels. As of October 2021, monthly air cargo volumes have recovered to pre-pandemic levels.[72] Canadian air carriers have improved their fuel efficiency by 17.8 percent between 2008 and 2019.[73]

2.7.3. Rail

The North American rail industry is highly integrated. The primary freight firms in Canada serve as an important supply chain link for Canada's key trade corridors and gateways. The rail transportation industry generated approximately $10 billion in 2020, about 10 percent of the Transportation Sector's contribution to Canada's GDP, 95 percent of which comes from rail freight operations, with the remaining 5 percent coming from passenger rail services.[74]

2.7.4. Marine

Canada's marine industry is comprised of domestic marine service operators who provide both domestic and international shipping services, as well as international shipping lines calling at major Canadian ports. Canadian ports and harbors serve as vital links and gateways that facilitate domestic and international economic activities. Canada is home to more than 560 port facilities, about 845 fishing harbours, and 106 recreational harbours.[75]

Table 2-4: GHG Emissions by Transportation Mode, 1990 to 2020

Sector and Mode	GHG Emissions (Mt CO_2 eq)							
	1990	2005	2015	2016	2017	2018	2019	2020
Transportation	**145**	**190**	**201**	**200**	**208**	**215**	**216**	**190**
Aviation	7.5	7.7	7.6	7.5	7.9	8.7	8.6	4.8
Road Transportation	84	130	142	145	148	152	153	131
Railways	6.9	6.6	7.1	6.5	7.5	7.6	7.7	7.2
Marine	3.1	4.0	3.4	3.5	3.6	3.8	4.4	4.2
Other Transportation*	44	42	41	38	41	43	43	43

*Other Transportation refers to recreational, commercial and residential off-road transporation.

Source: United Nations Framework Convention on Climate Change. 2022. *National Inventory Report 1990-2020: GHG Sources and Sinks in Canada*, Part I, Table 2-3.

2.8. Industry Profile

Canada's Industrial Sector is very diverse with facilities engaged in mining, manufacturing, construction and forestry. Taken together, these sectors contributed over 18 percent of Canada's GDP in 2021,[76] with the total value of exports from the top 25 industries representing $631 billion in 2021.[77]

Table 2-5: Emissions by Industry, 2005 to 2020

Industry	1990	2005	2015	2016	2017	2018	2019	2020
	Mt CO_2 Equivalent							
Heavy Industry	97	87	78	76	76	77	77	72
Mining	6.7	6.7	7.7	7.1	7.8	9.2	8.8	9.2
Smelting and Refining (Non-Ferrous Metals)	17	14	10	11	11	9.8	11	10
Pulp and Paper	15	9	6.4	6.6	6.9	7.8	8.2	7.2
Iron and Steel	16	16	15	15	15	16	15	12
Cement	10	13	10	10	11	11	11	9.9
Lime and Gypsum	2.9	3.5	2.5	2.5	2.6	2.4	2.3	2.1
Chemicals and Fertilizers	29	24	26	24	22	21	22	21
Coal Production	4.0	2.3	2.3	2.4	2.2	2.5	2.5	2.3
Light Manufacturing, Construction, and Forest Resources	28	24	21	21	22	22	22	20

Source: *National Inventory Report 1990-2020: GHG Sources and Sinks in Canada*. United Nations Framework Convention on Climate Change. 2022.

2.9. Waste

In 2018, Canadians generated 25.7 million tonnes of municipal solid waste.[78] About 43 percent of the waste generated originated from residential sources and 57 percent from non-residential sources.[79] Of this total, 38 percent was diverted through material recovery facilities or centralized organics processing operations (i.e., recycling and composting), and 62 percent was sent for disposal in landfills or incineration facilities.[80] Paper fibres made up the largest portion of all diverted materials at 35 percent (3.5 million tonnes), followed by organic materials at 30 percent (2.8 million tonnes).[81]

During the period of 2002 to 2018, the quantity of solid waste diverted through recycling and composting increased by 27 percent.[82] The total amount of organic waste diverted to recycling or organics processing facilities doubled between 2002 and 2018.[83] Operating expenditures in the waste management industry increased by 29 percent since 2010, reaching $6.5 billion in 2018.[84]

At many large municipal solid waste landfill facilities, landfill gas is captured to be flared or utilized, or both. Nationally, landfill methane emissions declined between the early 1990s and 2011 due to installation of landfill methane recovery and combustion infrastructure at very large landfills.[85] This was largely motivated by regulatory and permitting requirements in some provinces, landfill gas utilization incentives and the sale of emission credits. However, emissions from municipal solid waste landfills have not declined since 2011, even though further reduction is technically viable. In 2019, although there were 112 landfill gas recovery systems spread across nearly every province, only about one third of the methane generated in Canadian landfills was recovered.[86] Currently, just over half of recovered landfill methane in Canada is utilized as a renewable energy source. The quantity of methane generated at an individual landfill and the economic viability of these projects are major limiting factors.[87]

2.10. Building Stock

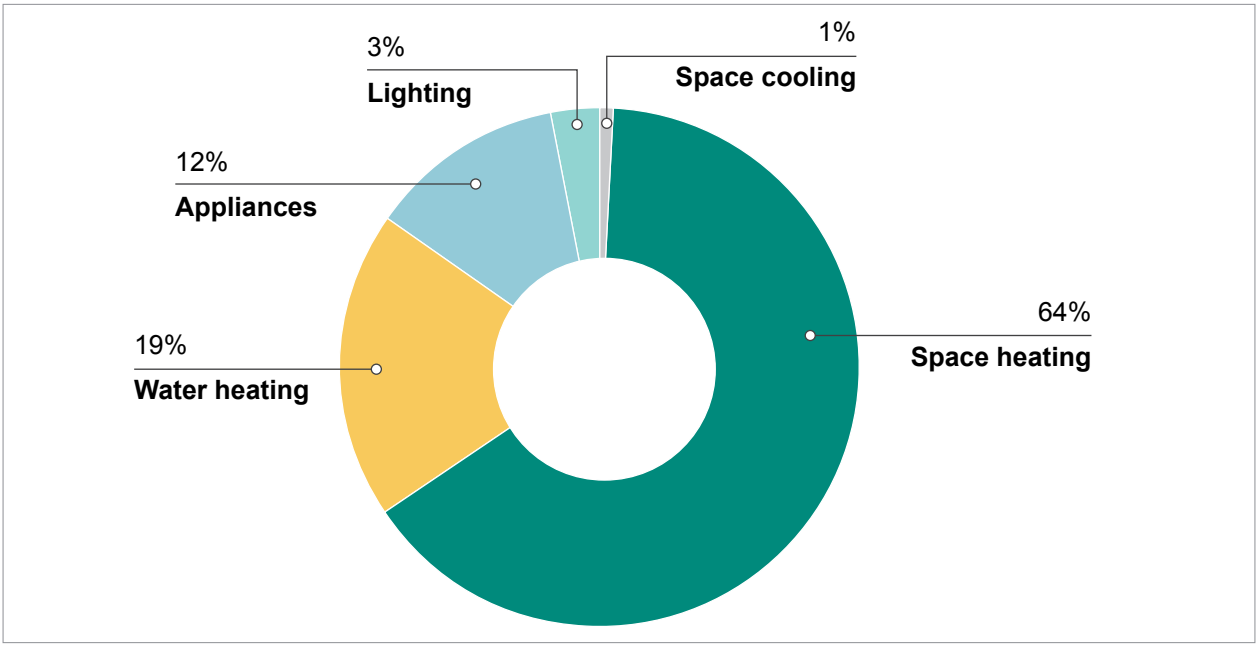
2.10.1. Residential

Between 1990 and 2017, the number of households in Canada increased by 46.5 percent (4.6 million) and the population grew by 32 percent (8.4 million).[88] In addition to the rise in the number of households, the average living space and the penetration rate of appliances have also increased. Despite these trends, residential energy use increased by just 5.8 percent over the same period as homeowners switched to cleaner energy sources (such as natural gas) and energy efficient technologies. The main sources of residential energy use include natural gas, electricity, wood, heating oil, and propane. As per Figure 2-3, due to Canada's relatively cold climate, space heating and water heating are the main residential energy uses.[89]

The amount of energy used by the Residential Sector to heat each square metre of living space decreased by 41 percent between 1990 and 2019, mainly driven by energy efficiency gains. More Canadians shifted from oil to less emissions-intensive natural gas as a source of home heating fuel, with the proportion of space heating derived from natural gas increasing from 37.1 percent in 1990 to 47.6 percent in 2019. Over the same period, the use of oil for space heating decreased by 72 percent.[90]

The number of major appliances operated in Canada between 1990 and 2019 increased by about 55 percent. However, the total amount of energy that households used to power major appliances decreased by 39.4 percent due to significant energy efficiency improvements.[91] Some of these improvements can be attributed to federal, provincial, and territorial government efforts to work with industry and public stakeholders to implement energy guide rating systems (i.e., EnerGuide) and voluntary standards such as ENERGY STAR that help increase consumer awareness of major appliances' energy use and associated operating costs.

Figure 2-3: Distribution of Residential Energy Use by End Use, 2019



Source: Natural Resources Canada. 2021. Energy Use Data Handbook Tables, Ottawa (ON).

2.10.2. Commercial/Institutional

In 2019, the Commercial/Institutional Buildings Sector was responsible for 12 percent of the total energy use in Canada.[92] In the commercial/institutional sector, energy is used for space heating, cooling, lighting and water heating, as well as for operating auxiliary equipment (such as computers and servers) and motors. Space heating accounts for the largest share of energy use, around 54 percent, followed by auxiliary equipment at 14 percent.[93] Energy usage by auxiliary equipment has risen steadily due to increasing use of new electronic technologies.

Energy efficiency efforts have reduced overall Buildings Sector energy intensity in terms of energy consumed per unit of floor space by 2.2 percent between 1990 and 2017.[94] Over the same period, the total floor space has increased by 59.1 percent while total energy consumption rose by 55.7 percent.[95] Energy consumption growth can be explained by economic growth, an increase in computerization of the work environment and an increase in the number of devices per employee.

2.11. Agriculture

In 2021, Canada's primary Agriculture Sector accounted for 2 percent of GDP while being at the heart of a broader agriculture and agri-food system which represents 6.8 percent of total GDP, employs approximately 2.1 million Canadians (one in nine jobs), and places Canada as the fifth largest exporter of agri-food and seafood internationally.[96] Canada's agriculture and food exports reached $82 billion in 2021.[97]

Although Canada is the second largest country in the world, and one of the most sparsely populated, in 2021, total farm area was only 62.2 million hectares, or 6.3 percent of Canada's land area.[98] Land for crop production has been increasing over time, rising to 37.8 million hectares in 2021.[99]

The Agriculture Sector contributed 7 percent of Canada's total GHG emissions annually since 1990, except in 2020 where the contribution rose to 8 percent. Emissions within the sector increased by 34 percent between 1990 and 2020.[100] Of this total, livestock emissions in 2020 from enteric fermentation accounted for 24 Mt CO_2 eq while crop production accounted for 21 Mt CO_2 eq from the application of synthetic nitrogen fertilizer and crop residue decomposition.[101]

In recent decades, Canadian farmers have increasingly substituted conventional tillage with no-till and conservation tillage seeding techniques. No-till practices are currently used on 60 percent of total land prepared for seeding while conservation tillage is used on 24 percent.[102]

2.12. Forest

Canada has 411 million hectares of forest, other wooded land, and other land with tree cover.[103] Forest land accounts for 362 million hectares.[104] This estimate is larger than previous years due to improvements and updates to data sources and forest techniques that increased the estimate of the area of the northern "unmanaged forest". 62 percent of this area is considered "managed forest" (forests under direct human influence) for the purposes of the GHG inventory.[105] In 2020, the Forest Sector provided income for local workers in 2,400 communities, contributed $25.2 billion to nominal GDP, supported approximately 300 forest-reliant communities and directly employed more than 184,000 Canadians.[106]

Most of Canada's forest land is publicly owned; 88.4 percent is under provincial or territorial jurisdiction, 4 percent is under federal or Indigenous jurisdiction, and the remaining 6.7 percent is privately owned.[107] By law, all publicly-owned forests harvested in Canada must be regenerated; this includes both provincial and federal Crown land. Canada's strict monitoring and enforcement ensures that legal and sustainable forest management practices are followed across the country, including in the boreal forest. As of December 2021, Canada had 158 million hectares of forests certified as being sustainably managed under one or more of three globally recognized certification systems.[108]

A small portion of Canada's forests are disturbed by harvesting and other human activities each year. Harvest volumes, including fuelwood and firewood, peaked at a record level of 211 million cubic metres in 2004 and were estimated to be 143.1 million cubic metres in 2020.[109] Since 1990, less than half of 1 percent of Canada's forest lands have been deforested. Canada's annual rate of deforestation in 2019 was less than 0.02 percent.[110] These changes are small compared to the area of natural disturbances caused by fire and insects.

Canada's vast forest ecosystems are exposed to significant natural disturbances such as fire, insects, disease and weather-related events that affect forest health and structure. Despite Canada's ongoing fire suppression efforts, the annual total area burned by wildfire in the forest has increased in recent years. In 2021, approximately 6,500 forest fires burned about 4.3 million hectares in total forest (managed and unmanaged forest), which is about 50 percent above the 10-year average for area burned.[111] Even with an integrated pest management approach, pest infestations (e.g., spruce budworm, forest tent caterpillar, mountain pine beetle, and jack pine budworm) have severely damaged over 17.8 million hectares across Canada in 2020.[112] Insect damage can increase the risk of wildfire, and drought can stress trees, making them more susceptible to attack by insects and disease.[113] It is expected that climate change (changes in temperature, precipitation and season length) will further exacerbate the impacts and increase frequency of natural disturbances.[114]

In previous GHG inventories, Canada's estimates of managed forest emissions and removals displayed large interannual variability due to the impacts of natural disturbances, and this masked the impact of forest management activities. Starting with its *2017 National Inventory Report* on GHGs, Canada implemented an improved approach for estimating and reporting anthropogenic emissions and removals in its managed forests in which emissions and removals in forest stands dominated by natural disturbances are temporarily excluded from reporting.

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108 Certification Canada. 2022. Canadian Statistics: 2021 Year-end Statistics. [Webpage]. [Cited 2022 August 14]. Available online at: http://www.certificationcanada.org/en/statistics/canadian-statistics/.

109 National Forestry Database. Harvest [Webpage]. 2020. [Revised 2022 May 18; cited 2022 August 22]. Available online at: http://nfdp.ccfm.org/en/data/harvest.php.

110 Natural Resources Canada. 2022. The State of Canada's Forests: Annual Report 2021. 43 p. Available online at: https://www.nrcan.gc.ca/sites/nrcan/files/forest/sof2021/6317_NRCan_SoF_AR_2021_EN_P7B_web_accessible.pdf.

111 National Forestry Database. 2022. Forest Fires [Webpage]. [Revised 2022 May 18; cited 2022 August 22]. Available online at: http://nfdp.ccfm.org/en/data/fires.php.

112 National Forestry Database. 2022. Forest Insects. [Webpage]. [Revised 2022 May 18; cited 2022 August 22]. Available online at: http://nfdp.ccfm.org/en/data/insects.php.

113 Natural Resources Canada. 2020. Forest Ecosystem Impacts. [Webpage]. [Revised 2020 July 7; cited 2022 August 22]. Available online at: http://www.nrcan.gc.ca/forests/fire-insects-disturbances/pest-management/13389.

114 Natural Resources Canada. 2022. Forests: Climate Change Impacts. [Webpage]. [Revised 2022 August 22; cited 2022 August 22]. Available online at: http://www.nrcan.gc.ca/forests/climate-change/impacts/13095.

Chapter 3: Canada's Greenhouse Gas Inventory

Canada ratified the United Nations Framework Convention on Climate Change (UNFCCC) in December 1992, and the Convention came into force in March 1994. Articles 4 and 12 of the Convention commit all Parties to develop, periodically update, publish and make available to the Conference of the Parties (COP) their national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHGs) not controlled by the Montreal Protocol.[1]

Canada's National Inventory is prepared and submitted annually to the UNFCCC by April 15 of each year, in accordance with revised *Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories* (UNFCCC Reporting Guidelines), adopted through Decision 24/CP.19 at COP 19 in Warsaw in 2013. The annual inventory submission consists of the National Inventory Report (NIR) and the Common Reporting Format (CRF) tables.

The inventory GHG estimates include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3) in the following five sectors defined by the Intergovernmental Panel on Climate Change (IPCC): Energy, Industrial Processes and Product Use (IPPU), Agriculture, Waste, and Land Use, Land-Use Change and Forestry (LULUCF). The GHG emission and removal estimates contained in Canada's GHG inventory are developed using methodologies consistent with the 2006 IPCC inventory guidelines.

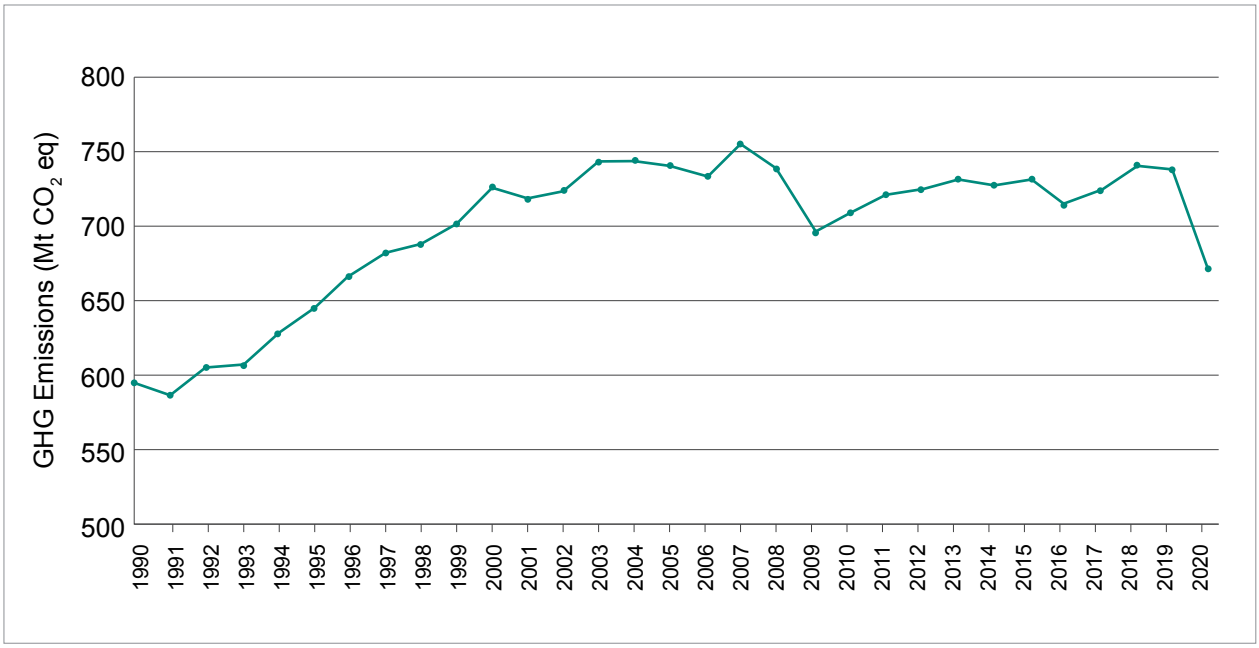
Continuous improvement is a key principle underlying Canada's annual greenhouse gas inventory. Important methodological improvements were implemented in the 2022 edition of the National Inventory Report (NIR) (e.g., fugitive methane emissions from upstream oil and gas and emissions from agricultural soils), and additional improvements are being considered for future editions (e.g., emissions and removals from managed forest land, and emissions from transport). The enhanced methods use Canadian-specific studies and knowledge, facilitate the adoption of new scientific data, and better capture the impact of improvements in technologies and industry practices on emissions.

This chapter summarizes information on Canada's net anthropogenic emissions as reported in the *National Inventory Report 1990–2020: Greenhouse Gas Sources and Sinks in Canada* (Canada's 2022 NIR) and provides a description of the factors underlying the emissions trends. The Executive Summary of Canada's 2022 NIR and the full 2022 submission to the UNFCCC are available online.

3.1. Overview, National GHG Emissions

In 2020, the most recent year for which data are available for this report, Canada's GHG emissions were 672 megatonnes of carbon dioxide equivalent (Mt CO_2 eq),[2] a net decrease of 69 Mt in total emissions or 9.3 percent from 2005 emissions (Figure 3-1).[3] In terms of overall trend since 1990, annual emissions steadily increased for ten years, fluctuated between 2000 and 2008, dropped in 2009, gradually increased until 2019, and dropped again between 2019 and 2020.

Figure 3-1: Canadian GHG Emissions Trend (1990 to 2020) (excluding LULUCF)



In 2020, the Energy Sector (consisting of Stationary Combustion Sources, Transport, and Fugitive Sources) emitted 540 Mt of GHGs or 80 percent of Canada's total GHG emissions (Figure 3-2). The remaining emissions were largely generated by the Agriculture (8.2 percent) and IPPU (7.5 percent) sectors, with contributions from the Waste Sector (4.1 percent). The LULUCF Sector removed 6.8 Mt of GHG from the atmosphere in 2020.

Canada's emissions profile is similar to that of most industrialized countries in that carbon dioxide (CO_2) is the largest contributor to Canada's GHG emissions, accounting for 535 Mt or 80 percent of total emissions in 2020 (Figure 3-3). As a result, trends in CO_2 emissions follow the same pattern as total GHG emissions. The majority of the CO_2 emissions in Canada result from the combustion of fossil fuels. Methane (CH_4) emissions in 2020 amounted to 92 Mt or 14 percent of Canada's total emissions. These emissions are largely from fugitive sources in oil and natural gas systems (35 percent of total CH_4 emissions), agriculture (30 percent of total CH_4 emissions), and solid waste disposal (municipal landfills) and industrial wood waste landfills (27 percent of total CH_4 emissions). Nationally, CH_4 emissions in 2020 were roughly equivalent to 1990. Although emissions in 1990 and 2020 are the lowest two years in the time series, emissions increased steadily from 1990 mostly due to fugitive sources in oil and gas, agriculture and landfills, peaked in 2006 at 126 Mt, and slowly decreased to 109 Mt from 2006 to 2019. The last decrease is due to improved gas conservation and leaks detection and repair (LDAR) programs in the oil and gas industry, a 9 percent decrease in natural gas production, a 20 percent decline in beef cattle population that led to a reduction in

enteric fermentation emissions between 2006 and 2011, and a decrease in landfill emissions. Nitrous oxide (N_2O) emissions mostly arise from agricultural soil management and accounted for 33 Mt or 4.9 percent of Canada's emissions in 2020. The primary source of N_2O emissions is the application of nitrogen fertilizers to agricultural soils. Emissions of synthetic gases (HFCs, PFCs, SF_6 and NF_3) accounted for 13 Mt in 2020, slightly less than 2 percent of national emissions.

Figure 3-2: Breakdown of Canada's Emissions by IPCC Sector (2020)

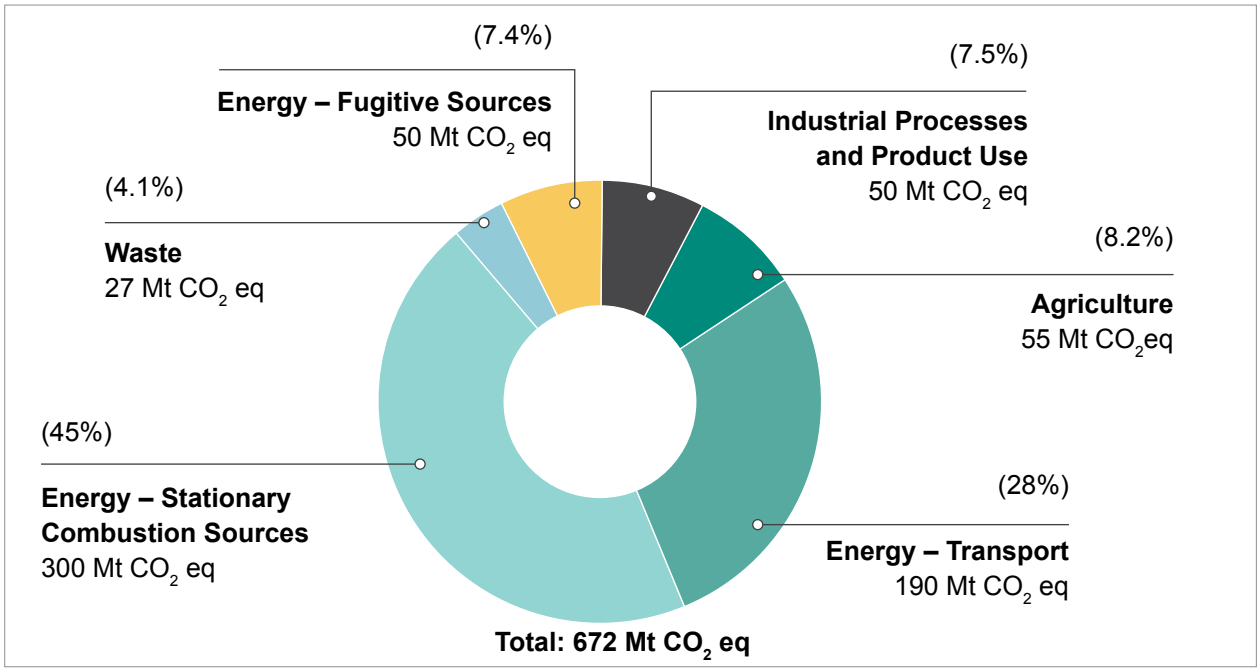
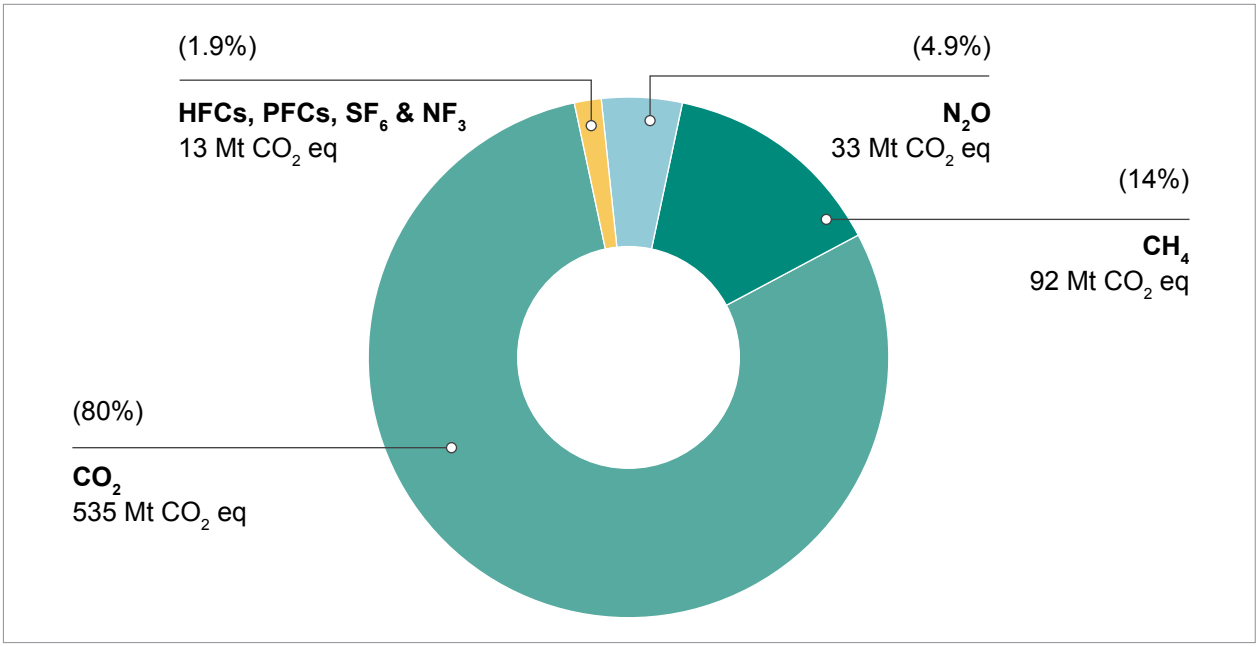


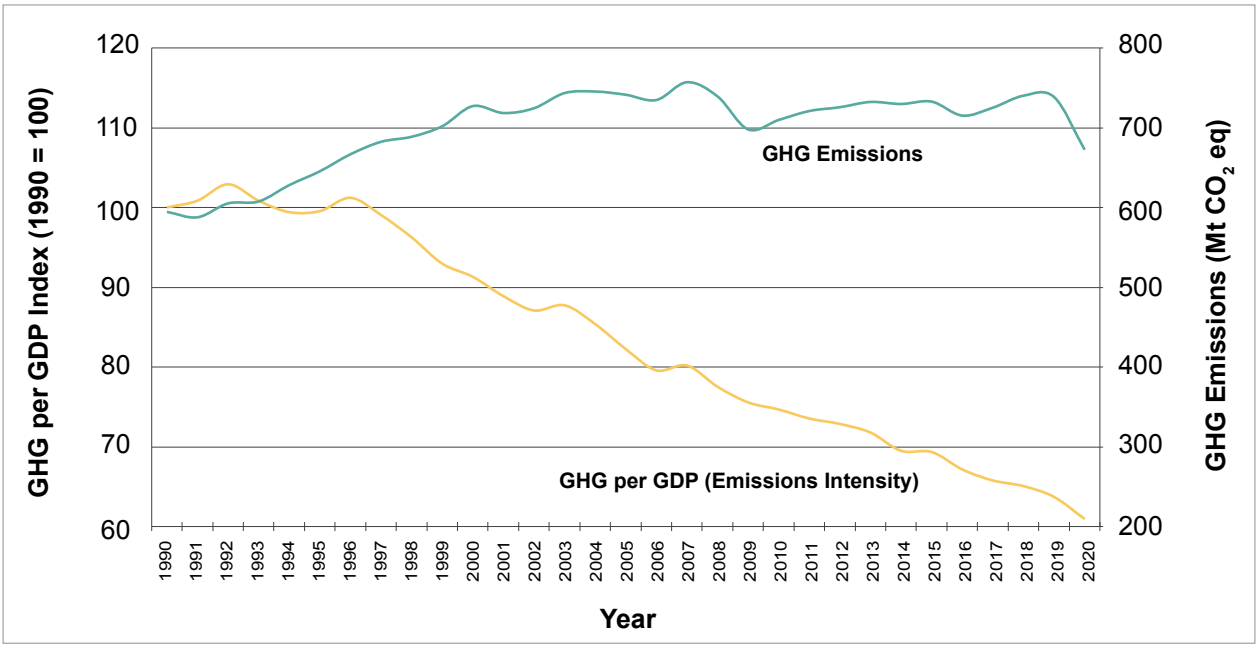
Figure 3-3: Breakdown of Canada's Emissions by GHG (2020)



Note: Totals may not add up due to rounding.

Over the long term, Canada's economy grew more rapidly than its GHG emissions. As a result, the emission intensity for the entire economy (or GHGs per Gross Domestic Product [GDP]) has declined by 39 percent since 1990 and 26 percent since 2005 (Figure 3-4 and Table 3-1). The decline in emissions intensity can be attributed to fuel switching, increases in efficiency, the modernization of industrial processes, and structural changes in the economy.

Figure 3-4: Canadian GHG Emissions and Indexed Trend Emissions Intensity (excluding LULUCF) (1990 to 2020)



Notes: Emissions do not yet reflect the impact of the most recent mitigation policies. Total emissions fall within a 2 percent uncertainty range.

GDP data source: StatCan (n.d.[a])[4]

Table 3-1: Trends in GHG Emissions and Economic Indicators, Selected Years

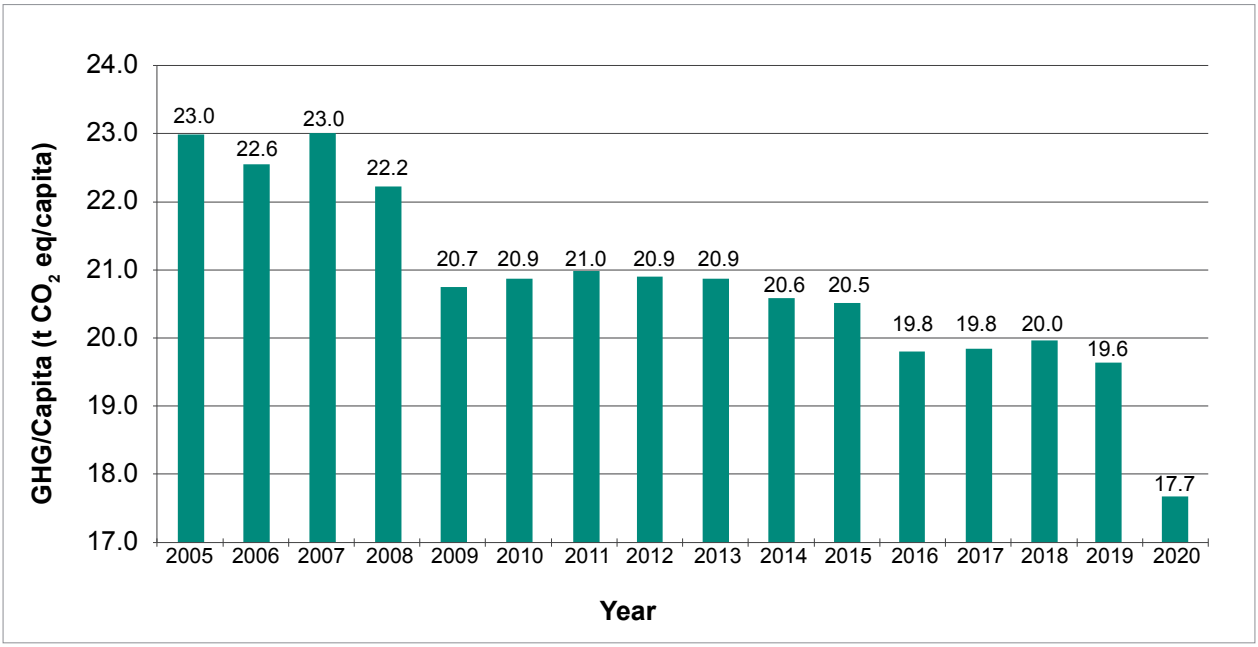
Year	2005	2015	2016	2017	2018	2019	2020
Total GHG (Mt)	**741**	**733**	**715**	**725**	**740**	**738**	**672**
Change since 2005 (%)	NA	-1.2%	-3.5%	-2.2%	-0.2%	-0.4%	-9.3%
GDP[a] (Billion 2012$)	**1 654**	**1 938**	**1 953**	**2 022**	**2 086**	**2 126**	**2 024**
Change since 2005 (%)	NA	17%	18%	22%	26%	29%	22%
GHG Intensity (Mt/$B GDP)	**0.45**	**0.38**	**0.37**	**0.36**	**0.35**	**0.35**	**0.33**
Change since 2005 (%)	NA	-16%	-18%	-20%	-21%	-23%	-26%

Notes: NA = Not applicable

Data Source = StatCan (n.d.[a])[5]

Canada accounted for approximately 1.6 percent of global GHG emissions in 2018,[6] although it is one of the highest per capita emitters. Since 2005, Canada's per capita emissions have declined from 23.0 t CO_2 eq per capita to a new low of 17.7 t CO_2 eq per capita in 2020 (Figure 3-5).

Figure 3-5: Canadian per Capita GHG Emissions (2005 to 2020)

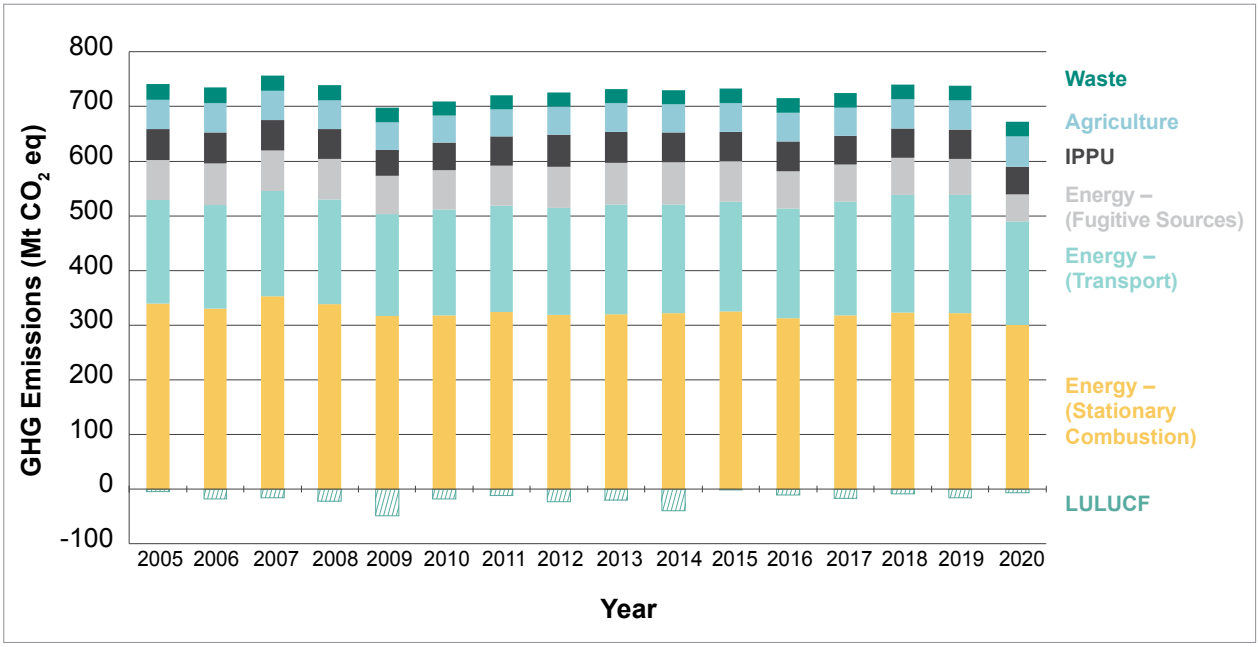


Note: Population data source: StatCan (n.d.[b])[7]

3.2. GHG Emissions and Trends by IPCC Sector

Over the period 2005 to 2020, total emissions decreased by 69 Mt or 9.3 percent (Figure 3-6). Two sources of the Energy Sector dominated this trend, with emission decreases of 23 Mt (32 percent) in Fugitive Sources and 39 Mt (12 percent) in Stationary Combustion Sources (Table 3-2). Over the same period, emissions have decreased by 6.3 Mt (11 percent) in the IPPU Sector and 1.4 Mt (4.8 percent) in the Waste Sector. Moreover, emissions from Transport (also in the Energy Sector) have generally increased from 2005 to 2019, but it decreased between 2019 and 2020, bringing the 2020 emissions to a level similar to 2005 (0.07 Mt or 0.0 percent increase). The Agriculture Sector emissions have remained relatively stable with 0.98 Mt or 1.8 percent increase (Figure 3-7).

Figure 3-6: Trends in Canadian GHG Emissions by Intergovernmental Panel on Climate Change Sector (2005 to 2020)



Chapter 2 of Canada's 2022 NIR provides more information on trends in GHG emissions from both 1990 and 2005 and their drivers.[8] Further breakdowns of emissions and a complete time series can be found at open.canada.ca.

Table 3-2: Canada's GHG Emissions by IPCC Sector, Selected Years

GHG Categories		2005	2015	2016	2017	2018	2019	2020
		Mt CO_2 equivalent						
TOTAL[a,b]		**741**	**733**	**715**	**725**	**740**	**738**	**672**
ENERGY		**602**	**600**	**581**	**594**	**606**	**604**	**540**
a.	Stationary Combustion Sources	339	325	313	318	323	322	300
	Public Electricity and Heat Production	125	88	81	79	71	70	62
	Petroleum Refining Industries	20	16	16	15	15	16	14
	Oil and Gas Extraction	63	98	94	98	104	104	100
	Mining	4.4	4.6	4.4	5.0	6.5	6.4	6.0
	Manufacturing Industries	48	44	42	43	43	43	39
	Construction	1.4	1.3	1.3	1.3	1.4	1.4	1.4
	Commercial and Institutional	32	30	32	34	36	38	36
	Residential	43	41	38	40	44	41	38
	Agriculture and Forestry	2.2	3.0	3.2	3.1	3.2	3.5	3.1
b.	Transport	190	201	200	208	215	216	190
	Aviation	7.7	7.6	7.5	7.9	8.7	8.6	4.8
	Road Transportation	130	142	145	148	152	153	131
	Railways	6.6	7.1	6.5	7.5	7.6	7.7	7.2
	Marine	4.0	3.4	3.5	3.6	3.8	4.4	4.2
	Other Transportation	42	41	38	41	43	43	43

c.	Fugitive Sources	73	74	68	68	68	66	50
	Coal Mining	1.4	1.1	1.3	1.2	1.3	1.4	1.1
	Oil and Natural Gas	71	73	67	67	67	65	49
d.	CO_2 Transport and Storage	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
INDUSTRIAL PROCESSES AND PRODUCT USE		**57**	**54**	**55**	**53**	**54**	**53**	**50**
a.	Mineral Products	10	8.0	7.9	8.6	8.6	8.8	8.1
b.	Chemical Industry	10	6.8	7.0	6.4	6.8	6.7	6.6
c.	Metal Production	20	14	15	15	15	14	13
d.	Production and Consumption of Halocarbons, SF6 and NF3	5.1	11	11	11	12	12	12
e.	Non-Energy Products from Fuels and Solvent Use	10	13	12	11	11	11	10
f.	Other Product Manufacture and Use	0.54	0.54	0.60	0.63	0.70	0.66	0.73
AGRICULTURE		**54**	**52**	**53**	**52**	**53**	**53**	**55**
a.	Enteric Fermentation	31	24	24	24	24	24	24
b.	Manure Management	8.7	7.7	7.8	7.9	7.8	7.8	7.8
c.	Agricultural Soils	13	18	18	17	19	19	21
d.	Field Burning of Agricultural Residues	<0.05	0.06	0.05	0.05	0.05	0.05	0.05
e.	Liming, Urea Application and Other Carbon-Containing Fertilizers	1.4	2.6	2.5	2.4	2.6	2.7	3.0
WASTE		**29**	**26**	**26**	**27**	**27**	**27**	**27**
a.	Solid Waste Disposal (Landfills)	23	21	21	21	22	22	22
b.	Biological Treatment of Solid Waste	0.24	0.31	0.32	0.33	0.36	0.36	0.36
c.	Wastewater Treatment and Discharge	1.9	2.6	2.4	2.5	2.5	2.5	2.5
d.	Incineration and Open Burning of Waste	0.35	0.20	0.20	0.19	0.18	0.18	0.16
e.	Industrial Wood Waste Landfills	3.3	2.5	2.4	2.4	2.3	2.2	2.2
LAND USE, LAND-USE CHANGE AND FORESTRY		**- 4.2**	**- 0.08**	**- 11**	**- 17**	**- 8.5**	**- 16**	**- 6.8**
a.	Forest Land	-135	-135	-136	-137	-134	-138	-130
b.	Cropland	-22	-10	-17	-23	-19	-14	-9.6
c.	Grassland	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
d.	Wetlands	3.1	3.0	3.1	3.1	2.8	2.9	2.9
e.	Settlements	1.7	2.5	2.5	2.4	2.2	2.2	2.2
f.	Harvested Wood Products	148	140	137	137	140	131	128

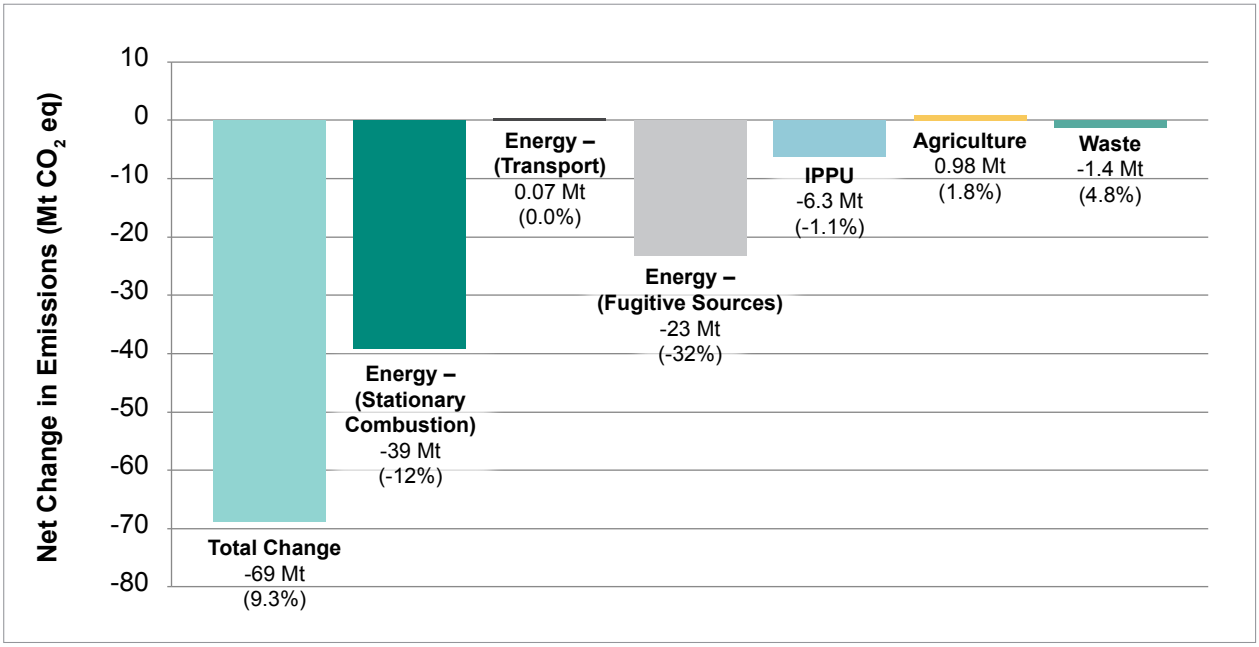
Notes:

Totals may not add up due to rounding.

a. National totals calculated in this table do not include removals reported in LULUCF.

b. This summary data is presented in more detail at open.canada.ca.

Figure 3-7: Changes in GHG Emissions by IPCC Sector (2005 to 2020)



The following describes the emissions and trends of each IPCC sector in further detail.

3.2.1. Energy—2020 GHG Emissions (540 Mt)

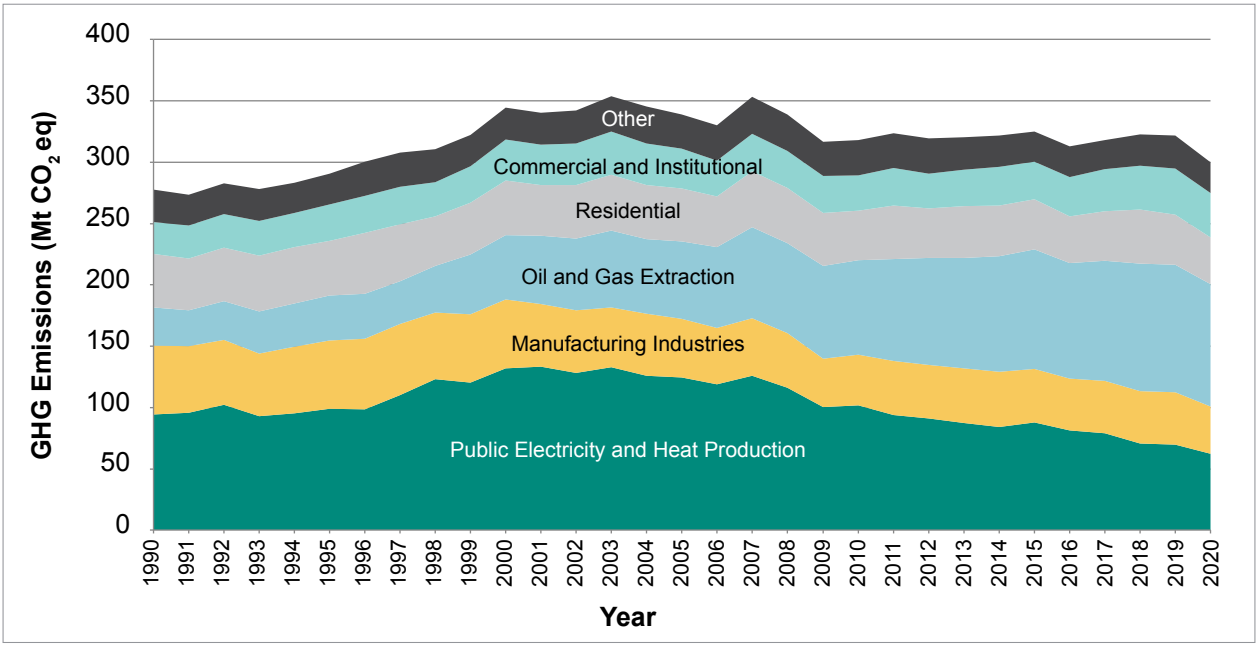
In 2020, the Energy Sector contributed 80 percent of Canada's total GHG emissions. In line with the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*,[9] sources in the Energy Sector are grouped under Stationary Combustion Sources, Transport, Fugitive Sources, and CO_2 Transport and Storage.

3.2.1.1. Stationary Combustion Sources

Stationary Combustion Sources accounts for 56 percent of emissions from the Energy Sector. In 2020, emissions totalled 300 Mt, an increase of 8 percent from the 1990 level of 278 Mt and a decrease of 12 percent from 2005 emissions of 339 Mt (Figure 3-8).

Dominant categories in Stationary Combustion Sources are Oil and Gas Extraction, which contributed 33 percent of the total Stationary Combustion emissions, and Public Electricity and Heat Production, which contributed 21 percent in 2020. Manufacturing Industries, Residential Buildings, and Commercial and Institutional Building contributed 13 percent, 13 percent and 12 percent, respectively, of the total Stationary Combustion emissions in 2020.

Figure 3-8: Trends in Canadian GHG Emissions from Stationary Combustion Sources (1990 to 2020)



Note: "Other" includes Petroleum Refining, Construction, Mining, Agriculture and Forestry

In 2020, GHG emissions from the IPCC Energy Sector (540 Mt) were 10 percent lower than in 2005 (602 Mt). Within the Energy Sector, there were increased combustion emissions from Oil and Gas Extraction (37 Mt) and Road Transportation (1.5 Mt), which were largely offset by decreased emissions from Public Electricity and Heat Production (63 Mt), stationary fuel consumption in Manufacturing Industries (9.1 Mt), Petroleum Refining (5.6 Mt), and the Residential Sector (5.3 Mt).

Decreasing energy generation from coal and oil (decreases of 62 percent and 86 percent, respectively), was a large driver of the 63 Mt decrease in emissions associated with Public Electricity and Heat Production between 2005 and 2020. The permanent closure of all coal-generating stations in the province of Ontario by 2014 accounted for 41 percent of the decreased coal consumption,[10] and reduced coal consumption in Alberta and Saskatchewan accounted for an additional 45 percent and 9 percent, respectively. Reduced coal consumption also occurred in Nova Scotia, New Brunswick and Manitoba. Decreased oil consumption for electricity in New Brunswick and Nova Scotia, offset by increased consumption in Newfoundland and Labrador, accounted for 98 percent of the reduced oil consumption. Emission fluctuations over the period reflect variations in the mix of electricity generation sources; over the time period, the amount of low-emitting generation in the mix has increased.[11]

The 37 Mt increase in emissions from stationary fuel consumption in Oil and Gas Extraction is consistent with a 190 percent rise in the extraction of bitumen and synthetic crude oil from Canada's oil sands operations since 2005. Since 2005, four petroleum refineries have permanently closed or converted to terminal facilities, contributing to the 5.6 Mt decrease in emissions from this sector.

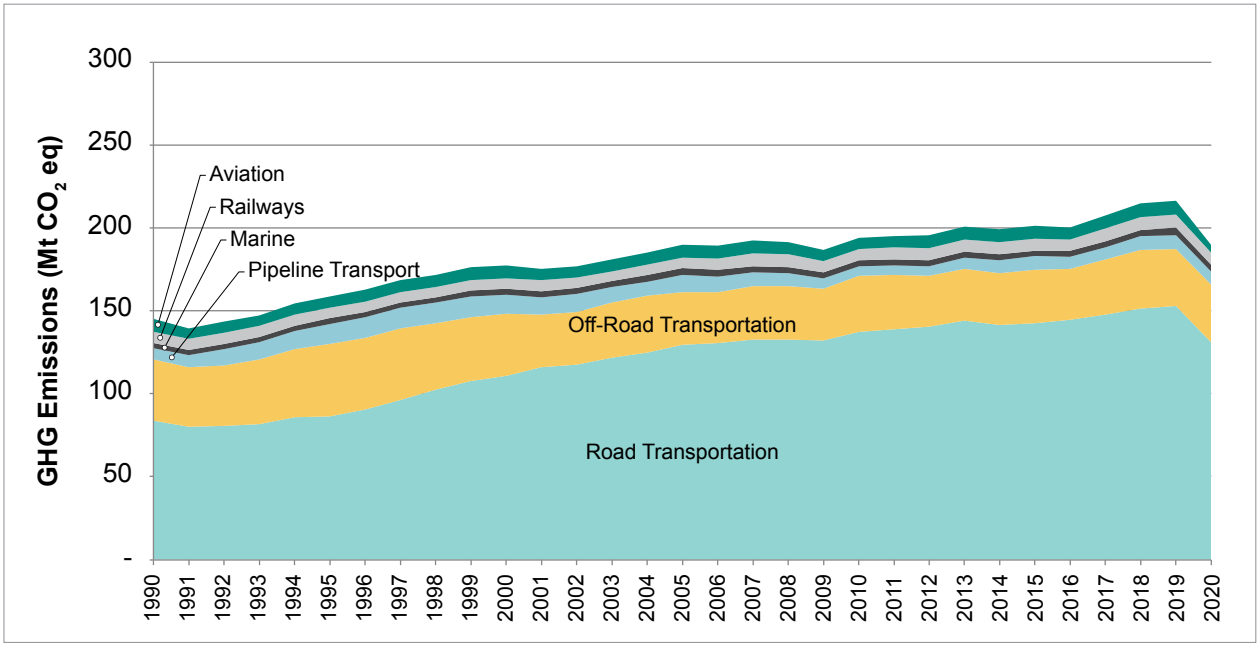
Combustion-based GHG emissions from Manufacturing Industries decreased by 9.1 Mt between 2005 and 2020, consistent with a 19 percent decrease in energy use.[12] This includes a decrease of -5.0 Mt between 2005 and 2019, and an additional -4.5 Mt between 2019 and 2020. While the decrease between 2005 and 2019 is based on decreases in certain sectors (Other Manufacturing, Cement, and Pulp, Paper and Print), offset by increases in others (1.4 Mt in Chemicals), the decrease between 2019 and 2020 occurred in all Manufacturing Industries. The largest decreases are from Iron and Steel (-1.4 Mt), Other Manufacturing (-1.0 Mt) and Cement (0.9 Mt).

In the Residential category, decreasing consumption of light fuel oil in all provinces and territories, except Newfoundland and Labrador (4 percent increase), between 2005 and 2020 is the largest driver of the 5.3 Mt decrease in emissions. Québec and Ontario account for 88 percent of the decrease in emissions from light fuel oil, with the remaining provinces and territories making up the remaining 12 percent.

3.2.1.2. Transport

Transport is a large and diverse subsector, accounting for 190 Mt of GHG emissions or 35 percent of Canada's Energy Sector emissions in 2020. Transport includes emissions from fuel combustion in five categories: Road Transportation, Aviation, Marine, Railways, and Other Transportation (Off-road and Pipeline). From 1990 to 2020, Transport emissions rose by 31 percent (45 Mt), accounting for a significant portion of Canada's emissions growth (Figure 3-9). From 2019 to 2020, Transport emissions decreased by 12 percent (27 Mt), bringing 2020 Transport emissions back to 2005 levels; it was the first notable year-to-year decrease to occur in the 1990 to 2020 time series for the sector since 2008 and 2009, which had a year-to-year decrease of 2.6 percent (5.0 Mt).

Figure 3-9: Trends in Canadian GHG Emissions from Transport (1990 to 2020)



In Canada, emissions from Transport result primarily from Road Transportation, which includes personal transportation (light-duty gasoline vehicles and trucks) and heavy-duty diesel vehicles. Other Transportation (Off-road and Pipelines) is the second largest category, accounting for 22 percent of Transport emissions, mainly through the combustion of diesel fuel used in off-road applications. The Aviation category was relatively stable over the reported time series until 2020, undergoing a 44 percent (3.8 Mt) decrease of emissions from 2019 levels. The Marine and Railways categories combined contributed to approximately 6 percent of the Transport emission in 2020 and, overall, were stable over the 1990 to 2020 time series.

The growth trend in Road Transportation emissions is largely due to more driving, exemplified by increases in the supply of diesel, in gasoline retail pump sales, and in the number of on-road vehicles. Despite a reduction in kilometres driven per vehicle, the total vehicle fleet has increased by 42 percent since 2005, most notably for trucks (both light- and heavy-duty), leading to more kilometres driven overall.

3.2.1.3. Fugitive Sources

Fugitive emissions are the intentional or unintentional releases of GHGs from the production, processing, transmission, storage and delivery of fossil fuels. Released hydrocarbon gases that are disposed of by combustion (e.g., flaring of natural gases at oil and gas production and processing facilities) and post-production emissions, including those from abandoned coal mines and abandoned oil and gas wells, are also considered fugitive emissions. Fugitive Sources are broken down into two main categories: Oil and Natural Gas (98 percent of the total fugitive emissions in 2020) and Coal Mining (2 percent).

Since 2005, fugitive GHG emission from fossil fuel production in Canada have decreased by 23 Mt. This includes a 6.5 Mt decrease between 2005 and 2019 that is largely the result of provincial regulations to increase conservation of natural gas (comprised mainly of methane), as well as a 16.6 Mt decrease between 2019 and 2020 that coincide with federal regulations to reduce methane emissions from the upstream oil and gas industry and equivalent provincial regulations in Saskatchewan, Alberta and British Columbia.

Top-Down Versus Bottom-up Methane Estimates for the Oil and Gas Sector

Accurately estimating fugitive emissions from oil and gas operations is a challenge. The industry in Canada includes tens of thousands of facilities, hundreds of thousands of wells and millions of components with the potential to emit. Traditional approaches, such as those used for this report, use engineering methods to estimate emissions for individual sources based on component-level emission factors and populations, process simulations, metered or calculated volumes of gas vented or flared, etc. to build inventory estimates from the “bottom-up”.

Recent studies in Canada that have used atmospheric measurements to produce “top-down” estimates suggest that “bottom-up” inventories under-estimate methane (CH4) emissions from the oil and gas industry.[13] Many of these studies highlight the significance of “super-emitters”, where a small number of facilities contribute a disproportionately high quantity of total emissions.

Historically, atmospheric measurements have only produced large-scale regional or facility-level estimates and have not been able to resolve the specific emission sources within a facility responsible for the emissions. Fully understanding the discrepancies between "bottom-up" and "top-down" approaches requires this level of detail. Recent advances in measurement technology are now able to identify specific sources in the atmospheric measurements.[14]

Environment and Climate Change Canada is actively working with researchers to understand the discrepancies between "bottom-up" inventory methods and atmospheric measurements with the goal of improving the accuracy of inventory estimates in future editions of this report.

3.2.2. Industrial Processes and Product Use—2020 GHG Emissions (50 Mt)

The IPPU Sector covers non-energy GHG emissions that result from manufacturing processes and use of products. Subsectors include: Mineral Products; Chemical Industry; Metal Production; Production and Consumption of Halocarbons, SF_6 and NF_3; Non-Energy Products from Fuels and Solvent Use; and Other Product Manufacture and Use. Emissions from the IPPU Sector contributed 50 Mt (7.5 percent) to Canada's 2020 emissions, compared with 57 Mt (7.6 percent) in 2005, a decrease of approximately 6.3 Mt or 11 percent.

Between 2005 and 2020, process emissions from most IPPU categories decreased. A notable exception is the 6.8 Mt (134 percent) increase in emissions from the use of HFCs to replace CFCs and HCFCs before the gradual phase down of HFCs mandated under the Kigali Amendment to the Montreal Protocol, which came into force in 2019 (Table 3-3).

Temporary shut downs of some industrial facilities in 2020 caused process emission decreases of 0.50 Mt (-7.0 percent) for Cement Production and of 0.15 Mt (-11 percent) for Lime Production, when compared to the 2019 emission values.

Since 2005, process emissions for the iron and steel industry have reduced by 3.3 Mt (-32 percent) primarily due to decline in use of metallurgical coke as reductant during pig iron production process and drop in pig iron production in 2020.The aluminium industry has also decreased its process emissions by 2.8 Mt (-32 percent) since 2005, largely due to implementation of technological improvements to mitigate PFC emissions and the shutdown of older smelters using Søderberg technology, the last of which was closed in 2015. Closure of primary magnesium plants in 2007 and 2008 also accounted for 1.1 Mt (92 percent) of the overall process emission drop (-7.2 Mt or -36 percent) seen in Metal Production between 2005 and 2020.

The overall decrease of 3.8 Mt (37 percent) of GHG emissions from chemical industries since 2005 is primarily a result of the closure in 2009 of the sole Canadian adipic acid plant located in Ontario. N_2O emissions abatement installations at a nitric acid production facility are responsible for a smaller proportion (1.0 Mt) of the decrease. Variations throughout the time series in petrochemical industry-related emissions can be attributed to facility closures and changes in production capacities at existing facilities, such as the closure of two methanol facilities in 2005 and 2006, and an increase in ethylene production in 2016.

Table 3-3: GHG Emissions from Industrial Processes and Product Uses Categories, Selected Years

GHG Source Category	GHG Emissions (Mt CO_2 eq)								Change (%)	
	1990	2005	2015	2016	2017	2018	2019	2020	1990–2020	2005–2020
Total – Industrial Processes	**57**	**57**	**54**	**55**	**53**	**54**	**53**	**50**	**-12%**	**-11%**
Mineral Products	**8.5**	**10**	**8.0**	**7.9**	**8.6**	**8.6**	**8.8**	**8.1**	**-4%**	**-21%**
Cement Production	5.8	7.6	6.2	6.1	6.8	6.9	7.1	6.6	14%	-13%
Lime Production	1.8	1.8	1.4	1.4	1.4	1.4	1.3	1.2	-34%	-32%
Mineral Product Use	0.9	0.9	0.4	0.4	0.3	0.3	0.3	0.3	-65%	-67%
Chemical Industry	**18**	**10**	**6.8**	**7.0**	**6.4**	**6.8**	**6.7**	**6.6**	**-62%**	**-37%**
Ammonia Production	2.8	2.7	2.9	2.9	2.6	2.4	2.5	2.5	-10%	-10%
Nitric Acid Production	1.0	1.2	0.2	0.3	0.2	0.3	0.3	0.2	-81%	-84%
Adipic Acid Production	10	2.5	-	-	-	-	-	-	-100%	-100%
Petrochemical Production & Carbon Black Production	3.5	4.0	3.6	3.9	3.5	4.1	3.9	3.9	12%	-1%
Metal Production	**24**	**20**	**14**	**15**	**15**	**15**	**14**	**13**	**-45%**	**-36%**
Iron and Steel Production	10	10	8.5	9.2	8.5	8.9	8.3	7.0	-33%	-32%
Aluminium Production	10	8.7	5.7	6.0	6.0	5.5	5.3	5.9	-43%	-32%
SF_6 Used in Magnesium Smelters and Casters	3.0	1.2	0.2	0.1	0.1	0.1	0.3	0.1	-97%	-92%
Production and Consumption of Halocarbons, SF_6 and NF_3	**1.0**	**5.1**	**11**	**11**	**11**	**12**	**12**	**12**	**1 130%**	**135%**
Non-Energy Products from Fuels and Solvent Use	**5.8**	**10**	**13**	**12**	**11**	**11**	**11**	**10**	**70%**	**-1%**
Other Product Manufacture and Use	**0.4**	**0.5**	**0.5**	**0.6**	**0.6**	**0.7**	**0.7**	**0.7**	**94%**	**33%**

Note: Totals may not add up due to rounding.

3.2.3. Agriculture—2020 GHG Emissions (55 Mt)

The Agriculture Sector covers non-energy GHG emissions related to the production of crops and livestock. In 2020, emissions from the Agriculture Sector accounted for 55 Mt, or 8.2 percent, of total GHG emissions in Canada, an increase of 1.0 Mt and 0.9 percent from 2005 levels, but corresponding to an increase of 14 Mt or 34 percent since 1990 (Table 3-4).

In 2020, the Agriculture Sector accounted for 30 percent of national CH_4 emissions and 75 percent of national N_2O emissions, up from 27 percent and 45 percent in 1990, respectively.

The main drivers of the emission trend in the Agriculture Sector are the fluctuations in livestock populations and continuous increases in the application of inorganic nitrogen fertilizers in the Prairie provinces. Since 2005, fertilizer use has increased by 89 percent, while livestock populations peaked in 2005 and then decreased sharply until 2011. In 2020, emissions from livestock digestion (enteric fermentation) accounted for 43 percent of total agricultural emissions, and the application of inorganic nitrogen fertilizers accounted for 21 percent of total agricultural emissions.

Table 3-4: GHG Emissions from Agriculture, Selected Years

GHG Source Category	GHG Emissions (Mt CO_2 eq)								Change (%)	
	1990	2005	2015	2016	2017	2018	2019	2020	1990–2020	2005–2020
Agriculture	**41**	**54**	**52**	**53**	**52**	**53**	**53**	**55**	**34%**	**2%**
Enteric Fermentation	22	31	24	24	24	24	24	24	6%	-23%
Manure Management	6.1	8.7	7.7	7.8	7.9	7.8	7.8	7.8	28%	-11%
Agricultural Soils	11	13	18	18	17	19	19	21	82%	56%
Field Burning of Agricultural Residues	0.22	0.04	0.06	0.05	0.05	0.05	0.05	0.05	-76%	25%
Liming, Urea Application and Other Carbon-Containing Fertilizers	1.2	1.4	2.6	2.5	2.4	2.6	2.7	3.0	155%	114%

Note: Totals may not add up due to rounding.

3.2.4. Waste—2020 GHG Emissions (27 Mt)

The Waste Sector includes GHG emissions from the treatment and disposal of liquid and solid wastes. Emissions from the Waste Sector contributed 27 Mt (4 percent) to Canada's total emissions in 2020, comparable to emission levels of 24 Mt in 1990 (4.1 percent of total emissions) and of 29 Mt (3.8 percent) in 2005 (Table 3-5).

In 2020, the primary source of emissions in the Waste Sector are disposal in landfills including municipal solid waste (MSW) landfills (22 Mt) and industrial wood waste landfills (2.2 Mt). In 2020, these landfills combined accounted for 89 percent of Waste emissions, while Biological Treatment of Solid Waste (composting), Wastewater Treatment and Discharge, and Incineration and Open Burning of Waste together accounted for the remaining 11 percent.

In 2020, CH_4 emissions from MSW landfills made up 81 percent of all waste emissions; these emissions decreased by 3.6 percent between 2005 and 2020. Of the 35 Mt CO_2 eq of CH_4 generated by MSW landfills in 2020, 22 Mt CO_2 eq (62 percent) were actually emitted to the atmosphere, with a large proportion (30 percent or 10 Mt CO_2 eq) being captured by landfill gas collection facilities and flared or used for energy, as compared to 25 percent in 2005.

Table 3-5: GHG Emissions from Waste, Selected Years

GHG Source Category	GHG Emissions (Mt CO_2 eq)								Change (%)	
	1990	2005	2015	2016	2017	2018	2019	2020	1990–2020	2005–2020
Waste Sector	**24**	**29**	**26**	**26**	**27**	**27**	**27**	**27**	**12%**	**-5%**
Biological Treatment of Solid Waste	0.07	0.24	0.31	0.32	0.33	0.36	0.36	0.36	389%	47%
Incineration and Open Burning of Waste	0.27	0.35	0.20	0.20	0.19	0.18	0.18	0.16	-40%	-52%
Industrial Wood Waste Landfills	2.9	3.3	2.5	2.4	2.4	2.3	2.2	2.2	-24%	-33%
Solid Waste Disposal	20	23	21	21	21	22	22	22	13%	-4%
Wastewater Treatment and Discharge	1.6	1.9	2.6	2.4	2.5	2.5	2.5	2.5	56%	32%

Note: Totals may not add up due to rounding.

3.2.5. Land Use, Land-Use Change and Forestry—2020 Net GHG Removals (6.8 Mt)

The Land Use, Land-Use Change and Forestry (LULUCF) Sector reports anthropogenic GHG fluxes between the atmosphere and Canada's managed lands, including those associated with land-use change. Emission of GHGs from sources and removals by sink are reported for five categories of managed lands—Forest Land, Cropland, Grassland, Wetlands and Settlements, and for the Harvested Wood Products (HWP) category, which is closely linked to Forest Land and Forest Conversion. The net LULUCF flux is calculated as the sum of CO_2 and non-CO_2 emissions to the atmosphere and CO_2 removals from the atmosphere.

In 2020, LULUCF was estimated to remove 6.8 Mt of CO_2 from the atmosphere, compared with net removals of 64 Mt in 1990 and 4.2 Mt in 2005 (Figure 3-10). When applied to the national totals, the estimated net GHG fluxes in the LULUCF Sector decrease the total Canadian GHG emissions by 11 percent in 1990, 0.6 percent in 2005 and 1.0 percent in 2020. National totals are reported to the United Nations Framework Convention on Climate Change (UNFCCC) with and without emissions and removals in the LULUCF Sector.

Net removals from the LULUCF Sector have varied over recent years, fluctuating between removals of 0.1 Mt in 2015 to 49 Mt and 39 Mt in 2009 and 2014, respectively. Fluctuations are driven by the variability in crop yields and by variations in emissions from HWP and removals from Forest Land, which are closely tied to harvest rates.

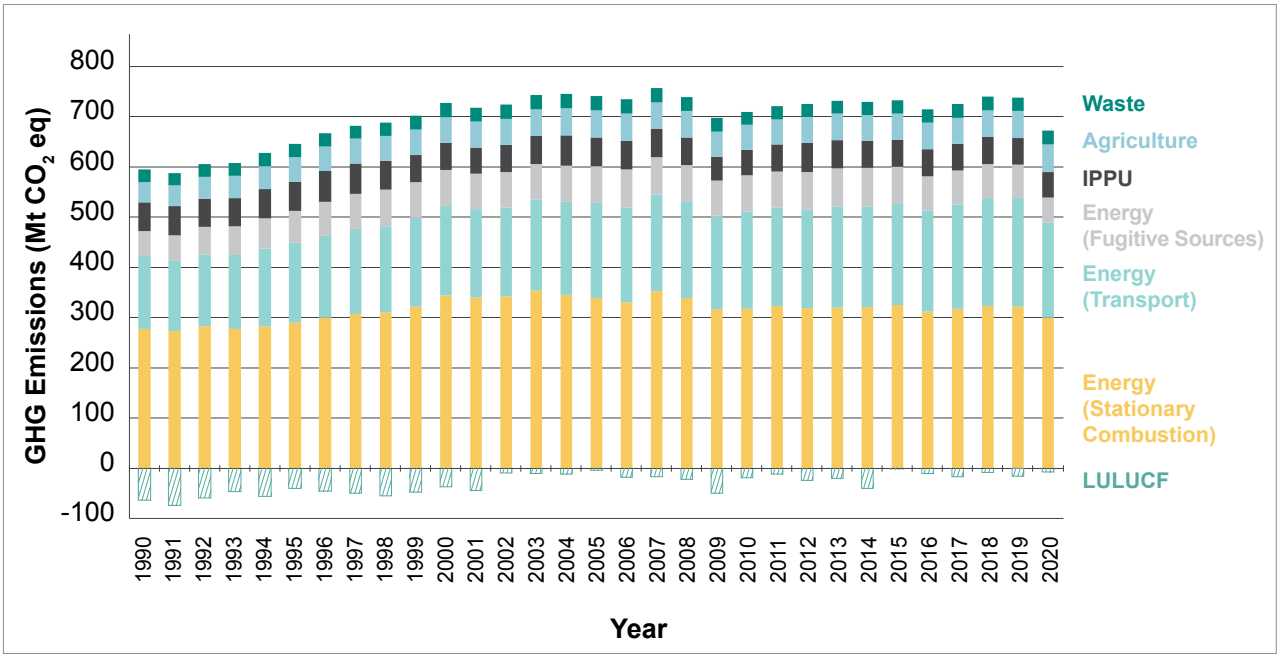
Estimates from the Forest Sector are split between emissions from HWP, emissions and removals resulting from significant natural disturbances on managed forests (wildfires and insects) and anthropogenic emissions and removals associated with forest management activities. The combined net flux from Forest Land and Harvested Wood Products—from forest harvest—fluctuated from a net source of 9.4 Mt in 2005 to a net sink of 22 Mt in 2009 (lowest harvest year),

and was observed to be a net sink of 6.5 Mt in 2020. Approximately 33 percent of HWP emissions result from long-lived wood products reaching the end of their economic life decades after the wood was harvested. Emission and removal patterns in both HWP and Forest Land have therefore been influenced by recent forest management trends and by the long-term impact of forest management practices in past decades.

Cropland has contributed to net removals in the land sector over the reporting period, with the exception of drought years on the prairies in early 2000s that result in a peak in net emissions in 2003 (7.6 Mt). Interannual variability is high throughout the time series, reflecting weather-related impacts to crop production. Net removals have increased, on average, as a result of improved soil management practices including conservation tillage and an overall gradual increase in crop productivity resulting from increased fertilization and reduced use of summerfallow. Since 2005, the decline in net removals that results from a decrease in perennial land cover has largely offset removals resulting from increasing yields and there is subsequently no clear trend. Recent trends are impacted by peak yields and subsequently peak removals in 2009 (-36 Mt) and 2014 (-44 Mt).

The conversion of forests[15] to other land uses is a prevalent practice in Canada and is mainly due to resource extraction and cropland expansion. Emissions resulting from forest conversion in the years 2005 to 2020 have fluctuated around 16 Mt.

Figure 3-10: Net Flux from LULUCF Relative to Total Canadian Emissions (1990 to 2020)



3.3. Emissions Trends by Canadian Economic Sectors

For the purposes of analyzing economic trends and policies, it is useful to allocate emissions to the economic sector from which they originate. In general, a comprehensive emission profile for a specific economic sector is developed by reallocating the relevant proportion of emissions from various IPCC subcategories. This reallocation simply re-categorizes emissions under different headings and does not change the overall magnitude of Canadian emissions estimates. The following section reports emissions according to the following Canadian economic sectors: Oil and Gas, Electricity, Transport, Heavy Industry, Buildings, Agriculture, and Waste and Others.

Examining the historical path of Canadian GHG emissions by economic sectors results in a better understanding of the connection between economic activities and emissions for the purposes of analyzing trends and for policy and public analysis. This approach is also more closely aligned with the sectoral categories of the *Pan-Canadian Framework on Clean Growth and Climate Change*, allowing Canada to track progress of its key policies and measures to reduce emissions. Within this report, Canada's economic sector categorization is used to present Canada's policies and measures to reduce GHG emissions (see Chapter 4), and Canada's emissions projections are presented using both IPCC and economic sector categories (see Chapter 5). Annex 10 of Canada's 2022 NIR (available at open.canada.ca) contains a series of tables which show the distribution of national emissions allocated on the basis of the Canadian economic sector from which they originate for all years in the time series (1990 to 2020) and the relationship between economic and IPCC categories or sectors.

GHG emissions trends in Canada's economic sectors have remained consistent with those described for IPCC sectors, with the Oil and Gas and Building economic sectors showing emission increases of 7.5 Mt or 4.4 percent and 4.1 Mt or 4.9 percent, respectively, since 2005 (Figure 3-11 and Table 3-6). These increases have been more than offset by emission decreases in Electricity (-61 Mt or -52 percent), Heavy Industry (-15 Mt or -18 percent) and Waste and Others (-5.0 Mt or -9.0 percent) (Figure 3-11 and Table 3-6). Since 2005, Transport emissions have generally increased; emissions in 2020 dropped and are comparable to 2005 levels (-0.93 Mt or -0.6 percent since 2005). Between the years 2019 and 2020, Oil and Gas emissions have decreased significantly (-25 Mt or -12 percent), coinciding with federal regulations to reduce methane emissions from the upstream oil and gas industry and equivalent provincial regulations in Saskatchewan, Alberta, and British Columbia.

Further information on economic sector trends can be found in Chapter 2 of Canada's 2022 NIR. Additional information on the IPCC and economic sector definitions, as well as a detailed crosswalk table between IPCC and economic sector categories, can be found in Part 3 of Canada's 2022 NIR.

Figure 3-11: Canada's Emissions Breakdown by Economic Sector (2020)

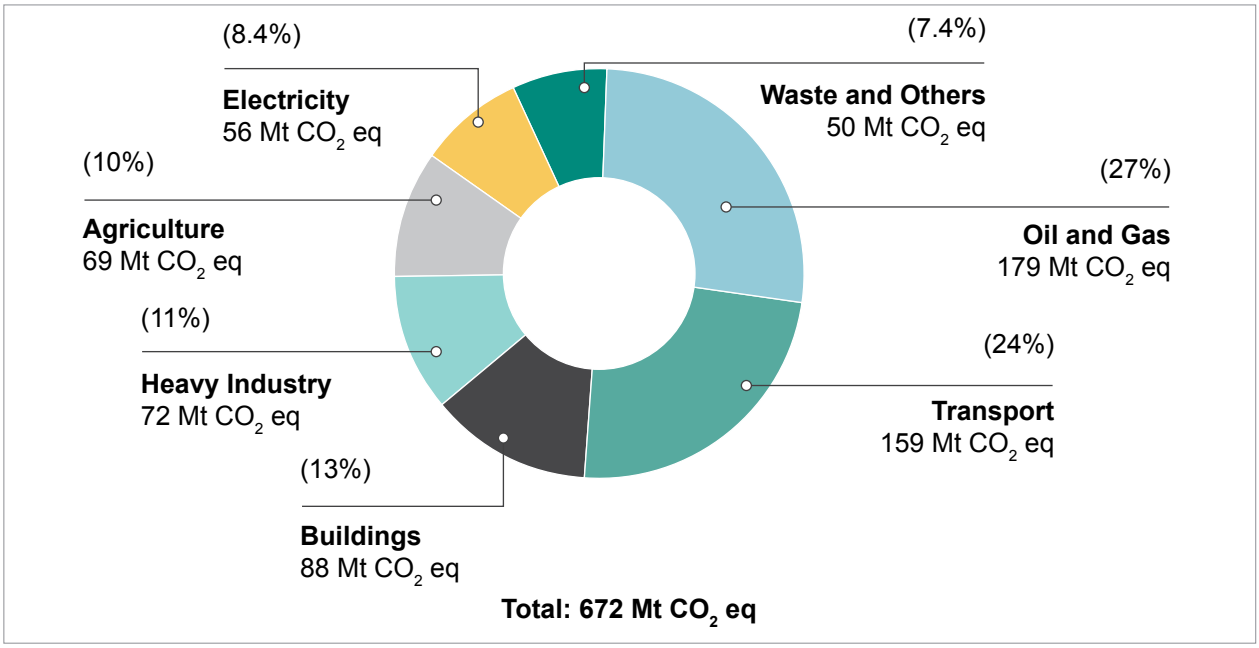


Table 3-6: Canada's GHG Emissions by Economic Sector, Selected Years

	2005	2015	2016	2017	2018	2019	2020
	Mt CO_2 equivalent						
National GHG Total	**741**	**733**	**715**	**725**	**740**	**738**	**672**
Oil and Gas	171	205	194	196	205	203	179
Electricity	118	80	74	73	63	62	56
Transport	160	172	173	179	184	185	159
Heavy Industry[a]	87	78	76	76	77	77	72
Buildings	84	84	82	87	93	92	88
Agriculture[b]	66	65	65	64	66	67	69
Waste and Others[c]	55	50	50	50	51	52	50

Notes:

Totals may not add up due to rounding.

Estimates presented here are under continuous improvement. Historical emissions may be changed in future publications as new data becomes available and methods and models are refined and improved.

a. Heavy Industry represents emissions arising from non-coal, -oil and -gas mining activities, smelting and refining, and the production and processing of industrial goods such as fertilizer, paper or cement.

b. Emissions associated with the production of fertilizer are reported in the Heavy Industry Sector.

c. "Others" includes Coal Production, Light Manufacturing, Construction and Forest Resources.

3.3.1. Oil and Gas

In 2020, the Oil and Gas Sector produced the largest share of GHG emissions in Canada (27 percent). Between 1990 and 2020, emissions from this sector increased by 76 Mt. While fluctuations due to economic conditions (e.g., crude oil and natural gas prices) caused short-term increases and decreases in emissions between 1990 and 2020, emissions from this sector have generally increased steadily from 103 Mt in 1990 to 205 Mt in 2014. From 2014 to 2019, emissions were relatively stable, followed by a significant decrease of 25 Mt (-12 percent) between 2019 and 2020. The majority of the increase (68 Mt) between 1990 and 2014 is due to massive expansion in Canada's oil sands. Since 1990, oil sands production has increased by over 725 percent and emissions have increased by over 430 percent. The decrease between 2019 and 2020 coincides with federal regulations to reduce methane emissions from the upstream oil and gas industry, which came into effect January 1, 2020, and equivalent provincial regulations in Saskatchewan, Alberta and British Columbia, as well as a sharp decrease in the price of crude oil in the early days of the COVID-19 pandemic.

3.3.2. Transport

Canada's Transportation Sector is the second-largest contributor to Canada's GHG emissions, accounting for 24 percent of total emissions in 2020. Between 1990 and 2020, emissions rose by 39 Mt (32 percent). Since then, emissions from this sector have continued to increase gradually, with the exception of the decrease between 2019 and 2020 largely due to fewer kilometres driven. Transport emissions in 2020 are comparable to 2005 levels (-0.93 Mt or -0.6 percent since 2005). Section 3.2 discusses the main drivers of historical emissions trends associated with passenger and freight transport.

3.3.3. Electricity

In 2020, the Electricity Sector (excluding industrial and commercial cogeneration) contributed 8.4 percent to total Canadian emissions. Between 1990 and 2020, emissions decreased by 39 Mt (41 percent). Emissions from the Electricity Sector increased in parallel with the rising demand for electricity both domestically and to satisfy exports to the United States over the earlier years of the reporting period, but have fallen significantly during the latter years. Electricity emissions decreased by 61 Mt or 52 percent since 2005. Section 3.2 of this chapter discusses the main historical drivers of emissions trends associated with electricity generation.

3.3.4. Heavy Industry

The Heavy Industry Sector experienced some fluctuation in emissions over the reporting period. In 2020, the Heavy Industry Sector contributed 11 percent to Canada's total emissions. Emissions from this sector were responsible for 16 percent of total Canadian emissions in 1990, falling to 12 percent in 2005. In more recent years, emissions have fallen further as a result of reduced economic activity and the continued evolution of Canadian production towards other sectors and services, representing a decrease of 15 Mt (18 percent) between 2005 and 2020.

3.3.5. Buildings

In 2020, the Buildings Sector contributed 13 percent to total Canadian emissions. While residential fuel use has remained relatively steady since 1990, increases in the service industry have resulted in an increase in emissions of 17 Mt (23 percent) between 1990 and 2020. Since 2005, emissions increased by 4.1 Mt or 4.9 percent. GHG emissions from the Buildings Sector have increased with population and commercial development but, like all sectors of the economy, decreased in the 2008–2009 recessionary period and have remained relatively steady since then.

3.3.6. Agriculture and Waste and Other

Emissions from the Agriculture Sector continued a slow upward trend throughout the reporting period, rising from 52 Mt in 1990 to 69 Mt in 2020. This increase in emissions is due primarily to increases in livestock and crop production. Emissions from the Waste and Others Sector remained relatively stable. Overall emissions increased over the time series, from 24 Mt in 1990 to 27 Mt in 2020. Section 3.2 discusses the main historical drivers of emissions trends associated with Agriculture and Waste.

3.4. Provincial and Territorial GHG Emissions

Emissions vary significantly by province and territory as a result of such factors as population, energy sources and economic structure. All else being equal, economies based on resource extraction will tend to have higher emission levels than service-based economies. Likewise, provinces that rely on fossil fuels for their electricity generation emit relatively more GHGs than those that rely more on hydroelectricity.

Historically, Alberta and Ontario have been the highest emitting provinces. Since 2005, emissions patterns in these two provinces diverged. Emissions in Alberta increased from 19 Mt (8.2 percent) since 2005, primarily as a result of the expansion of oil and gas operations (Figure 3-12 and Table 3-7). In contrast, Ontario's emissions have decreased by 55 Mt (27 percent) since 2005, owing primarily to the closure of the last coal-fired electricity generation plants in 2014. Québec's emissions decreased by 10 Mt (12 percent) between 2005 and 2020, and those in Saskatchewan and British Columbia also decreased by 5.4 Mt (7.6 percent) and 1.8 Mt (2.9 percent), respectively, over the same time period. Emissions in Manitoba have increased 1.1 Mt or 5.6 percent since 2005. Other provinces that have seen significant decreases in emissions include New Brunswick (7.3 Mt or a 37 percent reduction), Nova Scotia (8.4 Mt or a 36 percent reduction), Newfoundland and Labrador (1.0 Mt or a 9.1 percent reduction) and Prince Edward Island (0.29 Mt or a 15 percent reduction). Furthermore, emissions in the Northwest Territories have also decreased (0.32 Mt or 19 percent), and Yukon and Nunavut have seen increases in emissions (0.03 Mt or 5.6 percent, and 0.02 Mt or 3.2 percent, respectively).

Figure 3-12: Emissions by Province in 2005, 2010, 2015 and 2020

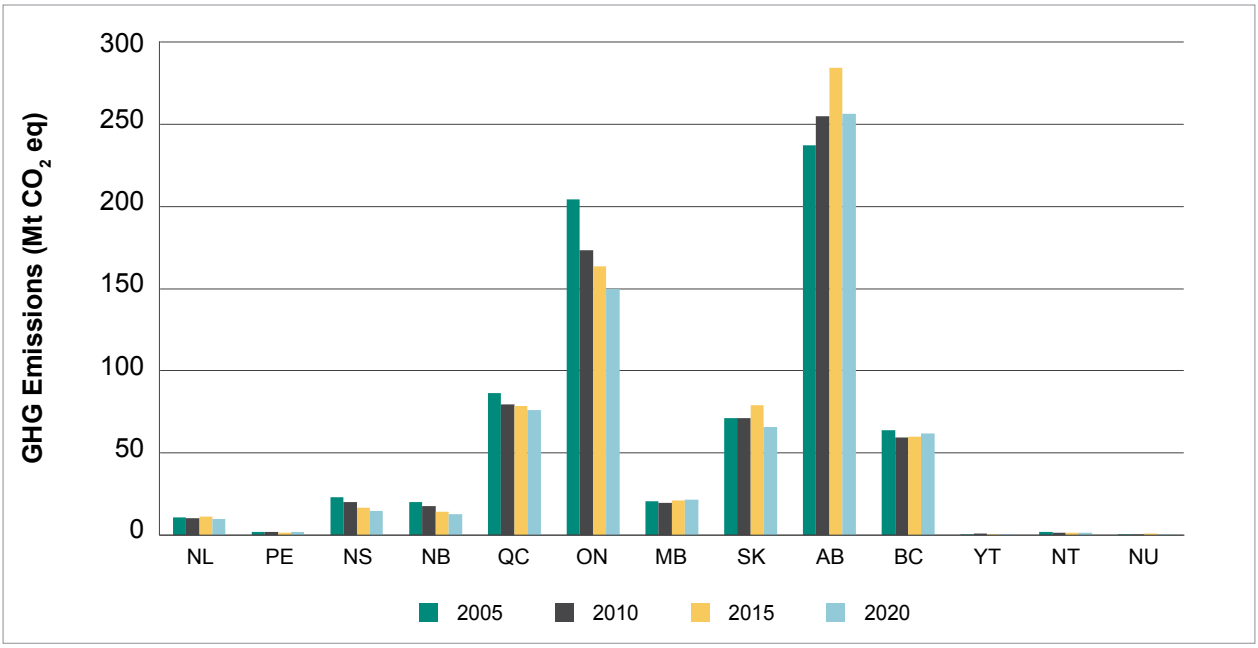


Table 3-7: GHG Emissions by Provinces / Territories, Selected Years

GHG Emissions (Mt CO_2 eq)									Change (%)
Year	1990	2005	2015	2016	2017	2018	2019	2020	2005–2020
GHG Total (Canada)	**595**	**741**	**733**	**715**	**725**	**740**	**738**	**672**	**-9.3%**
NL	9.6	10	11	11	11	11	11	9.5	-9.1%
PE	1.8	1.9	1.6	1.6	1.6	1.6	1.7	1.6	-15%
NS	20	23	17	15	16	17	16	15	-36%
NB	16	20	14	15	14	14	13	12	-37%
QC	85	86	79	78	80	82	84	76	-12%
ON	180	204	164	162	159	167	166	150	-27%
MB	18	21	21	21	22	23	22	22	5.6%
SK	45	71	79	77	79	80	78	66	-7.6%
AB	166	237	284	268	276	277	279	256	8.2%
BC	52	64	60	62	63	66	65	62	-2.9%
YT	0.55	0.57	0.53	0.53	0.56	0.65	0.69	0.60	5.6%
NT	NA	1.7	1.6	1.5	1.6	1.6	1.6	1.4	-19%
NU	NA	0.58	0.65	0.74	0.75	0.74	0.73	0.60	3.2%

Notes: Totals may not add up due to rounding.

NA= Not applicable

3.5. National Inventory Arrangements

The Pollutant Inventories and Reporting Division within Environment and Climate Change Canada is the single national entity with responsibility for preparing and submitting the National Inventory to the UNFCCC and for managing the supporting processes and procedures.

The institutional arrangements for the preparation of the inventory include: formal agreements supporting data collection and estimate development; a quality management plan, including an improvement plan; the ability to identify key categories and generate quantitative uncertainty analysis; a process for performing recalculations due to improvements; procedures for official approval; and a working archive system to facilitate third-party review.

Submission of detailed information regarding the national inventory arrangements, including details on institutional arrangements for inventory preparation, is also an annual requirement under the UNFCCC reporting guidelines on annual inventories (see Chapter 1, Section 1.2 of Canada's 2022 NIR).

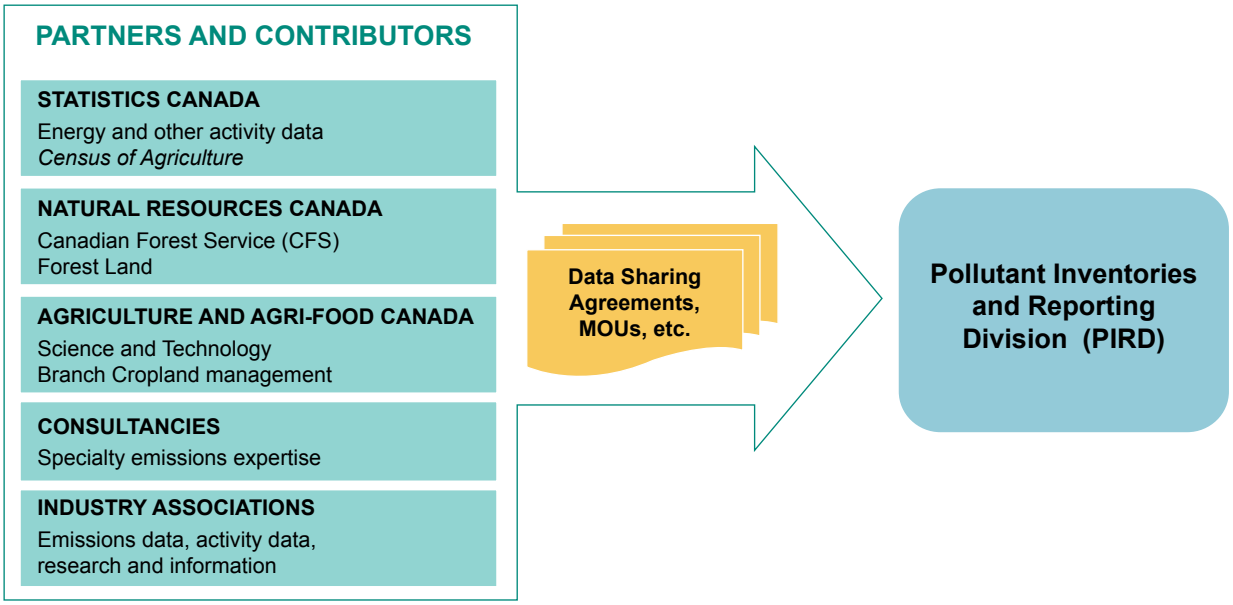
3.5.1. Institutional Arrangements

As the federal agency responsible for preparing and submitting the national inventory to the UNFCCC, Environment and Climate Change Canada has established and manages all aspects of the arrangements supporting the GHG inventory.

Sources and sinks of GHGs originate from a tremendous range of economic sectors and activities. Leveraging the best available technical and scientific expertise and information, Environment and Climate Change Canada has defined roles and responsibilities for the preparation of the inventory, both internally and externally. As such, Environment and Climate Change Canada is involved in many agreements with data providers and expert contributors in a variety of ways, ranging from informal to formal arrangements. These agreements include: partnerships with other government departments, namely Statistics Canada, Natural Resources Canada (NRCan), Agriculture and Agri-Food Canada (AAFC); arrangements with industry associations, consultants and universities; and collaborative agreements with provincial and territorial governments on a bilateral basis (Figure 3-13).

There have been no changes to the National Inventory Arrangements since the previous annual GHG inventory submission.

Figure 3-13: Partners and Contributors to National Inventory Arrangements

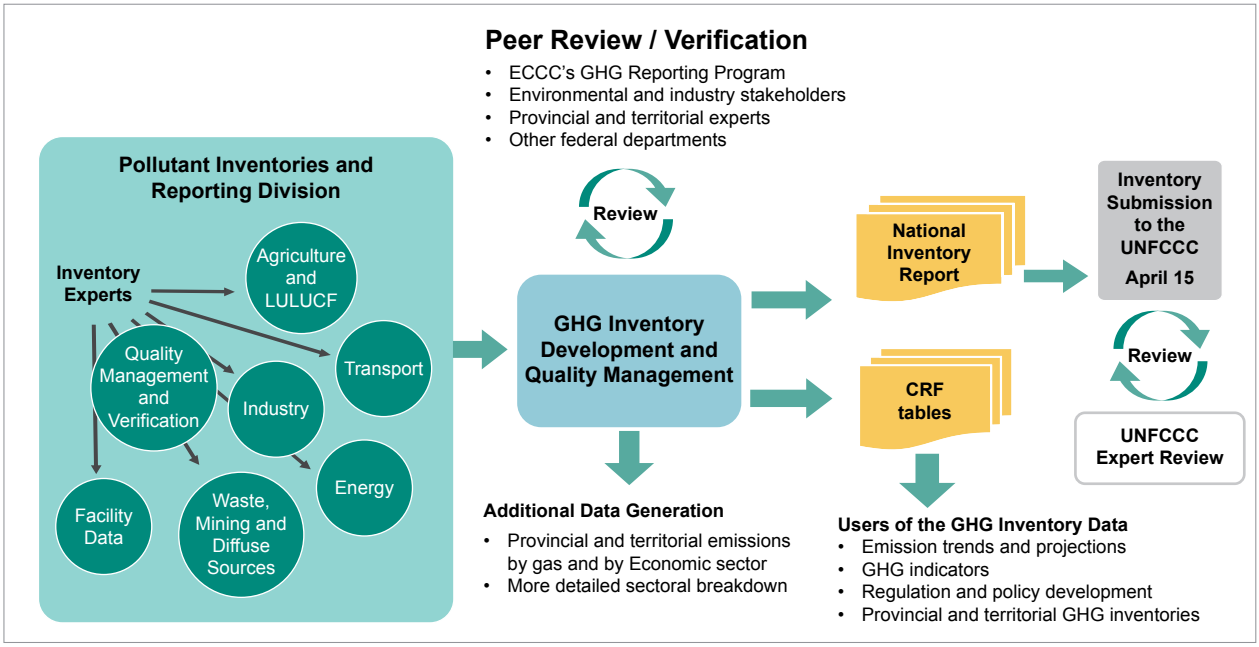


3.5.2. Process for Inventory Preparation

Canada's inventory is developed, compiled and reported annually by Environment and Climate Change Canada's Pollutant Inventories and Reporting Division, with input from numerous experts and scientists across Canada. Figure 3-14 identifies the various stages of the inventory preparation process.

The inventory builds from a continuous process of methodological improvements, refinements and review, in accordance with the quality management and improvement plans. The Quality Management and Verification Section is responsible for preparing the inventory development schedule, which may be adjusted each year based on the results of the lessons-learned review of the previous inventory cycle, quality assurance/quality control (QA/QC) follow-up, the UNFCCC review report, context of data collection, and collaboration with provincial and territorial governments. This process is done with ongoing collaboration and consultation with other inventory experts. Based on these outcomes, methodologies and emission factors are reviewed, developed and/or refined. QA reviews of methodologies and emission factors are typically undertaken for categories for which a change in methodology or emission factor is proposed and for categories that are scheduled for a QA review of methodology or emission factor.

Figure 3-14: Inventory Preparation Process



3.5.3. Quality Assurance, Quality Control and Verification

QA/QC and verification procedures are an integral part of the inventory development and submission processes. These procedures ensure that Canada is able to meet the UNFCCC reporting requirements of transparency, consistency, comparability, completeness and accuracy and, at the same time, continuously improve data and methods to ensure that a credible and defensible inventory is developed.

The development of Canada's GHG inventory is based on a continuous process of data collection, methodological refinement and review. QA/QC procedures take place at all stages of the inventory development cycle.

In order to ensure that an inventory of high quality is produced each and every year, a national inventory quality management system has been developed and implemented for the annual compilation and publication of the national GHG inventory. The quality management system includes a QA/QC plan, an inventory improvement plan, processes for creation, documentation and archiving of information, a standardized process for implementing methodological change, identification of key roles and responsibilities, as well as a timeline for completing the various NIR-related tasks and activities. Documentation of QA/QC procedure is at the core of the plan.

3.5.4. Process for Recalculations of Estimates

Continuous improvement is good inventory preparation practice. Environment and Climate Change Canada consults and works closely with key federal and provincial partners along with industry stakeholders, research centres and consultants, on an ongoing basis to improve the quality of the underlying variables and scientific information used to compile the national inventory. As new information and data become available and more accurate methods are developed, previous estimates are updated to provide a consistent and comparable trend in emissions and removals.

References

1 Under the United Nations Environment Programme (UNEP), the Montreal Protocol on Substances that Deplete the Ozone Layer is an international agreement designed to reduce the global consumption and production of ozone-depleting substances.

2 Unless explicitly stated otherwise, all emission estimates given in Mt represent emissions of GHGs in Mt CO_2 eq.

3 Throughout this chapter, data are presented as rounded figures. However, all calculations (including percentages) have been performed using unrounded data.

4 Statistics Canada. No date (a). Table 361-00369-01(formerly CANSIM 380-0106): Gross domestic product, expenditure-based, at 2012 constant prices, annual (x 1,00 0,000). Data. [accessed 2021 Feb 9]. Available online at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610036901.

5 Ibid.

6 Climate Watch. 2021. Historical GHG Emissions. Washington (DC): World Resources Institute. Available online at: https://www.climatewatchdata.org/ghg-emissions.

7 Statistics Canada. No date (b). Table 17-10-0005-01 (formerly CANSIM 051-0001): Population estimates on July 1st, by age and sex. Data. [accessed 2021 Feb 9]. Available online at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000501.

8 The complete NIR can be accessed here: https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/inventory.html?utm_campaign=not-applicable&utm_medium=vanity-url&utm_source=canada-ca_ghg-inventory.

9 Intergovernmental Panel on Climate Change. 2006. 2006 IPCC guidelines for national greenhouse gas inventories. Prepared by the National Greenhouse Gas Inventories Programme. Eggleston HS, Buendia L, Miwa K, Ngara T, Tanabe K (eds). IGES, Japan.

10 Ontario Power Generation Inc. 2015. Sustainable Development Report 2014 [accessed 2022 Jan 6]. Available online at: https://archive.opg.com/?collection=Performancepercent20andpercent20Environmentalpercent20Reports percent2FSustainability percent20Reports.

11 The mix of electricity generation sources is characterized by the amount of fossil fuel vs. hydro, other renewable sources and nuclear sources. In general, only fossil fuel sources generate net GHG emissions.

12 Statistics Canada. No date (c). Table 38-10-0032-01 (formerly CANSIM 153-0041) Disposal of waste, by source, Canada, provinces and territories. CANSIM (database). [accessed 2020 Sep 14]. Available online at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810003201.

13 Atherton E, Risk D, Fougère C, Lavoie M, Marshall A, Werring J, Williams JP, Minions C. 2017. Mobile measurement of methane emissions from natural gas developments in northeastern British Columbia, Canada. Atmos. Chem. Phys., 17: 12405-12420; Johnson MR, Tyner DR, Conley S, Schwietzke S, Zavala-Araiza D. 2017. Comparisons of airborne measurements and inventory estimates of methane emissions in Alberta upstream oil and gas sector. Environ. Sci. Technol., 51(21):13008-13017; Zavala-Araiza D, Herndon SC, Roscioli JR, Yacovitch TI, Johnson MR, Tyner DR, Omara M, Knighton B. 2018. Methane emissions from oil and gas production sites in Alberta, Canada. Elem. Sci. Anth., 6: 27; Chan E, Worth DEJ, Chan D, Ishizawa M, Moran MD, Delcloo A, Vogel F. 2020. Eight-year estimates of methane emissions from oil and gas operations in western Canada are nearly twice those reported in inventories. Environ. Sci. Technol., 54(23): 14899-14909; MacKay K, Lavoie M, Bourlon E, Atherton E, O'Connell E, Baillie J, Fougère C, Risk D. 2021. Methane emissions from upstream oil and gas production in Canada are underestimated. Sci. Rep., 11: 8041.; Tyner DR and Johnson MR. 2021. Where the Methane Is—Insights from Novel Airborne LiDAR Measurements Combined with Ground Survey Data. Environ. Sci. Technol., 55(14): 9773-9783.

14 Johnson MR, Tyner DR, Szekeres AJ. 2021. Blinded evaluation of airborne methane source detection using Bridger Photonics LiDAR. Remote Sens. Environ., 259:112418.

15 Forest conversion emissions are incorporated within sums of emissions of other land-use categories; therefore, the 16 Mt reported in this section is included in the sums associated with the other land-use category totals.

Chapter 4: Policies and Measures

4.1. Overall Policy Context

On climate change, the science is clear: in order to avoid the worst impacts of climate change, accelerated efforts are necessary to rapidly reduce greenhouse gas emissions by 2030 and achieve net-zero emissions by 2050. In its 2022 report on Climate Change Impacts, Adaptation and Vulnerability, the Intergovernmental Panel on Climate Change (IPCC) noted with very high confidence that reaching a 1.5°C global temperature increase over pre-industrial levels in the near-term would cause unavoidable increases in climate hazards and present risks to ecosystems and humans.[1] The economics are clear, too: to build a strong, resilient economy for generations to come, we must harness the power of a cleaner future.

Canada continues to increase ambition and build momentum across the country on actions to fight climate change. Since Canada's last Biennial Report, Canada has continued to adopt increasingly stringent greenhouse gas emissions reduction targets, including new legislation to enshrine in law the target of net-zero emissions by 2050. A number of provinces and territories, such as British Columbia, Nova Scotia, Prince Edward Island, and Québec have also made net-zero commitments, as well as major cities like Toronto, Montréal, Halifax, and Vancouver. Indigenous leaders and communities also continue to show climate leadership, reinforcing the need to take action to reduce pollution, adapt to the impacts of climate change, and improve the ways in which the natural environment is respected and protected. In the private sector, major Canadian businesses have made commitments and are taking action to reduce their emissions.

The Government of Canada is committed to taking action to reduce emissions, protect the environment, spur clean technologies and innovation, and help Canadians and communities adapt to the impacts of climate change. In 2016, the Government of Canada worked closely with the provinces and territories to jointly develop the *Pan-Canadian Framework on Clean Growth and Climate Change*, with input from Indigenous partners.

Building on this national effort, in December 2020, the Government of Canada released its strengthened climate plan, *A Healthy Environment and a Healthy Economy*, to provide clear direction on the climate action necessary to deepen emissions reductions across the economy, create new, well-paying jobs, make life more affordable for households, and build a better future.

The actions in the plan were projected to lead to emissions reductions that will exceed Canada's previous NDC, which at the time was 30 percent below 2005 levels by 2030. This plan included steps to:

- make the places Canadians live and gather more affordable by cutting energy waste;
- make clean, affordable transportation and power available in every Canadian community;
- continue to ensure that pollution isn't free and that households get more money back;
- build Canada's clean industrial advantage; and,
- embrace the power of nature to support healthier families and more resilient communities.

In 2021, Canada increased its ambition on climate change under the Paris Agreement, increasing its emissions reduction target to 40 to 45 percent below 2005 levels, and establishing new federal legislation targeting net-zero emissions by 2050. This marks the first time the Government of Canada has legislated a framework of climate action transparency and accountability as it works to deliver on its emissions reduction targets. The first emissions reduction plan for the target year of 2030 under the new Act was published in March 2022. Future emissions plans, reporting, and other accountability requirements under the Act will ensure Canada's efforts stay on track.

Moreover, in September 2022, the Government of Canada released *Faster and Further: Canada's Methane Strategy*. The Strategy provides a pathway to further reduce methane emissions from across the economy while supporting Canadian technology and creating good-paying jobs.

Canada is also determined to ensure that the approach it takes to reach its climate goals will also help ensure that the conditions are right to seize the economic opportunities of the changing global economy. For example, clean technology's contribution to Canada's GDP is expected to grow from $26 billion in 2016 to $80 billion by 2025.[2] Canadians have the knowledge and the skills to make Canada a destination of choice for investments in low-carbon solutions and to grow Canada's competitiveness.

4.1.1. Fulfilling Canada's Net-Zero Emissions Requirements

In June 2021, the Government of Canada enacted the *Canadian Net-Zero Emissions Accountability Act* (the Act), establishing legal requirements for current and future governments to plan, report, and course correct on the path to net-zero emissions by or before 2050. The Act commits Canada to: achieving its 2030 Nationally Determined Contribution of 40 to 45 percent below 2005 levels under the Paris Agreement; and, setting national targets (referred to as milestone years in the Act) for the reduction of greenhouse gas emissions every five years, from 2030 to 2045, with the objective of attaining net-zero emissions by 2050. The *Canadian Net-Zero Emissions Accountability Act* provides a durable framework of accountability and transparency to deliver on this commitment, establishing a transparent process to plan, assess, and adjust the federal government's efforts to achieve Canada's national targets, which are based on the best scientific information available.

The Act holds the Government of Canada to account by requiring the Minister of Environment and Climate Change to report to Parliament with respect to each target.

For each target, the Act requires:

- an emissions reduction plan outlining the measures and strategies the Government of Canada will take to achieve the target;
- a progress report to update on the ongoing implementation of the emissions reduction plan; and,
- an assessment report to indicate whether a target has been met and to assess the effectiveness of the measures and strategies described in the associated emissions reduction plan.

Each emissions reduction plan must contain:

- the greenhouse gas emissions target for the year to which the plan relates;
- a summary of Canada's most recent greenhouse gas emissions inventory (National Inventory Report) and information relevant to the plan that Canada submitted under its international climate change commitments;
- a description of the key emissions reduction measures the Government of Canada intends to take to achieve the target;
- a description of how Canada's international commitments on climate change are taken into account in the plan;
- a description of any relevant sectoral strategies;
- a description of emissions reduction strategies for federal government operations;
- a projected timetable for implementation;
- greenhouse gas emissions projections resulting from the measures and strategies; and
- a summary of key cooperative measures or agreements with provinces, territories and other governments in Canada.

Each emissions reduction plan must also explain how the measures and strategies outlined in the plan will contribute to Canada achieving net-zero emissions by 2050. When developing an emissions reduction plan, the Minister of Environment and Climate Change must provide the provinces and territories, Indigenous Peoples, the Net-Zero Advisory Body and interested persons with the opportunity to make submissions.

In the event of a missed target, the Minister of Environment and Climate Change must include in the assessment report for that target the reasons why Canada failed to meet the target and describe the actions the Government will take or is taking to address the failure.

In addition to the accountability provided by setting targets and planning in an open, consultative process, the Act includes specific measures for third parties to hold the Government to account:

- The Act establishes a Net-Zero Advisory Body in legislation, to provide independent advice on targets and emissions reduction plans, including measures and sectoral strategies that the Government of Canada could implement.

- The Act requires that the Commissioner of the Environment and Sustainable Development examine and report on the Government's implementation of climate-change mitigation measures at least once every five years. This measure will ensure rigorous oversight of the Government's progress toward implementation.
- The Act requires the Minister of Finance, in cooperation with the Minister of Environment and Climate Change, to publish an annual report outlining key measures that federal departments and Crown corporations have taken to manage the financial risks and opportunities related to climate change.

A comprehensive review of the Act is required five years after its coming into force.

4.1.2. Elements of the *2030 Emissions Reduction Plan*

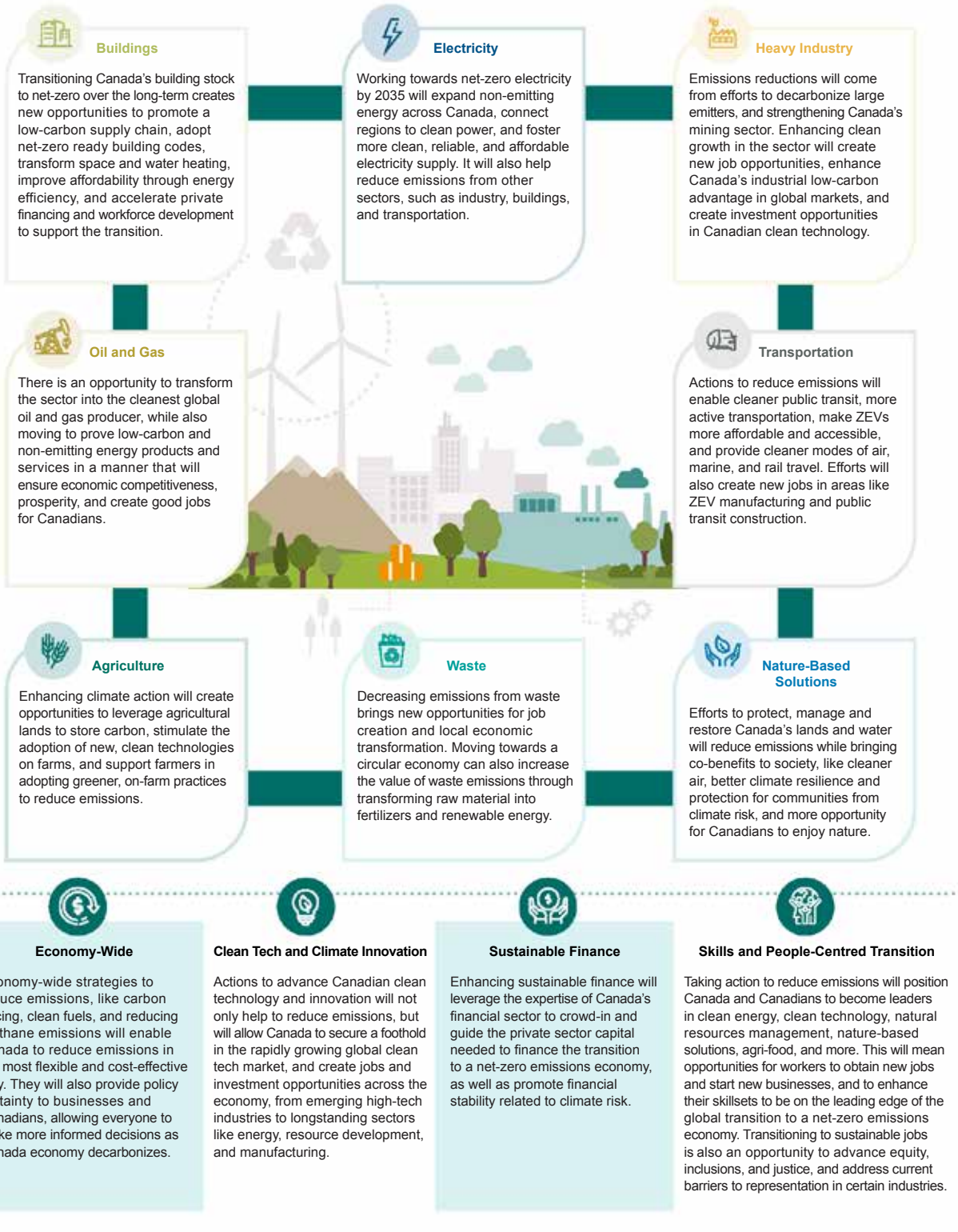
In March 2022, Canada published its first emissions reduction plan under the *Canadian Net-Zero Emissions Accountability Act*. The *2030 Emissions Reduction Plan* (2030 ERP) lays out a path to reach Canada's enhanced 2030 target, through both existing measures that are already driving significant reductions and new measures that are needed to drive emissions down even further. The 2030 ERP is designed to be an evergreen and comprehensive roadmap that reflects levels of ambition to guide emissions reduction efforts in each sector. As governments, businesses, non-profits and communities across the country work together to reach these targets, Canadians will identify and respond to new opportunities.

Achieving Canada's climate objectives demands that all sectors of the economy continue to decarbonize in a manner that makes cleaner alternatives more affordable and creates new sustainable job opportunities for workers. The 2030 ERP provides a road map that goes sector by sector to identify climate action and strategies.

The ERP uses a combination of two modelling approaches—a "bottom-up" and a "back-casting" approach. The "bottom-up" approach provides a floor for projected emissions reductions of about a 36 percent reduction from 2005 levels by 2030, achievable from existing climate measures and some new measures included in the Plan.

The 2030 ERP also used a back-casting approach to help account for policies and measures that are included in the plan but are still under development (e.g., Canada Green Buildings Strategy, exploring the feasibility of a bioenergy strategy to optimize how Canada uses its agricultural, forestry and municipal waste, and work to develop a Buy Clean Strategy to support and prioritize the use of made-in-Canada low carbon products). Under this approach, Canada's total emissions are capped at the level needed to achieve the 2030 target of 40 percent below 2005 levels, including the potential contribution from the Oil and Gas Sector, and models potential reductions for the remaining sectors in an economically efficient manner required to reach the 40 percent target by 2030.

Figure 4-1: Canada's Emissions Reduction Plan for 2030 and Pathway to 2050



4.1.2.1. What was heard from the 2030 ERP engagement process?

Engagement with provinces and territories

The Government of Canada recognizes the importance of working closely with provinces and territories. The provinces and territories were invited to submit details of their jurisdiction-specific actions for inclusion in the 2030 ERP. The plan includes a full chapter dedicated to collaboration efforts with provinces and territories as well as an annex of all submissions by jurisdictions. Provinces and territories highlighted key cooperative measures and agreements, as well as current and planned climate actions being taken by their jurisdiction, including:

- Supporting a clean electricity sector, building on efforts to phase-out coal-fired electricity and increase the production of renewable energy.
- Emissions reduction efforts in the buildings sector, with support for greater alignment of programs and incentives between governments.
- The electrification of the transportation sector, recognizing the important role of provincial and municipal governments to influence transportation choices and make significant contributions in this area.

The Government of Canada will continue to engage with provinces and territories to advance discussions on climate priorities to maximize efforts towards meeting Canada's emissions targets.

In developing the 2030 ERP, the Government of Canada heard from over 30,000 Canadians: young people, workers, Indigenous Peoples, business owners, and more. A key message to the Government was that climate action must go hand in hand with keeping life affordable for Canadians and creating good jobs. The Government also heard that:

- Canadians and stakeholders recognize that putting a price on carbon pollution is one of the best tools to fight climate change, and that support for vulnerable households will be critical as the price increases. Sound investment decisions will demand long-term certainty and a clear trajectory.
- A number of jurisdictions are working on new or updated climate change plans or related strategies, emissions targets, and carbon pollution pricing approaches for 2023–2030 that will comply with federal requirements.
- Submissions from Indigenous Peoples emphasized that market-based solutions have limitations, and the path toward net-zero emissions should be a holistic process leading to a just, equitable, and resilient future for generations to come, founded on Indigenous Peoples' right to self-determination.

Engagement with Indigenous Peoples

The Government of Canada acknowledges the requirement under the *Canadian Net-Zero Emissions Accountability Act* to take into account Indigenous Knowledge when setting emission reduction targets, as well as the requirement to consider the *United Nations Declaration on the Rights of Indigenous Peoples* in the establishment of emissions reduction plans. While more work needs to be done to ensure that Indigenous climate leadership is fully integrated into Canada's climate action, Canada has an ongoing commitment to improve the reflection of the UN Declaration in all of its policy and programming and to work with Indigenous partners to better support their climate priorities. The Government of Canada will work in partnership with Indigenous Peoples to develop more formal and consistent engagement processes to enable future emissions reduction plans to meaningfully incorporate Indigenous Knowledge. This could include efforts to emphasize the importance of building a net-zero emissions future that is just and resilient for generations to come, and reflect the lived realities of Indigenous Peoples. In order to better apply the principles of the UN Declaration, the Government will continue to work with Indigenous partners to co-develop an approach to incorporate Indigenous perspectives in other elements of emissions reduction plans, as well as work to better incorporate the multi-dimensional solutions offered by Indigenous Peoples, which could include land stewardship, food security, local and green power solutions, and language revitalization.

4.1.3. Institutional Arrangements

4.1.3.1. Canada's Partnership With Provinces and Territories

Federal leadership is only one part of Canada's climate story. Meeting the 2030 target and achieving net-zero emissions by 2050 will require all levels of governments across Canada to work cooperatively and collectively to advance joint interests to reduce emissions. Provinces and territories hold jurisdiction over many important sources of emissions in Canada, and have frequently demonstrated leadership in addressing and responding to climate change. As Canada experiences more extreme weather events as a result of climate change, including droughts, heat waves, floods, and fires, provinces and territories are under increasing pressure to respond to, and support Canadians through, these difficult challenges. A collaborative approach to climate action between the federal, provincial and territorial governments will continue to be a key priority for the Government of Canada.

The Government of Canada utilizes a wide variety of cooperative mechanisms to work with provinces and territories, as detailed below.

Formal Agreements and Memoranda of Understanding

The Government of Canada has concluded a number of bilateral agreements or memoranda of understanding with several provincial and territorial governments in a wide range of climate-related areas, including carbon pollution pricing (e.g., carbon offsets), natural gas sector electrification, nature, climate data, methane equivalency agreements (oil and gas sector) and other shared-priority areas.

Multilateral and Bilateral Cooperation

Federal, provincial, and territorial ministerial councils and tables, such as the Canadian Council of Ministers of the Environment, the Canadian Council of Forest Ministers, the Energy and Mines Ministers' Conference, and Canada's federal, provincial and territorial Ministers of Agriculture, amongst others, promote collaborative actions by governments to advance shared climate change objectives, undertake studies and analysis to develop best practices, and make recommendations to enhance government climate action. In addition to multilateral tables, the Government of Canada continues to engage provinces and territories on a bilateral and regional basis, to explore and pursue opportunities and issues of mutual interest. For example, the Government of Canada recently invested $25 million to launch the Regional Energy and Resource Tables. This collaborative initiative with provinces and territories is designed to identify, prioritize and pursue opportunities for economic growth and sustainable job creation in a low-carbon future for the energy, electricity, mining, forestry and clean technology sectors across all of Canada's regions.

Policy Frameworks and Partnerships

The Government of Canada and the provinces and territories have co-developed a number of cooperative policy frameworks over the years to address complex, horizontal and multijurisdictional issues, including climate change. This includes through the development of the *Arctic and Northern Policy Framework,* the Canadian Agricultural Partnership, and the Atlantic Loop.

Cooperation in International Fora

Provinces and territories also contribute to Canada's international engagement on climate change. For example, they are invited to send delegates as part of the Canadian delegation to meetings of the United Nations Framework Convention on Climate Change (UNFCCC). Provinces and territories have also been engaged in negotiations, such as on the rules of Article 6 of the *Paris Agreement*, and contributed to the submission of Canada's *Nationally Determined Contribution* in July 2021.

Pooling Resources towards Fighting and Adapting to Climate Change

The Government of Canada provides significant funding support to achieve shared climate objectives with provincial and territorial governments. A number of ongoing funding programs, covering a wide range of sectors, include the Low Carbon Economy Fund and the Natural Climate Solutions Fund, amongst others.

What's next?

The Government of Canada remains committed to working with provinces and territories. This includes ongoing collaboration with provinces and territories on: advancing the adoption of clean technology; maintaining electricity affordability; implementing off-diesel initiatives for Indigenous, northern and remote communities; and increasing uptake of zero-emission vehicles and electric vehicle charging infrastructure. The Government of Canada is also working with oil-producing provinces to support the industrial decarbonization of their economies and the just transition of workers towards a low-carbon future, and with regions and sectors vulnerable to the changing climate to recover from climate-related disasters and increase resilience.

4.1.3.2. Canada's Partnership With Indigenous Peoples

To further partnerships on climate, the Prime Minister of Canada and leaders of the Assembly of First Nations, Inuit Tapiriit Kanatami and the Métis National Council established three distinctions-based, Senior Bilateral Tables on Clean Growth and Climate Change in 2016. These structured, collaborative fora seek to promote the full and effective participation of First Nations, Inuit and Métis partners in federal climate action while addressing joint climate change priorities. More than five years later, these tables continue to demonstrate the benefits of sustained collaboration. The tables were instrumental in ensuring that Canada's *Strengthened Climate Plan* (December 2020) and the *2030 Emissions Reduction Plan* (March 2022) respond to Indigenous climate priorities.

- Further highlights from Canada's partnership with Indigenous Peoples on climate change include:
- More than $1.3 billion in targeted investments since 2020 to support Indigenous communities to transition to clean energy, advance nature-based solutions, build new or retrofit green community buildings, promote resilience of health systems, and undertake major disaster mitigation projects;
- Over 20 targeted programs to help support First Nations, Inuit and Métis proponents undertake climate actions, including support for over 800 distinct Indigenous-led climate projects across the country, representing more than $800 million in federal investments; and,
- The reflection of Indigenous Peoples' perspectives in Canada's Nationally Determined Contribution in June 2021.

What's next?

The Government of Canada will continue to work with First Nations, Inuit and Métis representatives and rights-holders to develop and implement a model of partnership for climate action that:

- Empowers self-determined climate action and the expression of Indigenous and Treaty rights, jurisdictions, governance, and legal traditions through climate action, and progressively vests authorities and resources in the hands of Indigenous governments;
- Leverages the transition to a net-zero emissions economy to support overarching efforts towards self-determination, the alleviation of socio-economic inequities, and the implementation of the UN Declaration, including Free, Prior and Informed Consent; and,
- Supports the expression of Indigenous Knowledge systems in national climate policy through appropriate governance arrangements, the promotion of Indigenous perspectives on climate change, and the weaving together of Indigenous and non-Indigenous knowledge systems.

As announced in the *2030 Emissions Reduction Plan*, Canada will invest $29.6 million over three years, beginning in 2022-23, to support the co-development of an Indigenous Climate Leadership Agenda to advance self-determined action in addressing Indigenous Peoples' climate priorities. The funding will also support the phased implementation of distinctions-based climate strategies.

In addition, the renewed and expanded Low Carbon Economy Fund noted above will include a new $180 million Indigenous Leadership Fund. The fund will support clean energy and energy efficiency projects led by First Nations, Inuit and Métis communities and organizations.

4.1.4. Legislative Instruments

The environment is an area of shared jurisdiction in Canada, where the federal, provincial, and territorial governments work together on efforts to protect it. At a federal level, Canada has a number of legislative instruments in place that establish and help address its climate change commitments. This includes the *Canadian Environmental Protection Act, 1999* (CEPA), the *Greenhouse Gas Pollution Pricing Act* (GGPPA), and most recently the *Canadian Net-Zero Emissions Accountability Act*.

CEPA is the cornerstone of Canada's environmental legislation, and an important part of Canada's efforts to fight climate change. The Act came into force on March 31, 2000, and has been updated with amendments since that date. In particular, this Act provides the Government of Canada with the authority to regulate pollution that can affect the climate, including from vehicles, engines, and fuels—as well as specific gas emissions such as hydrofluorocarbons.

The GGPPA came into effect on June 21, 2018. It establishes the framework for the federal carbon pollution pricing system in Canada. The federal system consists of two main parts, which can apply in whole or in part in a Canadian province or territory:

- a regulatory charge on fossil fuels (fuel charge), administered by the Canada Revenue Agency (CRA) under Part 1 of the Act; and,
- a regulatory trading system for industry, known as the Output-Based Pricing System (OBPS), administered by ECCC through the Output-Based Pricing System Regulations (OBPS Regulations), under Part 2 of the Act.

As described earlier, the *Canadian Net-Zero Emissions Accountability Act* enshrines in legislation the Government of Canada's commitment to achieve net-zero greenhouse gas emissions by 2050, and provides a framework of accountability and transparency to deliver on it.[3] The Act establishes a legally binding process to set five-year national emissions-reduction targets as well as develop credible, science-based emissions-reduction plans to achieve each target. The Act holds the Government of Canada to account by requiring the Minister of Environment and Climate Change to report to Parliament with respect to each target.

4.2. Monitoring and Evaluation of Progress Toward Canada's Emission Reduction Targets

In the 2009 Copenhagen Accord, Canada committed to a 2020 target of a 17 percent reduction in emissions from 2005 levels by 2020. Since 2015, Canada has been sustaining and increasing efforts to reduce its greenhouse gas emissions through enhanced ambition, supported by extensive national climate efforts. Canada has focused its efforts on achieving the 2030 national target and, most recently, examining potential paths towards net-zero emissions by 2050.

Historical emissions estimates from Canada's *2022 National Inventory Report* show that over the 2005–2020 period, total emissions in Canada decreased by 69 Mt CO_2 eq or 9.3 percent. This does not include the accounting contribution from the LULUCF sector or credits purchased by Québec from California under the Western Climate Initiative. The LULUCF accounting contribution in 2020 would contribute an additional 24 Mt (or 3 percent) of reduction in 2020. Official information on the net purchases by Québec of international credits is not yet available, but preliminary estimates suggest about 11 Mt. With these contributions, Canada's emissions would fall by about 14 percent from 2005 levels by 2020. This result reflects the time lag that exists between the development and implementation of new policies, regulations, and other initiatives, and the subsequent changes in behaviour required for their impacts on GHG emissions to be realized.

Canada signed the Paris Agreement in 2015 and adopted the *Pan-Canadian Framework on Clean Growth and Climate Change*, Canada's first national climate plan, in 2016. Prior to the adoption of the Pan-Canadian Framework, Canada's emissions were on a steady upwards climb and were projected to increase 12 percent above 2005 levels by 2030. Driven by measures in the Pan-Canadian Framework alone, Canada's emissions were projected to be 19 percent below 2005 levels by 2030 (227 Mt decrease), representing the single-largest projected drop in emissions in Canadian history.

Since the landmark adoption of the *Pan-Canadian Framework on Clean Growth and Climate Change*, Canada has continued work to increase its climate ambition, releasing the *Strengthened Climate Plan* in 2020. In 2021, Canada increased its 2030 target to an emissions reduction of 40 to 45 percent below 2005 levels by 2030. Subsequent actions include implementation of the *Canadian Net-Zero Emissions Accountability Act* in 2021 and the release of the *2030 Emissions Reduction Plan* in 2022.

Although Canada's actions have been focused on achieving the targets for 2030 and beyond, these actions, in addition to the impacts of COVID-19, have helped to shift Canada's 2020 emissions curve down significantly, as noted in Chapter 3. A comparison with Canada's business-as-usual case from 2015—reflecting a scenario without Canada's more recent efforts—demonstrated that, without these recent efforts, emissions would have been considerably higher in 2020 and beyond. The impacts of these recent actions will take time to be fully realized. Most recent emissions projections demonstrate that Canada continues to make progress on reducing emissions for 2030 and towards the deeper reductions needed to reach net-zero emissions by 2050.

As described previously in Section 4.1.1 and later in 4.2.1, the *Canadian Net-Zero Emissions Accountability Act* is a key piece of federal legislation that enshrines Canada's commitment to achieve net-zero greenhouse gas emissions by 2050. In addition, the Act requires that each five-year emissions target set between 2030 and 2050 must represent a progression beyond the previous target. Other provisions under the Act will ensure that progress towards Canada's emission reduction targets are monitored and evaluated through its framework of accountability and transparency.

Since the Pan-Canadian Framework was put in place, Canada has committed to ongoing monitoring and reporting of results in order to ensure that policies were effective, to take stock of progress achieved, and to inform Canada's future national actions in accordance with the Paris Agreement. This included annual reporting to the Prime Minister of Canada and provincial and territorial Premiers; external assessment and advice by experts, including the independent Canadian Climate Institute; meaningful engagement with Indigenous partners, including through distinction-based tables; and, reviews of carbon pricing approaches in 2020 and 2022, including expert assessment of stringency and effectiveness that compared carbon pricing systems across Canada. In addition, the Government of Canada continues to regularly evaluate regulatory approaches and track and report on progress.

Annual reports continue to provide an update on federal, provincial and territorial Pan-Canadian Framework actions, and allow First Ministers to take necessary decisions and task further work, as appropriate, under the Pan-Canadian Framework. The first of these reports was submitted to First Ministers in December 2017, with the fourth and most recent report published in March 2022 (reporting on actions in 2020).

4.2.1. Reporting and Accountability Under the *Canadian Net-Zero Emissions Accountability Act*

A key purpose of this Act was to enshrine a framework of transparency and accountability in federal legislation as Canada works towards achieving its emissions reduction targets. As such, the Government of Canada is held to account by requiring the Minister of Environment and Climate Change to report to Parliament with respect to progress in implementing the emissions reduction plans through progress reports as well as assessment reports to indicate whether or not targets have been met.

With respect to the *2030 Emissions Reduction Plan* and the target year of 2030, the first progress report must be prepared by no later than the end of 2023. Additional progress reports for this target year must be prepared by the end of 2025 and of 2027. The assessment report is expected to be due in 2032. For subsequent national emissions reduction target years, one progress report will be due no later than two years before the target year with assessment reports expected two years after the target year.

Overall, each progress report must contain:

- An update on the progress that has been made towards achieving the greenhouse gas emissions target;
    - Canada's most recent published greenhouse gas emissions projections for the next milestone year; and,
    - A summary of Canada's most recent official greenhouse gas emissions inventory and the information relevant to the report, that Canada submitted under its international commitments with respect to climate change.
- An update on the implementation of the federal measures, sectoral strategies and federal government operations strategies described in the relevant emissions reduction plan and, if available, updated projections of annual greenhouse gas emission reductions resulting from those combined measures and strategies;
    - An update on the implementation of the key cooperative measures or agreements with provinces or other governments in Canada described in the relevant emissions reduction plan;
    - If the projections indicate that the plan's greenhouse gas emissions target will not be met, details of any additional measures that could be taken to increase the probability of achieving that target; and
    - Any other information that the Minister considers appropriate.

Additionally, the Minister must prepare an assessment report in relation to a milestone year or to 2050, no later than 30 days after the day on which Canada submits its official greenhouse gas emissions inventory report (in accordance with the Convention in relation to the relevant milestone year or to 2050, as the case may be). Each assessment report must contain:

- A summary of Canada's most recent official greenhouse gas emissions inventory and information, relevant to the report, that Canada submitted under its international commitments with respect to climate change;
- A statement on whether Canada has achieved its national greenhouse gas emissions target for that year;

- An assessment of how the federal measures, sectoral strategies, and federal government operations strategies described in the relevant emissions reduction plan contributed to Canada's efforts to achieve the national greenhouse gas emissions target for that year;
    - An assessment of how the key cooperative measures or agreements with provinces or other governments in Canada described in the relevant emissions reduction plan contributed to Canada's efforts to achieve the national greenhouse gas emissions target for that year;
- Any information relating to adjustments that could be made to subsequent emissions reduction plans in order to increase the probability of meeting subsequent national greenhouse gas emissions targets; and
- Any other information that the Minister considers appropriate.

If the Minister concludes that Canada has not achieved its national GHG target for a milestone year or for 2050, the Minister must include the following in the assessment report:

- The reasons why Canada failed to meet the target;
- A description of actions the Government of Canada is taking or will take to address the failure to achieve the target; and
- Any other information that the Minister considers appropriate.

In addition, the Act requires that the Commissioner of the Environment and Sustainable Development examine and report on the Government's implementation of climate change mitigation measures at least once every five years. It also requires the Minister of Finance, in cooperation with the Minister of Environment and Climate Change, to publish an annual report outlining key measures that federal departments and Crown corporations have taken to manage the financial risks and opportunities related to climate change.

4.2.2. Key Information Sources

An annual synthesis report on implementation of the *Pan-Canadian Framework on Clean Growth and Climate Change* is prepared by an intergovernmental committee and provided to the Prime Minister of Canada and provincial and territorial Premiers. These annual synthesis reports provide an update on Pan-Canadian Framework actions, and have been published for 2017, 2018, 2019 and 2020.

Beyond arrangements to oversee the implementation of the Pan-Canadian Framework, progress toward meeting Canada's 2030 GHG reduction target is also monitored through a number of public and corporate reporting tools for government policies and programs.

Canada's National Inventory Report, which is submitted annually to the United Nations Framework Convention on Climate Change, provides information on estimated total historical GHG emissions levels and helps track progress on Canada's target from one year to the next.[4]

Whether through the *Biennial Report* or through *Canada's Greenhouse Gas and Air Pollutants Emissions Projections*, Canada publishes annual detailed GHG emissions projections towards 2030, including future impacts of policies and measures taken by provinces and territories and projections by sector (see Chapter 5: Projections and the Total Effects of Policies and Measures of this report for further information on Canada's economy-wide GHG projections and an estimate of the total effect of policies and measures).

The *2019–2022 Federal Sustainable Development Strategy* (FSDS) was tabled in Parliament in June 2019 and a report on progress against its goals and targets, including Canada's GHG reduction target, was tabled in Parliament in December 2020. Following this, the 2022–2026 FSDS was developed, consulted on through public consultation, and was tabled in Parliament in November 2022. The 2022–2026 FSDS is the first to reflect newly strengthened provisions under the *Federal Sustainable Development Act*. Taking a whole-of-government approach, it brings sustainable development goals, targets, milestones and implementation strategies from 101 federal organizations together in one place. The FSDS tracks Canada's progress towards its sustainable development priorities, including Canada's GHG reduction target, through the achievement of short-term milestones and reporting on targets every three years.

4.2.3. Additional Accountability Mechanisms

In addition to those explicitly required under the new *Canadian Net-Zero Emissions Accountability Act*, several other mechanisms exist within the federal government to ensure accountability on climate progress.

The Commissioner of the Environment and Sustainable Development reports to the Auditor General and provides objective, independent analysis and recommendations on the federal government's efforts to protect the environment and foster sustainable development. The Commissioner conducts performance audits and is responsible for assessing whether federal government departments are meeting their sustainable development objectives, including on climate change. Reports and audits are tabled in Parliament and provide observations and recommendations for initiatives that require improvement. In addition to arrangements at the federal level, provinces and territories also have their own respective arrangements to audit the effectiveness of environmental policies and programs. Under the new *Canadian Net-Zero Emissions Accountability Act*, the Commissioner is also required to examine and report on the Government's implementation of climate change mitigation measures at least once every five years.

Departmental Results Frameworks[5] are another mechanism of the federal government to measure the progress and achievements of departments against core responsibilities such as taking action on clean growth and climate change. Departmental Results Frameworks provide the structure through which departments can report annually to Parliament and Canadians through reports such as the Departmental Plans[6] and Departmental Results Reports[7] that are tracking expected results and indicators articulated around departmental core responsibilities and supported by program inventories. The Clean Growth and Climate Change Horizontal Initiative Supplementary Table tracks federal government departments' collective progress in implementing the outcomes of the *Pan-Canadian Framework on Clean Growth and Climate Change*.[8]

4.2.4. Accounting Toward Canada's Economy-Wide Emission Reduction Target

4.2.4.1. Land Use, Land-Use Change and Forestry Accounting

Canada's LULUCF accounting contribution is calculated in accordance with UNFCCC guidelines and Canada's Nationally Determined Contribution submitted to the UNFCCC in July 2021, where a reference level approach is used for managed forest and associated Harvested Wood Products, and a net-net approach is used for all the other LULUCF sub-sectors.

Historical estimates for LULUCF focus on anthropogenic emissions and removals as a basis for reporting and accounting for LULUCF and undergo continual improvement as science matures and data on the management of the land sector is improved over time.

4.2.4.2. Contribution of Internationally Transferred Mitigation Outcomes

Canada recognizes that internationally transferred mitigation outcomes (ITMOs) have the potential to complement domestic efforts and contribute to sustainable development abroad. Other countries, including New Zealand, Switzerland, and Japan, have stated their intent to use ITMOs towards the achievement of their NDCs and climate plans. Following Canada's strong advocacy of robust international rules for ITMOs to ensure environmental integrity, transparency and the avoidance of double counting at COP26, efforts are ongoing to develop a federal policy on ITMOs.

4.3. Policies and Measures to Reduce Greenhouse Gas Emissions

This section provides a narrative overview of Canada's key policies and measures by economic sector, with an emphasis on measures that were recently adopted.[9] The chapter annex provides comprehensive tabular information on key policies and measures in place at the federal and provincial/territorial levels, as required by the National Communication guidelines (National Communication Table 1: Summary of Policies and Measures by Sector; Biennial Report Table 3). Within this section, policies are organized by economic sector, beginning with key federal policies and measures, followed by provincial and territorial measures. Cross-cutting measures are provided first, followed by economic sectors.

Priority was given to policies and measures that have the most significant impact on sectoral GHG emissions. For additional context, information is provided on key supporting and enabling measures, such as clean technology policies, investment programs, as well as efforts to green government operations.

Where mitigation estimates were not provided, Canada has indicated the reason why they were not included (see notation legend within the Annex of Chapter 4: Policies and Measures). For example, mitigation estimates were not provided for measures that are still under development, and/or for measures where it is difficult to estimate the direct mitigation impact. The methods for estimating expected emissions reductions from individual measures may vary by implementing entity and have been included on an as-provided basis. An estimate of the total mitigation impact of policies and measures—including interactive effects—is provided in Chapter 5: Projections and the Total Impacts of Policies and Measures.

4.3.1. Cross-Cutting Policies and Measures

Federal, provincial and territorial governments are implementing significant cross-cutting GHG mitigation measures that will reduce emissions across the economy. For example, strategies like carbon pricing, clean fuels, and reducing methane emissions will enable Canada to reduce emissions in the most flexible and cost-effective way. They will also provide policy certainty to businesses and Canadians, allowing everyone to make more informed decisions as Canada's economy decarbonizes.

4.3.1.1. The Regional Energy and Resource Tables

The Government of Canada launched the Regional Energy and Resource Tables (Regional Tables) on June 1, 2022, as a collaborative initiative to work closely with each provincial and territorial government, Indigenous partners, as well as industry, and other stakeholders to identify and pursue opportunities for economic growth, energy systems transformation, and sustainable job creation in each region of the country.

Canada is both a vast country and a decentralized federation where each region has a unique set of natural resources, energy systems, labour markets and regulatory approaches, and therefore the economic opportunities available to each region will vary across the country. The Regional Tables aim to position every region in Canada to leverage its comparative advantage in the net-zero future.

There are three main elements to this process:

1. Close bilateral partnerships between federal and provincial and territorial governments to identify and accelerate a common list of the key economic growth priorities in each province and territory;
2. A tailored approach to engagement with Indigenous partners to reflect their priorities and perspectives on regional opportunities; and,
3. A process to seek input from experts, industry, labour, non-profit organizations, and others.

Following identification of the key economic growth priorities, joint action plans will be developed, setting a path forward for active collaboration between the federal and provincial and territorial governments over the next two years. These action plans will focus on tangible actions to align resources and investment, regulatory and permitting processes, and policy tools, and to identify the key issues and barriers to be overcome.

This initiative will culminate in the development of comprehensive place-based economic strategies that consider pathways to achieve economic growth opportunities and the enabling conditions such as building the workforce needed to advance these opportunities. These strategies will integrate Indigenous perspectives on regional opportunities, incorporate input from experts, and engagements with industry, labour and others.

The Government of Canada is taking a phased approach to launch a Regional Table in every jurisdiction, with an aim to launch the process in all jurisdictions by early 2023.

4.3.1.2. Just Transition Through the Creation of Sustainable Jobs

The Government of Canada is committed to ensuring a just transition to a low-carbon economy for Canadian workers and communities, alongside efforts to reduce emissions. To date, Canada has undertaken action to support coal power workers and communities transition away from coal-fired electricity. This includes establishing a Transition Task Force for Coal Power Workers (JTTF) in 2018, which delivered its final report in 2019, informing the Government's approach. This includes $185 million to support economic diversification and skills development in affected communities in Alberta, Saskatchewan, Nova Scotia and New Brunswick. As of September 2022, a total of over $84 million has been allocated to 79 projects across the four provinces.

Building on this work, the Government of Canada is committed to comprehensive action, including legislation, to ensure a just transition by helping to create sustainable jobs for Canadians, for generations to come. Virtual and online consultations on proposed sustainable jobs legislation were launched in July 2021 and concluded in 2022. The Government heard from more than 30,000 individuals and organizations in written submissions and held 17 roundtables with labour, industry, civil society, academia, and non-governmental organizations, along with engagement with provinces, territories and Indigenous partners. The proposed legislation is intended to codify the principles already at the heart of this Government's climate action, that the transition to a low-carbon economy should be equitable and prosperous for workers and communities. For the most up to date information on Canada's sustainable jobs action please visit: Just Transition | Natural Resources Canada (rncanengagenrcan.ca).

At COP26, Canada joined other nations in signing the Just Transition declaration to support the conditions for a just transition internationally. Recognizing the challenges faced by developing countries in phasing out coal, Canada will provide up to $1 billion to the Climate Investment Funds Accelerated Coal Transition Initiative to expand access to clean power and to support a fair, inclusive transition for coal workers and communities around the world.

4.3.1.3. Putting a Price on Carbon Pollution

The principle for putting a price on carbon pollution is straightforward: carbon pollution has a cost, and so businesses and households should pay for their carbon pollution. The higher the price, the greater the incentive to pollute less, conserve energy, and invest in low-carbon solutions.

Carbon pricing is the cornerstone of Canada's approach to climate action. Canada is leading the charge on sending the price signals needed to transform the economy. At COP26 in Glasgow, Canada called for global leaders to work together to triple the global emissions covered by carbon pollution pricing to 60 percent by 2030. At COP27, Canada convened a new partnership of countries committed to achieving this goal.

Since 2019, every jurisdiction in Canada has had a comparable price on carbon pollution. Canada's approach is flexible: any province or territory can design its own pricing system tailored to local needs, or it can choose the federal pricing system. The federal government sets minimum national stringency standards (the "benchmark") that all systems must meet to ensure they are comparable and effective in reducing GHG emissions. If a province or territory decides not to price carbon pollution, or proposes a system that does not meet these standards, the federal system is applied. In August 2021, the federal government published strengthened benchmark criteria that all pricing systems will need to meet from 2023 to 2030.

A key element of the federal benchmark is the price on carbon pollution.[10] The price on carbon pollution started at $20 per tonne of emissions in 2019—and has been rising at a predictable rate of $10 per year to reach $50 in 2022. Starting in 2023, the price will start rising by $15 per year until it reaches $170 per tonne in 2030. The price schedule is laid out to 2030 to create certainty, which is important for attracting private sector investment.

The federal carbon pollution pricing system has two parts: a regulatory charge on fossil fuels like gasoline and natural gas (the "fuel charge"), and a performance-based emissions trading system for industries, known as the Output-Based Pricing System (OBPS).

Fuel Charge

The federal fuel charge applies in Ontario, Manitoba, Saskatchewan, Alberta, Yukon, and Nunavut and will be applied in Newfoundland and Labrador, Nova Scotia and Prince Edward Island as of July 1, 2023. Applying the fuel charge at predictably higher rates over time will help to reduce GHG emissions and support clean growth. It also sends a signal to markets and provides an increasing incentive to choose cleaner sources of energy and reduce energy use through conservation and efficiency measures.

Output-Based Pricing System

The OBPS applies to industrial emitters that are emissions intensive and trade exposed. It ensures there is a price incentive for industrial emitters to reduce their emissions, spurring innovation and encouraging the adoption of cleaner technologies and fuels while minimizing competitiveness and "carbon leakage" risks (i.e., the risk of industrial facilities moving from one region to another to avoid

paying a price on carbon pollution). The federal OBPS applies in Prince Edward Island, Manitoba, Yukon, and Nunavut, and was applied partially in Saskatchewan until 2023. All other provinces and territories are implementing their own pricing systems for industrial emitters, aligned with the federal benchmark.

Carbon Pollution Pricing Proceeds

Ensuring that the direct proceeds of the federal price on carbon pollution remain in the province or territory where they were collected, and are used to support individuals, households, and communities, is an important component of the federal pricing system.

The Government of Canada has established a globally recognized pricing system focused on affordability, putting money back in the pockets of Canadians, and incentivizing decarbonization throughout the economy. Ensuring effective carbon pollution pricing systems are in place across Canada and a strong price signal across the economy is key to achieving Canada's climate objectives. Provinces and territories submitted plans for updates to their carbon pollution pricing systems in fall 2022 showing how they would be adjusted to align with the strengthened benchmark for 2023 to 2030, and are now finalizing implementation of these plans.

Ensuring Carbon Pricing Certainty

To enhance long-term certainty, the Government of Canada is exploring measures that help guarantee the future price of carbon pollution. In the 2022 Fall Economic Statement, the Government announced that contracts for difference would be offered under the new Canada Growth Fund. These contracts can provide greater certainty regarding future carbon costs and benefits for low-carbon project investors. The Government may also explore legislative approaches to support a durable price on carbon pollution. The Government of Canada will provide an update on these exploratory efforts in Canada's 2023 Progress Report under the *Canadian Net-Zero Emissions Accountability Act*.

Developing Canada's Domestic Offset System

The Government launched Canada's Greenhouse Gas (GHG) Offset Credit System on June 8, 2022, including:

- publication of the *Canadian Greenhouse Gas Offset Credit System Regulations* under the *Greenhouse Gas Pollution Pricing Act* (GGPPA);
- publication of the first federal offset protocol on *Landfill Methane Recovery and Destruction* to incentivize methane emission reductions from landfill sites that do not have legal requirement to do so; and,
- availability of the credit and tracking system to register offset projects and issue and track credits.

Canada's GHG Offset Credit System has been designed to encourage voluntary project activities across Canada that reduce GHG emissions or remove them from the atmosphere by allowing the generation of offset credits from projects implemented using a federal GHG offset protocol. This system encourages cost-effective, voluntary emissions reductions and removals from activities that go beyond legal requirements and common practice, as well as those not covered by carbon pollution pricing systems—further expanding the financial incentives to reduce carbon pollution.

Facilities covered by the Federal OBPS can use federal offset credits as a compliance option, while other groups, including governments and businesses, can use federal offset credits to meet other climate objectives.

Federal offset protocols outline specific requirements for a given project type and are developed on an ongoing basis outside of the Regulations. In addition to the first protocol published in June 2022, the Government also worked on developing protocols on: reducing emissions from high global warming potential (GWP) gases in refrigeration systems; sustainable agriculture to incentivize land management practices which enhance sequestration of organic carbon in soil, and to reduce enteric emissions from livestock; improving forest management; and, technology-based GHG removals projects such as direct air carbon dioxide capture and sequestration. As protocols are completed, the Government will continue to develop new protocols in order to incentivize further GHG reductions compared to business-as-usual practices.

Continuing to Use Carbon Pollution Proceeds to Support Canadians

Starting in 2022, the Government of Canada has been using proceeds collected through the federal fuel charge to support families through quarterly payments. The Government of Canada is also providing targeted support that recognizes the unique circumstances of Indigenous Peoples, farmers, and small and medium-sized businesses.

Using funds collected under the federal OBPS, the Government of Canada has introduced the Decarbonization Incentive Program and the Future Electricity Fund. The Decarbonization Incentive Program will support the deployment of clean technology projects to further reduce GHG emissions by incentivizing long-term decarbonization of Canada's industrial sectors. The Future Electricity Fund will support the production and delivery of clean electricity as well as its efficient use.

4.3.1.4. Key Investments

Low Carbon Economy Fund

Launched in June 2017, the Low Carbon Economy Fund (LCEF) was an important part of the *Pan-Canadian Framework on Clean Growth and Climate Change*. The LCEF supports projects that help to reduce Canada's greenhouse gas emissions, generate clean growth, build resilient communities, and create good jobs for Canadians. These projects are critical as Canada continues to build a sustainable net-zero emissions economy by 2050. Since 2017, the LCEF has supported approximately 132 projects across Canada in emissions-reducing technologies such as wind power, solar power and electric heating in buildings.

In the *2030 Emissions Reduction Plan* and in Budget 2022, the Government of Canada announced it was expanding the Low Carbon Economy Fund by investing an additional $2.2 billion over seven years, starting in 2022-23. From this new funding, up to $250 million over four years will help homeowners transition from home heating oil to more affordable and greener home heating sources, like electric heat pumps. This funding, which will focus on supporting lower-income households, will help interested provinces and territories expand existing programs or create new initiatives. The new LCEF funding will also support climate action by Indigenous Peoples with a new $180 million Indigenous Leadership Fund. This will support clean energy and energy efficiency projects led by First Nations, Inuit, and Métis communities and organizations.

Canada Growth Fund

The Canada Growth Fund was announced in Budget 2022. The fund will be initially capitalized at $15 billion over the next five years and will invest on a concessionary basis, with the goal that for every dollar invested by the fund, it will aim to attract at least three dollars of private capital. The Growth Fund will be launched by the end of 2022. Investments will help meet the following important national economic policy goals:

- Reduce emissions and achieve Canada's climate targets;
- Accelerate the deployment of key technologies, such as low-carbon hydrogen and carbon capture, utilization, and storage (CCUS);
- Scale up companies that will create jobs, drive productivity and clean growth, and encourage the retention of intellectual property in Canada; and,
- Capitalize on Canada's abundance of natural resources and strengthen critical supply chains to secure Canada's future economic and environmental well-being.

4.3.1.5. Clean Technology and Innovation

The Government of Canada is committed to innovation-backed economic development, which is being implemented through an array of federal programs and services, with support for clean technology across the innovation spectrum.

Energy Innovation Program

The Energy Innovation Program (EIP) advances clean energy technologies that will help Canada meet its climate change targets, while supporting the transition to a low-carbon economy. It funds research, development and demonstration projects, and other related scientific activities. Managed by the Natural Resource Canada's Office of Energy Research and Development (OERD), EIP has an annual grants and contributions budget and runs targeted calls, and other strategic collaboration and investments programs. It also provides funding for world-class research and development in Federal laboratories and research centres. Additionally, as part of Budget 2021, the government is investing $319 million into research, development, and demonstrations to advance the commercial viability of CCUS technologies.

Federal programming under Innovation, Science and Economic Development Canada's portfolio includes:

- For research and development, the National Research Council's Industrial Research Assistance Program (IRAP) provides advisory services, connections, as well as financial support, to help firms build their innovation capacity.
- For early demonstration and pre-commercialization innovations, Sustainable Development Technology Canada (SDTC) provides funding to Canadian companies with the potential to become world leaders in addressing climate change and clean air, water and soil. Since 2001, over $1.5 billion has been allocated to support pre-commercial cleantech companies through SDTC.
- For large-scale projects, the $8 billion Strategic Innovation Fund–Net-Zero Accelerator (SIF-NZA) provides federal funding to support the transition of Canada's economy towards a low-carbon future through projects that reduce GHG emissions, advance innovation, technology adoption and the commercialization of clean technologies.
- For ecosystem development, Budget 2022 confirmed an investment of $750 million in Phase II (2023-24 to 2027-28) of the Global Innovation Clusters program to further build innovation ecosystems in areas of Canadian competitive advantage, with an explicit focus on advancing cross-cutting priorities, including combatting climate change.

Clean Growth Hub

Launched in 2018, the Clean Growth Hub (Hub) is a unique whole-of-government focal point for clean technology, dedicated to helping Canadian clean technology innovators and adopters navigate federal programs and services most relevant to their needs. The Hub provides tailored advisory services to help stakeholders access federal programs, ranging from early technology readiness levels (TRLs) to scaling up already commercialized technologies.

As of January 2022, the Hub has served over 2,500 clients that range from small innovative firms with high potential for disruption to large adopters in high-emitting industries. By bringing together participants from many departments and agencies, the Hub streamlines client services for clean technology projects, improves federal program coordination, enables tracking and reporting on clean technology, and connects stakeholders to international markets.

Industrial Decarbonization Team

The Industrial Decarbonization Team was launched in 2022 to support the development and financing of transformative, multi-company decarbonization projects in Canada's industrial sectors that will result in significant greenhouse gas emissions reductions. The Team helps project proponents coordinate between federal and provincial stakeholders to identify applicable funding opportunities and ensure alignment with key governmental priorities.

Global Innovation Clusters

Canada's Global Innovation Clusters program (formerly the Innovation Superclusters Initiative) announced in February 2018 provides support for clusters in five areas of competitive advantage: Digital Technologies, Protein Industries, Advanced Manufacturing, Scale AI, and Ocean technologies. Each cluster is led by a not-for-profit organization that co-invests with industry and academia to build first-rate ecosystems to help scale up leading SMEs and accelerate economic growth. As announced in Budget 2022, the program is entering Phase II, with a focus on expanding clusters' national and international presence, collaborating to deepen the clusters' impact, and advancing joint missions aligned with key government priorities, such as fighting climate change and addressing supply chain disruptions.

Since 2012, Export Development Canada (EDC) has facilitated approximately $20 billion in cleantech exports. In 2021, EDC facilitated $6.3 billion-worth of business for cleantech—a 39 percent year-over-year increase from 2020. Support for clean technology companies is an important piece of EDC's 2030 corporate strategy and their commitment to net-zero emissions by 2050.

Investment Tax Credits

In its 2022 Fall Economic Statement, the Government of Canada announced $6.7 billion over five years to support an investment tax credit for clean technologies equivalent to 30 percent of the capital costs of investments in technologies such as electricity generation systems; stationary

storage energy systems; low-carbon heating equipment; industrial zero-emission vehicles and related charging or refueling equipment. To incentivize companies to create good jobs, those that adhere to certain labour conditions will be eligible for the full 30 percent credit, while those that do not will only be eligible for a credit of 20 percent. The ITC will be gradually phased out between 2032 to 2034, and no longer in effect at the start of 2035.

An investment tax credit to support clean hydrogen projects will also be launched. The credit will be refundable based on the life cycle carbon intensity of hydrogen and should be available for investments made by the time Budget 2023 is tabled.

Budget 2022 also proposed a refundable investment tax credit for businesses that incur eligible CCUS expenses, starting in 2022. The investment tax credit would be available to CCUS projects to the extent that they permanently store captured CO_2 through an eligible use.

Canadian Innovation and Investment Agency

Budget 2022 announced the government's intention to establish a Canadian innovation and investment agency, and committed $1 billion over five years, starting in 2022-23. The Canadian agency will work to help new and established Canadian firms innovate, commercialize research, and create new economic opportunities for workers and businesses in Canada. The agency will be accountable to Parliament but will operate independently from government on a day-to-day basis and draw on private sector experts to create new jobs, generate new and improved goods and services, and help Canadian businesses succeed in a changing global economy.

4.3.1.6. Government Leadership

The Centre for Greening Government was created in 2018 within the Treasury Board of Canada Secretariat (TBS). The Centre's mandate is to ensure that Canada is a global leader in government operations that are net-zero, resilient and green. The Centre is responsible for leading the federal Greening Government Strategy, which is committed to the green procurement of goods and services to aid the transition to a less carbon-intensive economy.

The Greening Government Strategy was launched in 2017 and is a set of government-approved commitments that apply to all core government departments and agencies with an objective to make Government of Canada's operation net-zero emissions by 2050 and climate-resilient. Commitments are focused on four key areas: Mobility and Fleet; Property and Workplaces; Climate-Resilient Services and Operations and Procurement of Goods and Services. Crown corporations with significant real property, fleet and procurement are also encouraged to adopt the Strategy or an equivalent set of commitments, including the commitment to net-zero emissions by 2050.

4.3.1.7. Cross-Cutting Provincial and Territorial Measures

Alberta's Technology Innovation and Emissions Reduction Regulation requires facilities to reduce their emissions intensity to meet a high-performance benchmark. Regulated facilities have three compliance options: submit emissions performance credits; submit Alberta Emission Offsets generated from qualifying emissions reductions outside of regulated facilities; or obtain fund credits by paying the prescribed price ($50 per tonne of CO_2 eq in 2022) to the TIER Fund.

The Québec government's cap-and-trade system for greenhouse gas emissions has been in operation since 2013 and has been fully linked to California's system since 2014. The Québec system covers industry, electricity production and imports as well as fuel distribution, which together account for about 85 percent of Québec's GHG emissions. Caps have been set on a declining linear trajectory to help achieve Québec's GHG emission target of 37.5 percent below 1990 levels.

In 2021, B.C. released the CleanBC Roadmap to 2030, a follow-up plan to CleanBC released three years earlier, that includes a range of accelerated and expanded actions to reduce emissions across eight pathways: low carbon energy; transportation; buildings; communities; industry, including oil and gas; forest bioeconomy; agriculture, aquaculture and fisheries; and negative emissions technologies.

4.3.2. Electricity Sector

Canada uses all forms of renewable energy sources for power generation. In the Electricity Sector, hydroelectricity is the largest renewable energy source in Canada; in 2020 accounting for 60 percent of Canada's electricity generation. Other renewable energy sources, such as biomass, wind, tidal and solar, contribute to increasing this share to 68 percent. When adding nuclear energy, nearly 83 percent of Canada's electricity generation does not emit greenhouse gases.

Canada continues to reduce GHG emissions in this sector through a number of actions. Working towards net-zero electricity by 2035 will expand non-emitting energy across Canada, connect regions to clean power, and foster a cleaner, more reliable, and affordable electricity supply. It will also enable economy-wide electrification and help reduce emissions from other sectors, such as industry, buildings, and transportation. Some provinces and territories already have nearly completely non-emitting electricity systems, including Yukon, Newfoundland and Labrador, Manitoba, British Columbia, and Québec. All provinces in Canada are continuing to take actions to increase the use of renewable energy through policies, initiatives and measures such as renewable energy targets, legislated renewable portfolio standards, competitive procurement processes, net metering arrangements, equipment rebates and tax credits.

4.3.2.1. Accelerating the Coal Phase-Out, Natural Gas Regulations and Putting a Price on Carbon Pollution

Coal-fired power is currently the biggest source of emissions in the Electricity Sector. The Government of Canada has passed regulations to accelerate the phase out of unabated coal-fired electricity by 2030, which is expected to cut carbon pollution by approximately 13 Mt in 2030.

The federal natural gas regulations complement the coal regulations and impose attainable performance standards on new natural gas generators. Carbon pollution pricing also applies to all electricity generators in provinces under the Federal Output-Based Pricing System (OBPS) to provide an economic signal to decarbonize generation.

4.3.2.2. Net-Zero Electricity by 2035 and the Clean Electricity Regulations

The Clean Electricity Regulations (CER) will be part of a suite of federal measures to move Canada's Electricity Sector to net-zero. The CER would help drive progress towards a net-zero electricity grid by 2035, while maintaining system reliability and electricity affordability for customers. The CER will set emissions performance standards for fossil-fuel fired electricity generation under the *Canadian Environmental Protection Act, 1999*. Public engagement was launched in March 2022 with a discussion paper and a proposed regulatory frame was published in July 2022 for public comment.

4.3.2.3. Funding Cleaner Grids

To meet the rising demand for non-emitting electricity, the Government of Canada has invested in several programs to deliver more clean and reliable power. These include the Smart Renewable Electrification Pathways Program, which was recapitalized with an additional $600 million in Budget 2022 (total funding $1.564 billion), and funds smart renewable energy and electrical grid modernization projects; the $100 million Smart Grid Program that invests in demonstration and deployment of smart grid technologies and systems; the $20 million PowerForward Challenge in collaboration with the UK government, and the $200 million Emerging Renewable Power Program that supports new renewable power projects to expand Canada's portfolio of commercially viable resources. The Canada Infrastructure Bank also has a priority investment area in clean power that has supported projects such as the Oneida Battery Storage: a 1,000 megawatt-hour energy storage development project made in partnership with the Six Nations community in Ontario.

4.3.2.4. Making Connections through Grid Interties

Building regional interties allows regions to distribute abundant non-emitting power to regions with more emissions-intensive grids. The Government of Canada has been working with provinces and territories, as well as the Canada Infrastructure Bank, to make progress on regional interties, such as the Atlantic Loop Projects. This work has been supported through the $25 million Strategic Interties Predevelopment Program. Budget 2022 committed $250 million in support of an Electricity Predevelopment Program, which will support predevelopment activities associated with clean electricity infrastructure projects of national significance, such as grid interties and small modular reactors.

4.3.2.5. Reducing Reliance on Diesel in Remote and Indigenous Communities

Over 200 remote communities in Canada rely on diesel for electricity and heat. These communities consume on average 680 million litres of diesel fuel every year. These diesel-reliant communities are largely Indigenous and located in remote areas from coast to coast to coast. The Government of Canada is currently supporting more than 200 renewable energy and capacity-building projects across Canada.

In 2022, the Government of Canada announced an additional $300 million to support clean energy projects through the Clean Energy for Rural and Remote Communities Program. The Government of Canada has also created a single-window approach to access clean energy funding for Indigenous, rural and remote communities as they transition to clean energy. Building on reconciliation efforts, an Indigenous Council is being formed that will guide the programming and project approval process.

4.3.2.6. Supporting the Development of Small Modular Reactors

In December 2020, the Government of Canada launched the Small Modular Reactor (SMR) Action Plan to lay out the next steps to develop and deploy this technology as a potential tool to reduce emissions within Canada and abroad. The Government will continue to work with utilities, as well as provinces and territories, Indigenous Peoples and communities, industry, innovators, laboratories, academia, and civil society to advance SMRs through Canada's SMR Action Plan. This includes through the SMR Leadership Table and the Indigenous Advisory Council.

The Government of Canada demonstrated its continued support for SMRs on our net-zero pathway in Budget 2022, which included $69.9 million for Natural Resources Canada to support activities to minimize waste generated from SMRs, support the creation of a fuel supply chain, strengthen international nuclear cooperation agreements, and enhance domestic safety and security policies and practices. The Canadian Nuclear Safety Commission also received $50.7 million to build capacity to regulate SMRs, and work internationally on regulatory harmonization. Additionally, Budget 2022 expanded the scope of the CIB's mandate to allow it to invest in nuclear, laying the groundwork for its $970 million investment in the first among G7 grid-scale SMR at the Darlington Nuclear Generating Station. The federal government has also provided significant funding for SMR projects through Innovation, Science, and Economic Development Canada's Strategic Innovation Fund and the Atlantic Canada Opportunities Agency.

4.3.2.7. Provincial and Territorial Measures in the Electricity Sector

All provinces in Canada are taking actions to increase the use of renewable energy through policies, initiatives and measures such as renewable energy targets; legislated renewable portfolio standards; competitive procurement processes, net metering arrangements, equipment rebate and tax credits.

Nova Scotia's Renewable Electricity Regulations require 80 percent of electricity supply to be generated from renewable sources by 2030. This will involve the adoption of a diverse mix of energy sources including wind, tidal, solar, hydro and bioenergy. The mitigation impact of this measure is included in the estimate for the federal measure Reduction of CO_2 Emissions from the Amendments to the Coal-Fired Generation of Electricity Regulations.

To assist small scale power producers, the Government of Yukon's Microgeneration Policy enables individuals and businesses to install electrical generating systems and connect them to the grid. The electricity generated is consumed on site and any surplus can be sold into the grid.

In Northwest Territories, the Inuvik Wind Project is a key initiative within the 2030 Energy Strategy. The territory will install a single 3.5 megawatt wind turbine, a small battery storage system, a six-kilometre access road and a distribution line to reduce GHG emissions and support a secure grid in Inuvik.

Prince Edward Island (PEI) completed a cable interconnection upgrade within the Northumberland Strait, between the provinces of Prince Edward Island and New Brunswick. Two 180 megawatt cables will help meet the growing demand for electricity on PEI, deliver reliable, long-term energy for Islanders, and help balance the intermittent nature of growing wind energy supply.

4.3.3. Transportation Sector

Canada's Transportation Sector is the second-largest contributor to overall GHG emissions. According to data from the most recent *National Inventory Report* (2022), emissions from transportation were 159 Mt CO_2 eq in 2020, accounting for 24 percent of total emissions in Canada.

To meet Canada's climate objectives, it will be necessary to decarbonize the Transportation Sector in Canada through actions such as enabling active and public transportation, increasing the share of zero-emission vehicles (ZEVs)[11] on the road, and investing in clean fuels for all transportation modes, including established fuels for small ground transportation, sustainable aviation fuel for air travel and marine biofuels for the marine sector, and advanced clean fuels for all vehicle sizes.

4.3.3.1. Public and Active Transportation

Since 2015, the Government of Canada has made the most significant public transit investments in Canada's history, with over 10 times the federal investments made in the decade prior. Over $30 billion has been allocated to public transit through Infrastructure Canada's programs. Additionally, in 2021 the Government of Canada committed to permanent public transit funding of $3 billion per year beginning in 2026-27, to allow for careful and long-term project planning and delivery.

4.3.3.2. Light Duty Vehicles Targets

Through Canada's *2030 Emissions Reduction Plan*, Canada set a mandatory target for 100 percent of new light-duty cars and passenger truck sales to be zero-emission by 2035, and will also put in place a sales mandate to ensure at least 20 percent of new light-duty vehicle sales will be zero-emission vehicles by 2026 and at least 60 percent by 2030.

4.3.3.3. Zero-Emissions Vehicles Incentives

Budget 2022 investments included $1.7 billion for purchase incentives of up to $5,000 for eligible light-duty zero-emission vehicles through the Incentives for Zero-Emission Vehicles (iZEV) Program, which will now be funded until March 2025. This brings the total investments to $2.3 billion. Over 175,000 Canadians have used the incentive. Additionally, the Government has implemented a 100 percent tax write-off for businesses that purchase light-, medium-, and heavy-duty ZEVs.

Launched in July 2022, the Incentives for Medium- and Heavy-Duty Zero-Emission Vehicle Program (iMHZEV) received $547.5 million over four years and provides up to $200,000 for new eligible medium- and heavy-duty ZEVs. Additionally, the Government has implemented a 100 percent tax write-off for businesses that purchase light-, medium-, and heavy-duty ZEVs and included a proposal for a refundable tax credit equal to 30 percent of the capital cost of investments in industrial zero-emission vehicles and related charging or refueling equipment, such as hydrogen or electric heavy-duty equipment used in mining or construction, in the 2022 Fall Economic Statement.

4.3.3.4. Medium and Heavy-Duty Vehicles (MHDVs)

In addition to developing and deploying low-carbon fuels, Canada announced a target to achieve 35 percent of total medium- and heavy-duty vehicle (MHDV) sales being ZEVs by 2030. In addition, the Government will develop a regulation to require 100 percent MHDV sales to be ZEVs by 2040 for a subset of vehicle types based on feasibility, with interim regulated sales requirements. Canada continues to develop regulations for heavy-duty vehicles and engines that are aligned with the most stringent standards in North America (whether at the federal or state level in the United States). Canada will also develop a ZEV regulation for heavy-duty vehicles to require 100 percent sales to be zero-emission by 2040 for a subset of heavy-duty vehicle types based on feasibility, with interim 2030 regulated sales requirements that would vary for different vehicle categories based on feasibility, and explore interim targets for the mid-2020's.

Canada's freight industry represents the sector with the fastest growing emissions profile. This is why the *2030 Emissions Reduction Plan* committed to improve freight movement, fuel efficiency and transitioning of freight trucking fleet to ZEVs over time. To enable this, Budget 2022 provided $200 million over five years, starting in 2022-23, to update and expand the Green Freight Program to help freight companies to assess their energy usage, and adopt fuel efficient retrofits and clean fuel technologies, reducing their emissions and saving them fuel costs.

4.3.3.5. EV Charging and Alternative Refueling Infrastructure and Awareness

Infrastructure programs supporting deployment, demonstrations, and codes and standards, have provided over $450 million since 2016 for EV charging and alternative fuel infrastructure. Investments have supported the deployment of public charging and refueling stations across Canada, the demonstrations of next-generation and innovative charging and hydrogen refueling technologies, and the development of codes and standards.

Zero-emission vehicle infrastructure programming has resulted in the deployment of over 35,000 chargers to date. However, more is needed to reach Canada's new and ambitious ZEV sales targets. In support of the Government's objective of adding an additional 50,000 ZEV chargers to Canada's network, Budget 2022 also provided an additional $400 million to NRCan for deploying zero-emission vehicle infrastructure. This is complemented by $500 million that Canada's Infrastructure Bank will invest in large-scale ZEV charging and refueling infrastructure that is revenue generating and in the public interest.

Since 2019, the Zero Emission Vehicle Awareness Initiative provided nearly $7 million in funding across 46 projects. The initiative supports projects that increase awareness, knowledge, and public confidence in zero-emission vehicles as well as public charging and refueling stations.

4.3.3.6. Small Spark-Ignition Off-Road Equipment

The Government of Canada is exploring zero-emission standards for new off-road small spark-ignition engines (such as lawn and garden equipment). The federal government may also investigate the potential to advance zero-emission technologies and clean fuels for other types and applications of off-road equipment.

4.3.3.7. Aviation

The federal government is committed to the development of a whole-of-government approach on the long-term decarbonization of aviation, informed through ongoing engagement with industry and other stakeholders on a renewed action plan to reduce emissions from aviation, which could include initiatives to expand the production and use of low-carbon sustainable aviation fuel, and efforts to decarbonize and electrify airport operations in Canada. In September 2022, the government published the renewed Aviation Climate Action Plan, co-developed by the federal government and industry, which has a voluntary use target of 10 percent by 2030.

Furthermore, the Government of Canada will continue to work with international partners to increase ambition in International Civil Aviation Organization (ICAO) emission reduction goals and measures. This would include consideration of a long-term aspirational goal for reducing emissions from international aviation.

4.3.3.8. Marine

The Government of Canada is committed to the development of a national action plan to enable the marine sector to reduce its emissions, which could include engagement with stakeholders on energy efficiency/carbon intensity requirements for domestic vessels in line with requirements for international vessels.

The federal government will continue to work with international partners to develop measures to reduce black carbon in the Arctic from international shipping. The Government of Canada is collaborating with partners through the International Maritime Organization (IMO) to develop new international standards and recommended practices for marine vessels. This includes the implementation of IMO's short-term GHG reduction measures by January 1, 2023 and discussion regarding the development of medium- and long-term measures, including market-based measures.

Following a Request for Information for the procurement of low-carbon-intensity fuels for the federal air and marine fleet, Public Services and Procurement Canada (PSPC) is reviewing possible clean fuel suppliers to reduce GHG emissions from the federal marine fleet. Furthermore, Canada's ERP reiterates the Government of Canada's support for driving innovation to reduce emissions in the marine sector and the importance of clean fuels in the energy transition.

4.3.3.9. Rail

Building on successive voluntary agreements with industry, the Government of Canada will develop an action plan to decarbonize rail in line with Canada's net-zero by 2050 goal, which could include efforts to advance zero-emission locomotives and locomotive electrification.

4.3.3.10. Provincial and Territorial Measures in the Transportation Sector

British Columbia has passed the *Zero-Emission Vehicles Act* to phase in targets for the sale of zero-emission vehicles (ZEVs). New targets were announced in 2021 as part of the CleanBC Roadmap to 2030. New light-duty sales targets are 26 percent by 2026, 90 percent by 2030, and 100 percent by 2035. The government will continue to support these targets with steps to make ZEVs more affordable, including the CleanBC incentive program, which increased its eligible incentive limit to $4,000 in 2022, while also introducing income testing provisions. The province has also committed to creating sales targets for medium and heavy-duty ZEVs in consultation with automakers, businesses and industry in alignment with jurisdictions like California.

Ontario is providing $91 million to help make electric vehicle (EV) chargers more accessible to the public across the province, including highway rest stops, carpool parking lots, Ontario Parks and in community hubs like hockey arenas and municipal parks. The province will also introduce the Rural Connectivity Fund to support the installation of EV chargers in rural communities and encourage EV adoption outside of urban centres.

Through its 2022-2027 Implementation Plan, Québec has increased the target for zero-emission vehicles on the road up to 1.6 million by 2030; supported increased funding and incentives for public and private charging stations; and, continued support for the zero-emission vehicle rebate. Québec offers a rebate for new fully electric vehicles and plug-in hybrids, which varies from $2,500 to $7,000. In its *2030 Plan for a Green Economy*, Québec also announced its intention to ban sales of all new gas light-duty vehicles by 2035. In 2022 legislative changes were made to allow such regulation. Québec continues to provide up to $7,000 towards new eligible light-duty ZEVs through their Roulez vert program, and up to $175,000 for new eligible commercial ZEVs through the Écocamionnage program. These incentives combined with Québec's ZEV mandate are further pushing ZEV adoption in the province.

Prince Edward Island's Electric Vehicle (EV) Rebate Program provides rebates of $2,500 to $5,000 towards a plugin hybrid or new or used EV. From January 2021 to March 2022, there was a 237 percent increase in the number of zero-emission vehicles registered in PEI. This has included investments in EV charging infrastructure for homes, and businesses and multi-unit residential buildings.

4.3.4. Oil and Gas Sector

As a major economic contributor to Canada and its largest source of greenhouse gas emissions, the Oil and Gas Sector has a critical role to play in meeting the country's climate objectives.

Petroleum contributed nearly 4 percent to Canada's GDP in 2020 and employs thousands of Canadians throughout the country. Oil and gas production is concentrated in Alberta, Saskatchewan, British Columbia, and Newfoundland and Labrador, though there are producing wells in Ontario, Manitoba, New Brunswick, and Northwest Territories. Midstream infrastructure, refineries, bulk storage, and distribution networks are located in every province and territory. The sector is diverse, comprising a wide range of activities from exploration, drilling and extraction, to processing, transportation, and refining of multiple resources, including light oil, heavy oil, oil sands and natural gas. In 2020, the Oil and Gas Sector produced 179 Mt, or 27 percent of national greenhouse gas emissions. While emissions intensity performance has improved, overall emissions have climbed by 5 percent from 2005 to 2020 due to significant production growth. The oil sands are the biggest driver of new production and emissions growth, with production nearly tripling from 2005 to 2020, and emissions more than doubling from 35 Mt in 2005 to 81 Mt in 2020.

The sector will be transformed as the world pursues a clean energy transition to address climate change. To remain competitive in a tighter future market, Canadian production will have to reduce its carbon intensity while the sector also explores opportunities to transition to non-emitting products and services.

The following initiatives will reduce emissions and encourage innovation within the Oil and Gas Sector.

4.3.4.1. Oil and Gas Sector Emissions Cap

Canada is committed to the goal of lowering emissions from the Oil and Gas Sector at a pace and scale needed to achieve net-zero emissions by 2050 and make a meaningful contribution toward Canada's 2030 emission reduction target. This approach includes holding the Oil and Gas Sector accountable for its emissions guided by the country's climate ambitions and commitments outlined in the *2030 Emissions Reduction Plan*. An emissions cap will maximize opportunities to invest in decarbonizing the sector while accounting for evolving energy security considerations.

The Government of Canada has proposed two regulatory options in a discussion document published in summer 2020. The first is a new cap-and-trade system for the sector, while the second involves modifying the existing carbon pricing system. Canada is currently engaging with Canadians on the two options and plans to communicate the key details of the emissions cap in 2023.

4.3.4.2. Best-in-Class Guidance for New Oil and Gas Projects

The Government of Canada is developing guidance to support "best-in-class" GHG emissions performance for oil and gas projects throughout their lifetime. The guidance will apply to oil and gas projects subject to a federal impact assessment under the *Impact Assessment Act*. The guidance will require new oil and gas projects that are subject to a federal impact assessment to provide information about whether, when and how they will achieve "best-in-class" emissions performance, or if they cannot, to explain why not. A draft guidance document was released on October 4, 2022 for a 60-day comment period. The Government of Canada expects to finalize the best-in-class guidance by early 2023.

4.3.4.3. Methane Regulations

Federal regulations are in place that require the Oil and Gas Sector to take action to reduce methane emissions by 40 to 45 percent below 2012 levels by 2025. In 2021, Canada joined the Global Methane Pledge, which aims to reduce global methane emissions by 30 percent below 2020 levels by 2030. As part of this Pledge, Canada was the first country to commit to reducing methane emissions in the Oil and Gas Sector by at least 75 percent below 2012 levels by 2030. Canada is currently developing a strengthened regulatory approach to meet this commitment.

4.3.4.4. Clean Fuel Regulations

The recently finalized Clean Fuel Regulations (CFR) will require liquid fossil fuel (gasoline and diesel) suppliers to reduce the carbon intensity of the fuels they produce and import for use in Canada over time. The Regulations will increase the demand for clean fuels and will provide incentives through the generation of credits for the development and adoption of clean fuels (e.g., ethanol, renewable diesel, and advanced clean fuels), technologies (e.g., carbon capture), and processes (e.g., enhanced oil recovery). While the regulations do not require reducing the carbon intensity of aviation fuel, the production and import of sustainable aviation fuel is also eligible to generate credits.

4.3.4.5. Clean Fuels Fund

To support the CFR, Budget 2021 re-affirmed an investment of $1.5 billion for the Clean Fuels Fund to: 1) de-risk the capital investment required to build up clean fuel production capacity in Canada; 2) establish biomass supply chains to improve logistics for the collection, supply, and distribution of biomass materials as a feedstock in clean fuel production facilities; and, 3) to address gaps and misalignment in codes, standards and regulations related to the production, distribution and end-use of clean fuels. The call for project proposals for the production stream closed on October 13, 2021. A call for project proposals for Indigenous-led clean fuel projects was launched on February 11, 2022, and will remain open until funding is no longer available. A call for project proposals targeted to projects that support the establishment of biomass supply chains launched on August 25, 2022 and closed on November 23, 2022.

4.3.4.6. Emissions Reduction Fund

The $675 million Emissions Reduction Fund (ERF) – Onshore Program is helping Canadian onshore oil and gas companies invest in green solutions to continue their progress toward reducing methane emissions. The $42 million Offshore Deployment Program further positions the offshore oil and gas sector as a leader in Canada's transition to a low-carbon future. The $33 million Offshore RD&D Program is supporting research, development, and demonstration projects that advance solutions to decarbonize the offshore oil and gas industry.

4.3.4.7. Clean Growth Program

The Clean Growth Program (CGP), for which funding ended in March 2022, was a $155 million investment over five years in clean technology research, development, and demonstration projects in three Canadian Sectors: Energy (including oil and gas), Mining, and Forestry.

4.3.4.8. Energy Innovation Program

A component of the Energy Innovation Program, the Canadian Emissions Reduction Innovation Network (CERIN) aims to accelerate the development, validation and deployment of technologies that reduce emissions from the oil and gas sector. CERIN is jointly funded by NRCan, which contributes $11 million, and Alberta Innovates, which contributes $6 million.

4.3.4.9. Carbon Capture, Utilization, and Storage Investment Tax Credit

In Budget 2022, the Government of Canada announced details of an investment tax credit for capital invested in carbon capture, utilization, and storage (CCUS) projects to encourage the development and deployment of CCUS technologies. The investment tax credit would be available to CCUS projects that permanently store captured CO_2 in dedicated geological storage or in concrete. From 2022 through 2030, the Investment Tax Credit rates would be set at:

- 60 percent for investment in equipment to capture CO_2 in direct air capture projects;
- 50 percent for investment in equipment to capture CO_2 in other CCUS projects; and
- 37.5 percent for investment in equipment for transportation, storage and use.

The CCUS Investment Tax Credit will help de-risk CCUS investments, drive down costs and encourage wider market adoption of CCUS in Canada.

4.3.4.10. Provincial and Territorial Measures in the Oil and Gas Sector

Alberta's *Oil Sands Emissions Limit Act* provides a legislative framework for implementing an annual oil sands GHG emissions cap of 100 Mt for oil sands facilities with provisions for co-generation and new upgrading capacity. Emissions remain below the limit.

Saskatchewan released the *Methane Action Plan* in January 2019. The plan commits to introducing regulations that will reduce methane emissions in the upstream oil and gas sector by between 40 percent and 45 percent by 2025. It also commits to introducing a suite of new programs and policies that increase and accelerate opportunities to capture and commercialize methane. Under this plan, the province continues to establish flexible compliance options for industrial emitters who do not meet output-based performance standards (OBPS) and mandatory emissions reductions for venting and flaring.

Newfoundland and Labrador is working with the federal government to adopt methane emissions regulations that recognize the unique management structure of the offshore petroleum industries in that province. Newfoundland and Labrador will introduce regulations that will allow the Canada–Newfoundland and Labrador Offshore Petroleum Board to regulate methane emissions in a manner similar to *Canadian Environmental Protection Act, 1999* regulations.

4.3.5. Buildings Sector

Since 2005, emissions in the Buildings Sector have increased by 4.9 percent (4.1 Mt) as Canada's building stock continued to grow with population growth and commercial development. More than 80 percent of Canada's building stock will be made of existing buildings that are still in operation in 2030.

Buildings accounted for 13 percent of Canada's direct GHG emissions in 2020, or 88 Mt. Offsite generation of electricity for use in buildings brings the total to around 18 percent. This percentage could increase further if accounting for embodied carbon from the manufacturing of building materials such as concrete and steel. Over 85 percent of emissions from the Buildings Sector come from space and water heating, due to the use of fossil fuel equipment, such as natural gas furnaces, and extra energy demand to heat and cool buildings with insufficient envelope performance. Remaining emissions come from electricity used to power appliances, lighting, and auxiliary equipment.

Transitioning Canada's building stock to net-zero over the long-term will create opportunities for more local jobs in small and medium-sized businesses installing energy efficient equipment and insulation, work for architects and engineers and increased demand for energy auditors. This will also improve affordability through energy efficiency, and accelerate private financing.

Several initiatives were launched through Strengthened Climate Plan—A *Healthy Environment and a Healthy Economy*, including supports to retrofit homes and municipal and community buildings. The Government of Canada also established stringent targets for its buildings as part of the updated greening government strategy, including that all new federal buildings be net-zero. The plan also included accelerated efforts to invest in Canada's own capacity to make buildings and homes more efficient and to develop its own green buildings manufacturing sector and supply chains.

Additional initiatives that will reduce emissions within the Buildings Sector follow.

4.3.5.1. Canada Greener Homes Initiative

The Canada Greener Homes Initiative helps homeowners make their homes more energy-efficient, grow domestic green supply chains, and fight climate change. It provides grants of up to $5,000, as well as loans of up to $40,000, to help homeowners make energy efficient retrofits to their homes, as supported by EnerGuide evaluations.

4.3.5.2. Green and Inclusive Community Buildings

To help tackle emissions from community buildings across Canada—including community centres, sport facilities, and cultural spaces—the Government launched the Green and Inclusive Community Buildings program. This program commits $1.5 billion in projects that improve energy efficiency through retrofits, repairs or upgrades, and new builds, 10 percent of which is reserved for projects benefiting Indigenous communities.

4.3.5.3. Canada Infrastructure Bank's Growth Plan

As part of its Growth Plan, the Canada Infrastructure Bank (CIB) has targeted $2 billion in financing for large-scale public and commercial building retrofits. The CIB aims to create a model for investment and procurement for energy performance projects that can be self-perpetuating as the market normalizes and accelerates towards net-zero targets in 2050.

4.3.5.4. Energy Efficiency in Indigenous Housing

First Nation Infrastructure Fund (FNIF) supports energy efficiency on reserve and the Northern REACHE program supports Inuit and Indigenous communities in the north with renewable energy and energy efficiency projects.

4.3.5.5. Charting a Path to Net-Zero Emissions

To lay the foundation for a net-zero Buildings Sector, the Government of Canada will invest $150 million to develop a national strategy to achieve net-zero by 2050: the Canada Green Buildings Strategy. Working with provinces, territories and other partners, the strategy will build off existing initiatives and set out new policies, programs, incentives and standards needed to drive a massive retrofit of the existing building stock, and construction to the highest zero-carbon standards. Under the Canada Green Buildings Strategy, the government will launch a new Code Acceleration Fund to accelerate the adoption and implementation of the highest performance tiers of the national model energy codes, while addressing persistent challenges in Canada's codes system, and paving the way to a code for alterations for existing buildings.

Retrofitting the existing built environment is crucial to achieve net-zero goals. Under the Canada Green Buildings Strategy, Canada is introducing new initiatives to accelerate uptake of deep energy retrofits, such as the Greener Neighbourhoods Pilot Program and the $200 million Deep Retrofit Accelerator Initiative. The Deep Retrofit Accelerator Initiative will support capacity-building efforts, such as audits, project aggregation, and project management services, to accelerate deep retrofits of large buildings.

Under the *2030 Emissions Reduction Plan*, the Canada Greener Homes Loan program will receive an additional investment of $458.5 million. In addition, starting in 2023, an incremental grant of up to $5,000 will be available as a new stream of the Canada Greener Homes Grant program to help low- to median-income Canadian homeowners who are currently heating their homes with oil make the transition to affordable electric cold-climate heat pumps. Together, these measures and others will help Canadians reduce emissions, save money on renovations and heating and cooling costs, and stimulate well-paying jobs in the economy.

The National Research Council's (NRC) Construction 4.0 Program will reduce emissions from the Buildings Sector by implementing a National Platform to Decarbonize the Construction Sector at Scale. This platform consists of Challenge Programs to develop low-carbon and digitalized solutions, as well as a series of solutions to accelerate the scale and speed of deployments of low-carbon technologies at a pace for the Buildings Sector to achieve its 2050 GHG carbon reduction targets. These investments will leverage private sector capacity in support of climate change mitigation, spur the growth of Canada's clean technology sector, and help achieve Canada's international commitments to reduce GHG emissions.

4.3.5.6. Green Construction through Wood (GCWood)

According to the World Green Building Council, buildings are currently responsible for 39 percent of global energy-related carbon emissions: 28 percent from operational carbon, and 11 percent from embodied carbon. The GCWood program was funded under the *Pan-Canadian Framework on Clean Growth and Climate Change* in 2017, $54.9 million over five years (2018-19 to 2022-23). GCWood's main objective is to contribute to climate change mitigation by advancing innovative uses of wood in construction in Canada to displace higher carbon intensity and non-renewable building materials. GCWood provides contribution funding for demonstration projects that showcase the innovative use of wood, and supports work in research and development, technical guidance, and associated code development to support adoption of tall wood buildings into the National Building Code of Canada (NBC). Using wood as a low-carbon building material will help mitigate climate change by contributing to decarbonizing the built environment.

4.3.5.7. Provincial and Territorial Measures in the Buildings Sector

A variety of programs in British Columbia provide incentives for energy efficiency measures and clean fuel-switching. CleanBC Better Homes and Better Buildings includes incentives for renovating or building homes and other buildings, including rebates for energy efficiency upgrades such as new windows, rebates to convert from fossil fuel heating systems to all-electric air source heat pumps, incentives to do energy-saving studies and upgrades, and energy coaching services for homes and businesses

Nova Scotia homeowners on a low income can qualify for no-charge home efficiency upgrades through Efficiency Nova Scotia's Low Income Homeowner Service. Since 45 percent of the heat loss in a typical home occurs through the walls, floors and roof, a primary focus is on insulation and draft proofing. For those who qualify for the program, a certified energy advisor will conduct a home-energy assessment and energy efficient upgrades are provided at no cost to the homeowner. Program participants who heat with non-electrical heat sources save, on average, $900 per year.

In partnership with the Climate Change Secretariat (CCS), the Nunavut Housing Corporation (NHC) provides funding for homeowners in Nunavut to help offset the cost of installing a renewable energy system on their house. Homeowners are eligible for a non-repayable grant of up to 50 percent of total project costs, up to a maximum of $30,000.

The Government of Yukon's Good Energy Rebate program provides rebates for energy-efficient choices, including household appliances, products, services and heating systems, retrofits or upgrades to buildings and homes, purchasing clean transportation vehicles, and generating electricity from renewable energy sources.

4.3.6. Heavy Industry

Canada's Heavy Industry Sector plays an essential role in Canada's economy by supporting regional jobs, building prosperous communities across Canada, and producing important inputs for global supply chains. Heavy industry is the fourth highest emitting sector in Canada and includes mining and manufacturing of various industrial and commercial products, such as metals, chemicals and fertilizers, cement, and pulp and paper. Decarbonizing the harder-to-abate Heavy Industry Sector is essential for meeting Canada's 2030 climate target, and particularly important for Canada's 2050 target, in order to create jobs and build a sustainable, globally competitive economy in a net-zero environment.

Challenges to decarbonizing the Heavy Industry Sector include energy intensive processes, emissions inherent in producing industrial goods, the high cost and long lifespan of equipment, hard-to-abate process emissions associated with chemical processes, and trade exposure. To maintain its competitiveness, Canadian heavy industry needs to decarbonize its operations by sourcing clean electricity, using low-carbon fuels like hydrogen or biofuels, and integrating new zero-emissions technologies like small modular reactors and capturing carbon at the source. Although carbon pollution pricing sends signals to decarbonize, and regulations in some sectors will advance emission reductions, additional public and private investments are required. These investments will help to accelerate the development and adoption of the new technologies, clean fuels and innovative processes needed to transition to a net-zero emissions economy.

4.3.6.1. Strategic Innovation Fund—Net-Zero Accelerator (SIF-NZA)

The Government of Canada has launched the $8 billion Net-Zero Accelerator to support the decarbonization of Canada's largest industrial emitters, scale-up clean technology and accelerate Canada's industrial transformation across all sectors. Investments in the adoption of clean technology and processes through the SIF-NZA will reduce the GHG footprint of these industries by 2030, and create pathways to net-zero by 2050. Particular emphasis is placed on the development and adoption of solutions that help Canada's largest sources of industrial emissions move towards net-zero. The Net-Zero Accelerator is built around three investment pillars to maximize the decarbonisation potential:

- Decarbonization of large emitters: aimed at Canada's largest industrial emitting sectors such as oil and gas and heavy industry (steel, aluminium, cement, mining and mineral processing and chemicals) to reduce their current domestic GHG footprint faster and with less financial risk. This pillar primarily supports Canada's 2030 climate goals, while aligning with 2050 objectives. With the right investments, this pillar could preserve thousands of jobs across Canada for decades to come.
- Industrial transformation: aimed at ensuring that established industrial sectors remain successful and competitive in the net-zero global economy of the future. With a net-zero objective less than three decades away and rapidly increasing global competition in developing clean growth sectors, Canada's industrial base in key sectors such as automotive transportation, aerospace and electricity (or electrification) needs to shift quickly towards net-zero models.
- Clean technology and battery ecosystem development: aimed at capitalizing on emerging clean economy opportunities, establish Canada as a global clean tech leader and promote the development of clean technologies such as hydrogen, Carbon Capture, Utilization and Storage (CCUS) and a made-in-Canada battery ecosystem.

4.3.6.2. Enhance Efforts to Decarbonize Large Emitters

The Government of Canada will make further investments to support new technologies and projects that will reduce emissions now while developing low-emissions technologies for a net-zero emissions future.

- This includes investing $194 million to expand industrial energy management programming to support energy management systems, energy managers, cohort-based training, audits, and energy efficiency-focused retrofits.
- A comprehensive Carbon Capture, Utilization, and Storage (CCUS) / Carbon Management Strategy is also in preparation to guide the development and deployment of CCUS technologies to mitigate GHG emissions from a range of industrial sectors in Canada, such as steel, cement, chemicals, and the oil and gas sector. CCUS will be a critical technology area for Canada to develop in order to achieve its climate and energy goals.
- In 2021-22, the Energy Innovation Program launched a Clean Fuels, Industrial Fuel Switching and Hydrogen Codes and Standards funding call for research, development and demonstration projects focused on accelerating decarbonization in hard-to-abate sectors.

4.3.6.3. Strengthen Canada's Mining Sector While Reducing Emissions

Building on initiatives such as the *Canadian Minerals and Metals Plan*, the Government of Canada has committed to improving critical mineral supply chain resiliency to support the transition to a green and digital economy.

Budget 2022 proposed up to $3.8 billion to implement Canada's first *Critical Minerals Strategy* to strengthen supply chain resiliency, develop critical minerals industries in Canada, and strengthen Canada's global leadership in critical minerals. It is proposed this funding will support a broad range of initiatives including geoscience and exploration, R&D and innovation, project development, critical minerals infrastructure, Indigenous economic reconciliation, Northern regulatory development, and enhancing Canada's global leadership and security in critical minerals.

Building on the success of Canada's "Mines to Mobility" approach—which has attracted major investments in the manufacturing of zero-emission vehicles—the Strategy plans to pursue an "Exploration to Recycling" approach to critical minerals. This means developing capacity at each stage of the value chain, from exploration to recycling, and everything in between. It will allow Canada to become a leader in critical minerals development and processing, ensure public benefits from increased value-added manufacturing, and provide the inputs necessary to reach our net-zero commitments.

The Strategy will focus on three priority value chains:

- Clean technologies—energy transmission systems, permanent magnets, wind turbines, panels, advanced batteries, hydrogen fuel cells, and small modular reactors;
- Semiconductors and information and communication technologies; and,
- Advanced manufacturing inputs and materials—ceramics, high value-added metals, electronic materials, composites, polymers, and biomaterials.[12]

As well, the Strategy will concentrate on six thematic areas:

- Driving research innovation and exploration to better target resource potential and deposits, and stimulate investment;
- Accelerating project development for Canada's critical minerals mining, processing, materials/inputs, and recycling projects to support our transition to the green and digital economy;
- Advancing Indigenous reconciliation through access to capital, meaningful participation in critical minerals projects and associated business opportunities;
- Growing a diverse workforce by promoting the contribution of diverse workers to Canada's green energy transition as part of the critical minerals workforce;
- Building sustainable infrastructure to connect communities with critical minerals development opportunities; and,
- Strengthening global leadership and security by developing resilient global supply chains shielded from market disruption while enhancing Canada's economic security.

The Government of Canada published *Canada's Critical Minerals Strategy* in December 2022.

4.3.6.4. Net-Zero Challenge

The Government of Canada launched the Net-Zero Challenge in August 2022. The Net-Zero Challenge is a made-in-Canada approach that is meant to be complementary to and aligned with many other international net-zero initiatives. This includes the United Nation's Race to Zero Campaign aimed at accelerating the momentum towards a decarbonized economy and achieving net-zero emissions by 2050.

First announced in Canada's 2020 strengthened climate plan, *A Healthy Environment and a Healthy Economy*, the Net-Zero Challenge is a voluntary initiative that aims to encourage businesses to develop and implement credible and effective plans to transition their facilities and operations to net-zero emissions by 2050. The goals of the Net-Zero Challenge are to normalize net-zero planning so that it becomes the default business practice, build momentum through guidance and leadership, and reduce GHG emissions from industrial and other sectors. A technical guide provides descriptive guidance for companies new to net-zero planning, on constructing a greenhouse gas inventory, conducting scenario analysis and identifying mitigation strategies.

4.3.6.5. Research for a Low-Carbon Industrial Sector

The National Research Council (NRC) is supporting emissions reductions through its Industrial Research Assistance Program (NRC IRAP). This program provides advice, connections and funding to Canadian small- and medium-sized enterprises, including those working in clean technology to support Canada's transition to a low-carbon economy. NRC IRAP supported 412 new clean technology projects in 2021-22, with $72.5 million in IRAP funding for clean technology projects.

Sustainable Development Technology Canada (SDTC) plays a key role in advancing demonstration projects for clean technologies in the industrial sector, including in working with their portfolio of small- and medium-sized enterprise to identify follow-on funding and opportunities to scale and deploy their technologies more broadly.

In addition, the NRC's Materials for Clean Fuels Challenge Program develops new materials for zero-emission transportation fuels and chemical feedstock across the continuum from discovery to commercialization. Through collaborative partnerships with key stakeholders, the program advances a unique initiative to bring disruptive solutions to the design, development and delivery of clean fuels and chemicals in Canada. As such, the Materials for Clean Fuels Challenge Program contributes significantly to GHG reduction across a variety of industrial sectors.

NRCan's Energy Innovation Program, is providing up to $53 million to advance projects and technologies to address hard-to-abate segments of industrial emissions and create pathways for the use of cleaner through its Clean Fuels and Industrial Fuel Switching call. This call featured three focus areas: clean fuels, industrial fuel switching, and hydrogen codes and standards.

4.3.6.6. Provincial and Territorial Measures in the Industrial Sector

Renewing Alberta's Mineral Future sets a framework to capitalize on Alberta's vast mineral resources, and to expand the minerals industry in a sustainable way to meet the demands of an electrifying economy. As the first step toward implementation of the *Minerals Strategy and Action Plan*, the Government of Alberta passed Bill 82: the *Mineral Resource Development Act* in December 2021 to improve the regulatory environment and promote responsible mineral resource development.

Ontario is developing a critical minerals strategy to support Ontario's transition to a low-carbon economy within the province, and abroad. Ontario's Budget 2022 allocated $5 million over two years to create a Critical Minerals Innovation Fund to support the mining industry, academia, start-ups, and research and developing firms to find innovative solutions for extraction and processing of critical minerals.

4.3.7. Waste Sector

The municipal solid Waste Sector encompasses disposal (landfill or incineration) and diversion (recycling and composting) and Statistics Canada collects data from companies and municipalities that manage these streams. Canada's Waste Sector is responsible for 4 percent of Canada's total emissions, and released 27.3 Mt of emissions in 2020, according to data from the most recent *National Inventory Report* (2022). The chief contributor to the Waste Sector emissions is solid waste disposal (landfills), which in 2020 accounted for 22.1 Mt of emissions (81 percent of the Waste Sector's emissions).

Canadian landfills are releasing large quantities of methane—a potent greenhouse gas. In 2018, the federal, provincial and territorial governments approved the Canada-wide Strategy on Zero Plastic Waste and endorsed two aspirational waste reduction goals to decrease waste by 30 percent by 2030 and 50 percent by 2040.

Federal, provincial, territorial and municipal governments, Indigenous communities and organizations, and the private sector have been working to cut GHG emissions from the Waste Sector, particularly by addressing landfill methane emissions and increasing waste diversion. However, the approach across Canada is uneven and emissions have not decreased for over a decade. To decarbonize this sector further, landfills across Canada need to capture more of the methane they generate, and seize the opportunity to convert methane into clean energy. Actions to reduce generation and increase diversion of biodegradable waste (the source of landfill methane) are also needed to achieve longer-term emission reductions. The following initiatives, among others, will help achieve these objectives.

4.3.7.1. Landfill Methane Regulations

The Government of Canada is developing new regulations to increase the number of landfills that collect and treat methane. Consultations on the development of the regulations took place in early 2022.

4.3.7.2. Food Waste Reduction

In 2020, the Government of Canada launched the Food Waste Reduction Challenge, a $20 million initiative over five years to incentivize developing and deploying innovative new solutions to reduce food waste across the supply chain.

4.3.7.3. Investments in Waste and Recycling Infrastructure

The Government of Canada has made significant investments to enhance waste and recycling infrastructure, and reduce greenhouse gas emissions, through, for example, the Investing in Canada Infrastructure Program and the Canada Community Building Fund (formerly the Gas Tax Fund).

4.3.7.4. Zero Plastic Waste Target

The Government of Canada has adopted a comprehensive approach to advance towards its target of zero plastic waste. The approach includes a mix of regulations, infrastructure funding, support for best practices and investing in research through Canada's Plastics Science Agenda, innovation through the Canadian Plastics Innovation Challenges, and in community action through the Zero Plastic Waste Initiative. Reducing the amount of plastic waste and retaining plastics in the economy will be an important demonstration of the merits of a circular economy approach that will have multiple benefits, including reduced GHG emissions from the creation of new virgin plastics and from methane emissions from landfill disposal.

4.3.7.5. Provincial and Territorial Measures in the Waste Sector

CleanBC Plastics Action Plan has been released and has begun implementing actions such as shoreline clean-ups and changes to legislation, including the Recycling Regulation. B.C.'s Budget 2022 also invested an additional $10 million in the CleanBC Plastics Action Fund to support more B.C.-based innovations to reduce the use of plastic and make better use of recycled plastic. The Province has been investing funding towards organic waste diversion projects to decrease the quantity of organic waste going to landfills, prolonging existing landfill life, and reducing greenhouse gas emissions by avoiding methane emissions. $30 million of combined federal, provincial and recipient funding is being provided through the Organics Infrastructure Program (OIP), under the Low Carbon Economy Leadership Fund (LCELF) to fund over 14 new and expanded organics processing facilities. In addition, over $25.9 million of provincial funding is being provided through CleanBC's Organics Infrastructure and Collections program (OICP) to both fund the establishment of residential organics collection programs, and fund new and expanded organics processing facilities.

Manitoba is working to modernize its waste diversion and recycling framework, including the exploration of policy options to reduce the landfilling of food and organic waste through prevention, recovery, and recycling.

In 2020, Québec released its *Stratégie de valorisation de la matière organique* which aims to offer organic matter collection to all Québec's citizens by 2025; manage organic matter in all industrial, commercial and institutional buildings by 2025; recycle or value 70 percent of targeted organic matter in 2030; and, reduce 270,000 t CO_2 eq per year by 2030. The 2022–2027 Implementation Plan allocated $50 million for the construction of compost and bio-methane facilities.

4.3.8. Agriculture Sector

Emissions from Canada's Agriculture Sector were 55 Mt in 2020, accounting for 8.2 percent of Canada's total emissions.[13] The sector is also one of the main sources of methane and nitrous oxide emissions, contributing 30 percent to Canada's total methane emissions in 2020 and 75 percent of nitrous oxide emissions. The majority of emissions come from biological processes, such as livestock production (enteric fermentation), the application of synthetic nitrogen fertilizers, manure management, and on-farm fuel use.

The main drivers of the emission trend in the Agriculture Sector are the fluctuations in livestock populations and continuous increases in the application of inorganic nitrogen fertilizers in the Prairie provinces. However, climate-smart farming practices and beneficial management practices such as no-till, low-till, cover cropping, rotational grazing and agroforestry are being increasingly adopted by farmers.

4.3.8.1. Canadian Agricultural Partnership

The Canadian Agricultural Partnership, launched in 2018, is a five-year $3 billion cost-shared investment by the federal, provincial, and territorial governments to support region-specific agriculture programs and services tailored to meet regional needs. Under the Partnership, cost-shared on-farm environmental stewardship programs are delivered by provinces and territories to support Environmental Farm Plans and adoption of beneficial management practices which have multiple environmental benefits, including soil and water conservation, reductions in emissions and emission intensity, and climate resilience. Federally-funded activities and programs such as AgriScience and AgriInnovate support the resilience and sustainability of the sector, helping farmers to adapt to climate change, conserve water and soil resources, and grow their business sustainably to meet increasing global food demand sustainably. The successor policy framework, the Sustainable Canadian Agricultural Partnership, is set to launch in April 2023 and has a strong focus on climate change and environment, including a commitment to contribute to a 3 to 5 Mt reduction in GHG emissions.

4.3.8.2. Clean Technology

The Agricultural Clean Technology program is part of Canada's strengthened climate plan *A Healthy Environment and a Healthy Economy* and is a $165.7 million fund that aims to create an enabling environment for the development and adoption of clean technologies that reduce emissions and enhance competitiveness. The program prioritizes energy and energy efficiency, precision agriculture and bioeconomy technologies. The *2030 Emissions Reduction Plan* and Budget 2022 provide an additional $330 million over six years to triple the size of the Agricultural Clean Technology Program.

4.3.8.3. Agricultural Climate Solutions

Increasing adoption of beneficial management practices and natural-climate solutions—such as rotational grazing, cover cropping, reducing tillage, nutrient management, manure management, and agroforestry—will play a key role in reducing emissions and increasing soil carbon sequestration in the Agriculture Sector.

The Agricultural Climate Solutions Living Labs program is a $185 million fund that supports carbon sequestration and GHG emissions reductions.[14] The Agricultural Climate Solutions On-Farm Climate Action Fund is a $200 million program to support immediate on-farm action in the areas of improved nitrogen management, increased cover cropping, and rotational grazing.

In its *2030 Emissions Reduction Plan*, the Canadian government also announced investments of $470 million to the Agricultural Climate Solutions: On-Farm Climate Action Fund, and $150 million for a resilient agricultural landscapes program to support carbon sequestration, adaptation and address other environmental co-benefits.

4.3.8.4. Fertilizer Emission Reductions

Under Canada's strengthened climate plan, Canada committed to setting a national fertilizer emission reduction target of 30 percent below 2020 levels by 2030 and to work with fertilizer manufacturers, farmers, provinces and territories, to develop an approach to meet it. Following the release of the target in 2020, Agriculture and Agri-Food Canada engaged in informal consultations throughout 2021, and launched formal consultations with Canadians including farmers, producers, Indigenous communities as well as other key stakeholders and partners from March to August 2022, followed by technical workshops to help guide the collaborative development of an approach to achieve this target. Canada's objective is ambitious—reducing emissions while maintaining or enhancing yields. Total emissions from the application of inorganic nitrogen fertilizers increased from 5.5 Mt in 1990 to 13 Mt in 2020.[15]

4.3.8.5. Invest in Transformative Science, Measurement and Knowledge Transfer

Data management and measurement will be essential to gauge the improvement in environmental performance of the Agriculture Sector. To help support further transformation, the Government will invest $100 million in transformative science for a sustainable sector in an uncertain climate and net-zero economy for 2050. This funding will support fundamental and applied research supporting a path to net-zero emissions, knowledge transfer, and metric development.

4.3.8.6. Provincial and Territorial Measures in the Agriculture Sector

All provinces and territories are implementing tailored programs addressing environment and climate change issues within their jurisdictions with support from the Canadian Agricultural Partnership and the incoming Sustainable Canadian Agricultural Partnership. Some have also launched additional provincial/territorial-only initiatives.

As part of British Columbia's Roadmap, the province is supporting the transition to technologies and practices that reduce both net GHG emissions and operating costs for producers. This includes encouraging fuel switching and electrification to reduce emissions from equipment in agriculture, aquaculture and fisheries, along with increased efficiency in manure and nutrient management. B.C. is also encouraging the development and piloting of new clean solutions such as electric tractors and technologies to further improve energy efficiency in greenhouses.

Alberta's Efficient Grain Handling Program supports grain handling and grain handling system components that significantly improve energy efficiency above standard configuration to enhance sustainable production, increase profitability in the Agriculture Sector and reduce emissions.

In 2018, Ag Action Manitoba announced program funding to help farmers implement and adopt beneficial management practices on their farm identified in their Environmental Farm Plan. These practices support reducing emissions among other benefits.

Ontario is advancing adoption of the 4R Nutrient Management Program will help reduce on-farm fertilizer emissions, and in response to the new federal fertilizer emission reduction target (30 percent below 2020 levels from on-farm fertilizer emissions by 2030).

Prince Edward Island's Agriculture Stewardship Program is working to advance emission reductions through a suite of initiatives designed to increase environmental sustainability, climate change mitigation and adaptation by providing technical and financial support to encourage producers to voluntarily implement beneficial management practices.

Newfoundland and Labrador's Environmental Sustainability and Climate Change Program will promote environmentally responsible agriculture, address agriculture's impacts on natural resources, reduce greenhouse gas emissions, and mitigate and adapt to the impacts of climate change.

4.3.9. Nature-Based Climate Solutions

The climate change crisis and biodiversity loss are very closely interconnected. Climate change is now a leading threat to biodiversity and, conversely, destruction of ecosystems undermines nature's ability to provide a critical contribution to climate change mitigation and adaptation.[16] Nature-based solutions can make a significant and cost-effective contribution to greenhouse gas reductions through actions like planting trees, restoring grasslands and wetlands, and improving agricultural land management to capture and store more carbon.

4.3.9.1. Natural Climate Solutions Fund

The Natural Climate Solutions Fund is a 10-year, $4 billion program that was announced at the Fall 2020 Economic Statement and aims to address climate change and biodiversity loss in Canada. It includes Natural Resources Canada's 2 Billion Trees Program, Environment and Climate Change Canada's Nature Smart Climate Solutions Fund, and Agriculture and Agri-Food Canada's Agricultural Climate Solutions Program, including the On-farm Climate Action Fund. These programs aim to provide substantial emissions reductions (13–17 Mt of CO_2 annually in 2050) while also providing important co-benefits for human well-being and biodiversity.

4.3.9.2. 25 by 25 and 30 by 30

Canada committed to conserve 25 percent of Canada's land and 25 percent of Canada's water by 2025 while working towards protecting 30 percent of each by 2030. Canada has already conserved over 13 percent of its lands and ocean for future generations and to help deliver on this commitment, Canada is investing $460 million over five years to protect and expand 22 of Canada's national wildlife areas. This funding, as part of the Enhanced Nature Legacy, will also see the government create ten new national parks and four new freshwater marine conservation areas, while working to acquire the land needed to expand and complete existing national parks. This work remains grounded in science, Indigenous Knowledge and local perspectives.

4.3.9.3. Natural Infrastructure Fund

The $200 million Natural Infrastructure Fund, announced in June 2021, supports projects that use natural or hybrid approaches to protect the natural environment, support healthy and resilient communities, contribute to economic growth, and improve access to nature for Canadians. This Fund is the first of its kind at the federal level in Canada.

4.3.9.4. Indigenous Protected and Conserved Areas

The establishment of new Indigenous Protected and Conserved Areas (IPCAs) and Indigenous Guardians programs will continue to be a key priority for Canada, in partnership with Indigenous communities and advancing Indigenous leadership in conservation. The Edéhzhíe National Wildlife Area, established as a Dehcho protected area in 2018 and designated as a National Wildlife Area in 2022, was the first Indigenous Protected and Conserved Area established. It covers 14,218 square kilometres and was established as a result of a collaborative process with the Dehcho First Nations and the Government of Canada. Qat'muk, Thaidene Nene, Arqvilliit and Peel Watershed, are other examples of new IPCAs underway. In February 2022, the Minister of Environment and Climate Change and the President of Nunatsiavut signed a Memorandum of Understanding to determine the feasibility of establishing an Indigenous protected area in northern Labrador under the *Canada National Marine Conservation Areas Act*.

4.3.9.5. Climate Finance

At the 2021 G7 Leaders' Summit, Canada announced it would double its international climate finance commitment, to provide $5.3 billion over the next five years. This commitment supports developing countries to combat climate change, while striving to address biodiversity loss around the world. To address the interconnected crises of climate change and biodiversity loss, Canada will allocate at least 20 percent of this amount to projects that leverage nature-based solutions and projects that contribute biodiversity co-benefits in developing countries. This represents more than $1 billion.

4.3.9.6. Provincial and Territorial Measures in Nature-Based Solutions

British Columbia's Forest Carbon Initiative uses a portfolio approach to enhance the carbon sequestration capacity of forests with the rehabilitation of damaged forest stands, roads, wildfire and mountain pine beetle sites, and other areas where there is no legal obligation for replanting. The initiative aims to increase planting density and the use of residual wood, to improve the use of forest fibre for biofuels and longer-lived wood products, and to promote sustainable forestry practices.

The Growing Outcomes in Watersheds Program in Manitoba supports emissions reduction and sequestration. The program will help producers and ranchers with projects such as restoring wetlands, planting windbreaks and balancing drainage with water retention. Benefits include improved water management, enhanced sustainable agricultural production, improved biodiversity and habitat, and carbon sequestration and storage.

Ontario is implementing *Sustainable Growth: Ontario's Forest Sector Strategy*, released in August 2020, as a way to enhance carbon sequestration through increased forest growth, increase carbon storage in wood products, and mitigate emissions through substitution benefits associated with replacing less environmentally friendly products (e.g., concrete, plastics) with wood. As part of delivering on commitments in the strategy, the province developed a *Forest Biomass Action Plan* in 2022 aimed at securing jobs and encouraging sustainability in the forest sector, while supporting economic development through the use of forest biomass (i.e., mill by-products and forest biofibre).

Prince Edward Island's Carbon Capture Tree Planting program is an initiative to plant native tree species on about 250 hectares of abandoned or marginal public and private land. This project is also enhancing carbon sequestration through afforestation of marginal agricultural land.

4.4. Modifying Longer-Term Trends in Greenhouse Gas Emissions

In November 2016, Canada submitted its Mid-Century Strategy (MCS) to the UNFCCC, making it one of the first countries to articulate its long-term, deep decarbonization considerations under the Paris Agreement. Informed through engagement with Canadian experts, the Mid-Century Strategy outlined various non-policy prescriptive pathways to a low-carbon economy by 2050, while acknowledging areas where emissions reductions will be more challenging. For the purpose of the Mid-Century Strategy, Canada examined various pathways to achieve an illustrative 80 percent reduction in GHG emissions from 2005 levels and identified key building blocks that remain relevant in the context of net-zero emissions planning, including:

- Electrification of end-use applications and clean electricity generation;
- Energy efficiency and demand-side management;
- Abatement of non-carbon dioxide GHGs such as methane and hydrofluorocarbons;
- Sequestration from Canada's forests and lands; and,
- The role of innovation, a scale up of research, development and deployment (RD&D), and private sector investment in easing the transition to a low-carbon economy.

Canada's efforts to fight climate change are reducing emissions out to 2030, but are also placing Canada on a path to achieve net-zero emissions by 2050. These efforts are inclusive of the foundations built by the Pan-Canadian Framework, but have been added to over the intervening years by a range of government investments and actions, culminating in the *2030 Emissions Reduction Plan*.

In November 2022, Canada released its long-term strategy submission to the UNFCCC *Exploring Approaches for Canada's Transition to Net-Zero Emissions.* The Strategy builds on the 2016 Mid-Century Strategy, reaffirms Canada's commitment to realizing net-zero emissions by 2050 and explores potential approaches to get there.

Canada's Strategy is a technical analysis that shows illustrative approaches to 2050 based on modelled scenarios, and builds off Canada's current projected pathway to 2030 through actions outlined in the 2030 ERP. While this report is aligned with the 2030 ERP, it is not policy prescriptive, and does not identify the range of policies, measures and regulations that would be undertaken.

4.5. Economic and Social Consequences of Measures Taken to Address Climate Change

Climate change has and will continue to have significant impacts on Canadians' health and on the economy. The earlier that Canada takes action to address climate change, the more effectively the country can reduce its risks and protect the health, safety, and wellbeing of Canadians. Taking climate action now is also a critical economic opportunity. Businesses, consumers, and governments are increasingly making decisions to contribute to environmental sustainability and as a community invest in clean energy, resilient and green buildings, and energy efficiency.

Achieving Canada's climate objectives demands that all sectors of the economy continue to decarbonize in a manner that makes cleaner alternatives more affordable and creates new sustainable job opportunities for workers.

Canada's economy has for the most part recovered well from the COVID-19 pandemic. Businesses have reopened and unemployment remains low. However, many Canadians are facing economic pressures of increased food and energy prices in addition to high interest rates, which have sharply increased over the last year to battle high inflation rates. Current economic uncertainties make it more difficult to plan ahead but climate change remains a very clear and immediate threat and we cannot delay action. While the economic impacts that climate actions can have on Canadians have been stressed by some groups, the environmental impacts of climate change are also continuing to hit Canadians financially and the cost of inaction is continuing to rise. Severe weather across Canada continues to be a financial burden for both insurers and taxpayers. The cost of severe weather events across Canada reached $2.1 billion in insured damages last year, according to Catastrophe Indices and Quantification Inc.[17] Canada's climate plans include measures to ease the transition towards a low-carbon economy. The *2030 Emissions Reduction Plan* included a $2.2 billion recapitalization of the Low Carbon Economy Fund, which will support climate actions from provinces and territories, municipalities, universities, colleges, schools, hospitals, businesses, not-for-profit organizations, and Indigenous communities and organizations. In addition, Canadians living in Ontario, Manitoba, Saskatchewan, and Alberta—provinces where the federal carbon pollution pricing system applies—will receive quarterly Climate Action Incentive (CAI) payments. The CAI payment program keeps affordability and fairness in mind—eight out of ten households get more money back than they pay in, with low- and middle-income households benefitting the most.

Economy-wide measures such as setting a price on carbon pollution can have impacts on economic competitiveness, on the most vulnerable groups of society, and on Indigenous Peoples. The principles adopted in the Pan-Canadian Framework regarding pricing carbon pollution highlight revenue recycling measures to avoid a disproportionate burden on most vulnerable groups and Indigenous Peoples, and to increase carbon prices in a predictable and gradual way to limit economic impacts. Carbon pricing policies should minimize carbon leakage and the impacts of competition, particularly for emissions-intensive, trade-exposed sectors.

There is an urgent economic and social need to make sure Canada prospers and that people succeed as carbon pollution is reduced. Meeting Canada's 2030 and 2050 climate objectives will create good, middle-class jobs, and grow a competitive, sustainable and inclusive economy.

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1 IPCC. 2022. Climate Change 2022: Impacts, Adaptation and Vulnerability*:* https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/.

2 Royal Bank of Canada cited in *2030 Emissions Reduction Plan: Canada's Next Steps for Clean Air and a Strong Economy*, Environment and Climate Change Canada (https://www.canada.ca/en/environment-climate-change.html), consulted September 2022.

3 See CNZEAA description in Section 4.1.1.

4 *National Inventory Report 1990-2020*: Greenhouse Gas Sources and Sinks in Canada, report, 14 April 2022, https://unfccc.int/documents/461919.

5 Environment and Climate Change Canada, Departmental Results Framework: https://www.canada.ca/en/environment-climate-change/corporate/transparency/briefing-materials/corporate-book/departmental-results-framework.html.

6 Environment and Climate Change Canada, Departmental Plan 2022-23: https://www.canada.ca/en/environment-climate-change/corporate/transparency/priorities-management/departmental-plans/2022-2023.html.

7 Environment and Climate Change Canada, Departmental Results Report 2020 to 2021: https://www.canada.ca/en/environment-climate-change/corporate/transparency/priorities-management/departmental-results-report/2020-2021.html.

8 When two or more departments must work together to achieve Government objectives, Ministers may formally designate a horizontal initiative (HI). In such instances, departments received funds to work collaboratively to pursue shared outcomes. HIs have specific reporting requirements to show combined expenditures and achievement of outcomes. The objective is to provide parliamentarians and Canadians consolidated information on the HI. The Clean Growth and Climate Change supplementary table can be consulted here: https://www.canada.ca/en/environment-climate-change/corporate/transparency/priorities-management/departmental-plans/2022-2023/supplementary-tables/horizontal-initiatives.html#toc3.

9 For additional information on the IPCC and economic sector definitions, as well as a detailed cross-walk between IPCC and the economic sector categories, please see Chapter 3: Canada's Greenhouse Gas Inventory.

10 This applies for direct pricing systems (e.g., fuel charge, carbon levy or carbon tax) only, and not to cap and trade systems, where the market determines the price.

11 ZEV is defined as battery-electric, plug-in hybrid electric, or a hydrogen fuel cell vehicle.

12 Canada's critical minerals strategy: Discussion paper – Canada.ca.

13 *National Inventory Report 1990-2020: Greenhouse Gas Sources and Sinks in Canada*, report, 14 April 2022, https://unfccc.int/documents/461919. Please note that this figure omits GHG emissions and reductions related to agriculture in the LULUCF sector and emissions from on-farm fuel use. As a result, from an NIR reporting perspective, some of these changes will occur within the Agriculture sector while others will occur within the LULUCF sector.

14 Agriculture and Agri-Food Canada. Agricultural Climate Solutions – Living Labs: The power of farms. consulted December 2022. https://agriculture.canada.ca/en/environment/agricultural-climate-solutions/agricultural-climate-solutions-power-farms.

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16 2019, IPBES Global Assessment on Biodiversity and Ecosystem Services: https://www.ipbes.net/global-assessment.

17 Insurance Bureau of Canada, media release, January 18, 2022: http://www.ibc.ca/ns/resources/media-centre/media-releases/severe-weather-in-2021-caused-2-1-billion-in-insured-damage#:~:text=January percent2018 percent2C percent202022 percent20(TORONTO),to percent20both percent20insurers percent20and percent20taxpayers.

Chapter 4 Annex: National Communication Table 1 Summary of Policies and Measures by Sector (CTF Table 3)

This table provides information on core mitigation measures planned or already implemented by federal, provincial, and territorial governments. Policies and measures are presented in accordance with Canada's economic sector categories, with cross-cutting measures appearing first. Within the sectoral groupings, federal measures appear first, followed by provincial and territorial measures from west to east. Priority has been given to those policies and measures that have the most significant impact on sectoral GHG emissions. As much as possible, direct mitigation impacts have been estimated for key policies, provided by the implementing entity. Where mitigation estimates were not provided, Canada has indicated the reason why they were not included (see notation legend). For example, mitigation estimates were not provided for measures that are still under development and/or for those measures where it is difficult to estimate the direct mitigation impact, such as for supporting measures. Note that the reduction impacts identified for discrete measures are not necessarily all additional as many measures will operate together.

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
CROSS-CUTTING									
Northern Responsible Energy Approach for Community Heat and Electricity (REACHE) program	Cross-cutting	CO_2	Reduce reliance on diesel in remote Indigenous communities	Economic	Implemented	2016	Crown-Indigenous Relations and Northern Affairs Canada	1.00	23.00
Brief Description	The Government of Canada, through Budget 2017, allocated $53.5 million over ten years and $5.4 million ongoing to continue the Northern Responsible Energy Approach for Community Heat and Electricity Program (Northern REACHE) to reduce reliance on diesel for heat and electricity in rural and remote Indigenous communities. Budget 2021 invested an additional $300 million over five years to advance the Government's commitment to ensure that rural, remote and Indigenous communities that currently rely on diesel have the opportunity to be powered by clean, reliable energy by 2030. This funding will be delivered jointly through the Northern REACHE Program and Natural Resources Canada's Clean Energy and Rural and Remote Community Program through a new Indigenous and Remote Communities Clean Energy Hub. Northern REACHE will deliver $60 million of the $300 million. Budget 2021 also committed $40.4 million over three years, starting in 2021-22, to support feasibility and planning of hydroelectricity and grid interconnection projects in the North. This funding will be delivered by Northern REACHE. As of March 2022 the program has funded 140 projects to reduce reliance on diesel including: energy efficiency, renewable energy, and capacity building projects.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Climate Action and Awareness Fund	Cross-cutting	CH_4, CO_2, N_2O	Raise awareness of climate change and build capacity to increase climate actions	Fiscal, Education, Information	Implemented	2020	Environment and Climate Change Canada	NA[d]	NA[d]
Brief Description	The Climate Action and Awareness Fund (CAAF) will invest up to $206 million over five years to support awareness and capacity building projects that help to reduce Canada's GHG emissions. The CAAF is designed to support projects that lead to climate action and can create middle class jobs for Canadians who work in science and technology, academia and at the grassroots community level. These projects will help to build a sustainable net-zero emissions economy by 2050. The CAAF has three main priorities: to support youth climate awareness and community-based climate action; to support climate research at Canadian think tanks and in academia; and to advance climate science and technology. The CAAF was created with contributions funded from the Environmental Damages Fund and from the Climate Action Fund.								
Clean Fuel Regulations*	Cross-cutting	CH_4, CO_2	The Regulations are intended to reduce GHG emissions by reducing the lifecycle carbon intensity of gasoline and diesel used in Canada as well as incentivizing the use of clean technologies and fuels	Regulatory	Implemented	2023	Environment and Climate Change Canada	NA[b]	26,600.00

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	In November 2016 the Government of Canada announced that it would consult with provinces and territories, Indigenous Peoples, industries, and non-governmental organizations to develop *Clean Fuel Regulations* to reduce the lifecycle carbon intensity (CI) of fossil fuel used in Canada through the increased use of lower carbon fuels and technologies. Final regulations were published on July 6, 2022. The *Clean Fuel Regulations* require gasoline and diesel primary suppliers (i.e. producers and importers) to reduce the CI of the gasoline and diesel they produce and import for use in Canada from 2016 CI levels by 3.5 grams of carbon dioxide equivalent per megajoule (gCO_2 eq/MJ) in 2023, increasing to 14 gCO_2 eq/MJ in 2030. The Regulations also establish a credit market whereby the annual CI reduction requirement could be met via three main categories of credit-creating actions: (1) actions that reduce the CI of the fossil fuel throughout its lifecycle, (2) supplying low-carbon fuels, and (3) supplying fuel and energy in advanced vehicle technologies. Parties that are not fossil fuel primary suppliers are able to participate in the credit market as voluntary credit creators by completing certain actions (e.g., low-carbon fuel producers and importers).								
Greenhouse Gas Offset Credit System	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions	Regulatory	Implemented	2022	Environment and Climate Change Canada	NA[b]	NE[c]
Brief Description	In June 2022, the Government of Canada launched Canada's Greenhouse Gas Offset Credit System, a key measure outlined in Canada's 2030 Emissions Reduction Plan. The offset system will give municipalities, foresters, farmers, Indigenous communities, and others a market-based incentive to undertake innovative projects that reduce GHGs by preventing emissions and removing GHGs from the atmosphere. Under the new system, registered participants can carry out projects following a federal offset protocol, which sets out a consistent approach for measuring GHG emissions reductions or removals for specific types of projects. These projects can generate one tradeable offset credit for every tonne of emissions they reduce or remove from the atmosphere. Once a credit is earned, it can be sold to others to help them meet their compliance obligations or emissions reduction goals under the carbon pollution pricing system. A protocol for landfill methane recovery and destruction activities is available. Four additional offset protocols are currently in development including for activities such as advanced refrigeration, agriculture, and forest management, Direct Air Carbon Capture and Sequestration, and technologies that directly remove carbon dioxide from the atmosphere and permanently store it underground. Canada's Greenhouse Gas Offset Credit System is aligned with the Pan-Canadian Greenhouse Gas Offsets Framework and incorporates expertise from across the country. Provinces including Alberta, British Columbia and Québec have already demonstrated leadership in this area by launching provincial offset credit programs, and by sharing their experiences to help support the design of the federal system. The availability of offset credits is expected to help stimulate innovation and private sector investment in economic activities to reduce emissions.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Low Carbon Economy Fund*	Cross-cutting	CH_4, CO_2, HFCs, N_2O	Leverages climate actions from provinces and territories, municipalities, universities, colleges, schools, hospitals, businesses, not-for-profit organizations, and Indigenous communities and organizations	Fiscal, Economic	Implemented	2017	Environment and Climate Change Canada	NA[a]	4,000.00
Brief Description	There are two parts to the existing Low Carbon Economy Fund (LCEF): the Low Carbon Economy Leadership Fund and the Low Carbon Economy Challenge. The Low Carbon Economy Leadership Fund is providing up to $1.4 billion to provinces and territories in Canada. The funding helps deliver on provincial and territorial priorities to reduce carbon pollution and contribute to meeting and exceeding Canada's 2030 climate target. The approximately $500 million Low Carbon Economy Challenge is open to a wide range of applicants from across the country who are adopting climate solutions. The fund supports projects that leverage ingenuity to reduce GHG emissions and generate clean growth in Canada. The Government of Canada has committed an additional $2.2 billion to the advanced and enhanced Low Carbon Economy Fund. The funding aims to leverage further climate actions from a wide range of partner and stakeholder efforts to reduce domestic GHG emissions. The LCEF renewal will include a new $180 million Indigenous Leadership Fund to support clean energy and energy efficiency projects led by First Nations, Inuit and Métis communities and organizations. The estimate of mitigation impact reflects projects funded to date. Additional GHG emissions reductions are anticipated to result from the 2022 intake of the Low Carbon Economy Challenge – Champions stream. Further emissions reductions will be achieved through future projects funded under the advanced and enhanced LCEF.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Memorandum of Cooperation between the California Environmental Protection Agency and Environment and Climate Change Canada	Cross-cutting, Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions (from transportation and oil and gas sector), prevent pollution, adapt to climate change and conserve nature	Voluntary Agreement	Adopted	2022	Environment and Climate Change Canada	NA[b]	NA[d]
Brief Description	The agreement commits Canada and California to work together to advance their respective policies and regulatory measures aimed at preventing pollution, adapting to climate change and conserving nature through initiatives focused particularly on the following areas of cooperation: Clean Transportation; Clean Technology and Innovation; Biodiversity Conservation; Climate Change Adaptation; Circular Economy, including Plastics Management; and, any other areas of cooperation they may jointly decide upon.								
Output-Based Pricing System (OBPS) Proceeds Fund**	Cross-cutting, Heavy Industry, Electricity	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	GHG emissions reduction in sectors and jurisdictions where the federal Output-Based Pricing System applies	Economic	Implemented	2022	Environment and Climate Change Canada	NA[b]	NE[g]
Brief Description	With a focus on industrial decarbonization and clean energy production, the OBPS Proceeds Fund supports making Canada's heavy industries cleaner and more efficient as it transitions to a low-carbon economy. The OBPS Proceeds Fund is comprised of two streams: the Decarbonization Incentive Program (DIP) and the Future Electricity Fund (FEF). The DIP is a merit-based application program that incentivizes long-term decarbonization of Canada's industrial sectors by supporting clean technology projects that result in GHG emissions reductions within most facilities regulated by the federal OBPS. The FEF stream is designed to support clean electricity projects and/or programs by returning proceeds collected from electricity generating facilities (i.e., utilities) covered by the federal OBPS.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Regulation of Hydrofluo-rocarbons*	Cross-cutting	HFCs	Reduce emissions of HFCs	Regulatory	Implemented	2019	Environment and Climate Change Canada	1,000.00	9,000.00
Brief Description	In October 2016, Parties to the Montreal Protocol, including Canada, adopted an HFC phase-down amendment (the Kigali Amendment) wherein developed countries will begin in 2019 to gradually phase down the consumption of HFCs to 15% of calculated baseline levels by 2036.								
Return of Fuel Charge Proceeds to Indigenous Recipients	Cross-cutting	CO_2	Support for Indigenous climate change priorities	Economic	Planned	2023	Environment and Climate Change Canada	NA[d]	NA[d]
Brief Description	The Government of Canada returned a portion of the 2019–2020 federal fuel charge proceeds to Indigenous recipients through federal programming, including the Climate Action Incentive Fund (CAIF) and top-ups to three existing Indigenous programs targeting clean growth and climate change priorities (Indigenous Services Canada's Capital Facilities and Maintenance Program/First Nations Infrastructure Fund; Crown-Indigenous Relations and Northern Affairs Canada's Indigenous Community-Based Climate Monitoring Program; and Natural Resources Canada's Clean Energy for Rural and Remote Communities Program). Beginning in 2020–21, Canada committed to returning federal fuel charge proceeds to Indigenous recipients through solutions co-developed with Indigenous partners in jurisdictions where the federal fuel charge applies: Alberta, Saskatchewan, Manitoba, and Ontario. Environment and Climate Change Canada is working with Indigenous partners on a distinctions basis to co-develop solutions by which these proceeds will be returned. Environment and Climate Change Canada expects to begin returning fuel charge proceeds to Indigenous recipients in 2023.								
Strategic Assessment of Climate Change (SACC)	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Enable consistent, predictable, efficient and transparent consideration of climate change throughout the federal impact assessment process	Information	Implemented	2020	Environment and Climate Change Canada	NA[d]	NA[d]

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								2020	2030
Brief Description	Describes the GHG and climate change information that project proponents need to submit at each phase of a federal impact assessment; requires proponents of projects with a lifetime beyond 2050 to provide a credible plan that describes how the project will achieve net-zero emissions by 2050.								
Carbon pollution pricing across Canada*	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions, stimulate investments in low-carbon innovation and create a sustainable clean growth economy	Regulatory, Economic	Implemented	2019	Environment and Climate Change Canada, Finance Canada	NE[j]	NE[j]
Brief Description	The Pan-Canadian Approach to Pricing Carbon Pollution, announced in 2016, gives provinces and territories the flexibility to implement their own carbon pollution pricing system aligned with common minimum national stringency requirements ("federal backstop"). The federal government implements a "backstop" federal carbon pricing system in provinces and territories that request it or do not have a system in place that meets the federal stringency requirements. The *Greenhouse Gas Pollution Pricing Act* established the framework for the federal carbon pollution pricing system. The federal carbon pollution pricing system has two parts: a trading system for large industry, also known as the Output-Based Pricing System, and a regulatory charge on fossil fuels (fuel charge). Carbon pollution pricing has been in place across Canada since 2019. In August 2021, the federal government strengthened the minimum national requirements for all pricing systems for 2023–2030, including a rising minimum price trajectory for direct pricing systems to $CAD 170 t/$CO_2$ eq in 2030.								
Improving Access to Capital for CleanTech Companies	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Help Canada's clean technology firms grow and expand	Economic	Implemented	2017	Export Development Canada, Business Development Canada	NA[f]	NA[f]

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								2020	2030
Brief Description	The Government of Canada committed $1.4 billion in new financing in 2017 through the Business Development Bank of Canada (BDC) and Export Development Canada (EDC). This financing includes $950 million in growth capital to support clean technology producers ($700 million by BDC and $250 million by EDC). It also includes approximately $450 million to EDC in additional project financing for "first of kind commercial scale" clean technology projects. EDC has approved two projects under this financing, and is working to approve additional clean technology projects. To mobilize its allocated financing, BDC allocated $600 million of this funding to launch its Cleantech Practice in 2018 to support the growth and expansion of future Canadian global technology companies with transactions that exceed BDC's normal risk appetite, and a further $100 million in line with BDC's normal risk parameters. The Cleantech Practice helps high-potential clean technology firms expand by providing them with the capital they need to hire new staff, develop products, support sales, and scale up and compete globally. As of March 31, 2022, BDC has invested $510 million via the Cleantech Practice, and is broadly on target to meet its timelines to allocate the funding to transactions. BDC has already surpassed $100 million for its investment support in line with its normal risk parameters. To date, EDC has approved $52 million out of the $450 million project finance amount, with additional projects in due diligence. EDC has surpassed its target of $220 million of working capital support to cleantech companies, having approved $5.2 billion in transactions, utilizing internal funding. EDC has also surpassed the target of $30 million of equity support to cleantech companies, having supported $161 million in the period, also utilizing internal funding.								
Green Municipal Fund	Cross-cutting	CH_4, CO_2, N_2O	Core GMF supports projects across energy, transportation, waste, water and land use sectors. New funding supports increased energy efficiency in the built environment, which will in turn contribute to reduced GHG emissions	Economic, Education, Fiscal, Information	Implemented	2000, 2019	Federation of Canadian Municipalities, Environment and Climate Change Canada, Natural Resources Canada, Infrastructure Canada	NA[d]	NA[d]

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								2020	2030
Brief Description	Administered by the Federation of Canadian Municipalities (FCM), Core GMF began with an endowment in 2000 and has maintained the original capital while funding projects through several top ups. It operates as a revolving fund, providing grants and loans for plans, studies, pilots, and capital projects. GMF supports municipalities and municipal partners in undertaking innovative or replicable environmental projects across sectors. Budget 2019 provided $950 million in new funding to support increased energy efficiency in the built environment through the following four initiatives: Sustainable Affordable Housing, launched May 2020, ($300 million); Community Efficiency Financing, launched March 2020 ($300 million); Community Buildings Retrofit, launched April 2021 ($167 million); and Low Carbon Cities Canada (LC3), which has created a network of seven urban climate centres each with their own endowment that support local solutions ($183 million). After the Budget 2019 investment, the nominal value of the GMF is $1.0125 billion.								
Canada Growth Fund**	Cross-cutting	CH_4, CO_2, N_2O	Accelerate the deployment of key technologies, such as low-carbon hydrogen and carbon capture, utilization, and storage	Economic	Implemented	2022	Finance Canada	NA[b]	NE[h]
Brief Description	The Canada Growth Fund was announced in Budget 2022. The fund will be initially capitalized at $15 billion over the next five years and will invest on a concessionary basis, with the goal that for every dollar invested by the fund, it will aim to attract at least three dollars of private capital. The Growth Fund will be launched by the end of 2022. Investments will help meet the following important national economic policy goals: • Reduce emissions and achieve Canada's climate targets; • Accelerate the deployment of key technologies, such as low-carbon hydrogen and carbon capture, utilization, and storage (CCUS); • Scale up companies that will create jobs, drive productivity and clean growth, and encourage the retention of intellectual property in Canada; and, • Capitalize on Canada's abundance of natural resources and strengthen critical supply chains to secure Canada's future economic and environmental well-being.								

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								2020	2030
Investment Tax Credit for CCUS*	Cross-cutting	CO_2	De-risk CCUS investments, drive down costs and encourage wider market adoption of CCUS in Canada to increase sequestration of CO_2	Economic	Planned	2022	Finance Canada	NA[b]	NE[h]
Brief Description	In Budget 2022, the Government of Canada announced details of an investment tax credit for capital invested in CCUS projects to encourage the development and deployment of CCUS technologies. The investment tax credit would be available to CCUS projects that permanently store captured CO_2 in dedicated geological storage or in concrete. From 2022 through 2030, the Investment Tax Credit rates would be set at: • 60% for investment in equipment to capture CO_2 in direct air capture projects; • 50% for investment in equipment to capture CO_2 in other CCUS projects; and, • 37.5% for investment in equipment for transportation, storage and use.								
Investment Tax Credits for Clean Technologies and for Clean Hydrogen**	Cross-cutting	CH_4, CO_2, N_2O	Incentivize companies to invest in clean technologies and create good jobs, and incentivize support for clean hydrogen projects	Economic	Planned	2023	Finance Canada	NA[b]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	In its 2022 Fall Economic Statement, the Government of Canada announced an investment tax credit for clean technologies equivalent to 30% of the capital cost of investments in technologies such as electricity generation systems; stationary electricity storage systems; low carbon heating equipment; and industrial zero-emission vehicles and related charging or refueling equipment. To incentivize companies to create good jobs, those that adhere to certain labour conditions will be eligible for the full 30% credit, while those that do not will only be eligible for a credit of 20%. The ITC will be gradually phased out between 2032 to 2034, and no longer in effect at the start of 2035. An investment tax credit to support clean hydrogen projects will also be launched. The credit will be refundable, based on the life cycle carbon intensity of hydrogen and should be available for investments made as of the day Budget 2023 is tabled.								
Strategic Innovation Fund, including the Net-Zero Accelerator*,[1]**	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Promote innovation including to reduce GHGs and other environmental impacts; support the transformation of industries towards the net-zero economy; and develop clean technologies	Economic	Implemented	2017 (SIF), 2020 (NZA)	Innovation, Science and Economic Development Canada	NA[f]	10,700.00[2]
Brief Description	The Strategic Innovation Fund (SIF), created in 2017, supports large-scale, transformative projects to promote research and development, clean growth, and the advancement of Canada's innovation ecosystem. SIF is open to all sectors of the Canadian economy, including clean-tech projects. The Net-Zero Accelerator, a SIF initiative, was announced in the *A Healthy Economy and A Healthy Environment* plan in 2020, earmarking $3 billion over five years to rapidly expedite decarbonization projects with large emitters, scale up clean technology, and accelerate Canada's industrial transformation across all sectors. Budget 2021 increased funding for the NZA by $5 billion over seven years.								
Clean Fuels Fund	Cross-cutting	CO_2	Increase domestic clean fuel production capacity	Economic	Implemented	2021	Natural Resources Canada	NA[b]	NA[d]

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								2020	2030
Brief Description	The Clean Fuels Fund will de-risk the capital investment required to build new or expand existing clean fuel production facilities, including facility conversions. Support will be provided for feasibility and front-end engineering and design (FEED) studies, and the establishment of biomass supply chains to improve the logistics for the collection, supply and distribution of biomass materials as a feedstock for clean fuel production facilities. Resources will also be provided to address gaps and misalignment in codes, standards and regulation related to the production, distribution and end-use of clean fuels. The call for project proposals for the production stream closed on October 13, 2021. A call for project proposals for Indigenous-led clean fuel projects was launched on February 11, 2022, and will remain open until funding is no longer available. A call for project proposals targeted to projects that support the establishment of biomass supply chains launched on August 25, 2022, and accepted applications until November 23, 2022.								
Clean Growth Program	Cross-cutting	CH_4, CO_2, N_2O	Improve environmental performance of Canada's natural resources sectors	Research, Information, Economic	Implemented	2016	Natural Resources Canada	NA[b]	500.00
Brief Description	Under the Clean Growth program, the Government of Canada invested $155 million over five years to co-fund 43 research, development, and demonstration projects in Canada's energy, mining, and forestry sectors through trusted partnerships with provinces and territories. The program helped accelerate emerging clean technologies toward commercial readiness. The longer term objective focused on addressing pressing environmental challenges and economic opportunities facing Canada's natural resource operations in five areas: reducing GHG and air-polluting emissions; minimizing landscape disturbances and improving waste management; the production and use of advanced materials and bioproducts; efficient energy use and productivity; and reducing water use and impacts on aquatic ecosystems. To better leverage investments, the program required collaboration with the provinces and territories. Funded projects are on track to meet the program target of reducing GHG emissions by 0.3 Mt to 0.7 Mt per year by 2027. In 2021-22 projects reduced annual GHG emissions by 14.13 kt. It also reduced water use by 13,712,426 m^3/per year and reduced waste by 70,896 tonnes/year. Please note that in 2022–23 the Clean Growth Program will be renewed and consolidated under the Energy Innovation Program. Therefore, results will be reported under EIP in subsequent years.								

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								2020	2030
Energy Innovation Program*	Cross-cutting	CH_4, CO_2, N_2O	Achieve environmental benefits from technology and/or new policies, codes and standards	Fiscal, Research, Information	Implemented	2016	Natural Resources Canada	282.00	4,000.00
Brief Description	The Energy Innovation Program (EIP) advances clean energy technologies and solutions that will help Canada meet its climate change targets, while supporting the transition to a low-carbon economy. It funds innovative clean energy research, development and demonstrations projects and related scientific activities. EIP supports clean energy innovation across four missions: improving efficiency from energy end use; accelerating electrification and maximizing benefits of low emitting heat and power; developing cleaner fuel pathways; and, maintaining safe and resilient energy systems. EIP uses a range of flexible tools and program streams including grants, contributions, funding to territorial laboratories, federal/provincial/territorial collaborations and public-private partnerships, such as Breakthrough Energy Solutions Canada (Natural Resources Canada, Breakthrough Energy and Business Development Bank of Canada). Other EIP funding streams include Oil and Gas Clean Tech Program, Canadian Emissions Reduction Network (with Alberta Innovates), Clean Fuels, Industrial Fuel Switching and Hydrogen Codes and Standards funding call. As part of Budget 2021, under EIP the federal government is also investing an additional $319 million over seven years in RD&D to advance the commercial viability of carbon capture. To date, the EIP has supported over 70 external grants and contribution projects and over 90 applied research projects in labs focused on addressing innovation gaps and opportunities to reduce GHGs in key areas such as renewable energy, smart grids, energy-efficient buildings, carbon capture use and storage, and cleaner production of oil and gas. In 2021-22, projects reduced 2,715 kt/year GHG emissions and are on track to achieve EIP's 2030 GHG emission reduction target of 4,250 kt/year (10,000 – 16,000 kt including direct and indirect reductions). Please note that in 2022–23 the Clean Growth Program and Impact Canada Initiative Clean Technology Stream will be renewed and consolidated under the Energy Innovation Program. Therefore results will be reported under EIP in subsequent years. Additionally, a small number of large demonstration projects that were funded via an earlier Natural Resources Canada clean energy RD&D program (the Clean Energy Fund that sunset in 2013) such as Shell Quest, Alberta Trunk Line and Boundary Dam are reported under EIP.								
Enhancing Canada's Supply of Critical Minerals	Cross-cutting	CO_2	Support the development of critical minerals	Fiscal	Adopted	2022	Natural Resources Canada	NA[b]	NE[e]

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								2020	2030
Brief Description	Funding to support Canada's Critical Minerals Strategy. Budget 2022 provided approximately $3.8 billion over eight years to launch the strategy. This includes support for a number of initiatives from exploration to innovation R&D infrastructure.								
Federal Energy Efficient Equipment and Appliances Program*	Cross-cutting	CH_4, CO_2, N_2O	Improve standards for equipment and appliances	Regulatory	Implemented	2016	Natural Resources Canada	3,320.00	9,700.00
Brief Description	Since 2016, this program published four omnibus amendments to the *Energy Efficiency Regulations*, updating or introducing minimum energy efficiency standards for nearly 50 product categories. The program is developing additional amendments that are expected to be published between 2022 and 2025 covering more than 20 product categories. During this period, the program has also updated or introduced high performance ENERGY STAR specifications for 25 product categories. The program also works with provincial and territorial governments and industry stakeholders to encourage market transformation in three equipment areas: windows, space heating and water heating.								
Hydrogen Strategy for Canada**	Cross-cutting	CO_2	Support role of hydrogen in decarbonization	Education, Information, Research, Voluntary Agreement	Implemented	2020	Natural Resources Canada	NA[d]	NA[d]
Brief Description	Following extensive national consultations, Natural Resources Canada released the Hydrogen Strategy for Canada in December 2020, as a call to action and an important demonstration of the Government's resolve to achieve net-zero by 2050. Through eight pillars and 32 recommendations over the short-, medium- and long-term, the strategy guides Canada on how to fully seize the economic and environmental opportunities across all emitting sectors of the economy. The Hydrogen Strategy relies on Canadian expertise throughout the entire value chain to build new hydrogen supply, distribution, and end uses that will support a low-carbon energy ecosystem. To deliver on the recommendations, an Implementation Framework has been formalized in order to operationalize activities and actions across the country. Natural Resources Canada is in the process of launching 16 working groups and three executive committees which include government and industry co-chairs and numerous stakeholders focused on developing a hydrogen society across major sectors of the economy (e.g., transport, heavy industry, ports, and export).								

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								2020	2030
Impact Canada Initiative – Clean Technology Stream	Cross-cutting	CH_4, CO_2, N_2O	Unlock breakthrough clean technology solutions to complex and persistent problems	Fiscal, Research, Information	Implemented	2017	Natural Resources Canada	NA[f]	NA[f]
Brief Description	In Budget 2017, Canada allocated $75 million over four years to create the Clean Technology stream of Impact Canada, a new initiative to help focus and accelerate efforts toward solving Canada's big challenges, such as helping Canada's northern and remote communities reduce their reliance on diesel as a power source. Six challenges have been launched under this initiative: The Women in Cleantech Challenge, the Sky's the Limit Challenge, the Power Forward Challenge, the Crush It! Challenge, the Indigenous Off-Diesel Initiative, and the Charging the Future Challenge. The program was extended by one year in response to COVID. Following rigorous assessments, finalist and grand prizes winners for all six of the ICI Clean Tech Initiatives have been awarded. Preliminary results show that the program accelerated the development of over 25 innovative clean growth technologies, solutions and/processes; helped to build Canada's clean energy ecosystems, including laying the foundations for new supply chains; supported the growth of new enterprises; built critical skills and capacity among individuals and enterprises. In collaboration Indigenous Clean Energy Social Enterprise and the Pembina Institute, provided funding and training for 14 Indigenous Energy Champions and their communities to develop and begin implementing clean energy plans to reduce diesel use. Please note that in 2022–23 Impact Canada Clean Technology Stream will be renewed and consolidated under the Energy Innovation Program. Therefore results will be reported under EIP in subsequent years.								
Regional Energy and Resource Tables	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Accelerate economic activity and leverage regional growth opportunities emerging from the shift to a low carbon future	Economic, Voluntary Agreement	Implemented	2022	Natural Resources Canada	NA[b]	NA[d]
Brief Description	Federal initiative to collaborate with partners (provinces, territories, Indigenous peoples, experts, industry) to leverage regional competitive advantages and advance the top economic growth opportunities that arise from the shift to net-zero. Aims to align priorities, funding and financing opportunities, and policy and regulatory approaches on a regional basis to accelerate economic activity, support regional growth opportunities and the creation of sustainable jobs.								

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								2020	2030
Sustainable Development Technology Canada	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Support pre-commercial development and demonstration of clean technology projects	Economic	Implemented	2001	Sustainable Development Technology Canada	NA[f]	NA[f]
Brief Description	Sustainable Development Technology Canada (SDTC) helps Canadian companies develop and deploy sustainable technologies by delivering critical funding support and promoting the development of a robust Canadian ecosystem that supports innovation. We do this by funding the development and demonstration of new environmental technologies; fostering and encouraging collaboration among organizations in the private sector, academia, the not-for-profit sector and others to develop and demonstrate new technologies; and promoting the timely diffusion of new technologies across key economic sectors in Canada. SDTC is a foundation created by the Government of Canada, which announced a $750 million recapitalization of SDTC over 5 years in December 2020 as part of the Strengthened Climate Plan. SDTC has recently modernized its approach to assessing environmental benefits in three sustainability impact areas: climate change; circular economy; and people, communities, and nature. As of March 31, 2022, SDTC has allocated $1.53 billion to support hundreds of Canadian entrepreneurs, leveraging an additional $3.84 billion in public and private sector investment, and an estimated $10.25 billion in follow-on financing for funded companies since its establishment in 2001. For the period April 2021 to March 2022, SDTC-supported technologies generated an estimated 22.6 Mt CO_2 eq emissions reductions, $3.1 billion in revenues and 20,942 direct and indirect jobs (cumulative). In FY 2021-22 alone, SDTC approved funding for 109 new sustainable technology projects.							

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								2020	2030
Greening Government Operations	Cross-cutting	CH_4, CO_2, N_2O	The Government of Canada's operations will be net-zero emissions by 2050 including: government-owned and leased real property; mobility – fleets, business travel and commuting; procurement of goods and services; national safety and security operations	Fiscal, Information, Education, Economic, Research	Implemented	2017	Treasury Board Secretariat, Natural Resources Canada (leads); all departments	NA[a]	195.00
Brief Description	This ongoing program leads and coordinates the implementation of the Greening Government Strategy (GGS) and the Policy on Green Procurement, including by: providing strategic advice, practical guidance and tools to departments for net-zero, climate-resilient and green real property, fleet, and procurement. This will support federal organizations to meet commitments including the target of net-zero emissions for federal operations by 2050. To implement net-zero in real property and fleet operations, the Government of Canada is reducing absolute Scope 1 and Scope 2 GHG emissions by 40% by 2025 and at least 90% below 2005 levels by 2050. For 2020-21, the most recent reporting year, GHG emissions had been reduced by 40.6% for real property and conventional fleet compared with the 2005 baseline.								

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British Columbia Carbon Neutral Government Program and Carbon Neutral Capital Program	Cross-cutting	CO_2	Achieve carbon neutrality in government operations	Regulatory	Implemented	2007	British Columbia	NE[h]	NE[h]
Brief Description	The *Climate Change Accountability Act* requires the provincial government, including provincial ministries and agencies, schools, colleges, universities, health authorities and Crown corporations, to achieve carbon neutrality in their operations (buildings, fleet, paper, travel) every year, and to make public an annual report detailing actions taken towards carbon neutrality. The province has achieved carbon neutrality for its public sector operations each year from 2010 to 2021. For the 2021 reporting year, overall public sector organization emissions were 14% lower than they were in 2010. Established in 2012, the provincial government's Carbon Neutral Capital Program (CNCP) helps schools, hospitals, colleges and universities with projects and initiatives to cut carbon emissions and energy costs. The current CNCP base budget is approximately $50 million annually, delivered by the ministries of Advanced Education and Skills Training, Education and Child Care, and Health.								
British Columbia Carbon Tax*	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions from fossil fuel use	Economic	Implemented	2008	British Columbia	NE[h]	NE[h]
Brief Description	This tax applies to virtually all fossil fuels, including gasoline, diesel, natural gas, coal, propane, and home heating fuel. The carbon tax started at a rate based on $10 per tonne of associated carbon or carbon-equivalent emissions and is currently set at $50/tonne CO_2 eq. British Columbia's carbon tax will continue to meet or exceed any federal carbon price requirements for 2023 and beyond.								
British Columbia *Greenhouse Gas Emission Control Regulation**	Cross-cutting	CH_4, CO_2	Reduce GHG emissions	Regulatory	Implemented	2016	British Columbia	NE[h]	NE[h]
Brief Description	The *Greenhouse Gas Emission Control Regulation* establishes the infrastructure and requirements for issuing emission offset units and funded units. These are the foundational elements that enable compliance with the performance standards listed within a Schedule to the *Greenhouse Gas Industrial Reporting and Control Act*. The Regulation also establishes the BC Carbon Registry, which enables the electronic issuance, transfer and retirement of compliance units (emission offset units, funded units and earned credits).								

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								2020	2030
British Columbia Innovative Clean Energy Fund	Cross-cutting	CO_2	Support advancement of clean energy technologies	Economic	Implemented	2008	British Columbia	NE[h]	NE[h]
Brief Description	The Innovative Clean Energy Fund is funded through a levy on energy sales, designed to support the Province's energy, economic, environmental and GHG reduction priorities, to advance BC's clean energy sector. Since 2008, the Innovative Clean Energy Fund has committed approximately $97 million to support pre-commercial clean energy technology projects, clean energy vehicles, research and development, and energy efficiency programs.								
British Columbia Natural Gas Utility GHG Emissions Cap**	Cross-cutting	CO_2	Reduce GHG emissions from buildings and industry	Regulatory	Planned	2030	British Columbia	NA[b]	NE[h]
Brief Description	GHG cap for natural gas utilities with a variety of compliance options. The cap will be set at approximately 6 Mt CO_2 eq per year for 2030.								
CleanBC* and Clean BC Roadmap to 2030	Cross-cutting	CO_2	Reduce emissions in British Columbia	Regulatory, Economic, Fiscal, Voluntary Agreement	Implemented	2018	British Columbia	NE[h]	28,400.00
Brief Description	Interim emissions target of 16% below 2007 levels by 2025. Legislated emission targets reductions: 40% by 2030, 60% by 2040, and 80% by 2050 compared to 2007 levels. Mandate commitment to legislate net-zero by 2050. In 2021, BC released the CleanBC Roadmap to 2030, a follow-up plan that includes a range of accelerated and expanded actions to reduce emissions across eight pathways: low carbon energy; transportation; buildings; communities; industry, including oil and gas; forest bioeconomy; agriculture, aquaculture and fisheries; and negative emissions technologies.								

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CleanBC Communities Fund	Cross-cutting	CH_4, CO_2	Reduce emissions in British Columbia and contribute to a national ten megatonne GHG reduction	Fiscal	Implemented	2018	British Columbia	NE[h]	NE[h]
Brief Description	CleanBC Communities Fund (funded through Investing in Canada Infrastructure Program bilateral agreement) has had three application intakes. 1st intake: allocated up to $63.4 million in provincial-federal funding 2nd intake: allocated up to $47.4 million in provincial-federal funding 3rd intake: allocated up to $134 million in provincial-federal funding								
Alberta Carbon Capture, Storage and Utilization*	Cross-cutting	CO_2	Enable government support for carbon capture and storage projects	Economic	Implemented	2008	Alberta	NE[c]	NE[c]
Brief Description	The Large Emitter legislation (SGER, CCIR and now TIER) has enabled Alberta to administer funding to support large-scale carbon capture, utilization and storage (CCUS) projects. Two large-scale CCUS projects currently receive funding from the Government of Alberta: The Quest CCS project and the Alberta Carbon Trunk Line (ACTL) Enhanced Oil Recovery (EOR) project. Beginning in 2015, the Quest Project is the world's first application of CCUS at an oil sands upgrading facility. The Quest project captures and geologically stores over 1 Mt CO_2 per year from Shell's Scotford Oil Sands Upgrader. It has captured and safely stored 6 Mt in its first five years—more than any other industry CCUS facility in the world. The Alberta Carbon Trunk Line (ACTL), which has capacity to safely transport 14.6 Mt per year from industrial facilities to geological storage, commenced commercial operation in 2020. The ACTL is one of the world's newest integrated large-scale CCUS systems. By the end of 2020, the ACTL project will capture approximately 1.2 Mt of CO_2 from the North West Redwater Refinery and approximately 0.3 Mt of CO_2 per year from the Nutrien Fertilizer Facility. The captured CO_2 will then be injected into a mature oil field, now an approved enhanced oil recovery scheme, and will be permanently stored. To date, the Government of Alberta has committed $1.24 billion in funding for these two CCUS projects. The 2020 estimate of mitigation impact is included under the Large Emitter Regulations. These emission reductions are not listed to avoid double counting since these CCUS projects' emission reductions are listed by the federal government (reported under the Energy Innovation Program). The Alberta government has invested significant resources to develop the funding, conduct the Regulatory Framework Assessment, and now develop a process for awarding carbon sequestration agreements for CCUS hub operators.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Alberta Emission Offset System*	Cross-cutting	CH_4, CO_2, N_2O	Enhance removals and reduce emissions	Economic	Implemented	2018	Alberta	4,500.00	4,500.00
Brief Description	Alberta continues to support the generation of voluntary emission offsets in various sectors such as agriculture, renewable energy, waste management, and oil and gas. Emission offsets are available as a regulatory compliance option for large industrial emitters under the TIER Regulation.								
Alberta Large Emitter Greenhouse Gas Regulations*[3] **2007-forward: *Specified Gas Emitters Regulation*** **2018-2019: *Carbon Competitiveness Incentive Regulation*** **2020-forward: *Technology Innovation and Emissions Reduction (TIER) Regulation***	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce the emissions intensity of large emitters	Economic	Implemented	2007, 2020	Alberta	14,000.00	20,000.00

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Alberta has regulated GHG emissions from large industry since 2007 with a focus on those sites emitting more than 100,000 tonnes of CO_2 eq annually. These entities represent approximately half of the province's emissions. The newly enacted TIER Regulation requires facilities to reduce their emissions intensity to meet a high-performance benchmark. Regulated facilities have three compliance options: submit emissions performance credits; submit Alberta Emission Offsets generated from qualifying emissions reductions outside of regulated facilities; or obtain fund credits by paying the prescribed price ($50/tonne CO_2 eq in 2022) to the TIER Fund. Note that estimated mitigation impacts are relative to 2015 projections and also include the impacts of measures such as: renewable electricity program; carbon capture, use and storage; coal phase-out; and, methane regulations. In response to Alberta's energy-only market and the single electricity benchmark under the TIER Regulation, Alberta has seen over $2 billion worth of utility scale renewable generation projects announced since 2019, accounting for more than 2 GW of capacity. These projects are market-driven and do not require government subsidies. TIER-funded programs are encouraging development of game-changing technology. The TIER Fund is invested in programs and projects that focus on innovation, research and technology to reduce emissions at a lower cost, while supporting jobs, and in programs and projects that help municipalities and Indigenous communities better understand, manage and adjust to a changing climate. TIER funds are provided to Emissions Reduction Alberta (ERA) to accelerate the development and deployment of innovative clean technology solutions.								
Alberta Renewable Fuels Standard (RFS)*	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce emissions from fuels	Regulatory	Implemented	2020	Alberta	NE[h]	NE[h]
Brief Description	The Alberta RFS pertains to fuels produced from renewable materials in the form of renewable fuel alcohols, such as ethanol, used in gasoline and bio-based diesel, used in diesel. These products may be produced using traditional technologies or emerging technologies based on advanced chemical and biological processes. The RFS requires a minimum annual average of 5% renewable alcohol in gasoline and 2% renewable diesel in diesel fuel sold in Alberta by fuel suppliers. To meet the RFS, renewable fuels must demonstrate at least 25% fewer GHG emissions than the equivalent petroleum fuel.								

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								2020	2030
Industrial Energy Efficiency and Carbon Capture Utilization and Storage (IEE CCUS) Grant Program	Cross-cutting	CO_2	Reduce emissions from large emitters	Economic	Implemented	2020	Alberta	NE[h]	NE[h]
Brief Description	The $131 million Industrial Energy Efficiency and Carbon Capture Utilization and Storage (IEE CCUS) Grant Program is part of Alberta's $750 million investment from the TIER Fund to cut emissions, create jobs and contribute to Alberta's economic recovery. The IEE CCUS program is helping Alberta's large industrial emitters: • Reduce emissions; • Increase competitiveness; • Lower carbon compliance costs; and, • Improve energy efficiency through technology and equipment upgrades.								
Prairie Resilience: A Made-in-Saskatchewan Climate Change Strategy	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Enhance the ability to cope with, adapt to, and recover from stress and change.	Economic, Education, Fiscal, Information, Regulatory, Research, Voluntary Agreement	Implemented	2017	Saskatchewan	NE[h]	NE[h]
Brief Description	Prairie Resilience is a strategy that takes a system-wide approach and includes more than 40 commitments designed to make Saskatchewan more resilient to the effects of a changing climate. The commitments—which go beyond emissions reductions alone—span Saskatchewan's natural systems and resources, infrastructure for electricity, transportation, homes and buildings, and community preparedness.								

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								2020	2030
Saskatchewan *Management and Reduction of Greenhouse Gases Act*	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Enable the implementation of emissions management	Regulatory	Implemented	2018	Saskatchewan	NE[h]	NE[h]
Brief Description	The *Management and Reduction of Greenhouse Gases Act* (MRGHG Act) was partially proclaimed and in force since January 1, 2018. Amendments to MRGHG Act were made in late 2018 to: • Revise existing prescriptive provisions related to GHG reporting and methodology; • Enable intensity-based performance standards for large emitters; • Enable compliance mechanisms for use by large emitters; • Enable the implementation of performance standards on large industrial emitters. The amended MRGHG Act was proclaimed in full in December 2018.								
Saskatchewan *Regulation Respecting the Management and Reduction of Greenhouse Gases (General and Reporting)*	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Regulate reporting of GHG emissions	Regulatory	Implemented	2018	Saskatchewan	NA[d]	NA[d]
Brief Description	These reporting regulations require all emitters of more than 10,000 t CO_2 eq annually to report emissions. The additional data will help produce a more robust provincial GHG inventory and allow Saskatchewan to efficiently target and reduce sources of GHG emissions in the province.								

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								2020	2030
Saskatchewan *Regulation Respecting the Management and Reduction of Greenhouse Gases (Standards and Compliance)**[3]	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce industrial emissions	Economic, Regulatory	Implemented	2019	Saskatchewan	NE[h]	NE[h]
Brief Description	Saskatchewan has developed a sector-specific Output-based Performance Standards (OBPS) Program for facilities emitting more than 25,000 tonnes of CO_2 eq per year. The standards currently apply to 88 large facilities and 62 aggregate facilities, comprised of more than 13,000 small oil and gas facilities, which account for over 18% (over 13 million tonnes) of total provincial emissions. Registered facilities that emit more than is permitted must pay compliance. Compliance can be paid in two ways: making payments into the Saskatchewan Technology Fund, or retiring performance credits. Performance credits are awarded to regulated facilities that emit less than the permitted level and can be banked for future use or sold to other regulated facilities. On January 1, 2023, Saskatchewan will be implementing updates to the OBPS program, which will satisfy the national requirements established in the 2023–2030 federal carbon pricing benchmark. These updates will add electricity and natural gas transmission to the program.								
Saskatchewan SaskPower Demonstration and Implementation of Carbon Capture Technology*	Cross-cutting	CO_2	Reduce GHG emissions from coal energy	Voluntary Agreement, Research	Implemented	2014	Saskatchewan	NE[c]	NE[c]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Together with industry and government partners, Saskatchewan has initiated a number of capture and storage projects. These include the Aquistore deep saline geological formation CO_2 storage project. The Weyburn-Midale project is the largest capture and storage demonstration site for enhanced oil recovery in the world. Saskatchewan is continuing to fund research related to the Weyburn reservoir through the Saskatchewan CO_2 Oilfield Use for Storage and EOR Research Project. Saskatchewan has also implemented the approximately $1.35 billion, 108 megawatt carbon capture and storage project at Boundary Dam Power Station, with a $240 million federal government contribution. The Boundary Dam Carbon Capture Facility began commercial operation in the fall of 2014 and as of July 2022, has captured and sequestered more than 4.5 million tonnes of CO_2 since commissioning. These emission reductions (729,187 tonnes in 2020; 800,000 tonnes in 2030) are not listed to avoid double counting since the Boundary Dam emission reductions are listed by the federal government reported under the Energy Innovation Program). Saskatchewan has been injecting carbon dioxide into the subsurface since 1984.								
Saskatchewan Technology Fund	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Invest in GHG-reducing innovation and technologies	Fiscal	Implemented	2022	Saskatchewan	NA[b]	NE[h]
Brief Description	The Saskatchewan Technology Fund will invest in transformative technologies and innovation to reduce GHG emissions.								
Saskatchewan's Climate Resilience Measurement Framework	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Track and annually report across all areas of focus to convey progress in making the province more resilient to climate change	Information	Implemented	2018	Saskatchewan	NE[h]	NE[h]
Brief Description	The Climate Resilience Measurement Framework tracks annual progress on 25 resilience measures across five key areas: natural systems, physical infrastructure, economic sustainability, community preparedness and human well-being. Annual reporting on all measures provides a better understanding of Saskatchewan's incremental resilience to climate change. It may also help identify where, in future years, alternative or additional policies and programs may enhance resilience.								

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								2020	2030
Ag Action Manitoba Program – Assurance: Beneficial Management Practices and Watershed Ecological Goods and Services	Cross-cutting, Agriculture, LULUCF	CH_4, CO_2, N_2O	Reduce emissions, enhance carbon sequestration, and provide co-benefits such as water quality, bio-diversity, soil health, etc.	Voluntary Agreement	Implemented	2018	Manitoba	NE[h]	NE[h]
Brief Description	In 2018, Ag Action Manitoba announced program funding to help farmers implement and adopt beneficial management practices (BMPs) on their farm identified in their Environmental Farm Plan. These practices support reducing emissions among other benefits. Farmers can apply directly to the Ag Action Manitoba BMP activity for practices that provide environmental benefits, including reducing on-farm GHG emissions. Watershed districts can apply to the Ag Action Manitoba program activity called Watershed Ecological Goods and Services, which provides funding to watershed districts to work with farmers to implement practices that conserve and enhance ecological goods and services on the agricultural landscape.								
Conservation and Climate Fund	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, SF_6	Reduce GHG emissions	Voluntary Agreement	Implemented	2020	Manitoba	NE[h]	NE[h]
Brief Description	The purpose of the Conservation and Climate Fund is to support projects occurring in Manitoba that incorporate actions to combat and adapt to climate change and protect the environment in alignment with the priorities and implementation of the Climate and Green Plan.								
Efficiency Manitoba Act* and Energy Savings Targets	Cross-cutting	CH_4, CO_2, N_2O	Reduce energy use	Regulatory	Implemented	2018 (legislation), 2020 (programming)	Manitoba	NE[h]	NE[h]

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								2020	2030
Brief Description	In 2018, the *Efficiency Manitoba Act* was established and the province established Efficiency Manitoba, a new Crown corporation with the sole purpose of administering and delivering cost-effective energy savings to consumers. As per the *Efficiency Manitoba Act*, Manitoba must meet legislated savings targets of 22.5% of domestic electricity demand (an average of 1.5% annually of domestic electricity consumption) and 11.25% of domestic natural gas demand (an average of 0.75% annually of natural gas consumption) over a 15-year period. Efficiency Manitoba can achieve additional energy savings if they can be achieved in a cost effective manner. Efficiency Manitoba's efforts will help mitigate the impact of rate increases and delay the point at which capital investments in major new generation and transmission projects will be required by Manitoba Hydro to serve the needs of Manitobans. If and when prescribed by regulation under the *Efficiency Manitoba Act*, the corporation will carry out the prescribed duties in respect of: demand for electrical power in Manitoba, potable water consumed in Manitoba, and fossil fuels consumed in the transportation sector in Manitoba. The corporation will promote and encourage the involvement of the private sector and other non-governmental entities in the delivery of its demand-side management initiatives. The province is continuing to expand Efficiency Manitoba grant offerings to support building energy efficiency programs across all sectors.								
Indigenous Community Energy Efficiency Plan	Cross-cutting, Electricity, Buildings	CO_2	Identify energy-saving opportunities in Indigenous communities	Fiscal, Voluntary Agreement	Planned	2022	Manitoba	NA[b]	NE[h]
Brief Description	For a two-year period starting in 2022, Efficiency Manitoba has confirmed its commitment of $440,000 to fund 11 energy efficiency advocate (EEA) positions in First Nation communities across Manitoba through Efficiency Manitoba's Indigenous Community Energy Efficiency Program.								
Manitoba Carbon Savings Account	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, SF_6	Reduce GHG emissions	Regulatory	Implemented	2018	Manitoba	941.00	NE[h]
Brief Description	Manitoba is the first jurisdiction in North America to establish an economy-wide carbon savings account, settings its emissions reduction goal for 2018–2022 in June 2019 ahead of the November regulatory deadline. The carbon savings account for 2018–2022 was based on the recommendations of the independent Expert Advisory Council, including its emission reduction target of 1 Mt CO_2 eq cumulative emission reductions from 2018 to the end of 2022. Five-year carbon savings accounts will continue to be set, as required in the *Climate and Green Plan Act*, to drive emission reductions in a timely and sustained manner. The 2023–2027 CSA will be set by December 31, 2022.								

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								2020	2030
Electrification & Energy Transition Panel	Cross-cutting	CH_4, CO_2	Advise the Minister of Energy on key integrated energy planning matters related to electrification and energy transition	Information	Adopted	2022	Ontario	NA[b]	NA[d]
Brief Description	Building on ongoing work in the sector, the Electrification & Energy Transition Panel will provide advice to the Government on highest value short-, medium- and long-term opportunities for the energy sector and opportunities to strengthen Ontario's long-term energy planning process by better coordinating fuels and the electricity sector. The Panel will deliver a formal report with recommendations to the Government.								
Green Bond Program	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Funded projects that have environmental benefits	Fiscal	Implemented	2014	Ontario	NE[h]	NE[h]
Brief Description	Ontario has issued $9.45 billion worth of green bonds to capitalize on the province's ability to raise funds at low interest rates and help finance public transit initiatives, extreme-weather resistant infrastructure, and energy efficiency and conservation projects								
Ontario Energy Efficiency Standards for Products and Appliances and Equipment	Cross-cutting	CH_4, CO_2, N_2O	Reduce GHG emissions in the residential, commercial and industrial sectors	Regulatory	Implemented	1989	Ontario	NE[h]	NE[h]
Brief Description	Ontario's regulation O. Reg. 509/18 sets efficiency requirements for over 90 products using electricity, natural gas, and oil in the residential, commercial and industrial sectors. Efficiency standards reduce energy use and GHG emissions across all sectors. Ontario is committed to regularly updating its efficiency standards and harmonizing its standards with leading North American jurisdictions, such as the US Department of Energy and Natural Resources Canada.								

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								2020	2030
Ontario Provincial Land Use Policy, Plans and Legislation	Cross-cutting	CO_2	Reduce GHG emissions through land use planning policies and approaches such as permanently protecting prime agricultural land and environmental sensitive areas	Regulatory	Implemented	Various	Ontario	NE[h]	NE[h]
Brief Description	Ontario's *Planning Act* requires that planning authorities, in carrying out their responsibilities under the Act, shall have regard to matters of provincial interest including the mitigation of GHG emissions. It also requires that a municipal official plan contain policies that identify goals, objectives and actions to mitigate GHG emissions. The Provincial Policy Statement (PPS) is issued under section 3 of the *Planning Act* and applies Ontario-wide. It sets the policy foundation for regulating the development and use of land. The PPS, 2020, which came into effect May 1, 2020, replacing the PPS, 2014, includes a range of policies to support reduction of GHG emissions, such as promoting compact form, a structure of nodes and corridors, the use of active transportation, transit-supportive development and intensification. It requires municipalities to integrate these considerations in their local official plans, zoning by-laws and land use planning decisions. The policies of the PPS are complemented by provincial plans which build on the policy foundation of the PPS and provide additional land use planning policies to address issues facing specific geographic areas in Ontario. A Place to Grow: the Growth Plan for the Greater Horseshoe (A Place to Grow, 2020), the Greenbelt Plan (2017), the Oak Ridges Moraine Conservation Plan (2017) and the Niagara Escarpment Plan (2017) are four provincial land use plans that work together to manage growth, build compact and complete communities, curb sprawl and protect the natural environment—all of which contribute to lower GHG emissions. In addition, A Place to Grow requires municipalities to develop official plan policies which identify actions to reduce GHG emissions and address climate change adaption goals. Ontario's land use plans are enabled by key legislation. The *Places to Grow Act (2005)* enables the development of regional growth plans that guide government investments and land use planning policies. The *Greenbelt Act (2005)* allows for the designation of an area of land as the Greenbelt Area—lands protected from development.							

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								2020	2030
Québec Bioenergy Program	Cross-cutting, Buildings, Heavy Industry	CO_2	Reduce GHG emissions from heating buildings and industrial energy demands	Economic	Implemented	2013	Québec	79.00	NE[i]
Brief Description	This program aims to reduce GHG emissions and the consumption of fossil fuels by funding specific energy conversion projects to switch from fossil fuels to residual forest biomass, and other bioenergy sources.								
Québec EcoPerformance Program*	Cross-cutting	CO_2, HFCs	Reduce GHG emissions	Economic	Implemented	2013	Québec	913.00	NE[i]
Brief Description	The EcoPerformance program is available to businesses, institutions and municipalities. Both small and large energy consumers can apply for financial assistance. The program aims to improve the energy efficiency of commercial and institutional buildings as well as that of industrial processes in order to reduce fugitive and regular GHG emissions in processes and to diminish the consumption of fossil fuels. In addition to direct reductions projected in the short term, indirect, longer term mitigation impacts are also expected. Québec increased funding for the program, specifically for buildings and large emitters, through its 2022-2027 Implementation Plan.								
Québec Green Hydrogen and Bioenergy Strategy*	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions across the economy and reduce our dependence on fossil fuels	Economic, Fiscal, Regulatory	Implemented	2022	Québec	NA[b]	NE[i]
Brief Description	Increase bioenergy production by 50% by 2030, 5% renewable natural gas in the grid by 2025, and a minimum of 10% by 2030. In 2022, the Québec Green Hydrogen and Bioenergy Strategy will present, in line with the 2030 Plan for a Green Economy, a vision and government policy related to the development of these sectors. Its deployment will make it possible to diversify complementary solutions to electrification in order to decarbonize Québec, particularly in the industrial sector. The use of green hydrogen and bioenergy will, among other things, facilitate the management of electricity peaks in a context where the gradual abandonment of fossil fuels will result in increased pressure on hydroelectric networks.								

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								2020	2030
Québec *Regulation Respecting Halocarbons*	Cross-cutting	Other (Halocarbons)	Reduce halocarbon emissions	Regulatory	Implemented	2020	Québec	NE[h]	NE[h]
Brief Description	April 16, 2020, marked the adoption of the *Regulations Amending the Halocarbon Regulations*. The purpose of the strengthened regulations is to reduce the release of halocarbons into the atmosphere in order to ensure the protection of the ozone layer and to minimize the increase in the greenhouse effect.								
Québec Technoclimat Program	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Develop new innovative technologies or processes in the areas of energy efficiency	Economic	Implemented	2013	Québec	NE[h]	NE[h]
Brief Description	The objective of Technoclimat is to encourage the development, in Québec, of technological innovation in the areas of energy efficiency, renewable energies, bioenergies and GHG emission reductions by offering financial assistance to project promoters who wish to demonstrate the potential of technological innovation. It also promotes the testing in Québec of technologies that are either unavailable or not widely available in the Québec market. Québec increased funding for the program through its 2022-2027 Implementation Plan.								
Québec's Cap-and-Trade System for Greenhouse Gas Emission Allowances*	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions across the economy	Economic	Implemented	2013	Québec	NE[h]	NE[i]
Brief Description	The Québec government's cap-and-trade system for GHG emissions has been in operation since 2013 and has been fully linked to California's system since 2014. The Québec system covers industry, electricity production and imports as well as fuel distribution. Offset protocols are also in place in sectors not covered by the system. By the end of 2022, Québec and California will have held a total of thirty-four joint auctions of GHG emission allowances. Estimation of mitigation impact in 2020 and 2030: caps for 2020 have been set on a declining linear trajectory to help achieve Québec's GHG emission target of 20% below 1990 levels; caps from 2021 to 2030 have been similarly set from 55.26 Mt CO_2 eq in 2021 to 44.14 Mt CO_2 eq in 2030 to help achieve Québec's target of 37.5% below 1990 levels in that year.								

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								2020	2030
Recovery and reuse of heat	Cross-cutting, Electricity, Buildings, Heavy Industry	CH_4, CO_2, N_2O	Reduce GHG emissions and energy consumption in the Buildings Sector	Economic	Implemented	2021	Québec	NA[b]	NE[i]
Brief Description	Reuse waste heat and support the circular economy. As an alternative to fossil fuels, using waste heat from one industry to meet the heat needs of another nearby industry or organization is part of a logic of optimizing the use of resources.								
Regulation respecting the integration of low-carbon-intensity fuel content into gasoline and diesel fuel*	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions across the economy and reduce our dependence on fossil fuels	Regulatory	Implemented	2021	Québec	NA[b]	NE[i]
Brief Description	The regulation is in line with the orientations of the 2030 Energy Policy and the 2030 Plan for a Green Economy launched last November, including its 2021-2026 Implementation Plan. The Government aims to increase the use of renewable fuels to 15% of gasoline and 10% of diesel by 2030. The regulations are particularly ambitious in that they aim to incorporate low-carbon fuels that will result in real GHG reductions. In addition, the regulation will support the deployment of the emerging bioenergy sector in Québec by providing a stable and predictable market for producers. It will provide significant regional economic benefits, while helping to reduce fossil fuel imports and achieve the Government's GHG reduction target.								
New Brunswick 2016 Climate Change Action Plan	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions	Regulatory	Implemented	2016	New Brunswick	NA[b]	2,870.00 – 3,260.00
Brief Description	The 2016 5-year action plan included 118 actions to address climate change. The plan included New Brunswick's 2030 and 2050 targets of 10.7 Mt and 5 Mt respectively, which are now in regulation. It included actions to transition New Brunswick to a low-carbon economy and achieve its 2030 target. At the conclusion of the plan, 76% of the actions were completed.								

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New Brunswick 2022 Climate Change Action Plan	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions	Regulatory	Implemented	2022	New Brunswick	NA[b]	2,350.00 – 3,160.00
Brief Description	The plan (updated every 5 years) includes 30 new and incremental measures, keeping the province on the path to meet its 2030 target. It also includes a commitment to be net-zero by 2050.								
New Brunswick Carbon Tax*[3]	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions	Economic, Regulatory	Implemented	2021	New Brunswick	NA[b]	11.00
Brief Description	Effective April 1, 2020, the provincial government introduced a federally compliant provincial carbon tax at $30/tonne on 22 different fuels. The carbon tax was increased to $40/tonne on April 1, 2021 and to $50/tonne on April 1, 2022. A portion of the incremental revenue from the carbon tax was directed toward climate change initiatives in 2020–2021 and to the Climate Change Fund in 2021–2022.								
New Brunswick *Climate Change Act*	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions	Regulatory	Implemented	2018	New Brunswick	NE[h]	NE[h]
Brief Description	New Brunswick's *Climate Change Act* was established in 2018. The Act brought New Brunswick's 2020, 2030, and 2050 GHG emission reductions targets into law. The *Climate Change Act* declares New Brunswick's commitment to addressing climate change mitigation and adaptation; provides the authority to implement a carbon pricing mechanism; establishes a climate change fund with authority to spend proceeds; establishes industrial emissions limits; and provides transparency, accountability and reporting.								
New Brunswick Climate Change Fund	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions	Regulatory	Implemented	2018	New Brunswick	NE[h]	NE[h]
Brief Description	The Climate Change Fund was established under the *Climate Change Act* in 2018.								

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								2020	2030
New Brunswick Innovation Foundation	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Clean Technology acceleration and commer-cialization	Research, Economy	Implemented	2021	New Brunswick	NA[b]	NA[d]
Brief Description	Opportunities New Brunswick (ONB) has partnered with the New Brunswick Innovation Foundation to deliver on a Clean Technology innovation initiative to develop a pipeline of clean technology innovation in the province. The initiative has developed momentum for applied climate research and cleantech innovation in New Brunswick through four main program streams: Climate Impact Research Fund; Cleantech Startup Investment Fund; Corporate Cleantech Innovation Fund; and Climate Early Stage Commercialization Fund. Full outcomes of the first year of the initiatives will be available in 2022.								
New Brunswick Output Based Pricing (OBPS) for Industry and Electricity*[3]	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Improve the carbon intensity of large industry and electricity generation	Regulatory	Implemented	2020, 2021	New Brunswick	NA[b]	900.00
Brief Description	For large emitters, the New Brunswick Output-Based Pricing System was approved by the federal government in 2020 and came into effect on January 1, 2021. New Brunswick expects to meet the new federally strengthened benchmark and continue to implement the New Brunswick OBPS. Under the system, large industrial emitters are required to reduce their GHG emissions intensity (stringency) to 2030 and electricity generators are required to meet performance standards that have been designed to reduce GHG emissions while minimizing rate impacts on New Brunswickers. Any revenue generated under the Output-Based Pricing System will be directed to the New Brunswick Climate Change Fund.								
***Environmental Goals and Climate Change Reduction Act* (EGCCRA)**	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions, conserve land and water	Regulatory	Implemented	2021	Nova Scotia	NA[b]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Includes the strongest 2030 target for GHG reduction (53% below 2005 levels). Other 2030 commitments in the Act include phasing out coal-fired electricity generation in the province, supplying 80% of Nova Scotia's energy from renewable sources, having 30% of new vehicle sales of all light duty and personal vehicles be zero-emissions vehicles by 2030, and reducing solid waste disposal rates to no more than 300 kilograms per person per year. EGGCRA also includes commitments to support, strengthen and set targets for energy efficiency programming and to conserve at least 20% of total land and water mass.								
Nova Scotia Cap-and-Trade Program*[3]	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions across Nova Scotia's economy	Regulatory	Implemented	2019	Nova Scotia	170.00	NE[h]
Brief Description	As part of the Pan-Canadian Framework on Clean Growth and Climate Change, Nova Scotia implemented a cap-and-trade program which covers approximately 86% of GHG emissions in the province. Estimation of mitigation impact in the first compliance period from 2019 to 2022 is a cumulative total of at least 680 kt CO_2 eq.								
Energy Rebate	Cross-cutting	CO_2	Incentivize Islanders to reduce carbon emissions and make electricity cheaper	Economic	Implemented	2018	Prince Edward Island	NE[h]	NE[h]
Brief Description	Energy rebate to engage Islanders to reduce carbon emissions and work to make electricity cheaper. Clean Energy Price Incentive will rebate 10% of the first block of residential electricity, as well as on lower emitting heat sources, including firewood, pellets, and propane. This will save $120 per household each year and provide a clear pricing signal for cleaner energy. The following energy products are eligible for provincial rebates: • Electricity – rebate on first block (2,000 kWh per month) on eligible residential bills for year-round customers; • Propane – rebate on purchases for residential home heating; • Wood Pellets – rebate on pellets used for space heating; • Firewood – rebate on purchases of one cord or more used for space heating; and, • Wood Chips – purchases for residential heating eligible for a rebate by submitting an application. The rebate will be at the retail level and the Prince Edward Island will reimburse the supplier for 10% of sales subject to HST. The rebate will be deducted from electricity, propane, or wood fuel bill.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
PEI Climate Challenge Fund	Cross-cutting	CO_2	Support innovative solutions to climate change	Fiscal	Implemented	2020	Prince Edward Island	NE[h]	NE[h]
Brief Description	$3 million over 3 years to support innovative solutions to climate change. $100,000 to support projects that reduce GHG emissions, help communities and the economy adapt to climate change, and address inequities and discrimination that are generated from the negative impacts of climate change. To date, this fund has supported 29 projects (15 in 2020–21; 14 in 2021–22) across sectors and organization types, including First Nations, municipalities, non-profit organizations, local businesses and academic institutions. PEI has also supported clean technology projects through its Climate Challenge Fund (e.g., hydrogen fuel systems).								
Prince Edward Island 2040 Net Zero Framework	Cross-cutting	CO_2	Achieve net-zero GHG emissions by 2040	Voluntary Agreement	Implemented	2022	Prince Edward Island	NA[b]	NE[h]
Brief Description	In February 2022, Prince Edward Island released its 2040 Net Zero Framework to achieve the goals and targets required to become Canada's first net-zero province. The priorities included in this framework will be supported by the development and implementation of a series of five-year action plans that will include interim emission reduction targets and reporting of progress made to date. The framework focuses on six pillars: • Transforming the way Islanders move; • Transitioning to cleaner and more efficient buildings; • Shaping agriculture for PEI's transition to net-zero; • Removing carbon through forestry, technology and emerging opportunities; • Creating a clean industry and waste advantage; and, • Inspiring transformational change through leadership and engagement. Each pillar is supported by specific goals and priorities, as well as sector-based targets for 2030 and 2040.								
Prince Edward Island Climate Change Action Plan	Cross-cutting	CH_4, CO_2, N_2O	Reduce emissions and increase climate resilience	Voluntary Agreement	Implemented	2018	Prince Edward Island	NE[h]	180.00

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	This plan is set to expire in 2023. The 2040 Net Zero Framework has replaced the mitigation section in this plan. A new provincial climate adaptation plan will be released in 2022.								
Prince Edward Island *Climate Leadership Act*	Cross-cutting	CO_2	Reduce the use of fossil fuels for heating and transportation	Regulatory	Implemented	2019	Prince Edward Island	NE[h]	NE[h]
Brief Description	Prince Edward Island administered a provincial carbon tax through the *Climate Leadership Act*. Gasoline and diesel for agriculture and fisheries, light fuel oil for heating, and propane are exempt from the carbon tax. The price started at $20/tonne in 2019 and will increase in increments of $10/tonne per year until the price reaches $50/tonne. As of 2022, the carbon price was set at $50/tonne. The revenue is returned to PEI citizens through rebates for income qualified households, tax or fee reductions, and several emissions reduction programs. PEI has voluntarily adopted the federal backstop for large emitters.								
Prince Edward Island Energy Strategy	Cross-cutting	CO_2	Reduce energy use and develop renewable energy	Voluntary Agreement	Implemented	2016	Prince Edward Island	NE[h]	NE[h]
Brief Description	Prince Edward Island has developed a 10-year energy strategy to reduce energy use, establish cleaner and locally produced energy sources and moderate future energy price increases. The Strategy is guided by three principles: lowering GHG emissions, cost-effectiveness, and creating local economic opportunities.								
Renewables in Agriculture Program	Cross-cutting, Agriculture, Electricity	CO_2, N_2O	Support farmers to mitigate the production of GHGs and/ or sequester carbon in the soil	Fiscal	Planned	2023	Prince Edward Island	NA[b]	NE[h]
Brief Description	A new program developed to assist the agricultural industry in installing on-farm renewable energy generation equipment. Program not yet publicly advertised. $500,000 in budget for 2022–23.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Green Technology Tax Credit	Cross-cutting	CH_4, CO_2, N_2O	Reduce GHG emissions	Fiscal	Implemented	2022	Newfoundland and Labrador	NA[b]	NE[h]
Brief Description	A new 20% green technology tax credit for companies that invest in equipment for energy conservation and clean energy generation, use fuels from waste, or make efficient use of fossil fuels. The maximum credit is $1 million annually, of which 40% is refundable.								
Newfoundland and Labrador carbon pricing*[3]	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Implement a carbon pricing system to reduce GHG emissions from all sectors of the economy	Regulatory	Implemented	2019	Newfoundland and Labrador	NE[h]	NE[h]
Brief Description	Newfoundland and Labrador's carbon pricing system for GHG emissions came in to force on January 1, 2019 and covers over 90% of GHG emission in the province (some covered emissions are exempted within the program). It conceptually mirrors the federal approach by applying a carbon tax "at the pump" and implementing performance standards for large industrial facilities. This system is expected to allow the province to make progress toward its 2020 GHG reduction target (to reduce GHGs by 10% below 1990 levels) and 2030 GHG reduction target (to reduce GHGs by 30% below 2005 levels).								
Newfoundland and Labrador Climate Change Challenge Fund	Cross-cutting	CH_4, CO_2, N_2O	Reduce industrial GHG emissions in multi-unit residential buildings, municipalities, commercial, non-profit and industrial sectors	Fiscal	Implemented	2019	Newfoundland and Labrador	0.00	81.70
Brief Description	Newfoundland and Labrador is delivering a Climate Change Challenge Fund which can help enhance efficiency and promote forestation. This program is supported by the Low Carbon Economy Leadership Fund.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Newfoundland and Labrador *Management of Greenhouse Gas Act* and Regulations*[3]	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions	Regulatory, Economic	Implemented	2019	Newfoundland and Labrador	NE[h]	NE[h]
Brief Description	Newfoundland and Labrador is implementing its made-in-Newfoundland and Labrador carbon pricing system for the large industrial sector through this policy. The approach is currently under review as part of a national review of carbon pricing.								
The Way Forward on Climate Change in Newfoundland and Labrador: 2019-24 Climate Change Action Plan	Cross-cutting	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions	Regulatory, Economic	Implemented	2019	Newfoundland and Labrador	NE[h]	NE[h]
Brief Description	The implementation of a made-in-Newfoundland and Labrador carbon pricing system in 2019 and GHG emission reductions made under the Low Carbon Economy Leadership Fund as key actions. From the perspective of the Low Carbon Economy Leadership Fund, targets set out in the federal-provincial agreement are expected to be exceeded. The action plan contains commitments related to every sector of the economy, from businesses and large industry, to households and transportation, and government. Of the 45 action items, 30 are completed, and substantial progress has been made on the remaining 15 action items.								
Clean Energy Act	Cross-cutting	CH_4, CO_2, N_2O	Reduce GHG emissions	Regulatory	Implemented	2022	Yukon	NA[b]	NE[h]
Brief Description	Create a *Clean Energy Act* by 2023 that legislates Yukon's GHG reduction targets and our commitments to energy efficiency and demand-side management to hold the Government of Yukon accountable.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Our Clean Future: A Yukon Strategy for Climate Change	Cross-cutting	CH_4, CO_2, N_2O	Reduce GHG emissions, ensure access to renewable energy, adapt to climate change, build a green economy	Economic, Education, Fiscal, Information, Research, Regulatory, Voluntary Agreement	Implemented	2020	Yukon	NE[h]	121.00
Brief Description	The Government of Yukon released Our Clean Future: a Yukon strategy for climate change, energy and a green economy, the Yukon's 10-year climate change strategy, in 2020. The Strategy was designed in partnership with First Nations governments, municipalities, and other organizations. The Strategy is designed to achieve four goals: 1. Reducing GHG emissions 2. Ensure Yukoners have access to reliable, affordable and renewable energy 3. Adapt to the impacts of climate change 4. Build a green economy The strategy features 136 actions, which fall under seven areas. Note that the estimate of mitigation impact includes the impact of other mitigation actions implemented by the Yukon Government. The total does not match the sum of the individual policies because of policy interactions where two or more policies contribute to the same GHG reduction.								
Yukon Government *Carbon Price Rebate Act*	Cross-cutting	CH_4, CO_2, N_2O	Reduce GHG emissions	Regulatory, Economic	Implemented	2019	Yukon	0.00	12.00
Brief Description	Aligns with commitments specified in the *Pan-Canadian Framework on Clean Growth and Climate Change*.								
Arctic Energy Alliance's Outreach	Cross-cutting	CO_2	Educate, raise awareness and help residents adopt energy saving practices	Education	Implemented	2007	Arctic Energy Alliance	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The Arctic Energy Alliance, a non-profit organization, provides free information, advice, incentives and answers to questions from residents of the Northwest Territories on energy efficiency and hosts annual Energy Actions Awards. The Arctic Energy Alliance also conducts energy audits to educate residents on how to reduce home energy consumption.								
2030 NWT Climate Change Strategic Framework (CCSF)	Cross-cutting	CH_4, CO_2	The CCSF has three goals: 1) Transition to a strong, healthy economy that uses less fossil fuel, thereby reducing GHG emissions by 30% below 2005 levels by 2030; 2) Improve knowledge of the climate change impacts occurring in the NWT; and 3) Build resilience and adapt to a changing climate	Economic, Education, Fiscal, Information, Research, Regulatory, Voluntary Agreement	Implemented	2019	Northwest Territories	NE[h]	NE[h]
Brief Description	The Government of the Northwest Territories' (GNWT) plan to address climate change is outlined in the 2030 NWT Climate Change Strategic Framework (CCSF). The CCSF was published in 2018 and provides a roadmap to transition the territory to a lower carbon economy, build a sustainable energy system and strengthen our understanding of the effects of climate change, while implementing solutions that increase our resiliency and adaptability to a changing climate. The CCSF is implemented in conjunction with the GNWT's 2030 Energy Strategy and Carbon Tax, and involves partnerships with Indigenous, municipal, and federal governments, along with non-government and industry stakeholders.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
GHG Grant Program (LCELF funded)	Cross-cutting	CO_2	Provide support for emissions-reducing projects over $100,000 and led by NWT organizations	Economic	Implemented	2018	Northwest Territories	0.10	5.60
Brief Description	The Northwest Territories launched the GHG Grant Program with support from Environment and Climate Change Canada. The program provides grants to various recipients including Indigenous, municipal and community governments; GNWT departments; businesses; non-profits; and individual building owners who implement projects that reduce GHG emissions within the Northwest Territories.								
NWT 2030 Energy Strategy	Cross-cutting	CO_2	Territorial strategy to develop secure, affordable and sustainable energy and achieve the 2030 GHG emissions target of 30% below 2005 levels	Economic, Education, Fiscal, Information, Regulatory, Research, Voluntary Agreement	Implemented	2018	Northwest Territories	NE[h]	NE[h]
Brief Description	The Government of the Northwest Territories' plan to meet the territorial target of reducing GHG emissions by 30% by 2030 is outlined in the 2030 Energy Strategy.								
NWT Carbon Tax*[3]	Cross-cutting	CO_2	Reduce GHG emissions	Regulatory	Implemented	2019	Northwest Territories	NE[h]	NE[h]
Brief Description	The NWT Carbon Tax became effective on September 1, 2019. The carbon tax rate will increase from $50 to $65 per tonne of GHG emissions on April 1, 2023, raising the carbon tax rate from 11.7 cents to 14.3 cents per litre of gasoline. Increased revenue from carbon pricing will be recycled to NWT.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Other initiatives funded by LCELF	Cross-cutting	CO_2	Supporting energy and heating efficiency and fuel switching, carbon sequestration through forest management, and decarbonizing marine transportation within the NWT	Economic	Implemented	2018	Northwest Territories	0.00	1.50
Brief Description	Through three other streams derived from the LCELF the GNWT was able to target specific sectors of its economy to decarbonize. Through this support, those hard to support sectors were able to meet stated goals and move the Energy Divisions strategy forward for a low-carbon economy by 2030.								
Municipal Green Infrastructure Fund – Nunavut	Cross-cutting	CO_2	Reduce GHG emissions	Fiscal	Implemented	2019	Nunavut	NE[h]	NE[h]
Brief Description	The Municipal Green Infrastructure Fund allows municipalities to apply for funding towards climate change projects, including energy efficiency retrofits and installation of renewable energy systems on municipality-owned buildings. This is being funded by carbon tax revenue.								
Nunavut EnergyWise	Cross-cutting	CO_2	Reduce GHG emissions	Education	Implemented	2017	Nunavut	NA[d]	NA[d]
Brief Description	EnergyWise is a GN-led public awareness campaign targeting Nunavummiut at home and in the workplace to reduce emissions by increasing energy efficiency and reducing energy consumption.								
Nunavut new district heating systems	Cross-cutting	CO_2	Reduction of fossil fuel consumption	Voluntary Agreement	Implemented	2018	Qulliq Energy Corporation (Nunavut's Utility)	0.82	7.37

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The communities of Sanikiluaq and Taloyoak, in Nunavut, will benefit from a new district heating system that will help reduce the territory's fuel consumption and cut carbon emissions. The project, funded by the Government of Canada's Low Carbon Economy Fund, captures residual heat from power generation and provides space and hot water heating to nearby commercial and institutional buildings, allowing customers to save on energy costs and extend the life of their heating equipment. Feasibility studies estimate that a new district heating system in Sanikiluaq and Taloyoak will displace approximately 298,000 litres of fuel and reduce emissions by 830 tonnes of CO_2 annually. New District Heating System are being installed in Sanikiluaq and Taloyoak by Qulliq Energy Corporation. Funding for this project has come from the Low Carbon Economy Fund.								
ELECTRICITY									
Clean Electricity Regulations**	Electricity	CO_2	Reduce GHG emissions from electricity generation	Regulatory	Planned	TBD	Environment and Climate Change Canada	NA[b]	NE[e]
Brief Description	As part of the 2030 Emissions Reduction Plan, the Government of Canada committed to introduce a Clean Electricity Standard to help drive the transition to a net-zero emission electricity sector by 2035. It will ensure that existing electricity generation transitions to non-emitting sources and that any new power generation built in Canada is clean.								
Reduction of CO2 Emissions from the Amendments to the Coal-Fired Generation of Electricity Regulations*	Electricity	CO_2	Reduce GHG emissions from coal-fired electricity generation	Regulatory	Implemented	2015, 2018	Environment and Climate Change Canada	NA[b]	12,800.00
Brief Description	Regulations under the *Canadian Environmental Protection Act, 1999* apply a performance standard to new coal-fired electricity generation units and to existing units once they reach a defined period of operating life (generally 45 to 50 years). Amendments to the *Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations*, which were finalized and published in the Canada Gazette, Part II, on December 12, 2018, require all coal-fired electricity generating units to comply with an emissions performance standard of 420 tonnes of carbon dioxide per gigawatt-hour of electricity produced (tonnes of CO_2/GWh) by 2030, at the latest. This performance standard is designed to phase out conventional coal-fired electricity by the end of its operating life, or by 2030, whichever comes first.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Regulations Limiting CO2 Emissions from Natural Gas-Fired Electricity*	Electricity	CO_2	Limit GHG emissions from natural gas-fired electricity	Regulatory	Implemented	2019 (boiler units), 2021 (combustion engine units)	Environment and Climate Change Canada	NE[c]	NE[c]
Brief Description	The *Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Generation of Electricity* were finalized and published in the Canada Gazette, Part II, on December 12, 2018. The regulations for natural gas-fired electricity ensure that new natural gas-fired electricity generation uses efficient technology. The regulations will encourage companies to convert their coal units to natural gas ahead of their end-of-life under the amended coal regulations, while also providing assurance that higher emitting coal-to-gas converted units will be phased out more rapidly than better performers.								
Clean Energy for Rural and Remote Communities*	Electricity	CO_2	Reduce consumption of diesel fossil fuels	Fiscal, Research, Information, Education	Implemented	2018	Natural Resources Canada	NA[a]	138.00
Brief Description	This is a Green Infrastructure program under the Investing in Canada Plan. The program provides up to $220 million in funding for renewable energy projects in rural and remote communities to reduce their reliance on diesel and other fossil fuels. Activities include deployment of new renewable energy technologies, demonstration of innovative clean energy solutions, support for the development of bioheating projects, and capacity-building. After two rounds of intake, program funding is fully allocated, with 112 projects supported and 115 agreements signed. The program is on track to meet its 2030 target. The Strengthened Climate Plan announced an additional $300 million in funding for renewable energy projects in rural, remote, and Indigenous communities to reduce their reliance on diesel. This program, along with the Northern REACHE program at CIRNAC was recapitalized to co-deliver on this funding through a newly established Indigenous and Remote Clean Energy Hub.								
Electricity Predevelopment Program (Clean Electricity Projects pre-development activities)	Electricity	CO_2	Support large clean energy projects	Fiscal	Adopted	2022	Natural Resources Canada	NA[b]	NE[g]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The Electricity Predevelopment Program (EPP) is a $250 million program to support predevelopment work of large clean electricity projects, in collaboration with provinces. EPP will look to allocate funding via contribution agreements to fund eligible predevelopment activities, including engineering assessments, community engagement, and environmental and regulatory studies. No funding has of yet been allocated.								
Emerging Renewable Power Program*	Electricity	CO_2	Support deployment of emerging renewable power projects	Economic	Implemented	2018	Natural Resources Canada	NA[a]	227.00
Brief Description	This is a Green Infrastructure program under the Investing in Canada Plan. The $200 million Emerging Renewable Power Program was launched in February 2018 to support the deployment of emerging renewable energy technologies and to expand the portfolio of commercially viable renewable energy sources available to provinces and territories as they work to reduce GHG emissions from their electricity sectors. The call for proposals launched on February 26, 2018 and closed on April 20, 2018. Six projects have since been announced; with $29.8 million funding for an instream tidal project in the Bay of Fundy, Nova Scotia, $25.6 million for a deep geothermal project near Estevan, Saskatchewan, $15.3 million for a solar project near Suffield, Alberta, $25.4 million for a deep geothermal project in the Municipal District of Greenview, $28.5 million for a floating tidal project in Grand Passage, Nova Scotia, and $40.5 million for a geothermal project in northeastern British Columbia near Fort Nelson First Nation.								
Enabling Responsible SMR Deployment Program*	Electricity	CO_2	Reduce emissions from the electricity sector by supporting the development of SMRs	Fiscal	Adopted	2022	Natural Resources Canada	NA[b]	NE[g]
Brief Description	The Enabling Responsible SMR Deployment Program will be delivered over the next five years to provide direct funding via transfer payments to external Canadian recipients to advance Canada's expertise and knowledge in the areas of: radioactive waste management and minimization for SMRs; robust supply chains for SMRs; and SMR fuel supply. Budget 2022 proposes to include almost $70 million to support SMR deployment in Canada.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Small Modular Reactors Action Plan Implementation*	Electricity	CO_2	Reduce emissions from the electricity sector by supporting the development of Small Modular Reactors	Fiscal	Implemented	2020	Natural Resources Canada	NA[b]	NA[f]
Brief Description	Nuclear energy, and SMRs, will be part of the “all-options” approach in the transition to a low-carbon economy. Canada's SMR Action Plan was launched in December 2020, in partnership with provinces and territories, Indigenous Peoples and communities, power utilities, industry, innovators, laboratories, academia, and civil society. Since its launch, the SMR Action Plan includes 119 members – that have committed to over 500 concrete actions, including 27 Government of Canada actions. The Deputy Minister of Natural Resources Canada chaired the inaugural meeting of the SMR Leadership Table in April 2022, in response to a recommendation made in Canada’s 2018 SMR Roadmap and actions committed to by the Government of Canada in the SMR Action Plan. Since then, SMR Leadership Table has continued to function as a convening body. The second meeting, co-chaired by the Associate Deputy Minister of Natural Resources Canada and the Indigenous Advisory Council, was held in October 2022. The first ever SMR Leadership Table progress update was also publicly published in October 2022.								
Smart Grid Program*	Electricity	CO_2	Support the deployment of integrated smart grid systems and the demonstration of promising, near-commercial smart grid technologies	Economic, Research, Fiscal	Implemented	2018	Natural Resources Canada	NA[a]	900.00

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	This is a Green Infrastructure program under the Investing in Canada Plan. The program is investing $100 million to accelerate the transition to a clean growth economy by better utilizing the existing capacity of electricity assets, increasing the penetration of renewable generation, increasing the reliability, resiliency, and flexibility of the power system while maintaining cyber security, and reducing GHG emissions. As of March 31, 2022, the program had committed $41.0 million to ten deployment projects, $13.2 million to six demonstration projects and $31.7 million to six hybrid projects ($15.4 million for deployment, $16.3 million for demonstration) for a total of 22 projects (with 28 funding agreements). Projects are on track to meet the 2030 emission reduction target of 0.9 Mt/year (900 kt/year). The Smart Grid Program will sunset on March 31, 2023.								
Smart Renewables and Electrification Pathways Program*	Electricity	CO_2	Support renewable energy deployment projects which can provide grid services, and grid modernization projects, as well as Capacity Building Stream to support the equitable transition to a cleaner electrical grid	Fiscal	Implemented	2021	Natural Resources Canada	NA[b]	NE[h]
Brief Description	$964 million in Budget 2021 to the Smart Renewables and Electrification Pathways Program to support renewable electricity and grid modernization projects, and for capacity building projects that build knowledge and skills related to renewable energy and grid modernization technologies, and also support equity, diversity and inclusion activities. An additional $600 million recapitalization was announced in Budget 2022. To date, 144 deployment applications have been received, 47 deployment projects have been approved, and 47 capacity-building projects have been approved. All initial funding ($964 million in Budget 2021) is allocated.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Strategic Interties Predevelopment Program*	Electricity	CO_2	Provide funding for interties pre-development activities	Fiscal	Implemented	2021	Natural Resources Canada	NA[b]	NE[h]
Brief Description	The Strategic Interties Predevelopment Program (SIPP) established a dedicated funding envelope of $25 million to help accelerate the development of two electricity transmission projects of national significance: the Atlantic Loop and the Prairie Link. $11.9 million has been approved for eligible predevelopment activities as of August 2022.								
British Columbia *Clean Energy Act*: Clean or Renewable Electricity Requirement*	Electricity	CH_4, CO_2	Maintain low carbon electricity supply	Regulatory	Implemented	2010	British Columbia	NE[h]	NE[h]
Brief Description	British Columbia continued to exceed its target of 93% clean electricity, with 98% generated from clean sources in 2018. BC amended the *Greenhouse Gas Reduction (Clean Energy) Regulation* to support the development of additional transmission infrastructure in northeast BC to provide clean electricity to meet increasing demand from the upstream natural gas sector. As part of the Roadmap to 2030, BC is committing to adopting a 100% clean electricity delivery standard. BC Hydro will meet the new standard by ensuring it has produced or acquired sufficient clean electricity to meet the needs of its domestic customers and phasing out remaining gas-fired facilities on its integrated grid by 2030.								
British Columbia *Clean Energy Act*: Demand Side Management	Electricity	CO_2	Reduce emissions from utilities consumers	Regulatory	Implemented	2010	British Columbia	NE[h]	NE[h]
Brief Description	BC amended the *Greenhouse Gas Reduction (Clean Energy) Regulation* to allow utilities to take demand side measures to encourage customers to switch from higher emission fuels to clean electricity. The provincial electricity utility BC Hydro is required to meet 66% of its forecasted incremental electricity demand through demand side management. BC also amended the Demand Side Measures Regulation to allow utilities to double energy efficiency programs for natural gas fired equipment.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Alberta Coal-Fired Electricity Generation phase-out	Electricity	CO_2	Phase out the use of coal as a source of electricity by 2030	Regulatory	Implemented	2015	Alberta	NE[h]	NE[c]
Brief Description	As part of Alberta's Climate Leadership Plan announced in 2015, pollution from coal-fired sources of electricity will be phased out completely by 2030. Alberta is on track to well surpass this with projections that all coal power to be eliminated by 2023. Estimate of mitigation impact in 2030 is included in Large Emitter Greenhouse Gas Regulations impacts.								
Alberta *Renewable Electricity Act*	Electricity	CO_2	Increase renewable electricity generation	Regulatory	Implemented	2016, 2020	Alberta	NE[h]	NE[h]
Brief Description	Outlines Alberta's commitment to increasing renewable electricity generation to meet the legislated target of 30% of Alberta's electricity from renewable sources by 2030.								
Alberta Renewable Electricity Program*	Electricity	CO_2	Increase renewable energy capacity	Economic	Implemented	2017	Alberta	NE[c]	NE[c]
Brief Description	The Renewable Electricity Program supported development of 1,100 MW of renewable electricity capacity to be connected to the Alberta grid system by 2021. The program was run through a series of competitions in 2017 and 2018 to incent the development of renewable electricity generation through the purchase of renewable attributes. Estimate of mitigation impact in 2020 and 2030 is included in Large Emitter Greenhouse Gas Regulations impacts.								
Electricity Statutes (Modernizing Alberta's Electricity Grid) Amendment Act, 2022	Electricity	CO_2	Modernize Alberta's electricity grid	Regulatory	Implemented	2022	Alberta	NA[b]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The *Electricity Statutes (Modernizing Alberta's Electricity Grid) Amendment Act, 2022*, helps Alberta's electricity system meet the evolving needs of consumers. It fosters a low-carbon future through investment from industry rather than costly subsidies from taxpayers and ensures that consumers continue to have access to safe, reliable and affordable electricity.								
Geothermal Resource Development Act	Electricity	CO_2	Increase renewable electricity generation	Regulatory	Implemented	2020	Alberta	NE[h]	NE[h]
Brief Description	Establishes a clear path forward for geothermal projects, while ensuring the resource is developed responsibly and in the best interest of Albertans. Encouraging geothermal development—which has one of the lowest impacts of any renewable energy source—will help further Alberta's commitment to responsible energy production. Researchers have identified more than 6,100 MW of thermal power capacity and more than 1,150 MW of technically recoverable electrical power capacity potential across several municipal districts in western Alberta.								
Small Modular Reactor Memorandum of Understanding	Electricity	CO_2	Provide safe, emissions-free nuclear energy in remote areas	Voluntary Agreement	Implemented	2021	Alberta, Saskatchewan, Ontario, New Brunswick	NA[b]	NE[h]
Brief Description	Alberta, Saskatchewan, Ontario and New Brunswick signed a memorandum of understanding to support the development and deployment of small modular reactors (SMRs) that will provide safe, emissions-free nuclear energy to cities, industry and remote settlements.								
Development and deployment of small modular reactors (SMRs)**	Electricity	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Deploy 1,200 MW of non-emitting power from SMRs between 2034 and 2042 in Saskatchewan	Fiscal	Adopted	TBD	Saskatchewan	NA[b]	NE[h]
Brief Description	The Saskatchewan Growth Plan commits the province to exploring the development and deployment of small modular reactors (SMRs) to supply safe and reliable zero-emissions baseload power.								

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								2020	2030
Saskatchewan *Regulation Respecting the Management and Reduction of Greenhouse Gases (General and Electricity Producer)**	Electricity	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce emissions from electricity generation	Regulatory	Implemented	2018	Saskatchewan	1,350.00	10,900.00
Brief Description	The *Management and Reduction of Greenhouse Gases (General and Electricity Producer) Regulations* came into force January 1, 2018. The regulations impose a GHG emissions cap on coal and gas-fired electricity generators in the province (namely SaskPower), and impose a minor reporting obligation on independent power producers. In June 2019, an equivalency agreement for coal-fired electricity regulations between Saskatchewan and Canada was finalized. The agreement enables SaskPower to manage a decrease in the use of coal on a fleet-wide basis, rather than on a facility basis, and supplants federal regulations effective January 1, 2020. The mitigation impact of this measure is included in the estimate for the federal measure *Reduction of CO_2 Emissions from the Amendments to the Coal-Fired Generation of Electricity Regulations*.								
SaskPower Electricity Initiatives*	Electricity	CO_2	Reduce GHG emissions from electricity generation and enhance supply of renewables	Voluntary Agreement	Implemented	2007, 2018	Saskatchewan	NE[h]	NE[h]
Brief Description	SaskPower has a mandate to reduce emissions by 50% below 2005 levels by 2030 (14.2 Mt to 7.1 Mt CO_2 eq). SaskPower has also set a target to achieve up to 50% of its generation capacity from renewable sources by 2030. Within the next eight years, SaskPower plans to retire approximately 1,400 MW of conventional coal generation while expanding its wind and solar renewable generation fleet by as much as 2,000 MW. Meanwhile, expanded regional transmission interconnections, battery energy storage, new natural gas generation, and demand side management programming are also planned.								

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								2020	2030
SaskPower Programs*	Electricity	CH_4, CO_2, N_2O	Increase carbon neutral generation	Voluntary Agreement	Implemented	2018	Saskatchewan	2.20	NE[h]
Brief Description	In October 2018, SaskPower introduced the new Power Generation Partner Program (PGPP) to replace the existing Small Power Producers and Flare Gas Power Generation Programs. As of August 2022, there are a total of 35 projects proceeding or in-service (32 solar & 3 carbon neutral), representing 30 MW of generation. SaskPower's Net Metering program continues to be offered to customers who wish to self-generate. The price paid to Net Metering customers for excess power generated and sent to the grid has been extended at 7.5 cents per kilowatt-hour to March 31, 2026. Total generation within the Net Metering program since it began in 2007 is 40.36 MW.								
Tantallon to Birtle 230 kV Transmission Line Project*	Electricity	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	SaskPower is increasing the amount of its renewable capacity to meet new and emerging emissions regulations through importing renewable baseload hydropower from Manitoba Hydro	Voluntary Agreement	Implemented	2021	Saskatchewan, Manitoba	NA[b]	NE[h]
Brief Description	In 2020, Manitoba Hydro and SaskPower signed a power purchase agreement to export an additional 215 MW of hydroelectric capacity added to the SaskPower grid in 2022. On March 29, 2021, the Tantallon to Birtle 230 kV Transmission Line Project began delivering renewable hydropower from Manitoba to Saskatchewan. SaskPower currently has import agreements with Manitoba Hydro which total 290 MW.								
Manitoba Keeyask Hydro-electricity Project*	Electricity	CH_4, CO_2	Increase renewable energy generation (local and export)	Economic	Implemented	2021	Manitoba	NA[b]	3,000.00

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Manitoba constructed the Keeyask generating station, which added 695 MW of renewable electricity capacity in the province, when its first generator went into service in February 2021 and its seventh—and final—unit in March 2022. The project will allow for GHG reductions of approximately 3.0 Mt per year in Saskatchewan and US states.								
Manitoba last coal-generating unit phase-out*	Electricity	CH_4, CO_2, N_2O	Phase out of coal-fired generating	Regulatory	Implemented	2018	Manitoba	NE[c]	NE[c]
Brief Description	Brandon Generation Station, which housed the last coal-fired generator in Manitoba, ceased operation of the coal unit ahead of schedule in August 2018. The generator was converted to use as a synchronous condenser in February 2019 providing greater reliability of Manitoba's electrical grid. The phasing-out of coal is expected to reduce annual GHG emissions by 45,000–187,000 tonnes. The mitigation impact of this measure is included in the estimate for the federal measure *Reduction of CO_2 Emissions from the Amendments to the Coal-Fired Generation of Electricity Regulations*. In addition, two natural gas generating units ceased operations after Selkirk Generating Station was taken offline in April 2021. The closure reduces emissions by 5,000 tonnes annually.								
Manitoba Long-Term Energy Strategy	Electricity	CO_2	Reduce emissions from transportation, heavy industry, and buildings sectors	Information	Planned	TBD	Manitoba	NA[b]	NE[e]
Brief Description	Manitoba is developing a long-term energy strategy that builds on the province's significant renewable electricity assets and focuses on greening transportation, industrial, and building efficiency. This strategy will provide critical forward-looking information, set provincial policy objectives on energy, and outline pathways to meet the province's future energy needs while reducing GHG emissions.								
Net-zero Ontario Power Generation electricity by 2040	Electricity	CH_4, CO_2	Reach net-zero electricity emissions from Ontario Power Generation by 2040	Fiscal, Research	Planned	TBD	Ontario	NA[b]	NE[e]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Ontario Power Generation, Ontario's largest electricity producer, plans to have net-zero emissions by 2040 through such actions as advancing electrification initiatives; advancing SMR development and deployment for both on-grid and off-grid applications, continued investment in hydroelectric generation and nuclear refurbishment, exploring opportunities in non-hydro renewables and energy storage, investigating negative emissions technology, and supporting nature-based solutions and biodiversity initiatives to help provide offsets and support resiliency.								
Ontario Coal Phase-out*	Electricity	CH_4, CO_2, N_2O	Eliminate coal-fired electricity generation and the associated GHG emissions	Regulatory	Implemented	2003	Ontario	NE[c]	NE[c]
Brief Description	Initiated in 2003, coal-fired electricity was successfully eliminated from all Ontario Power Generation stations by April 2014, 19 generating units in total. In 2021, over 90% of Ontario electricity generation came from emissions-free sources. The mitigation impact of this measure is included in the estimate for the federal measure *Reduction of CO_2 Emissions from the Amendments to the Coal-Fired Generation of Electricity Regulations*.								
Small Modular Reactors*	Electricity	CH_4, CO_2	Clean electricity	Fiscal	Planned	2028	Ontario, Canadian Nuclear Safety Commission	NA[b]	300.00 – 2,000.00
Brief Description	Moving forward with plans to build Canada's first SMR at the Darlington site by 2028, pending regulatory approvals from the Canadian Nuclear Safety Commission (CNSC); the Darlington SMR would provide reliable and emission-free electricity to help meet growth in Ontario's electricity demand including from increasing electrification of the economy.								
Planning and implementation of renewable energy projects in off-grid communities	Electricity	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions across the economy and reduce our dependence on fossil fuels	Economic	Implemented	2022	Québec	NA[b]	NE[i]
Brief Description	80% of off-grid systems' energy supply from renewable sources by 2030. Supporting off-grid communities in planning and implementing renewable energy projects, in line with Hydro-Québec's initiatives with customers still served by off-grid systems, most of which produce their energy using diesel generators.								

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								2020	2030
New Brunswick *Electricity Act*, Renewable Portfolio Standard Regulation, and Energy Efficiency Mandate*	Electricity	CO_2, N_2O	Achieve 40% of renewable energy for electricity sold in New Brunswick	Regulatory	Implemented	2014	New Brunswick	178.00 – 220.00	NE[h]
Brief Description	The *Electricity from Renewable Resources Regulation* requires 40% of electricity sold in New Brunswick to be from renewable sources by 2020 (Climate Change Action Plan – Action 42). By 2020, 75% of in-province electricity demand will be met by non-emitting or renewable sources. In 2020–21, about 6.6 TWh of renewable sourced electricity was used to serve in-province electricity needs (about 51%).								
New Brunswick Phase-out of Coal-Fired Electricity Generation*	Electricity	CO_2, N_2O	Achieve GHG reductions through the phase out of coal-fueled electricity generation	Regulatory	Planned	2030	New Brunswick	NA[b]	800.00 – 1,300.00
Brief Description	Phase-out coal-fired electricity generation in compliance with the federal *Reduction of CO_2 Emissions from the Amendments to the Coal-Fired Generation of Electricity Regulations*.								
Nova Scotia *Electricity Act* *	Electricity	CH_4, CO_2, N_2O	Creation, sale, and distribution of electricity	Regulatory	Implemented	2004,2022	Nova Scotia	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Nova Scotia's *Electricity Act* governs the creation, sale, distribution, and supervision of electricity and electricity providers. In 2022, the Act was amended to ensure Nova Scotians can generate their own renewable power, such as with solar panels, and gain more control of their energy use. Amendments include guaranteeing ratepayers the full right to net metering without fear of new special charges, fees or rates that prohibit homeowners from bringing the energy portion of their electricity bill to $0 annually if they can generate enough power from renewable sources like solar panels. Other amendments will require the province's Community Solar Program and Green Choice Program to be simplified, as well as requiring Nova Scotia Power to fully implement the Green Button standard, which enables customers to securely download their household or business electricity usage data and connect this data to online applications to help manage their electricity bills. These changes are aimed at helping the province meet its goal of generation 80% of its electricity through renewables by 2030.								
Nova Scotia Electricity Efficiency Regulations*	Electricity	CO_2	Use energy more efficiently	Regulatory	Implemented	2014	Nova Scotia	NE[c]	NE[c]
Brief Description	Nova Scotia created Canada's first energy efficiency utility, Efficiency Nova Scotia. Since 2011, Efficiency Nova Scotia has made a 24% contribution to Nova Scotia's overall GHG emission reductions, avoiding over 1 Mt CO_2 eq annually. It also administers comprehensive energy efficiency programs for low income and First Nations Nova Scotians. The *Electricity Efficiency and Conservation Restructuring Act (2014)* requires Nova Scotia Power to purchase efficiency resources whenever they are lower cost than producing power. Efficiency resources are provided by Efficiency Nova Scotia for commercial, industrial, and residential consumers. Targets for electricity efficiency are guided by a periodic Integrated Resource Plan required by the Utility and Review Board. GHG reductions achieved through electricity efficiency are included in the GHG reduction estimates provided for the Nova Scotia *Greenhouse Gas Emissions Regulations*.								
Nova Scotia Electricity Sector Regulations and Nova Scotia *Greenhouse Gas Emissions Regulations**	Electricity	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions from the electricity sector and to increase the share of clean energy in the province's energy use	Regulatory	Implemented	2009, 2010, 2013	Nova Scotia	NE[c]	NE[c]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Nova Scotia has implemented two separate regulations to address emissions from the electricity sector and enhance the supply of renewables, which are together expected to result in emission reductions of at least 2,700 kt CO_2 eq in 2020. The *Greenhouse Gas Emissions Regulations* implement a mandatory declining cap on GHG emissions from electricity generation facilities. The decreases are scheduled in progressive steps from a cumulative 2010-2011 total of 19,220 kt to 7,500 kt or below by 2020 and further to 4,500 kt or below by 2030. Total electricity GHG reduction in Nova Scotia for 2010 to 2030 will be at least 5,700 kt CO_2 eq. The *Renewable Electricity Regulations* require 80% of electricity supply to be generated from renewable sources by 2030. This will involve the adoption of a diverse mix of energy sources including wind, tidal, solar, hydro and bioenergy. The mitigation impact of this measure is included in the estimate for the federal measure *Reduction of CO_2 Emissions from the Amendments to the Coal-Fired Generation of Electricity Regulations*.								
Prince Edward Island *Renewable Energy Act**	Electricity	CO_2	Pursue cleaner sources of energy and reduce reliance on imported energy	Regulatory	Implemented	2005	Prince Edward Island	NE[h]	NE[h]
Brief Description	The *Renewable Energy Act* established a minimum purchase price that utilities must pay for power produced by large-scale renewable energy generators and makes it economically feasible for island homeowners, small businesses or farmers who have an interest in generating their own electricity to install small-scale generating systems through net-metering. Currently about 25% of Prince Edward Island's electricity consumption is sourced from on-island wind farms.								
Prince Edward Island Wind Farm Development*	Electricity	CO_2	Develop additional renewable electricity supply	Economic	Planned	TBD	Prince Edward Island	NA[b]	22.00
Brief Description	Two new wind farms on Prince Edward Island. 70 MW of new wind generation by 2026.								
Western Transmission Line Expansion Project	Electricity	CO_2	System improvements	Economic	Planned	TBD	Prince Edward Island	NA[b]	NE[h]
Brief Description	Proposed 100 km, 138 kV transmission line in Western PEI to increase access for renewables and increase reliability.								

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								2020	2030
Prince Edward Island-New Brunswick Cable Interconnection Upgrade Project*	Electricity	CO_2	Deliver reliable, long-term energy, and balance the growing wind energy supply	Economic	Implemented	2017	Prince Edward Island, New Brunswick	NE[h]	NE[h]
Brief Description	PEI completed a cable interconnection upgrade within the Northumberland Strait, between the provinces of Prince Edward Island and New Brunswick. Two 180 MW cables will help meet the growing demand for electricity on PEI, deliver reliable, long-term energy for Islanders, and help balance the intermittent nature of growing wind energy supply.								
Newfoundland and Labrador Muskrat Falls hydroelectric project*	Electricity	CH_4, CO_2, N_2O	Implement Muskrat Falls hydroelectric project	Economic	Planned	2023	Newfoundland and Labrador	NA[b]	1,400.00
Brief Description	This project will allow for the closure of a thermal oil generating facility and will result in 98% of electricity consumption in the province coming from renewable sources. The project will also allow for GHG reductions of at least 1 Mt per year in other provinces such as Nova Scotia. The project is expected to be completed in 2023.								
Newfoundland and Labrador Renewable Energy Plan*	Electricity	CH_4, CO_2, N_2O	Renewable electricity strategy	Economic	Implemented	2021	Newfoundland and Labrador	NA[b]	NE[h]
Brief Description	Building on the Muskrat Falls development, which will reduce GHG emissions in Newfoundland and Labrador by 10% once operational, Newfoundland and Labrador published a renewable energy strategy in 2021 that will, among other items, to increase capacity and demand for renewable electricity in isolated diesel systems in the province's northern, remote and Indigenous communities.								
Yukon Independent Power Production Policy	Electricity	CH_4, CO_2, N_2O	Reduce diesel consumption for electricity and heat generation	Economic	Implemented	2019	Yukon	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	To assist large scale power producers, the Government of Yukon has adopted the Independent Power Production Policy which aims at enabling independent, non-utility electricity producers to sell electricity to Yukon's two public utilities through renewable energy technologies, such as wind power, micro-hydro, biomass and solar electric (or photovoltaic) systems. The IPP policy was fully implemented in January 2019 and three projects were reviewed and approved by July 2019. More recently, the Government of Yukon raised the cap for Independent Power Production from 20 to 40 gigawatt-hours.								
Yukon Microgeneration Policy*	Electricity	CH_4, CO_2, N_2O	Reduce diesel consumption for electricity and heat generation	Economic	Implemented	2014	Yukon	NE[h]	NE[h]
Brief Description	To assist small scale power producers, the Government of Yukon's Microgeneration Policy enables individuals and businesses to install electrical generating systems and connect them to the grid. The electricity generated is consumed on site and any surplus can be sold into the grid. By December 2021, the microgeneration program consisted of 6.0 MW of installed capacity.								
Yukon Energy Corporation 10-Year Renewable Electricity Plan*	Electricity	CH_4, CO_2, N_2O	Reduce GHG emissions from electricity grid and electrify the Territory's transportation and heating sectors	Regulatory	Implemented	2020	Yukon Energy Corporation	1.00	46.00
Brief Description	Our Clean Future has mandated that an average of 93% of electricity generated on the grid must be produced from renewable sources and includes specific actions to electrify the Territory's transportation and heating sectors. This plan outlines a portfolio of key projects and partnerships needed by 2030 to address the substantial demand for renewable electricity that will result from ongoing economic growth of the Territory, and from the policies and actions outlined in Our Clean Future.								
Inuvik Wind Project*	Electricity	CO_2	Reduce diesel and LNG consumption and NWT's GHG emissions	Fiscal	Implemented	2023	Northwest Territories	NA[b]	6.00
Brief Description	The Inuvik Wind Project is a key initiative within the 2030 Energy Strategy. It will install a single 3.5 MW wind turbine, a small battery storage system, a six-kilometre access road and a distribution line to reduce GHG emissions and support a secure grid in Inuvik. It is expected to be commissioned in 2023.								

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								2020	2030
Net metering program	Electricity	CO_2	Allows residents to participate in power generation	Economic	Implemented	2014	Northwest Territories	0.60	1.80
Brief Description	The net metering program allows customers to receive credits for renewable electricity generated (installations up to 15 kW).								
Transmission Line to Fort Providence and Kakisa	Electricity	CO_2	Reduce use of diesel-generated electricity in the communities of Fort Providence and Kakisa	Economic	Implemented	2025	Northwest Territories	NA[b]	3.00
Brief Description	$45 million transmission line connecting the communities of Fort Providence and Kakisa to the existing Taltson hydropower transmission system, displacing diesel-fuelled electricity generation. It is expected to be commissioned in 2025.								
Transmission Line to Whati	Electricity	CO_2	Reduce use of diesel-generated electricity in the community of Whati	Economic	Planned	TBD	Northwest Territories	NA[b]	1.40
Brief Description	Transmission line connecting the community of Whati to the existing Snare hydropower transmission system, displacing diesel-fuelled electricity generation.								
Exploring alternatives to diesel-fired electricity generation	Electricity	CO_2	Reduce dependence on fossil fuels	Research	Implemented	2020	Nunavut	NE[h]	NE[h]
Brief Description	Qulliq Energy Corporation has been working with various levels of governments and stakeholders on alternative energy research in order to reduce its dependence on diesel.								

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								2020	2030
LED Replacement Project – Nunavut	Electricity	CO_2	Reduce GHG emissions	Fiscal, Economic	Implemented	2017	Nunavut	NE[h]	NE[h]
Brief Description	The LED Replacement Project by Qulliq Energy Corporation is replacing conventional streetlights with LED lights in all communities across Nunavut. Funding for this project has come from various government sources, including carbon tax revenue.								
Nunavut Commercial and Institutional Power Producers Program	Electricity	CO_2	Promote renewable energy use	Economic	Implemented	2021	Nunavut	NA[b]	NE[h]
Brief Description	Commercial and Institutional Power Producers Program by Qulliq Energy Corporation (QEC) allows commercial and institutional customers to generate electricity on their premise using renewable energy systems and to sell the power generated to QEC. This program promotes the use of renewable energy.								
Nunavut's Independent Power Producer (IPP) Program	Electricity	CO_2	Reduction of fossil fuel consumption	Economic	Adopted	2022	Qulliq Energy Corporation (Nunavut's Utility)	NA[b]	NE[h]
Brief Description	The IPP program allows producers outside the Qulliq Energy Corporation (QEC) who meet the technical requirements and who are successful in being approved for participation in the IPP program by QEC to generate electrical power from renewable energy systems and sell it directly to QEC. Integrating renewable energy systems in the territory's energy grid helps decrease Nunavut's dependency on diesel fuel, enabling the corporation to reduce carbon emissions and promote energy self-reliance.								
Nunavut's Net Metering Program	Electricity	CO_2	Reduction of fossil fuel consumption	Economic	Implemented	2018	Qulliq Energy Corporation (Nunavut's Utility)	NE[h]	NE[h]
Brief Description	Launched on April 10, 2018, this program encourages hamlet and residential customers to install their own renewable energy system and offers energy credits for communities and individuals for feeding energy back into the Qulliq Energy Corporation's energy grid. This program enables interested customers to offset their energy use and help reduce their carbon footprint.								

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								2020	2030
TRANSPORTATION									
Heavy Duty Vehicle GHG Regulations Phase 1*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from the on-road transportation sector	Regulatory	Implemented	2013	Environment and Climate Change Canada	2,600.00	5,700.00
Brief Description	These regulations apply increasingly stringent GHG emissions standards to new on-road heavy-duty vehicles and engines of model year 2014 to 2020 imported or manufactured in Canada.								
Heavy Duty Vehicle GHG Regulations Phase 2*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from the on-road transportation sector	Regulatory	Implemented	2021	Environment and Climate Change Canada	NA[b]	5,800.00
Brief Description	The amendments to the *Heavy-duty Vehicle and Engines Greenhouse Gas Emission Regulations* were published on May 30, 2018. These regulations apply increasingly stringent GHG emissions standards to new on-road heavy-duty vehicles and engines imported or manufactured in Canada starting with model year 2021. Further, the regulations introduce new GHG emission standards that apply to trailers hauled by on-road transport tractors imported or manufactured in Canada for 2020. The trailer standards are suspended until April 19, 2023, due to legal challenges in the United States. The Regulatory Impact Analysis Statement accompanying the regulations indicates $1.6 billion in benefits from fuel savings in 2030.								
Heavy-duty vehicles GHG and ZEV sales requirements**	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from the transportation sector	Regulatory	Planned	TBD	Environment and Climate Change Canada	NA[b]	NE[e]
Brief Description	Develop GHG performance-based standards for heavy-duty vehicles and engines that are aligned with the most stringent standards in North America. Develop a medium-and heavy-duty vehicles (MHDV) ZEV regulation to require 100% MHDV sales to be ZEVs by 2040 for a subset of vehicle types based on feasibility, with interim 2030 regulated sales requirements that would vary for different vehicle categories based on feasibility, and explore interim targets for the mid-2020s.								
Light-Duty Vehicle GHG Regulations Phase 1*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from the on-road transportation sector	Regulatory	Implemented	2010	Environment and Climate Change Canada	11,900.00	23,300.00

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The regulations establish progressively stringent GHG emission standards to new passenger automobiles and light trucks manufactured or imported into Canada for model years 2011 to 2016.								
Light-Duty Vehicle GHG Regulations Phase 2*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from the on-road transportation sector	Regulatory	Implemented	2017	Environment and Climate Change Canada	2,800.00	24,300.00
Brief Description	The regulations establish progressively stringent GHG standards for new passenger automobiles and light trucks manufactured or imported into Canada for model years 2017 to 2025.								
Light-duty vehicles GHG and ZEV sales requirements**	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from the transportation sector	Regulatory	Planned	2026	Environment and Climate Change Canada	NA[b]	NE[e]
Brief Description	Develop GHG performance-based standards for light-duty vehicles that are aligned with the most stringent standards in North America. Develop a light-duty vehicle (LDV) ZEV sales mandate, which will set annually increasing requirements towards achieving 100% LDV ZEV sales by 2035, including mandatory interim targets of at least 20% of all new LDVs offered for sale by 2026 and at least 60% by 2030.								
Zero-emission requirements for small-spark ignition engines (e.g., lawn and garden equipment)**	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions and other air contaminants from off-road equipment	Regulatory	Planned	2026	Environment and Climate Change Canada	NA[b]	1,000.00
Brief Description	Environment and Climate Change Canada would introduce zero-emission standard requirements for some small-spark ignition equipment 19 kW and under.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Electric Vehicle Charging and Alternative Fuel Refuelling Infrastructure	Transportation	CH_4, CO_2, N_2O	Accelerate demonstration and deployment of charging and refuelling infrastructure, and supporting codes and standards	Regulatory, Economic, Research, Information, Fiscal	Implemented	2016	Natural Resources Canada	NA[d]	NA[d]
Brief Description	The program supports the demonstration and deployment of electric vehicle chargers, and alternative fuel (e.g. natural gas, hydrogen) stations along Canada's highways and freight corridors. In addition, it supports the development and revision of enabling codes and standards for electric and alternative fueled vehicles and refuelling infrastructure. This is a Green Infrastructure initiative under the Investing in Canada Plan. The program is an enabling measure that will not directly reduce emissions but will contribute to unlocking larger emissions reductions. As of August 2022, projects selected for federal infrastructure investments will result in: 34,447 chargers, 33 hydrogen stations, and 22 natural gas stations, by 2024. Additionally, the EV Infrastructure Demonstration (EVID) program is currently supporting 23 real world demonstrations of innovative EV infrastructure technology and solutions that overcome barriers to adoption of EV infrastructure in the urban environment, such as multi-unit residential buildings and for people without dedicated parking, at workplaces and public transit. Projects also supported applications including bi-directional charging with energy storage; heavy-duty truck charging and hydrogen infrastructure; and battery repurposing.								
Energy efficiency of replacement tires	Transportation	CO_2	Reduce GHG emissions from transportation fuels	Regulatory	Planned	2023	Natural Resources Canada	NA[b]	NE[e]
Brief Description	Canada is developing a standard for the energy efficiency of replacement tires. In 2017, tire testing was initiated in collaboration with Transport Canada and the United States National Highway Traffic Safety Administration, which will inform development of the standard. A report containing results from tire testing was released as well as a market study on the domestic tire industry. The tire industry has been engaged and preliminary discussions with standard development agencies have begun.								
Energy Efficient Transportation	Transportation	CH_4, CO_2, N_2O	Improve energy efficiency in transportation in Canada	Information, Education, Regulatory	Implemented	2016	Natural Resources Canada	1,100.00	1,900.00

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	This program has 3 elements: 1) to provide Canadians a suite of information and awareness tools and materials, including the EnerGuide label for vehicles to help consumers choose more fuel efficient vehicles; 2) to operate Canada's SmartWay Partnership program, which helps Canada's commercial/ institutional freight sector benchmark and track their fuel consumption; 3) to promote freight management best practices and accelerate the adoption of energy management best practices in fleets and supply chains.								
Green Freight Program	Transportation	CO_2	Reduce emissions from heavy and medium-duty vehicles	Fiscal	Adopted	2022	Natural Resources Canada	NA[b]	500.00
Brief Description	Expansion and recapitalization of the Green Freight Assessment Program, which will be renamed the Green Freight Program. This program will support fleet energy assessments, truck retrofits and repowers, the purchase of new near-zero vehicles and the implementation of better logistical practices.								
Greening Government Operations – Fleets Program	Transportation	CO_2	Support federal departments and agencies in achieving the fleet targets outlined in the Greening Government Strategy, namely the 2030 100% ZEV compositional target for the conventional light-duty fleet	Fiscal	Adopted	2022	Natural Resources Canada	NA[b]	NE[g]
Brief Description	$2.2 million to support Greening Government fleet zero-emission vehicle commitments through two streams of services—assessing internal combustion engine duty cycles for ZEV suitability, and assessing federal facilities for EV readiness.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Long Haul Hydrogen-Truck Demonstration Program	Transportation	CH_4, CO_2, N_2O	Support long-haul zero-emission trucking commerci-alization	Fiscal	Adopted	2022	Natural Resources Canada	NA[b]	NE[g]
Brief Description	$33.8 million for hydrogen trucking demonstration projects that address barriers to long-haul zero-emission trucking commercialization—including technical, regulatory and standards challenges.								
Retrofit large trucks currently on the road**	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from the transportation sector	Fiscal	Adopted	2022	Natural Resources Canada	NA[b]	NE[g]
Brief Description	$199.6 million to retrofit large trucks currently on the road.								
Zero Emission Vehicle Infrastructure Program (ZEVIP)	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from the transportation sector	Fiscal	Adopted	2022	Natural Resources Canada	NA[b]	NE[g]
Brief Description	$400 million in additional funding for ZEV charging stations, in support of the Government's objective of adding 50,000 ZEV chargers to Canada's network.								
ZEV Charging and Refueling Infrastructure	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from the transportation sector	Fiscal	Adopted	2022	Natural Resources Canada	NA[b]	NE[g]
Brief Description	The Canada Infrastructure Bank will invest $500 million in large-scale ZEV charging and refueling infrastructure that is revenue-generating and in the public interest.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Canada's Aviation Climate Action Plan*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from the aviation sector	Voluntary Agreement	Implemented	2022	Transport Canada	NA[b]	NE[e]
Brief Description	Canada's Aviation Climate Action Plan is a voluntary initiative that sets a vision for net-zero aircraft emissions by 2050 and identifies how the Government of Canada and the aviation industry intend to collaborate to reduce GHG emissions from aviation activities over the course of this plan. The new action plan sets a purposefully ambitious goal of 10% for the use of sustainable aviation fuel by 2030 to send a clear signal that Canada and the aviation sector recognize the need for significant volumes of sustainable aviation fuel to achieve its vision of net-zero by 2050.								
Carbon Dioxide Standards for Aviation*	Transportation	CO_2	Reduce GHG emissions from new airplanes	Regulatory	Implemented	2020	Transport Canada	NE[h]	NE[h]
Brief Description	Canada participated in the development of a new international CO_2 standard for new and in-production airplanes through the Committee on Aviation Environmental Protection at the International Civil Aviation Organization (ICAO). ICAO has adopted the new standard and Canada adopted the new standard into the *Canadian Aviation Regulations* in December 2019.								
Carbon Offsetting and Reduction Scheme for International Aviation	Transportation	CO_2	Reduce carbon emissions from international aviation	Regulatory	Implemented	2019	Transport Canada	NE[h]	NE[h]
Brief Description	The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is an international initiative by the International Civil Aviation Organization (ICAO) that requires operators to acquire and cancel emissions units to offset a portion of their CO_2 emissions from 2021 to 2035. Its role is to complement a broader basket of measures to achieve carbon neutral growth for international aviation from 2020 onwards. Canada is a signatory to CORSIA alongside 192 other member states. CORSIA is a market-based measure requiring affected air operators to purchase eligible emission units on the open market to offset a portion of their emissions. Canada implemented CORSIA domestically through amendments to the *Canadian Aviation Regulations*. The monitoring, reporting, and verification phase started on January 1, 2019 and the offsetting phase on January 1, 2021.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
ecoTECHNOLOGY for Vehicles Program	Transportation	CH_4, CO_2, N_2O	Support development of low-emission vehicle regulations, standards, etc.	Research, Information	Implemented	2017	Transport Canada	NA[d]	NA[d]
Brief Description	The ecoTECHNOLOGY for Vehicles program proactively tests, evaluates, and provides expert technical information about the environmental and safety performance of advanced on-road vehicle technologies, including light-duty and heavy-duty vehicles. The program shares technical findings to inform the development of vehicle emission regulations; to guide the proactive development of new or revised safety regulations, standards, codes and guidelines; and to support the development of non-regulatory industry codes and standards to help integrate new clean vehicle technologies into Canada in a safe and timely manner.								
High Frequency Rail	Transportation	CH_4, CO_2, N_2O	Support development of high-frequency rail project in the Toronto-Québec City corridor	Fiscal	Planned	TBD	Transport Canada	NA[b]	NE[g]
Brief Description	Transport Canada is supporting the development of High Frequency Rail in the Toronto-Québec City corridor. HFR will include partial electrification of passenger rail, reducing source emissions, and encourage modal shift. The project is currently in the procurement phase and is targeted for completion in the 2030s. Recent modelling indicates that HFR could provide a 10.2 million-tonne reduction in GHG emissions (compared to business-as-usual passenger rail service) over a 30-year timeframe.								
Incentives for Zero-Emission Medium- and Heavy-Duty Vehicles Program (iMHZEV)*	Transportation	CH_4, CO_2, N_2O	Accelerate the uptake of medium- and heavy-duty zero-emission vehicles (MHZEVs)	Fiscal	Implemented	2022	Transport Canada	NA[b]	200.00
Brief Description	In order to encourage the adoption of medium- and heavy-duty ZEVs by Canadian businesses, the Government of Canada launched the Incentives for Medium- and Heavy-Duty Zero-Emission Vehicles (iMHZEV) Program in July of 2022. The iMHZEV Program offers point-of-sale incentives for Canadian organizations and businesses (subject to funding availability) who buy or lease an eligible MHZEV.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Incentives for Zero-Emission Vehicles Program (iZEV)*	Transportation	CH_4, CO_2, N_2O	Accelerate the uptake of electric vehicles	Fiscal	Implemented	2019	Transport Canada	251.30	1,851.00
Brief Description	The Government of Canada launched the Incentives for Zero-Emission Vehicles (iZEV) Program in May 2019, offering incentives of up to $5,000 for purchasing/leasing an eligible zero-emission vehicle. In Budget 2022, an additional $1.7 billion was provided to extend and expand the program for an additional three years. As of October 31, 2022, over 175,000 Canadians and Canadian businesses have taken advantage of this program.								
Invest in efficient trade and transportation corridors	Transportation	CH_4, CO_2, N_2O	Improve the efficiency of trade and transportation corridors	Economic	Implemented	2017 (Calls for Proposals), 2018 (Project implementation)	Transport Canada	NA[a]	NA[a]
Brief Description	Through the National Trade Corridors Fund (NTCF), the Government of Canada is investing $2.4 billion over 11 years to strengthen the efficiency and resilience of Canada's transportation system by addressing bottlenecks, adding capacity, and improving its ability to adapt to a changing climate. Since 2017, Transport Canada has announced funding for 81 projects through three competitive calls for proposals, with a total cost of $3.6 billion and a federal investment of $1.7 billion. Projects funded by the NTCF are located in every province and territory, and were required to demonstrate their ability to meet the NTCF's overall program objectives, including increasing the resilience of the Canadian transportation system in a changing climate and ensure it adapts to new technologies and future innovation. All applicants were required to include climate change adaptation and resilience assessments and GHG emissions analysis in their comprehensive project proposals.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Memorandum of Understanding between Transport Canada and the Railway Association of Canada for Reducing Locomotive Emissions*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from railway locomotives operated by Canadian railway companies in Canada	Voluntary Agreement	Implemented	2018	Transport Canada	150.00	600.00
Brief Description	This Memorandum of Understanding is a Canadian industry-government initiative, covering the 2018–2022 time period. The MOU includes GHG intensity targets for Class I freight, intercity passenger railways and short line railways and also encourages railways to adopt measures and undertake actions to improve GHG emission intensity from rail operations. In addition, the *Locomotive Emission Regulations* under the *Railway Safety Act* came into effect on June 9, 2017, and target criteria air contaminant emissions from locomotives.								
Rail and Marine**	Transportation	CH_4, CO_2, N_2O	Reduce greenhouse gas emissions from rail and marine transport	Information	Planned	TBD	Transport Canada	NA[b]	NE[h]
Brief Description	Canada is committed to developing an action plan to decarbonize rail in line with Canada's net-zero by 2050 goal, and a national action plan to enable the marine sector to reduce its emissions. Canada will continue to work with international partners to develop measures to reduce black carbon in the Arctic from international shipping, by collaborating through the International Maritime Organization (IMO) to develop new international standards and recommended practices for marine vessels, including the implementation of IMO's short-term GHG reduction measures by January 1, 2023 and discussion regarding the development of medium- and long-term measures, including market-based measures.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Federal-Provincial-Territorial Task Force on Heavy-Duty Vehicle Retrofits	Transportation	CO_2	Reduce GHG emissions from existing heavy-duty vehicles	Information, Research	Implemented	2019	Transport Canada, Provincial and territorial governments	NE[h]	NE[h]
Brief Description	Jurisdictions are taking collective action via a federal, provincial and territorial task force to study opportunities to encourage greater use of fuel saving devices in heavy-duty trucks.								
Meeting Canada's Zero-Emission Vehicle Targets**	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from on-road light-duty vehicles and support clean transportation innovation	Economic, Voluntary Agreement	Implemented	2019	Transport Canada, Provincial, territorial, and municipal governments, industry, non-governmental organizations	NA[a]	7,100.00
Brief Description	In 2022, the Government of Canada set the following sales targets for zero-emission vehicles: at least 20% of new light-duty vehicle sales by 2026; at least 60% by 2030; and 100% by 2035. The federal government is pursuing a suite of measures to help put Canada on a path towards meeting these targets. Through announcements made in both the 2030 Emissions Reduction Plan and Budget 2022, Canada has allocated over $3.1 billion towards measures meant to aid in the adoption of ZEVs. This includes $900 million to build Canada's network of ZEV charging infrastructure, $1.7 billion to extend the Incentive for Zero-Emission Vehicles Program, and over $547 million to introduce purchase incentives for medium and heavy-duty vehicles (MHDVs).								
BC Hydrogen Strategy	Transportation	CO_2	Promote innovation and investment in the production and deployment of hydrogen	Information, Voluntary Agreement	Implemented	2021	British Columbia	NA[b]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	BC's Hydrogen Strategy was released in 2021.								
British Columbia Increased Supply of Renewable Fuels	Transportation	CO_2, N_2O	Reduce GHGs from transportation	Economic, Education, Fiscal, Information, Regulatory, Research, Voluntary Agreement	Implemented	2020	British Columbia	NE[h]	NE[h]
Brief Description	In the Roadmap to 2030, BC doubled their commitment to increase production capacity for renewable fuels to supply 1.3 billion litres per year by 2030.								
British Columbia Light-Duty Zero-Emission Vehicle Mandate**	Transportation	CO_2, N_2O	Reduce GHGs from transportation	Regulatory	Implemented	2019	British Columbia	NE[h]	NE[h]
Brief Description	British Columbia has passed the *Zero-Emission Vehicles Act* to phase in targets for the sale of zero-emission vehicles (ZEVs). New targets were announced in 2021 as part of the CleanBC Roadmap to 2030. New light-duty sales targets are 26% by 2026, 90% by 2030, and 100% by 2035. The government will continue to support these targets with steps to make ZEVs more affordable.								
British Columbia Low Carbon Fuel Standard (LCFS)*	Transportation	CO_2	Reduce GHGs from transportation	Regulatory	Implemented	2008	British Columbia	NE[h]	NE[h]
Brief Description	CleanBC increased the Low Carbon Fuel Standard by 10% to require fuel producers to reduce the carbon intensity of diesel and gasoline fuels by 20% by 2030 through blending in renewable fuels.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
British Columbia Medium- and Heavy-Duty Zero-Emission Vehicle Mandate**	Transportation	CO_2, N_2O	Reduce GHGs from transportation	Regulatory	Planned	2023	British Columbia	NA[b]	NE[h]
Brief Description	In the Roadmap, BC committed to creating sales targets for medium and heavy-duty ZEVs in consultation with automakers, businesses and industry in alignment with jurisdictions like California.								
British Columbia Right-To-Charge legislation	Transportation	CO_2, N_2O	Reduce GHGs from transportation	Regulatory	Adopted	TBD	British Columbia	NA[b]	NE[h]
Brief Description	To enable the installation of charging infrastructure in buildings, BC will introduce Right-To-Charge legislation.								
British Columbia SCRAP-IT Program	Transportation	CO_2, N_2O	Reduce GHGs from transportation	Economic	Implemented	1996	British Columbia	NE[c]	NE[c]
Brief Description	The SCRAP-IT Program, operational on and off since 1996, offers qualifying vehicle owners incentives to take their older vehicles off the road rather than resell them. Incentives are offered to support the purchase of zero-emission vehicles and support other low carbon forms of transportation. Emissions reduction estimates for this measure are aggregated into the estimates for another overarching measure. Starting in 2022, SCRAP-IT is providing rebates for both Battery Electric and Plug-In Hybrid Vehicles.								
British Columbia Transport Infrastructure Investments	Transportation	CO_2, N_2O	Reduce GHGs from transportation	Economic	Implemented	2016	British Columbia	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	British Columbia now requires consideration of climate change impacts in transportation infrastructure design. BC plans to improve the province's transportation network and transition to electric drive or low carbon fuels by transitioning to a fully electric bus fleet over two decades and investing in hybrid diesel-electric or dual fuel capable ferries that can run on either liquefied natural gas or ultra-low sulphur diesel. In 2022, BC is investing $295 million in a Highway Infrastructure Climate Adaptation Program. The program will span nine years and focus on replacing and repairing culverts to bolster the resilience of the transportation network to new climate conditions and ensure public safety. BC will release a Clean Transportation Action Plan in 2023 that will set out actions to reduce emissions from transportation by 27-32% (from 2007 levels).								
CleanBC Go Electric program	Transportation	CO_2, N_2O	Reduce GHGs from transportation	Economic	Implemented	2018	British Columbia	NE[h]	NE[h]
Brief Description	The CleanBC Go Electric Program offers homeowners up to $350 in incentives to install charging stations at home and offers up to $5,000 in incentives to install in condos, apartments, or office buildings. As part of BC's Roadmap to 2030, BC will work in partnership with Indigenous communities, the private sector, utilities, and other jurisdictions to install 10,000 electric charging stations across the province.								
CleanBC GoElectric suite of programs to support ZEV adoption**	Transportation	CO_2, N_2O	Increase ZEV adoption	Economic, Research, Education	Implemented	2018	British Columbia	NE[h]	NE[h]
Brief Description	A suite of programs to support ZEV adoption: Light-duty vehicle point of purchase rebates; commercial vehicle rebates; hydrogen fueling infrastructure; home and workplace and public charging programs; ZEV sector economic development (research and development); fleet program; investments in research and development for medium and heavy-duty ZEVs; research training and public education and outreach.								
CleanBC HDVE Program	Transportation	CO_2, N_2O	Reduce emissions from the transportation sector	Education, Economic	Implemented	2019	British Columbia	NE[h]	NE[h]
Brief Description	Investments into reducing emissions from the existing heavy-duty vehicle fleet through a program of education and equipment purchase incentives through the CleanBC HDVE Program.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Expand the Low Carbon Fuel Standard (LCFS) to aviation and marine fuels**	Transportation	CO_2	Reduce GHGs from transportation	Regulatory	Planned	2023	British Columbia	NA[b]	NE[e]
Brief Description	As part of the Roadmap to 2030, BC intends to modernize the legislation governing the Low Carbon Fuel Standard, including expanding it to cover marine and aviation fuels beginning in 2024. BC intends to complete consultations and regulatory development in time for the new Regulations to be approved by Summer 2023, providing all stakeholders with clarity regarding the changes that would come into force on January 1, 2024.								
Move Commute Connect: BC's Active Transportation Strategy	Transportation	CO_2	Increase active transportation options and usage	Economic	Implemented	2019	British Columbia	NE[h]	NE[h]
Brief Description	Move Commute Connect: BC's Active Transportation Strategy includes support for community planning and infrastructure.								
Sectoral emissions target – Transportation	Transportation	CO_2	Reduce emissions from the transportation sector	Regulatory	Implemented	2021	British Columbia	NA[b]	NE[h]
Brief Description	Sectoral target set of a reduction of 27-32% of 2007 sector emissions by 2030.								
Alberta GreenTRIP	Transportation	CO_2	Increase accessibility and use of public transit in Alberta	Economic	Implemented	2010	Alberta	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	GreenTRIP helps provide Albertans with a wider range of sustainable public transit alternatives for local, regional and inter-municipal travel, making public transit more accessible. It also helps reduce traffic congestion by lowering the number of single occupancy vehicles on Alberta roads and provides people with broader transportation options.								
Alberta Zero Emission Hydrogen Transit (AZEHT) project	Transportation	CH_4, CO_2, N_2O	Develop hydrogen fuel cell electric bus (FCEB) technologies	Research, Fiscal, Voluntary Agreement	Adopted	2021	Alberta	NA[b]	NE[h]
Brief Description	ERA provided support for the Alberta Zero Emission Hydrogen Transit (AZEHT) project, which will demonstrate two hydrogen fuel cell electric buses (FCEB) to be used in road trials shared by the municipalities of Edmonton and Strathcona County, with the active participation of Calgary and Banff/Bow Valley.								
Alberta Zero Emissions Truck Electrification Collaboration (AZETEC) project	Transportation	CH_4, CO_2, N_2O	Develop technologies that reduce freight transportation emissions	Research, Fiscal, Voluntary Agreement	Adopted	2019	Alberta	NE[h]	NE[h]
Brief Description	Via Emissions Reduction Alberta (ERA), the Alberta Zero Emissions Truck Electrification Collaboration (AZETEC) is a project in conjunction with the Alberta Motor Transport Association. It will feature the development of two long-range fuel-cell electric trucks for operation between Edmonton and Calgary to showcase Alberta's role in developing technologies that reduce freight transportation emissions.								
Regulatory Cooperation	Transportation	CO_2	Reduce emissions from freight transportation	Voluntary Agreement	Planned	2022	Saskatchewan	NA[b]	NE[h]
Brief Description	The Ministry of Highways is working collaboratively with the other provinces and territories in the adoption of best practices to improve inter-jurisdictional planning for key trade corridors, improving freight fluidity, and reducing traffic congestion.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Saskatchewan Congestion and Idling Reduction Program	Transportation	CO_2	Reduce emissions from congestion and idling	Voluntary Agreement	Implemented	2019	Saskatchewan	NE[h]	NE[h]
Brief Description	The program will utilize traffic data to identify congested areas and bottlenecks and to develop the program and projects to address congestion issues and help mitigate GHG emissions.								
Saskatchewan Government Vehicles Right Sizing and Best Practice Procurement Program	Transportation	CO_2	Increase fuel efficiency of government vehicles	Voluntary Agreement	Adopted	2009	Saskatchewan	NE[h]	NE[h]
Brief Description	Minimize the environmental impact of government vehicles by right-sizing the fleet. The initiative involves meeting regularly with Ministry clients to identify their needs for fleet size, utilization, and standardized vehicles based on service delivery. Since 2009, the Saskatchewan Government has reduced the size of the fleet by 2,500 vehicles, or almost 45%. The existing fleet is now approximately 3,200 vehicles. A right-sizing assessment is completed and reviewed as a part of all new vehicle and vehicle-replacement requests to ensure the fleet is operating in the most efficient and effective capacity. The government's goal is to reduce CO_2 emissions from its vehicles by 20% from 2007 levels by 2020. The Government has made progress and is close to meeting the target with an 18% reduction of emissions from full maintenance passenger vehicles achieved as of March 31, 2017.								
Saskatchewan Short Line Rail Program	Transportation	CO_2	Increase use of short line rail to reduce transportation emissions	Voluntary Agreement	Implemented	2018	Saskatchewan	NE[h]	NE[h]
Brief Description	Support industry in expanding the size and usage of the short haul (short line) rail systems.								
Saskatchewan Trucking Partnership Program	Transportation	CO_2	Increase fuel efficiency of trucks	Voluntary agreement	Implemented	2019	Saskatchewan	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The approach is to first baseline fuel savings already in place through existing agreements and then work to expand the program and quantify savings annually.								
Green Transportation Strategy	Transportation	CO_2	Reduce emissions from the transportation sector	Information	Planned	2023	Manitoba	NA[b]	NE[e]
Brief Description	Manitoba is committed to develop a province-wide Green Transportation Strategy by December 31, 2022.								
Manitoba biofuel mandates*	Transportation	CO_2	Reduce emissions from transportation	Regulatory	Implemented	2020	Manitoba	365,000.00	456,000.00
Brief Description	As of January 1, 2022, Manitoba increased the minimum mandatory ethanol content in gasoline to 10% and the minimum mandatory biodiesel content in diesel fuel to 5%.								
Manitoba Efficient Trucking Program	Transportation	CO_2	Reduce emissions from freight transportation	Voluntary Agreement	Implemented	2019	Manitoba	NE[h]	5.70
Brief Description	Manitoba intends to form a new working group to develop a progressive sustainable environmental strategy, with the primary aim of significantly reducing trucking-related emissions while enhancing the competitiveness of its transportation industry. In June 2019, Manitoba and Canada launched a 3-year $11.8 million efficient trucking program for the installation of fuel saving technologies and retrofits to heavy-duty vehicles to reduce fuel consumption and GHG emissions, which includes $5.9 million in funding from the Low Carbon Economy Leadership Fund. The program is forecast to reduce global emissions by 60,000 tonnes by 2023. Estimated cumulative emissions reductions associated with the program over the period spanning 2020 to 2030 are 85 kt CO_2 eq in Manitoba and 244 kt CO_2 eq in Canada. As of March 31, 2022, results demonstrate the following: • 366 successful applications; • 3,627 units (1,934 trucks and 1,693 trailers) receiving fuel savings device installations; • 13,583 tonnes of reduced emissions over 110 kt estimated by 2030; and, • Over 5 million litres of fuel or 213,047 gigajoules saved.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Manitoba government fleet reduction	Transportation	CO_2	Reduce emissions from transportation	Voluntary Agreement	Implemented	2018	Manitoba	3.50	3.00
Brief Description	In October 2018, the Manitoba government committed to remove 400 vehicles as part of a fleet vehicle reorganization. An extensive review resulted in the removal of 450 light-duty vehicles. There has been a reduction of approximately 1.5 million litres of fuel annually. It should be noted that there was a reduction in kilometres travelled during the pandemic, in addition to a reduction in the number of fleet vehicles.								
Cleaner Transportation Fuels: Renewable Content Requirements for Gasoline and Diesel Fuels*	Transportation	CO_2	Reduce GHG emissions from transportation	Regulatory	Implemented	2005, 2020	Ontario	NE[c]	NE[c]
Brief Description	Building on requirements first introduced in 2005, the *Cleaner Transportation Fuels Regulation* (O. Reg. 663/20) requires that fuel suppliers blend 10% of renewable content in gasoline from 2020 to 2024. The renewable content requirement increases to 11% in 2025, 13% in 2028, and 15% in 2030 and onward. This renewable content must emit 45% fewer GHG emissions than fossil gasoline on a lifecycle basis before 2030, and 50% fewer from 2030 onward. The regulation also requires fuel suppliers to continue to blend 4% renewable content in diesel. This renewable content must emit 70% fewer GHG emissions than fossil diesel on a lifecycle basis. Emissions reductions estimates for the *Cleaner Transportation Fuels Regulation* are included in the estimate for the Ontario *Greenhouse Gas Emissions Performance Standards Regulation*.								
Investing in Electric Vehicles	Transportation	CH_4, CO_2, N_2O	To pivot Ontario's auto manufacturing cluster to the production of battery electric vehicles	Fiscal	Adopted	2022	Ontario	NA[b]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Ontario is supporting a vibrant clean technology sector and investing in innovation, including: • Providing up to $295 million to support a $1.8 billion investment to retool Ford of Canada's Oakville Assembly Complex into a global hub for battery EV production; • Providing up to $259 million to support a $2 billion investment by General Motors of Canada that will include the production of commercial electric vehicles at the company's Ingersoll plant; • Providing up to $513 million to support a $3.6 billion investment by Stellantis to retool its Brampton and Windsor assembly plants to enable them to produce electric vehicles; • Providing up to $132 million to support a $1.4 billion investment by Honda of Canada Mfg. (HCM), a division of Honda Canada Inc., to upgrade and retool its plants in Alliston to begin manufacturing hybrid models; • Supporting LG Energy Solution, Ltd. (LGES) and automaker Stellantis to jointly invest $5 billion to build the province's first large-scale electric vehicle (EV) battery manufacturing plant; and, • Supporting Umicore to build an industrial scale cathode and precursor materials manufacturing plant that supports Ontario's vision of building an end-to-end EV supply chain. These historic investments put Ontario on a path to becoming one of the most vertically integrated automotive jurisdictions in the emerging North American EV market.								
Making Electric Vehicle Charging More Accessible	Transportation	CH_4, CO_2, N_2O	Supporting the uptake of electric vehicles	Economic	Planned	2023	Ontario	NA[b]	NE[h]
Brief Description	Providing $91 million to help make EV chargers more accessible to the public across the province, including highway rest stops, carpool parking lots, Ontario Parks and in community hubs like hockey arenas and municipal parks. The province will also introduce the Rural Connectivity Fund to support the installation of EV chargers in rural communities and encourage EV adoption outside of urban centres.								
Ontario Critical Minerals Strategy	Transportation	CO_2	Supporting development of electric vehicle production in Ontario	Research, Fiscal	Planned	2022	Ontario	NA[b]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Ontario is developing a critical minerals strategy to support Ontario's transition to a low-carbon economy within the province, and abroad. Budget 2022 allocated $5 million over two years to create a Critical Minerals Innovation Fund to support the mining industry, academia, start-ups, and research and developing firms to find innovative solutions for extraction and processing of critical minerals.								
Ontario *Driving Prosperity* Plan – Phase 2	Transportation	CH_4, CO_2, N_2O	Position Ontario as a North American leader in developing and building the car of the future through emerging technologies and advanced manufacturing processes	Economic, Research, Fiscal	Implemented	2021	Ontario	NA[b]	NE[h]
Brief Description	Phase 2 of *Driving Prosperity* builds on the success of Phase 1. It focuses on transforming the auto sector by building electric, autonomous, and connected vehicles and supporting a broader supply chain that includes the exploration, mining and production of critical minerals. This includes supporting the attraction of large-scale EV and a setting a goal of attracting 2 to 3 battery plants to anchor an advanced electric battery supply chain in Ontario. Phase 2 includes a commitment to fund the Ontario Vehicle Innovation Network (OVIN) at a rate of $56.4 million over four years. On April 22, 2022, Ontario announced a new OVIN Northern Regional Technology Development Site (RTDS) to connect Ontario's manufacturing might with Northern Ontario's mining and mineral expertise, talent and leadership. The Northern RTDS will provide Ontario businesses with the support they need to help build the next generation vehicles.								
Ontario Transit Investments	Transportation	CH_4, CO_2, N_2O	Increasing options for transportation, safe and secure mobility, and lower GHG emissions	Economic	Implemented	Various	Ontario	NE[h]	580.00

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Historic provincial investments across Ontario in transit initiatives that are in various phases of development, including: Ontario Line, Yonge North Subway Extension, Eglinton Crosstown West Extension, Scarborough Subway Extension, GO Rail Expansion, Hamilton LRT, Eglinton Crosstown LRT, Hurontario LRT, and Finch West LRT.								
Québec Assistance Program to Improve Public Transit Services	Transportation	CH_4, CO_2	Reduce GHG emissions from the transportation sector	Economic	Implemented	2013	Québec	23.00	NE[i]
Brief Description	The program will impact GHG emissions associated with passenger transportation through supporting transit authorities to increase public transit services, operations, and capital projects. Investments are made in urban and rural services as well as interregional bus transport. Québec has provided increased funding for the electrification of urban buses through its 2022–2027 Implementation Plan.								
Québec Eco Trucking Program*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions in the transportation sector	Economic	Implemented	2013	Québec	325.00	NE[i]
Brief Description	The Eco-trucking program aims to promote the use of equipment and technology to improve energy efficiency while reducing GHGs in the transportation of goods. This program offers financial support for eligible technology and the completion of projects to reduce GHG emissions. Québec has provided additional funding for the program through its 2022–2027 Implementation Plan.								
Québec Energy Efficiency Program for Marine, Air and Railway Transportation*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions in the transportation sector	Economic	Implemented	2013	Québec	135.00	NE[i]
Brief Description	This program aims to reduce or avoid GHG emissions by offering financial assistance to improve the energy efficiency of organizations and companies that use marine, air or railway transportation services, particularly through the use of more efficient transportation materials and equipment. The program consists of two components: Infrastructure and Equipment, and Studies and Pilot Projects. Businesses, municipal organizations and other legally constituted organizations with an establishment in Québec are eligible for the program. Québec has provided additional funding for the program through its 2022–2027 Implementation Plan.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Québec Support for the deployment of electric school buses*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions in the transportation sector	Economic	Implemented	2013	Québec	NE[h]	NE[h]
Brief Description	A one-time rebate of $105,000 is granted for the purchase of a fully electric school bus. The rebate is issued to: 1) school bus providers on contract with school boards and private teaching establishments, and 2) school boards and accredited private teaching establishments. Amount was amended to $150,000 for FY 2021–22, $125,000 for FY 2022–23, and $100,000 for FY 2023–24. A change to regulation will accelerate the deployment of electric school buses.								
Québec Transportation Electrification Initiatives*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions in the transportation sector and accelerate the deployment of electric vehicles and associated infrastructure	Economic, Fiscal	Implemented	2012	Québec	90.00	NE[i]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Québec places significant emphasis on electric transportation, including light vehicles and electric public transportation, and promoting the development of the electric industrial sector. Targets for 2020 aim to: reach 100,000 electric vehicles and rechargeable hybrids; reduce the number of litres of fuel consumed annually in Québec by 66 million; reach 5,000 jobs in the electric vehicle sector and bring about investments of $500 million. The Drive Green program has two components: the Drive Electric program and the Connected at Work program. The Drive Electric program offers a rebate to individuals, businesses, not-for-profit organizations and municipalities in Québec who purchase or rent an eligible vehicle. All those who purchase or rent a fully electric vehicle or a plug-in hybrid electric vehicle can also ask for financial assistance to purchase and install a 240-volt charging station at their home. The Connected at Work program offers businesses, municipalities and organizations a reimbursement on the installation of charging stations at the workplace. The financial assistance offered for a charging station equals the lesser of the following amounts: 50% of the eligible expenses or $5,000. The maximum amount of financial assistance granted to an establishment is set at $2,000 per fiscal year. Hydro-Québec's Electric Circuit is the first public network of charging stations for electric vehicles in Canada, offering 240-volt and 400-volt charging stations. As of June 2019, the network had 1,947 charging stations in service, including 195 quick-charge stations. Through its 2022–2027 Implementation Plan, Québec has increased the target for zero-emission vehicles on the road up to 1.6 million by 2030; supported increased funding and incentives for public and private charging stations; and continued support for the zero-emission vehicle rebate. With Budget 2022, the rebate for new fully electric vehicles and plug-in hybrids decreased and, as of July 1, 2022, varies from $2,500 – $7,000. In its 2030 Plan for a Green Economy, Québec announced its intention to ban sales of all new gas light-duty vehicle by 2035. In 2022 legislative changes were made to allow such regulation.								
Québec Zero-Emission Vehicle Regulation*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from the transportation sector and accelerate the deployment of electric vehicles and related infrastructure	Regulatory	Implemented	2018	Québec	NE[h]	NE[i]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Starting with 2018 models, automakers are required to meet a credit target set by the government. Credits may be accumulated by the sale of zero-emission vehicles, or by obtaining credits from other auto manufacturers. Automakers that sell or lease a yearly average of more than 4,500 new vehicles (all light models combined) are subjected to the ZEV standard. The ZEV standard is expected to contribute to the acquisition of approximately 64,000 electric vehicles by 2020. This regulation is an enabling measure that will not directly reduce emissions but will contribute to unlocking larger emissions reductions. In 2022, public consultations were held on proposed changes to the ZEV standard requirements. New regulation changes will be proposed to increase ZEV supply. Through its 2022–2027 Implementation Plan, Québec has increased the target for zero-emission vehicles on the road up to 1.6 million by 2030.								
New Brunswick Electric Vehicles and Infrastructure*	Transportation	CO_2, N_2O	To have 20,000 electric vehicles registered by 2030	Voluntary Agreement	Adopted	2016, 2021	New Brunswick	NE[h]	50.00 – 250.00
Brief Description	First fully connected province for electric vehicle charging infrastructure with a robust charging network throughout the province. 2021 commencement of incentive program for new and used EVs and home chargers (2016 Climate Change Action Plan – Action 46 & 47).								
Electrify Rebate Program	Transportation	CH_4, CO_2, N_2O	Encourage the purchase of electric vehicles	Economic	Implemented	2021	Nova Scotia	NA[b]	NE[h]
Brief Description	A $3,000 rebate is available for the purchase of a new battery-operated electric vehicle or long-range plug-in hybrid electric vehicle. A $2,000 rebate is available for the purchase of a new short-range plug-in hybrid electric vehicle. A $2,000 rebate is available for the purchase of a used battery-operated electric vehicle and a $1,000 rebate is available for the purchase of a used short-range plug-in hybrid electric vehicle. A $500 rebate is available for the purchase of an e-bike that retails for more than $1,200. These rebates are offered in addition to the federal rebates for electric vehicles.								
Active Transportation Strategy	Transportation	CO_2	Support active transportation	Voluntary Agreement	Implemented	2021	Prince Edward Island	NA[b]	NE[h]
Brief Description	The Active Transportation Strategy lays out pathways to support Islanders in making active, cleaner and healthier transportation choices. The Active Transportation Strategy was developed as part of the Sustainable Transportation Action Plan.								
Bike incentives	Transportation	CO_2	Support active transportation	Economic	Implemented	2022	Prince Edward Island	NA[b]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The Bicycle Rebate will help increase active transportation on the Island. The instant rebate of up to $100 will be offered on bicycles with a retail price of up to $2,000 (before tax). There is a price floor of $50 (the bike cannot be sold for a sticker price of less than $50 after the rebate has been applied).								
e-Bike Incentive	Transportation	CO_2	Support active transportation	Economic	Implemented	2022	Prince Edward Island	NA[b]	NE[h]
Brief Description	The Government of Prince Edward Island is offering eligible Islanders and organizations a $500 rebate for those who purchase an e-Bike (Power Assisted Bicycle). The purpose of the program is to encourage greater adoption of Active Transportation options among Islanders.								
PEI Active Transportation Fund	Transportation	CO_2	Support active transportation	Fiscal	Implemented	2021	Prince Edward Island	NA[b]	NE[h]
Brief Description	$25 million over 5 years to support active transportation (AT) in PEI. The AT Fund is helping to build new walking and bike paths, install paved shoulders, and better connect existing walking and cycling trails to improve and grow PEI's active transportation network. Sixty-five projects have been completed under the Active Transportation Fund including investment in PEI's Confederation Trail system.								
PEI Electric Vehicle Charging Funding Program	Transportation	CO_2	Promote adoption of electric vehicles	Economic	Implemented	2022	Prince Edward Island	NA[b]	NE[h]
Brief Description	The PEI Electric Vehicle Charging Fund will support up to 75% of eligible costs for First Nations, municipalities, business, academic and community organizations in PEI to install commercial EV chargers in public parking areas, workplaces, light-duty vehicle fleet parking, and designated multi-unit residential buildings (MURBs). Funded in part through Natural Resources Canada's ZEVIP.								
PEI Electric Vehicle Rebate Program*	Transportation	CO_2	Promote adoption of electric vehicles	Economic	Implemented	2021	Prince Edward Island	NA[b]	NE[h]
Brief Description	The Electric Vehicle Rebate Program provides rebates of $2,500 to $5,000 towards a plugin hybrid or new or used EV. From January 2021 to March 2022, there was a 237% increase in the number of zero-emission vehicles registered in PEI. This has included investments in EV charging infrastructure for homes, and businesses and multi-unit residential buildings.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Prince Edward Island Electric Vehicle Charging Network	Transportation	CO_2	Encourage adoption of electric vehicles	Voluntary Agreement	Implemented	2019	Prince Edward Island	NE[h]	NE[h]
Brief Description	Federal and provincial funding support was secured to build PEI's first level 3 electric vehicle fast charger network. PEI continues to invest in level 2 public chargers across the province.								
Prince Edward Island Greening Government	Transportation	CO_2	Reduce emissions from government fleet and buildings	Voluntary Agreement	Implemented	2018	Prince Edward Island	NE[h]	6.00
Brief Description	The program includes energy efficiency upgrades to provincial buildings, improved fuel efficiency of its vehicle fleet, and a commitment to green procurement. Fuel-switching (light fuel oil to biomass) has begun in several government buildings and 15 electric vehicles have been added to the government fleet. Additional fuel-switching and energy efficiency measures are planned for the following years, and additional electric and hybrid vehicles will be added to the government fleet.								
Prince Edward Island Sustainable Transportation Action Plan	Transportation	CO_2	Reduce emissions from transportation sector through efficiency, fuel-switching and alternative transportation modes	Voluntary Agreement	Implemented	2019	Prince Edward Island	NA[b]	NE[h]
Brief Description	A Sustainable Transportation Action Plan was released in November 2019. The action plan contains 27 actions in four key areas: public transit, vehicles, active transportation, and community design. A variety of government departments, agencies, and organizations will implement the plan through programs, services and policies over the course of 5 years.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Rural Transit Pilot Program	Transportation	CO_2	Reduce GHG emissions	Fiscal	Implemented	2019	Prince Edward Island	NE[h]	NE[h]
Brief Description	The Province of Prince Edward Island has developed a province-wide integrated public transportation system with routes available across all of PEI.								
School Bus Electrification	Transportation	CO_2	Reduce GHG emissions	Fiscal	Implemented	2019	Prince Edward Island	NE[h]	NE[h]
Brief Description	Prince Edward Island announced that the province would transition their school bus fleet to electric. Currently 47 electric buses will be used this upcoming school year with 35 more to be delivered by January 2023. The province plans have 20% of the fleet electric by the end of 2022.								
Transit subsidy (reduced fares), school aged youth 18 and under ride free	Transportation	CO_2	Support mode shifting	Economic	Implemented	2019, 2022	Prince Edward Island	NE[h]	NE[h]
Brief Description	10% rebated through carbon tax revenues and additional subsidies for 19+ fares. All transit routes on Prince Edward Island are free for school aged youth 18 and under.								
Electric vehicle incentive program*	Transportation	CH_4, CO_2, N_2O	Support EV penetration	Fiscal	Implemented	2020	Newfoundland and Labrador	NE[h]	1.50
Brief Description	Newfoundland and Labrador delivers an EV incentive program for residential and commercial sector battery and plug-in hybrid electric vehicles.								
Newfoundland and Labrador freight transportation measures	Transportation	CH_4, CO_2, N_2O	Improve on-road freight transportation efficiency	Fiscal	Implemented	2019	Newfoundland and Labrador	NE[h]	9.20
Brief Description	To provide incentives for freight transportation companies to install technologies to reduce fuel consumption and GHG emissions. This program is supported by the Low Carbon Economy Leadership Fund.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Newfoundland electric vehicle charging network	Transportation	CH_4, CO_2, N_2O	Encourage adoption of electric vehicles	Fiscal	Implemented	2019	Newfoundland and Labrador	NE[h]	NE[h]
Brief Description	14 level-3 charging stations have been installed on the Trans Canada Highway, and the electric utilities have since received federal funding to install level 2 chargers throughout the province. A new initiative in 2021–22 seeks to further enhance the Level-3 network, including through provincial and cost shared federal funding. Level 3 stations are necessary to allow for increased penetration of EVs in the province.								
Renewable Fuel Regulations**	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from transportation sector	Regulatory	Planned	2025	Yukon	NA[b]	33.00
Brief Description	Require all diesel fuel sold in Yukon for transportation to align with the percentage of biodiesel and renewable diesel by volume in leading Canadian jurisdictions beginning in 2025, aiming for around 20%. Require all gasoline sold in Yukon for transportation to align with the percentage of ethanol by volume in leading Canadian jurisdictions beginning in 2025, aiming for around 10%.								
ZEV Sales Target/ Mandate*	Transportation	CH_4, CO_2, N_2O	Reduce GHG emissions from transportation sector	Regulatory	Implemented	2020	Yukon	NE[h]	27.00
Brief Description	Supports the following Our Clean Future actions: T1: Work with local vehicle dealerships and manufacturers to establish a system by 2024 to ensure zero-emission vehicles are 10% of light duty vehicle sales by 2025 and 30% by 2030. T2: Ensure at least 50% of all new light-duty cars purchased by the Government of Yukon are zero-emission vehicles each year from 2020 to 2030.								
Northwest Territories Electric Vehicle Infrastructure Program	Transportation	CH_4, CO_2, N_2O	Enhance the electric vehicle charging infrastructure network	Fiscal	Adopted	2022	Northwest Territories	NE[h]	NE[h]
Brief Description	An application-based grant program designed to support installing new electric vehicle charging infrastructure in the NWT in public places, on-street, at multi-unit residential buildings, workplaces, as well as other locations in support of charging light duty electric vehicles.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
OIL AND GAS									
Guidance for the Submission of Information on Best-in-Class Emissions Intensity by Oil and Gas Projects Undergoing Federal Impact Assessment	Oil and Gas	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Explain how proponents of new oil and gas projects subject to a federal impact assessment should use the analysis required by the Government of Canada's strategic assessment of climate change (SACC) to demonstrate that the project will be "best-in-class"	Information	Planned	2022	Environment and Climate Change Canada	NA[b]	NA[d]
Brief Description	Guidance describes that proponents will be asked to: show how the project will integrate advanced technologies and best environmental practices, including emerging technologies to minimize GHG emissions either now or when the technology becomes feasible; compare the project's GHG emissions performance with high performing projects nationally and internationally, which would be regarded as best-in-class; and, demonstrate a plan to achieve net-zero emissions by 2050 if the project will continue to operate after that year.								
Oil and Gas Emissions Caps	Oil and Gas	CH_4, CO_2	Limit and reduce emissions from the oil and gas industry	TBD	Planned	TBD	Environment and Climate Change Canada	NA[b]	NE[e]
Brief Description	The Government of Canada has committed to cap and cut emissions from the oil and gas sector. A discussion paper was published in July 2022 to consult on two potential approaches, including the development of a new cap-and-trade system under CEPA 1999 legislation, or the modification of existing carbon pollution pricing systems.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Regulations to Address Methane in the Oil and Gas Sector*	Oil and Gas	CH_4	Reduce methane emissions from the oil and gas sectors in Canada	Regulatory	Implemented	2020	Environment and Climate Change Canada	4,000.00	20,000.00
Brief Description	As part of the Pan-Canadian Framework, the Government of Canada reaffirmed its commitment to reduce methane emissions from the oil and gas sector by 40 to 45% from 2012 levels by 2025, building on provincial actions and targets. To implement this commitment, Canada introduced federal regulations in April 2018 to reduce venting and fugitive methane emissions from existing and new oil and gas sources. The regulations entered into force in January 2020.								
Strengthened Regulations to Further Reduce Methane in the Oil and Gas Sector**	Oil and Gas	CH_4	Further reduce methane emissions from the oil and gas sectors in Canada	Regulatory	Planned	TBD	Environment and Climate Change Canada	NA[b]	NE[e]
Brief Description	Strengthened methane regulations are being developed to achieve at least a 75% reduction of oil and gas methane emissions by 2030, compared to 2012 levels. Proposed regulations will be published in 2023.								
Emissions Reduction Fund	Oil and Gas	CH_4, CO_2	Reduce GHG emissions in the onshore and offshore oil and gas sector	Fiscal	Implemented	2021	Natural Resources Canada	NA[b]	NE[e]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The program was launched in October 2020 as a COVID-19 measure to provide primarily repayable funding to eligible onshore and offshore oil and gas firms to support capital investments, clean technology deployment, and research to reduce GHG emissions and help maintain jobs in a time of economic hardship and uncertainty. Of the total $750 million, up to $675 million was available to eligible onshore oil and gas companies to invest in green technologies to reduce or eliminate methane emissions from conventional oil and gas production. Projects funded under the first two intake periods are ongoing but will be completed by March 2023; projects to be funded under the third and final intake period are being finalized. ERF Onshore projects are anticipated to achieve methane emission reductions of ~ 4 Mt CO_2 eq in the first twelve months following project completion. Data will be confirmed when projects are complete. The remaining $75 million was available to offshore oil and gas companies ($42 million for the Offshore Deployment Program and $33 million for the Offshore RD&D Program) for capital investments and research, development and demonstration (RD&D) to reduce GHGs in the offshore oil and gas sector in Newfoundland and Labrador.								
British Columbia Electrification of the Natural Gas Sector*	Oil and Gas	CH_4, CO_2, N_2O	Reduce oil and gas GHG emissions	Economic	Implemented	2016	British Columbia	NE[h]	1,120.00
Brief Description	BC amended the GHG Reduction Regulation to support the development of additional transmission infrastructure in northeast BC to provide clean electricity to meet increasing demand from the upstream natural gas sector. The regulation enables the electricity utility BC Hydro to provide incentives for electrification to bridge the cost difference between using natural gas and electricity in upstream oil and gas infrastructure. CleanBC (2018) committed to providing clean electricity to natural gas production and will add new and interconnecting transmission lines to support electrification of other large industrial operations. In August 2019, BC and Canada signed a joint Memorandum of Understanding on the Electrification of the Natural Gas and Liquefied Natural Gas Sectors.								
British Columbia Expanded Incentives for Efficient Gas Equipment	Oil and Gas	CO_2, N_2O	Reduce oil and gas GHG emissions	Economic	Implemented	2017	British Columbia	NE[h]	NE[h]
Brief Description	The incentives will allow utilities to expand their incentives by at least 100%, to encourage further adoption of technologies that reduce the emissions from gas-fired equipment.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
British Columbia Methane Reduction Policy*	Oil and Gas	CH_4	Reduce oil and gas GHG emissions	Regulatory	Implemented	2017	British Columbia	NE[h]	NE[h]
Brief Description	This policy was introduced through an amendment to British Columbia's *Drilling and Production Regulation*. It came into effect on January 1, 2020 to reduce methane emissions from upstream oil and gas operations to meet or exceed federal and provincial methane emission reduction targets. The policy targets extraction and processing emissions (referred to as upstream in the natural gas sector), including: legacy phase, targeting a 45% reduction by 2025 in fugitive and vented emissions in infrastructure built before January 1, 2015; and transition phase, including incentives through a new offset protocol to encourage further innovative projects. The CleanBC Roadmap to 2030 commits to implementing stronger methane policies that will reduce methane emissions from the oil and gas sector by 75% below 2014 levels by 2030 and nearly eliminate all industrial methane emissions by 2035.								
British Columbia Regulatory Framework for Carbon Capture and Storage	Oil and Gas	CO_2	Reduce oil and gas GHG emissions	Regulatory	Planned	TBD	British Columbia	NE[h]	NE[h]
Brief Description	The framework will allow carbon capture and storage projects at natural gas extraction and processing facilities to proceed upon the completion of regulatory policy work. CleanBC reaffirms the commitment to establish a regulatory framework for safe and effective underground CO_2 storage and direct air capture.								
Oil and Gas Royalty System	Oil and Gas	CH_4, CO_2	Reduce oil and gas GHG emissions	Economic	Adopted	2021	British Columbia	NE[h]	NE[h]
Brief Description	A 2021 review of all Oil and Gas Royalty Programs resulted in the elimination of the Clean Growth Infrastructure Royalty Program, the Deep Well Royalty Program, and many other outdated and inefficient subsidies. The new system is a revenue-minus-cost system designed to achieve a return of 50% of profits on the public resource after costs are accounted for. It will be phased in and applied to new wells on September 1, 2022 and will be fully implemented by September 1, 2024. The new system increases the minimum royalty rate from 3% to 5%, which will provide more revenue in support of climate action and public services.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Sectoral emissions target – Oil and gas	Oil and Gas	CO_2	Reduce emissions from oil and gas sector	Regulatory	Implemented	2021	British Columbia	NE[h]	NE[h]
Brief Description	Oil and gas sectoral target of a reduction of 33–38% of 2007 emissions by 2030.								
Alberta Directive 060: Upstream Petroleum Industry Flaring, Incinerating and Venting*	Oil and Gas	CH_4, CO_2	Reduce flaring and venting in the oil and gas sector	Regulatory	Implemented	1999	Alberta	4,000.00	NE[h]
Brief Description	Requirements have been developed in consultation with the Clean Air Strategic Alliance to eliminate or reduce the potential and observed impacts of these activities and to ensure that public safety concerns and environmental impacts are addressed before beginning to flare, incinerate, or vent. Directive 060 requirements are also aligned to ensure compliance with Alberta Environment and Sustainable Resource Development's Alberta Ambient Air Quality Objectives and Guidelines.								
Alberta Methane Emissions Program (AMEP)	Oil and Gas	CH_4	Reduce methane emissions from upstream oil and gas operations by 45% from 2014 level by 2025	Economic	Implemented	2021	Alberta	NE[h]	NE[h]
Brief Description	The Alberta Methane Emissions Program (AMEP) is a three-year $17.6 million initiative to support methane emissions reductions that is funded by the Government of Alberta through the TIER Fund. Carbon Management Canada and the Sundre Petroleum Operators Group were selected through a competitive process to deliver the program.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Alberta *Oil Sands Emissions Limit Act*	Oil and Gas	CO_2	Cap emissions from the oil sands sector to 100 Mt	Regulatory	Adopted	2018	Alberta	NE[h]	NE[h]
Brief Description	Alberta's *Oil Sands Emissions Limit Act* provides a legislative framework for implementing an annual oil sands GHG emissions cap of 100 Mt for oil sands facilities with provisions for co-generation and new upgrading capacity. Emissions remain below the limit.								
Alberta reduction of methane emissions*	Oil and Gas	CH_4	Reduce methane emissions from upstream oil and gas operations by 45% from 2014 level by 2025	Regulatory	Implemented	2020	Alberta	NE[c]	NE[c]
Brief Description	Alberta will reduce upstream oil and gas methane emissions by 45% by 2025. This will be achieved through the implementation of methane emission reduction requirements contained in Alberta Energy Regulator Directive 060: Upstream Petroleum Industry Flaring, Incinerating and Venting and Directive 017: Measurement Requirements for Oil and Gas Operations. These Directive amendments were published in December 2018 along with the Government of Alberta's *Methane Emission Reduction Regulation*. Estimates of mitigation impact are included under Alberta's Large Emitter Greenhouse Gas Regulations. Alberta was the first sub-national jurisdiction in North America to set a methane reduction target for the oil and gas sector of 45% below 2014 levels by 2025. Alberta is on track to meet the target.								
Saskatchewan Methane Action Plan*	Oil and Gas	CH_4	Reduce emissions from venting and flaring	Regulatory	Implemented	2019	Saskatchewan	NE[h]	NE[h]
Brief Description	Saskatchewan released the Methane Action Plan in January 2019. The plan commits to introducing regulations that will reduce methane emissions in the upstream oil and gas sector by between 40% and 45% by 2025. It also commits to introducing a suite of new programs and policies that increase and accelerate opportunities to capture and commercialize methane. Under this plan, the province continues to establish flexible compliance options for industrial emitters who do not meet output-based performance standards (OBPS) and mandatory emissions reductions for venting and flaring.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Saskatchewan Oil and Gas Emissions Management Regulations*	Oil and Gas	CH_4, CO_2	Reduce emissions from venting and flaring	Regulatory	Implemented	2019	Saskatchewan	5,660.00	4,500.00
Brief Description	Regulations under the Methane Action Plan to reduce GHG emissions from oil and gas wells and facilities using a results-based system that: Provides each oil and gas operator the ability to efficiently prioritize emission reduction investments; supports adoption of innovative emissions reduction technologies; firmly establishes provincial regulatory oversight of emissions from the oil and gas industry; and includes a strategy to support the increased use of methane produced in association with oil for heating and electricity production, including the establishment of usage requirements for this source of natural gas.								
Newfoundland and Labrador methane regulations*	Oil and Gas	CH_4	Reduce emissions from venting and flaring	Regulatory	Planned	TBD	Newfoundland and Labrador	NA[b]	NE[e]
Brief Description	Through the Frontier and Offshore Regulatory Renewal Initiative (FORRI), Newfoundland and Labrador is working with the federal government to develop regulatory requirements relating to the reduction of emissions such that the Canada-Newfoundland and Labrador Offshore Petroleum Board will regulate methane emissions under the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Act*. The federal regulations to reduce methane emissions from the upstream oil and gas industry under the *Canadian Environmental Protection Act, 1999* will continue to apply to the offshore petroleum sector until such changes are realized.								
BUILDINGS									
Canada Greener Homes Loan Initiative**	Buildings	CO_2	Support homeowners through low-cost financing to make deeper, more costly energy retrofits to their homes	Fiscal, Economic	Adopted	2022	Canada Mortgage and Housing Corporation	NA[b]	200.00 – 400.00
Brief Description	This program helps homeowners complete deep home retrofits through interest-free loans worth up to $40,000. In combination with available grants (through Natural Resources Canada Greener Homes Grant Program), this will help eligible participants make deeper, more costly retrofits that have the biggest impact in reducing a home's environmental footprint and energy bills.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Innovative construction materials R&D/Building Standards	Buildings	CO_2	Support a decarbonized and climate resilient construction sector	Fiscal, Research, Regulatory	Adopted	2022	National Research Council Canada	NA[b]	NA[d]
Brief Description	$183 million to support a decarbonized and climate resilient construction sector through the development of standards and building codes, the establishment of a Centre of Excellence, research and development activities—including a concrete and cement R&D initiative, timber construction R&D initiative, and multi-sector collaboration challenges—and a procurement challenge.								
Canada Green Buildings Strategy**	Buildings	CO_2	Drive a massive retrofit of existing building stock	Fiscal, Research, Regulatory, Education	Adopted	2022	Natural Resources Canada	NA[b]	NE[e]
Brief Description	$150 million to develop a national net-zero by 2050 buildings strategy, the Canada Green Buildings Strategy. Working with partners, the strategy will set out measures to accelerate retrofits of existing buildings in Canada, encourage the highest zero-carbon standards in new buildings (commercial and residential), transform how we heat buildings and the water we use, and enhance resilience of buildings to climate change. The Buildings Strategy will: • Develop a Low Carbon Building Materials Innovation Hub to drive further research, building code reform, and demonstration activities, all promoting the use of lower carbon construction materials (e.g., wood, steel, cement, etc.) in the built environment; • Develop regulatory, standards, and an incentive framework to support the transition off fossil-fuels for heating systems; • Develop an approach to require EnerGuide labeling of homes at the time of sale, and design a complementary Climate Adaptation Home Rating Program; • Launch a new Net-Zero Building Code Acceleration Fund to accelerate adoption and implementation of the highest performance tiers of the national model energy codes, incentivizing stakeholder participation while addressing persistent challenges in Canada's codes system and paving the way to a code for alterations for existing buildings; • Improve federal capacity and technical support to provinces, territories and key stakeholders for the development and adoption of net-zero emission codes, and alteration to existing buildings codes; and, • Develop an approach to increase the climate resilience of the built environment.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Canada Greener Homes Grant Initiative*	Buildings	CO_2	Up to 700,000 grants for homeowners across Canada	Fiscal, Education	Implemented	2021	Natural Resources Canada	NA[b]	NE[e]
Brief Description	Provide grants of up to $5,000 to help homeowners make energy-efficient home improvements, free energy assessments, and support to recruit and train energy auditors. Starting in 2023, an additional grant of up to $5,000 will be available specifically to cover the costs of changing oil heating to electric cold-climate heat pumps.								
Deep Retrofit Accelerator Initiative**	Buildings	CO_2	Build capacity to develop deep retrofit projects for large buildings	Fiscal	Adopted	2022	Natural Resources Canada	NA[b]	NE[g]
Brief Description	$200 million to support capacity building activities related to the development and implementation of deep retrofits.								
Federal Energy Efficient Buildings Initiatives	Buildings	CH_4, CO_2, N_2O	Accelerate and enhance the promotion of energy efficiency in the buildings sector	Information	Implemented	2018	Natural Resources Canada	NE[h]	11,200.00
Brief Description	A number of energy efficiency measures have been outlined under the Green Infrastructure stream, as part of the Investing in Canada Plan. These actions include: the development of net-zero energy ready model building codes; the development of a new model code for building alterations by 2022; and joint efforts between the federal, provincial and territorial governments to require labelling of building energy use. As of 2021–22, the Infrastructure Energy Efficient Buildings Research, Development and Demonstration Program is supporting 18 RD&D projects. RD&D projects will accelerate the development and adoption of net-zero-energy-ready codes and cleaner technologies to promote highly energy-efficient building design and construction practices, provide cost-effective building solutions, and validate their applications with real-world demonstrations. Energy efficient buildings initiatives are on track to meet the 2030 emission reductions target.								
Green Construction through Wood Program	Buildings	CO_2	Mitigate GHG emissions in the buildings sector	Fiscal	Implemented	2018	Natural Resources Canada	NA[a]	NA[a]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The program launched in October 2017 and supports projects and activities that increase the use of wood as a greener building material in infrastructure projects. Calls for Expressions of Interest for tall wood buildings, low-rise non-residential buildings, and timber bridges have all closed. The program received 57 applications over the three calls and is targeting the delivery of 15–20 demonstration projects under the program. The majority of agreements have been signed and projects are underway.								
Greener Neighbourhoods Pilot Program	Buildings	CO_2	Retrofit homes to advance decarbonization	Fiscal, Research, Information	Adopted	2022	Natural Resources Canada	NA[b]	NE[e]
Brief Description	$33 million to implement a Greener Neighbourhoods Pilot Program, which will retrofit homes or units in up to six communities across the country. This support for community-level home retrofits aligns with the Net-Zero Advisory Body's recommendation to seek out opportunities to decarbonize multiple buildings at once. Emission reduction target to be confirmed.								
BC Building Innovation Fund	Buildings	CO_2	Reduce emissions from buildings	Fiscal	Implemented	2021	British Columbia	NA[b]	NE[h]
Brief Description	Investments in low-carbon technologies through the Building Innovation Fund including heating and ventilation equipment, digital tools, construction systems as well as mass timber manufacturing technology and demonstration projects.								
British Columbia Building Green Code*	Buildings	CO_2	Improve energy efficiency in new houses and buildings	Regulatory	Implemented	2008	British Columbia	NE[h]	NE[h]
Brief Description	Since 2008, British Columbia has been working to improve energy efficiency in the building sector, including for large residential, industrial and commercial buildings, houses and small buildings, as well as in public sector buildings, including a LEED Gold requirement and research on low carbon building material options. In 2017, BC introduced a Step Code: Increased Energy Efficiency Requirements in the BC Building Code, Energy Step Code: Energy Efficiency, and a Net-Zero Energy Ready Building Design Incentive. CleanBC, released in 2018, seeks to improve the Building Code further. In the Roadmap to 2030, BC committed to adding a new carbon pollution standard to the BC Building Code, supporting a transition to zero-carbon new buildings by 2030. It also committed to highest-efficiency standards for new space and water heating equipment by 2030, and earlier where feasible. After 2030, all new space and water heating equipment sold and installed in BC will be at least 100% efficient.								
British Columbia Climate Action Charter	Buildings	CO_2	Reduce GHG emissions in buildings and transportation	Economic	Implemented	2008	British Columbia	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The Charter is an Agreement between provincial and municipal governments to work towards carbon neutral operations and complete, compact, low carbon communities. In 2022, BC introduced the Local Government Climate Action Program (LGCAP) for signatories to the BC Climate Action Charter. The LGCAP provides funding for local governments and Modern Treaty Nations to plan and implement climate action that will reduce emissions, create new opportunities for people in the clean economy and prepare communities for future climate impacts.								
British Columbia Technology and Retrofit Incentive Programs*	Buildings	CO_2	Reduce GHG emissions in buildings	Economic	Implemented	2015	British Columbia	NE[h]	NE[h]
Brief Description	A variety of programs provide incentives for energy efficiency measures. CleanBC Better Homes and Better Buildings includes incentives for renovating or building homes and other buildings, including rebates for energy efficiency upgrades such as new windows, rebates to convert from less efficient oil heating systems to all-electric air source heat pumps, incentives to do energy-saving studies and upgrades, and energy coaching services for homes and businesses. The ISO 50001 incentive is run by the BC Government and the federal government and offers up to $80,000 of cost-shared assistance to BC industrial companies to implement energy management system projects that help facilities to comply with the standard, which enables companies to systematically reduce energy consumption and emissions.								
Energy Efficiency Standards Regulation	Buildings	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Increase energy efficiency in buildings	Regulatory	Implemented	2021	British Columbia	NE[h]	NE[h]
Brief Description	Introduced new and updated energy efficiency standards for gas boilers and residential windows.								
Low Carbon Building Materials Strategy	Buildings	CO_2	Reduce the embedded carbon in infrastructure	Economic	Adopted	2023	British Columbia	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	BC is developing a Low Carbon Building Materials Strategy that includes a holistic approach to decarbonizing buildings, initially emphasizing public sector buildings, supporting the development and implementation of embodied carbon targets for public sector buildings by 2030. BC is also developing methods for quantifying and analyzing the total embodied carbon of our built environment and identifying pathways to reduce it. BC released a Mass Timber Action Plan in 2022. The Mass Timber Action Plan maximizes opportunities for British Columbia as the market for mass timber grows across North America. It draws together the strengths of government, industry and academia to create new economic value from our vast forest resource, manufacturing base, construction sector, and trade networks.								
Reframed Lab	Buildings	CO_2	Increase energy efficiency in buildings	Fiscal	Implemented	2022	British Columbia	NE[h]	NE[h]
Brief Description	The province, together with BC Housing, the City of Vancouver, the Metro Vancouver Housing Corporation (MVHC), the BC Non-Profit Housing Association and the Pembina Institute, are providing upgrades to public buildings and public housing to improve energy efficiency. BC is supporting the design and capital costs of this project through funding from the Capital Renewal Fund, a 10-year $1.1 billion investment committed to preserving and improving BC's 51,000 units of social housing. This initiative also received $460,000 from the Province's CleanBC Building Innovation Fund (CBBIF).								
Sectoral emissions target – Buildings and communities	Buildings	CO_2	Reduce emissions from buildings and communities	Regulatory	Implemented	2021	British Columbia	NE[h]	NE[h]
Brief Description	Sectoral target set of a reduction of 59–64% of 2007 sector emissions by 2030.								
Saskatchewan Energy Efficiency Standards for Buildings*	Buildings	CO_2	Reduce emissions associated with buildings	Regulatory	Planned	2019, 2024	Saskatchewan	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Adopted the 2015 National Building Code effective January 1, 2018, with provisions that improve energy efficiency standards for houses and small buildings taking effect January 1, 2019. The National Energy Code for Buildings 2017, for application to large buildings, was adopted January 1, 2019. Facilitates provisions in the National Building Code 2015 that provide for increased use of wood in building construction in order to extend carbon storage. New government buildings are required to exceed the energy performance requirements of the 2015 National Energy Code for Buildings by 10%. In addition, all new government builds and major renovations will be designed to meet or exceed LEED Silver certification standards. The 2020 editions of the National Building Code and the National Energy Code for Buildings is proposed to be adopted on January 1, 2024. This new edition will raise the minimum energy efficiency standards required for all buildings (both large and small) when compared to the 2015 editions of these codes. The 2020 editions of these codes are tiered codes, which move from minimal energy efficiency standards (tier 1) to very high energy efficiency standards (tier 5). It is proposed that Saskatchewan adopt tier 1 as a minimum standard until further analysis and consultations can be conducted on the impact these requirements will have on industry and consumers.								
Efficiency Manitoba Act* and Energy Efficiency Programing	Buildings	CO_2	Reduce energy use and improve energy efficiency	Voluntary Agreement	Implemented	2020	Efficiency Manitoba	NE[h]	NE[h]
Brief Description	Efficiency Manitoba, established as a new Crown corporation officially launched on April 1, 2020, to deliver demand-side management (DSM) programs and services to its residential, Indigenous, income qualified, commercial, institutional, industrial and agricultural to assist them to reduce their use of electricity and natural gas. As per the *Efficiency Manitoba Act*, Efficiency Manitoba must meet legislated energy savings targets of 22.5% of domestic electricity demand (an average of 1.5% annually of domestic electricity consumption) and 11.25% of domestic natural gas demand (an average of 0.75% annually of natural gas consumption) over a 15-year period. The province is continuing to expand Efficiency Manitoba grant offerings to support building energy efficiency programs across all sectors. Efficiency Manitoba is expected to reduce emissions in the province by an estimated 135 kt CO_2 eq by 2023. Efficiency Manitoba leveraged $32.3 million over three years from Canada's Low Carbon Economy Leadership Fund for its natural gas DSM programs.								
Ontario Building Code*	Buildings	CH_4, CO_2, N_2O	Establish standards and promote improvements in energy efficiency	Regulatory	Planned	2018, 2024	Ontario	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Ontario is consulting on the adoption of new energy efficiency provisions for the Ontario Building Code that are in the National Construction Codes and, if adopted, would come into effect in 2024. Ontario intends to review its building code and support the adoption of cost effective energy efficiency measures that can lower the cost of electricity and natural gas needed to operate buildings. Ontario is also proposing to modernize the building code to better equip homes and buildings to be better able to withstand extreme weather events.								
Ontario Natural Gas Demand Side Management Programs*	Buildings	CO_2	Reduce natural gas consumption in the residential, commercial and industrial sectors	Regulatory	Implemented	2003, 2015	Ontario	4,200.00	NE[h]
Brief Description	Ontario's main natural gas utility, Enbridge Gas, has been delivering natural gas energy efficiency programs to its industrial, commercial, institutional and residential customers for over 30 years, with oversight of Ontario Energy Board (OEB). The first multi-year natural gas Demand Side Management program Framework was established in 2005. From 2007 to 2020, Ontarians conserved 2,159 million m^3 of natural gas from natural gas conservation programs (the equivalent to the natural gas used by 900,000 homes/year). These persisting savings are equivalent to GHG emission reductions of 4.2 Mt in the year 2020. The most recent year for verified DSM program savings is 2020. Verified savings for 2021 will be available later in 2022. In July 2020 and August 2021, OEB approved DSM transition plans for the 2021 and 2022 program years, respectively. These transition plans rolled over 2020 budgets and targets into 2021 and 2022 to ensure that programming would continue to be available while OEB finalizes a multi-year plan. An OEB decision on Enbridge's application for 2023-2027 DSM programming, which would see a modest increase in DSM spending and savings, is expected by early September 2022.								
Québec Chauffez Vert Program*	Buildings	CO_2	Reduce GHG emissions in the building sector (residential sector)	Economic	Implemented	2016	Québec	329.00	NE[i]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Chauffez Vert is a program that encourages energy-efficient residential renovations in order to reduce the energy consumption and GHG emissions of homes in Québec, while improving the comfort of occupants. Financial assistance is granted for the conversion of a primary heating system that uses oil, propane or any other fossil fuel except natural gas, to a primary heating system powered by geothermal, hydro, wind or solar energy. Québec has increased funding for the Chauffez Vert program as part of its 2022–2027 Implementation Plan. A new feature is the integration of bienergy (hydroelectricity and other renewable energies and natural gas within the residential sector to manage excess electrical punctual demands). In 2021, Québec announced a ban on oil heating in all new construction projects and encouraged residents to switch to more efficient electric home heating options (enforced on December 31, 2021).								
Québec – Making institutions eco-responsible*	Buildings	CO_2	Reduce GHG emissions in the building sector (institutional)	Economic	Implemented	2016	Québec	23.00	NE[i]
Brief Description	The program aims to provide financial assistance for projects that implement one or more targeted means of saving fossil fuel consumption with a prospect of reducing or avoiding overall GHG emissions. An example of a project: Work to replace oil or natural gas-fired boilers with systems that run on renewable energy (geothermal, aerothermal, electric boilers, etc.). Through Québec's 2022-2027 Implementation Plan, the target is to reduce GHG emissions from public institutional buildings by 60% by 2030 when compared to 1990 and by 100% by 2040 (zero-emission).								
Building Codes*	Buildings	CO_2, N_2O	Improve building energy usage and efficiency	Regulatory	Implemented	2020	New Brunswick	NE[h]	NE[h]
Brief Description	The *Building Code Administration Act* was introduced on March 17, 2020. The 2015 National Building Code of Canada and the 2011 National Energy Code for Buildings were adopted through the Act on February 1, 2021.								
New Brunswick Energy Efficiency Program	Buildings	CO_2, N_2O	Improve the energy efficiency of buildings and operations for all fuels	Regulatory	Implemented	2005, 2022	New Brunswick	50.00	250.00

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Amendments to the *Electricity Act* to create regulations that will set annual electricity efficiency targets for NB Power (New Brunswick's Efficiency Service Delivery Agency) and establish a fund to provide long-term funding for non-electric programs. The regulatory authority will also establish annual reporting requirements on all sectors. The *Electricity Act* was also amended in late 2021 to allow NB Power to fund low-income energy efficiency programs. NB Power continues to be committed to cost-effective DSM programming with annual budgets approved by the regulator. In addition, the federal government's Low Carbon Economy Fund is providing $51 million in funding between 2017 to 2024 that extends NB Power's energy efficiency programs beyond electricity to all fuel types, including oil, natural gas, and propane. In 2020-2021 and 2021-2022, NB Power has also received money from the New Brunswick Climate Fund. The total annual budget from all sources has increased from $13.6 million in 2017-2018 to a projected $34.3 million in 2021-2022.								
Provincial Buildings Energy Retrofit and Renewable Energy	Buildings	CO_2, N_2O	Improve clean energy usage and performance of government buildings	Fiscal	Implemented	2016	New Brunswick	40.00	160.00
Brief Description	These measures reduce GHG emissions through building systems re-commissioning, lighting upgrades, converting to lower emissions fuel sources and implementation of renewable energy systems.								
Nova Scotia Energy Efficiency Measures for Non-Electrically Heated Homes	Buildings	CH_4, CO_2, N_2O	Encourage energy efficiency	Economic	Implemented	2011	Nova Scotia	NE[h]	NE[h]
Brief Description	Homeowners on a low income can qualify for no-charge home efficiency upgrades through Efficiency Nova Scotia's Low Income Homeowner Service. Since 45% of the heat loss in a typical home occurs through the walls, floors and roof, a primary focus is on insulation and draft proofing. For those who qualify for the program, a certified energy advisor will conduct a home-energy assessment and energy efficient upgrades are provided at no cost to the homeowner. Program participants who heat with non-electrical heat sources save, on average, $900 per year.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Free Heat Pump Program	Buildings	CO_2	Combustion emissions from buildings	Economic	Implemented	2021	Prince Edward Island	NA[b]	NE[h]
Brief Description	An emissions reducing measure to help income-qualified Island residents become less reliant on home heating oil came into effect on December 1, 2021.								
Prince Edward Island Biomass Heating	Buildings	CO_2	Reduce energy use and GHG emissions from the building sector	Economic	Implemented	2019	Prince Edward Island	NE[h]	4.00
Brief Description	The province solicited proposals for the installation of biomass heating systems in public buildings. Nine biomass plants, supplying heat to 18 facilities across PEI: West Royalty Elementary, Westwood Primary, ME Callaghan Intermediate, a combined plant for Kensington Intermediate Senior High School and Queen Elizabeth Elementary, École Francois Buote, a combined plant for Glen Stewart Primary and Stratford Elementary Schools, Queens County Highway Depot, seven senior's apartment complexes in Summerside, and a combined plant for Montague Intermediate School and Riverview Manor. These nine plants were completed between June 2019 and March 2022. This project is funded in part by the Government of Canada's Low Carbon Economy Leadership Fund.								
Prince Edward Island *Building Code Act**	Buildings	CO_2	Reduce energy use and GHG emissions from the building sector	Regulatory	Implemented	2020	Prince Edward Island	NE[h]	10.00
Brief Description	The 2015 National Building Code and 2017 National Energy Code for buildings are in force province-wide.								
Prince Edward Island Energy Efficiency and Fuel Switching Rebate Programs (efficiencyPEI)	Buildings	CO_2	Support residential and commercial energy efficiency	Fiscal	Implemented	2008, 2017	Prince Edward Island	41.79	57.61

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Programs to enhance efficiency in residential and commercial buildings. Programs include the Energy Efficiency Equipment Appliance Rebates, Home Insulation Rebates, Instant Energy Savings Program (point-of-sale), New Home Construction Incentive, Energy Efficiency Loan Program, Home Comfort and Winter Warming Programs (Low-income weatherization Building Envelope Upgrades), Energy Audit Programs, Solar Electric Rebate Program, and Business Energy Rebates. All of these programs, except New Home Construction, have been expanded because of support from the Low Carbon Economy Leadership Fund.								
Fuel oil to electricity incentive program	Buildings	CH_4, CO_2, N_2O	Support residential energy efficiency	Fiscal	Implemented	2020	Newfoundland and Labrador	NE[h]	13.70
Brief Description	Newfoundland and Labrador delivers a fuel switching program in the residential sector. Homes primarily heated by fossil fuels are eligible for a rebate on the installation on electrification technology.								
Newfoundland and Labrador energy efficiency support – public buildings	Buildings	CH_4, CO_2, N_2O	Support energy efficiency in public buildings, such as office buildings, schools, medical facilities and post secondary institutes	Fiscal	Implemented	2019	Newfoundland and Labrador	NE[h]	16.80
Brief Description	Newfoundland and Labrador delivers a program to enhance efficiency in the public sector through the Low Carbon Economy Leadership Fund. Given that electricity will be largely emissions-free after 2019, GHG reductions will accrue from fuel-oil heated buildings.								
Newfoundland and Labrador energy efficiency support – residential homes	Buildings	CH_4, CO_2, N_2O	Support residential energy efficiency	Fiscal	Implemented	2019	Newfoundland and Labrador	NE[h]	4.70

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Newfoundland and Labrador, including through the electrical utilities, delivers a range of programs to enhance efficiency in the residential sector through the Low Carbon Economy Leadership Fund. Given that electricity will be largely emissions-free after 2019, GHG reductions will accrue from fuel-oil heated homes and in off-grid communities.								
Government of Yukon Building Retrofits	Buildings	CH_4, CO_2, N_2O	Reduce energy use and GHGs	Regulatory	Implemented	2020	Yukon	NA[b]	8.00
Brief Description	Conduct retrofits to Government of Yukon buildings to reduce energy use and contribute to a 30% reduction in GHG emissions by 2030. Continue to require all new Government of Yukon buildings to be designed to use 35% less energy than the targets in the National Energy Code for Buildings, in accordance with the Government of Yukon's Design Requirements and Building Standards Manual. Install renewable electricity generation systems in 5 Government of Yukon buildings in off-grid locations by 2025 to reduce reliance on diesel-generated electricity.								
Yukon Good Energy Rebates	Buildings	CH_4, CO_2, N_2O	Reduce diesel consumption for electricity and heat generation	Economic	Implemented	2020	Yukon	1.00	16.00
Brief Description	The Government of Yukon's Good Energy Rebate program which provides rebates for energy-efficient choices, including household appliances, products, services and heating systems, retrofits or upgrades to buildings and homes, purchasing clean transportation vehicles, and generating electricity from renewable energy sources.								
Arctic Energy Alliance's Enhanced Programs and Services (Low Carbon Economy Leadership Fund (LCELF) funded)	Buildings	CO_2	Enhanced support for energy efficient initiatives	Fiscal	Implemented	2018	Arctic Energy Alliance	0.80	7.50

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								2020	2030
Brief Description	The Northwest Territories, with support from Environment and Climate Change Canada, has provided enhanced funding opportunities for some of the existing programs and services offered through Arctic Energy Alliance in addition to new programs such as; Low Income Energy Assistance; Deep Home Energy Retrofits; Energy Efficiency Rebates for NGOs; Electric Heat Incentives; Wood Stove Programs; Community Energy Planning Implementation.								
Arctic Energy Alliance's Rebate Programs	Buildings	CO_2	Support energy and water efficient technologies	Economic	Implemented	2007	Arctic Energy Alliance	0.50	NE[h]
Brief Description	The Northwest Territories has several publicly available building efficiency programs including: the Energy Efficiency Incentive Program (2007) that provides rebates for energy efficient appliances, residential retrofits, and new homes; the Alternative Technologies Program (2007) to support Indigenous and community governments, non-profit organizations, commercial businesses, and residents to convert to renewable and clean energies; and the Commercial Energy Conservation and Efficiency Program (2011) that enables eligible small businesses to receive free energy audits and rebates on the cost of retrofit expenses.								
Capital Asset Retrofit Fund	Buildings	CO_2	Improve energy conservation and reduce GHG emissions and operational cost in territorial-owned building and assets	Economic	Implemented	2007	Northwest Territories	2.00	1.50
Brief Description	The Northwest Territories has initiated the Capital Asset Retrofit Fund to improve building efficiency for territorial owned assets through energy audits, building surveys and energy benchmarking.								
Nunavut Energy Management Program	Buildings	CO_2	Reduction of fossil fuel consumption	Voluntary Agreement	Implemented	2007	Nunavut	2.14	23.78
Brief Description	Initiated in 2007, the Nunavut Energy Management Program is a Government of Nunavut program led by the Department of Community and Government Services. It involves implementing energy retrofits on GN-owned buildings. The objectives are: to reduce by 20% water, fuel and electricity consumption by retrofitting existing Government of Nunavut owned facilities territory wide; to reduce GHG emissions by substituting diesel generated energy with renewables where feasible; and to explore new energy efficient building technologies. This program is currently targeting the South Baffin and North Baffin regions and has received funding from the Low Carbon Economy Fund.								

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								2020	2030
Nunavut Housing Corporation's Accelerated Modernization and Improvement Project	Buildings	CO_2	Reduction of fossil fuel consumption	Economic	Implemented	2018	Nunavut	2.04	20.43
Brief Description	The Nunavut Housing Corporation's Accelerated Modernization and Improvement Project received funding from the Government of Canada's Low Carbon Economy Fund in fall 2018 to oversee energy efficiency upgrades and retrofits to public housing units. Housing retrofits will include window and door replacements (Target 1) as well as hot water heater replacement (Target 2) and furnace/boiler replacements (Target 3). To kick-off this project, a master list of units which could benefit from upgrades was created out of 9/25 communities in Nunavut. These communities are Kugluktuk, Taloyoak, Baker Lake, Coral Harbour, Rankin Inlet, Sanikiluaq, Hall Beach, Igloolik, Iqaluit. From this list, specific units for 2019 have been selected in Iqaluit, Coral Harbour and Rankin Inlet. Contracts have been issued and work is expected to begin fall 2019 upon arrival of the sealift to the community.								
Renewable Energy Cabin Grant Program	Buildings	CO_2	Increase renewable energy use	Economic	Implemented	2021	Nunavut	NA[b]	NE[h]
Brief Description	The Department of Environment's Climate Change Secretariat provides funding for cabin owners in Nunavut to help offset the cost of installing a renewable energy system on their cabin. This funding is provided in the form of a one-time non-repayable grant.								
Renewable Energy Homeowner Grant Program	Buildings	CO_2	Increase renewable energy use	Economic	Implemented	2021	Nunavut	NA[b]	NE[h]
Brief Description	In partnership with the Climate Change Secretariat (CCS), the Nunavut Housing Corporation (NHC) provides funding for homeowners in Nunavut to help offset the cost of installing a renewable energy system on their house. Homeowners are eligible for a non-repayable grant of up to 50% of total project costs, up to a maximum of $30,000.								

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								2020	2030
HEAVY INDUSTRY									
Fuel Charge Proceeds Return Program**	Heavy Industry	CO_2	Economic support for emissions-intensive, trade-exposed small and medium-sized enterprises	Economic	Planned	2023	Environment and Climate Change Canada	NA[b]	NA[d]
Brief Description	In 2019–20 and 2020–21, the Government of Canada returned a portion of the 2019–2020 federal fuel charge proceeds through federal programming, including the Climate Action Incentive Fund (CAIF). As announced in Budget 2022, Environment and Climate Change Canada will deliver programming to return an estimated $1.6 billion in fuel charge proceeds collected between 2020–21 and 2022–23, as well as the outstanding 2019–20 fuel charge proceeds not returned through CAIF. Proceeds will be returned as direct payments to emissions-intensive trade-exposed small and medium-sized enterprises in jurisdictions where the federal fuel charge applies: Alberta, Saskatchewan, Manitoba, and Ontario. Environment and Climate Change Canada expects to begin returning fuel charge proceeds to small and medium-sized enterprises in 2023. Further programming information will be available in due course.								
Innovation Superclusters Initiative	Heavy Industry	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Support expansion of climate innovation	Fiscal	Adopted	2022	Innovation, Science and Economic Development Canada	NA[b]	NA[d]
Brief Description	Support the further growth and development of Canada's Global Innovation Clusters. Building on their success to date, these clusters will expand their national presence and will collaborate to deepen their impact, including through joint missions aligned with key government priorities, such as fighting climate change and addressing supply chain disruptions.								
Support the development of critical mineral value chains**	Heavy Industry	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Support the development of critical minerals to grow domestic and global value chains for the green and digital economy	Fiscal	Adopted	2023	Innovation, Science and Economic Development Canada	NA[b]	NE[g]

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								2020	2030
Brief Description	Budget 2022 announced $1.5 billion funding ($500 million from existing funds and $1 billion in new funds) to support the development of critical minerals value chains through SIF, with a focus on critical minerals manufacturing, processing and recycling applications.								
Canadian CCUS Strategy	Heavy Industry	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Mitigate GHG emissions from industrial sector	Information	Adopted	2022	Natural Resources Canada	NA[b]	NE[e]
Brief Description	Develop a comprehensive CCUS Strategy to guide the development of CCUS technologies to mitigate GHG emissions from a range of industrial sectors in Canada, such as steel, cement, chemicals, and the oil and gas sector. Emission reduction targets will be announced as part of the release of the strategy.								
Centre of Excellence on Critical Minerals	Heavy Industry	CO_2	Support development of critical minerals	Fiscal	Adopted	2024	Natural Resources Canada	NA[b]	NA[d]
Brief Description	Renewal of Canada's Centre of Excellence on Critical Minerals, which collaborates with provincial, territorial, and other partners, and provides direct assistance to help developers of critical minerals navigate regulatory processes and existing support measures.								
Green Industrial Facilities and Manufacturing Program	Heavy Industry	CO_2	Support energy-efficiency retrofits	Fiscal, Education	Adopted	2022	Natural Resources Canada	NA[b]	NA[d]
Brief Description	$194 million to expand the existing Industrial Energy Management Program to support ISO 50001 certification, energy managers, cohort-based training, audits, and energy efficiency-focused retrofits for key small-to-moderate projects that fill a gap in the federal suite of industrial programming.								
Industrial Energy Management Program*	Heavy Industry	CO_2	Improve industrial energy efficiency in Canada	Fiscal, Voluntary Agreement, Information, Education	Implemented	2016	Natural Resources Canada	1,100.00	6,700.00
Brief Description	This program promotes energy management practices in the industrial sector. This includes financial support for certification to the ISO50001 standard and other industrial energy management approaches, as well as capacity building programs such as ENERGY STAR for Industry (certification and challenge) and the Canada Industry Partnership for Energy Conservation (CIPEC) network.								

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Promoting Sustainable Mining Extraction and Processing	Heavy Industry	CO_2	Support development of critical minerals	Research	Adopted	2022	Natural Resources Canada	NA[b]	NA[d]
Brief Description	Support research, development, and the deployment of technologies and materials to support critical mineral value chains.								
Public access to critical mineral exploration and development data	Heavy Industry	CO_2	Support the development of critical minerals	Research, Information	Adopted	2022	Natural Resources Canada	NA[b]	NA[d]
Brief Description	Provide public access to integrated data sets to inform critical mineral exploration and development.								
BC Centre for Innovation and Clean Energy	Heavy Industry	CH_4, CO_2	Reduce emissions from industry	Research	Implemented	2021	British Columbia	NA[b]	NE[h]
Brief Description	In partnership with Canada, BC is establishing the Centre for Innovation and Clean Energy which will focus on: Carbon Capture Utilization and Storage; production, use and distribution of low carbon hydrogen; biofuels and synthetic fuels; renewable natural gas; and battery technology, storage and energy management systems.								
British Columbia CleanBC Program for Industry	Heavy Industry	CH_4, CO_2, N_2O	Reduce GHG emissions from industry	Economic	Implemented	2019	British Columbia	NE	2,400.00

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								2020	2030
Brief Description	CleanBC Program for Industry provides incentives to industrial operations that meet world-leading low-carbon emissions benchmarks in different sectors and invests in GHG-reducing projects and increases opportunities for innovative clean technologies. British Columbia will direct a portion of BC's carbon tax paid by industry into incentives for cleaner operations, such as transmission grids and access to low carbon fuels. Eligibility is based on a facility's performance against a world-leading benchmark.								
Sectoral emissions target – Industry	Heavy Industry	CO_2	Reduce emissions from industry	Regulatory	Implemented	2021	British Columbia	NA[b]	NE[h]
Brief Description	Industry sectoral target of a reduction of 38-43% of 2007 emissions by 2030.								
Industrial Electrification	Heavy Industry	CO_2	Reduce GHG emissions from industry	Economic	Implemented	2021	British Columbia, BC Hydro	NA[b]	NE[h]
Brief Description	In 2021, BC directed $84.4 million from the Government of Canada's Investing in Canada Infrastructure Program (ICIP) to create the CleanBC Facilities Electrification Fund. The fund provides support to customers to reduce the costs of connecting to the electricity grid or upgrading their connections to use more electricity and reduce air pollution. The province and BC Hydro are providing a 20% discount from standard industrial electricity rates for new and existing industrial customers who power their operations with clean electricity. The discounted rates apply to new clean industries setting up or expanding operations in BC (including hydrogen and biofuels); eligible existing customers that install new equipment that uses electricity rather than fossil fuels; and eligible new customers that can demonstrate they could have used fossil fuels rather than electricity to power their facilities.								
Alberta's Hydrogen Roadmap	Heavy Industry	CH_4, CO_2	Increase use of clean hydrogen	Economic, Fiscal, Voluntary Agreement	Implemented	2021	Alberta	NA[b]	6,000.00 – 14,000.00
Brief Description	Alberta's Hydrogen Roadmap outlines a strategy to develop an integrated hydrogen economy and create low-carbon hydrogen for domestic use and export to global markets. Increased usage of clean hydrogen can have a significant impact on emissions in a number of sectors, including industrial processes, commercial and residential heating, power generation and transportation. Alberta's Hydrogen Roadmap outlines the enormous opportunity for government, industry and municipalities to grow Alberta's hydrogen sector and position the province as an international leader in clean hydrogen.								

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Clean Hydrogen Centre of Excellence	Heavy Industry	CH_4, CO_2	Increase use of clean hydrogen	Economic	Implemented	2022	Alberta	NA[b]	NE[h]
Brief Description	The Alberta government will invest $50 million to create the new centre, which will drive innovation in the production, deployment and use of hydrogen across the economy. The centre is a pillar in Alberta's Hydrogen Roadmap, which lays out the path to growing the provincial hydrogen economy and accessing global markets.								
Renewing Alberta's Mineral Future	Heavy Industry	CO_2	Sustainably expand Alberta's minerals industry to meet the demands of the electrifying economy	Economic, Regulatory	Implemented	2021	Alberta	NA[b]	NE[h]
Brief Description	Renewing Alberta's Mineral Future sets a framework to capitalize on Alberta's vast mineral resources, and to expand the minerals industry in a sustainable way to meet the demands of an electrifying economy. As the first step toward implementation of the Minerals Strategy and Action Plan, the Government of Alberta passed Bill 82: the *Mineral Resource Development Act* in December 2021 to improve the regulatory environment and promote responsible mineral resource development.								
Hydrogen Strategy for Ontario	Heavy Industry	CH_4, CO_2, N_2O	Support development and use of hydrogen fuel in Ontario	Information, Regulatory, Research	Adopted	2022	Ontario	NA[b]	NE[h]
Brief Description	Ontario's hydrogen strategy aims to leverage electricity for hydrogen production, electric vehicle charging and energy storage; and create local jobs and attract investment while reducing GHG emissions.								

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								2020	2030
Ontario *Greenhouse Gas Emissions Performance Standards Regulation** [3]	Heavy Industry	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduce GHG emissions from large industrial emitters	Regulatory	Implemented	2022	Ontario	NA[b]	5,350.00
Brief Description	Ontario's Emissions Performance Standards (EPS) program sets GHG emission limits for large industrial facilities. The program was developed as an alternative to the federal output-based pricing system (OBPS) and helps Ontario achieve GHG emissions reductions. The EPS program came into full effect on January 1, 2022. Ontario intends to consult in summer 2022 on a proposal for the EPS program for the 2023-2030 period, to be finalized by end of 2022. The emissions reductions estimates include reductions associated with Ontario's *Cleaner Transportation Fuels Regulation*.								
Supporting the development of geologic carbon storage	Heavy Industry	CO_2	Support development of geologic carbon storage in Ontario	Regulatory	Planned	TBD	Ontario	NA[b]	NE[h]
Brief Description	Ontario is developing a discussion paper on geologic carbon storage that explores legislative amendments to support the development of innovative technology in Ontario, including carbon storage.								
Ontario Regulatory Changes and Investments for Reducing Coal Use in Energy-Intensive Industries	Heavy Industry	CO_2	Reduce GHG emissions, and coal and petroleum coke use	Regulatory, Fiscal	Implemented	2015	Ontario, Innovation, Science and Economic Development Canada	NE[h]	5,100.00

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								2020	2030
Brief Description	Regulatory changes have been developed for major-emitting industrial sectors (including cement, lime and iron and steel manufacturers) that would help facilities use alternative, less carbon intensive fuels (such as biomass and waste materials) in place of coal and petroleum coke, and stay competitive with other jurisdictions that similarly allow the use of alternative fuel. To support the phase out of the industrial use of coal, Ontario has taken action to provide clean, reliable and affordable electricity to secure a landmark investment from Algoma Steel to transition from coal to all-new low-emission electric arc furnaces in Sault Ste Marie. In addition, Ontario has made a landmark investment to transform the ArcelorMittal Dofasco steel mill in Hamilton from coal-fed furnaces to new, low-emission direct reduction and electric arc furnace technology. These investments will help to sustain good paying jobs and anchor the Ontario auto industry for generations to come while also reducing emissions.								
Supporting industrial energy conversion projects	Heavy Industry	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	Reduced emissions from industrial emitters	Economic	Implemented	2021	Québec	NA[b]	NE[i]
Brief Description	Québec is providing funding to cover the operating costs of industrial projects undergoing conversion to electrification and/or low carbon energy sources. Many new programs have been put in place to more efficiently support the overall industrial sector, mainly the following programs: MADI, Défi GES, GIGES, etc.								
GHG Reporting and Management Requirements	Heavy Industry	CH_4, CO_2, HFCs, N_2O, NF_3, PFCs, SF_6	GHG reporting and Management Requirements	Regulatory	Implemented	2017, 2019	New Brunswick	150.00	NE[h]
Brief Description	In 2017, the provincial government amended Operating Approvals for industrial facilities that emit at least 10,000 tonnes of GHG emissions per year, requiring that they report their GHG emissions. Also extended the GHG management requirements for those facilities that emit at least 25,000 tonnes of GHGs per year. The Approvals amendments were completed in 2019.								
Mining Industry Emissions Target	Heavy Industry	CH_4, CO_2, N_2O	Reduce sectoral GHG emissions	Regulatory	Planned	TBD	Yukon	NA[b]	NE[h]
Brief Description	Establish an intensity-based GHG reduction target for Yukon's mining industry in 2022, as well as additional actions needed to reach the target Require quartz mines to project their anticipated GHG emissions, identify measures to reduce emissions, and annually report GHG emissions through the quartz mine licensing process beginning in 2022.								

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								2020	2030
WASTE									
Federal landfill methane regulations**	Waste	CH_4	Reduce methane emissions from landfills	Regulatory	Planned	TBD	Environment and Climate Change Canada	NA[b]	NE[h]
Brief Description	The Government of Canada is developing new regulations to increase the number of landfills that collect and treat methane. Consultations on the development of the regulations began in early 2022. Draft regulations are anticipated to be published in Canada Gazette Part 1 for public comment in 2024.								
BC Organics Infrastructure Program*	Waste	CH_4	Reduce GHG emissions from waste	Fiscal	Implemented	2019	British Columbia	NE[h]	NE[h]
Brief Description	Organic Infrastructure Program (co-funded by Low Carbon Economy Leadership Fund) keeps organic waste out of landfills by investing $10 million provincially, and $30 million in total.								
British Columbia *Landfill Gas Management Regulation**	Waste	CH_4	Increase methane capture rate at landfills	Regulatory	Implemented	2009	British Columbia	NE[h]	860.00
Brief Description	Under the regulation, regulated landfill sites (landfills that have over 100,000 tonnes of waste in place or receive more than 10,000 tonnes of municipal solid waste in any year after 2008) are required to conduct landfill gas assessments. If the assessment conducted in accordance with the regulation estimates a landfill will generate more than 1000 tonnes of methane in a calendar year, then they must install and operate a landfill gas collection and destruction system. The initial series of landfill gas assessments took place in 2011 with the requirement of a performance standard of 75% capture being in place by 2016. A new series of landfill gas assessments took place in 2016 with the same requirement being required for 2021. Reduction estimates are based on modelling of likely impact of the regulatory approach, allowing for variances in the performance of the technologic solutions applied to meet the standard. CleanBC commits the province to helping communities achieve 95% organic waste diversion, including systems in place to capture 75% of landfill gas. The province will also pursue efforts to make better use of waste, including bioenergy and biofuels.								

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								2020	2030
CleanBC Organics Infrastructure and Collection Program*	Waste	CH_4	Improve organic waste collection and processing	Fiscal	Implemented	2021	British Columbia	NA[b]	NE[h]
Brief Description	CleanBC Organic Infrastructure and Collection Program is investing up to $25.9 million of provincial funds in new, or expanded, organic waste processing infrastructure, and residential organic waste collection programs. Recipients contribute $12.95 million for a total of $38.85 million investment.								
CleanBC Plastics Action Plan	Waste	CH_4, CO_2	Improve plastics recycling and biogas capture	Fiscal, Regulatory	Implemented	2021	British Columbia	NA[b]	NE[h]
Brief Description	CleanBC Plastics Action Plan released and implemented; examples of actions include shoreline clean-up and changes to recycling regulations. Support for biogas capture to support renewable fuel development. Engagement on new proposed regulations and actions has concluded. New regulations to be drafted in fall/winter 2022/2023. BC's Budget 2022 invests an additional $10 million in the CleanBC Plastics Action Fund to support more BC-based innovations to reduce the use of plastic and make better use of recycled plastic.								
Management of Wastewater Biosolids	Waste	CH_4, CO_2, N_2O	Improve use of biosolids	Research, Regulatory	Implemented	2012	British Columbia	NE[h]	NE[h]
Brief Description	Continued support for land application and beneficial use of biosolids in alignment with the Canadian Council of Ministers of the Environment Canada-Wide Approach for the Management of Wastewater Biosolids.								
Saskatchewan Solid Waste Management Strategy*	Waste	CH_4, CO_2	Reduce emissions from municipal waste	Voluntary Agreement	Implemented	2020	Saskatchewan	NE[h]	NE[h]
Brief Description	Work with clients to identify and advance offset projects in support of Prairie Resilience. Eligible projects may include waste management practices that go beyond business-as-usual activities or regulatory requirements, such as: regionalized waste facilities with methane capture; organic composting programs; incinerated-waste-to-energy projects; and afforestation at closed landfills.								

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Manitoba Waste Diversion	Waste	CO_2	Divert food and organic waste from landfills	Information	Planned	TBD	Manitoba	NA[b]	NE[h]
Brief Description	Manitoba is working to modernize its waste diversion and recycling framework, including the exploration of policy options to reduce the landfilling of food and organic waste through prevention, recovery, and recycling.								
Ontario *Landfill Gas Collection and Control Regulation**	Waste	CH_4	Reduce emissions from the waste sector	Regulatory	Implemented	2008	Ontario	1,800.00	2,000.00
Brief Description	Ontario regulations require large landfills to collect and report on the use or destruction of landfill gas.								
Ontario's Food and Organic Waste Framework*	Waste	CH_4, CO_2	Strategy for a zero waste future with zero GHG emissions from the waste sector	Fiscal	Implemented	2018	Ontario	NE[h]	970.00
Brief Description	Ontario's plan to reduce food waste and recover resources from food and organic waste; and reduce GHG emissions from the waste sector.								
Québec Processing organic matter using biomethane and composting Program	Waste	CH_4, CO_2, N_2O	Reduce emissions in the waste sector	Economic	Implemented	2009	Québec	80.00	NE[h]
Brief Description	This program provides financial support to municipalities and the private sector for the development of facilities to process organic matter. The program aims to reduce the amount of organic matter and thus reduce GHG emissions. The program has been extended until 2022.								

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								2020	2030
Québec Residual Materials Management Policy*	Waste	CH_4, CO_2, N_2O, Other (Halocarbons)	Reduce emissions from the waste sector; reduce halocarbon emissions	Regulatory, Economic, Information	Implemented	2011	Québec	NE[h]	NE[h]
Brief Description	Québec's policy on residual waste management is aimed at creating a waste-free society that maximizes value added through sound management of Québec's residual waste, and the policy's underlying objective is to ensure that only residual waste disposed of in Québec is final waste. To help achieve this objective, the policy sets out the implementation of measures for addressing three major residual waste management issues: stop wasting resources; help achieve the objectives of Québec's action plan on climate change and energy strategy; and empower all those concerned by residual waste management. The policy is still in effect. The 2019–2024 action plan was released early 2020.								
Québec Royalties (Regular and Extra) for Residual Material Disposal	Waste	CH_4, CO_2, N_2O	Reduce emissions from the waste sector	Regulatory	Implemented	2006	Québec	NE[h]	NE[h]
Brief Description	Royalties on residual material disposal were implemented in 2006 and 2010 to reduce the quantities of eliminated residual material and also to increase the lifespan of disposal sites. The royalties also fund the preparation, implementation and revision of residual material management plans as well as the measures arising from the Québec Policy on Residual Waste Management (Politique québécoise de gestion des matières résiduelles) and the Biomethanization and compost treatment program for organic material (Programme de traitement des matières organiques par biométhanisation et compostage).								
Québec Stratégie de valorisation de la matière organique	Waste	CH_4, CO_2, N_2O	Reduce emissions in the waste sector	Regulatory, Economic, Information	Implemented	2020	Québec	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	In 2020 Québec released its Stratégie de valorisation de la matière organique which aims to: • Offer organic matter collection to all Québec's citizens by 2025; • Manage organic matter in all industrial, commercial and institutional buildings by 2025; • Recycle or value 70% of targeted organic matter in 2030; and, • Reduce 270 kt CO_2 eq per year by 2030. The 2022–2027 Implementation Plan allocated $50 million for the construction of compost and bio-methane facilities.								
New Brunswick Landfill Gas Management*	Waste	CH_4	Increase methane capture rate at regional landfills	Voluntary Agreement	Implemented	2014	New Brunswick	340.00	340.00
Brief Description	All six regional landfills have installed approved landfill gas capture systems. Five of the six landfills are generating electricity from the biogas. This 2014–2020 voluntary agreement is implemented by New Brunswick and the Landfill Commissions.								
Nova Scotia *Solid Waste Resources Management Regulations**	Waste	CH_4, CO_2	Increase the rate of waste diversion from landfills in Nova Scotia	Regulatory	Implemented	1996	Nova Scotia	NE[h]	NE[h]
Brief Description	Implemented in 1996, this regulation resulted in Nova Scotia having the highest waste diversion rate in Canada and includes a ban on organics entering landfills in Nova Scotia. Currently 59% of Nova Scotia's source separated organic wastes are diverted from all second generation landfills to composting or grid connected anaerobic digestors, converting the potential methane from these organics to CO_2 emissions (25 times lower global warming potential).								
Prince Edward Island Waste Watch*	Waste	CH_4	Reduce methane generation from landfill	Voluntary Agreement	Implemented	2002	Prince Edward Island	NE[h]	NE[h]
Brief Description	Prince Edward Island is a national leader in sustainable waste management practices through its innovative Waste Watch program. It offers a curbside three source separation system (waste, compost, and recyclables) to all residents. The Waste Watch program was launched province-wide in 2002 by the Island Waste Management Corporation, a provincial crown corporation. The program successfully diverts as much as 65% of waste produced by Islanders from disposal in landfill. Compostable waste is diverted to a central compost facility. PEI keeps more waste out of landfills—per person—than anywhere else in Canada due to the province's recycling and composting programs via the Island Waste Management Corporation.								

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Newfoundland and Labrador measures to reduce emissions from waste*	Waste	CH_4	Reduce methane generation from landfill	Regulatory	Implemented	2002	Newfoundland and Labrador	NE[h]	NE[h]
Brief Description	Includes measures to reduce landfill volumes, increase composting, destroy methane and allow for biogas electricity generation.								
AGRICULTURE									
Agricultural Clean Technology Program	Agriculture	CH_4, CO_2, N_2O	Support the development and adoption of clean technology to reduce GHG emissions and enhance competitiveness of the sector	Fiscal, Research	Implemented	2021	Agriculture and Agri-Food Canada	NA[b]	NE[h]
Brief Description	The Agricultural Clean Technology Program ($165.7 million, 2021–2028) provides farmers and agri-businesses with access to funding to help develop and adopt the latest clean technologies to reduce GHG emissions and enhance their competitiveness. An additional $330 million investment was provided in Budget 2022 to expand the existing program, tripling the support for innovation and the development and adoption of clean technologies in the agricultural sector.								
Agricultural Climate Solutions: Living Labs**	Agriculture	CH_4, CO_2, N_2O	Co-develop and test beneficial management practices that sequester carbon and/or reduce GHG emissions on farms	Research	Implemented	2021	Agriculture and Agri-Food Canada	NA[b]	200.00 – 1,780.00

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The Agricultural Climate Solutions: Living Labs Program ($185 million, 2021–2031) aims to establish a strong, Canada-wide network of living labs. Through these living labs, regional leaders will bring together farmers, scientists, and other sector partners to co-develop, test and monitor beneficial management practices on farms to sequester carbon and/or mitigate GHG emissions and enhance climate resiliency.								
Agricultural Climate Solutions: On-Farm Climate Action Fund**	Agriculture	CH_4, CO_2, N_2O	Increase carbon sequestration and reduce GHG emissions from the primary agriculture sector	Fiscal	Implemented	2021	Agriculture and Agri-Food Canada	NA[b]	4,190.00 (by 2028)
Brief Description	The Agricultural Climate Solutions: On-Farm Climate Action Fund ($200 million, 2021–2024) aims to support farmers in adopting beneficial management practices that store carbon and reduce GHGs in three areas: nitrogen management, cover cropping and rotational grazing practices. An additional $470 million investment was provided in Budget 2022 to expand the program. This funding will allow the program to top-up funding for some current successful applicants, broaden support to additional key climate mitigation practices, extend the program past its current end date of 2023–24, and support adoption of practices that contribute to the fertilizer emissions target and Global Methane Pledge.								
Agricultural Greenhouse Gases Program	Agriculture	CH_4, CO_2, N_2O	Support research on GHG mitigation and make new mitigation technologies available to farmers	Research	Implemented	2010	Agriculture and Agri-Food Canada	NA[d]	NA[d]
Brief Description	The Agricultural Greenhouse Gases Program supported innovative research projects that developed technologies, practices and processes that can be adopted by farmers to mitigate GHG emissions. A first phase of the program ran from 2010–2015 ($27 million) and the second phase of the program (2016–2021), extended Canada's commitment to support the objectives of the Global Research Alliance on Agricultural Greenhouse Gases. This $27 million five year commitment funded twenty projects to create technologies, practices and processes that can mitigate additional GHG emissions. Most projects were led by Canadian universities across the country and fell under one or more of the following four priority areas: livestock systems, cropping systems, agricultural water use efficiency, and agroforestry. The program ended in 2021.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Canadian Agricultural Partnership Federal-Only Program: AgriInnovate	Agriculture	CH_4, CO_2, N_2O	Support the development, commercialization, and adoption of innovative technologies in the agriculture and agri-food sector, including those that could reduce GHG emissions from the agricultural sector	Research	Implemented	2018	Agriculture and Agri-Food Canada	NA[d]	NA[d]
Brief Description	The AgriInnovate program (2018–2023) aims to accelerate the commercialization, adoption and/or demonstration of innovative products, technologies, processes or services that increase sector competitiveness and sustainability. Priority areas for AgriInnovate under the current Canadian Agricultural Partnership include: adoption of new or world-leading clean technology, including precision agriculture; and increased productivity through advanced manufacturing, automation or robotics.								
Canadian Agricultural Partnership Federal-Only Program: AgriScience	Agriculture	CH_4, CO_2, N_2O	Support research on GHG mitigation and make new mitigation technologies available to farmers	Research	Implemented	2018	Agriculture and Agri-Food Canada	NA[d]	NA[d]
Brief Description	The AgriScience program (2018–2023) aims to accelerate the pace of innovation by providing funding and support for pre-commercial science activities and cutting-edge research that benefits the agriculture and agri-food sector and Canadians. One of the priority areas under AgriScience is to enhance efforts in clean growth, environment and climate change, such as: addressing environmental challenges and adaptation to changing climate; agricultural impacts on air, water and soil; reducing GHG emissions; transforming agricultural products into biofuels; and water management and soil management.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Fertilizer (30% reduction from 2020 levels)**	Agriculture	N_2O	Reduce emissions from fertilizer	Information, Voluntary Agreement	Adopted	2022	Agriculture and Agri-Food Canada	NA[b]	NE[h]
Brief Description	30% reduction in N_2O emissions from fertilizer from 2020 levels, by 2030.								
Transformative Science for Agriculture in a Net-Zero Economy	Agriculture	CH_4, CO_2, N_2O	Reduce GHG emissions from the agriculture sector	Research	Adopted	2023	Agriculture and Agri-Food Canada, Federal granting councils (NSERC, SSHRC)	NA[b]	NE[g]
Brief Description	$100 million to the federal granting councils to support the sector's role in the transition to a net-zero economy for 2050, including fundamental and applied research, knowledge transfer, and developing metrics.								
Canadian Agricultural Partnership**	Agriculture	CH_4, CO_2, N_2O	Reduce GHG emissions from the agricultural sector	Education, Fiscal	Implemented	2018	Agriculture and Agri-Food Canada, Provincial and territorial governments	NA[d]	NA[d]
Brief Description	The Canadian Agricultural Partnership, launched April 1, 2018, is a five-year, $3 billion investment by federal, provincial and territorial governments to strengthen the agriculture and agri-food sector. Through the Partnership, provinces and territories design and manage delivery of cost-shared environmental stewardship programs to support Environmental Farm Plans and adoption of best management practices such as cover crops, precision nutrient application, equipment for reduced tillage seeding and enhanced irrigation efficiency.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Sustainable Canadian Agricultural Partnership**	Agriculture	CH_4, CO_2, N_2O	Tackling climate change and environmental protection to support GHG emission reductions and the long-term vitality of the sector while positioning producers and processors to seize economic opportunities from evolving consumer demands	Fiscal	Adopted	2023	Agriculture and Agri-Food Canada, Provincial and territorial governments	NA[b]	3,500.00
Brief Description	The Sustainable Canadian Agricultural Partnership (S-CAP), a new five-year partnership with federal, provincial and territorial governments to strengthen the agriculture and agri-food sector, is planned for April 2023. Climate Change and Environment is one of the five priorities identified for the S-CAP. Through the S-CAP, provinces and territories will design and manage delivery of cost-shared programs. Climate Change and Environment focus areas for the S-CAP include: • Prepare for and respond to a changing climate by supporting Beneficial Management Practices and accelerating technological adoption; • Reduce GHG emissions and improve carbon sequestration; • Protect and regenerate soil, water and air quality; and, • Improve biodiversity and protect sensitive habitats. S-CAP will include the $250 million Resilient Agricultural Landscapes Program, to support ecological goods and services provided by the agriculture sector.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Agricultural Clean Technology and Adaptation Initiatives**	Agriculture	CO_2	Reduce GHG emissions from the agricultural sector and support the sector's adaptation to climate change	Economic	Implemented	2021	British Columbia	NA[b]	700.00
Brief Description	As part of the Roadmap, the province will continue to support the transition to technologies and practices that reduce both net GHG emissions and operating costs for producers. This includes encouraging fuel switching and electrification to reduce emissions from equipment in agriculture, aquaculture and fisheries, along with increased efficiency in manure and nutrient management. BC is encouraging the development and piloting of new clean solutions such as electric tractors and technologies to further improve energy efficiency in greenhouses. BC's Climate Preparedness and Adaptation Strategy includes several measures to help the agricultural sector adapt. These include the Extreme Weather Preparedness for Agriculture program and the Agricultural Water Infrastructure program, as well as enhancing the existing Agricultural Weather Monitoring Network.								
British Columbia Nutrient Management Program	Agriculture	N_2O	Reduce GHG emissions from the agricultural sector	Education, Research	Implemented	2015	British Columbia	NE[h]	NE[h]
Brief Description	The Nutrient Management Program promotes the right amount, form, placement, and timing of fertilizers and manure to optimize crop growth and minimize the environmental impacts of nutrient application, including GHG emissions and nitrate leaching into ground water. This program includes: expanding trials to develop and demonstrate nutrient management best practices to the agriculture industry; increasing funding to the sector to implement beneficial management practices that promote better nutrient management and further reductions in GHG emissions; and nutrient management planning to help producers improve nutrient applications and meet new environmental regulations under the new Agricultural Environmental Management Code of Practice.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Canadian Agricultural Partnership • **Farm Stewardship Program** • **Irrigation Program**	Agriculture	CH_4, CO_2, N_2O	Reduce emissions from agriculture	Fiscal	Implemented	2018	Saskatchewan	NE[h]	NE[h]
Brief Description	Provides Saskatchewan producers with government cost share funding for the implementation of the following practices: • Livestock Stewardship – Manure Management; • Permanent Tame Forage; • Permanent Native Forage; • Native Rangeland Grazing Management; • Drainage Stewardship and Multi Producer Water Management (helps facilitate WSA Agriculture Water Management Strategy; and, • Irrigation Environmental Efficiency Program (fuel conversion, fertigation).								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Saskatchewan Agriculture Water Management Strategy	Agriculture	N_2O	The program supports responsible and sustainable agricultural water management practices that protect the environment, including to reduce direct nitrous oxide (N_2O) emissions from agricultural runoff and enhance carbon sequestration by conserving wetland habitats	Regulatory	Implemented	2018	Saskatchewan	NE[h]	NE[h]
Brief Description	Saskatchewan's agricultural water management framework assures continued productivity, enhances wetland habitat conservation and improves runoff management during extreme weather events such as droughts and floods. Saskatchewan provided 10 watershed and community groups $922,250 to assist in 11 agricultural water management demonstration projects. They are testing innovative water management solutions that will inform a new mitigation policy, which will include a wetlands competent. Wetlands are natural carbon sinks; this strategy helps preserve these sinks and prevents stored GHGs from entering the atmosphere. Similarly, responsible agricultural water management, specifically agricultural drainage, can facilitate efficient application of nitrogen-based fertilizers and reduce the amount of fertilizer that is lost to the atmosphere as N_2O due to volatilization.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Manitoba 4R Nutrient Stewardship System	Agriculture	N_2O	Reduce N_2O emissions and provide co-benefits (e.g., water quality)	Voluntary Agreement	Implemented	2018	Manitoba	NE[h]	NE[h]
Brief Description	The Government of Manitoba, Fertilizer Canada and Keystone Agricultural Producers have renewed their partnership in promoting 4R Nutrient Stewardship as the overarching approach to sustainable use of fertilizers in crop production. The Memorandum of Understanding links the Government of Manitoba's objectives for water quality protection and GHG emissions reduction with the sustainability programming developed by Canada's fertilizer industry.								
On-Farm Best Management Practices	Agriculture	CH_4, CO_2, N_2O	Improved GHG management	Fiscal	Implemented	2016	New Brunswick	0.50	50.00
Brief Description	New Brunswick financially supports the adoption of on-farm beneficial management practices focusing on precision farming, nutrient management and renewable energy systems in New Brunswick farms.								
Biological Nitrogen Availability Trials	Agriculture	N_2O	Reduce GHG emissions	Research	Implemented	2021	Prince Edward Island	NA[b]	NE[h]
Brief Description	Trial-based research activities related to biological (soil-based) availability of nitrogen, nitrogen fertilizer management and nitrous oxide emissions.								
PEI Agriculture Climate Solutions Program	Agriculture	CO_2, N_2O	Support farmers to mitigate the production of GHGs and/or sequester carbon in the soil	Economic	Implemented	2021	Prince Edward Island	NA[b]	0.23
Brief Description	The PEI Agriculture Climate Solutions Program is designed to encourage and provide assistance to the PEI agriculture industry to implement best management practices that mitigate the production of GHGs during or from various agricultural activities or by prompting carbon storage in soils. The Program provides financial assistance for the adoption of beneficial on-farm projects payments that encourage the adoption of beneficial practices through demonstration, validation, and knowledge-transfer. Funding for this program is provided by Environment and Climate Change Canada's Low Carbon Economy Fund and the Province of Prince Edward Island.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Prince Edward Island Alternative Land Use Services Program	Agriculture	CO_2, N_2O	Remove environmentally sensitive land from production	Economic	Implemented	2008	Prince Edward Island	NE[h]	NE[h]
Brief Description	Provides agricultural landowners with assistance to remove environmentally sensitive land from production. The program includes the expansion of buffer zones, grassed headlands, retiring high-sloped land, and converting annual cropland to perennial soil and water conservation structures. The program supports the conversion of over 2,800 hectares of farmland from annual production to perennial cover. Starting in 2021, the program is being reviewed and updated to enhance positive impact on carbon sequestration and increase farm landscape resilience to climate change risks.								
Prince Edward Island Winter Cover Crop Beneficial Management Practice in Agriculture Stewardship Program	Agriculture	CO_2, N_2O	Establish winter cover crops to sequester carbon and limit N_2O emissions	Economic	Implemented	2016	Prince Edward Island	2.00	2.00
Brief Description	Funded through the Canadian Agricultural Partnership. Available to farmers to provide cost-share support for establishing winter cover crops, reducing nutrient loss in the soil. The program also influences carbon sequestration and direct/indirect losses of nitrous oxide. A per acre incentive is provided with almost 1,000 acres currently committed for 2019. The program has the capacity to include additional acreage this year. The program, with its expanded scope will continue in 2020 with capacity to support about 1,500 acres.								
Ruminant Feeding Trials	Agriculture	CH_4	Reduce GHG Emissions	Research	Implemented	2022	Prince Edward Island	NA[b]	NE[h]
Brief Description	Trial-based research activities determining the impact of including kelp in dairy and beef rations on methane emissions. In-vitro research suggests that kelp inclusion can achieve a 30% reduction in methane. This finding will be validated in the feeding trial, and optimal inclusion rate will be determined.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
LULUCF									
Nature Smart Climate Solutions Fund**	LULUCF	CO_2, N_2O	Reduce Canada's net greenhouse gas emissions using natural climate solutions, while providing benefits for biodiversity and human well-being	Economic	Planned	2021	Environment and Climate Change Canada	NA[b]	5,000.00 – 7,000.00
Brief Description	The Fund supports projects that conserve, restore and improve the management of Canada's vast and globally significant endowment of wetland, peatland, grassland, and forest ecosystems to store and capture carbon.								
BC Old Growth Nature Fund	LULUCF	CO_2	Support the conservation and protection of old growth forests	Fiscal	Planned	2022	Environment and Climate Change Canada, Natural Resources Canada	NA[b]	NE[h]
Brief Description	The Government intends to establish an Old Growth Nature Fund in collaboration with the Province of British Columbia, non-governmental organizations, and Indigenous and local communities. Funding is contingent on matching investment by the Government of British Columbia.								
2 Billion Trees program*	LULUCF	CO_2	Plant 2 billion trees to increase carbon sequestration while achieving co-benefits for biodiversity and human well-being.	Fiscal	Implemented	2021	Natural Resources Canada	NA[b]	NA[a]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/ or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	The 2 Billion Trees (2BT) program aims to motivate and support new tree planting projects. Over a period of 10 years, by 2031, up to $3.2 billion will be invested in tree planting efforts to support provinces, territories, municipalities, third-party organizations (for and not-for profit) and Indigenous organizations to plant two billion trees across Canada. In February 2021, Natural Resources Canada launched two initiatives to seek information on organizations with immediate access to land or trees and those who are interested in collaborating on tree planting initiatives, resulting in the planting of 28.9 million trees in the 2021 season. In December 2021, Natural Resources Canada launched a call for proposals to establish long-term agreements with eligible partners from across the country and build a strong foundation for the ramp up of tree planting efforts.								
Renewed Forest Bioeconomy Framework for Canada	LULUCF	CO_2	Reduce GHG emissions and advance innovation in the forest sector	Voluntary Agreement	Adopted	2022	Natural Resources Canada, Provincial and territorial governments	NA[d]	NA[d]
Brief Description	Federal, provincial and territorial governments are working together through the Canadian Council of Forest Ministers (CCFM) to deliver a Renewed Forest Bioeconomy Framework for Canada. The renewed framework will provide indirect emissions reductions by outlining actions to address gaps related to accelerating bioeconomy investments, supporting healthy and resilient forests, increasing value per cubic metre from harvested trees, and promoting the efficient use of sustainable forest biomass that provides opportunities for multiple industrial sectors to meet their emissions reduction commitments.								
British Columbia Forest Carbon Initiative	LULUCF	CH_4, CO_2, N_2O	Enhance forest carbon removals and reduce emissions	Economic	Implemented	2017	British Columbia	NE[h]	NE[h]
Brief Description	BC's Forest Carbon Initiative uses a portfolio approach to enhance the carbon sequestration capacity of BC's forests with the rehabilitation of damaged forest stands, roads, wildfire and mountain pine beetle sites, and other areas where there is no legal obligation for replanting. The initiative aims to increase planting density and the use of residual wood, to improve the use of forest fibre for biofuels and longer-lived wood products, and to promote sustainable forestry practices. The initiative is supported by funding from the federal government's Low Carbon Economy Leadership Fund (LCELF). Together, the province and Canada have committed $290 million to FCI from 2017–18 to 2021–22.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
British Columbia Forest Carbon Offsets	LULUCF	CO_2	Increase carbon stocks through sustainable forest management and conservation	Regulatory	Implemented	2017	British Columbia	1,093.00	910.00
Brief Description	British Columbia pursues offset projects in the forestry sector and is currently developing an updated forest carbon offset protocol that would enable new forest carbon offset projects going forward. As an example, the Great Bear Forest Carbon Offset Projects implement an ecosystem-based management regime and protect 85% of the 6.4-million-hectare area. Offsets are purchased by the province as part of the Carbon Neutral Government Program.								
Growing and Caring for BC's Carbon Sinks	LULUCF	CO_2	Reduce GHG emissions and increase storage in the LULUCF sector	Research, Information	Implemented	2021	British Columbia	NA[b]	NE[h]
Brief Description	Development of forest management knowledge/tools for increasing sinks and reducing emissions, for example, development of an updated forest carbon offset protocol supported by stand-level models/tools and vegetative or forest inventories.								
Mountain Pine Beetle Prevention	LULUCF	CO_2	Protect pine forests from insect disturbance and maintain carbon stocks	Voluntary Agreement, Fiscal	Implemented	2011	Alberta, Saskatchewan	NE[h]	NE[h]
Brief Description	Strategy to prevent the eastern spread of mountain pine beetle (MPB) from Alberta into Saskatchewan forests. The partnership between the Saskatchewan Ministry of Environment Forest Service Branch and Alberta Ministry of Agriculture and Forestry has been implemented since 2011 through a series of Interprovincial agreements with the government of Alberta to slow the eastern spread of MPB using detection and control actions. Since 2011 Saskatchewan has invested $8,674,392 towards the agreement.								
Saskatchewan Forest Management on Commercial Forest Lands	LULUCF	CO_2	Increase carbon sequestration	Voluntary Agreement, Regulatory, Education	Implemented	2018	Saskatchewan	NE[h]	NE[h]

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Brief Description	Ensure natural and commercially forested lands are managed in a manner that enhances the removal and storage of carbon from the atmosphere while allowing for sustainable harvesting, respecting normal forest cycles and fire preparedness.								
Saskatchewan SaskPower Shand Greenhouse Seedlings	LULUCF	CO_2	Mitigate GHG emissions from SaskPower's use of fossil fuels to produce electricity	Voluntary Agreement	Implemented	1992	Saskatchewan	111.00	129.00
Brief Description	The SaskPower Shand Greenhouse grows and distributes tree, shrub and native plant seedlings utilizing waste heat from the adjacent coal-fired generating station. Typical annual production is 500,000 seedlings. Each production cycle is estimated to contribute 3.3 to 5.6 kt CO_2 eq sequestration per year of growth. It is estimated that 1,348 kt CO_2 eq will have been cumulatively sequestered due to seedling production and associated plantings in the period from 1992 to 2020 and that 2,669 kt CO_2 eq will have been cumulatively sequestered in the period from 1992 to 2030.								
Manitoba Conservation Trust	LULUCF	CO_2, N_2O	Increase carbon sequestration and other benefits (reduce flooding and drought vulnerability, improve water quality, etc.)	Voluntary Agreement	Implemented	2018	Manitoba	NE[h]	NE[h]
Brief Description	The $102 million Conservation Trust established in 2018 supports programs related to conserving ecosystems, enhancing natural infrastructure, improving water quality, and strengthening flood and drought mitigation and adaption to the impacts of climate. The program supports increasing carbon sequestration. As of March 31, 2022, a total of $12.464 million has been committed from Trust revenues to grantees for projects in Manitoba.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Manitoba Growing Outcomes in Watersheds Program	LULUCF	CO_2, N_2O	Improve watershed resilience to the impacts of a changing climate	Voluntary Agreement	Implemented	2019	Manitoba	NE[h]	NE[h]
Brief Description	The Growing Outcomes in Watersheds (GROW) Program supports emissions reduction and sequestration. The $52 million GROW Trust was established in 2019. The $50 million Wetlands GROW Trust was established in 2020. The program will help producers with the establishment of projects that improve on-farm water management, enhance sustainable agricultural production, improve biodiversity and habitat, and carbon sequestration and storage.								
Water Management Strategy	LULUCF	CO_2	Protect the province's water resources and ecosystems while sustainably growing the economy and communities	Information	Implemented	2022	Manitoba	NA[b]	NE[h]
Brief Description	Manitoba has developed a comprehensive provincial water management strategy to conserve wetlands, enhance resilience, improve surface water quality, manage nutrients, protect biodiversity and sustain economic development.								
Mitigation through Sustainable Forest Management	LULUCF	CO_2	Sustainable forest management	Information, Research	Implemented	Various	Ontario	NE[h]	NE[h]
Brief Description	Ontario sustainably manages large, healthy, resilient forests by using a forest policy framework that is continuously updated with the best available science and supports climate change adaptation and mitigation. MNRF supports forest managers to reduce emissions and increase carbon storage in forests and encourages climate change mitigation opportunities through relevant sustainable forest management policies, guidance, and manuals. MNRF also considers opportunities to advance nature-based solutions in Ontario's ecosystems and lands (e.g., restoring damaged and degraded forests and enhancing sustainable forest management activities in Ontario's managed forests).								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Sustainable Growth: Ontario's Forest Sector Strategy	LULUCF	CO_2	Strategy for Ontario's forests	Information, Research	Implemented	2020	Ontario	NE[h]	NE[h]
Brief Description	Ontario is implementing Sustainable Growth: Ontario's Forest Sector Strategy, released in August 2020, as a way to: enhance carbon sequestration through increased forest growth, increase carbon storage in wood products, and mitigate emissions through substitution benefits associated with replacing less environmentally friendly products (e.g. concrete, plastics) with wood. As part of delivering on commitments in Ontario's Forest Sector Strategy, the province developed a Forest Biomass Action Plan in 2022 aimed at securing jobs and encouraging sustainability in the forest sector, while supporting economic development through the use of forest biomass (i.e., mill by-products and forest biofibre).								
Accounting and management of agriculture and forest carbon sinks	LULUCF	CO_2	Improve the accounting and management of carbon sinks	Voluntary Agreement	Implemented	2021	New Brunswick	NA[b]	NE[h]
Brief Description	Commencing a two-phase research project: Phase 1: The Evaluation of Greenhouse Gas Emissions and Carbon Capture on New Brunswick Farms; and Phase 2: Benchmarking GHG emissions and carbon sequestration on New Brunswick farms in the potato, blueberry and dairy sectors using HOLOS software. New Brunswick has incorporated the ability to estimate current forest level carbon stocks and forecast those stocks 80 years into the future. This forecasting ability has been incorporated into the evaluation of management strategies for both Crown and private land forests.								
PEI Buffer Zone Buy Back Program and 2 Billion Tree Program	LULUCF	CO_2	Reduce GHG emissions, increase GHG sequestration	Fiscal	Implemented	2022	Prince Edward Island	NA[b]	NE[h]
Brief Description	The 2022–23 capital budget allocated $0.5 million to go towards a new buffer zone buyback and restoration project that will increase greenspaces and benefit Island ecosystems, and $1 million to support the province's efforts to plant over one million trees a year, an important step toward meeting the province's 2040 net-zero target.								

Name of Mitigation Action	Sector(s) Affected	GHG(s) Affected	Objective and/or Activity Affected	Type of Instrument	Status of Implementation	Start year of Implementation	Implementation Entity	Estimate of Mitigation Impact (kt CO_2 eq)	
								2020	2030
Prince Edward Island Carbon Capture Tree Planting Program	LULUCF	CO_2	Sequester carbon through tree planting	Economic	Implemented	2019	Prince Edward Island	0.22	4.95
Brief Description	The Carbon Capture Tree Planting program—an initiative to plant native tree species on public and privately owned abandoned or marginally productive agricultural land. The program covers all planting and seeding costs. To date, 469 hectares of trees have been planted (approximately one million trees). It is funded in part by the Government of Canada's Low Carbon Economy Leadership Fund.								

* Denotes a policy that was explicitly modeled in the "with measures" scenario in Chapter 5
** Denotes a policy that was explicitly modeled in the "with additional measures" scenario in Chapter 5

[1] Some projects that have been announced are modeled in the "with measures" scenario, whereas other funding is modelled in the "with additional measures" scenario.
[2] Reflects projects that have already been announced, but not the full extent of the funding that is still to be distributed.
[3] For more details on how provincial and territorial carbon pricing regimes were modelled, please refer to Chapter 5.

NA = Not applicable
NE = Not estimated
TBD = To be determined

a) Impacts are expected to be minimal.

b) Measure not in place in 2020.

c) Emissions reductions of this measure are aggregated into the estimates of another overarching measure.

d) The measure is expected to generate indirect, rather than direct, emissions reductions.

e) The details of the policy are still under development. Therefore, at this time it is premature to estimate the mitigation impact.

f) The measure contributes to the Government of Canada's efforts to transition to a low carbon economy by fostering the growth of Canadian clean technologies and companies. Although mitigation impacts cannot be directly attributed to this measure, it may have an indirect impact on GHG emissions.

g) The funding is yet to be distributed. Since decisions have not yet been made on the projects to be funded, it is premature to estimate the mitigation impact.

h) The department, province or territory did not provide an estimate at the time of submission.

i) The *2022–2027 Implementation Plan of Québec's 2030 Plan for a Green Economy* provides an estimate of anticipated reductions based on economic sector: http://www.finances.gouv.qc.ca/documents/Autres/fr/analyse_impact_plan_mise_oeuvre_2022_2027.pdf. Estimates are not available for individual measures. https://cdn-contenu.quebec.ca/cdn-contenu/adm/min/environnement/publications-adm/plan-economie-verte/plan-mise-oeuvre-2022-2027.pdf?1652278896.

j) Carbon pricing is a pillar of Canada's Emissions Reduction Plan, and has been in place across Canada since 2019, through a mixture of federal, provincial and territorial systems, aligned with common minimum national stringency requirements. As an economy-wide, market based instrument, it works in concert with other measures, programs, and incentives. This dynamic means that it is not feasible to estimate the specific impact of carbon pricing in isolation from other measures. As indicated in Canada's *Climate Actions for a Healthy Environment and a Healthy Economy* (2021), it is estimated that pricing will contribute over a third of the total reductions that will occur between now and 2030.

Chapter 5: Projections and the Total Effects of Policies and Measures

This chapter provides projections of greenhouse gas (GHG) emissions through 2035, aligned to Canada's historical emissions from 1990 to 2020 as presented in *Canada's 2022 National Inventory Report* (NIR2022) and Chapter 3 of this report.

Results presented show detailed projections according to Canada's economic sector categories and by gas, aligned with the presentation of policies and measures in Chapter 4. While in previous National Communications (NCs) and Biennial Reports (BRs), projections were presented out to 2030, this report includes projections out to 2035 (as per the latest United Nations Framework Convention on Climate Change (UNFCCC) guidelines revised at COP25 in Madrid in December 2019 [Decision 6/CP.25]). Where applicable, historical emissions for 2005, 2010, 2015 and 2020 (the most recent year for which historical emissions are available) are also shown.

A short presentation of projected emissions by the Intergovernmental Panel on Climate Change (IPCC) sector categories is also provided. A description of the relationship between Canada's economic sectors and IPCC sectors can be found in Chapter 3. Canada's GHG inventory open data tables are available online.

Since Canada's last Biennial Report was published in 2019, Canada has continued to adopt increasingly stringent greenhouse gas emissions reduction targets and take the action necessary to reduce emissions, protect the environment, spur clean technologies and innovation, and help Canadians and communities adapt to the impacts of climate change. In 2020, the of Canada released its strengthened climate plan (SCP), *A Healthy Environment and a Healthy Economy*. In 2021, the *Canadian Net-Zero Emissions Accountability Act,* was implemented. The Act established the 2030 greenhouse gas emissions target as Canada's Nationally Determined Contribution (NDC) under the Paris Agreement, an emissions reduction target of 40 to 45 percent below 2005 levels by 2030. In 2022, as an early deliverable under the *Canadian Net-Zero Emissions Accountability Act*, Canada published its first Emissions Reduction Plan (ERP). The *2030 Emissions Reduction Plan* lays out the next steps to reach Canada's 2030 emissions reduction target, providing greater certainty and improving transparency and accountability on the way to net-zero. Under the Act, a progress report on the 2030 ERP must be completed by the end of 2023.

Canada's GHG projections are derived using a detailed bottom-up simulation model where energy data is allocated to the economic sectors presented in this report. As in past NCs and BRs, projections are based on the Environment and Climate Change Canada Energy, Emissions and Economy Model for Canada (E3MC), which is internationally recognized and incorporates external data. Environment and Climate Change Canada consults extensively with other government officials, selected experts, and provinces and territories on annual emissions projections (for more information on E3MC, please see Annex 7).

For its *Eighth National Communication and Fifth Biennial Report*, Canada has presented projections that include both a "with measures" scenario (WM) and a "with additional measures" scenario (WAM), both outlined in Section 5.2.[1]

- The WM scenario builds on the WM projections presented in the *Fourth Biennial Report* (BR4), and includes all policies and measures funded, legislated and implemented by federal, provincial and territorial governments up to November 2022.
- The WAM scenario accounts for those additional policies and measures that are under development but have not yet been fully implemented, some of which were announced as part of the 2030 ERP (e.g., Clean Electricity Regulations, strengthened methane regulations in the oil and gas sector targeting a 75 percent reduction by 2030 and proposed landfill gas regulations). This scenario is provided for the purposes of representing progress to Canada's 2030 target and to better demonstrate the full impact of Canada's climate policies.
- While every effort is made to be as complete as possible in what is included in the model, both the WM and WAM scenarios do not include all announced measures. Measures that have not been sufficiently developed are not reflected in the WM and WAM results, these include the oil and gas cap on emissions, elements of the Green Buildings Strategy, as well as additional mitigation measures that could be implemented by the provinces and territories between now and 2030. Emissions reductions from additional future actions will be assessed and included as new measures are developed and implemented.

Projections from both the WM and WAM scenarios reflect the estimated impact of recent global events, which were not reflected in either the BR4 or the 2030 ERP projections. These have had significant impacts on the projections, and include:

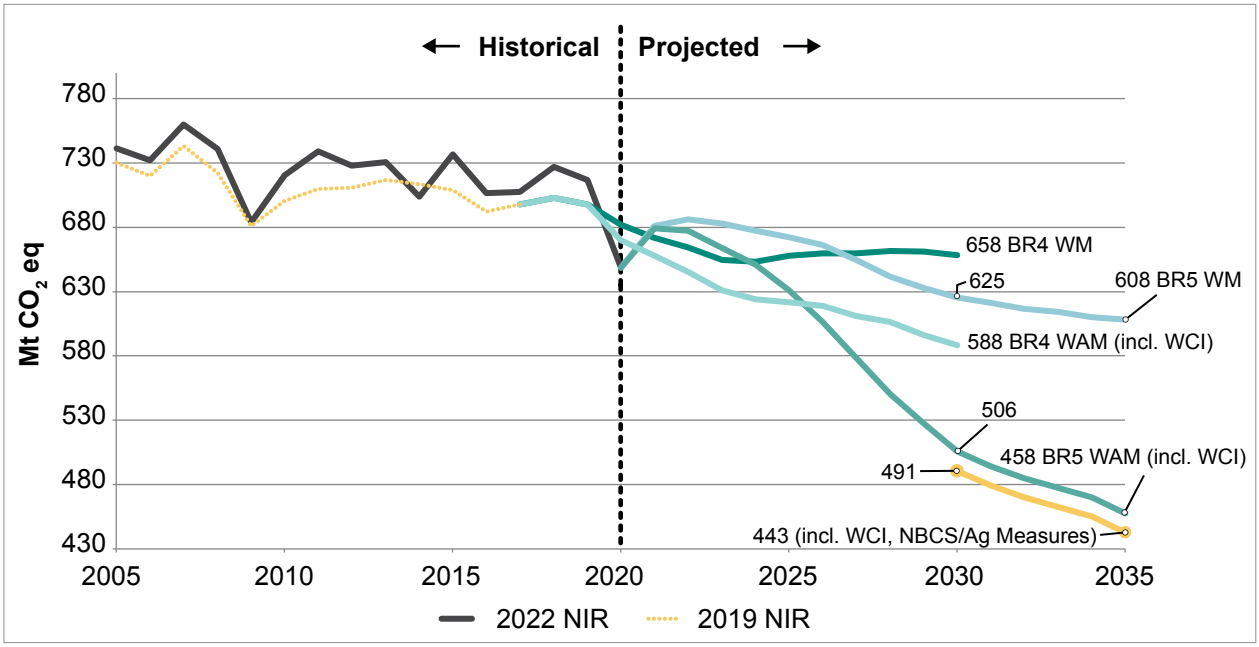
- Disruptions to global energy markets due to the war in Ukraine, which are leading countries previously relying on natural gas sourced from Russia to find other suppliers.
- Global inflation, including in Canada, reaching highs not seen in decades, which has an impact on future prices (such as that for carbon), when those are set in nominal prices.
- The COVID-19 pandemic, which could not have been taken into consideration when BR4 projections were prepared, and the long-lasting effects of which could still not be fully known when the 2030 ERP projections were prepared.

1 The policies and measures modelled in each of these scenarios are listed in Table 5A-49 in Annex 1 of this chapter, and several are described in more detail in Chapter 4: Policies and Measures. It should be noted that the sum of emission reductions associated with individual policies and measures—as summarized in Table 1, Chapter 4: Policies and Measures of the National Communication—will not be equivalent to the overall projected emission reductions of policies and measures in this chapter due to the interaction effects between measures and different modelling approaches.

Under the WAM scenario, emissions in 2030 decline to 491 Mt, including contributions from Land Use, Land-Use Change, and Forestry (LULUCF), Nature-Based Climate Solutions (NBCS) and Agricultural Measures and credits purchased under the Western Climate Initiative (WCI). This is 97 Mt below the 2030 WAM projection in BR4. Post-2030, the WAM scenario sees emissions continuing to decline, reaching 443 Mt in 2035.

Figure 5-1 shows projections under the WM and WAM scenarios, as well as the projections presented in Canada's BR4.

Figure 5-1: Scenarios of Canadian Emissions (Including LULUCF) to 2035 (Mt CO_2 eq)



Note:
* Assumes the 2030 estimate for NBCS & Agriculture Measures (reduction of 14 to 16 Mt CO_2 eq) is constant out to 2035.

5.1. Assessment of Aggregate Effect of Policies and Measures

ECCC updates Canada's GHG emissions projections annually, reflecting the latest historical data and updated future economic and energy market assumptions. As such, projections fluctuate over time as a result of changes in these assumptions.

5.1.1. Comparing Activity Sector Categories to Economic Sectors

In line with the UNFCCC reporting guidelines, Canada has chosen to use economic sectors to present policies and measures as well as projections in our National Communication and Biennial Report. Examining the historical path of Canadian GHG emissions by economic sector allows for a better understanding of the connection between economic activities and GHG emissions. This approach is aligned with that taken in the SCP and 2030 ERP and this categorisation was used in all of Canada's previous NCs and BRs. It is also presented in Canada's NIR along with GHG emissions categorized under the IPCC reporting requirements by activity sectors. More information about how Canada reallocates GHG emissions from activity sector categories to economic sectors is found in Annex 1.

5.2. Greenhouse Gas Emissions Projections by Economic Sector and Gas Under the WM and WAM Scenarios

This section presents Canada's WM and WAM scenario emissions projections to 2030 and 2035 with comparisons made to 2005, Canada's base year for its GHG emissions reduction target.[2]

5.2.1. Impacts of the COVID-19 Pandemic

The COVID-19 pandemic had a notable impact on the Canadian economy. In particular, gross domestic product (GDP) fell by 5.3 percent in 2020, but recovered in 2021 increasing by 4.6 percent. While Canada's economy has for the most part recovered from the pandemic, taking its future impact into account has created a challenge in developing the WM and WAM scenarios.

Moreover, the COVID-19 pandemic and the Saudi-Russia oil price war had substantial impacts on the Oil and Gas Sector in 2020. In April 2020 crude oil prices were at their lowest level in decades and temporarily were trading at negative prices. The COVID-19 pandemic and subsequent price shock led to a 5.2 percent decrease in crude oil production relative to 2019 levels and delayed planned developments in the conventional and unconventional oil sectors. Combined with federal regulations to reduce methane emissions from the upstream oil and gas industry and equivalent provincial regulations in Saskatchewan, Alberta, and British Columbia, this led to a decrease in GHG emissions from the Oil and Gas Sector of 25 Mt between 2019 and 2020.

In the Buildings Sector, the COVID-19 pandemic had a significant impact on energy demand. Between 2019 and 2020, commercial and residential energy demand declined by 4.5 percent and 3.3 percent, respectively. In the Commercial Sector, that decline marked a trend reversal where energy demand had increased every year between 2015 and 2019. Note that the magnitude of the impact of the COVID-19 pandemic on Buildings Sector energy demand is comparable to previous economic recessions.

In the Transportation Sector, energy demand and emissions declined in 2020 as a result of curtailed activity levels and pandemic measures. Freight GHG emissions fell by 9.0 percent and passenger GHG emissions fell by 19.2 percent. For both subsectors, the model was calibrated on 2019 data instead of 2020 data in order to improve the accuracy of the projections. Passenger subsector activity levels are assumed to return to pre pandemic trends by 2025. The freight subsector uses gross domestic product as its economic driver so there are no additional pandemic-related assumptions.

5.2.2. Historical Revisions

Since the release of the BR4, several revisions have been made to the national inventory historical data, including the following:

- In the Agriculture Sector, the main revisions to historical data have resulted from: the implementation of a methodology for estimating nitrous oxide (N_2O) emissions from the application of biosolids to agricultural soils and updates to activity data (NIR2020), whose combined effect decreased emissions by about 2 Mt carbon dioxide equivalents (CO_2 eq) in 2017; and revision to the methodology used to calculate direct N_2O emissions from agricultural soils, which reduced emission factors for mainly dry areas of the prairies and for

2 In March 2022, the Government of Canada introduced Canada's 2030 Emissions Reduction Plan, which provides a roadmap for the Canadian economy to achieve 40-45 percent emissions reductions below 2005 levels by 2030, building upon the actions outlined in Canada's previous climate plans.

the application of nitrogen to perennial lands (NIR2022), decreasing emissions estimates from the previous submission by about 5.5 Mt CO_2 eq throughout the time series. For more information, see Section 5.1 and Tables 5–2 and 5–3 of NIR2020,[3] NIR2021,[4] and NIR2022.[5]

- In the Oil and Gas Sector, revisions to methane emissions have led to increased historical emissions, especially in conventional oil and natural gas production and processing sectors.
- In the Transportation Sector, historical revisions have led to a higher proportion of energy use (and consequently emissions) being allocated to light-duty trucks, which are traditionally less efficient than passenger cars.
- In the Waste Sector, refinements in the calculation of material specific decay functions rather than bulk waste quantity and revisions to the decay rates in areas with low precipitation have led to a higher level of emissions in the historical period that are carried forward into the projections.
- In the LULUCF Sector, there have been significant revisions to the historical data due to methodological improvements (for more details, see Section 6.1 and Tables 6–2 and 6–3 of NIR2020,[3] NIR2021,[4] and NIR2022[5]):
  - NIR2020: Significant recalculations in reported estimates for Forest Land and Settlements.
  - NIR2021: Significant recalculations in reported estimates for the Forest Land and Harvested Wood Products categories.
  - NIR2022: Significant recalculations in reported estimates for Forest Land, Cropland and Harvested Wood Products categories.

5.2.3. Methodological Revisions

Since the release of the BR4, a number of methodological revisions have taken place.

- In the Buildings Sector, changes have been made to make the model more responsive to changes in energy prices when homeowners make decisions to replace their heating equipment. Specifically, the model allows homeowners to replace their space heating equipment at the end of its lifetime with a different type of technology (for example, by replacing a natural gas furnace or oil heater with an electric heat pump) before the building reaches its end of life.
- In the Transportation Sector, projections reflect updated projections of fuel consumption in the passenger subsector to better reflect typical on-road conditions, driving behaviour, and the types of vehicles Canadians are driving. This change as well as historical data revisions led to a substantial increase in projected transportation-related emissions out to 2030 as compared to the BR4 projections.
- In the Electricity Sector, the model is now able to add new plant types, such as electricity storage, small modular nuclear reactors, biomass with carbon capture and storage, and natural gas with carbon capture and storage.
- Carbon Capture and Storage (CCS) cost curves have been updated in the model to endogenously forecast CCS for the Heavy Industry and Oil and Gas Sectors.
- In the LULUCF Sector, the methodological improvements for Cropland and Forest Land also affect projections in the same direction. For projections for emissions from deforestation (FL-L), a review of major upcoming events, submitted in 2021, reassessed the potential of occurrence. Events now incorporated in the NIR2022 data have been removed.

3 En81-4-2018-1-eng.pdf (publications.gc.ca)
4 En81-4-2019-1-eng.pdf (publications.gc.ca)
5 En81-4-2020-1-eng.pdf (publications.gc.ca)

5.2.4. Scope of the Scenarios

5.2.4.1. With Measures

Projections in the WM scenario are based on policies and measures in place as of November 2022 and assume no further government action. The report also presents results from the WAM scenario, which includes measures that have been announced but are not yet in place (see Section 5.2.4.2 for more details).

Since the submission of Canada's *Fourth Biennial Report* a number of policies and significant measures have been implemented, such as increased stringency of carbon pricing, reaching $170/t by 2030, federal and provincial investments in the decarbonisation of Ontario's large Iron and Steel facilities, the Clean Fuel Regulations and grants given under the Canada Green Buildings Strategy, among others, and as such are now included in Canada's WM scenario. As a result, emissions in 2030 in the WM scenario are now 32 Mt lower than in BR4, decreasing to 638 Mt (not including the LULUCF accounting contribution).

The LULUCF Sector is projected to reduce Canada's emissions by 12 Mt in 2030. Full quantification details for the LULUCF contribution both for the historical and projected periods are provided in Annex 6.

Including the accounting contribution from the LULUCF Sector, projected emissions in 2030 under the WM scenario are 625 Mt. The WM scenario sees emissions continue to decline, to reach a level of 608 Mt in 2035.

The list of federal, provincial and territorial policies and measures that were included in the WM scenario is provided in Table 5A-49 in Annex 3.

5.2.4.2. With Additional Measures

The WAM scenario includes policies and measures that were announced in the 2030 ERP in March 2022 but have not yet been fully implemented. This includes the following policies and measures:

- Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations will target sales of 60 percent Light Duty Vehicles (LDV) Zero Emissions Vehicles (ZEVs) by 2030 and 100 percent by 2035.
- Heavy Duty Vehicles (HDV) ZEVs to reach 100 percent by 2040.
- Clean Electricity Regulations to achieve a net-zero electricity system in Canada by 2035.
- Loans for building retrofits under the Canada Green Buildings Strategy.
- Strengthened methane regulations in upstream oil and gas, targeting a 75 percent reduction by 2030 from 2012 levels.
- Federal landfill gas regulations to reduce methane emissions either through installation of landfill gas recovery systems or other approaches that directly mitigate emissions.
- An investment tax credit for clean technology announced in the 2022 Fall Economic Statement.
- Significant investments by the federal and provincial governments into industrial decarbonization projects, such as the Rio Tinto's critical minerals facility in Québec.
- Other policies and measures (Table 5A-49 has the full list of measures included in the WAM scenario).

Negotiations are still underway to ensure that international purchases of credits under the Western Climate Initiative (WCI) could be used towards Canada's compliance with the Paris Agreement. According to WAM projections, there could be up to 4 Mt of credits purchased under the WCI by 2030.

Nature-Based Climate Solutions and Agriculture Measures represent avoided conversion and restoration of ecosystems such as wetlands, grasslands, and forest land, as well as the use of best management practices on agricultural land. Preliminary estimates for the GHG impact of Nature-Based Solutions and Agriculture Measures indicate that these programs could reduce the net flux in the LULUCF Sector by between 14 and 16 Mt CO_2 eq per year in 2030 and 2035. These estimates are not accounting values but represent how accounting contributions could change in the presence of these programs. The accounting contribution will be determined by updated methodologies over the next few years.

Under the WAM scenario, Canada's projected emissions in 2030 are expected to decrease to 491 Mt. Post-2030, emissions are expected to continue to decrease to 443 Mt in 2035 as emissions from electricity generation, oil and gas, and transportation continue to decline.

5.2.5. Results from WM and WAM Scenarios

Table 5-1 illustrates how the projected trends in GHG emissions vary by economic sector, while Table 5-2 provides a breakdown of projected trends in GHG emissions by IPCC sector.

Table 5-1: GHG Emissions by Economic Sector Under WM and WAM Scenarios, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected							
					With Measures				With Additional Measures			
	2005	2010	2015	2020	2025	2030	2035	Change 2005 to 2030	2025	2030	2035	Change 2005 to 2030
Oil and Gas	171	181	205	179	195	183	179	11	184	135	130	-36
Electricity	118	95	80	56	41	33	28	-85	36	19	2	-98
Transportation	160	167	172	159	177	163	157	3	177	158	135	-2
Heavy Industry	87	75	78	72	77	72	71	-15	74	60	58	-28
Buildings	84	79	84	88	76	69	65	-15	69	55	50	-28
Agriculture	66	62	65	69	69	69	69	3	67	63	63	-3
Waste and Others	55	51	50	50	50	50	51	-5	42	32	32	-23
Subtotal	***741***	***710***	***733***	***672***	***684***	***638***	***621***	***-103***	***650***	***522***	***470***	***-219***
WCI Credits	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-7	-4	0	-4
LULUCF	n.a.	11	5	-24	-12	-12	-13	-12	-12	-12	-13	-12
NBCS and Agriculture Measures	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-15	-15	-15
Total	**741**	**721**	**737**	**649**	**672**	**625**	**608**	**-116**	**631**	**491**	**443**	**-250**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

In 2020, the last year for which historical data was available, Canada's emissions were 672 Mt. When considering the accounting contribution of the Land Use, Land-Use Change and Forestry (LULUCF) Sector, Canada's emissions reached 649 Mt (or 12 percent below 2005).

As previously noted, 2020 was not a normal year in terms of energy use and emissions in Canada. However, since it is the last historical year reported in the NIR 2022, this section of the report will refer to it when discussing projections to 2030.

Between 2005 and 2020, the Oil and Gas, Buildings and Agriculture Sectors showed emission increases of 7 Mt, 4 Mt and 2 Mt of CO_2 eq, respectively. These increases have been more than offset by emission decreases in the Electricity (61 Mt), Heavy Industry (15 Mt) and Waste and Others (5 Mt) Sectors. Since 2005, Transportation Emissions have generally increased; but emissions dropped in 2020 and are comparable to 2005 levels, in part caused by the COVID-19 pandemic.

At the sectoral level, expected reductions between 2020 and 2030 in the WM scenario are 24 Mt in Electricity and 19 Mt in Buildings. On the other hand, emissions in the Oil and Gas and Transportation Sectors are expected to experience growth during that period of 4 Mt each.

In the WAM scenario, 2030 emissions are lower in all economic sectors as compared to the WM scenario, with the largest reductions occurring in the Oil and Gas Sector (48 Mt).

More detailed projections by economic sector and a comparison between projections by sector categories and economic sectors are provided in Annex 1.

Table 5-2: GHG Emissions by IPCC Sector (Excluding LULUCF, NBCS and WCI Credits) Under WM and WAM Scenarios, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected					
	2005	2010	2015	2020	With Measures			With Additional Measures		
					2025	2030	2035	2025	2030	2035
Stationary Combustion and Fugitive Sources	412	390	399	350	338	308	295	307	210	182
Transport	190	194	201	190	209	196	192	210	190	167
Industrial Processes	57	51	54	50	54	51	51	57	54	53
Agriculture	54	50	52	55	56	56	56	55	51	51
Waste	29	26	26	27	27	26	26	22	16	16
Total	**741**	**710**	**733**	**672**	**684**	**638**	**621**	**650**	**522**	**470**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

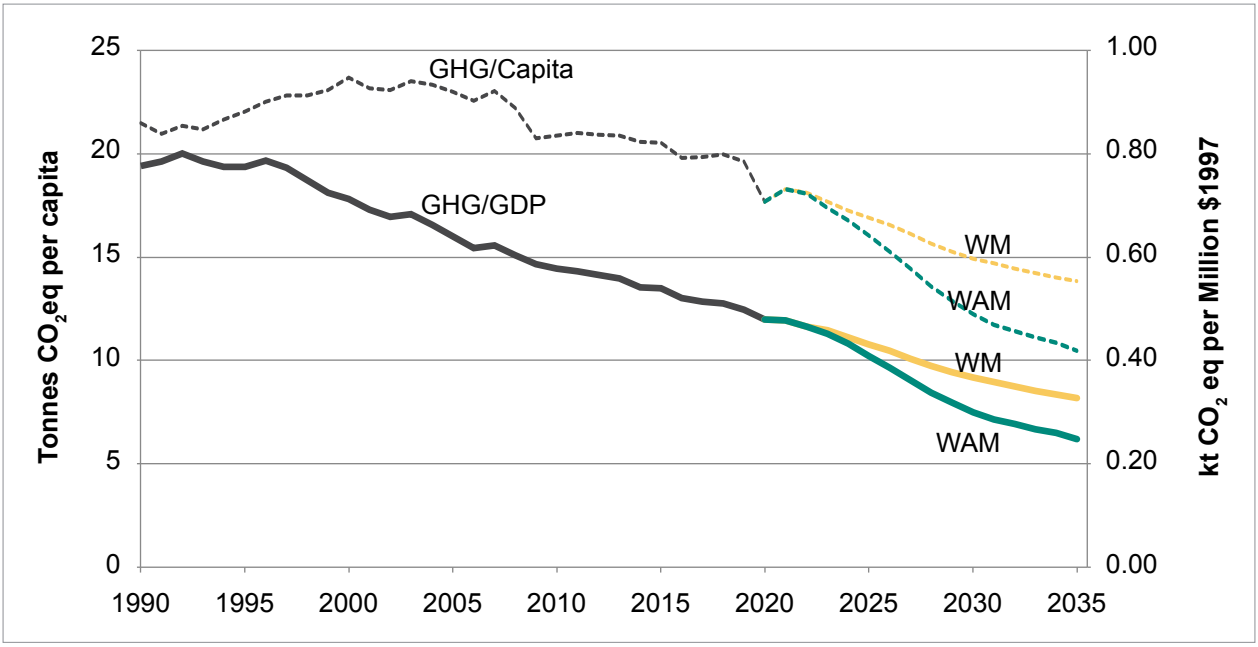
5.2.5.1. Emissions Intensity

Canadian per capita GHG emissions have been decreasing significantly since 2005, declining by an average of 1.9 percent per year over the 2005 to 2020 period. Emissions intensity is expected to decrease by 1.7 percent per year between 2020 and 2030 in the WM scenario, and by 3.6 percent per year in the WAM scenario.

Emissions per capita were 23.0 tonnes CO_2 eq per person in 2005. In 2020, emissions per capita (excluding the contribution of LULUCF, NBCS, Agriculture Measures and WCI credited) were 17.7 tonnes CO_2 eq per person, the lowest level recorded since records began in 1990. This is due in part to the impact of the COVID-19 pandemic on Canada's economic activity and GHG emissions that year. Nevertheless, the WM projections show per capita emissions will continue to decrease through 2030 and are expected to fall to 14.9 tonnes per person in 2030 and 13.8 tonnes in 2035, a significant decrease since 2005. This is despite a projected increase of Canada's population of 12 percent between 2020 and 2030. In the WAM scenario, emissions intensity decreases even more, to reach 12.2 tonnes per person in 2030 and 10.5 tonnes per person in 2035.

Figure 5-2 shows the evolution of Canada's GHG emissions intensity per unit of GDP and per capita from 1990 to 2035.

Figure 5-2: Canadian Emissions Intensity per Unit of GDP and per Capita under WM Scenario (Excluding LULUCF, NBCS, Agriculture Measures and WCI), 1990 to 2035



5.2.5.2. Emissions by Gas

Detailed emissions projections by gas and economic sectors are provided in Annex 1. Total Canadian GHG emissions over the projection period by gas are presented in natural units in Table 5-3 below. Table 5-4 converts the information into CO_2 eq with global warming potential values from the fourth Assessment Report of the IPCC and provides emissions totals excluding Land Use, Land-Use Change and Forestry (LULUCF) emissions.

Table 5-3: Total Canadian Emissions (Excluding LULUCF, NBCS, Agriculture Measures and WCI Credits) Under WM and WAM Scenarios by Gas, 2005 to 2035 (kilotonne [kt]—natural form)

	Historical				Projected					
					With Measures			With Additional Measures		
	2005	2010	2015	2020	2025	2030	2035	2025	2030	2035
Carbon Dioxide (CO_2)	575 000	557 000	574 000	535 000	544 000	502 000	487 000	516 000	424 000	375 000
Methane (CH_4)	5 000	4 600	4 600	3 700	3 800	3 700	3 700	3 600	2 400	2 400
Nitrous Oxide (N_2O)	110	90	100	110	110	120	120	110	100	100
Hydrofluo-rocarbons (HFCs)	4	5	8	8	7	6	4	7	6	5
Perfluoro-carbons (PFCs)	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sulphur-Hexafluoride (SF_6)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nitrogen Trifluoride (NF_3)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Note: Historical emissions data come from NIR 2022.

Table 5-4: Total Canadian Emissions (Excluding LULUCF, NBCS, Agriculture Measures and WCI Credits) Under WM and WAM Scenarios by Gas, 2005 to 2035 (Mt CO_2 eq, except for NF_3)

	Historical				Projected							
					With Measures				With Additional Measures			
	2005	2010	2015	2020	2025	2030	2035	Change 2005 to 2030	2025	2030	2035	Change 2005 to 2030
Carbon Dioxide (CO_2)	575	557	574	535	544	502	487	-73	516	424	375	-151
Methane (CH_4)	124	115	116	92	95	92	92	-32	91	60	60	-64
Nitrous Oxide (N_2O)	32	28	30	33	34	34	34	3	32	29	29	-3
Hydrofluo-rocarbons (HFCs)	5	8	11	12	10	9	6	3	11	9	7	4
Perfluoro-carbons (PFCs)	4	2	1	1	1	1	1	-3	<1	<1	<1	-3
Sulphur-Hexafluoride (SF_6)	1	<1	<1	<1	<1	<1	<1	-1	<1	<1	<1	-1
Nitrogen Trifluoride (NF_3) (kt CO_2 eq)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total	**741**	**710**	**733**	**672**	**684**	**638**	**621**	**-103**	**650**	**522**	**470**	**-219**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

5.2.5.3. Emissions by Province

Emissions vary considerably by province, driven by diversity in population size, economic activity, and resource base, among other factors. For example, provinces where the economy is oriented more toward resource extraction tend to have higher emissions levels whereas more manufacturing or service-based economies tend to have lower emissions levels. Electricity generation sources also vary, with provinces that rely on fossil fuels for their electricity generation having higher emissions than provinces that rely more on non-emitting sources of electricixty, e.g., hydroelectricity, nuclear and wind.

Table 5-5 displays projected provincial and territorial GHG emissions from 2005 to 2035 reflecting a diversity of economic factors and provincial/territorial measures to reduce GHG emissions. These include energy efficiency and renewable electricity programs, carbon pricing, regulatory measures, and legislated renewable electricity targets.[6]

Table 5-5: Provincial and Territorial GHG Emissions (Excluding LULUCF, NBCS and Agriculture Measures) Under WM and WAM Scenarios, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected							
					With Measures				With Additional Measures			
	2005	2010	2015	2020	2025	2030	2035	Change 2005 to 2030	2025	2030	2035	Change 2005 to 2030
Newfoundland and Labrador	10	10	11	10	9	9	9	-1	8	9	8	-2
Prince Edward Island	2	2	2	2	2	2	2	< -1	2	1	1	< -1
Nova Scotia	23	20	17	15	12	10	9	-13	12	8	6	-15
New Brunswick	20	18	14	12	13	11	9	-9	12	8	7	-12
Québec*	86	79	79	76	79	74	71	-12	68	60	57	-26
Ontario	204	173	164	150	165	152	148	-53	157	129	111	-75
Manitoba	21	19	21	22	21	21	20	< 1	21	18	17	-3
Saskatchewan	71	71	79	66	62	58	57	-13	60	46	42	-25
Alberta	237	255	284	256	256	236	229	< -1	239	182	169	-55
British Columbia	64	59	60	62	61	61	61	-3	59	53	50	-11
Yukon Territory	1	1	1	1	1	1	1	< 1	1	1	1	< 1
Northwest Territory	2	1	2	1	2	2	1	< -1	2	1	1	< -1
Nunavut	1	1	1	1	2	2	2	1	2	2	2	< 1
Canada	**741**	**710**	**733**	**672**	**684**	**638**	**621**	**-103**	**643**	**518**	**470**	**-223**

Note:
Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

* Projections for Québec include purchased credits under Western Climate Initiative in the WAM scenario only.

6 Although provincial and territorial governments have announced a diverse range of measures, only measures that could be readily modelled or have an announced regulatory or budgetary dimension were modelled under the WM and WAM scenarios. Aspirational goals and targets are not included in the projections. The policies and measures modelled in this section are listed in Table 5A-49 in Annex 3 of this chapter.

5.2.6. Comparison of Current and Previous Projections

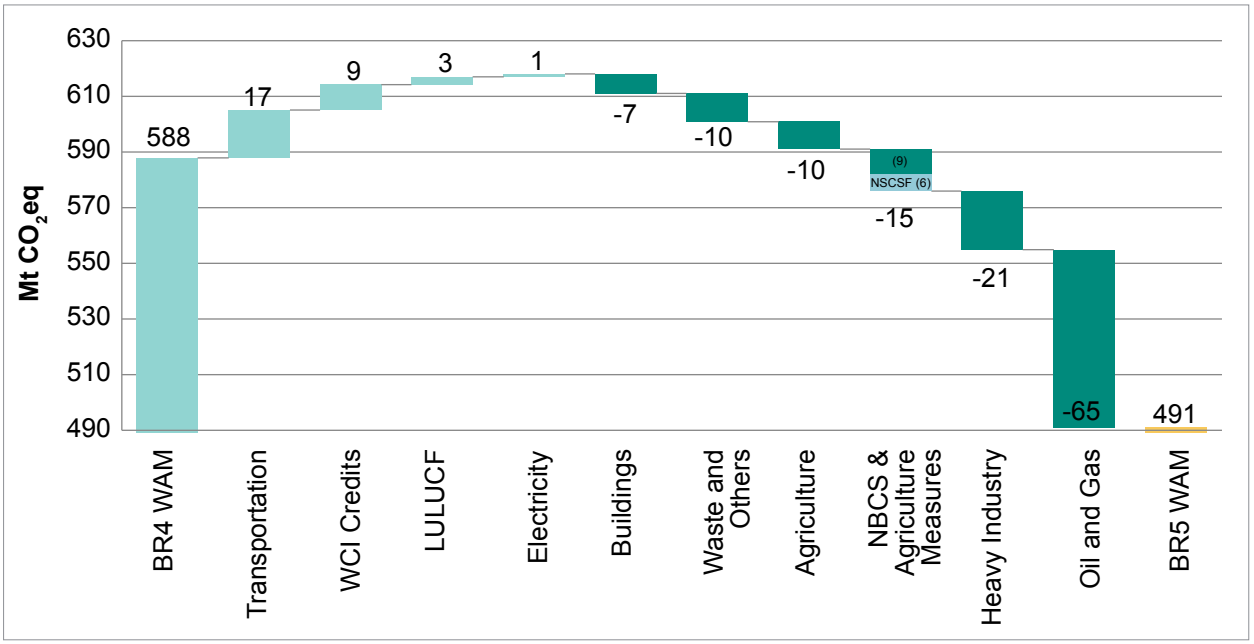
In 2030, Canada's GHG emissions under the WM Scenario (including the accounting contribution from the LULUCF Sector) are projected to decline to 625 Mt, or 33 Mt below the WM scenario of 658 Mt presented in Canada's BR4. This change is primarily driven by new policies and measures that have been put in place since 2019 (see Section 5.2.3). Not only have projected emissions changed, but historical emissions have also changed, with revisions going back to 2005, due to improvements and refinements to data sources and methodologies (see Section 5.2.2).

Since the release of BR4, Canada's 2005 GHG emissions have been revised upwards from 730 Mt to 741 Mt. Emissions for the last historical year at the time of the release of BR4 projections, 2017, were also revised upwards, from 716 Mt to 727 Mt. Additional information about methodological changes can be found in Sections 5.2.2 and 5.2.3 and in Annex 4.

Relative to Canada's BR4 WAM projections, changes presented in this report are mostly due to new policies announced in the SCP and 2030 ERP (see full list in Annex 3) and updated macroeconomic assumptions such as population growth and oil and gas production forecasts. In the WAM scenario, Canada's GHG emissions (including LULUCF, NBCS and Agriculture Measures and WCI credits) are projected to be 97 Mt (or 17 percent) lower than the WAM projections included in BR4 and this report.

Figure 5-3 illustrates the contribution of each sector to projected emissions reductions in 2030.

Figure 5-3: Contribution to Differences in Level of Emissions in 2030 in WAM Scenario – BR5 vs BR4 (Mt CO_2 eq)



Note:

*NBCS & Agriculture Measures is split into reductions from programs funded by the Nature Smart Climate Solutions Fund (NSCSF), and other Agricultural Nature Based Solutions and Measures.

Table 5-6 presents changes at the economic sector level between the WM and WAM scenarios.

Table 5-6: Comparison of Current WM and WAM Scenario 2030 Projections with that Presented in BR4, by Economic Sector (Mt CO_2 eq)

	With Measures			With Additional Measures		
	BR4	NC8/BR5	Change	BR4	NC8/BR5	Change
Oil and Gas	213	183	-30	199	135	-65
Electricity	24	33	9	18	19	1
Transportation	153	163	9	141	158	17
Heavy Industry	84	72	-12	80	60	-21
Buildings	77	69	-8	62	55	-7
Agriculture	76	69	-7	74	63	-10
Waste and Others	45	50	4	42	32	-10
WCI Credits	n.a.	n.a.	n.a.	-13	-4	9
LULUCF	-15	-12	3	-15	-12	3
NBCS & Agriculture Measures	n.a.	n.a.	n.a.	n.a.	-15	-15
Total	**658**	**625**	**-32**	**588**	**491**	**-97**

Note: Numbers may not sum to the total due to rounding.

5.2.7. Land Use, Land-Use Change and Forestry (LULUCF) Sector

The LULUCF projection estimates presented in Table 5-7 are modelled separately from the other sectors. The table provides projected aggregated net GHG flux estimates for the LULUCF Sector; the detailed breakdown by LULUCF sub-sectors of projected emissions with the description of the methodologies is provided in Annex 6. The aggregated accounting contribution for LULUCF Sectors is presented in Table 5-8.

Table 5-7: LULUCF Sector Net GHG Flux Estimates for Selected Years (Mt CO_2 eq)

	Net GHG flux (Mt CO_2 eq)										
	Historical Estimates								Projections*		
	1990	2005	2015	2016	2017	2018	2019	2020	2025	2030	2035
Total LULUCF	**-64**	**-4.2**	**-0.1**	**-11**	**-17**	**-8.5**	**-16**	**-6.8**	**-11**	**-10**	**-8.3**

Note:

* Historical estimates include all LULUCF sub-categories. Projected estimates include only sub-sectors for which projections are available, i.e., they exclude grassland, settlements remaining settlements and other land sub-sectors.

The accounting contribution for Forest Land remaining Forest Land (FLFL, also known as the managed forest) and associated harvested wood products (HWP) is calculated using the Reference Level approach. For the rest of the LULUCF sub-sectors, including afforested land, the accounting contribution is calculated using the net-net approach, with 2005 being the base year. Details of these calculations by LULUCF sub-sector are provided in Annex 6.

FLFL and associated HWP provide the largest share of the overall historical accounting and show a growing contribution (see Annex 6) through to 2020 because actual harvest rates continued to remain below the historical average harvest levels used to calculate the Reference Level. After 2020, the projected harvest rates and Reference Level harvest rates increasingly converge, reducing the accounting contribution from FLFL and associated HWP. They also include projected GHG impacts of the 2 Billion Trees Program.

The historical accounting contribution from Cropland Remaining Cropland varies significantly due to the high variability in emissions/removals from soil organic carbon input tied to crop production levels. The gradual decline in the carbon sink over the projected period is driven by emissions from conversion of perennial cropland to annual crops as more land went into annual crop production. These emissions partially offset carbon gains from crop production and tillage management. The level of these activities was held stable over the projected time period resulting in lower carbon gains and reduced variability as soil carbon begins to stabilize.

Table 5-8: LULUCF Accounting Contribution (Mt CO_2 eq)

	Historical Estimates						Projected Estimates*		
	2015	2016	2017	2018	2019	2020	2025	2030	2035
Total LULUCF Accounting Contribution	**4.5**	**-8.3**	**-17**	**-13**	**-21**	**-24**	**-12**	**-12**	**-13**

Note:

* Historical estimates include all LULUCF sub-categories. Projected estimates include only sub-sectors for which projections are available, i.e., they exclude grassland, settlements remaining settlements and other land sub-sectors.

5.2.8. Nature-Based Climate Solutions and Agriculture Measures

Nature-Based Climate Solutions and Agriculture Measures are estimated to reduce emissions by between 14 to 16 (15) Mt CO_2 eq per year in 2030. Nature-Based Climate Solutions include programs funded under the Nature Smart Climate Solutions Fund (NSCSF) and Agricultural Climate Solutions Fund (discussed in Annex 1). NSCSF programs include activities covering avoided conversion, improved management, and restoration of ecosystems such as wetlands, grasslands, and forest land, and is targeted to reduce emissions by 5 to 7 (6) Mt CO_2 eq per year in 2030 and up to 5 to 7 (6) Mt CO_2 eq in 2035. Agriculture Measures comprises programs funded under the Agricultural Climate Solutions Fund that include activities such as tree planting on agricultural land, rotational grazing, and implementation of best nutrient and manure management practices, and are estimated to reduce emissions by 9 Mt CO_2 eq per year in 2030 and 2035.

A more detailed breakdown of these reductions can be found in Annex 1.

5.3. Sensitivity Analysis

Uncertainty is inherent to any model that looks into the future. To address this important issue, this section examines alternative scenarios to demonstrate the sensitivity of GHG emission projections to variables such as energy prices and economic growth. Other sources of uncertainty also exist, and they are discussed in more detail in Annex 5.

Given the uncertainty regarding the key drivers of GHG emissions, while the scenarios presented in the previous section represent the best available information at this time, events that will shape emissions and energy markets cannot be fully anticipated, as we have seen from recent global developments. Moreover, future developments in technologies, demographics and resources cannot be foreseen with certainty. Therefore, the variation in these complex economic and energy variables implies that the modelling results should be viewed as a range of plausible outcomes.

Uncertainty is addressed via modelling and analysis of alternate cases that focus on variability in future economic growth, population and oil and natural gas prices. These assumptions are presented in Table 5-9 and Table 5-10, and the overall range of emissions is presented in Figure 5-4. [7]

Table 5-9: Economic Growth and Population, 2022 to 2035

	2022 to 2035		
	Low	With Measures	High
Annual GDP Growth Rate	1.22%	1.86%	2.93%
Annual Population Growth Rate	0.67%	1.15%	1.51%

7 The High and Low alternate emissions scenarios from presented in this section are equivalent to the Fast GDP—High World Oil Prices and Slow GDP—Low World Oil Prices scenarios respectively in Annex 5.

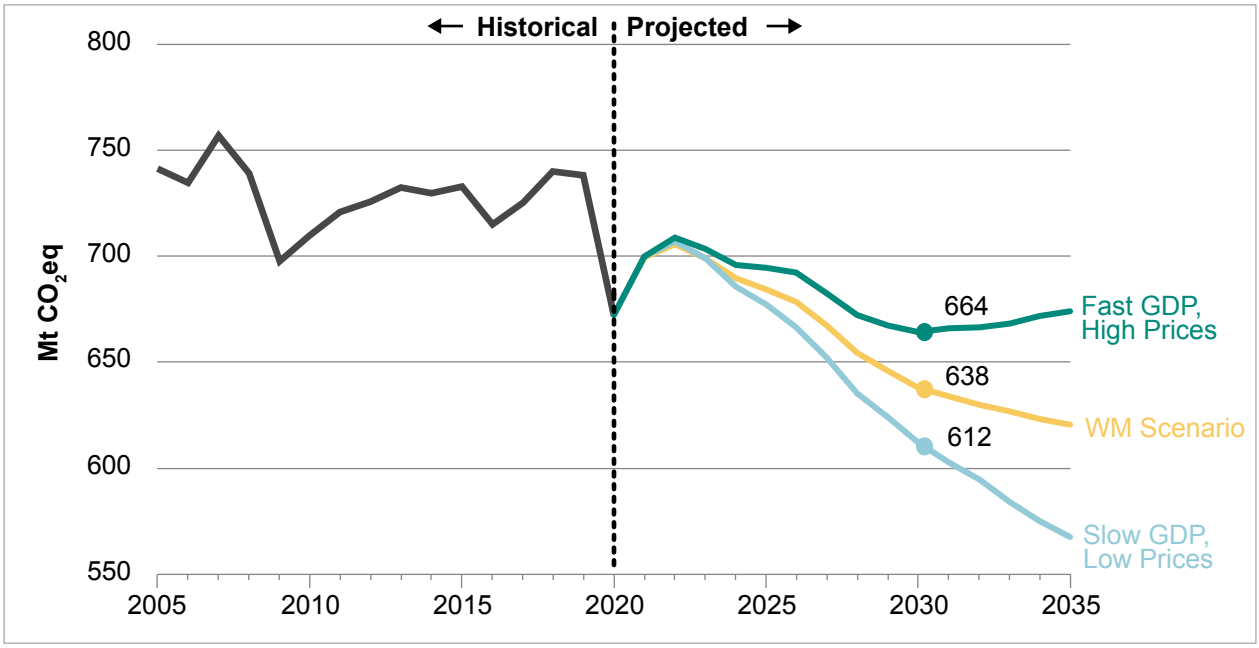
Table 5-10: Oil and Gas Prices and Production, 2030 and 2035

FUEL	UNITS	2030			2035		
		Low	With Measures	High	Low	With Measures	High
Crude Oil Price (WTI)	2020US$/bbl	$34	$67	$111	$34	$67	$111
Heavy Oil (WCS)	2020US$/bbl	$24	$55	$ 98	$24	$55	$98
Crude Oil	1000 bbl/day	4 747	5 246	5 684	4 366	5 392	6 270
Natural Gas (Henry Hub)	2020US$/ MMBtu	$2.22	$3.13	$4.38	$ 2.45	$3.36	$4.61
Natural Gas	Billion Cubic Feet	6 838	8 686	10 353	6 129	8 698	10 971

Table 5-11: Sensitivity of GHG Emissions (excluding LULUCF) to Changes in GDP and Prices (Mt CO_2 eq)

Scenarios	2025	2030	2035	2030 Projections – 2005 Emissions
Slow GDP, Low World Oil and Gas Prices	677	612	568	-129
Fast GDP, High Oil and Gas Prices	694	664	674	-77
WM Scenario	684	638	621	-103
Sensitivity Range	677 to 694	612 to 664	568 to 674	-77 to -129

Figure 5-4: Canada's Domestic Emissions Projections (Mt CO_2 eq): Low, WM and High Scenarios



Annex 1: Detailed Results

A1.1. Comparing Activity Sector Categories to Economic Sectors

Table 5-1 in Chapter 5 illustrates how the projected trends in GHG emissions vary by economic sector. Adjustments that are made to the IPCC categories to calculate economic sector emissions include reallocating:

- Off-road transportation emissions related to farming (primarily farm tractors and other mobile machinery) to the Agriculture Sector instead of Transportation;
- Off-road transportation emissions related to mining operations from Transportation to the Oil and Gas Sector and the Heavy Industry Sector;[i]
- Emissions related to pipeline operations to the Oil and Gas Sector;
- Some industrial process emissions to the Buildings Sector;
- Stationary combustion emissions under the IPCC categorisation across economic sectors, as appropriate;
    - Almost all industrial process and fugitive emissions under these processes are aligned with the economic sector that generates them (primarily in the Heavy Industry and Oil and Gas Sectors).
- Landfill emissions to the Waste and Others Sector.

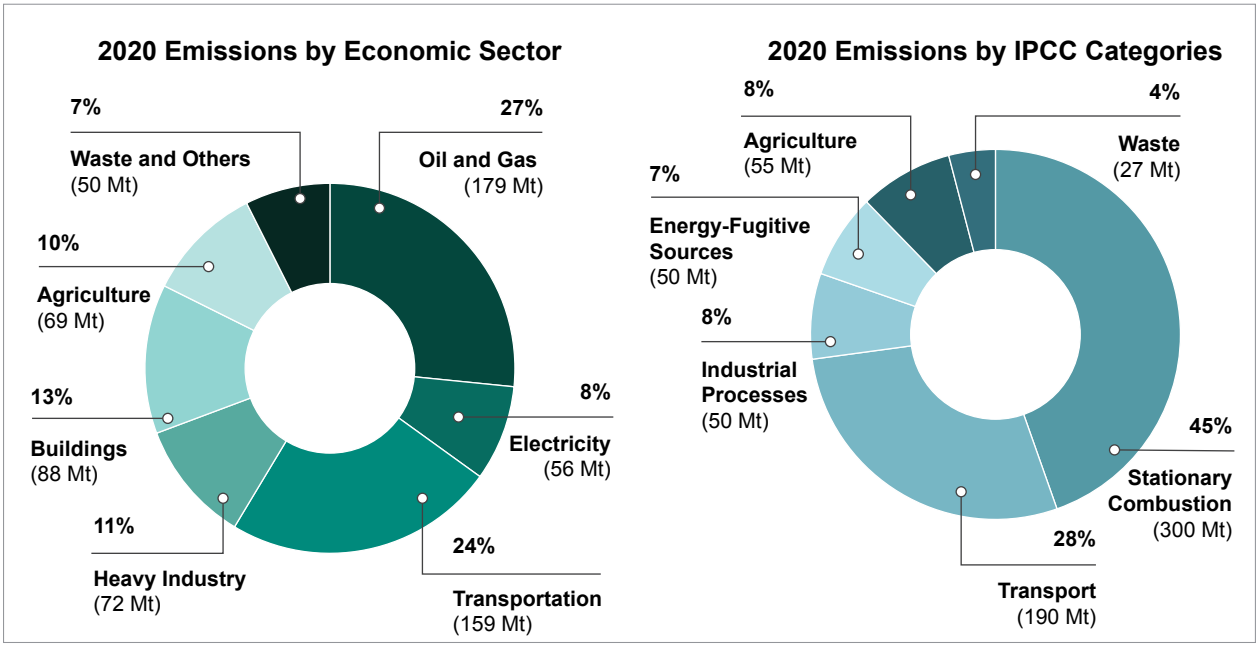
For a more detailed description of the reconciliation between economic and IPCC sector categories, please see Chapter 3: Canada's Greenhouse Gas Inventory and Annex 10 of NIR2022.[ii]

Figure 5A-1 shows the distribution of 2020 emissions on an IPCC activity basis versus an economic sector basis.

i Heavy industry subsectors include mining activities, smelting and refining, and the production and processing of industrial goods such as chemicals, fertilizers, pulp and paper, aluminum, iron and steel and cement.

ii Specifically, the section called "Reallocation of Emissions from IPCC Sector to Canadian Economic Sector."

Figure 5A-1: Total Canadian 2020 GHG Emissions (excl. LULUCF) (672 Mt CO_2 eq) – Methods of Categorisation



A1.2. Results for WM and WAM Scenarios

A1.2.1. Emissions by Gas

CO_2 emissions decreased by 7 percent between 2005 and 2020 and are projected to decline by about 13 percent between 2005 and 2030 in the WM scenario. On a CO_2 eq basis, CO_2 represented 78 percent of total Canadian GHG emissions in 2005. By 2030, in the WM scenario, this share is expected to increase slightly to 79 percent.

Between 2005 and 2020, CO_2 emissions increased in the Oil and Gas, Agriculture and Transportation Sectors. Between 2005 and 2030, in the WM scenario, CO_2 emissions are projected to decrease in the Electricity, Buildings, Waste and Others, and Heavy Industry Sectors, while they are projected to increase in the Agriculture, Oil and Gas and Transportation Sectors.

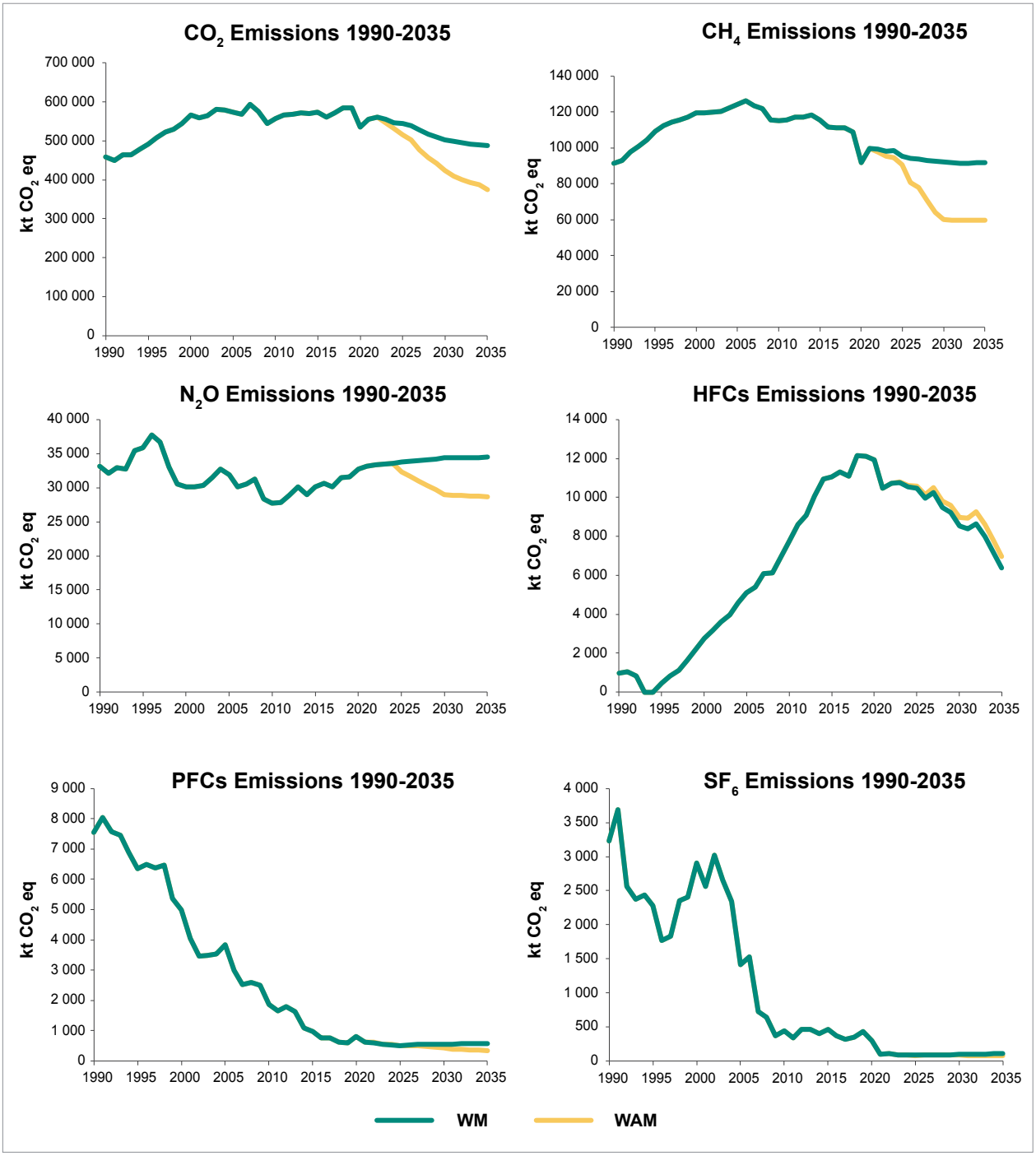
Between 2005 and 2020, methane (CH_4) emissions decreased by 26 percent, mostly due to declines in emissions from the Oil and Gas and Agriculture Sectors, the largest contributors to CH_4 emissions. Between 2005 and 2030, in the WM scenario, CH_4 emissions are projected to decrease by 26 percent, with emissions from the Oil and Gas Sector decreasing by 36 percent, and emissions from Transportation, Electricity and Heavy Industry remaining at low levels throughout the projection period. That said, the upstream Oil and Gas Sector is projected to remain the largest industrial source of methane in Canada even when taking into account the impact of Canada's methane regulations. The WAM scenario forecasts methane emissions to be significantly lower, due to the impacts of the proposed federal landfill gas regulations and strengthening of the oil and gas methane regulations.

Nitrous oxide (N_2O) emissions increased by 1 Mt between 2005 and 2020 and are projected to increase by 3 Mt CO_2 eq between 2005 and 2030 in the WM scenario. N_2O emissions arise primarily from the Agriculture Sector, whose growth in emissions is somewhat compensated by declines in the Heavy Industry, Transportation and Electricity Sectors. The WAM scenario reflects the impact of achieving the 30 percent reduction in N_2O emissions from fertilizer use in the Agricultural Sector.

Hydrofluorocarbons (HFCs) have been increasingly used in the last decade in refrigeration and air conditioning systems as an alternative to ozone damaging hydrochlorofluorocarbons (HCFCs), which lead to 2020 emissions being 7 Mt higher than in 2005. HCFCs are being phased out under the Montreal Protocol and the Kigali Amendment to that agreement in 2016 added the phase down of the use and production of HFCs. As a result, emissions of HFCs are projected to peak in 2020 at 11.9 Mt CO_2 eq before declining to 8.5 Mt CO_2 eq in 2030 in the WM scenario. In the WAM scenario emissions of HFCs are projected to be slightly higher than in the WM scenario, due to increased activity in the commercial sector due to increased investments in the sector.

Perfluorocarbons (PFCs) and sulphur-hexafluoride (SF_6) are projected to decrease substantially over the projection period. Emissions of nitrogen trifluoride (NF_3) are expected to be less than 1 kilotonne during the same period. The main releases of these gases into the environment occur during the manufacture of semi-conductors, refrigeration equipment and the production of aluminium as well as other industrial processes such as in the magnesium industry. Reductions are anticipated from voluntary measures in the aluminum industry, electricity transmission and other sectors.

Figure 5A-2: Total Canadian Emissions by Gas (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6) under WM and WAM Scenario (excluding LULUCF, NBCS and Agriculture measures), 1990 to 2035 (kt CO_2 eq)



A1.2.2. Emissions by Gas and Economic Sector

The following tables summarize total GHG projections by sector and by gas under the WM and WAM Scenarios, excluding LULUCF, NBCS and Agriculture measures, and illustrate how the projected trends vary by gas and by economic sector.

Table 5A.1: Emissions of CO_2, CH_4, and N_2O by Economic Sector, 1990 to 2035 (Mt CO_2 eq)

	Historical							Projected					
								With Measures			With Additional Measures		
	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2025	2030	2035
CO_2													
Oil and Gas	66	79	98	112	123	144	143	154	144	141	144	119	114
Electricity	94	97	128	117	94	79	56	40	32	27	36	19	2
Transportation	115	116	137	152	159	165	153	171	158	153	171	153	131
Heavy Industry	74	80	84	78	71	75	70	76	71	70	73	58	57
Buildings	68	74	79	79	73	74	76	65	60	57	59	46	42
Agriculture	12	15	15	14	14	15	16	16	16	16	16	15	15
Waste and Others	29	29	27	24	23	21	21	22	22	23	18	14	14
Total	**458**	**491**	**567**	**575**	**557**	**574**	**535**	**544**	**502**	**487**	**516**	**424**	**375**
CH_4													
Oil and Gas	36.4	48.0	56.4	58.4	58.0	59.5	35.0	39.6	37.4	37.2	39.6	15.5	15.5
Electricity	<0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.2	0.2	0.2	<0.1
Transportation	1.6	1.5	1.2	0.8	0.8	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.6
Heavy Industry	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.3
Buildings	2.2	2.1	1.7	1.4	1.4	1.5	1.4	1.0	0.8	0.7	1.0	0.7	0.6
Agriculture	25.0	29.8	31.4	34.8	28.9	27.8	27.6	27.6	27.6	27.5	27.7	27.5	27.3
Waste and Others	26.1	27.3	28.5	28.6	25.9	25.8	26.7	25.9	25.2	25.2	21.2	15.3	15.2
Total	**91.6**	**109.1**	**119.5**	**124.3**	**115.3**	**115.6**	**91.7**	**95.4**	**92.2**	**91.9**	**90.6**	**60.1**	**59.5**
N_2O													
Oil and Gas	0.3	0.5	0.6	0.7	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8
Electricity	0.5	0.5	0.7	0.7	0.6	0.5	0.4	0.3	0.3	0.3	0.3	0.2	0.0
Transportation	3.8	4.2	5.8	5.8	4.2	3.3	3.2	3.6	3.5	3.5	3.6	3.4	3.1
Heavy Industry	11.7	11.7	2.5	4.2	0.9	0.7	0.6	0.5	0.5	0.5	0.4	0.4	0.4
Buildings	0.8	0.9	1.1	1.0	0.9	1.0	1.2	1.1	1.1	1.1	1.1	1.0	1.1
Agriculture	15.0	16.9	18.0	18.0	18.9	22.1	24.7	25.2	25.8	25.8	23.9	21.0	21.0

	Historical							Projected					
	1990	1995	2000	2005	2010	2015	2020	With Measures			With Additional Measures		
								2025	2030	2035	2025	2030	2035
Waste and Others	1.1	1.3	1.4	1.5	1.6	1.7	2.0	2.2	2.3	2.4	2.1	2.2	2.3
Total	**33.2**	**35.9**	**30.2**	**31.9**	**27.7**	**30.1**	**32.8**	**33.8**	**34.4**	**34.5**	**32.3**	**29.0**	**28.7**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

Table 5A-2: Emissions of HFCs, PFCs, and SF_6 by Economic Sector, 1990 to 2035 (Mt CO_2 eq)

	Historical							Projected					
	1990	1995	2000	2005	2010	2015	2020	With Measures			With Additional Measures		
								2025	2030	2035	2025	2030	2035
HFCs													
Oil and Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation	0.0	0.2	1.2	1.9	2.7	2.7	2.5	1.8	0.6	0.0	1.8	0.6	0.0
Heavy Industry	1.0	0.0	0.0	0.0	0.5	0.5	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Buildings	0.0	0.3	1.5	2.8	4.1	7.2	8.8	8.2	7.5	6.0	8.3	7.9	6.6
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste and Others	0.0	0.0	0.1	0.4	0.3	0.7	0.4	0.4	0.3	0.3	0.4	0.3	0.3
Total	**1.0**	**0.5**	**2.8**	**5.1**	**7.7**	**11.1**	**11.9**	**10.5**	**8.5**	**6.4**	**10.6**	**9.0**	**7.0**
PFCs													
Oil and Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy Industry	7.6	6.3	4.9	3.8	1.8	1.0	0.8	0.5	0.5	0.5	0.4	0.4	0.3
Buildings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste and Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Total	**7.6**	**6.3**	**5.0**	**3.8**	**1.9**	**1.0**	**0.8**	**0.5**	**0.6**	**0.6**	**0.5**	**0.4**	**0.3**

	Historical							Projected					
	1990	1995	2000	2005	2010	2015	2020	With Measures			With Additional Measures		
								2025	2030	2035	2025	2030	2035
SF_6													
Oil and Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Transportation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy Industry	3.0	2.1	2.7	1.2	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Buildings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste and Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1
Total	**3.2**	**2.3**	**2.9**	**1.4**	**0.4**	**0.5**	**0.3**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**

Note:

F-gases consist of HFCs, PFCs, and SF_6.

Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.3. Detailed Results for WM Scenario

A1.3.1. Oil and Gas

Production, pipeline transportation, processing, refining, and distribution of oil and gas products all contribute to the emissions of the Oil and Gas Sector. In 2020, the Oil and Gas Sector produced the largest share of GHG emissions in Canada, approximately 27 percent.

Since 2005, GHG emissions from the Oil and Gas Sector have increased, reflecting growth in production due to increased development and evolving technologies in oil sands operations, from 171 Mt in 2005 to 179 Mt in 2020, a 4 percent increase shown in Table 5A-3. In 2020, the COVID-19 pandemic and the Saudi-Russia oil price war led to crude oil prices reaching decade-lows and even temporarily reaching negative levels in April 2020. The price-shock and pandemic led to production declines in 2020 as well as delayed investment and development of crude oil resources.

For the projection period, increased emissions from unconventional oil sands activity have been partly offset by declining emission-intensities in conventional oil and natural gas sectors in Canada and limited expansion of the refining sector. Government measures, such as regulations on methane emissions in the upstream Oil and Gas Sector, Carbon Pricing and the Clean Fuel Regulations are projected to constrain emissions while oil and gas production increases further. Emission projections in the Oil and Gas Sector are driven by the preliminary Canada Energy Regulator's (CER) projections of oil and natural gas prices as well as the CER's corresponding estimates of production.[iii]

Table 5A-3: Oil and Gas Sector Emissions, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Natural Gas Production and Processing	66	64	61	44	47	38	35	-28
Conventional Oil	35	33	40	25	29	30	32	-5
Light Oil Production	19	19	25	17	20	21	23	2
Heavy Oil Production	14	13	13	6	7	7	7	-8
Frontier Oil Production	2	2	2	2	1	2	2	1
Oil Sands	35	54	73	81	91	84	82	49
In Situ	12	23	38	41	46	46	47	34
Mining and Extraction	6	8	11	15	18	17	17	12
Upgraders	17	23	24	25	26	20	18	3
Oil and Natural Gas Transmission	12	7	10	10	10	9	9	-3
Downstream Oil and Gas	23	23	21	18	18	17	16	-6
Petroleum Products	22	22	20	17	17	16	16	-6
Natural Gas Distribution	1	1	1	1	1	1	1	0
LNG Production	0	0	0	0	1	4	5	4
Total	**171**	**181**	**205**	**179**	**195**	**183**	**179**	**11**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

iii CER provided ECCC with preliminary oil and gas price and production projections for inclusion in this report. CER is planning to publish updated projections in its Energy Future 2023 report in Spring 2023.

A1.3.1.1. Upstream Oil and Gas Production

In Table 5A-4, upstream Oil and Gas Sector includes the extraction, production, and processing of both conventional and unconventional oil and gas. Crude oil and natural gas production are expected to increase throughout the projection period, driven in part by increases in crude oil and natural gas prices. The West Texas Intermediate and Western Canadian Select benchmarks for light and heavy crude oil experience higher pricing levels from 2022 to 2030 than previous reports, as a result of international sanctions against Russia and the subsequent decrease in fossil fuel exports to the global market. Moreover, the Henry Hub natural gas price is expected to see significantly higher levels in 2022-2024 relative to previous projections, which results in substantial natural gas investment and development in the early-to-mid 2020's in both the WM and WAM scenarios.

Table 5A-4: Upstream Oil and Natural Gas Production: Emissions and Drivers, 2005 to 2035

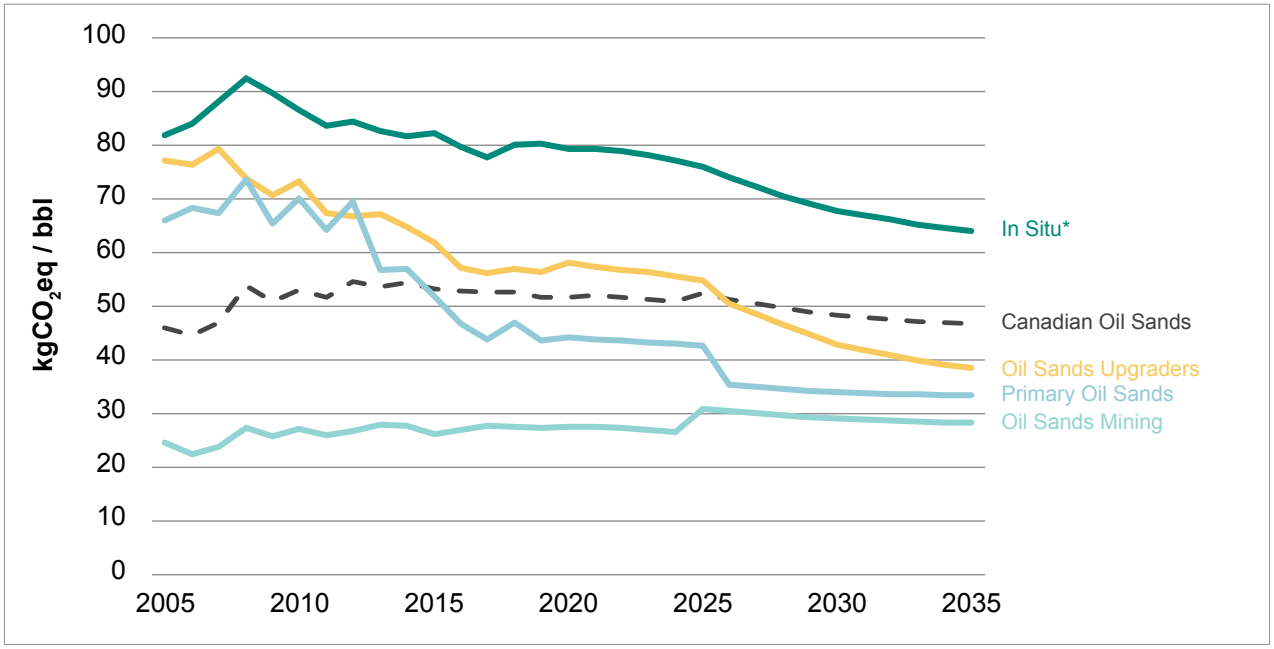
	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Conventional Oil Production							
Emissions (Mt CO_2 eq)	35	33	40	25	29	30	32
Production (1000 bbl/day)	1 360	1 231	1 264	1 194	1 440	1 651	1 677
Emissions Intensity (kg CO_2 eq /bbl)	70.8	74.3	86.9	58.3	54.9	50.6	52.0
Oil Sands (Excluding Upgraders)							
Emissions (Mt CO_2 eq)	18	31	49	56	64	63	63
Production (1000 bbl/day)	1 065	1 613	2 529	2 977	3 365	3 595	3 715
Emissions Intensity (kg CO_2 eq /bbl)	45.9	53.0	53.3	51.7	52.3	48.3	46.7
Natural Gas Production and Processing							
Emissions (Mt CO_2 eq)	66	64	61	44	47	38	35
Production (1000 bbl eq/day)	3 609	3 124	3 151	3 254	4 021	4 054	4 060
Emissions Intensity (kg CO_2 eq /bbl)	50.0	55.8	53.0	37.2	32.0	25.8	23.8

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

Emissions from upstream oil and gas production are estimated to grow from 126 Mt in 2020 to 132 Mt in 2030. The emissions trajectory for the upstream Oil and Gas Sector is a function of growing output and declining emission intensity. Relative to historical 2005 production levels, conventional oil, oil sands, and natural gas production and processing sectors all experience production growth throughout the projection period. Oil Sands emissions (excluding emissions from Upgraders) are expected to increase from 18 Mt in 2005 to 63 Mt in 2030. Emissions from oil sands mining are projected to increase by 12 Mt and In Situ production emissions are expected to increase by 35 Mt from 2005 to 2030.

Emissions from conventional crude oil production are expected to decrease from 35 Mt to 30 Mt from 2005 to 2030, whereas emissions from natural gas production and processing are expected to decline from 66 Mt in 2005 to 38 Mt in 2030. Though both conventional oil and natural gas experience growing output in the projection period, emission intensities experience substantial declines as a result of policies such as carbon pricing, the CleanBC Climate Plan, the Clean Fuel Regulations, and various provincial methane regulations. Moreover, growing levels of Carbon Capture and Storage in gas processing and heavy oil contribute to emissions reductions in the WM scenario.

Figure 5A-3: Canadian Oil Sands Emissions Intensity



Note:

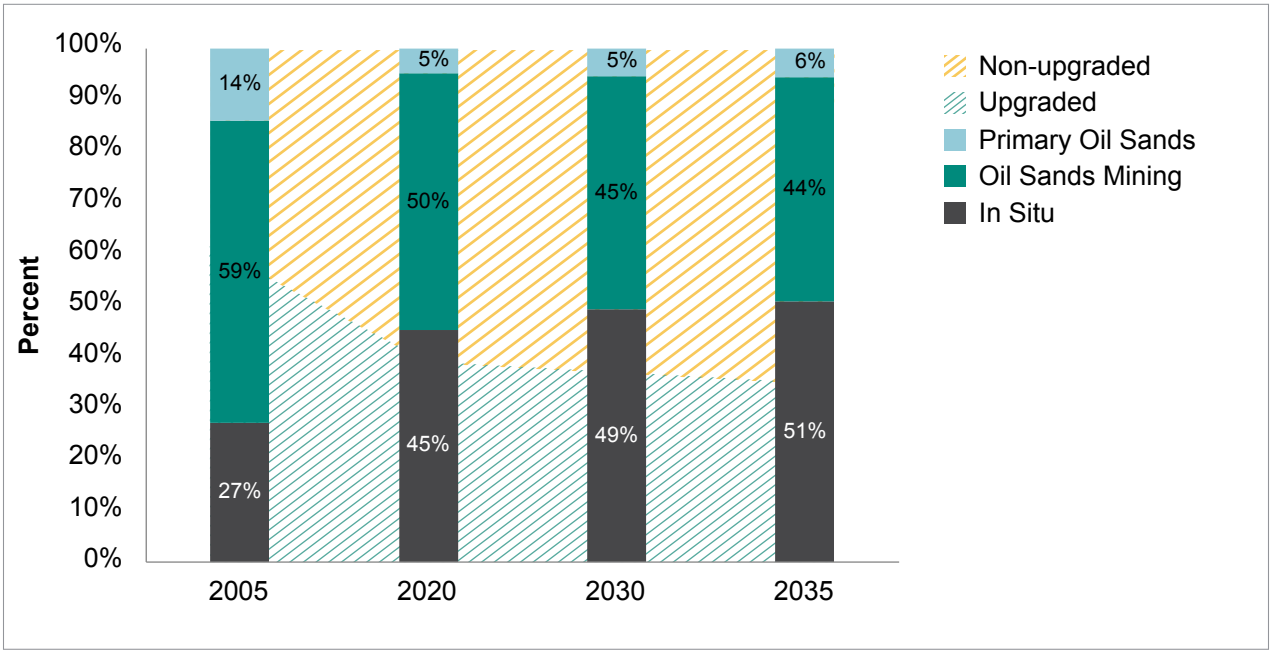
* In Situ comprises production from Cyclic Steam Stimulation (CSS) and Steam Assisted Gravity Drainage (SAGD).

Oil production from unconventional sources continues to grow. In general, extracting oil from oil sands via an In Situ method (e.g., using in-ground techniques to separate the oil from the sand) is more emissions intensive than oil sands mining (Figure 5A-3). Production growth in the oil sands sector between 2005 and 2020 resulted in growing emissions and strong production growth in the Oil Sands is expected to continue throughout the projection period.

In the historical period, overall bitumen extraction emissions intensity has remained relatively flat while bitumen production increased by about 180 percent between 2005 and 2020. Looking at Figure 5A-3, emissions intensity for Canadian oil sands bitumen extraction peaked at 55 kg CO_2 eq/bbl in 2012 before declining slightly to 52 kg CO_2 eq/bbl in 2020.

In the forecast, several factors influence emissions intensities in the oil sands. As can be seen in Figure 5A-3, growth in oil sands mining emissions intensity is a result of planned increases in cogeneration. Most notably, the Suncor Base Plant is expected to replace petroleum coke boilers with a natural gas cogeneration plant and sell excess electricity to the Alberta grid beginning in 2025. In general, there are some upward pressures on emissions intensity from factors such as declining reservoir quality, ageing of existing facilities, and shifts from mining operations to more emissions intensive In Situ extraction processes. Conversely, reductions in oil sands emissions intensity are expected to be driven by more ambitious government policy in the WM scenario, such as the implementation of the Clean Fuel Regulations, carbon pricing, and the Carbon Capture, Utilization and Storage investment tax credit. In the future, emissions intensities from the oil sands will experience additional downward pressures as well. For instance, production growth from brownfield expansions and new greenfield facilities are expected to utilize more energy-efficient processes and are most poised to pilot and deploy emerging technologies within the unconventional crude oil sector.

Figure 5A-4: Oil Sands Production



As depicted in Figure 5A-4, In Situ production rose from 27 percent of total oil sands production in 2005 to 45 percent in 2020 and is expected to contribute 49 percent by 2030. At the same time, production from oil sands mining declined from 59 percent in 2005 to 50 percent of total oil sands production in 2020 and is expected to decline to 45 percent by 2030.

A1.3.1.2. Transportation and Distribution of Oil and Gas

Emissions from Oil and Natural Gas Transmission and Natural Gas Distribution are projected to remain relatively flat in the forecast. The CER in their preliminary 2023 Current Measures scenario assumes that infrastructure required for the transportation and distribution of oil and gas products over the long term is built as needed.[iv] As such, emissions from the transportation and distribution of oil and gas products are likely to remain constant in the medium term and grow as assumed pipeline capacity expands.

iv Canada Energy Regulator, preliminary 2023 projections provided to ECCC.

A1.3.1.3. Petroleum Refining and Upgrading

Table 5A-5 displays emissions associated with the petroleum refining and upgrading sectors from 2005 to 2035. Emissions from traditional petroleum refining stay relatively unchanged over the projection period, however, emission intensity from conventional refineries declines from 30 kg CO_2 eq/bbl to 22 kg CO_2 eq/bbl between 2005 and 2030.

Emissions associated with the upgrading of oil sands bitumen are expected to decrease from 25 Mt in 2020 to 20 Mt by 2030. Decreasing emissions from upgraders, even as output increases, is due in part to the expanding use of Carbon Capture and Storage (CCS) technology at upgrading facilities, such as the Quest Project at Fort Saskatchewan, Alberta. In addition, the 240 kilometre Alberta Carbon Trunk Line (ACTL) is expected to enhance the capture, storage and use of significant quantities of carbon dioxide in oil sands operations. Enhance Energy, the owner and operator of the ACTL, has agreed to source and use carbon dioxide for Enhanced Oil Recovery from Nutrien, a fertilizer plant, and the Sturgeon Refinery.

Decreasing emissions intensity in downstream Oil and Gas Sectors are largely driven by the deployment of CCS technology endogenously forecasted in the WM scenario, as petroleum refining and upgrading are some of the lowest cost Oil and Gas Sectors to build carbon capture capacity. Incentives such as carbon pricing, the Clean Fuels Regulations, and the CCS Investment Tax-Credit spur development of carbon capture in the projection period. By 2030, refineries and upgraders are expected to build over 7 Mt-worth of Carbon Capture and Storage. This results in declining emissions intensities for upgraders in the projection period, from 77 kg CO_2 eq/bbl in 2005 to 43 kg CO_2 eq/bbl in 2030.

Table 5A-5: Petroleum Refining and Upgrading Sector Emissions and Drivers, 2005 to 2035

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Traditional Refineries							
Emissions (Mt CO_2 eq)	22	22	20	17	17	16	16
Refined Petroleum Processed (1000 bbl/day)	1 987	1 952	1 833	1 829	1 988	1 988	1 988
Emissions Intensity (kg CO_2 eq /bbl)	30.0	30.7	29.2	25.8	23.4	21.8	21.4
Upgraders							
Emissions (Mt CO_2 eq)	17	23	24	25	26	20	18
Refined Petroleum Processed (1000 bbl/day)	613	860	1 046	1 161	1 313	1 313	1 311
Emissions Intensity (kg CO_2 eq /bbl)	77.2	73.2	61.9	58.2	54.7	42.7	38.4

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.3.2. Transportation

In 2020, transportation (including passenger, freight, and residential and commercial off-road emissions) was the second largest contributor to Canada's GHG emissions, representing 24 percent of overall emissions.

Between 2005 and 2020, total transportation emissions increased from 160 Mt in 2005 to 185 Mt by 2019 and then fell to 159 Mt in 2020, a year when transportation demand was reduced, and trade experienced significant bottlenecks due to the impact of lockdowns imposed in response to the

COVID-19 pandemic. Because transportation emissions were artificially low in 2020, they are projected to increase in the short-term as activity ramps back up to previous levels. They reach as high as 177 Mt in 2025 and then start declining to 163 Mt by 2030 as the stock of existing vehicles is gradually turned over with more efficient gasoline and diesel vehicles as well as with an increasing share of zero emission vehicles (ZEV).

The federal heavy-duty vehicle and engine (HDV) GHG emissions regulations and the revised HDV emissions regulations contribute to increased fuel-efficiency of on road freight vehicles. The most recent revised standards set increasing stringencies for model years 2021-2027, maintaining model year 2027 stringencies for all subsequent years. The federal Incentives for Medium- and Heavy-Duty Zero-Emission Vehicles (iMHZEV) program, providing incentives for ZEV medium and heavy-duty vehicle lease or purchase over the next four years also contributes to reducing emissions in the growing freight sector. The projections also include the impact of public transit investments.

As depicted in Table 5A-6, the Transportation Sector comprises several distinct subsectors: passenger, freight, air and others (e.g., rail and marine). Each subsector exhibits different trends during the projection period. For example, emissions from passenger transportation are projected to decrease by 8 Mt between 2005 and 2030, while those for ground freight, off-road and other vehicles are projected to grow by 11 Mt over the same period. Passenger emissions post 2030 through to 2035 drop a further 8 Mt, as an increasing number of ZEV vehicles on the road in the passenger sector are balanced with economic growth driving increased freight emissions.

Table 5A-6: Transportation: Emissions by Subsector, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Passenger Transport	90	90	92	80	93	82	74	-8
Cars, Light Trucks and Motorcycles	82	82	83	73	83	72	62	-11
Bus, Rail and Domestic Aviation	8	8	9	6	9	10	12	2
Freight Transport	60	67	72	70	75	71	73	11
Heavy Duty Trucks, Rail	54	63	67	66	70	66	68	12
Domestic Aviation and Marine	5	5	4	5	5	5	5	-1
Other: Recreational, Commercial and Residential	10	10	9	9	9	10	11	0
Total	**160**	**167**	**172**	**159**	**177**	**163**	**157**	**3**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

Over the 2005 to 2020 period, increasing fuel efficiency of light-duty vehicles as a result of the Light Duty Vehicle (LDV) GHG Regulations has partly offset the effects of a growing economy and population putting more vehicles on the road and resulting in more kilometres (km) driven. For example, between 2005 and 2020, the sales-weighted on-road fuel efficiency for new gasoline cars improved from 9.3 litres (L) per 100 km to 8.1 L/100 km, while the sales-weighted on-road fuel efficiency for new gasoline light trucks improved from 12.8 L/100 km to 10.8 L/100 km.

Additional measures targeting light duty vehicles in passenger transportation include the Government of Canada's Incentives for Zero Emission Vehicles (ZEV), ZEV mandates in British Columbia and Québec as well as other various provincial subsidies. British Columbia's Clean Fuel Standard covers the entire sector, and it was strengthened under the CleanBC plan in 2019 with expanded coverage of aviation and marine fuels in the WAM scenario.

The combination of the LDV GHG Regulations and increasing ZEV uptake will substantially improve the new vehicle efficiency of the on-road passenger fleet. Between 2020 and 2030, the sales-weighted on-road fuel efficiency for new passenger vehicles will improve from 9.4 L/100 km to 6.4 L/100 km, a 32 percent improvement.

A1.3.3. Electricity Generation

As Canada moves towards a low-carbon future, the Electricity Sector will play an increasingly significant role in decarbonizing the economy. Most, if not all, deep decarbonisation pathways involve a clean electricity grid and electrification of other economic sectors. As about 85 percent of the utility electricity supply in Canada is generated from non-GHG emitting sources, the Electricity Sector comprised only 9 percent of total Canadian GHG emissions (excl. LULUCF accounting) in 2020. Since 2005, Electricity Sector emissions have fallen an average of 5 percent per year (mainly due to the Ontario and Alberta coal phase-outs), the fastest of any sector in Canada. The mix of sources of energy used to generate electricity vary considerably across the country, depending on regional features such as the availability of renewable energy resources like hydropower, transmission interconnections to other provinces and the United States, and access to natural gas. Several provinces rely almost exclusively on hydropower, while other jurisdictions have highly diversified mixes of power that combine non-emitting generation from renewables and nuclear with fossil fuel generation. A few provinces rely primarily on fossil fuels such as coal, natural gas, and refined petroleum products.

Several Canadian provinces have achieved nearly 100 percent non-emitting grids by 2020. Prince Edward Island, Québec, Manitoba, and British Columbia generate over 99 percent of their electricity from hydro and other renewables and are expected to continue to develop new renewable resources in the future. Newfoundland and Labrador has reached 97 percent of renewable electricity generation, while Yukon has also substantially reduced its reliance on diesel and now generates 83 percent of its electricity from renewable sources.

Growing use of on-site cogeneration to meet industrial electricity and steam demands has reduced utility demands and has further reduced Electricity Sector emissions. Cogeneration is the simultaneous generation of electricity and heat and/or steam that can be used in industrial processes such as in situ oil sands extraction. In some cases, these cogeneration plants sell their excess electricity to the utility grid. As a result of increasing use of cogeneration, emissions for electricity production are shifted from the utility Electricity Sector to the Oil and Gas Sector. Moreover, the combined production of power and steam is more efficient than their separate production due to the capturing of waste heat and steam. As a result, the general economy-wide impact of shifting from utility natural gas-fired electricity generation (or other fossil fuel sources) to industrial cogeneration using natural gas is a reduction in GHG emissions. In the particular context of Alberta's electricity grid, these reductions can be substantial. For example, the Suncor Base Plant (cogeneration facility) will replace old industrial petroleum coke boilers and could displace higher-emitting utility generation.

The recent downward trend in emissions from the Electricity Sector is expected to continue over the next decade due to various federal and provincial governmental initiatives. Emissions in the Electricity Sector fell by 62 Mt from 2005 to 2020 and are projected to further decrease by 23 Mt by 2030, for a total decrease of 85 Mt over the period while total generation increases. Table 5A-7 outlines the decline in projected emissions alongside the expected increase in electricity generation from 2005 through 2035.

Table 5A-7: Utility Electricity Sector: Emissions and Drivers, 2005 to 2035

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Emissions (Mt CO_2 eq)	118	95	80	56	41	33	28	-85
Generation (TWh)	550	541	578	578	617	695	771	146

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

Federal regulations to reduce CO_2 emissions from coal-fired electricity came into effect on July 1, 2015. The regulations apply a stringent performance standard to new coal-fired electricity generation units and those coal-fired units that have reached the end of their economic life. The regulations are facilitating a permanent transition towards lower or non-emitting types of generation such as high-efficiency natural gas and renewable energy. With these regulations, Canada became the first major coal user to effectively ban construction of conventional coal-fired electricity generation units. To further its commitment to eliminate coal-fired electricity, the federal government accelerated the coal-phase out to 2030 by introducing amendments to the regulations.

As such, coal generation is expected to be close to zero by 2030. Saskatchewan's carbon capture and storage Boundary Dam 3 plant is the only unit currently expected to not be affected by the regulation, as it would operate below the performance standard limit of 420 tCO_2/GWh. Natural gas generation is expected to compensate for decreasing coal generation, as well as to support the increasing use of intermittent wind and solar generation. Indeed, when the sun is not shining or the wind is not blowing, more reliable sources of electricity generation (such as natural gas) are needed to balance the grid.

In addition, several provinces have introduced significant measures to move away from fossil fuel electricity generation and towards cleaner sources of power that contribute to the decline in Electricity Sector emissions. Newfoundland and Labrador is constructing a new large hydro dam (Muskrat Falls) and an underwater transmission link between Labrador and Newfoundland Island to replace ageing, high-emitting heavy fuel oil generation on the Island with renewable power and export more hydroelectricity to the Maritimes. Nova Scotia and New Brunswick decreased their Electricity Sector emissions through renewable portfolio standards that required 40 percent of non-emitting electricity by 2020. Saskatchewan aims to reduce electricity emissions by 50 percent as compared to 2005 levels by 2030. Alberta electric utilities aim to retire coal electricity generation by the end of 2023, several years before the federal regulation.

Consequently, the proportion of utility electricity generation coming from renewable sources is projected to increase from 69 percent in 2020 to 79 percent in 2030. This increase in renewable generation share is due in large part to wind power increasing its share of total generation from 7 percent in 2020 to 19 percent in 2030. The share of electricity generated from nuclear power, however, is expected to decline by 28 percent over the same time frame, as Ontario reduces its nuclear capacity between 2020 and 2030 with the retirement of several ageing units.

Overall, emissions from coal-fired generation are projected to decline by 98 Mt over the 2005 to 2030 time period. Emissions from refined petroleum products such as diesel and fuel oils are expected to fall by over 10 Mt. Emissions from natural gas are expected to increase by about 23 Mt over the period, as natural gas replaces coal in some provinces, helps meet growing electricity demand, and supports the integration of higher levels of intermittent renewables.

Table 5A-8: Utility Electricity Sector Emissions by Fuel Type, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Coal	99	79	63	35	4	0	0	-99
Refined Petroleum Products	11	5	5	4	3	1	1	-10
Natural Gas	7	11	11	17	33	30	26	23
Biofuels	0	0	0	0	0	0	0	0
Steam Generation	0	0	0	0	0	0	0	0
Total	**118**	**95**	**80**	**56**	**40**	**32**	**28**	**-85**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.3.4. Heavy Industry

The Heavy Industry Sector includes metal and non-metal mining activities, smelting and refining, and the production and processing of industrial goods such as chemicals, fertilizers, aluminum, pulp and paper, iron and steel, and cement.

Emissions from the Heavy Industry Sector decreased by 15 Mt between 2005 and 2020, with the 2009 recession contributing to the drop in 2010 and the COVID-19 pandemic contributing to slowing economic activity in 2020. From 2020, emissions are projected to increase by 5 Mt in 2025 due to increased production in some subsectors, and then decrease to 2020 levels in 2030 due to measures such as the decarbonisation of Ontario's integrated iron and steel facilities. Emissions are estimated to have been at their lowest point in 2009 following a decline in pulp and paper, iron and steel, and smelting and refining output, but then recovered somewhat with increased chemical and fertilizer production.

Table 5A-9: Heavy Industry: Emissions and Drivers, 2005 to 2035

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Emissions (Mt CO_2 eq)	87	75	78	72	77	72	71	-15
Gross Output of Heavy Industry (1997 $billions)	144	116	142	130	149	160	172	16

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

On average, emissions generated by heavy industry subsectors are projected to be 17 percent less than 2005 levels by 2030. Emissions decreased from 2005 to 2010 due to production losses during the economic downturn of 2009. Modest production growth in successive years has been offset by continued reduction of emissions intensities, in response to some government funding for energy and emission reduction projects.

Over the 2020 to 2030 period GHG emissions from a number of subsectors are projected to increase. For example, emissions are projected to grow 8 percent for mining, 9 percent for cement, 11 percent for lime and gypsum, and 7 percent for smelting and refining. This reflects expected increases in production, while the energy efficiency of the subsectors increases more slowly.

Table 5A-10: Heavy Industries' Emissions by Subsector, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Mining	7	8	8	9	11	11	11	4
Smelting and Refining (Non-Ferrous Metals)	14	11	10	10	10	11	11	-3
Pulp and Paper	9	7	6	7	7	7	5	-2
Iron and Steel	16	14	15	12	15	10	10	-6
Cement	13	10	10	10	11	11	11	-2
Lime and Gypsum	3	3	2	2	2	2	2	-1
Chemicals and Fertilizers	24	22	26	21	21	21	21	-3
Total	**87**	**75**	**78**	**72**	**77**	**72**	**71**	**-15**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.3.5. Buildings

Emissions in Canada's commercial and residential buildings (excluding indirect emissions from electricity) increased by 4 Mt between 2005 and 2020. Between 2005 and 2020, buildings have accounted for about 12 percent of Canada's GHG emissions in any given year. Despite a growing population and increased housing stock and commercial/institutional building stock, energy efficiency improvements are projected to help emissions decline by 15 Mt from 2005 to 2030. This highlights the decreasing emissions intensities in the average building due to increasing energy costs (including the impact of carbon pricing) being managed with better technologies, for example by replacing natural or oil-fired space heating equipment with electric heat pumps. Post-2030, emissions from buildings are expected to decline by a further 4 Mt.

A1.3.5.1. Residential

As shown in Table 5A-11, GHG emissions from residential buildings (e.g., houses, apartments and other dwellings) declined by 4 Mt between 2005 and 2020, and are projected to decline by 14 Mt between 2005 and 2030. This is despite an expected 13.3 percent increase in the number of Canadian households (a key driver of residential emissions growth) between 2020 and 2030. In addition, federal and provincial measures aimed at increasing the energy efficiency of residential buildings, such as building code regulations, rebates for energy efficiency improvements and voluntary housing energy efficiency standards help to improve efficiencies in this subsector over time. Post-2030, emissions from residential buildings are expected to decline by a further 1 Mt.

Table 5A-11: Residential Subsector: Emissions and Drivers, 2005 to 2035

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Emissions (Mt CO_2 eq)	44	41	42	40	33	30	29	-14
Households (millions)	12	13	14	15	16	17	18	5

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.3.5.2. Commercial

As shown in Table 5A-12, emissions in the commercial subsector increased by 8 Mt (or 20 percent) between 2005 and 2020, while commercial floor space (the principal driver of emissions from this subsector) increased by 16.4 percent during the same period. Between 2005 and 2030, emissions are expected to decline by 1 Mt despite floor space increasing by 36 percent, as a result of continued efficiency improvements and the phase down of and bulk import ban on HFCs used in refrigeration and air conditioning. As HFCs have an average global warming potential that is up to 1900 times more potent than CO_2, decreasing HFCs consumption has a significant impact on projected emissions. Post-2030, emissions from commercial buildings are expected to reach 37 Mt in 2035, 2 Mt lower than in 2030.

Table 5A-12: Commercial Subsector: Emissions and Drivers, 2005 to 2035

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Emissions (Mt CO_2 eq)	40	38	42	48	42	39	37	-1
Floor space (millions m^2)	654	714	748	761	797	842	892	188

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.3.6. Agriculture

The majority of GHG emissions from agriculture are due to biological processes in animal and crop production, as well as emissions from inorganic and organic fertilizer. Most of the GHGs emitted in the agricultural sector (on a CO_2 equivalency basis) are methane and nitrous oxide with a smaller amount of carbon emissions from on-farm fuel combustion.

Canadian agricultural GHG emissions were approximately 66 Mt CO_2 eq in 2005, decreasing slightly over the rest of the decade, and increasing again over the following ten years, reaching approximately 69 Mt CO_2 eq in 2020. Projections show a slight decrease over the next decade to 69 Mt in 2030, 3 Mt higher than the 2005 levels.

The sources of those emissions show a compositional shift over the historical period. In 2005, crop production emissions were about 12 Mt (18 percent of total agricultural emissions, excluding LULUCF), and increased to 21 Mt (30 percent) in 2020. This increase was due to an increased use of fertilizers and was offset by a decrease in livestock production emissions, which dropped from 42 Mt (64 percent of agricultural emissions, excluding LULUCF) to 34 Mt (50 percent) over the same period as a result of decreased cattle herds. Emissions from on-farm fuel use are expected to keep with the historical trend of approximately 13 Mt per year (18 percent of total agriculture emissions, excluding LULUCF).

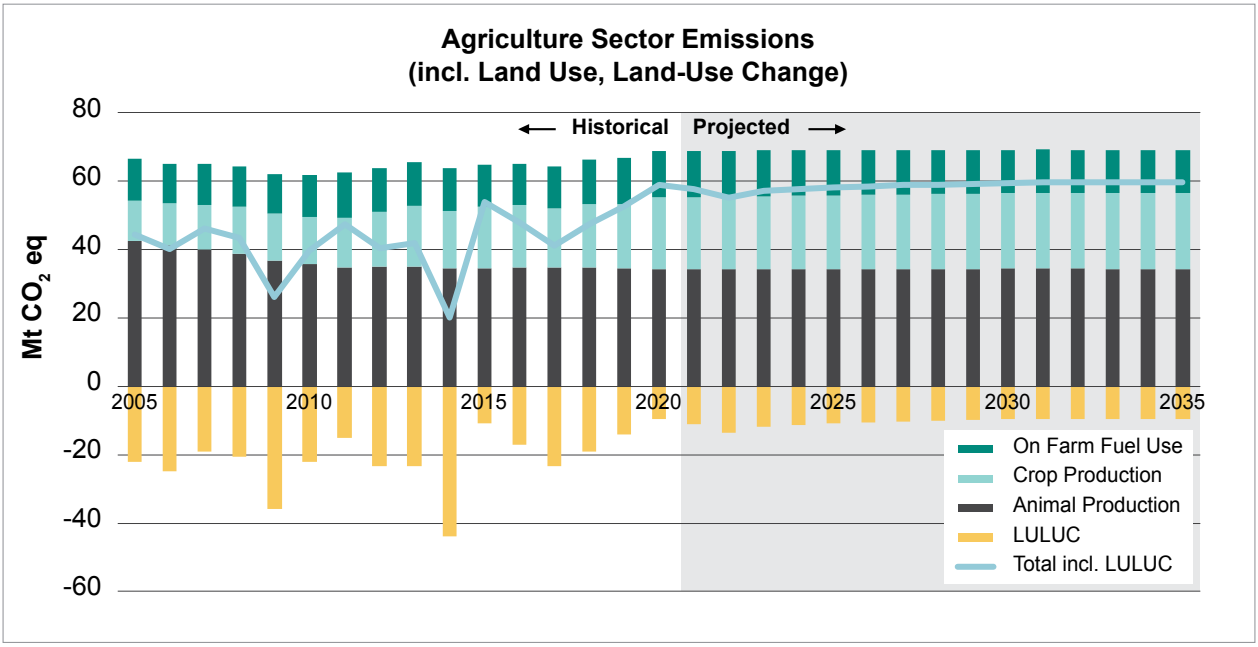
Table 5A-13: Agriculture Sector Emissions by Subsector, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
On Farm Fuel Use	12	12	12	13	13	13	13	0
Crop Production	12	14	18	21	22	22	22	10
Animal Production	42	36	34	34	34	34	34	-8
Total	**66**	**62**	**65**	**69**	**69**	**69**	**69**	**3**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

In addition to crops, animals, and fuel combustion, changes in land use patterns also play a significant role in the GHG impact of the agricultural sector. Over the last decade, agricultural land in Canada has been a net carbon sink, reducing the total GHG impact of the sector. This trend can be seen in Figure 5A-5. Although targeted by agriculture policies, emissions and removals (sequestration) of carbon from agricultural soils due to changes in land management practices and land-use are accounted for separately in the LULUCF Sector.

Figure 5A-5: Net Agriculture Sector Emissions (Including Net GHG Flux from Land Use, Land-Use Change on Agricultural Land) from 2005 to 2035



A1.3.7. Waste and Others

From 2005 to 2020, GHG emissions from municipal solid waste landfills declined, as a result of provincial government measures aimed at capturing landfill gas as well as organic waste diversion. Between 2005 and 2030, emissions are expected to decline by 5 Mt despite projected population growth.

Non-emissions-intensive industrial subsectors included in the Waste and Others sector represent a wide variety of operations, and include light manufacturing (e.g., food and beverage, and electronics), construction, and the forestry and logging service industry. Emissions from these various subsectors declined after the 2009 economic downturn and are projected to decrease by 9 percent from 2005 to 2030 as total emissions stay flat relative to the 2020 historical year. Carbon pricing is currently the main policy measure that helps contain the growth in emissions from the light manufacturing, construction, and forest resources sector.

Table 5A-14: Waste and Others Emissions by Subsector, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Waste	29	26	26	27	27	26	26	-3
Coal Production	2	3	2	2	2	2	2	0
Light Manufacturing, Construction and Forest Resources	24	22	21	20	21	21	22	-2
Total	**55**	**51**	**50**	**50**	**50**	**50**	**51**	**-5**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.3.8. Foreign Passenger and Foreign Freight

Emissions from Foreign Passenger and Foreign Freight Sectors are not included in the national total consistent with UNFCCC reporting guidelines.

Emissions from the Foreign Passenger and Foreign Freight sectors comprise total Canadian fuel sold to foreign registered watercraft and aircraft. Emissions increased by 4 Mt between 2005 and 2019 reaching 24 Mt before declining in 2020 to 14 Mt. Between 2005 and 2030, emissions are expected to be flat as increases in Foreign Passenger emissions are offset by declining emissions in Foreign Freight. These projections account for energy efficiency improvements, including voluntary emissions reduction agreements in the aviation sector.

Table 5A-15: Emissions from Fuel Used for International Aviation and Maritime Transportation by Subsector, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Foreign Freight	11	10	10	8	8	8	9	-3
Foreign Passenger	8	8	10	6	11	12	13	3
Total	**20**	**18**	**20**	**14**	**19**	**20**	**21**	**0**

Note: Numbers may not sum to the total due to rounding. Total historical emissions data is taken from NIR 2022 and represents the sum of International Aviation from Table 3-3 and International Navigation from Table 3-4 from that document.

A1.4. Detailed Results for WAM Scenario

A1.4.1. Oil and Gas

Though activity in Canada's Oil and Gas Sector is often defined by the international price for crude oil and natural gas, the WAM scenario explores how the sector could evolve in a more ambitious policy environment. In this scenario, the Oil and Gas Sector experiences substantial emissions abatement due to existing and announced policies driving decarbonization throughout the industry. A breakdown of emissions abatement by oil and gas sub-sector can be found in sections below.

Table 5A-16: Oil and Gas Sector Emissions, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Natural Gas Production and Processing	66	64	61	44	47	30	28	-36
Conventional Oil	35	33	40	25	29	19	20	-16
Light Oil Production	19	19	25	17	20	12	13	-7
Heavy Oil Production	14	13	13	6	7	5	5	-10
Frontier Oil Production	2	2	2	2	1	2	2	1
Oil Sands	35	54	73	81	81	62	58	27
In Situ	12	23	38	41	40	28	28	16
Mining and Extraction	6	8	11	15	17	13	13	8
Upgraders	17	23	24	25	24	21	18	4
Oil and Natural Gas Transmission	12	7	10	10	9	8	7	-4
Downstream Oil and Gas	23	23	21	18	17	13	12	-11
Petroleum Products	22	22	20	17	16	12	12	-10
Natural Gas Distribution	1	1	1	1	1	1	1	-1
LNG Production	0	0	0	0	1	3	4	3
Total	**171**	**181**	**205**	**179**	**184**	**135**	**130**	**-36**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.4.1.1. Upstream Oil and Gas Production

Emissions from the upstream Oil and Gas Sector as shown in Table 5A-17 reach 91 Mt in 2030 in the WAM scenario, an additional 42 Mt decrease from the WM case. Emissions from conventional oil extraction and natural gas production and processing are expected to experience significant reductions relative to historical emissions levels. By 2030, emissions decrease from 25 Mt in 2020 to 19 Mt in conventional oil, and decrease from 44 Mt in 2020 to 30 Mt in natural gas production and processing. One of the central levers of Oil and Gas Sector emissions abatement in the WAM case is the Strengthened Methane Regulation. In addition to the existing provincial methane regimes, the enhanced methane regulation achieves a 75 percent reduction in methane emissions compared to 2012 historical levels. Emissions reductions from the Strengthened Methane Regulation are present through most oil and gas subsectors, but the reductions associated with the enhanced regulations are primarily concentrated in conventional oil and natural gas production and processing, as these sectors have a high proportion of fugitive methane emissions relative to total sector-level greenhouse gas emissions.

Table 5A-17: Upstream Oil and Natural Gas Production: Emissions and Drivers, 2005 to 2035

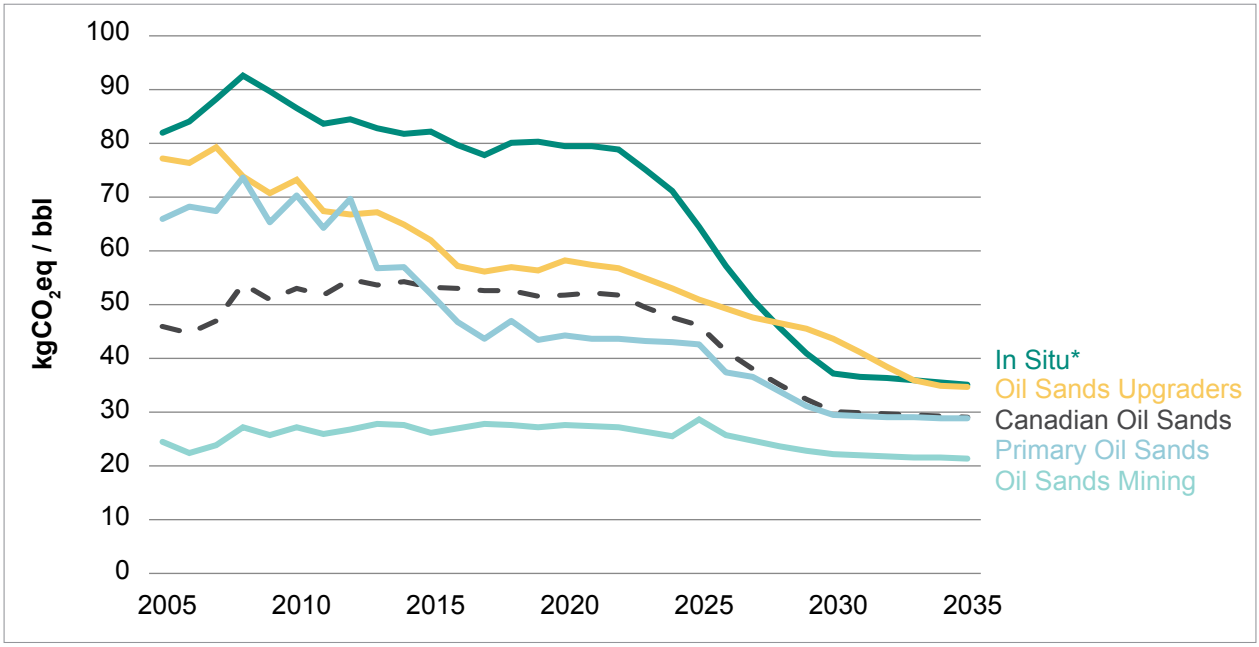
	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Conventional Oil Production							
Emissions (Mt CO_2 eq)	35	33	40	25	29	19	20
Production (1000 bbl/day)	1 360	1 231	1 265	1 194	1 454	1 708	1 727
Emissions Intensity (kg CO_2 eq /bbl)	70.8	74.3	86.9	58.3	54.7	30.8	32.0
Oil Sands (Excluding Upgraders)							
Emissions (Mt CO_2 eq)	18	31	49	56	57	41	41
Production (1000 bbl/day)	1 065	1 613	2 529	2 977	3 386	3 725	3 834
Emissions Intensity (kg CO_2 eq /bbl)	45.9	53.0	53.3	51.7	46.1	30.2	29.3
Natural Gas Production and Processing							
Emissions (Mt CO_2 eq)	66	64	61	44	47	30	28
Production (1000 bbl eq/day)	3 609	3 124	3 151	3 254	4 028	4 087	4 057
Emissions Intensity (kg CO_2 eq/bbl)	50.0	55.8	53.0	37.2	32.0	20.3	18.8

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

Oil sands emissions (excluding emissions from upgraders) are expected to decline from 56 Mt in 2020 to 41 Mt in 2030, a 22 Mt reduction relative to the WM scenario. Emissions intensities decline from 46 kg CO_2 eq/bbl in 2005 to 30 kg CO_2 eq/bbl in 2030. Despite strong levels of oil sands production growth through the projection period, emissions are constrained in part due to increased use of hydrogen as a substitute for natural gas consumption. Increased use of hydrogen generates significant emissions reductions, as the oil sands are some of the largest industrial consumers of natural gas throughout the Canadian economy. Investment and funding measures such as carbon revenue (OBPS and fuel charge proceeds programs), and investments from the Canada Growth Fund additionally contribute emissions reductions in the oil sands. Moreover, increased utilization of solvent deployment in the oil sands drives emission intensity reductions throughout the projection period. By 2025 in the WAM scenario, it is assumed that all new SAGD oil sands facilities deploy solvent technology, either through co-injection or utilization of pure solvents.

The upstream Oil and Gas Sector experiences small increases in production in the WAM scenario relative to the WM case. For the oil sands, increased output is a result of growing utilization of solvent technology. It is assumed for new SAGD facilities that deploy solvent technology will experience a 40 percent increase in production compared to WM production levels. Furthermore, in the conventional oil sector, small increases in production in the WAM scenario are a result of projected declines in the Clean Fuels Regulation (CFR) credit price in the WAM scenario. In the WM case, the conventional oil sector experiences an obligation to reduce emissions intensity in order to comply under the Clean Fuels Regulation. Conversely in the WAM scenario, the regulatory obligation from the Clean Fuels Regulation is substantially reduced, as more ambitious targets for zero-emission vehicles sales are met, which leads to a greater supply of CFR credits in the market, driving down the projected credit price. Decreased stringency in the Clean Fuels Regulation in the WAM scenario leads to a reduction in production costs for oil producing sectors, resulting in a small increase in development and production. Increases in gross natural gas production in the WAM scenario relative to the WM case, are driven by increased associated gas produced from conventional oil wells.

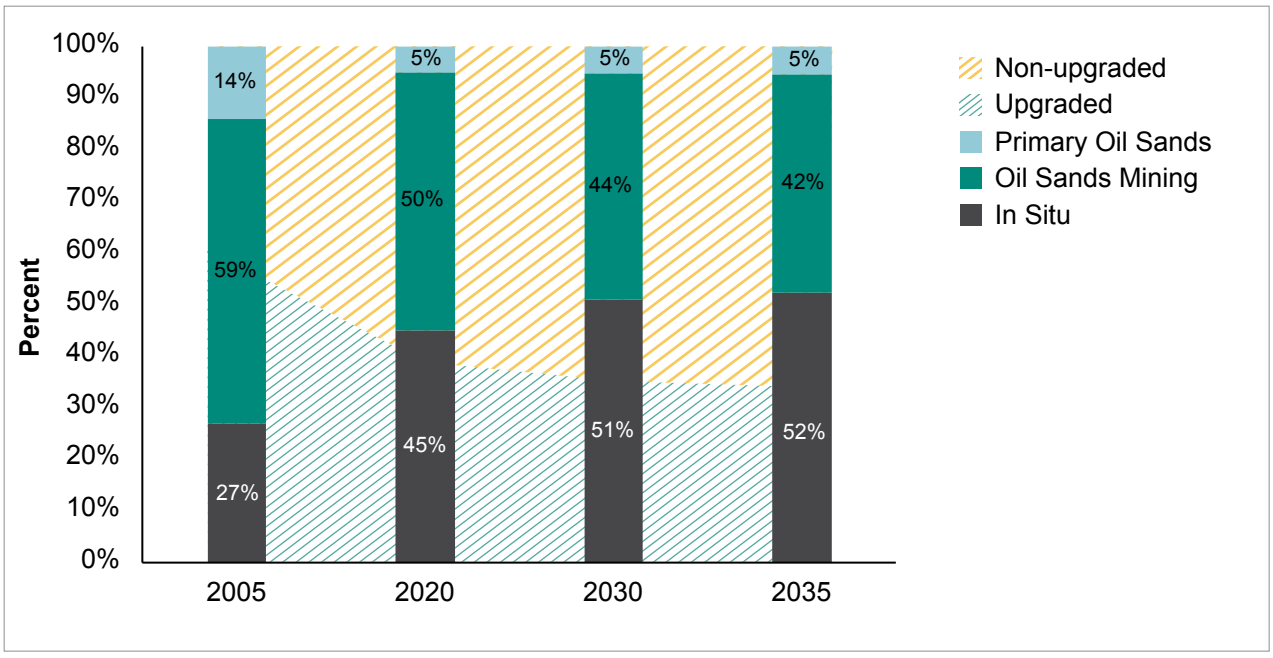
Figure 5A-6: Canadian Oil Sands Emissions Intensity



Note:

* In Situ comprises production from Cyclic Steam Stimulation (CSS) and Steam Assisted Gravity Drainage (SAGD).

Figure 5A-7: Oil Sands Production



As depicted in Figure 5A-7, In Situ production rose from 27 percent of total oil sands production in 2005 to 45 percent in 2020 and is expected to contribute 51 percent of total oil sands production by 2030. Relative to the WM case, In Situ production in the WAM scenario comprises a higher proportion of total oil sands output, due to production increases associated with the deployment of solvent technology. Production from oil sands mining declines from 59 percent in 2005 to 50 percent of total oil sands production in 2020 and is expected to decline to 44 percent by 2030 in the WAM scenario.

A1.4.1.2. Transportation and Distribution of Oil and Gas

Emissions from Oil and Natural Gas Transmission and Natural Gas Distribution are expected to decline from 10 Mt in 2020 to 8 Mt in 2030, a 1 Mt decrease relative to the WM scenario. Emissions abatement in the oil and natural gas distribution sector are primarily due to the Strengthened Methane Regulation and increased hydrogen consumption.

A1.4.1.3. Petroleum Refining and Upgrading

As shown in Table 5A-18, emissions from conventional refineries reach 12 Mt by 2030, an additional 4 Mt reduction relative to the WM scenario. Though production remains relatively constant throughout the projection period, emissions abatement in the WAM scenario is partially driven by increased hydrogen use as a substitute for natural gas consumption among conventional refineries. Additionally, increased deployment of Carbon Capture and Storage (CCS) for conventional refineries leads to additional abatement. Though in the WAM scenario there are no additional policies that incent incremental CCS development relative to the WM case, proposed CCS projects in advanced stages of development at the time of this report's publication are assumed to reach a final investment decision in the WAM scenario and begin sequestration during the forecast period.

Emissions from oil sands upgraders decrease from 25 Mt in 2020 to 21 Mt in 2030, a 1 Mt increase relative to the WM scenario. Upgraders are one of the few sectors that experience increased emissions in the WAM scenario relative to the WM case. This is a result of decreased CCS deployment for oil sands upgraders in the WAM scenario; due to increased energy prices from the Hydrogen Mandate that adversely impacts CCS project economics, and decreased regulatory stringency for upgraders, from a weaker Clean Fuels Regulation (CFR) credit price. Upgraders in the WM scenario face a strong financial incentive to invest in CCS deployment, partially due to a high CFR credit price. However, in the WAM scenario, increased electric vehicle sales generate more CFR credits, therefore driving down the CFR credit price, reducing the regulatory burden and providing less incentive for upgraders to build CCS capacity. Nevertheless, oil sands upgraders do generate emissions abatement through alternative pathways in the WAM scenario, such as substituting hydrogen for natural gas consumption, carbon revenue investments, and abating methane emissions in compliance with the Strengthened Methane Regulation.

Table 5A-18: Petroleum Refining and Upgrading Sector Emissions and Drivers, 2005 to 2035

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Traditional Refineries							
Emissions (Mt CO_2 eq)	29	22	20	17	16	12	12
Refined Petroleum Processed (1000 bbl/day)	1 987	1 952	1 833	1 829	1 988	1 988	1 988
Emissions Intensity (kg CO_2 eq/bbl)	30.0	30.7	29.2	25.8	21.5	16.3	16.3
Upgraders							
Emissions (Mt CO_2 eq)	17	23	24	25	24	21	18
Refined Petroleum Processed (1000 bbl/day)	613	860	1 041	1 161	1 313	1 313	1 397
Emissions Intensity (kg CO_2 eq/bbl)	77.2	73.2	61.9	58.2	51.0	43.6	34.7

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.4.2. Transportation

Emissions from the Transportation Sector as shown in Table 5A-19 reach 158 Mt in 2030 in the WAM case, a further reduction of 5 Mt compared to emissions in the WM case. Emissions from the passenger sector fall to 78 Mt in 2030, driven by extended efficiency gains in diesel and gasoline passenger vehicles, as well as increased targets for new passenger zero-emission vehicle (ZEV) sales (60 percent by 2030 and 100 percent by 2035). With these more stringent assumptions, the sales-weighted fuel efficiency for new passenger vehicles reaches 3.9 L/100 km in 2030. This amounts to an efficiency gain of 59 percent over the new vehicle efficiency of 9.4 L/100 km in 2020 and a 39 percent efficiency improvement over the new vehicle efficiency of 6.4 L/100 km for 2030 in the WM case.

In the freight sector, emissions reach 70 Mt in 2030, pushed lower by stricter targets for zero-emission vehicle (ZEV) sales share in medium and heavy-duty vehicles (MHDVs). MHDV ZEV market shares see their increase take effect in later years targeting 35 percent in 2030 and 100 percent where feasible by 2040, resulting in a lower impact in 2030. As more vehicles enter the market, the impact is greater, with the sector emitting 66 Mt in 2035, a reduction of 7 Mt versus the WM case. Additionally, funding for retrofitting existing stock of MHDVs as well as improved efficiency assumptions for marine, air, and trucks contribute to 2030 emissions reductions in the freight sector.

Table 5A.19: Transportation: Emissions by Subsector, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Passenger Transport	90	90	92	80	93	78	60	-12
Cars, Light Trucks and Motorcycles	82	82	83	73	83	68	50	-14
Bus, Rail and Domestic Aviation	8	8	9	6	9	10	10	1
Freight Transport	60	67	72	70	75	70	66	11
Heavy Duty Trucks, Rail	54	63	67	66	70	66	61	11
Domestic Aviation and Marine	5	5	4	5	5	5	5	-1
Other: Recreational, Commercial and Residential	10	10	9	9	9	9	9	-1
Total	**160**	**167**	**172**	**159**	**177**	**158**	**135**	**-2**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.4.3. Electricity Generation

Electricity generation is higher by the end of the projections in the WAM than in the WM scenario due to more ambitious electrification of the economy. While in 2030 electricity generation is only 4 TWh higher in the WAM scenario, this difference rises to 25 TWh by 2035. Despite this higher level of electricity generation, electricity emissions are projected lower in the WAM scenario: by 14 Mt CO_2 eq in 2030 and 26 Mt CO_2 eq in 2035. The strategic interconnections (Atlantic Loop and the Prairie Link) and the Clean Electricity Regulations are the main reasons why emissions are lower in the WAM scenario. Also, projects such as the carbon capture and storage at Genesee power plant in Alberta are expected to contribute to emissions reductions in the WAM scenario.

Table 5A-20: Utility Electricity Sector: Emissions and Drivers, 2005 to 2035

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Emissions (Mt CO_2 eq)	118	95	80	56	36	19	2	-98
Generation (TWh)	550	541	578	578	616	699	796	150

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

Table 5A-21: Utility Electricity Sector Emissions by Fuel Type, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Coal	99	79	63	35	4	0	0	-99
Refined Petroleum Products	11	5	5	4	2	1	0	-10
Natural Gas	7	11	11	17	30	18	1	11
Biofuels	0	0	0	0	0	0	0	0
Steam Generation	0	0	0	0	0	0	0	0
Total	**118**	**95**	**80**	**56**	**36**	**19**	**2**	**-99**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.4.4. Heavy Industry

Since 2005, GHG emissions from the Heavy Industry Sector have followed a downward trend, with their lowest levels in 2009 and 2020 during economic downturns. By 2030, GHG emissions should be around 60 Mt (i.e., 31 percent below 2005 levels). Compared to the WM scenario, the WAM scenario's GHG emissions decrease by 13 Mt in 2030, which represents a 17 percent reduction.

Electrification initiatives, carbon revenue returns, and energy efficiency programs are the main drivers of the drop in emissions in this sector.

Table 5A-22: Heavy Industry: Emissions and Drivers, 2005 to 2035

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Emissions (Mt CO_2 eq)	87	75	78	72	74	60	58	-28
Gross Output of Heavy Industry (1997 $billions)	144	116	142	130	152	161	172	17

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

Between 2005 and 2020, emissions from the Heavy Industry Sector are dominated by the cement, iron and steel and chemical & fertilizers industries. This trend is maintained over the projection period. In the Heavy Industry Sector, emissions reductions are led by the Non-Ferrous Metals, Chemicals and Fertilizers industries. In 2030, GHG reductions in these two industries account for 65 percent of total reductions relative to the WM scenario.

Table 5A-23: Heavy Industries' Emissions by Subsector, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Mining	7	8	8	9	9	7	8	1
Smelting and Refining (Non-Ferrous Metals)	14	11	10	10	10	8	6	-6
Pulp and Paper	9	7	6	7	7	5	4	-4
Iron and Steel	16	14	15	12	16	9	9	-7
Cement	13	10	10	10	11	10	11	-3
Lime and Gypsum	3	3	2	2	2	2	2	-1
Chemicals and Fertilizers	24	22	26	21	20	18	18	-7
Total	**87**	**75**	**78**	**72**	**74**	**60**	**58**	**-28**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.4.5. Buildings

In the projection period of the WAM scenario, Buildings Sector GHG emissions decline by an additional 14 Mt by 2030 and by 15 Mt by 2035 in comparison to emissions in the WM scenario. This decline occurs in both the residential and commercial subsectors. In both subsectors, net-zero ready building codes for new buildings cause the largest additional emission reductions. Labeling, codes, grants, and loans for retrofitting existing buildings cause the second largest additional emission reductions.

A1.4.5.1. Residential

In the WAM scenario, residential subsector GHG emissions decline by 43 percent (19 Mt) between 2005 and 2030. By 2035, emissions decline by 52 percent (23 Mt). These emission reductions occur while the number of households in Canada increases. Overall, electrification of heating equipment causes most reductions, but those reductions also occur in the WM scenario. In the WAM scenario, the additions of the net-zero ready building codes for new buildings and building shell efficiency improvements via retrofitting of existing buildings drive the additional reductions.

Table 5A-24: Residential Subsector: Emissions and Drivers, 2005 to 2035

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Emissions (Mt CO_2 eq)	44	41	42	40	32	25	21	-19
Households (millions)	12	13	14	15	16	17	18	5

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.4.5.2. Commercial

In the WAM scenario, commercial subsector GHG emissions decline by 23 percent (9 Mt) between 2005 and 2030. By 2035, emissions decline by 28 percent (11 Mt). Congruent to the residential subsector, electrification of heating equipment in the commercial subsector causes most reductions, but those reductions also occur in the WM scenario. In the WAM scenario, the additions of the net-zero ready building codes for new buildings and building shell efficiency improvements via retrofitting of existing buildings drive the additional reductions.

Table 5A-25: Commercial Subsector: Emissions and Drivers, 2005 to 2035

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Emissions (Mt CO_2 eq)	40	38	42	48	38	31	29	-9
Floor space (millions m^2)	654	714	748	761	810	899	995	244

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.4.6. Agriculture

Much of the potential for GHG impact in agriculture is related to land use management practices taking place on agricultural land, and thus this impact is attributed to the LULUCF Sector. Hence the WAM agriculture emissions projections are similar to the WM projections.

The key differences can be attributed to the voluntary fertilizer target—a reduction of N_2O emissions from fertilizer use to 30 percent below 2020 levels, which reduces N_2O emissions from Crop Production by around 4 Mt CO_2 eq in 2030 relative to the WM scenario, and carbon pricing and clean fuel regulations, which reduce emissions from On-Farm Fuel Use by around 2 Mt CO_2 eq in 2030 relative to the WM scenario.

Table 5A-26: Agriculture Sector Emissions by Subsector, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
On Farm Fuel Use	12	12	12	13	13	12	12	0
Crop Production	12	14	18	21	20	17	17	6
Animal Production	42	36	34	34	34	34	34	-8
Total	**66**	**62**	**65**	**69**	**67**	**63**	**63**	**-3**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.4.7. Waste and Others

The WAM scenario has total GHG emissions from Waste and Others decreasing to 32 Mt CO2 eq in 2030 and remain at that level to 2035. Compared to the WM scenario, this represents a reduction of 36 percent. The reductions occur primarily in the Solid Waste and Light Manufacturing sectors. This is due to additional measures impacting the industrial sector including the Strategic Innovation Fund - Net-Zero Accelerator (SIF-NZA) funding program and the federal landfill gas regulations that regulate landfills to reduce their methane emissions through installation of landfill gas recovery systems.

Table 5A-27: Waste and Others Emissions by Subsector, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Waste	29	26	26	27	22	16	16	-13
Coal Production	2	3	2	2	2	2	2	0
Light Manufacturing, Construction and Forest Resources	24	22	21	20	18	14	14	-10
Total	**55**	**51**	**50**	**50**	**42**	**32**	**32**	**-23**

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from NIR 2022.

A1.4.8. Foreign Passenger and Foreign Freight

Table 5A-28: Emissions from Fuel Used for International Aviation and Maritime Transportation by Subsector, 2005 to 2035 (Mt CO_2 eq)

	Historical				Projected			Change 2005 to 2030
	2005	2010	2015	2020	2025	2030	2035	
Foreign Freight	11	10	10	8	8	9	9	-2
Foreign Passenger	8	8	10	6	11	11	12	3
Total	**20**	**18**	**20**	**14**	**19**	**20**	**21**	**0**

Note: Numbers may not sum to the total due to rounding. Total historical emissions data is taken from NIR 2022 and represents the sum of International Aviation from Table 3-3 and International Navigation from Table 3-4 from that document.

A1.4.9. Nature-Based Climate Solutions and Agriculture Measures

Nature-Based Climate Solutions (NBCS) and Agriculture Measures are estimated to reduce emissions by between 14 to 16 Mt (15) CO_2 eq in 2030. Nature-Based Climate Solutions comprise the 2 Billion Trees program (GHG impact already included in LULUCF accounting), and programs funded under Nature Smart Climate Solutions Fund (NSCSF) and Agricultural Climate Solutions Fund (ACSF) (discussed in 'Agriculture Measures' below).

Nature-Smart Climate Solutions Fund (NSCSF)

NSCSF programs include activities covering avoided conversion, improved management, and restoration of ecosystems such as wetlands, grasslands, and forest land, and is targeted to reduce emissions by between 5 to 7 (6) Mt CO_2 eq in 2030 and up to 5 to 7 (6) Mt CO_2 eq in 2050.

Agriculture Measures

Agriculture Measures comprises programs funded under the Agricultural Climate Solutions Fund along with other agriculture measures such as the Agricultural Clean Technology Program. Examples include activities such as tree planting on agricultural land, and implementation of rotational grazing and improved nutrient and manure management practices. These are estimated to reduce emissions by 9 Mt CO_2 eq per year in 2030 through to 2035.

Table 5A-29: 2030 Emissions Reductions / Accounting Impact of Nature-Based Solutions and Agriculture Measures

Item	What's Included?	2030 Emissions Reductions / Accounting Impact (Mt CO_2 eq/yr)
Agriculture Measures	Agricultural Climate Solutions (ACS) • On−Farm Climate Action Fund • ACS Living Labs	5 4 1
	Other Agriculture Measures • Sustainable Canadian Agricultural Partnership ○ Next Policy Framework (*0.3 Mt is fertilizer related) & Resilient Agricultural Landscapes Program • Agricultural Clean Technology Program	4 3.5 0.7
	Subtotal	9
NSCSF	Nature Smart Climate Solutions (Round 1) • Avoided conversion of wetlands, grasslands, and forests • Restoration of wetlands and grasslands • Improved forest management • Tree-planting on agricultural land	2 to 4 (3)
	Nature Smart Climate Solutions (Round 2) • Extension of activities listed in Round 1	3
	Subtotal	5 to 7 (6)
TOTAL NBCS and Agriculture Measures		**14 to 16 (15)**

A1.5. Air Pollutant Emissions Projections Under the WM Scenario

Air quality is important for all Canadians as it has broad impacts, including on human health, the natural environment, buildings and infrastructure, crop production, and the economy. Air pollutant emissions projections inform both domestic and international work related to improving air quality.

Canada works with other countries in international fora to address air pollution, including from outside its borders, which has impacts on Canadian air quality. Canada works with the United States (U.S.) under the Canada-U.S. Air Quality Agreement (AQA) to address transboundary air pollution between the two countries and is a Party to the United Nations Economic Commission for Europe's (UNECE) Convention on Long-Range Transboundary Air Pollution (LRTAP or Air Convention).

The Gothenburg Protocol is the most recent and most active of the eight protocols under the Air Convention. Canada ratified the Gothenburg Protocol and its amendments in November 2017, and the Protocol entered into force in October 2019.

Canada's commitments under the Gothenburg Protocol include:

- Emissions ceilings of 1,450 kt for sulphur dioxide (SO_2), 2,250 kt for nitrogen oxides (NOx) and 2,100 kt for volatile organic compounds (VOCs) to be achieved by 2010 and maintained to 2020;
- Indicative emission reduction commitments expressed as a percentage reduction from a base year of 2005 of 55 percent for SO_2, 35 percent for NOx, 20 percent for VOCs and 25 percent for fine particulate matter,[v] to be met by 2020 and maintained; and
- Limiting emissions in specific sectors using Canadian air pollution emission reduction measures (included in the Protocol annexes).

The Canada-U.S. AQA includes commitments to reduce emissions of SO_2, NOx and VOCs that have long been met by both countries. Both the Gothenburg Protocol and the AQA are currently under review, and may be updated as a result.

In addition, Canada works with Arctic countries under the Arctic Council to collectively reduce emissions of black carbon, an air pollutant with significant climate warming properties. Canada and other Arctic States have committed to a collective, aspirational goal to reduce emissions of black carbon by 25 to 33 percent below 2013 levels by 2025.

The following section provides projections of air pollutant emissions through 2035, aligned to Canada's historical air pollutant emissions from 1990 to 2020 as presented in *Canada's Air Pollutant Emissions Inventory Report 2022* (APEI 2022) and *Canada's Black Carbon Inventory Report 2022*. This section is divided into sub-sections providing background information on what causes the growth or decline of projected air pollutant emissions in Canada. Figures 5A-8 to 5A-17 present emissions trends from 2005 to 2035 for each of the 10 pollutants modelled, as well as their respective emissions reduction commitment or goal, where applicable.

Table 5A-30 through Table 5A-39 provide detailed national emissions by economic sector and pollutant for select historical and projection years. In accordance with international reporting requirements, Canada's national total emissions exclude emissions from domestic and international air transportation at cruise speed, and international marine navigation emissions. These emissions are compiled under the category "Other Sources". The list of federal, provincial and territorial air pollutants policies and measures that were included in the WM scenario is provided in Table 5A-51 in Annex 3.

A1.5.1. Sulphur Oxides (SOx)

In Canada, sulphur oxides (SOx) emissions are driven mostly by the metallurgical industry, coal-fired electricity generation, and natural gas processing. SOx emissions have been declining significantly over the recent past and are expected to drop further over the projection period—with reductions primarily due to the coal phase-out for electricity generation and regulations on low sulphur fuels. SOx emissions are expected to stay below the Gothenburg Protocol reduction commitment in the forecast period.

v Note that the commitment for fine particulate matter under the Gothenburg Protocol does not include open sources.

Figure 5A-8: Sulphur Oxides Emissions, 2005 to 2035 (kt)

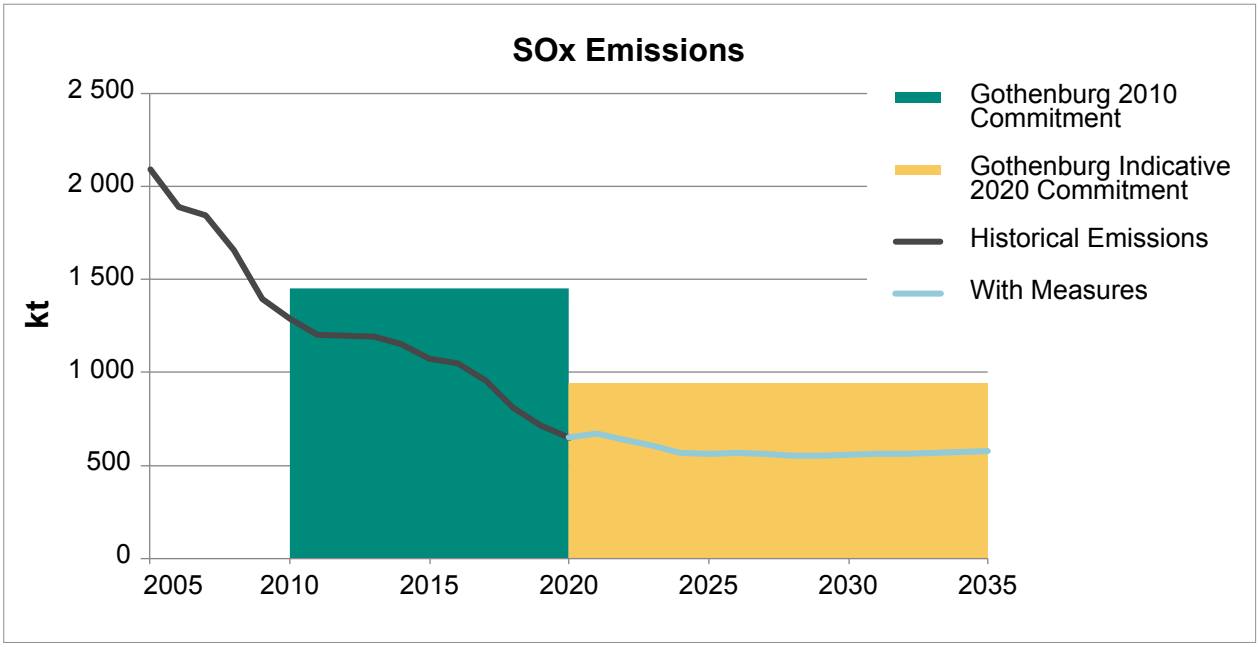


Table 5A-30: Sulphur Oxides Emissions, 2005 to 2035 (kt)

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Oil and Gas	476	351	281	250	282	270	270
Electricity	522	334	251	168	31	12	11
Transportation	57	31	7	3	3	4	4
Heavy Industry	942	540	521	221	239	266	285
Buildings	37	16	7	4	3	3	3
Agriculture	5	4	0	0	0	0	0
Waste and Others	52	11	6	5	5	5	5
Total	**2 091**	**1 287**	**1 073**	**651**	**565**	**560**	**579**
Other Sources	92	81	10	6	9	9	10

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from APEI 2022.

A1.5.2. Nitrogen Oxides (NOx)

The main sources of nitrogen oxides (NOx) emissions in Canada are diesel use in transportation, natural gas production, and utility electric generation. NOx emission levels decreased at a steady rate since 2005 and are expected to continue to decline in the projections, due in part to regulations in the Transportation Sector, natural gas production and electricity generation. Emissions are expected to exceed the Gothenburg Protocol reduction commitment in the early years of the projections due to high electricity demand requiring additional generation from non-renewable sources. Emissions are expected to decline post-2022 as the proportion of utility electricity generation coming from renewable sources is projected to increase, and then stay below the commitment level from 2025 and beyond.

Figure 5A-9: Nitrogen Oxides Emissions, 2005 to 2035 (kt)

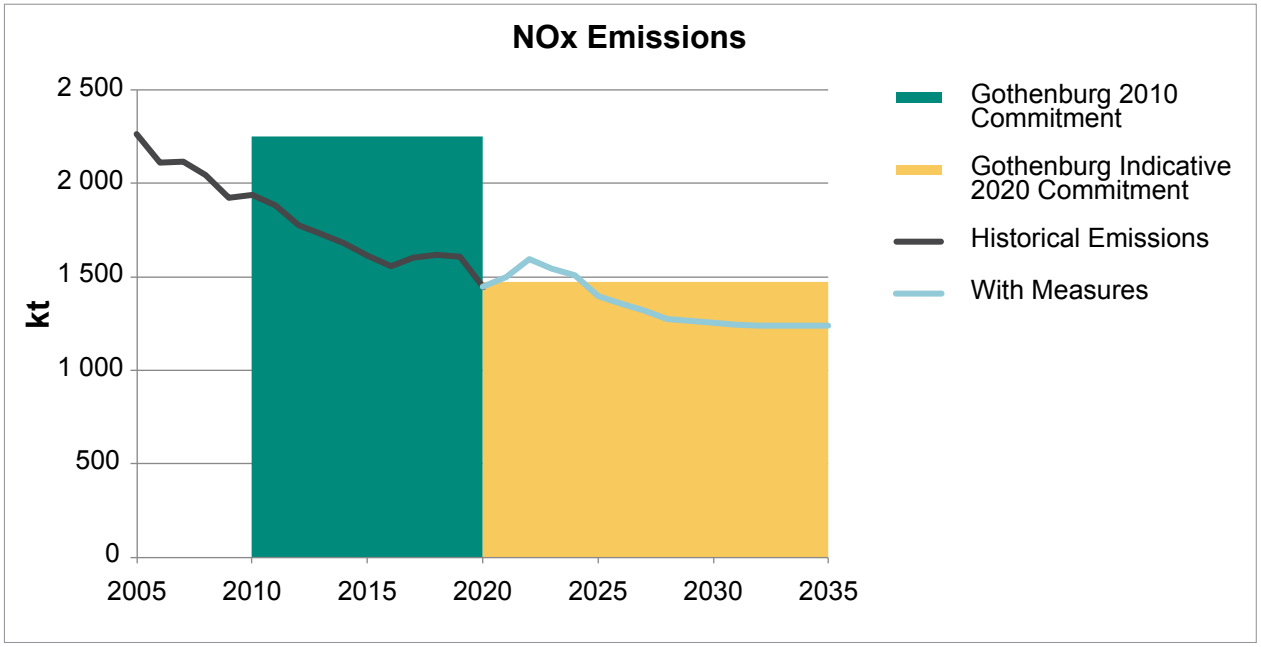


Table 5A-31: Nitrogen Oxides Emission, 2005 to 2035 (kt)

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Oil and Gas	450	475	495	468	316	278	259
Electricity	248	229	145	94	128	45	41
Transportation	992	789	595	547	624	622	629
Heavy Industry	212	161	160	142	150	151	157
Buildings	79	69	71	70	59	53	50
Agriculture	129	113	75	68	60	48	44
Waste and Others	156	103	71	58	62	58	60
Total	**2 265**	**1 939**	**1 613**	**1 446**	**1 399**	**1 255**	**1 240**
Other Sources	206	194	206	146	188	199	214

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from APEI 2022.

A1.5.3. Volatile Organic Compounds (VOCs)

Volatile organic compounds (VOCs) emissions are primarily driven by steady year over year growth of fugitive VOC emissions in oil and gas production. The regulations for reducing methane and VOC emissions in the upstream Oil and Gas Sector will be fully in place by 2025, when VOC emissions are projected to bottom out, but are then expected to increase slowly until 2035. The increase is linked to higher expected light oil production. Overall, VOC emissions are expected to stay below the Gothenburg Protocol reduction commitment in the forecast period.

Figure 5A-10: Volatile Organic Compounds Emissions, 2005 to 2035 (kt)

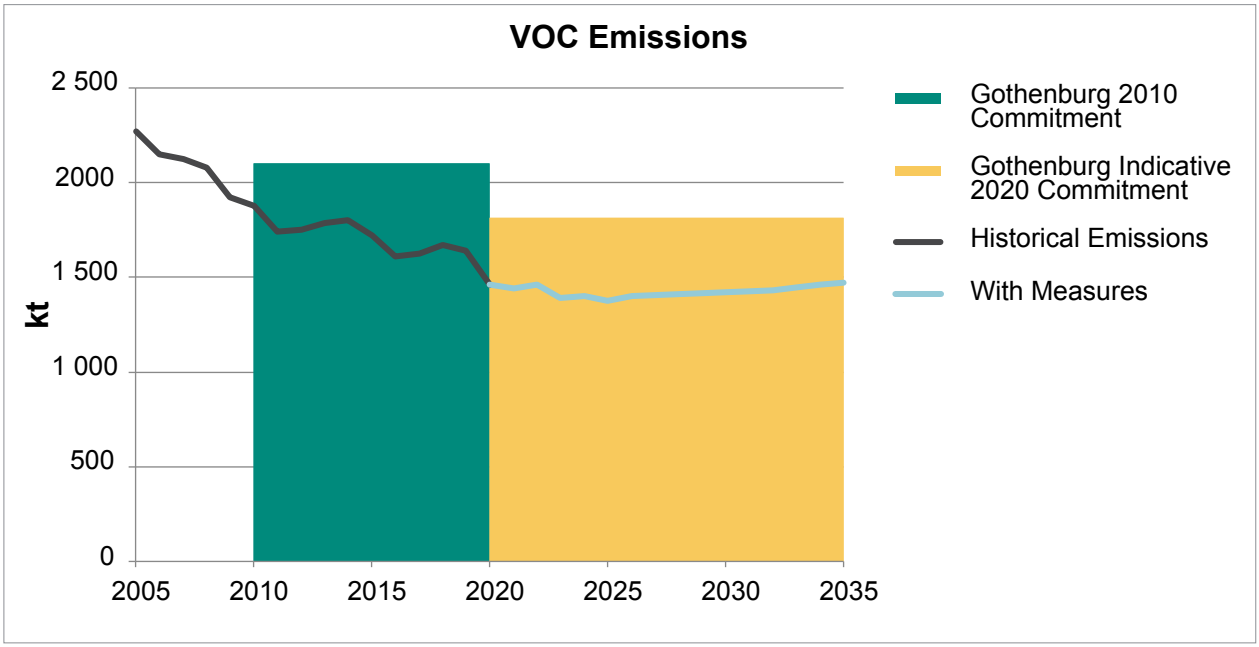


Table 5A-32: Volatile Organic Compounds Emissions, 2005 to 2035 (kt)

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Oil and Gas	709	624	720	585	492	528	554
Electricity	3	2	1	1	2	2	2
Transportation	590	468	273	232	248	240	236
Heavy Industry	127	84	71	69	75	79	83
Buildings	320	302	290	254	209	201	203
Agriculture	158	147	143	144	144	145	145
Waste and Others	361	253	222	176	205	227	249
Total	**2 268**	**1 880**	**1 720**	**1 462**	**1 376**	**1 421**	**1 471**
Other Sources	8	8	7	6	7	7	8

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from APEI 2022.

A1.5.4. Particulate Matter (PM)

The majority of emissions of particulate matter (TPM, PM10 and PM2.5) come from open sources. Open sources include emissions from construction (excluding mobile and stationary off-road equipment emissions), crop production and road dust, and account for 97 percent of total PM emissions.

Other significant sources of PM emissions are utility electric generation, production of non-ferrous metals and iron ore pelletizing. Current policies and regulations—such as Base Level Industrial Emission Requirements (BLIERs)—are driving reductions of non-open sources particulate matter

emissions in targeted industries. However, total emissions of PM are expected to grow; increases in emissions from open sources have and will continue to more than offset the reductions from the targeted industries. Projected increase in PM emissions from open sources are driven by growth in transportation and construction activity, and crop farming.

Fine particulate matter emissions excluding open sources are expected to stay below the Gothenburg Protocol reduction commitment for the forecast period.

Figure 5A-11: Total Particulate Matter Emissions, 2005 to 2035 (kt)

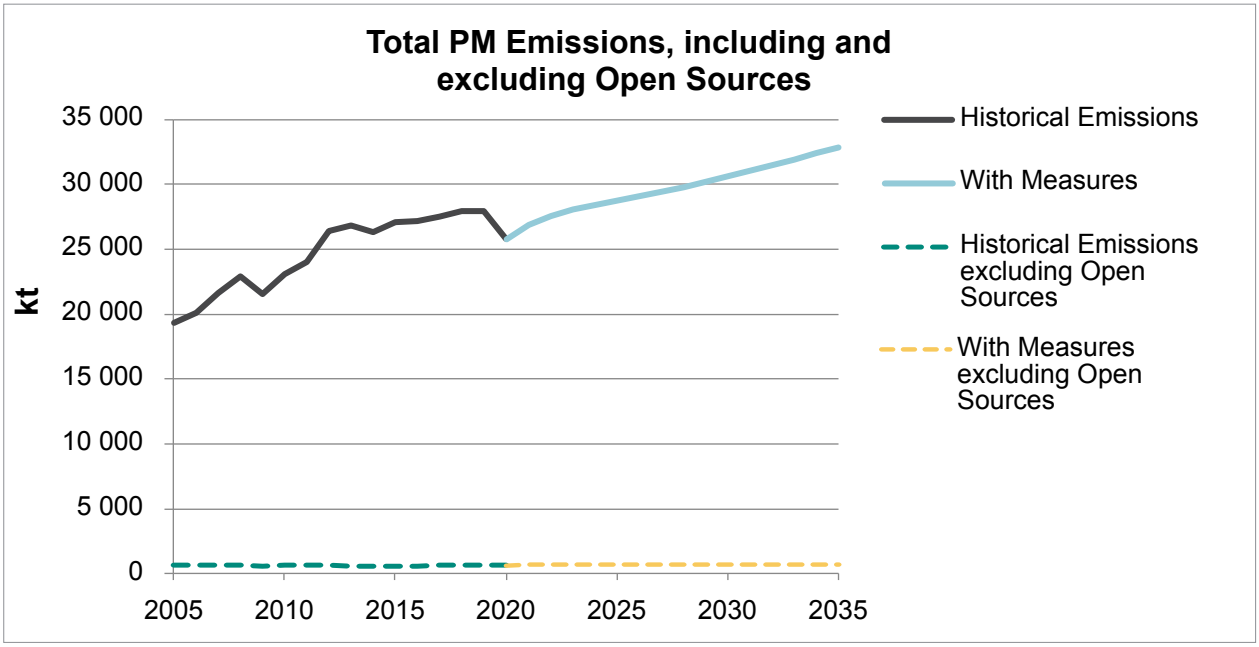


Table 5A-33: Total Particulate Matter Emissions, 2005 to 2035 (kt)

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Oil and Gas	34	18	21	25	27	27	27
Electricity	34	20	18	11	4	3	4
Transportation	55	46	33	31	36	38	40
Heavy Industry	182	137	128	123	146	152	160
Buildings	158	165	177	173	153	143	139
Agriculture	4 550	3 818	3 802	3 528	3 540	3 555	3 571
Waste and Others	14 341	18 890	22 923	21 892	24 885	26 728	28 950
Total (excluding open sources)	**673**	**634**	**576**	**661**	**680**	**687**	**704**
Total	**19 354**	**23 095**	**27 103**	**25 784**	**28 791**	**30 646**	**32 890**
Other Sources	12	11	3	3	3	3	3

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from APEI 2022.

Figure 5A-12: Particulate Matter 10 Emissions, 2005 to 2035 (kt)

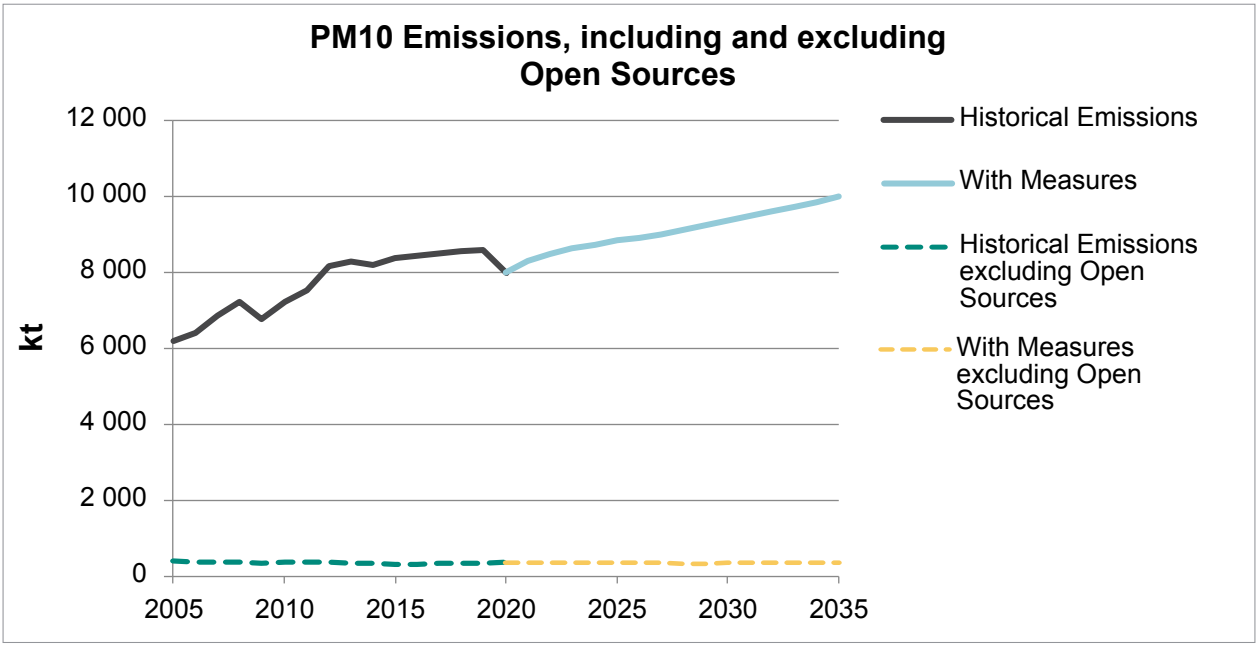


Table 5A-34: Particulate Matter 10 Emissions, 2005 to 2035 (kt)

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Oil and Gas	24	14	17	18	20	19	20
Electricity	15	9	7	5	3	3	3
Transportation	54	45	33	31	36	38	39
Heavy Industry	98	76	72	66	77	81	85
Buildings	120	121	124	117	97	86	82
Agriculture	1 747	1 521	1 560	1 474	1 478	1 484	1 490
Waste and Others	4 147	5 440	6 565	6 271	7 121	7 636	8 262
Total (excluding open sources)	**409**	**364**	**326**	**364**	**365**	**361**	**365**
Total	**6 204**	**7 227**	**8 378**	**7 982**	**8 833**	**9 347**	**9 981**
Other Sources	12	11	3	3	3	3	3

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from APEI 2022.

Figure 5A-13: Particulate Matter 2.5 Emissions, 2005 to 2035 (kt)

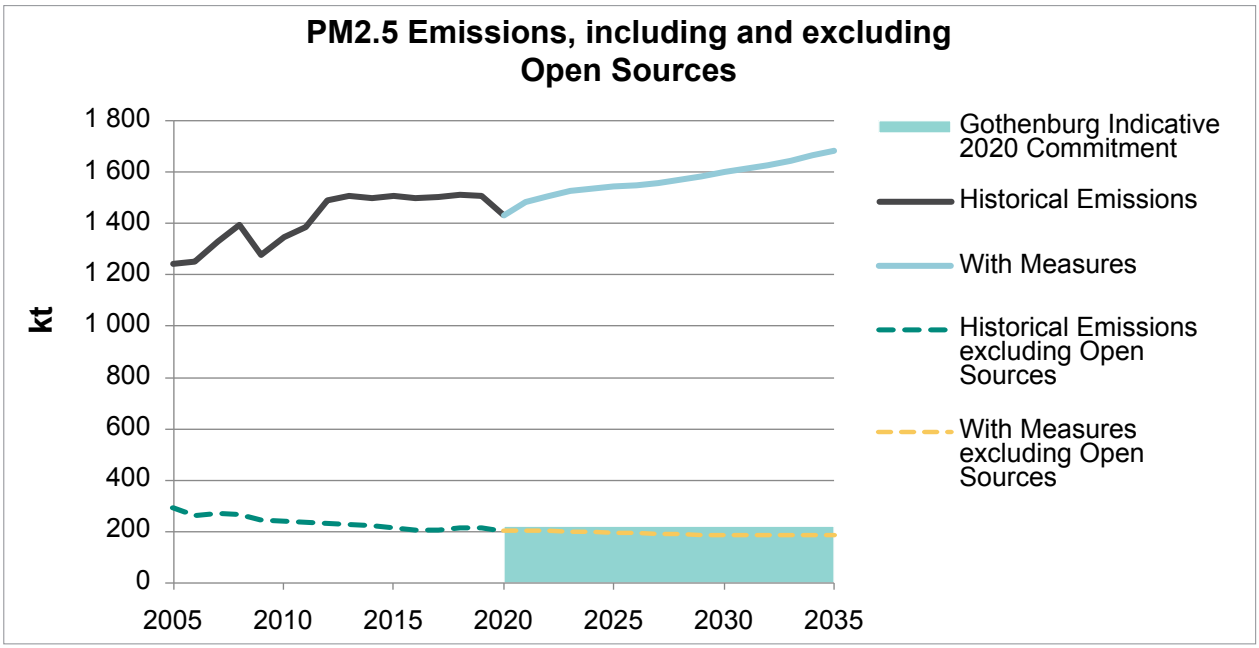


Table 5A-35: Particulate Matter 2.5 Emissions, 2005 to 2035 (kt)

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Oil and Gas	17	11	13	13	15	15	15
Electricity	8	5	3	2	2	2	2
Transportation	43	34	22	21	23	23	24
Heavy Industry	55	38	34	29	34	36	38
Buildings	109	108	108	103	85	75	70
Agriculture	463	388	382	353	354	355	356
Waste and Others	549	764	948	910	1 031	1 094	1 178
Total (excluding open sources)	**293**	**241**	**215**	**203**	**195**	**187**	**187**
Total	**1 244**	**1 348**	**1 509**	**1 432**	**1 544**	**1 599**	**1 682**
Other Sources	11	10	3	2	3	3	3

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from APEI 2022.

A1.5.5. Black Carbon

The main sources of black carbon emissions are combustion of diesel and biomass fuel. In 2020, transportation and mobile equipment accounted for 60 percent of total black carbon emissions, while home firewood burning contributed 23 percent. The projected downward trend in black carbon emissions is driven by more efficient pollution-control technologies and emission standards—in particular, on-road and off-road transportation and stationary engines for diesel, and decrease use of biomass for heating in residential buildings. Black carbon emissions are expected to meet Canada's aspirational Arctic Council commitment in the forecast period.

Figure 5A-14: Black Carbon Emissions, 2005 to 2035 (kt)

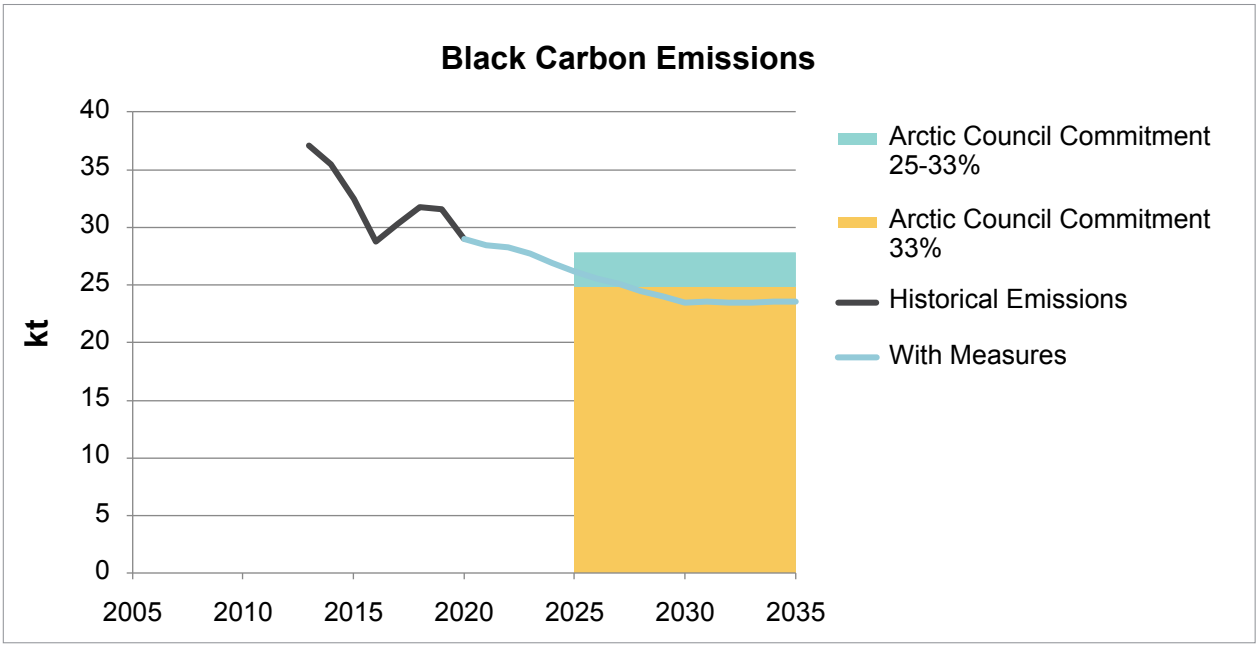


Table 5A-36: Black Carbon Emissions, 2005 to 2035 (kt)

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Oil and Gas	n.a.	n.a.	3.2	2.8	3.0	2.9	2.9
Electricity	n.a.	n.a.	0.2	0.2	0.1	0.1	0.1
Transportation	n.a.	n.a.	10.2	10.1	10.4	9.9	10.4
Heavy Industry	n.a.	n.a.	2.6	2.0	1.7	1.5	1.5
Buildings	n.a.	n.a.	8.7	8.1	6.4	5.4	4.9
Agriculture	n.a.	n.a.	4.2	3.5	2.6	2.0	2.0
Waste and Others	n.a.	n.a.	3.5	2.4	2.1	1.7	1.8
Total	n.a.	n.a.	**32.5**	**29.0**	**26.2**	**23.5**	**23.6**
Other Sources	n.a.	n.a.	2.2	1.8	2.1	2.2	2.3

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from the 2022 Black Carbon Inventory. Black Carbon emissions inventory begins in 2013.

A1.5.6. Carbon Monoxide (CO)

Carbon monoxide (CO) emissions have consistently trended downwards starting from 2005 and are projected to continue declining throughout the projection period. The main source of CO emissions is incomplete combustion of hydrocarbon-based fuels, primarily from mobile sources. The wood industry and residential wood heating are also significant but lesser sources of carbon monoxide. The projected reduction in carbon monoxide emissions is primarily driven by a reduction in passenger transportation emissions, specifically the emissions from light duty vehicles (LDV).

Figure 5A-15: Carbon Monoxide Emissions, 2005 to 2035 (kt)

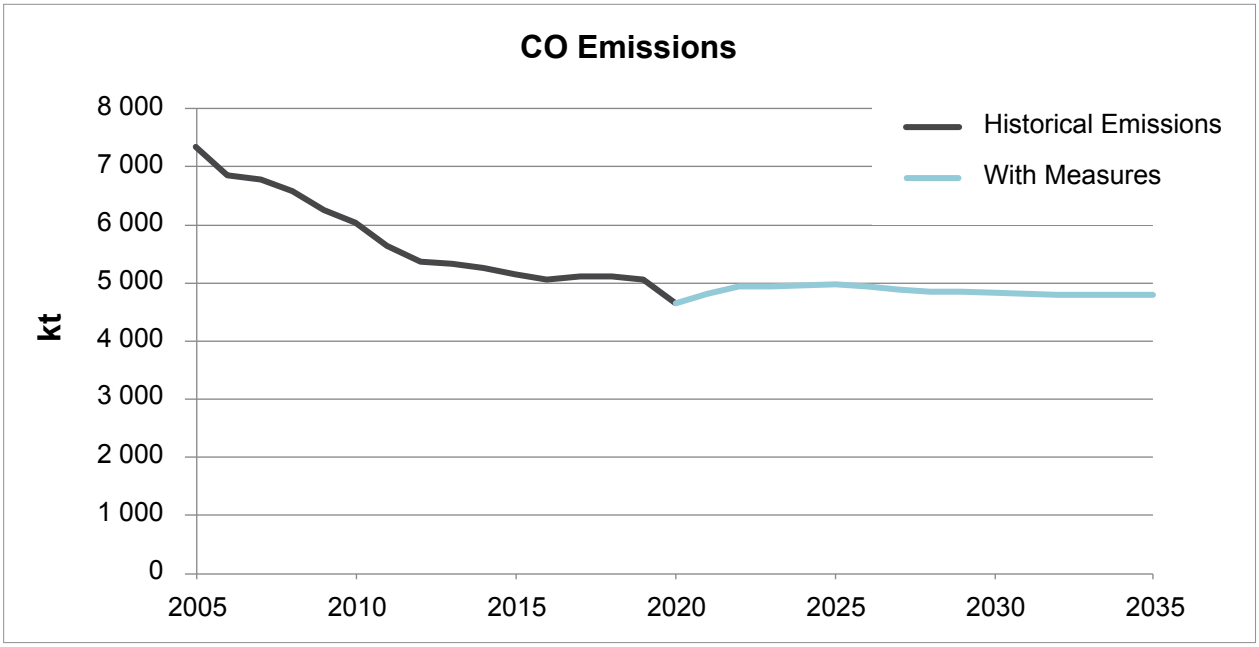


Table 5A-37: Carbon Monoxide Emissions, 2005 to 2035 (kt)

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Oil and Gas	516	539	574	518	541	482	468
Electricity	46	34	29	21	95	60	57
Transportation	4 855	3 810	2 884	2 705	2 924	2 873	2 858
Heavy Industry	650	655	635	613	727	803	824
Buildings	604	617	683	582	445	363	322
Agriculture	87	78	50	47	49	49	49
Waste and Others	590	302	295	166	190	199	212
Total	**7 348**	**6 034**	**5 150**	**4 652**	**4 971**	**4 828**	**4 790**
Other Sources	92	67	57	40	56	56	59

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from APEI 2022.

A1.5.7. Mercury

Emissions of mercury in the atmosphere come from various sectors such as: iron and steel production, electric power generation from combustion of coal, waste incineration and various commercial, residential and institutional uses. Emissions of mercury have declined significantly since 2007, mainly driven by reductions in smelting, refining, and coal-fired electricity generation. From 2011 through 2025, total mercury emissions are expected to continue to decrease, although at a slower rate. From 2025 onward, mercury emissions are expected to increase slowly—driven by expected economic growth especially in the iron and steel sector and population growth driving waste incineration emissions upward.

Figure 5A-16: Mercury Emissions, 2005 to 2035 (kg)

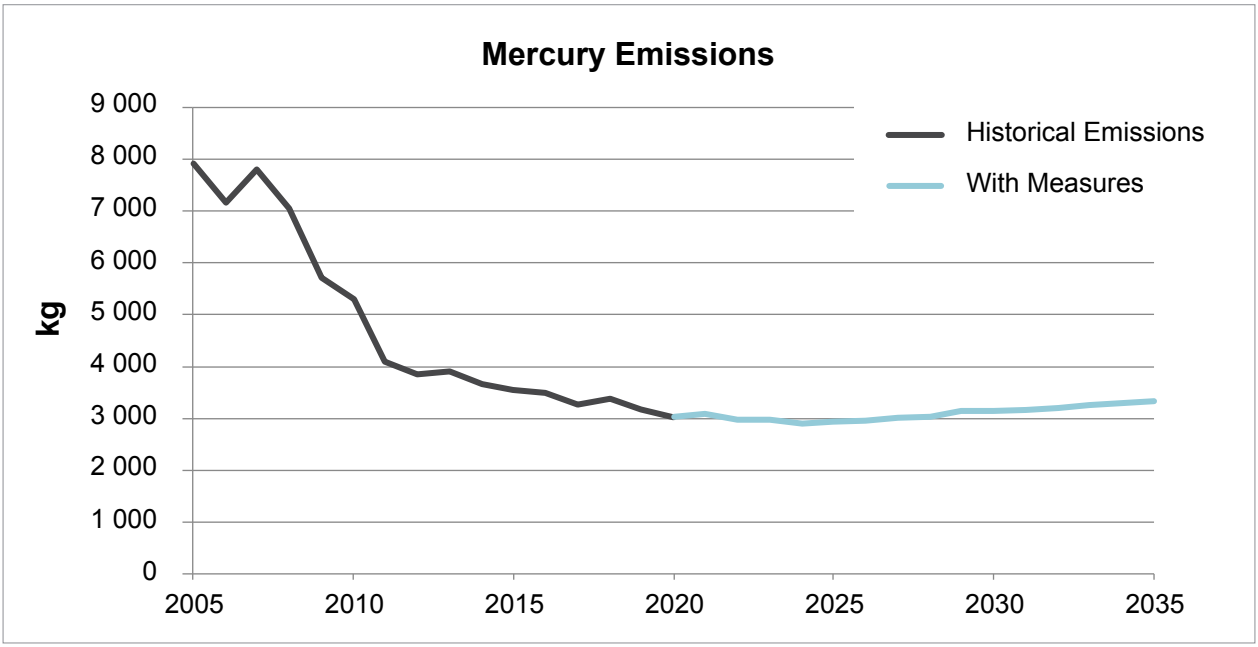


Table 5A-38: Mercury Emissions, 2005 to 2035 (kg)

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Oil and Gas	93	133	74	68	73	72	71
Electricity	2 161	1 583	731	493	110	63	63
Transportation	97	77	57	55	59	61	67
Heavy Industry	2 966	1 710	1 390	1 149	1 392	1 583	1 708
Buildings	861	733	582	480	465	469	480
Agriculture	3	8	7	6	5	4	4
Waste and Others	1 737	1 060	709	774	835	887	938
Total	**7 918**	**5 304**	**3 550**	**3 025**	**2 939**	**3 139**	**3 330**
Other Sources	5	5	0	0	0	0	0

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from APEI 2022.

A1.5.8. Ammonia

Historically, ammonia emissions have been relatively steady from 2005 to 2020, staying below 500 kt each year. Starting in 2021 emissions are expected to increase gradually—driven by a steady increase in animal and crop production emissions and expected increased use of nitrogen-based fertilizer. Animal and crop production were responsible for approximately 94 percent of total projected ammonia emissions in 2020. The third largest contributor to the ammonia emissions was fertilizer production at 2 percent of total projected ammonia emissions.

Figure 5A-17: Ammonia Emissions, 2005 to 2035 (kt)

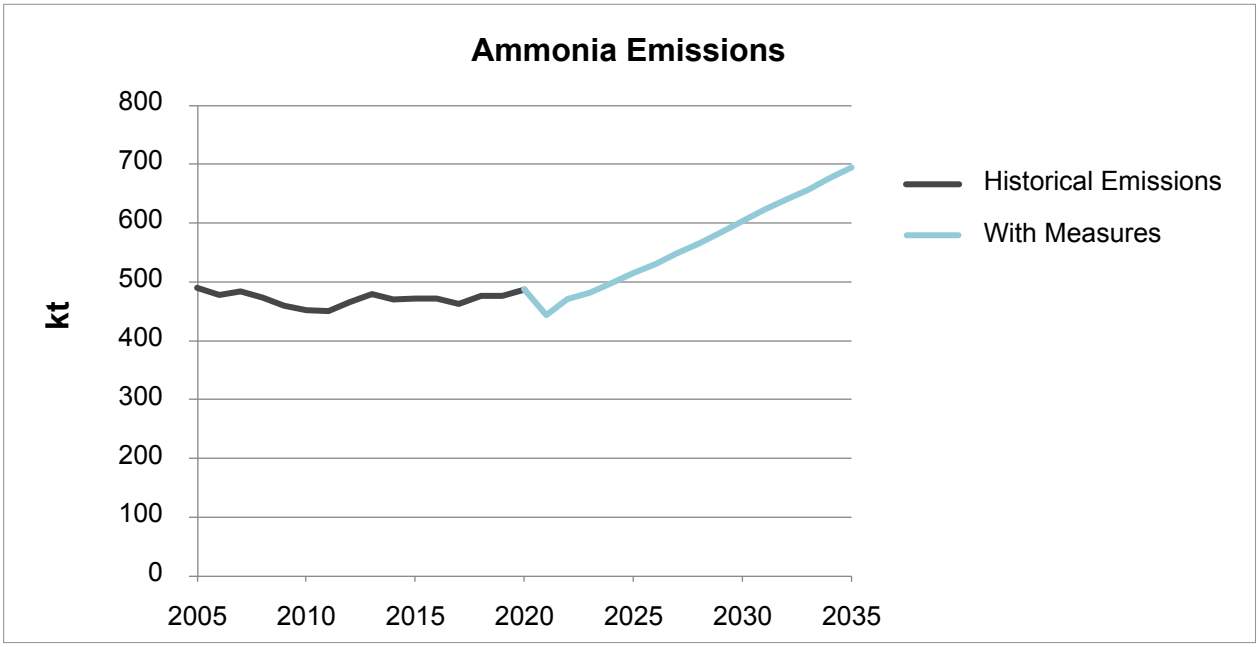


Table 5A-39: Ammonia Emissions, 2005 to 2035 (kt)

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Oil and Gas	3	2	2	2	3	3	3
Electricity	1	1	0	0	0	0	0
Transportation	11	9	7	7	8	7	6
Heavy Industry	14	12	12	12	13	14	15
Buildings	7	6	6	5	5	6	6
Agriculture	449	418	440	457	483	570	660
Waste and Others	6	3	4	3	4	4	4
Total	**490**	**452**	**472**	**487**	**515**	**603**	**694**
Other Sources	0	0	0	0	0	0	0

Note: Numbers may not sum to the total due to rounding. Historical emissions data come from APEI 2022.

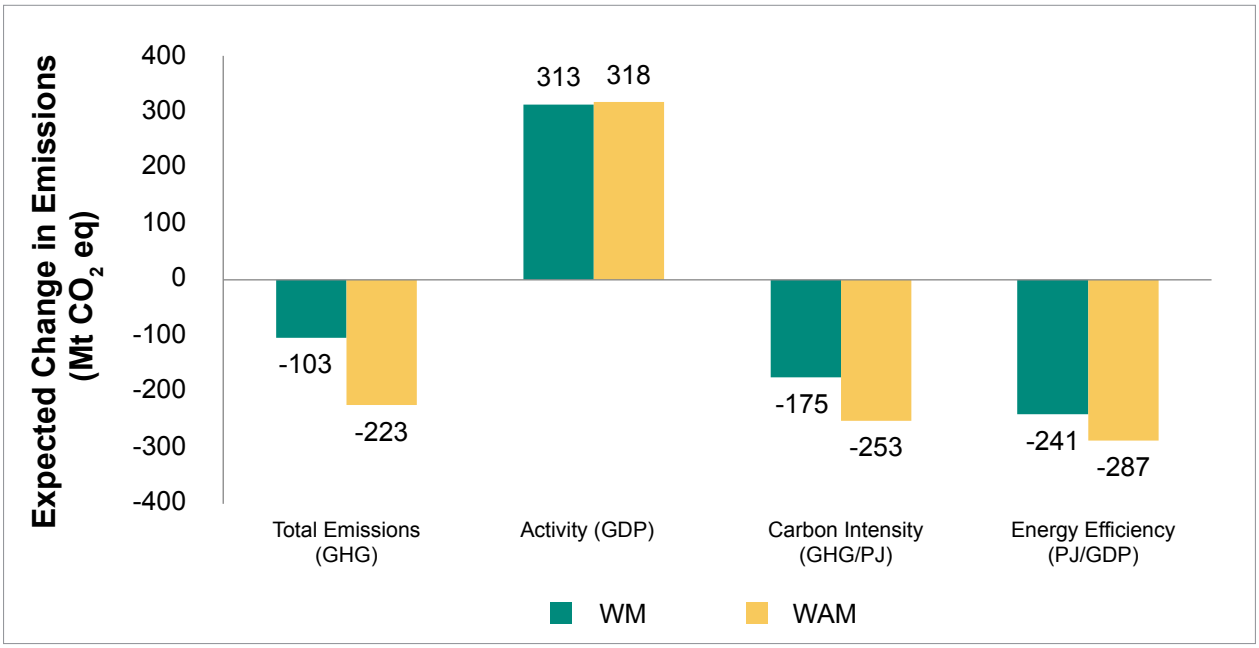
Annex 2: Decomposition of Projected Change in Canada's GHG Emissions Projections in the WM and WAM Scenarios

The following explores how different factors contribute to trends in historical and projected emissions through a decomposition analysis of Canada's GHG emissions for the 2005 to 2030 period under the WM scenario (see Figure 5A-18).

- The **Activity Effect** measures the impact of economic growth (estimated to be 50 percent over the 2005 to 2030 period). On its own, this growth would have been expected to lead to 313 Mt of additional GHG emissions in 2030 in the WM scenario (318 in the WAM scenario).
- The **Carbon Intensity Effect** measures changes in the carbon emission coefficient of energy. The shift to cleaner fuels such as the replacement of coal-fired electricity with cleaner sources, as well as measures to reduce fugitive and process emissions, are projected to have a significant impact, reducing emissions by 175 Mt in 2030 in the WM scenario (253 Mt in the WAM scenario).
- The **Energy Efficiency Effect** measures changes in energy efficiency at the subsector level. The projections indicate that the uptake of energy efficient technologies—induced by policies, consumer responses to energy prices, and stock turnover—reduces emissions by 241 Mt in 2030 in the WM scenario (or 287 Mt in the WAM scenario).

The decomposition shows that over the period from 2005 to 2030, there is a decoupling of economic growth and combustion emissions: upward pressure on GHG emission projections arising from GDP growth are offset by the switch to cleaner and more efficient energy use.

Figure 5A-18: Decomposition of Emissions Growth, 2005 to 2030 under WM and WAM Scenarios (Excluding LULUCF, NBCS, Agriculture Measures and WCI Credits)



Annex 3: Baseline Data and Assumptions

Many factors influence the future trends of Canada's GHG emissions. These key factors include economic growth, population and household formation, energy prices (e.g., world oil price and the price of refined petroleum products, regional natural gas prices, and electricity prices), technological change, and policy decisions. Varying any of these assumptions could have a material impact on the emissions outlook.

In constructing the emissions projections, alternate pathways of key drivers of emissions were modelled to explore a range of plausible emissions growth trajectories. The baseline emissions projections scenario represents the mid-range of these variations, but remains conditional on the future path of the economy, world energy markets and government policy. The assumptions and key drivers are listed in this section. Alternative cases are explored in the sensitivity analysis in Annex 5.

Table 5A-40: Summary of Key Price-Related Assumptions Used in Projection Analysis, 2005 to 2035

	Historical				Projected		
	2005	2010	2015	2020	2025	2030	2035
Oil Price (2020 US$/bbl)	65.02	86.82	51.30	38.03	79.81	66.67	66.67
Natural Gas Price (2020 US$/ MMBtu)	10.00	4.71	2.76	1.84	2.95	3.13	3.36
CPI (1992 = 100)	127.34	138.65	150.67	163.03	194.13	215.04	237.36

Table 5A-41: Summary of Key Economic and Demographic Assumptions Used in Projection Analysis (average annual percent change), 2006 to 2035

	Historical			Projected		
	2006-2010	2011-2015	2016-2021	2022-2025	2026-2030	2031-2035
Real GDP	1.2%	2.0%	1.3%	2.0%	1.8%	1.7%
Population	1.1%	1.0%	1.2%	1.4%	1.1%	1.0%
Population of driving age (18–75)	1.3%	1.1%	1.1%	1.3%	0.8%	0.6%
Labour Force	1.3%	0.8%	1.1%	1.3%	1.2%	1.1%

Table 5A-42: Summary of Key Agriculture Assumptions Used in Projection Analysis (average annual percent change), 2010 to 2030

	Historical		Projected	
	2010-15	2015-2020	2020-25	2025-30
Total Crops	2.10%	0.29%	0.43%	0.15%
Total Cattle	-1.60%	-0.46%	-1.20%	0.21%
Total Hogs	0.15%	0.95%	-0.50%	-0.40%
Total Poultry	1.70%	2.70%	2.20%	1.60%

Historical and projected estimates for emissions from Crop Production, Animal Production, and On-Farm Fuel Use produced by Agriculture and Agri-Food Canada (AAFC) for the years 2020 and 2030 are used to develop annual growth rates which are applied to 2020 historical data to generate projected emissions to 2030. After 2030, Animal Production and Crop Production emissions are assumed to be flat, with the assumption being that emission intensity improvements keep pace with growing output.

A3.1. Key Economic Drivers and Assumptions

The emissions projections baseline scenario is designed to incorporate the best available information about economic growth as well as energy demand and supply into the future. The projections capture the impacts of future production of goods and services in Canada on GHG emissions.

Historical data on GDP is provided from Statistics Canada. Consumer price index and population demographics are also produced by Statistics Canada while historical emissions data are provided by the *National Inventory Report*, 2022 (NIR 2022).

Economic projections (including real and nominal GDP growths, GDP inflation, exchange rate, three-month treasury bill rate, ten-year government bond rate, unemployment rate and consumer price index inflation) to 2027 are calibrated to Finance Canada's 2022 Fall Economic Statement. Economic projections between 2028 and 2035 are based on Finance Canada's long-term projections.

Forecasts of oil and natural gas price and production are taken from the Canada Energy Regulator's preliminary 2023 Current Measures scenario. The CER is an independent federal agency that regulates international and interprovincial aspects of the oil, gas and electric utility industries. The U.S. Energy Information Administration's outlook on key parameters is also taken into account in the development of energy and emissions trends.

A3.2. Economic Growth

The Canadian economy grew by 1.5 percent per year from 2006 through 2021, a period that includes the 2009 global recession and the COVID-19 pandemic. Real GDP growth is expected to average 1.9 percent per year from 2022 to 2035.

Growth in the labour force and changes in labour productivity influence Canada's real GDP. Labour productivity is expected to increase by an average of 0.5 percent annually between 2022 and 2035, similar to the 0.6 percent average annual growth during the period between 2006 and 2021. The increase in productivity is attributed to an expected rise in capital formation, and contributes to the growth in real disposable personal income, which is expected to increase by an average of 0.7 percent between 2022 and 2035.

Table 5A-43: Macroeconomic Assumptions – Average Annual Growth Rates, 2006 to 2035

	Historical	Projected		
	2006-2021	2022-2025	2026-2030	2031-2035
Gross Domestic Product	1.5%	2.0%	1.8%	1.7%
Consumer Price Index	1.8%	3.6%	2.1%	2.0%

A3.3. Population Dynamics and Demographics

The population size and its characteristics (e.g., age, sex, education, household formation, among others) have important impacts on energy demand. Canada's overall population is projected to grow on average at an annual rate of 1.4 percent between 2022 and 2025, slowing to 1.1 percent per year between 2026 and 2030 and 1.0 percent between 2031 and 2035.

Major demographic factors that can have measurable impacts on energy consumption are summarized below:

- Household formation: This is the main determinant of energy use in the residential sector. The number of households is expected to increase on average by 1.5 percent per year between 2022 and 2025 and by an average of 1.2 percent per year between 2026 and 2030 and 1.1 percent between 2031 and 2035.
- Labour force: Its annual average growth rate was 1.0 percent per year between 2006 and 2021, and is projected to be 1.3 percent per year between 2022 and 2025; 1.2 percent between 2026 and 2030; and then 1.1 percent between 2031 and 2035.

A3.4. World Crude Oil and North American Natural Gas Prices

A major factor in projected GHG emissions is the assumption about future world oil and natural gas prices since this is a major factor that drives the level of crude oil and natural gas production. Canada is a price taker in crude oil markets as its share of world oil production and consumption are not large enough (5 percent and 2 percent, respectively)[i] to significantly influence international oil prices. North American crude oil prices are determined by international market forces and are most directly related to the West Texas Intermediate (WTI) crude oil price at Cushing, which is the underlying physical commodity market for light crude oil contracts for the New York Mercantile Exchange. The increase in North American oil supply and the resulting transportation bottleneck at Cushing have created a divergence between the WTI price of crude oil and the Brent price of crude oil. As such, the North American oil market is currently being priced differently from the rest of the world.

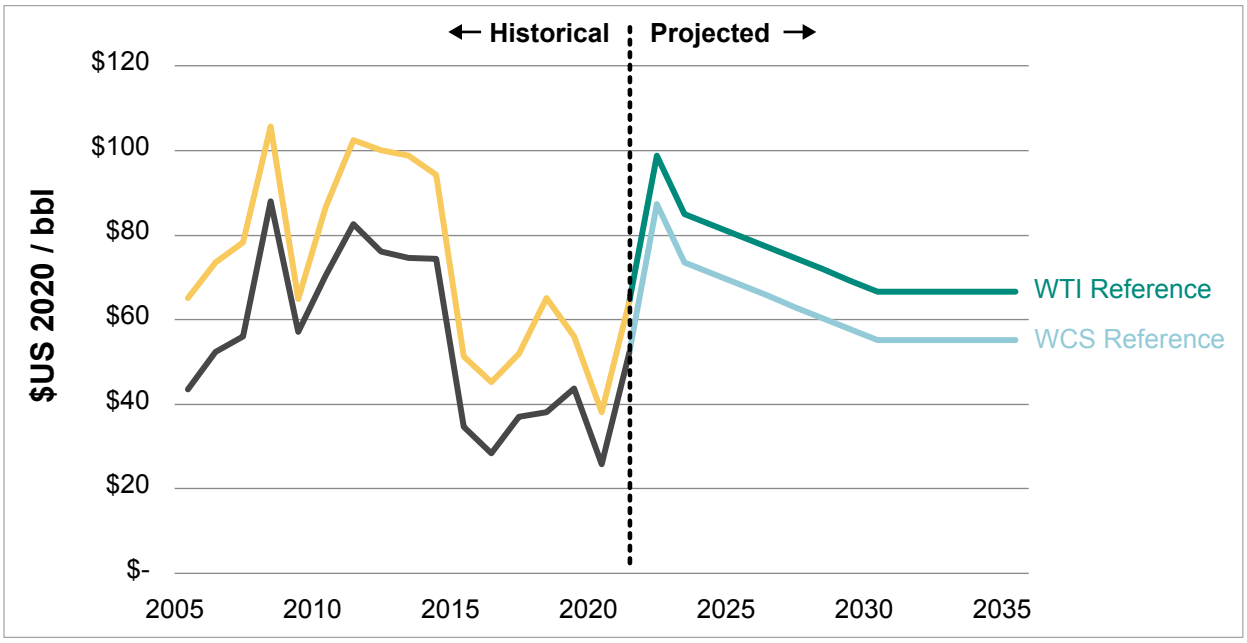
The emissions outlook's WM scenario is anchored by the world oil price assumptions developed by the CER. According to the CER, the world crude oil price for WTI is projected to rise from about US$38 per barrel of oil (bbl) in 2020 to about US$67/bbl in 2035. Higher and lower price scenarios are used for the sensitivity analysis in Annex 5 of this report.

Figure 5A-19 shows prices for light crude oil (WTI) and heavy crude oil (WCS). Historically the price of heavy oil (Alberta Heavy) has followed the light crude oil price (WTI) at a discount of 25 percent to 35 percent. However, in 2008 and 2009 the differentials between the prices of light and heavy crude oils ("bitumen/light-medium differential") narrowed significantly owing to a global shortage of heavier crude oil supply. This differential peaked in 2018, which led to Alberta's Provincial government curtailing oil production to reduce the pricing discount of heavy crude oil. The substantial decrease in light and heavy crude oil prices in 2020 was a result of the COVID-19 pandemic and the Saudi-Russia oil price war which severely impacted energy markets. Finally, the price spike in 2022 is a result of international sanctions against Russia and the subsequent lost supply of fossil fuel exports to the global market.

i Natural Resources Canada, Oil Supply and Demand.

The CER expects the bitumen/light-medium differential to remain constant between US$11 and US$12 throughout the projection period. Take-away capacity in Western Canada is expected to increase from historical levels due to the completion of Enbridge's Line 3 Replacement in 2021, and the expected completion of the Trans Mountain Expansion project in the end of 2023.[ii]

Figure 5A-19: Crude Oil Price: WTI and Alberta Heavy (US$ 2020/bbl)



As shown in Figure 5A-20, the Henry Hub price for natural gas decreases significantly from 2005 to 2020, to US$1.83 per million British thermal units (MMBtu). Natural gas prices consistently decrease over the historical period due to increased supply of natural gas, driven by decreasing costs of production, especially from unconventional extraction methods. The conflict in Ukraine and resulting international sanctions against Russian supply of fossil fuels cause the price for natural gas to peak in 2022 at US$6.44/MMBtu. Eventually, supply and demand begin to re-balance, and prices decrease reaching $3.36 per MMBtu by 2035.

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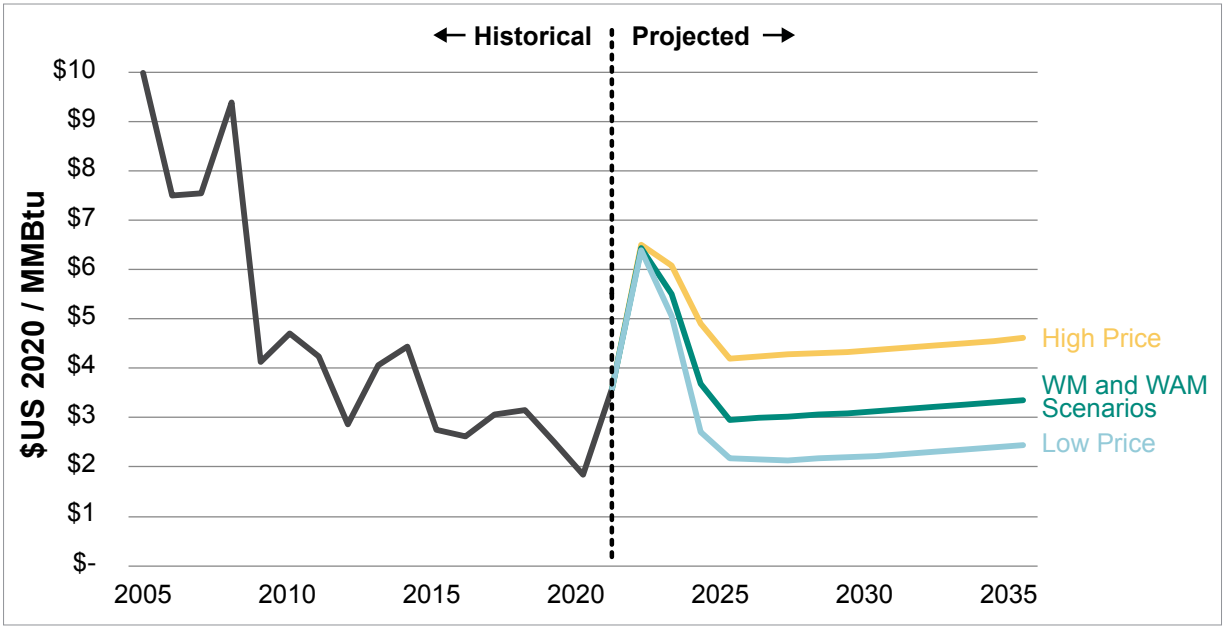
Figure 5A-20: Henry Hub Natural Gas Price ($US 2020/MMBtu)



A3.5. Energy Supply

A3.5.1. Oil and Gas

CER projections illustrate that growth in both conventional natural gas and conventional oil production will be outstripped by unconventional extraction methods, as a result of declining supply of conventional resources and recent improvements to unconventional extraction methods and technology. As such, it is expected that from 2020 to 2030 oil sands in situ production will increase by about 32 percent and oil sands mining production will increase by 10 percent in the WM scenario (see Table 5A-44).

Table 5A-44: Crude Oil Production (thousand barrels per day), 2005 to 2035

	Historical				Projected					
					With Measures			With Additional Measures		
	2005	2010	2015	2020	2025	2030	2035	2025	2030	2035
Crude and Condensates	**1 525**	**1 375**	**1 490**	**1 670**	**2 285**	**2 534**	**2 610**	**2 299**	**2 593**	**2 656**
Conventional Heavy	414	323	323	417	504	495	481	513	518	501
Conventional Light	622	617	760	629	796	856	925	801	891	955
C5 and Condensates	165	144	225	476	844	884	933	845	885	928
Frontier Light (offshore + northern)	323	291	182	148	140	299	271	140	299	271
Oil Sands	**1 065**	**1 613**	**2 529**	**2 977**	**3 365**	**3 595**	**3 715**	**3 385**	**3 725**	**3 834**
Oil Sands: Primary	150	194	262	147	173	195	206	173	195	206
Oil Sands: In Situ	288	562	1 106	1 343	1 561	1 768	1 889	1 582	1 898	2 010
Steam-Assisted Gravity Drainage	*84*	*318*	*843*	*1 129*	*1 313*	*1 491*	*1 596*	1 334	1 624	1 724
Cyclic Steam Stimulation	*204*	*244*	*263*	*214*	*248*	*277*	*293*	248	274	286
Oil Sands Mining	627	857	1 161	1 487	1 631	1 632	1 620	1 631	1 631	1 618
Total Production (gross)	**2 590**	**2 988**	**4 019**	**4 647**	**5 650**	**6 130**	**6 325**	**5 684**	**6 318**	**6 490**

There are two main products from oil sands production: synthetic crude oil (or upgraded bitumen) and non-upgraded bitumen, which is sold as heavy oil. Table 5A-45 illustrates historical and projected oil sands disposition. Synthetic crude oil production is projected to slowly increase from about 1.16 million barrels per day (bbl p/d) in 2020 to about 1.31 million bbl p/d by 2030 in the WM scenario. Non-upgraded bitumen will increase from 1.69 million bbl p/d in 2020 to 2.16 million bbl p/d by 2030 in the WM scenario. and then to 2.28 million bbl p/d by 2035. This non-upgraded bitumen is either sold as heavy oil to Canadian refineries or transported to U.S. refineries for upgrading to refined petroleum products.

Table 5A-45: Oil Sands Disposition (thousand barrels per day), 2005 to 2035

	Historical				Projected					
	2005	2010	2015	2020	With Measures			With Additional Measures		
					2025	2030	2035	2025	2030	2035
Oil Sands (gross)	**1 065**	**1 613**	**2 529**	**2 977**	**3 365**	**3 595**	**3 715**	**3 385**	**3 725**	**3 834**
Oil Sands (net)	**979**	**1 498**	**2 411**	**2 848**	**3 229**	**3 469**	**3 593**	**3 261**	**3 618**	**3 730**
Synthetic Crude Oil	613	860	1 046	1 161	1 313	1 313	1 311	1 313	1 313	1 397
Non-Upgraded Bitumen	366	638	1 365	1 687	1 916	2 156	2 282	1 948	2 305	2 333
Own Use	**86**	**115**	**118**	**129**	**136**	**127**	**123**	**125**	**107**	**104**

Projections in the WM scenario show gross natural gas production will increase from 6.97 trillion cubic feet (Tcf) in 2020 to 8.69 Tcf in 2030. Growth in natural gas production is expected from primarily non-conventional sources such as shale gas and coal-bed methane that come to market and offset the continued decline in conventional gas production. Increased Henry Hub natural gas prices from 2022 to 2024 drives investment and development in the natural gas sector in the early portion of the projection period. Natural gas production growth continues through the projection period, in part from a growing Liquefied Natural Gas (LNG) sector in Canada and the United States. This results in incremental drilling and production of natural gas to serve as feedstock for an expanding LNG sector.

Table 5A-46: Natural Gas Production (billion cubic feet), 2005 to 2035

	Historical				Projected					
	2005	2010	2015	2020	With Measures			With Additional Measures		
					2025	2030	2035	2025	2030	2035
Natural Gas Supply	**6 724**	**6 274**	**6 405**	**6 845**	**8 349**	**8 442**	**8 453**	**8 349**	**8 442**	**8 453**
Marketable Gas	**6 387**	**5 472**	**5 694**	**5 804**	**7 334**	**7 452**	**7 487**	**7 334**	**7 452**	**7 487**
Natural Gas Production (gross)	7 731	6 692	6 750	6 971	8 616	8 686	8 698	8 629	8 756	8 692
Own Use	1 344	1 220	1 056	1 167	1 282	1 234	1 210	1 296	1 304	1 205
Imports	**337**	**802**	**711**	**1 041**	**1 015**	**990**	**966**	**1 015**	**990**	**966**
Liquefied Natural Gas Production (Bcf/d)	**0.0**	**0.0**	**0.0**	**0.0**	**0.9**	**3.7**	**4.6**	**0.9**	**3.7**	**4.6**

A3.5.2. Electricity

Electricity is generated to meet demand from many other sectors of the economy; for example, space heating in the Buildings Sector or charging electric vehicles in the Transportation Sector. This demand for electricity changes for each sector depending on relative fuel and electricity prices, technology choices, energy efficiency changes, policy impacts, and economic driver growth. The supply of electricity grows to meet the evolving demand. The source of electricity supply depends on the historical state of each province and territory's supply mix as well as scheduled refurbishments and retirements, planned and modelled additions to capacity, growing industrial generation and interprovincial and international flows. Government actions further constrain supply choices in the projections, such as the expected retirement of coal units due to the amendments to the federal coal-fired electricity regulations, and renewable portfolio standards in provinces such as Nova Scotia and New Brunswick.

Electricity required is projected to grow 30 percent from 2005 to 2030 and a further 14 percent by 2035 in the WM scenario, as economic growth and electrification outpace energy efficiency improvements. However, utility generation is only projected to grow 26 percent from 2005 to 2030 and a further 14 percent by 2035. The difference can be explained by the growth in industrial generation, which outpaces that of utility generation with 55 percent growth from 2005 to 2030, with an additional 5 percent by 2035. Excess industrial electricity generation is often sold to the utility grid to help meet end-use demand. Over the period, exports of electricity to the US tend to increase, while imports stay relatively flat.

Electricity generation in Canada is dominated by hydro. In 2020 in the WM scenario, it represents 61 percent of utility generation and 42 percent of industrial generation. The remaining utility generation is comprised of nuclear (16 percent), fossil fuels (15 percent) and some other renewables (8 percent), whereas the remaining industrial generation is comprised of fossil fuels (45 percent) and other renewables (12 percent). In the projections, the fastest source of growth is from other renewables such as wind and solar. Hydropower continues to grow, but at a slower rate, while nuclear generation decreases due in large part to the refurbishments and closures of nuclear plants in Ontario. Regarding fossil fuels, coal generation is phased out by 2030 while natural gas generation grows to help the transition away from coal and to balance the growing intermittent renewables.

In the WAM scenario, the Clean Electricity Regulations lead to a significant reduction in fossil fuel use for utility electricity generation. Natural gas utility generation still increases in the short-term but is significantly lower in 2035 compared to the WM scenario (55 TWh lower). This difference is made up by higher generation from other renewables (62 TWh) and nuclear (19 TWh), which could allow higher electricity exports to the U.S. Moreover, in the WAM scenario, industrial generation from other renewables increases in the projections to produce hydrogen for industry.

Table 5A-47: Electricity Supply and Demand (Terawatt hours), 2005 to 2035

	Historical				Projected					
					With Measures			With Additional Measures		
	2005	2010	2015	2020	2025	2030	2035	2025	2030	2035
Electricity Required	**602**	**593**	**647**	**642**	**701**	**780**	**865**	**711**	**785**	**901**
Total Gross Demand	546	535	552	552	624	701	755	632	701	755
Purchased from Grid	495	487	491	492	547	617	667	545	601	657
Own Use	51	48	62	60	77	85	88	87	100	98
Net Exports	24	26	62	58	41	39	67	43	45	103
Exports	44	44	73	67	58	66	84	61	83	116
Imports	20	19	11	10	17	21	17	18	18	12
Losses	32	32	32	32	36	40	43	36	39	42
Electricity Produced	**609**	**596**	**655**	**645**	**703**	**789**	**867**	**712**	**808**	**904**
Utility Generation	550	541	578	578	617	695	771	616	699	796
Coal and Coke	96	81	60	37	5	1	1	5	1	0
Refined Petroleum Products	15	6	7	5	3	1	1	3	1	0
Natural Gas	18	28	31	43	80	75	65	72	52	10
Nuclear	87	86	96	93	68	67	74	68	67	93
Hydro	327	321	345	355	385	386	396	383	385	396
Other Renewables	7	19	39	46	76	166	234	84	190	296
Hydrogen	0	0	0	0	0	0	0	2	4	1
Industrial Generation	60	55	77	66	86	93	96	96	109	108
Coal and Coke	0	0	0	0	0	0	0	0	0	0
Refined Petroleum Products	2	2	2	1	2	2	2	2	2	2
Coke Oven Gas	0	0	0	0	0	1	1	0	1	1
Natural Gas	19	22	35	29	42	45	47	39	38	38
Hydro	31	27	33	28	32	36	36	31	32	31
Other Renewables	7	4	6	8	10	10	10	21	30	29
Hydrogen	0	0	0	0	0	0	0	3	6	7

A3.6. Emissions Factors

Table 5A-48 provides a rough estimate of carbon dioxide equivalent emissions emitted per unit of energy consumed by fossil fuel type for combustion and industrial processes. These numbers are estimates based on the latest available data. Specific emission factors can vary slightly by year, sector, and province.

Table 5A-48: Mass of CO_2 eq Emissions Emitted per Quantity of Energy for Various Fuels

Fuel	CO_2eq Emission Factor (g/MJ)
Aviation Gasoline	73.07
Biodiesel	5.28
Biomass	3.19
Coal	91.70
Coke	110.30
Coke Oven Gas	36.72
Diesel	71.44
Ethanol	2.35
Gasoline	71.67
Heavy Fuel Oil	75.33
Jet Fuel	69.37
Kerosene	68.14
Light Fuel Oil	71.16
LPG	37.67
Lubricants	57.72
Naphtha Specialties	17.77
Natural Gas	48.75
Natural Gas Raw	56.07
Other Non-Energy Products	36.41
Petrochemical Feedstocks	14.22
Petroleum Coke	83.38
Renewable Natural Gas	0.37
Still Gas	49.12
Waste	92.99

A3.7. Federal, Provincial and Territorial Measures

Many federal, provincial, and municipal policies and measures currently exist in Canada that are aiming to reduce GHG emissions or energy consumption. Some of these have been fully implemented (e.g., methane regulations that have received royal assent), while others are still in the development or planning stages. Environment and Climate Change Canada applies a set of criteria for a policy to be included in the WM scenario. These criteria include:

- The policy has the necessary legislative and financial support;
- The measure is expected to produce meaningful reductions (at least 100 kt CO_2 eq);
- There is sufficient quantifiable information available to estimate the impact of the policy/measure; and,
- The measure is incremental to other policies/measures already included in the model.

The WM scenario does not consider the impact of broader strategies or future measures within existing plans where significant details are still under development.

Announced policies that have not satisfied the criteria for the WM scenario could still be included in the WAM scenario, if expected reductions are meaningful and there is sufficient information available to model it. ECCC engages with provinces and territories in extensive consultations to ensure their initiatives are accounted for in the analysis and modelling of emissions projections.

Table 5A-49 identifies the major federal, provincial, and territorial measures that are included in the WM and WAM scenarios. This includes measures that have been implemented or announced in detail as of September 2019. Where program funding is set to end, the projections assume that the impacts of these programs, other than those embodied in consumer behaviour, cease when the approved funding terminates.

Table 5A-49: GHG Measures Reflected in WM and WAM Scenarios

<table>
<tr><th>Provincial/Territorial Measures</th><th>Federal Measures</th></tr>
<tr><td colspan="2">With Measures (WM Scenario)</td></tr>
<tr><td>Adoption of the National Energy Code for Buildings of Canada (2010-2012) by all provinces and territories</td><td rowspan="6">Federal Backstop Carbon Pollution Pricing (reaching $170/t in 2030)
Clean Fuel Regulation
Amendments accelerating the phase out of coal-fired generation of electricity and performance standards for natural gas electricity generation[a]
Energy Innovation Program
Incentives to Zero Emission Vehicles
Public Transit Investments
Emerging renewables and smart grids[b]
Off-diesel energy systems in remote communities
Equipment Standards (Amendments 13 to 16 of the Energy Efficiency Regulations)
Canada Greener Homes Grant
Voluntary emission reductions for planes and trains
Light-duty vehicles (LDV) GHG emissions standards for the light-duty vehicle model years 2011 to 2016 (LDV-1) and 2017 to 2026 (LDV-2)
Heavy-duty vehicles (HDV) GHG emissions standards for heavy-duty vehicle model years 2014 to 2018 (HDV-1) and 2021 to 2027 (HDV-2)</td></tr>
<tr><td>Renewable Fuel Content across all jurisdictions (except for Newfoundland and Labrador, Yukon, the Northwest Territories and Nunavut)</td></tr>
<tr><td>Newfoundland and Labrador
Muskrat Falls hydro project
Waste Management Strategy
Newfoundland’s carbon pricing system</td></tr>
<tr><td>Prince Edward Island (PEI)
PEI Fuel Charge</td></tr>
<tr><td>Nova Scotia
Nova Scotia's carbon pricing system
Cap on GHG emissions from the Electricity Sector
Renewable portfolio standard for electricity generation
Electricity demand-side management policies
Solid Waste-Resource Management Regulations
Phase out of coal-fired electricity plants by 2030</td></tr>
<tr><td>New Brunswick
40 percent Renewable Portfolio Standard by 2020
New Brunswick’s Carbon Levy
New Brunswick’s Output-Based Pricing System
National Building Code of Canada 2015</td></tr>
</table>

Québec • Western Climate Initiative cap-and-trade regime[c] • Low carbon fuel content requirement (by 2030 15 percent for gasoline and 10 percent for diesel) • Demand-side management program to reduce power peak demand • Drive electric program • Landfill gas regulation • Eco-performance program for industry • Program to support energy efficiency improvements in marine, air and rail transport (PETMAF) • Program to reduce/avoid GHG emissions by using intermodal transportation (PREGTI) • Program Écocamionnage • Renewable natural gas blending mandate (5 percent by 2025 and 10 percent by 2030) • Québec policy for the management of residual materials • Residual forest biomass program • Passenger ZEV mandate, (100 percent ZEV sales by 2035)	• iMHZEV program offers funding for purchase or lease of ZEV MHDVs 2022 to 2026 • Regulations Amending the Ozone-depleting Substances and Halocarbon Alternatives Regulations • Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas sector) • Accelerating Industrial Energy Efficiency Management • Low-Carbon Economy Challenge Fund • Low-Carbon Economy Leadership Fund • Net Zero Accelerator Initiative: Algoma and Dofasco steel sector decarbonisation projects, Air Products hydrogen production • Strategic Interconnections in electricity (extend existing contracts for 2041 to 2050 between Manitoba – Saskatchewan and Québec – New Brunswick) • Investment Tax Credit for Carbon Capture, Utilization, and Storage • Two Billion Trees Program
Ontario • Cleaner Transportation Fuels regulation (4 percent biodiesel content in diesel and ethanol content in gasoline to 15 percent by 2030) • Residential electricity peak savings (time-of-use pricing) • Feed-in tariff program • Landfill gas regulation (O. Reg. 216/08 and 217/08) • Strategy for a Waste-free Ontario • Nuclear refurbishment • Energy Storage Contract with Québec • Ontario Natural Gas 2015-2021 Demand Supply Management (DSM) • Ontario Electricity 2021-2024 Conservation Demand Management Framework • Coal phase-out – electricity generation	

Manitoba • Biofuel Mandate (ethanol content in gasoline increasing to 10 percent and biodiesel content in diesel to 5 percent by 2022) • Manitoba Building Code Section 9.36 (for housing) • Manitoba Composts program • Efficiency Manitoba Act • Waste Reduction and Recycling Support Program	
Saskatchewan • *Uniform Building and Accessibility Standards Regulations* (2013) • Electricity emissions reduction target to 50 percent below 2005 levels by 2030 • Solid Waste Management Strategy • Saskatchewan's output-based performance standards system • Saskatchewan Oil and Gas Emissions Management Regulations	
Alberta • Alberta's Technology Innovation and Emissions Reduction System with Regulation (TIER) • 100 Mt cap for oil sands • Quest, Sturgeon, and Nutrien carbon capture and storage project • Carbon Trunk Line Project – CO_2 capture and use for enhanced oil recovery • Energy efficiency requirements for housing and small buildings, section 9.36 of the 2014 Alberta Building Code edition • Directive 060: Upstream Petroleum Industry Flaring, Incinerating and Venting • Phasing out electricity emissions from Coal (original target of 2030 but expected achieved by the end of 2023)	

British Columbia
• Carbon tax increasing to $40 in 2019 and $50 in 2021
• CleanBC plan:
  ○ ZEV mandate and incentives
  ○ Tailpipe Emissions Standard
  ○ Heat Pump Incentive
  ○ Organic Waste Diversion and Landfill gas
  ○ Industrial Electrification
  ○ CleanBC for Industry	

• Low Carbon Fuel Standard
• Landfill gas management regulation
• Renewable natural gas mandate (5 percent by 2025)
• Drilling and Production Regulation
• British Columbia *Clean Energy Act*:
  ○ Clean or renewable electricity requirement – 100 percent of electricity from clean or renewable sources by 2025
  ○ Demand-side management measures to reduce power peak demand
• Revisions for energy efficiency of large residential and commercial buildings (Part 3) (reg # 167/2013)
• Revisions for energy efficiency of housing and small buildings (Part 9) (reg # 173/2013)
• City of Vancouver Building Codes
• Clean Energy Vehicles Program (Phase 1, 2, Phase 3 and Beyond), a ZEV mandate and support for zero emissions vehicle charging stations in buildings
• Step Code: Increased Energy Efficiency Requirements in the Building Code
• Municipal Waste disposal target and organic waste disposal restriction
• Energy Efficiency Standards Regulation on gas-fired boilers
• British Columbia's Drilling and Production Regulation	

Northwest Territories • Biomass Strategy • NWT Carbon tax	
Yukon • 93 percent of renewable electricity on the main grid by 2030 • Reducing the use of fossil fuels for electricity generation in off-grid communities by 30 percent through community-based renewable energy projects by 2030 • Substituting some of the diesel used to generate electricity with clean diesel alternatives by 2030	

<table>
<tr><th colspan="2">With Additional Measures (WAM Scenario)</th></tr>
<tr><td>Québec
WCI credits (Assumes Québec meets its legislated emissions targets through purchases of WCI allowances.) to 2030</td><td rowspan="3">Federal Backstop Carbon Pollution Pricing (reaching 170$/t in 2030). Post 2030, the modelling assumes that stringency increase to 3 percent per year in the OBPS system, electric utility credit free allocation drops to 0 in 2031 and Québec joins the federal system that same year.
Clean Electricity Regulations
Net-zero energy ready building codes (for new commercial and residential buildings) by 2030
Retrofits – Labelling and codes for existing buildings in the commercial sector and the Canada Greener Homes Loan program in the residential sector
More stringent Energy Efficiency Standards for appliances and equipment
Regulations for off-road industrial, commercial, residential and recreational vehicles
Post-2026 LDV regulations
The Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations, targeting 60 percent ZEV sales by 2030 and 100 percent ZEV sales by 2035
On-road freight medium and heavy-duty vehicles to reach ZEV sales target of 30 percent by 2030 and 100 percent where feasible by 2040
$200m in federal funding for the retrofit of heavy-duty vehicles.
Measures to reduce emissions from air, marine and rail through efficiency gains and low carbon fuel blending
Electrification of lawn and garden equipment by 2034
Additional strategic Interconnections in electricity (Manitoba – Saskatchewan, Québec – New Brunswick, Québec – Nova Scotia)
Smart Renewables and Electrification Pathways Program
Clean Energy for Rural and Remote Communities Program</td></tr>
<tr><td>British Columbia
Implement 100 percent Clean Electricity Delivery Standard by 2030
Clean Energy Vehicles Program – $75m/year (2023-2030) in funding for ZEV HDVs
HDV ZEV sales mandate – 100 percent of new HDVs to be ZEV by 2040
Expansion of the low carbon fuel standard to aviation and marine
Expansion of the renewable natural gas blending mandate (15 percent by 2030)</td></tr>
<tr><td>Yukon
Introduction of ethanol and biodiesel blending mandate (10 percent ethanol and 20 percent biodiesel by 2025)</td></tr>
</table>

	• Strengthened Methane Regulation
	• Net Zero Accelerator Initiative:
	  ○ Rio Tinto's critical minerals project
	  ○ Generic Electrification and Energy Efficiency improvements in key industrial sectors
	  ○ Suncor/ATCO hydrogen project
	• Investment and funding measures: carbon revenue (OBPS and fuel charge proceeds programs), Canada Growth Fund, and other measures
	• Investment Tax Credit for CCUS, Renewable Electricity Small Modular Nuclear Reactors and Electricity Storage, Clean Technology and Hydrogen
	• Hydrogen Strategy for Canada
	• Deployable Mitigation Technologies Fund
	• Federal Landfill Gas Regulations
	• Nature Smart Climate Solutions Fund and other nature based and agriculture measures
	• Voluntary Agriculture Fertilizer Emissions Reduction Target

a) A number of provinces are currently working with the Government of Canada on Equivalency agreements in lieu of the amended coal-fired electricity regulations.

b) Indicates policies that were added and/or modified for the 2022 WM case.

c) Expected net purchases of credits by Quebec under the WCI are not included.

Canadian provinces and territories have committed to taking action on climate change through various programs and regulations. In the WM scenario, provincial and territorial targets are not modelled. Instead, individual policies that are brought forward as methods to attain the provincial targets may be included in the modelling if they meet the criteria discussed above. Table 5A-50 lists the emissions reductions targets announced by each province or territory.

Table 5A-50: Announced GHG Reduction Targets of Provincial/Territorial Governments

Province / Territory	Target in 2020	Target in 2030	Target in 2050
Newfoundland and Labrador	10% below 1990	30% below 2005	75% to 85% below 2001
Prince Edward Island	10% below 1990	40% below 2005	N/A
Nova Scotia	10% below 1990	53% below 2005	Net-zero emissions
New Brunswick	Total emissions output of 14.8 Mt/CO_2 eq	Total emissions output of 14.1 Mt/CO_2 eq	Total emissions output of 5 Mt/CO_2 eq
Québec	20% below 1990	37.5% below 1990	80% to 95% below 1990
Ontario	17% below 2005	30% below 2005	N/A
Manitoba	1 Mt CO_2 eq cumulative reduction (2018 to 2022)	N/A	N/A
Saskatchewan	N/A	N/A	N/A
Alberta	N/A	N/A	N/A
British Columbia	N/A	40% below 2007	80% below 2007
Nunavut	No Territorial target announced	N/A	N/A
Yukon	N/A	30% below 2010	N/A
Northwest Territories	N/A	30% below 2005	N/A

Table 5A-51: Air Pollutant Measures Reflected in the WM Scenario

Provincial/Territorial Measures	Federal Measures
With Measures (WM Scenario)	
Newfoundland and Labrador • Newfoundland Air Control Regulations	• Base-Level Industrial Emission Requirements (BLIERs) • Multi-Sector Air Pollutants Regulations (MSAPR) • Sulphur in Gasoline Regulations • Canada and USA Emission Control Area (ECA) for Ships • On-Road Vehicle and Engine Emission Regulations • Off-Road Compression-Ignition (Mobile and Stationary) and Large Sparke-Ignition Engine Emission Regulations • Off-Road Small Spark-Ignition Engine Emission Regulations • Locomotive Emissions Regulations • VOC Concentration Limits for Architectural Coatings Regulations • Reduction in the Release of Volatile Organic Compounds Regulations (Petroleum Sector) • Volatile Organic Compound Concentration Limits for Certain Products Regulations
Nova Scotia • Nova Scotia Air Quality Regulations for Utility Electric Generation	
Québec • Québec Clean Air Regulation	
Ontario • Reducing sulphur dioxide emissions from Ontario's petroleum facilities	

Table 5A-52 provides a list of detailed assumptions for some of the key measures underlying the WAM scenario. This list is not intended to be comprehensive of all of the measures included in the scenario.

Table 5A-52: Key Assumptions Found in WAM Scenario

CROSS-CUTTING MEASURES	
Carbon Pricing	
Fuel Charge	The federal government announced that the federal fuel charge rates will reflect an annual increase of $15/tonne CO_2 eq after 2022 until the fuel charge rates reflect a carbon price of $170/t CO_2 eq in 2030. As carbon pricing systems are in the process of being adjusted to align with the 2023 to 2030 minimum national stringency requirements (federal benchmark), for illustrative purposes the modelling assumes that the federal fuel charge applies in all provinces and territories apart from Québec, which is modelled based on its current cap-and-trade carbon pricing system. Because the cap levels that will apply post-2030 in provincial cap-and-trade systems are not yet known, for illustrative purposes it is assumed that the federal fuel charge applies in Québec for the post-2030 period. Decisions have not been taken on the national minimum carbon price for the post-2030 period. As a result, for the purpose of this modelling, the assumption is that the price remains at $170/t CO_2 eq in nominal terms.
Federal Output-Based Pricing System	The Output-Based Pricing System (OBPS) is a performance-based emissions trading system for industry that puts a price incentive on all industrial emissions. For every tonne of excess emissions above a specified annual limit (based on emissions intensity output-based standards), facilities have to pay the carbon price or submit eligible credits. Facilities with emissions below the limit receive credits to sell or use for compliance. The federal government announced that the charge for excess emissions under the OBPS will increase annually by $15/tonne CO_2 eq starting in 2023 until it reaches $170/tonne CO_2 eq in 2030. Decisions have not been taken on the national minimum carbon price for the post-2030 period. As a result, for the purpose of this modelling, the analysis assumes that the price remains at $170/t CO_2 eq in nominal terms. As carbon pricing systems are in the process of being adjusted to align with the 2023 to 2030 minimum national stringency requirements (federal benchmark), for illustrative purposes the modelling assumes large emitters are covered under an OBPS-type system in all provinces and territories apart from Québec, which is modelled based on its current cap-and-trade carbon pricing system. The modelling of the OBPS assumes a 2 percent tightening in stringency every year post-2022 and the modelling assumes that any excess credits in the OBPS market post-2027 are cleared at the benchmark carbon price. Post 2030, the modelling assumes that stringency increases by 3 percent per year in order to keep the OBPS system aligned with the benchmark requirement that systems be designed to maintain the marginal price at the national minimum carbon price. Because the cap levels that will apply post-2030 in provincial cap-and-trade systems are not yet known, for illustrative purposes it is assumed that the OBPS-type system applies in Québec. In addition, in alignment with the stated policy intent to apply the carbon price to all remaining electricity emissions by 2035, electric utility free allocation is eliminated starting in 2031. As the new decarbonization measures outlined in this plan are further defined and implemented, carbon pricing systems targeting industrial emissions may need to be further strengthened post-2027 to maintain their effectiveness and continue to drive emissions reductions at the benchmark price. An interim assessment of carbon pricing systems by 2026 will create an opportunity to adjust systems if necessary.

Investments and Investment Tax Credits	
Investments	Significant investments made by the government including the Canada Growth Fund, new funding for Low Carbon Economy Fund, and revenues from carbon pricing were modelled as exogenous funding measures. These investments aim at increasing production from clean technologies by displacing conventional methods. By 2030, approximately $57 billion are injected into the economy. This funding is also assumed to be leveraged at a 3.5:1 ratio, meaning that for every dollar government invests, an additional 3.5 dollars of capital is diverted from conventional production to less carbon intense production.
Investment Tax Credit (ITC) for Clean Technologies	An ITC for clean technologies equivalent to 30 percent of the capital cost of investments in technologies such as: electricity generation systems; stationary electricity storage systems; low carbon heating equipment; industrial zero-emission vehicles and related charging or refueling equipment. The ITC will be phased out gradually between 2032 to 2034, and will no longer be in effect at the start of 2035.
ITC for Clean Hydrogen and Hydrogen Strategy	Following the release of the Hydrogen Strategy for Canada, there have been several announcements to foster the development of this sector in Canada. Recently, in the 2022 Fall Economic Statement, the government has announced an Investment Tax Credit (ITC) for clean hydrogen. The ITC will support clean hydrogen projects and will be similar to the ITC for Clean Technologies. It will be refundable, based on the life cycle carbon intensity of hydrogen. Given that details of the ITC for Clean Hydrogen and additional measures to support the Hydrogen Strategy are yet to be developed, the modelling assumes a proxy of a 7.3 percent hydrogen (on an energy basis) blending mandate into the natural gas stream in term of purchased natural gas. The hydrogen production method varies from one province to another depending on the available energy inputs. For western provinces where low-cost natural gas is available, hydrogen production is produced mainly by reformation processes (ATR, SMR) coupled with CCS. A non-negligible part of the hydrogen production in these provinces is by electrolysis from dedicated renewable electricity sources. In the eastern provinces, hydrogen production is primarily from electrolysis pathways with electricity supplied from the grid or renewables (wind and solar) and biomass gasification.
SECTOR-SPECIFIC MEASURES	
Buildings	
Residential efficiency retrofits	Greener Homes program provides up to 700,000 grants of up to $5,000 to help homeowners make energy efficient retrofits to their homes, such as better insulation. To help homeowners and build on these measures, the 2021 Federal Budget proposed $4.4 billion over 5 years, starting in 2021-22 to help up to 175,000 homeowners complete major home retrofits through interest-free loans of up to $40,000. Together, the grants and loans reduce the 2026 residential energy demand by approximately 40 PJ in comparison to a scenario without these policies.
Energy efficiency for space heating and cooling – commercial	Between 2022 and 2030, building shell energy efficiency of all building stock increases such that energy demand per floor space declines by 3.5 percent for space heating and by 3.6 percent for space cooling (compounded year-over-year).
Energy efficiency for auxiliary equipment – commercial	Between 2022 and 2030, energy efficiency of all equipment stock (excl. refrigeration) increases by an average additive increment of 0.9 percent per year, and refrigeration stock efficiency increases by an average of 1.3 percent per year.

Energy efficiency for auxiliary motors – commercial	Between 2022 and 2030, energy efficiency of all equipment stock increases by an average additive increment of 1.3 percent per year.
Energy efficiency of lighting – commercial	Between 2022 and 2030, energy efficiency of all equipment stock increases by an average additive increment of 1.1 percent per year.
Net-zero ready building codes	Residential: Increase energy efficiency such that new buildings use 61 percent less energy by 2025 and 65 percent less energy by 2030 in comparison to 2019. Commercial: Increase energy efficiency such that new buildings use 47 percent less energy by 2025 and 59 percent less energy by 2030 in comparison to 2019.
Transportation	
Light duty vehicles (LDV)	Annual improvements in new vehicle fuel efficiency of 1.5 percent for 2021-2022, 10 percent for 2023, 5 percent for 2024-2026; with no ZEV carve out (i.e., can be met through ZEV sales).
Electrify passenger LDV and Light duty trucks (LDT)	Increase sales shares of LDV Electric, LDT Electric, LDV Hybrid, and LDT Hybrid to a total of 60 percent in 2030 and 100 percent in 2035.
Post-2026 LDV standards aligned to upcoming California regulations	For the years 2027 to 2030, annual fuel efficiency improvements of 1.5 percent per year for new gasoline and diesel LDVs. Modelled consistently with the ZEV carve out (i.e., cannot be met through ZEV sales).
Electrify freight heavy duty vehicles (HDV)	Increase sales shares to reflect 100 percent sales of HDVs “where feasible”: reaching approximately 35 percent by 2030.
Sustainable Aviation Fuel	Switches out 6 percent of jet fuel for low carbon fuel in Air Freight and Air Passenger in 2030.
National Active Transportation Strategy	Reduces energy demand in passenger transportation by 0.33 percent in 2030.
Electrifying Public Transit System	100 percent of new buses are electric by 2040.
Invest $200M to retrofit large trucks	Retrofit spread evenly over four years, starting in the second half of 2024.
Heavy Industry (Proxy for Net Zero Accelerator/Strategic Innovation Fund)	
Electrification in key industrial sectors	Starting in 2022, electricity share (percent) of all equipment stock increases linearly to attain an incremental increase in 2030 of: • 2 percent in Pulp & Paper; • 2 percent in Chemicals & Fertilizers; • 1 percent in Cement; • 4 percent in Off Road Mining; and • 19 percent in Light Manufacturing
Energy efficiency for all sectors of Heavy Industry	Starting in 2022, energy efficiency of all GHG-emitting facility installations for all end-uses increases by a target of 2 percent each year until 2030.
Energy Efficiency for Light Manufacturing	Starting in 2022, energy efficiency of all GHG-emitting facility installations for all end-uses increases by a target of 2 percent each year until 2030.
Inert aluminum anodes	20 percent adoption by 2030. After 2030, linear decline until complete phase-out of traditional anodes by 2050.

Oil and Gas	
Extended Methane Regulation	75 percent reduction relative to 2012 by 2030.
Steam Assisted Gravity Drainage solvents (proxy for NZA)	All new SAGD facilities as of 2025 are assumed to utilize solvent technology. For some brownfield facilities (i.e., expansions to existing facilities) co-injection of solvents are assumed, which yields a 30 percent improvement of energy intensities. For all Greenfield (i.e., new operations) and some Brownfield facilities, pure solvent utilization is assumed, which yields an 80 percent improvement of the facility's energy intensity. Moreover, utilization of solvent technology for new SAGD facilities leads to roughly a 40 percent increase in oil production at the facility-level.
Electricity	
Implement a Clean Electricity Regulations (CER) for electricity-generating units	A key element to achieve a net-zero electricity system in Canada by imposing a performance standard on emissions for electricity produced by many power plants in 2035. For more information, please visit this Government of Canada website[a].
Availability of new types of electricity-generating units: Small Modular Nuclear Reactors, Electricity Storage, Bioenergy with CCS, and Natural Gas with CCS	Project economics determines deployment.
Restoration of interties: BC-AB	In 2030: restoration of existing line from 800 to 1200 MW.
Construction of new interties: SK-MB	In 2030: new 500 MW line.
Construction of new interties: QC-NB	In 2030, new 600 MW line, contract of 2 TWh/year (from QC to NB).
Construction of new interties: QC-NS	In 2030, new 550 MW line, contract of 2 TWh/year (from QC to NS).
Waste	
Increasing landfill methane recovery	Starting in 2022, landfill gas capture at municipal solid waste facilities increase linearly to attain collection efficiency in 2030 between 31 percent to 75 percent at the provincial level.

Agriculture and Nature Based Climate Solutions	
Clean Technology Program	The Clean Technology Program consists of an adoption stream, subsidizing low-carbon technology, precision agriculture, and bioeconomic solutions adoption, and a research and innovation stream. Over the next two years, funding will be provided for low-carbon energy use on farms and for purchasing more efficient grain dryers.
Fertilizer Target	30 percent reduction in N_2O emissions from fertilizer from 2020 levels, by 2030.
Resilient Agricultural Landscapes Program	The Resilient Agricultural Landscapes Program supports ecological goods and services provided by the Agriculture Sector.
Next Policy Framework	he Sustainable Canadian Agricultural Partnership (S-CAP), a new five-year partnership with federal, provincial, and territorial governments to strengthen the Agriculture and Agri-food sector, is planned for April 2023. Climate Change and Environment focus areas for the S-CAP include preparation for and response to a changing climate by supporting Beneficial Management Practices and accelerating technological adoption, reduction of GHG emissions and improved carbon sequestration, protection and regeneration of soil, water and air quality, improved biodiversity and protection of sensitive habitats.
Agricultural Climate Solutions (ACS): Living Labs	ACS: Living Labs Program aims to establish a strong, Canada-wide network of living labs. Through these living labs, regional leaders will bring together farmers, scientists, and other sector partners to co-develop, test and monitor beneficial management practices on farms to sequester carbon and/or mitigate GHG emissions and enhance climate resiliency.
Agricultural Climate Solutions: On-Farm Climate Action Fund (ACS-OFCAF)	ACS-OFCAF aims to support farmers in adopting Beneficial Management Practices that store carbon and reduce GHGs in three areas, nitrogen management, cover cropping, and rotational grazing practices. With additional funding to support additional key climate mitigation practices, extend the program past its current end date of 2023-24, and support adoption of practices that contribute to the fertilizer emissions target and Global Methane Pledge.
Nature Smart Climate Solutions Fund	Reduce Canada's net greenhouse gas emissions using natural climate solutions, while providing benefits for biodiversity and human well-being.

a) https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/proposed-frame-clean-electricity-regulations.html

Annex 4: Modelling and Methodological Differences from Canada's *Fourth Biennial Report*

This annex provides information on revised Assumptions changes to the modelling framework since the release of Canada's BR4:

A4.1. Revised Assumptions

- Macroeconomic assumptions and oil and gas price and production forecasts have been updated.
- The Clean Fuel Regulations are now modelled endogenously in the WM scenario.
- The Carbon Pricing Systems are now modelled in the WM scenario, reaching $170/t CO_2 eq in 2030 as compared to $50/t CO_2 eq in only the WAM scenario in the BR4.
- Update technology cost curves for the Iron & Steel and Pulp & Paper sectors
- Updated projections of fuel consumption in the passenger Transportation Sector to better reflect typical on-road conditions, driving behaviour, and the types of vehicles Canadians are driving. This change, as well as historical data revisions, led to a substantial increase in projected transportation-related emissions out to 2030 as compared to the BR4 projections.
- Associated Natural Gas: in previous projections, associated natural gas (or solution gas) was included in the total natural gas production as a driver for emissions in the sector. This overestimated emissions in previous projections, as emissions from associated gas are already correctly accounted for in Conventional Oil Sectors. Now, the Natural Gas Sector's driver accounts only for natural gas produced at a gas-well.
- Updated operating parameters of wind and solar electric units.
- Revisions to the assumptions on energy efficiencies and electrification lead to higher electricity demand by 2030. Consequently, there is higher electricity generation, which leads to higher electricity emissions.
- Carbon Capture and Storage (CCS) cost curves have been added to the model to forecast endogenous CCS construction in the projection period.
- In the Buildings Sector, changes have been made to make the model more responsive to changes in energy prices when homeowners make decisions to replace their heating equipment. Specifically, the model allows homeowners to replace their space heating equipment at the end of its lifetime with a different type of technology (for example, by replacing a natural gas furnace or oil heater with an electric heat pump) before the building reaches its end of life.
- For the Solid Waste Sector, the same set of equations of the decay model is used, but with new parameterization and refinement on the waste composition. The previous decay rates were underestimated in areas with low precipitation, methane generation have been revised upwards in the history and in the projections.

A4.2. Changes to the Modelling Framework

- Several other modelling improvements have been made over the last three years:
- In the Electricity Sector, the model is now able to add new plant types, such as electricity storage, small modular nuclear reactors and biomass with carbon capture and storage
- Efficiencies for lighting, geothermal and air source heat pumps were updated with more recent industry forecasts.
- Market shares of zero emission vehicles (ZEV) were aligned to Transport Canada's September 2022 ZEV Reference Case, which reflects the extension of the Federal iZEV subsidy, British Columbia and Québec's ZEV mandates, as well as various other provincial measures.
- Market shares for ZEV on road freight vehicles were aligned to Transport Canada's supplied reference case. This reference case includes funding provided through the iMHZEV program.
- Addition of a hydrogen module to simulate supply and demand. Supply modes include electrolysis, steam methane reformation, autothermal reformation, and biomass gasification. Hydrogen demand is modelled in fuel cells and feedstocks or mixed in the natural gas pipeline.

Annex 5: Sources of Uncertainty and Sensitivity Analysis

A5.1. Sensitivity Analysis

Given the uncertainty regarding the key drivers of GHG emissions, the emissions projections for the WM scenario presented in Chapter 5 should be considered as one estimate within a range of plausible outcomes. Future economic growth, energy prices, and developments in technologies cannot be foreseen with certainty. Typically, these key uncertainties are addressed by examining alternative cases. The sensitivity analysis presented here focuses on two key uncertainties: the future rate of economic and population growth; and the evolution of world fossil fuel prices.

In Table 5A-53, the emissions outcomes of these alternative cases are presented independently and in various combinations. These alternative cases explore the interaction of energy markets and economic growth, and their impact on emissions, under a range of assumptions.

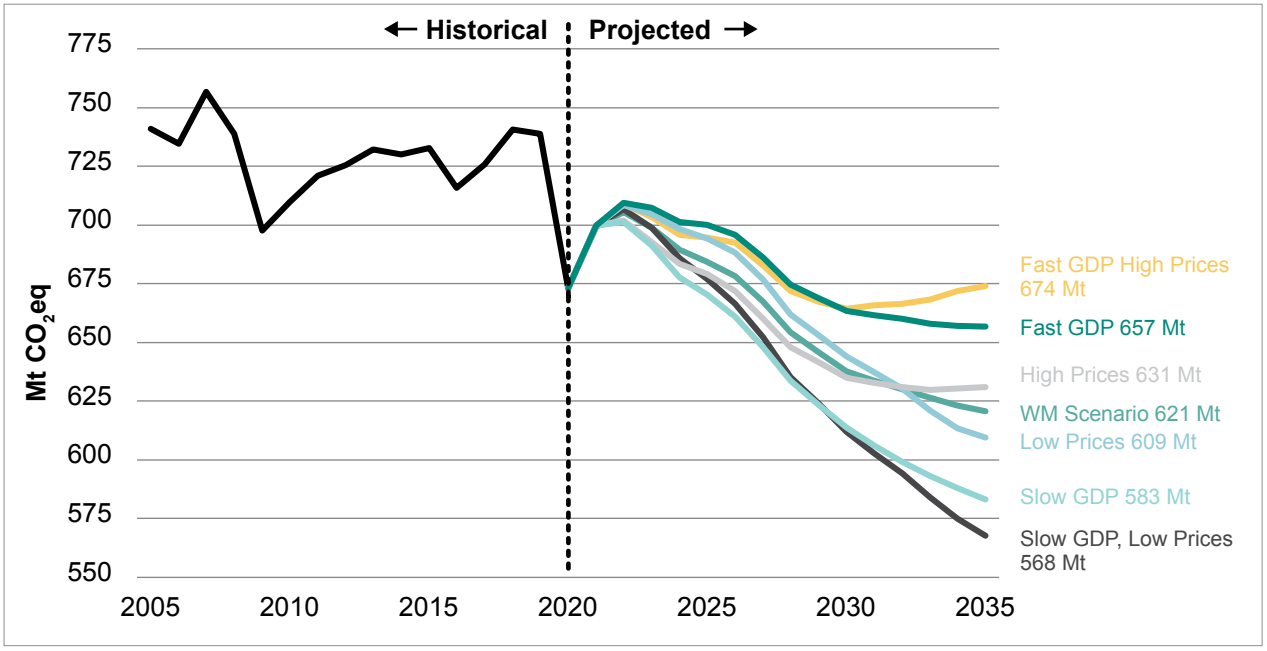
Table 5A-53: Canada's Total GHG Emissions in the WM scenario under Various Sensitivity Scenarios, Mt CO_2 eq (Excluding LULUCF)

Scenario	GHG Emissions in 2030	GHG Emissions in 2035	Difference Between 2005 and 2030
Fast GDP, High Prices	664	674	-77
Fast GDP	663	657	-78
High Prices	635	631	-106
WM Scenario	638	621	-103
Low Prices	644	609	-97
Slow GDP	614	583	-127
Slow GDP, Low Prices	612	568	-129
Range	612 to 664	568 to 674	-77 to -129

In our scenario with slow GDP, slow population growth, and low world oil prices, GHG emissions could be as low as 612 Mt CO_2 eq by 2030 and 568 Mt in 2035 on the low end. On the high end, emissions could be 664 Mt CO_2 eq in our scenario with fast GDP, high population growth, and high world oil prices in 2030 and 674 Mt in 2035. This represents a range of 52 Mt CO_2 eq in 2030 and 106 Mt in 2035.

Oil and gas price assumptions are taken from the CER's high and low oil and gas price scenarios. The price forecasts are inputted to the Oil and Gas Module (OGM), which creates a development and production response to changes in commodity prices. In the OGM, development and investment decisions by industry are primarily driven by the given Oil and Gas play's estimated return on investment, which is determined in part by supply costs and the given benchmark price. This forms the basis and structure of the high and low alternative emissions scenarios. The fast and slow GDP assumptions were derived from the 2022 Annual Energy Outlook by the U.S. Energy Information Administration. Population growth assumptions were derived by applying the relative differences between Statistics Canada's most recently released (August 2022) high, M1 and low scenarios to the population growth from our WM scenario. Figure 5A-21 illustrates how differing price and GDP growth assumptions in various combinations might impact Canadian GHG emissions through 2035.

Figure 5A-21: Projected GHG Emissions in the WM scenario under Full Range of Alternative Economic Assumptions (excluding LULUCF)



As depicted in Figure 5A-21 above, the high and low oil and gas price scenarios intersect with one another and the WM case in 2032, then begin to take alternative trajectories for the remainder of the projection period. This is due to the complex interactions in Canada's economy and emissions profile when oil and gas prices evolve differently than what is expected in the WM scenario. For instance, in the high oil and gas price scenario, sectors such as Heavy Industry and Electricity react to higher oil and natural gas prices by reducing industrial activity, increasing energy efficiency, and reducing natural gas electricity generation. Conversely, Canada's Oil and Gas Sector reacts to higher commodity prices by investing in and developing existing and new assets, as there is a greater financial incentive to produce and sell fossil fuels. The demand sectors react quite early in the projection period to higher input costs relative to the Oil and Gas Sector, as there is a longer lag between increasing oil and gas prices and changes in asset development and total fossil fuel output, especially in the oil sands. Starting in 2032, growing emissions in the Oil and Gas Sector begin to exceed emissions decreases from all other sectors, as this trend grows and continues for the remainder of the projection period. The opposite is true for the low oil and gas price scenarios.

Table 5A-54: Projected Difference in GHG Emissions between the WM scenario and the Alternate Emission Scenarios by Sector (excluding LULUCF) in Mt CO_2 eq in 2030

Sector	Fast GDP-High World Oil Price	Fast GDP	High World Oil Prices	Low World Oil Prices	Slow GDP	Slow GDP-Low World Oil Prices
Electricity and Steam	4	3	-2	5	-3	-4
Oil and Gas	10	1	9	-10	0	-9
Transportation	7	6	1	-1	-8	-9
Buildings	-1	1	-2	1	-1	0
Agriculture	0	1	0	0	0	0
Waste and Others	1	2	-1	1	-1	-1
Heavy Industry	6	12	-6	9	-10	-4
Grand Total	**27**	**26**	**-3**	**6**	**-24**	**-26**

The range of oil and gas emissions between scenarios is 19 Mt CO_2 eq by 2030 and 53 Mt CO_2 eq by 2035. This represents 36 percent and 50 percent of the total range of emissions in the alternate emissions scenarios, reflecting the sector's overall contribution to Canadian emissions and its sensitivity to the highly uncertain driver of world oil and gas prices. Moreover, the Heavy Industry Sector experiences opposing reactions in the fast GDP and high oil and gas price scenario. Since growth of Canada's Heavy Industry Sector is closely tied to that of GDP, fast GDP and population growth lead to higher emissions in the Heavy Industry Sector compared to the WM scenario. However, when world oil prices are high, Canada's Heavy Industry Sector emissions decline slightly due to higher fuel costs. This creates opposing impacts when GDP and commodity prices increase together in the projection period. The opposite is true for the slow growth and low price scenarios.

Another way to look at uncertainty of GHG emissions projections is to use a Monte Carlo method. Essentially, a Monte Carlo analysis applies a large number of random variations to key variables instead of a few specific variations with the sensitivity analysis. By doing so, it is possible to complement the sensitivity analysis by estimating a probability. Recently ECCC has started to explore GHG emissions projections uncertainty using a Monte Carlo method.

A5.2. Other Sources of Uncertainty for Canada's GHG Projections

Other sources of uncertainty outside the ones discussed above influence the projections, including relating to the decision-making of agents under given assumptions and the pace of clean technology development and adoption. For instance, consumer adoption of emerging technologies in the future may diverge from model projections due to the influence of behavioural decision-making processes not captured in the model. For example, the diffusion of electric vehicles depends not only on relative vehicle prices, but also on consumer awareness of electric vehicles and the availability of recharging infrastructure, both of which will evolve over time and are therefore hard to predict when looking at historical behaviour. This source of projection uncertainty is present across all economic sectors with the rapid emergence of new and cleaner technologies.

Some sources of uncertainty are also specific to sectors, several of which are listed below.

- **Oil and Gas**: Canadian oil and gas production projections vary significantly depending on world price assumptions. The global price itself is determined by supply and demand for oil, driven by factors like economic growth, technological developments, and geopolitics, and is set in international markets.
- **Electricity**: On the demand side, key factors of uncertainty, other than economic and population growth, include electricity demand changes arising from the electrification of vehicles or industrial processes. On the supply side, emissions are affected by changes to the fleet of electricity units. Therefore, assumptions on future capital costs of new electric units, availability of emerging technologies (such as intermittent renewables and energy storage), and cooperation for the construction of new interprovincial transmission lines are key sources of uncertainty.
- **Transportation**: Over the short term, vehicle-kilometres travelled is the key driver of emissions, influenced by assumptions regarding factors such as population, fuel prices, and optimization of freight trucks (increased tonnage per km) and freight transportation volume resulting from changes in economic activity. Over the medium to long term, the changing characteristics of the fleet will be important and will be influenced by government policies, different types of vehicle's respective production costs, technological development, and consumer choices.
- **Heavy Industry**: Emissions are primarily driven by expected economic growth in each subsector. Future technological developments that would affect the costs of electrification and carbon capture and storage technologies, the use of clean fuels such as hydrogen, novel methods of reducing non-combustion emissions, as well as other energy efficiency improvements, would also have an impact on emissions.
- **Buildings**: Emission projections in this sector will be affected by consumer response to emerging technologies and government policies. Future relative fuel prices and technology costs will also have an impact.
- **Agriculture**: Emissions from agriculture production are affected by production costs such as fertilizer prices and international prices of agricultural commodities that affect the crop composition and livestock size.

Annex 6: Projections and Contribution of the Land Use, Land-Use Change and Forestry Sector and Modelling Methodologies

A6.1. Introduction

This Annex describes reporting, projecting, and accounting for emissions and removals occurring in the Land Use, Land-Use Change and Forestry (LULUCF) Sector in Canada. Table 5A-55 below outlines the scope of LULUCF reporting included in Canada's National GHG Inventory Report (NIR), as well as the scope of LULUCF accounting included in Canada's 2020 and 2030 emission reductions targets.

Previous technical reviews of Canada's National Communications and Biennial Reports noted that the information required to understand the LULUCF contribution to targets was spread over different sections of the National Communication, Biennial Report, and NIR. This Annex, therefore, aims to include all relevant information on LULUCF reporting, projecting, and accounting in one place, to provide a clear and comprehensive picture of Canada's LULUCF Sector.

Table 5A-55: Scope of LULUCF reporting and accounting

	Reporting	Accounting	
Purpose	**National GHG Inventory Report**	**2020 Emissions Reductions Target***	**2030 Emissions Reductions Target****
Scope	Forest Land	Forest Land	Forest Land
	Cropland	Cropland	Cropland
	Grassland	Grassland	Grassland
	Wetlands	Wetlands	Wetlands
	Settlements	Settlements	Settlements
	Harvested Wood Products	Harvested Wood Products	Harvested Wood Products
	Other Lands		

Notes:

* Consistent with its quantified economy-wide emission reduction target for 2020 under the Copenhagen Accord, Canada accounts for LULUCF in 2020. See Sections A6.3 and A6.4.

** Consistent with its Nationally Determined Contribution (NDC) for 2030 under the Paris Agreement, Canada intends to account for LULUCF in 2030. However, projections are not yet available for all sub-sectors. The scope of accounting for this report therefore reflects the current availability of data (see Sections A6.3 and A6.4).

A6.2. LULUCF in the National Greenhouse Gas Inventory

As described in Chapter 6 of Canada's 2022 NIR covering the period 1990 to 2020, subsequently referred to as NIR2022,[i] the LULUCF Sector reports GHG fluxes between the atmosphere and Canada's managed lands (Forest Land, Cropland, Grassland, Wetlands, Settlements, and Other Land), including those associated with land-use change and emissions from harvested wood products (HWP) derived from these lands. LULUCF includes emissions and removals of carbon dioxide (CO_2); additional emissions of methane (CH_4) and nitrous oxide (N_2O)[ii] due to controlled biomass burning (but not emissions due to biomass used as fuel, which are reported under the Energy Sector); CH_4 and N_2O from wetland drainage and rewetting due to peat extraction; and N_2O released following Land Converted to Cropland.

In 2020, the estimated net GHG flux in the LULUCF Sector, calculated as the sum of GHG emissions and CO_2 removals, was a net removal of 6.8 Mt (Table 5A-56), or about 1 percent of the magnitude of total GHG emissions. The time series of LULUCF Sector estimates is available in Table 10 of the common reporting format (CRF) series for NIR 2022.[iii] Values are rounded to two significant figures (except for values under 1 kt, which are rounded to the first decimal) based on the same rounding protocol used in the Canada's NIR.

Table 5A-56: Historical LULUCF Net GHG Flux Estimates for Selected Years

	Net GHG Flux (kt CO_2 eq)[a]							
LULUCF Sub-sectors	**1990**	**2005**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
A. Forest Land	**-200 000**	**-130 000**	**-130 000**	**-140 000**	**-140 000**	**-130 000**	**-140 000**	**-130 000**
Forest Land remaining Forest Land (FLFL)[b]	-200 000	-130 000	-130 000	-140 000	-140 000	-130 000	-140 000	-130 000
FLFL from afforestation	*- 110*	*-1 700*	*-2 500*	*-2 600*	*-2 600*	*-2 700*	*-2 700*	*-2 800*
FLFL not from afforestation	*-200 000*	*-130 000*	*-130 000*	*-130 000*	*-130 000*	*-130 000*	*-130 000*	*-130 000*
Land Converted to Forest Land (LFL)	-1 100	- 950	- 500	- 440	- 390	- 340	- 300	- 240
B. Cropland[c]	**380**	**-22 000**	**-10 000**	**-17 000**	**-23 000**	**-19 000**	**-14 000**	**-9 600**
Cropland Remaining Cropland (CLCL)	-9 000	-26 000	-14 000	-20 000	-27 000	-22 000	-17 000	-13 000
Land Converted to Cropland (LCL)	9 300	3 800	3 400	3 400	3 300	3 400	3 500	3 500
C. Grassland	**0.6**	**0.9**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**
Grassland Remaining Grassland (GLGL)	0.6	0.9	1.2	1.2	1.2	1.2	1.2	1.2
Land Converted to Grassland (LGL)	NO	NO	NO	NO	NO	NO	NO	NO

i https://unfccc.int/ghg-inventories-annex-i-parties/2022

ii Consistent with NIR2022, GHG emissions from LULUCF shown in the tables in this Annex do not include carbon monoxide (CO) estimates. Carbon emissions in the form of CO are reported in NIR2022 (CRF Table 4) but not included in the sectoral totals, and are instead reported as indirect CO_2 emissions in CRF Table 6.

iii https://unfccc.int/documents/461923

D. Wetlands	**5 400**	**3 100**	**3 000**	**3 100**	**3 100**	**2 800**	**2 900**	**2 900**
Wetlands remaining Wetlands (WLWL)	1 500	2 600	2 500	2 700	2 700	2 500	2 700	2 700
Land Converted to Wetlands (LWL)	3 900	480	500	460	420	250	240	250
E. Settlements	**1 900**	**1 700**	**2 500**	**2 500**	**2 400**	**2 200**	**2 200**	**2 200**
Settlements remaining Settlements (SLSL)	-4 200	-4 400	-4 400	-4 400	-4 400	-4 400	-4 400	-4 400
Land Converted to Settlements (LSL)	6 100	6 000	6 900	6 900	6 800	6 600	6 700	6 600
F. Other Land	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**
G. Harvested Wood Products (HWP)[d]	**130 000**	**150 000**	**140 000**	**140 000**	**140 000**	**140 000**	**130 000**	**130 000**
HWP from FLFL	130 000	140 000	140 000	130 000	130 000	140 000	130 000	120 000
HWP from Forest Conversion	2 700	2 800	3 600	3 600	3 600	3 600	3 500	3 400
HWP from Residential Firewood[e]	1 100	790	710	870	1 100	980	840	820
Total LULUCF[f]	**-64 000**	**-4 200**	**- 78**	**-11 000**	**-17 000**	**-8 500**	**-16 000**	**-6 800**
Forest conversion[g]	*21 000*	*16 000*	*17 000*	*17 000*	*17 000*	*16 000*	*16 000*	*16 000*

Notes:

NE = Not Estimated
NO = Not Occurring

a) Negative sign indicates net removals of CO_2 from the atmosphere.

b) Wetlands subject to forest management practices are not included in NIR estimates due to a lack of suitable activity data and science to quantify the short, medium and long-term impacts of management on net GHG emissions.

c) Wetlands converted to Cropland and subject to agricultural management practices are not included in NIR estimates due to a lack of suitable activity data and science to quantify the short, medium and long-term impacts of conversion and management on net GHG emissions.

d) Emissions for different components shown separately for information and because the accounting approach differs between “HWP from FLFL” (Reference Level) and the other components (Net-Net).

e) This series represents HWP emissions from Residential Firewood coming from Cropland and Settlements only. HWP emissions from Residential Firewood coming from Forest Land is included in the “HWP from FLFL” series.

f) Totals may not add up due to rounding.

g) Shown for information only. Forest Conversion overlaps with the sub-sectors of “Cropland remaining Cropland (CLCL)”, “Land converted to Cropland (LCL)”, “Wetlands remaining Wetlands (WLWL)”, “Land converted to Wetlands (LWL)”, “Land converted to Settlements (LSL)” and “Harvested Wood Products (HWP)”.

Starting with NIR2017, and consistent with the 2019 IPCC Refinement to the 2006 Guidelines for GHG Inventories, Canada has implemented a Tier 3 approach for estimating anthropogenic emissions and removals from Forest Land remaining Forest Land (FLFL). Under this approach, emissions and removals from managed forest stands that have been impacted in recent history by significant natural disturbances (such as wildfires and insect infestations) are tracked separately from anthropogenic emissions and removals, and only considered anthropogenic when the forest stands have reached commercial maturity or pre-disturbance aboveground biomass, depending on the type of disturbance. As a result, the FLFL estimates reported in Canada's NIR focus on anthropogenic emissions and removals. Non-anthropogenic emissions and removals associated with significant natural disturbances are also provided in the NIR for information and transparency. For further information, please refer to Section 6.3.1 and Annex 3.5.2 of NIR2022.

A6.3. LULUCF Projections

Canada's LULUCF projections are shown in Table 5A-57 and descriptions of the modelling approaches used to produce the projections are provided below. Emissions and removals from the LULUCF Sector are modelled separately from other sectors (e.g., energy, transport, etc.). Additionally, individual LULUCF sub-sectors are projected using different models and methodologies. Given that projections are not yet available for all LULUCF sub-sectors, Table 5A-57 shows the sub-sectors and parts of sub-sectors for which projections are currently available (shading indicates where projections are not available). As a result, some of the historical information in Table 5A-57 differs from Table 5A-56. Table 5A-57 is provided to show historical information that is consistent with projections to facilitate understanding of the accounting projections (see Section A6.4). Work is ongoing to increase the scope of LULUCF projections for future reports.

Table 5A-57: Net GHG flux estimates for selected years from LULUCF sub-sectors for which projections are currently available

LULUCF Sub-sectors	Net GHG flux (kt CO_2 eq)[a]									
	Historical Estimates								Projected Estimates	
	1990	2005	2015	2016	2017	2018	2019	2020	2030	2035
A. Forest Land	**-200 000**	**-140 000**	**-140 000**	**-140 000**	**-140 000**	**-130 000**	**-140 000**	**-130 000**	**-140 000**	**-140 000**
Forest Land remaining Forest Land (FLFL)[b]	-200 000	-130 000	-130 000	-140 000	-140 000	-130 000	-140 000	-130 000	-140 000	-140 000
FLFL from afforestation	*- 110*	*-1 700*	*-2 500*	*-2 600*	*-2 600*	*-2 700*	*-2 700*	*-2 800*	*-2 600*	*-2 300*
FLFL not from afforestation	*-200 000*	*-130 000*	*-130 000*	*-130 000*	*-130 000*	*-130 000*	*-140 000*	*-130 000*	*-140 000*	*-140 000*
Land Converted to Forest Land (LFL)	-1 100	- 950	- 500	- 440	- 390	- 340	- 300	- 240	840	- 540

B. Cropland	**1 300**	**-22 000**	**-11 000**	**-17 000**	**-23 000**	**-19 000**	**-14 000**	**-9 700**	**-9 700**	**-9 500**
Cropland Remaining Cropland (CLCL)[c]	-7 900	-26 000	-14 000	-20 000	-27 000	-22 000	-17 000	-13 000	-12 000	-12 000
Land Converted to Cropland (LCL)[d]	9 200	3 800	3 300	3 400	3 300	3 400	3 400	3 500	2 700	2 400
C. Grassland[e]										
Grassland Remaining Grassland (GLGL)										
Land Converted to Grassland (LGL)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands[f]	**2 900**	**1 600**	**1 300**	**1 300**	**1 300**	**1 100**	**1 100**	**1 100**	**500**	**480**
Wetlands remaining Wetlands (WLWL)	580	1 200	970	960	940	930	920	910	460	420
Land Converted to Wetlands (LWL)	2 300	410	330	370	320	160	160	170	40	55
E. Settlements	**6 100**	**6 000**	**6 900**	**6 900**	**6 800**	**6 600**	**6 600**	**6 600**	**5 200**	**4 500**
Settlements remaining Settlements (SLSL)	0	0	0	0	0	0	0	0	- 16	- 22
Land Converted to Settlements (LSL)[g]	6 100	6 000	6 900	6 900	6 800	6 600	6 600	6 600	5 300	4 500
F. Other Land	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**
G. Harvested Wood Products (HWP)[h]	**130 000**	**150 000**	**140 000**	**140 000**	**140 000**	**140 000**	**130 000**	**130 000**	**140 000**	**140 000**
HWP from FLFL	130 000	140 000	140 000	130 000	130 000	140 000	130 000	120 000	130 000	140 000
HWP from Forest Conversion	2 700	2 800	3 600	3 600	3 600	3 600	3 500	3 400	2 600	2 400

HWP from Residential Firewood[i]										
Total LULUCF[j]	**-62 000**	**-2 900**	**1 100**	**-9 500**	**-16 000**	**-7 200**	**-15 000**	**-5 700**	**-10 000**	**-8 300**
Forest conversion[k]	*21 000*	*16 000*	*17 000*	*17 000*	*17 000*	*16 000*	*16 000*	*16 000*	*12 000*	*11 000*

Notes:

NE = Not Estimated
NO = Not Occurring

a) Negative sign indicates net removals of CO_2 from the atmosphere.

b) Historical estimates and projections do not include net emissions from drainage, as these projections are not yet available.

c) Historical estimates and projections do not include net emissions from agricultural woody biomass, as these projections are not yet available.

d) Historical estimates and projections are only for Forest Land converted to Cropland.

e) No projections are available for grasslands.

f) Historical estimates and projections are only for Forest Land converted to Wetlands.

g) Historical estimates and projections are only for Forest Land converted to Settlements.

h) Emissions for different components shown separately for information and because the accounting approach differs between “HWP from FLFL” (Reference Level) and “HWP from Forest Conversion” (Net-Net).

i) This series represents HWP emissions from Residential Firewood coming from Cropland and Settlements only, for which projections are not currently available. HWP emissions from Residential Firewood coming from Forest Land is included in the “HWP from FLFL series”.

j) Totals may not add up due to rounding.

k) Shown for information only. Forest Conversion overlaps with the sub-sectors of “Cropland remaining Cropland (CLCL)”, “Land converted to Cropland (LCL)”, “Wetlands remaining Wetlands (WLWL)”, “Land converted to Wetlands (LWL)”, “Land converted to Settlements (LSL)”, and “Harvested Wood Products (HWP)”.

A. Forest Land

Canada’s National Forest Carbon Monitoring Accounting and Reporting System (NFCMARS) builds on information in Canada’s National Forest Inventory and on additional provincial and territorial forest inventory information. Natural Resources Canada (NRCan) developed and maintains the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) as the core model of NFCMARS. CBM-CFS3 is a Tier 3 forest carbon dynamics estimation tool that is fully consistent with the IPCC inventory guidelines.

NFCMARS provides annual estimates of GHG emissions and removals as affected by forest management, natural disturbances, and land-use change. NRCan, in collaboration with the Canadian Space Agency, uses remote sensing and other data to monitor the area annually disturbed by wildfires, and maintains a deforestation monitoring program to estimate the area annually affected by conversion of forest to non-forest land uses. NFCMARS has been in place since 2006 and is described in detail in NIR2022.

NFCMARS is used to produce the projections shown here, using assumptions about human activities in the future. This ensures that the projections are fully consistent with historical emission estimates. For Forest Land remaining Forest Land (FLFL), projections are based on the same methodologies used to produce Canada's FLFL estimates for NIR2022. Harvesting is the human activity with the greatest impact on this sub-sector. Canada has based its projections on the latest available projected harvest estimates from provincial and territorial governments. Given the high variability of natural disturbances from year to year, for 2021 onward projections assume that wildfire occurs at the same average annual rate of area burned as in 1990 to 2020. Emissions and removals from severe natural disturbances and subsequent regrowth are tracked separately to support a focused view on impacts from human activities.

For Land Converted to Forest Land (LFL), projections are based on average historical rates, consistent with estimates reported in the NIR2022. However, as LFL activity data are not available from 2017 onward, LFL projections are based on a conservative assumption of zero afforestation from 2017 onward.[iv] As planned improvements to LFL estimates are implemented over the coming years and reflected in future NIRs, these projections are expected to change.

Wetlands subject to forest management practices are not included in the Forest Land sub-sector. Work is ongoing to develop suitable activity data and associated estimates.

B. Cropland

Agriculture and Agri-Food Canada (AAFC) generates GHG estimates for Cropland Remaining Cropland (CLCL) by using two models that it maintains: the Canadian Regional Agricultural Model (CRAM) and the Canadian Agricultural Greenhouse Gas Monitoring Accounting and Reporting System (CanAG-MARS). CRAM is used to estimate the resource use patterns in the Agriculture Sector for projections; these resource use patterns are fed into CanAG-MARS to generate emissions/removals estimates for CLCL.

CRAM is a static partial equilibrium economic model that provides a detailed characterization of agriculture activities in Canada. CRAM's features include coverage of all major cropping activities, livestock production and some processing, detailed provincial and/or sub-provincial breakdown of activities and a detailed breakdown of cropping production practices including choice of tillage regime, use of summer fallow, and stubble. CRAM is calibrated to the 2016 Census of Agriculture and all resource use patterns are aligned to the census. As CRAM is a static model, crop and livestock production estimates from AAFC's 2019 Medium Term Outlook (MTO) are used to set future resource use patterns for 2030.

CanAG-MARS reports on GHG sources and sinks accounting for the effects of organic carbon input and changes in land use and land management practices (LUMC) in Canada's agricultural sector. The estimation procedure follows a Tier 2 methodology under the 2006 IPCC Guidelines and is described in detail in Annex 3.5 of NIR2022.

iv This assumption is considered to be conservative because it underestimates LFL removals from 2017 onward, which in turn underestimates the contribution toward lowering Canada's GHG emissions for 2030 and 2035.

The amount of organic carbon retained in soil represents the balance between the rate of primary production (carbon transfer from the atmosphere to the soil) and soil organic carbon decomposition (carbon transfer from the soil to the atmosphere). How the soil is managed can determine whether the amount of organic carbon stored in soil is increasing or decreasing. The estimation procedure is based on the premise that primary production and changes in soil management influence the rate of soil carbon gains or losses in soils over time.

Carbon emissions and removals from changes in soil management on mineral soils are estimated by applying country-specific, spatially disaggregated carbon emission and removal factors multiplied by the relevant area of land that undergoes a management change. The carbon factor represents the rate of change in soil carbon per unit area for each LMC as a function of time since the land management change. Carbon input from primary production is measured using information on crop productivity and crop residue management. The impact of crop production and crop residue management on soil organic carbon is estimated using the IPCC Tier 2 Steady State approach.[v] Regional factors representing the annual change in soil carbon per unit area are generated and applied to the total area of land under annual cropland management.

For Cropland Remaining Cropland (CLCL), projections were based on the 2020 and 2030 resource use patterns generated within CRAM. Crop yields were set to the five-year average (2017 to 2021) and remained constant over the projection time period. These resource use patterns were integrated with the activity data used by CanAG-MARS to generate the emission/removal estimates reported in NIR2022. The consistency in data inputs ensures that the approach used to generate the projection estimates was consistent with that used in the NIR.

The historical CLCL emissions in Table 5A-56 include the emission and removal of CO_2 each year by woody biomass, values provided by Environment and Climate Change Canada (ECCC) – Science and Technology Branch. There were recalculations for this category since the *Fourth Biennial Report* that increased or decreased emissions by up to approximately 0.5 Mt CO_2 eq per year throughout the history. These recalculations are described in detail in Section 6.5.1.3 of NIR2021 and NIR2022. Since no methodology has been developed to date to make projections for emissions and removals from woody biomass on CLCL, this removal is excluded from the values provided in Table 5A-57 to avoid a methodological artefact when estimating the accounting contribution from CLCL.

Projected emissions from Forest Land Converted to Cropland are provided by ECCC – Science and Technology Branch as part of estimates for Forest Land Converted to other sub-sectors (see discussion of Forest Conversion projections below). No methodology has been developed yet to make projections for the conversion of Grassland to Cropland.

Wetlands subject to agricultural management practices are not included in the Cropland sub-sector. Work is ongoing to develop suitable activity data and associated estimates.

v [IPCC] Intergovernmental Panel on Climate Change. 2019. 2019 refinement to the 2006 IPCC guidelines for national greenhouse gas inventories. Volume 4: Agriculture, Forestry and Other Land Use. Intergovernmental Pane l on Climate Change. Available online at: https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/.

C. Grassland

Very little information is available on management practices on Canadian agricultural grassland and, while there are no detailed comprehensive activity data, there is no evidence to suggest that current management practices are degrading grasslands. Emissions of CH_4 and N_2O from prescribed burning in managed grassland are reported in Canada's NIR. Work is ongoing to determine to what extent management of grasslands can impact GHG emissions. To date, no methodology has been developed yet to project GHG emissions from Grassland Remaining Grassland (GLGL).

D. Wetlands

For the purpose of Canada's NIR, the Wetlands category is restricted to those wetlands that are not already in the Forest Land, Cropland or Grassland categories. Emissions of CO_2, CH_4 and N_2O from peatlands drained for peat extraction, rewetted peatlands and flooded lands (hydroelectric reservoirs) are reported in Canada's NIR. To date, no methodology has been developed to make projections for emissions from peatland drainage and rewetting and from the surface of reservoirs. However, projected emissions of CO_2 from Forest Land Converted to Wetlands (hydroelectric reservoirs) are provided by ECCC – Science and Technology Branch as part of estimates for Forest Land converted to other sub-sectors (see discussion of *Forest Conversion* projections below).

E. Settlements

The drivers of urban tree cover change are currently not sufficiently well understood to provide reliable projections of the resulting emissions and removals. However, projected emissions from Forest Land Converted to Settlements are provided by ECCC – Science and Technology Branch as part of estimates for Forest Land Converted to other sub-sectors (see discussion of Forest Conversion projections below).

F. Other Land

In accordance with the land category definitions developed and adopted in Canada, and which are provided in Section 6.2 of NIR2022, Other Land comprises areas of rock, ice or bare soil, and all land areas that do not fall into any of the other five sub-sectors (e.g., A to E in Table 5A-56 and Table 5A-57), and which are classified as unmanaged land. Emissions for Other Land remaining Other Land are not currently estimated (hence the use of "NE" in the tables), whereas the conversion from other sub-sectors to Other Land does not occur in Canada (hence the use of "NO" in the tables).

G. Harvested Wood Products (HWP)

Canada has developed a country-specific model, the National Forest Carbon Monitoring, Accounting and Reporting Systems for Harvested Wood Products (NFCMARS-HWP), to monitor and quantify the fate of carbon from domestic harvest. The HWP category is reported following the Simple Decay approach, as described in the annex to Volume 4, Chapter 12 of the 2006 IPCC Guidelines. The approach is similar to the Production Approach but differs in that the HWP pool is treated as a carbon transfer related to forest harvest and therefore does not assume instant oxidation of wood in the year of harvest (for further detail see NIR2022, Annex 3.5.3).

Emissions associated with this category result from the use and disposal of HWP manufactured from wood coming from forest harvest on Forest Land remaining Forest Land (see Section A6.3.1) and from Forest Conversion (see Section A6.3.8) in Canada and consumed either domestically or elsewhere in the world. Products disposed of at the end of their useful life are assumed to be immediately oxidized.

Projected emissions from HWP use the same assumptions as used for HWP estimates for NIR2022, for example that the pool of HWP starts in 1900, with emissions occurring over time. These projections also reflect assumptions about future harvests (as provided by provincial and territorial governments), future forest conversion rates, and future end-uses of the harvest. The latter are based on the most recent annual (i.e., 2020) share of harvest in each of the four HWP commodity categories (sawnwood, panels, pulp and paper, and other products). It is assumed that using the most recent shares will reflect important emerging trends in wood product use, e.g., the decline in the use of some types of paper.

H. Forest Land Converted to Other Land Categories—Forest Conversion

Forest Conversion is not a LULUCF reporting category in the NIR, because it overlaps with the reporting sub-sectors of Cropland Remaining Cropland (CLCL), Land Converted to Cropland (LCL), Wetlands remaining Wetlands (WLWL), Land Converted to Wetlands (LWL), Land Converted to Settlements (LSL), and Harvested Wood Products (HWP). Forest Conversion is nevertheless reported as an information item in Canada's NIR, and is therefore reported as an information item in this Annex. For this report, Forest Conversion includes all immediate and residual emissions from FL converted to CL, WL, and SL and from the disposal of HWP resulting from these forest conversion activities (see Table 5A-56 and Table 5A-57).

Historical estimates for *Forest Conversion* are developed based on an earth observation sampling approach with resulting emission impacts calculated using NRCan's Carbon Budget Model and ECCC's Peat-Extraction and Reservoir models. *Forest Conversion* estimates consider activity extending from 1970 to 2020 and were developed by driver and end land use categories (Cropland, Wetlands, and Settlements).

Projected Forest Conversion area estimates are developed by NRCan based on a business-as-usual scenario of Forest Conversion activity for the 2021 to 2035 period, using the best available knowledge of drivers, policies and practices. Projections of emissions use an empirical model; model parameters were derived by driver and ecological region based on the relationship between areas converted and resulting emissions as reported in the most recent NIR submission. All emissions associated with the use and disposal of HWP manufactured from wood coming from Forest Conversion are derived using the IPCC Simple Decay approach (see discussion of HWP in Section A6.3.7 above).

A6.4. Accounting for the Contribution From the LULUCF Sector

A. General Accounting Approach

In its 2012 submission to the UNFCCC, Canada stated its intent to include the LULUCF Sector in its accounting of GHG emissions towards its 2020 target, noting that emissions and related removals resulting from natural disturbances would be excluded from the accounting.[vi] As described in Section A6.2 above, since Canada's *Fourth Biennial Report*, submitted in December 2019, Canada has implemented an approach for estimating anthropogenic emissions and removals from FLFL where emissions and removals from forest stands dominated by the impacts of natural disturbances are now tracked separately in the NIR. Canada's enhanced NDC (July 2021) reiterated this approach to addressing emissions and subsequent removals from natural disturbances on managed lands[vii].

When accounting for the LULUCF Sector, Canada uses the UNFCCC GHG inventory categories and accounting approaches consistent with those for non-LULUCF Sectors, wherever possible. As a result, for each LULUCF sub-sector apart from Forest Land remaining Forest Land (FLFL) and the HWP associated with FLFL, the accounting contribution is determined as the difference between the net emissions in a given year and the net emissions in the base year (2005). This is often referred to as the "net-net" approach.

Given the unique structure of FLFL, which is significantly impacted by the effects of past management and natural disturbances (i.e., the age-class legacy effect), Canada uses the reference level approach for FLFL and the HWP obtained from it. This approach is an internationally agreed and scientifically credible way to focus on changes in human management over time and remove the age-class legacy effect in this complex LULUCF sub-sector.

To ensure consistency in accounting for afforested land, net-net accounting is used for afforested land irrespective of whether the land is categorized as LFL or FLFL. Afforested land is initially categorized in the GHG inventory as LFL and is thus accounted for using the net-net approach. After 20 years, this land is re-categorized in the GHG inventory as FLFL and previously was accounted for using the reference level approach. This recategorisation of afforested land and the resulting change in accounting approach introduced inconsistency in the treatment of afforested land because the accounting approach changed simply depending on the age of the trees.

vi https://unfccc.int/sites/default/files/resource/docs/2012/awglca15/eng/misc01a02.pdf?download

vii https://unfccc.int/sites/default/files/NDC/2022-06/Canada%27s%20Enhanced%20NDC%20Submission1_FINAL%20EN.pdf

In this report, projections of the LULUCF accounting contribution are included for those LULUCF sub-sectors or parts of sub-sectors for which emission projections are currently available (see Section A6.3). These sub-sectors and parts of sub-sectors represent most of the estimated historical emissions and removals from LULUCF reported in NIR2022. Further work is needed to develop projections for remaining LULUCF sub-sectors based on sound methodologies and an acceptable level of understanding of the impact of the most important drivers of change.

B. The Reference Level Accounting Approach for FLFL and Associated HWP

Canada estimates the contribution from FLFL (excluding afforested land) and associated HWP using the reference level (RL) approach. This approach first involves defining the RL, which is a projection of emissions from FLFL and associated HWP that reflects a continuation of recent historical forest management policies and practices. For any given year, accounting then involves calculating the difference between actual emissions (or projected emissions, when historical data are not yet available) in that year and the pre-defined RL value for the same year. As a result, the contribution reflects the impact of actual management on emissions relative to the impact of the management assumed in the RL. In this way, the RL approach focuses accounting on the impacts of current activities, in line with the principles of accounting agreed under the UNFCCC. The RL approach used is consistent with the methodology used in Canada's First, Fourth, and Fifth Biennial Reports, as well as Canada's enhanced NDC. The approach is also consistent with Canada's Forest Management RL, which was constructed according to UNFCCC guidance, submitted to the UNFCCC in 2011, and assessed by international review experts in 2012.[viii]

For this report, Canada divides its RL approach into two periods: 2010 to 2020 and 2021 to 2035. Consistent with international guidance for RL construction, a "policy cut-off date" is used to ensure that only existing and implemented policies are reflected in the RL. For the first RL period, the agreed date is 2009 (as RLs were first constructed and submitted in 2011). For the second RL period, Canada uses a cut-off date of 2016, the year in which Canada ratified the Paris Agreement. Accounting results will therefore reflect the impacts of any changes in management implemented after the cut-off dates.

Canada's RL approach involves establishing assumptions for future harvest volumes over the two RL periods, consistent with policies and practices in place before the cut-off dates. These assumptions use averages of historical harvest data (1990 to 2009 for the first RL period and 1990 to 2016 for the second RL period).[ix] HWP from FLFL are included using the assumption that the HWP pool starts in 1900 and that emissions from the HWP pool are accounted using the IPCC Simple Decay approach (i.e., the same as is used in the NIR). The future shares of HWP in each product category are assumed to be the same as those in the recent historical period (2000-2009 for the first RL period and 2007-2016 for the second RL period).

viii https://unfccc.int/topics/land-use/workstreams/land-use--land-use-change-and-forestry-lulucf/forest-management-reference-levels

ix Future harvest volumes in Canada are significantly affected by the impacts of past disturbances, most notably mountain pine beetle outbreaks in western Canada and wildfire. In the event that projected RL harvest volumes exceed what is determined to be a sustainable level of harvest (as defined by the annual allowable cut, AAC), a "sustainability safeguard" will be applied to lower any future RL harvest value below the AAC.

C. LULUCF Sector Accounting Contribution

Three tables below show the accounting contributions derived using the approaches described above.

- Table 5A-58 presents the contribution from FLFL and associated HWP, showing how it is derived using the RL approach.
- Table 5A-59 presents the contribution from all LULUCF sub-sectors in selected historical years based on estimates shown in Table 5A-56 for net-net accounting and Table 5A-58 RL accounting.
- Table 5A-60 presents the projected contribution in 2030 and 2035 based on estimates shown in Table 5A-57 and Table 5A-58, for those sub-sectors for which emission projections are available.

Results from Table 5A-59 and Table 5A-60 cannot be compared directly, because for most LULUCF sub-sectors the scope of available data differs between historical years and projections.[x] In deriving Table 5A-58, Table 5A-59, and Table 5A-60, unrounded numbers are used to calculate the accounting contributions. These results are then rounded according to the rounding protocol explained in Section A6.2 above.

Table 5A-58: Calculation of the accounting contribution from Forest Land remaining Forest Land and associated Harvested Wood Products in selected years

Forest Land Remaining Forest Land + associated Harvested Wood Products	(kt CO_2 eq)[a]							
	Historical Values						Projected Values	
	2015	2016	2017	2018	2019	2020	2030	2035
Reference Level values	12 000	14 000	17 000	21 000	22 000	33 000	16 000	19 000
Historical values	3 600	- 730	- 790	4 100	-8 600	-3 500	-7 400	-3 400
Accounting contribution[b]	**-8 100**	**-15 000**	**-17 000**	**-16 000**	**-30 000**	**-37 000**	**-24 000**	**-22 000**

Notes:
Projected years: actual contribution will depend on actual emissions/removals occurring in those years.
Projections do not include emissions from drainage, as these projections are not yet available.

a) Negative values represent progress towards lowering Canada's GHG emissions.

b) Totals may not add up due to rounding.

FLFL and associated HWP provide the largest share of the overall accounting result and show a growing accounting contribution (see Tables Table 5A-58 and Table 5A-59) through to 2020 because actual harvest rates continued to remain below the historical average harvest levels used in the RL. After 2020, the projected harvest rates and RL harvest rates increasingly converge, reducing the accounting contribution from FLFL and associated HWP (see Table 5A-58).

x For example, in CLCL the removals from agricultural woody biomass (see Section A6.3.B above) are included in historical years but not in projections.

Table 5A-59: Accounting contribution by LULUCF sub-sector in selected historical years

LULUCF Sub-sectors	(kt CO_2 eq)[a]						Accounting Approach
	2015	2016	2017	2018	2019	2020	
A. Forest Land	**-3 300**	**-5 700**	**-7 500**	**-8 400**	**-12 000**	**-15 000**	
Forest Land Remaining Forest Land (FLFL) not from afforestation	-2 900	-5 400	-7 100	-8 100	-12 000	-15 000	Reference Level
Forest Land Remaining Forest Land from afforestation	- 840	- 890	- 930	- 980	-1 000	-1 100	Net-net
Land Converted to Forest Land (LFL)	450	510	560	620	650	710	Net-net
B. Cropland	**12 000**	**5 100**	**-1 300**	**3 000**	**8 200**	**12 000**	Net-net
Cropland Remaining Cropland (CLCL)	12 000	5 500	- 880	3 300	8 500	13 000	Net-net
Land Converted to Cropland (LCL)	- 410	- 380	- 450	- 360	- 310	- 290	Net-net
C. Grassland	**0**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	Net-net
Grassland Remaining Grassland (GLGL)	0	0.4	0.4	0.4	0.4	0.4	Net-net
Land Converted to Grassland (LGL)	NO	NO	NO	NO	NO	NO	Net-net
D. Wetlands	**- 100**	**- 13**	**- 56**	**- 370**	**- 210**	**- 210**	Net-net
Wetlands remaining Wetlands (WLWL)	- 120	12	11	- 130	29	23	Net-net
Land Converted to Wetlands (LWL)	13	- 25	- 67	- 240	- 240	- 240	Net-net
E. Settlements	**870**	**880**	**770**	**530**	**590**	**510**	Net-net
Settlements remaining Settlements (SLSL)	- 63	- 63	- 63	- 63	- 63	- 63	Net-net
Land Converted to Settlements (LSL)	930	940	830	590	660	580	Net-net
F. Other Land	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	

G. Harvested Wood Products (HWP)	-4 500	-8 500	-9 100	-7 400	-17 000	-21 000	
HWP from FLFL	-5 100	-9 300	-10 000	-8 400	-18 000	-22 000	Reference Level
HWP from Forest Conversion	730	720	770	770	670	600	Net-net
HWP from Residential Firewood[b]	- 81	80	280	190	48	34	Net-net
Total LULUCF[c]	**4 500**	**-8 300**	**-17 000**	**-13 000**	**-21 000**	**-24 000**	
Forest conversion[d]	*1 000*	*1 100*	*880*	*530*	*520*	*360*	*Net-net*

Notes:

NE = Not Estimated
NO = Not Occurring

a) Negative values represent progress towards lowering Canada's GHG emissions.

b) This series represents the accounting contribution of HWP emissions from Residential Firewood coming from Cropland and Settlements only. The accounting contribution of HWP emissions from Residential Firewood coming from Forest Land is included in the “HWP from FLFL” series.

c) Totals may not add up due to rounding.

d) Shown for information only. Forest Conversion overlaps with the sub-sectors of “Cropland remaining Cropland (CLCL)”, “Land converted to Cropland (LCL)”, “Wetlands remaining Wetlands (WLWL)”, “Land converted to Wetlands (LWL)”, “Land converted to Settlements (LSL)”, and “Harvested Wood Products (HWP)”.

Accounting for Forest Conversion uses a Net-Net approach so that changes in the accounting contribution over time reflect trends in Forest Conversion rates since 2005. The increasing accounting contribution in 2020 and 2030 (see Table 5A-49) compared to the historical contributions in Table 5A-59 result from projected steady declines in future Forest Conversion rates.

As for CLCL, which also uses a Net-Net approach, carbon removals in the sub-sector are decreasing in the projection years, resulting in increasing projected accounting debits in 2030 and 2035. Given current trends in land management, the carbon sequestration benefit (i.e., increased soil carbon) from conservation tillage is declining gradually over time as the rate of adoption begins to level off and soil carbon gains from past adoption approach a new equilibrium. Carbon gains from crop production decline through the projection period as soil carbon begins to stabilize due to static crop production levels. Moreover, in response to changes in demand (i.e., less meat, more plants), there has been and will continue to be a shift away from perennial crops towards annual crops. This shift results in the loss of soil carbon and lowers the potential of carbon removals from subsequent management on that land that may enhance soil carbon storage.

Table 5A-60 shows that the projected accounting contribution for the total LULUCF Sector is a credit of 12 Mt for 2030 and a credit of 13 Mt for 2035.

Table 5A-60: Projected accounting contribution by LULUCF sub-sector in 2030 and 2035

LULUCF Sub-sectors	(kt CO_2 eq)[a]		Accounting Approach
	2030	2035	
A. Forest Land	**-10 000**	**-11 000**	
Forest Land Remaining Forest Land (FLFL) not from afforestation	-11 000	-11 000	Reference Level
Forest Land Remaining Forest Land from afforestation	- 850	- 540	Net-net
Land Converted to Forest Land (LFL)	1 800	420	Net-net
B. Cropland[b]	**12 000**	**13 000**	Net-net
Cropland Remaining Cropland (CLCL)	14 000	14 000	Net-net
Land Converted to Cropland (LCL)	-1 100	-1 400	Net-net
C. Grassland[c]			Net-net
Grassland Remaining Grassland (GLGL)			Net-net
Land Converted to Grassland (LGL)	NO	NO	Net-net
D. Wetlands[d]	**-1 100**	**-1 100**	Net-net
Wetlands remaining Wetlands (WLWL)	- 700	- 730	Net-net
Land Converted to Wetlands (LWL)	- 370	- 360	Net-net
E. Settlements	**- 750**	**-1 500**	Net-net
Settlements remaining Settlements (SLSL)	- 16	- 22	Net-net
Land Converted to Settlements (LSL)[e]	- 730	-1 400	Net-net
F. Other Land	**NE,NO**	**NE,NO**	
G. Harvested Wood Products (HWP)	**-12 000**	**-12 000**	
HWP from FLFL	-12 000	-11 000	Reference Level
HWP from Forest Conversion	- 290	- 420	Net-net
HWP from Residential Firewood[f]			Net-net
Total LULUCF[g]	**-12 000**	**-13 000**	
Forest conversion[h]	*-3 500*	*-4 800*	*Net-net*

Notes:

Projected years: actual contributions will depend on actual emissions/removals occurring in those years.

NE = Not Estimated

NO = Not Occurring

a) Negative values represent progress towards lowering Canada's GHG emissions.

b) Projections are available only for Cropland remaining Cropland (CLCL, excluding agricultural woody biomass) and Forest Land converted to Cropland.

c) No projections are available.

d) Projections are available only for Forest Land converted to Wetlands.

e) Projections are available only for Forest Land converted to Settlements.

f) This series represents HWP emissions from Residential Firewood coming from Cropland and Settlements only, for which projections are not currently available. HWP emissions from Residential Firewood coming from Forest Land is included in the “HWP from FLFL series”.

g) Totals may not add up due to rounding.

h) Shown for information only. Forest Conversion overlaps with the sub-sectors of “Cropland remaining Cropland (CLCL)”, “Land converted to Cropland (LCL)”, “Wetlands remaining Wetlands (WLWL)”, “Land converted to Wetlands (LWL)”, “Land converted to Settlements (LSL)”, and “Harvested Wood Products (HWP)”.

Annex 7: Methodology for Development of Emissions Scenarios

The scenarios developed to support Canada's GHG emissions projections derive from a series of plausible assumptions regarding, among others, population and economic growth, prices, demand and supply of energy, and the evolution of energy efficiency technologies. Except for the WAM scenario, the projections also assume no further government actions to address GHG emissions beyond those already in place as of September 2022.

The emissions projections presented in this report cannot be viewed as a forecast or prediction of emissions at a future date. Rather, this report presents a simple projection of the current structure and policy context into the future, without attempting to account for the inevitable but as yet unknown changes that will occur in government policy, energy supply, demand and technology, or domestic and international economic and political events.

The emissions projections have been developed in line with recognized best practices. They incorporate IPCC standards for estimating GHG emissions across different fuels and processes, rely on outside expert views and the most up-to-date data available for key drivers such as economic growth, energy prices, and energy demand and supply, and apply an internationally recognized energy and macroeconomic modelling framework in the estimation of emissions and economic interactions. Finally, the methodology used to develop the projections and underlying assumptions has been subject to peer review by leading external experts on economic modelling and GHG emissions projections, as well as vetted with key stakeholders.

The approach to developing Canada’s GHG emissions projections involves two main features:

- Using the most up-to-date statistics on GHG emissions and energy use, and sourcing key assumptions from the best available public and private expert sources.
- Developing scenarios of emissions projections using E3MC, a detailed, proven energy, emissions and economy model for Canada.

A7.1. Up-To-Date Data and Key Assumptions

Each year, ECCC updates its models using the most recent data available from Statistics Canada's Report on Energy Supply and Demand in Canada and Canada’s National Inventory Report (NIR). Historical GHG emissions are aligned to the latest NIR. For these projections, the most recent historical data available were for 2020.

In addition to the most recent historical information, the projections are based on expert-derived expectations of key drivers (e.g., world oil price). Projections are based on the latest energy and economic data, with key modelling assumptions aligned with Government of Canada and provincial/territorial government views:

- Canada Energy Regulator (CER) views on energy prices and large-scale energy projects.
- Economic projections (including Real and Nominal GDP growths, GDP inflation, exchange rate, 3-month treasury bill rate,10-Year government bond rate, Unemployment rate and Consumer Price Index inflation) to 2027 are calibrated to Finance Canada's 2022 Fall Economic Statement. Economic projections between 2028 and 2035 are based on Finance Canada's long-term projections.
- Population growth projections are from provincial/territorial consultations.

Even with the benefit of external expert assumptions, there is considerable uncertainty surrounding energy price and economic growth assumptions, particularly over the medium- to long-term. As such, a range of emissions is presented representing a series of sensitivity analyses. These cases were based on high and low GDP growth as well as high and low oil prices and production levels.

A7.2. Energy, Emissions and Economy Model for Canada

The projections presented in this report were generated from ECCC's E3MC model. E3MC has two components: Energy 2020, which incorporates Canada's energy supply and demand structure; and the in-house macroeconomic model of the Canadian economy.

Energy 2020 is an integrated, multi-region, multisector North American model that simulates the supply of, price of, and demand for all fuels. The model can determine energy output and prices for each sector, both in regulated and unregulated markets. It simulates how such factors as energy prices and government measures affect the choices that consumers and businesses make when they buy and use energy. The model's outputs include changes in energy use, energy prices, GHG emissions, investment costs, and possible cost savings from measures, in order to identify the direct effects stemming from GHG reduction measures. The resulting savings and investments from Energy 2020 are then used as inputs into the macroeconomic model.

Energy 2020 is proprietary software maintained by Systematic Solutions, Inc. and has been used by a variety of organizations, such as government agencies, climate action groups, and utilities, to develop long-term energy and emissions projections and to conduct energy and emissions-related policy analyses. Energy 2020 is a successor to the policy model (FOSSIL2) used by the U.S. Department of Energy from the late 1970s to early 1990s. Energy 2020 has been used by ECCC, Natural Resources Canada and the Canada Energy Regulator (formerly the National Energy Board) since the early 1990s.

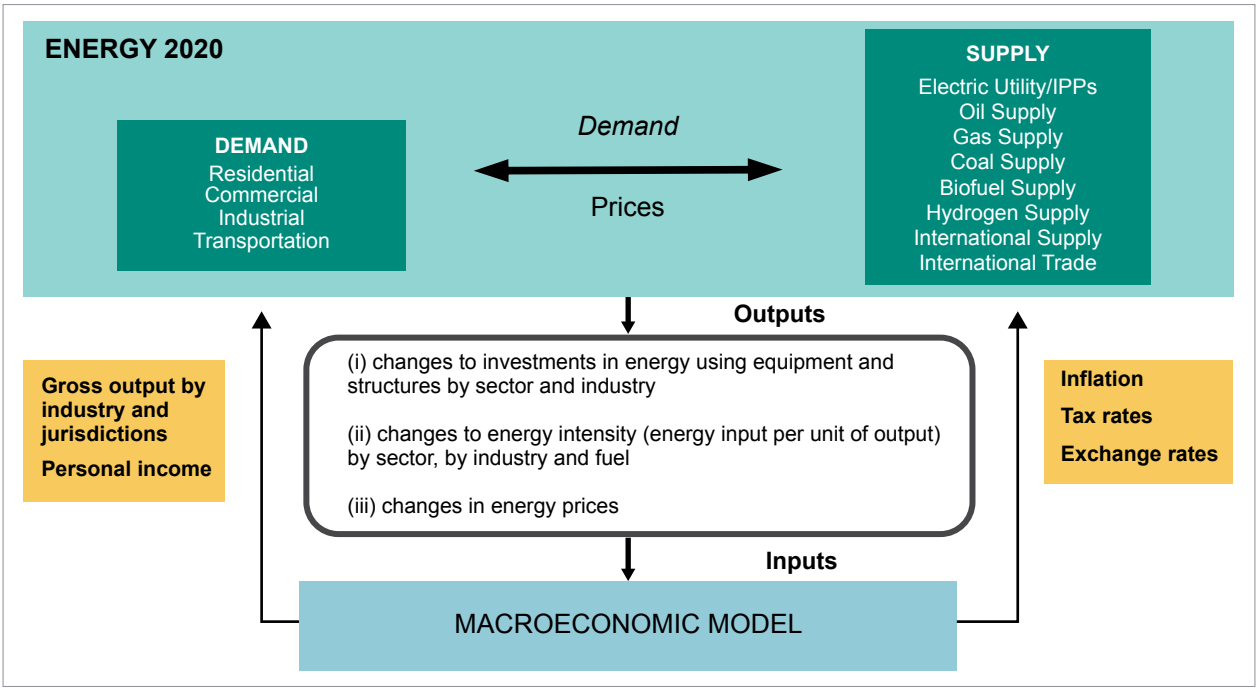
The in-house macroeconomic is the former Informetrica Model (TIM) containing revised economic data. It is a highly disaggregated Keynesian model designed to provide long-term economic forecasts and impacts of various energy and socioeconomic policies. The macroeconomic model is used to examine consumption, investment, production, and trade decisions in the whole economy. It captures the interaction among industries, as well as the implications for changes in producer prices, relative final prices, and income. It also factors in government fiscal balances, monetary flows, and interest and exchange rates. More specifically, the macroeconomic model incorporates 133 industries at a provincial and territorial level. It also has an international component to account for exports and imports, covering about 100 commodities. The macroeconomic model projects the direct impacts on the economy's final demand, output, employment, price formation, and sectoral income that result from various policy choices. These, in turn, permit an estimation of the effect of climate change policy and related impacts on the national economy.

E3MC develops projections using a market-based approach to energy analysis. For each fuel and consuming sector, the model balances energy supply and demand, accounting for economic competition among the various energy sources. This ensures consistent results among the sectors and regions. The model can be operated in a forecasting mode or an analytical mode. In forecasting mode, the model generates an annual energy and emissions outlook up to 2050. In analytical mode, it assesses broad policy options, specific programs or regulations, new technologies, or other assumptions.

The model's primary outputs are tables showing energy consumption, production and prices by fuel type, year and region. The model also identifies many of the key macroeconomic indicators (e.g., GDP or unemployment) and produces a coherent set of all GHG emissions (such as CO_2, CH_4 and N_2O) by sector and by province or territory.

Figure 5A-22 shows the general structure of E3MC. The component modules of E3MC represent the individual supply, demand, and conversion sectors of domestic energy markets, and include the macroeconomic module. In general, the modules interact through values representing the prices of the energy delivered to the consuming sectors and the quantities of end-use energy consumption.

Figure 5A-22: Energy, Emissions and Economy Model for Canada



A7.3. Treatment of Interaction Effects

The overall effectiveness of Canada's emissions-reduction measures will be influenced by how they interact with each other. Analysis of a policy package containing more than one measure or policy would ideally consider these interactions in order to understand the true contribution that the policy package is making (in this case, to emission reductions).

E3MC is a comprehensive and integrated model focusing on the interactions between sectors and policies. In the demand sectors, the fuel choice, process efficiency, device efficiency, and level of self-generation of electricity are all integrally combined in a consistent manner. The model includes detailed equations to ensure that all the interactions between these structures are simulated with no loss of energy or efficiency. For example, the electric generation sector responds to the demand for electricity from the energy demand sectors, meaning that any policy to reduce electricity demand in the consumer sectors will impact the electricity generation sector. The model accounts for emissions in the electricity generation sector as well as for emissions in the consumer demand sectors. As the Electricity Sector reduces its emissions intensity, policies designed to reduce electricity demand in the consumer sectors will cause less of an emissions reduction. The model also simulates the export of products by supply sectors.

Taken as a whole, the E3MC model provides a detailed representation of technologies that produce goods and services throughout the economy, and can simulate, in a realistic way, capital stock turnover and choices among technologies. The model also includes a representation of equilibrium feedbacks, such that supply and demand for goods and services adjust to reflect policy. Given its comprehensiveness, E3MC covers all the GHG emissions sources, including those unrelated to energy use.

A7.4. Additionality

Additionality represents what would have happened without a specific initiative. Problems of additionality arise when the stated emissions reductions do not reflect the difference in emissions between equivalent scenarios with and without the initiative in question. This will be the case if stated emissions reductions from an initiative have already been included in the WM scenario: emissions reductions will effectively be double counted in the absence of appropriate adjustments. The E3MC model controls for additionality by basing its structure on incremental or marginal decision-making. The E3MC model assumes a specific energy efficiency or emission intensity profile at the sector and end-use point (e.g., space heating, lighting, or auxiliary power). Under the E3MC modelling philosophy, if the initiative in question were to increase the efficiency of a furnace, for example, only the efficiency of a new furnace would be changed. The efficiency of older furnaces would not change unless those furnaces are retired and replaced with higher-efficiency ones. As such, any change in the model is incremental to what is reflected in the business-as-usual assumptions.

A7.5. Free Ridership

A related problem, free ridership, arises when stated reductions include the results of behaviour that would occur regardless of the policy. This can occur when subsidies are paid to all purchasers of an item (e.g., a high-efficiency furnace), regardless of whether they purchased the item because of the subsidy. Those who would have purchased the product regardless are termed free riders. In the E3MC model, the behaviour of free riders has already been accounted for in the WM scenario. Thus, their emissions are not counted toward the impact of the policy. Instead, the E3MC model counts only the incremental take-up of the emissions-reducing technology.

A7.6. The Rebound Effect

This describes the increased use of a more efficient product resulting from the implied decrease in the price of its use. For example, a more efficient car is cheaper to drive and so people may drive more. Emissions reductions will generally be overestimated by between 5 percent and 20 percent unless estimates account for increased consumption because of the rebound effect. Within the model, ECCC has mechanisms for fuel choice, process efficiency, device efficiency, short-term budget constraints, and cogeneration, which all react to changes in energy and emissions costs in different time frames. All of these structures work to simulate the rebound effect. In the example above, the impact of extra kilometres that may be driven because of improved fuel efficiency is automatically netted out of the associated emissions-reduction estimates.

A7.7. Simulation of Capital Stock Turnover and Endogenous Technological Change

As a technology vintage model, E3MC tracks the evolution of capital stocks over time through retirements, retrofits, and new purchases, in which consumers and businesses make sequential acquisitions with limited foresight about the future. This is particularly important for understanding the implications of alternative time paths for emissions reductions.

The model calculates energy costs (and emissions) for each energy service in the economy, such as heated commercial floor space or person-kilometres traveled. In each period, capital stocks are retired according to an age-dependent function (although the retrofitting of unretired stocks is possible, if warranted by changing economic or policy conditions). Demand for new stocks grows or declines depending on the initial exogenous forecast of economic output (i.e., a forecast that is external to the model and not explained by it) and the subsequent interplay of energy supply–demand with the macroeconomic module. A model simulation iterates between energy supply–demand and the macroeconomic module until there is a convergence. The global convergence criterion is set at 0.1 percent between iterations. This convergence procedure is repeated for each year over the simulation period.

The E3MC model simulates the competition of technologies at each energy service node in the economy, based on a comparison of their cost and some technology-specific controls, such as a maximum market share limit in cases where a technology is constrained by physical, technical or regulatory means from capturing all of a market. The technology choice simulation reflects the financial costs as well as the consumer and business preferences, revealed by real-world historical technology acquisition behaviour.

A7.8. Model Strengths and Weaknesses

While E3MC is a sophisticated analytical tool, no model can fully capture the complicated interactions associated with given policy measures between and within markets or between firms and consumers.

The E3MC model has a broad model boundary that captures the complex interactions that occur between producers, consumers and the environment across all energy sectors in the Canadian context. In addition, E3MC has an explicit causal structure that can be used to understand the origins of the patterns of behavior observed and also captures capital stock dynamics. Combined with the fact that it is calibrated to the Canadian experience, these provide considerable flexibility for the modelling of energy and environmental policies.

Unlike computable general equilibrium models, the E3MC model does not fully equilibrate government budgets and the markets for employment and investment. That is, the modelling results reflect rigidities such as unemployment and government surpluses and deficits. The model, as used by ECCC, also does not generate changes in nominal interest rates and exchange rates, as would occur under a monetary policy response to a major economic event. Consequently, the model is not designed to undertake welfare analysis.

Finally, the model lacks endogenous technological change for the industrial and Transportation Sectors. As a result, the E3MC model is not well-suited to modelling disruptive technological changes.

Chapter 6: Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

Canadians are already witnessing the devastating impacts of climate change. Unprecedented extreme events such as heatwaves, wildfires, and floods are impacting supply chains, disrupting infrastructure services, and damaging Canadian communities. Gradual, slow-onset impacts such as rising sea levels and thawing permafrost are altering ecosystems, livelihoods, and ways of being. These changes in climate will persist, and in many cases, intensify over the coming decades, highlighting the urgent need for adaptation action across Canada.

Adaptation is a shared responsibility among all sectors of Canadian society. All orders of government, Indigenous Peoples, businesses, individuals, and civil society have been taking individual and collective action across Canada to address climate risks. These actions to prepare for and adapt to climate change are continuing to grow in scale and ambition in the face of growing climate impacts.

This chapter provides an overview of progress on adaptation in Canada since *Canada's Seventh National Communication* (2017). It includes a brief overview of climate change impacts and knowledge assessments in Canada, and outlines key programs, policies, strategies, and frameworks implemented domestically and internationally by federal, provincial, territorial and municipal governments, Indigenous organizations, and communities.

Key Developments Since 2017

In November 2022, Canada released for final comment its first National Adaptation Strategy—*Canada's National Adaptation Strategy: Building Resilient Communities and a Strong Economy*. The Strategy reflects two years of engagement with provincial, territorial, and municipal governments; First Nations, Inuit, and Métis Nation representatives; key experts and stakeholders; and people from across Canada. The Strategy builds on the successes of the 2016 *Pan-Canadian Framework for Clean Growth and Climate Change*, establishes a shared vision for climate resilience in Canada, identifies key priorities for increased collaboration, and establishes a framework for measuring progress at the national level.

Canada also launched the *Government of Canada Adaptation Action Plan* as the federal plan to implement Canada's National Adaptation Strategy. The Action Plan includes a total of 68 federal actions across 22 departments and agencies, illustrating the depth and breadth of action being taken. The Government of Canada also announced $1.6 billion in new federal funding commitments.

The Government of Canada has already invested significantly in adaptation. New funding announced in November 2022 builds on the over $2.2 billion in adaptation programming in the 2020–2022 period, which included $1.375 billion to renew Canada's Disaster Mitigation and Adaptation Fund—Canada's largest adaptation program to date—to support infrastructure projects that build resilience to climate change impacts in communities. Other investments support initiatives such as improved wildfire resilience, flood mapping, health adaptation planning, and resilient building codes and standards.

Many provinces, territories, municipalities, and Indigenous communities are undertaking comprehensive climate risk assessments and setting out ambitious strategies to advance climate resilience. Importantly, jurisdictions have moved beyond the planning stage and are implementing a wide variety of actions, ranging from legislative and regulatory reforms to direct investments including enhanced climate services, capacity-building, and built and natural infrastructure.

Progress at all levels is supported by collaborative mechanisms to advance shared priorities. This includes distinctions-based bilateral tables between the Government of Canada and First Nations, Inuit, and the Métis Nation on clean growth and climate change, and a commitment to the co-development of an Indigenous Climate Leadership Agenda, which will support self-determined action in addressing Indigenous Peoples' climate priorities.

Canada is also mobilizing climate finance to support the international community in adapting to climate change. For example, in 2021, the Government of Canada committed $5.3 billion to help developing countries already affected by climate change transition to sustainable, low-carbon, climate-resilient, nature-positive, and inclusive development.

6.1. Climate Modelling, Projections, and Scenarios

6.1.1. Experienced Changes

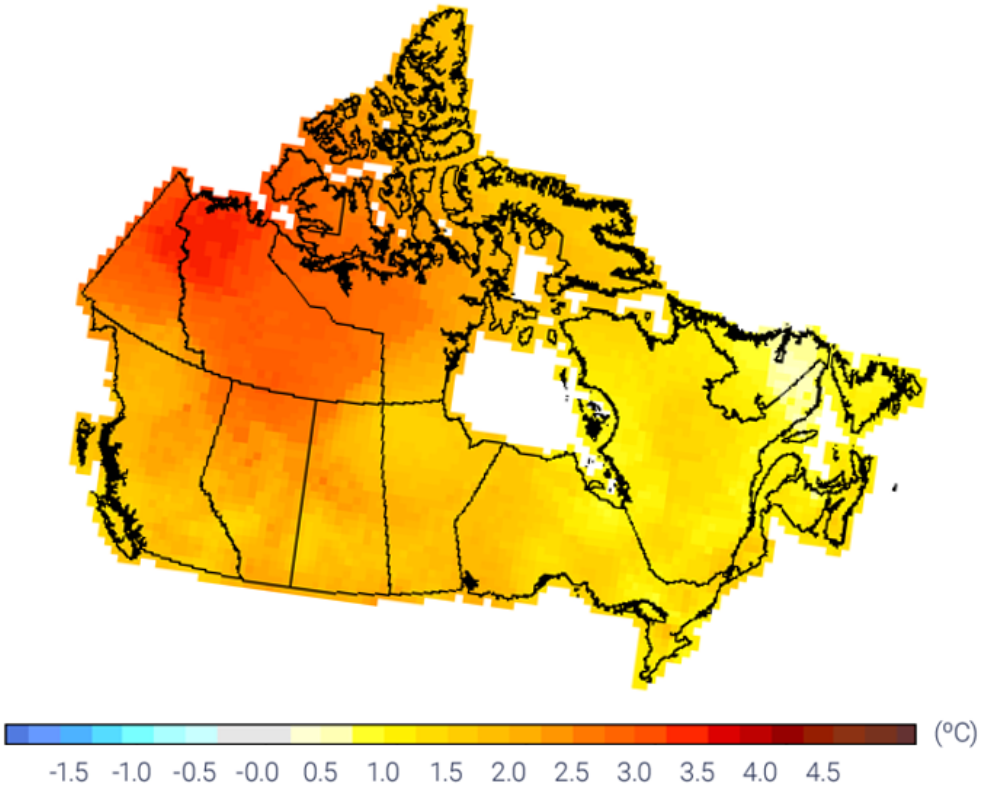
Canada's national-scale climate change assessment process is titled *Canada in a Changing Climate: Advancing our Knowledge for Action*. Whereas past national assessments in Canada have focused on climate change impacts and how Canadians are adapting, the current assessment cycle includes a comprehensive assessment of physical changes in Canada's climate. *Canada's Changing Climate Report* (2019) assessed the state of knowledge on how and why Canada's climate has changed and what changes are projected for the future, and thus laid a climate science foundation for other reports comprising the national assessment. The report represents an authoritative, robust assessment of published literature on changes in Canada's climate, covering changes in temperature and precipitation and related extremes, changes in snow, ice and permafrost, changes in freshwater availability, and changes in oceans surrounding Canada.

Canada's Changing Climate Report concluded that both past and future warming in Canada is, on average, about double the magnitude of global warming, with Northern Canada[1] warming at an even greater rate.[2] Between 1948 and 2018, average temperatures increased by 1.74°C for Canada as a whole,[3] and it is likely that more than half of this observed annual warming is due to the influence of

human activities.[4] Northern Canada warmed by 2.3°C between 1948 and 2018, which is roughly three times the global mean rate over the same period.[5] Warming has been observed consistently across Canada, and across all seasons, but with stronger trends in the north and west (Figure 6-1), and in winter and spring. Extreme warm temperatures have become hotter, while extreme cold temperatures have become less cold.

Given the available observing network across Canada, there is medium confidence that annual mean precipitation has increased across Canada, with larger relative increases over Northern Canada.[6] To summarize the observed changes across other climate indicators, *Canada's Changing Climate Report* also concluded that the effects of widespread warming are evident in many parts of Canada, including more extreme heat, less extreme cold, longer growing seasons, shorter snow and ice cover seasons, earlier spring peak streamflow, thinning glaciers, thawing permafrost and rising sea levels. In addition, because further warming is unavoidable, these trends are predicted to continue.

Figure 6-1: Observed changes (°C) in annual temperature across Canada between 1948 and 2018, based on linear trends



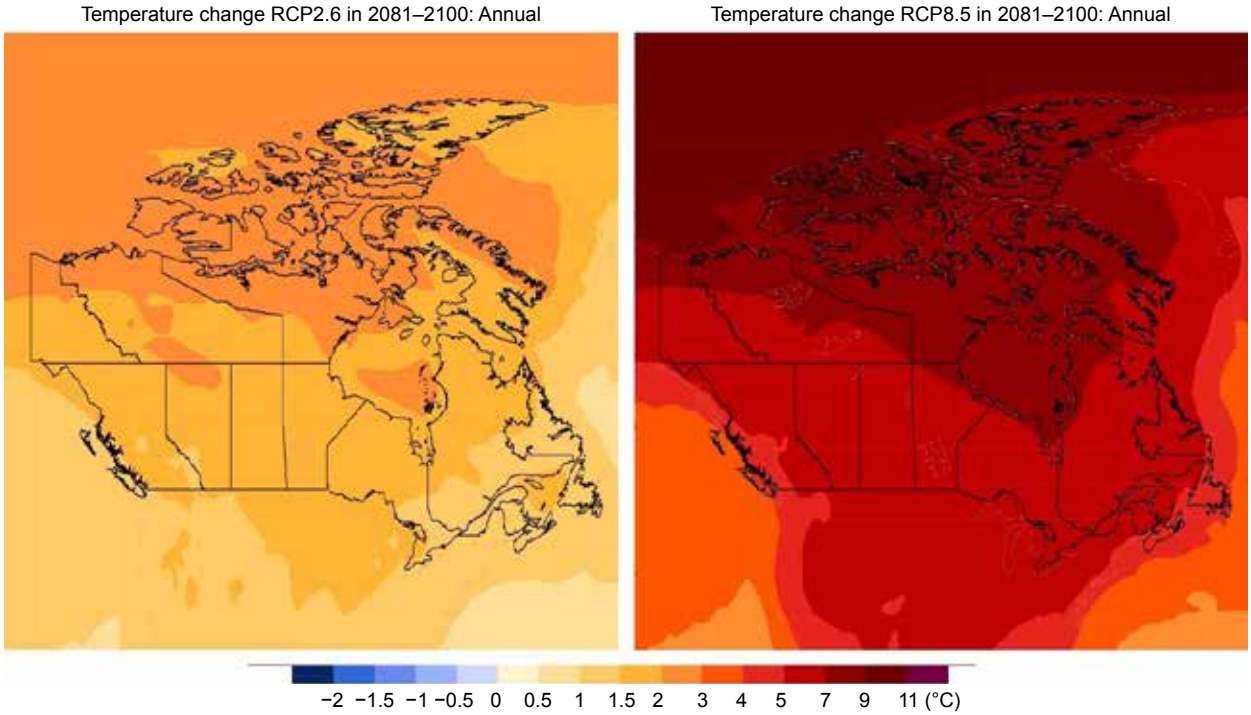
Source: A Third Generation of Homogenized Temperature (Vincent et al., 2020).[7]

6.1.2. Future Projections and Scenarios

Future climate projections for Canada, based on the models featured in the Intergovernmental Panel on Climate Change (IPCC) *Fifth Assessment Report* (CMIP5 models), were presented in *Canada's Changing Climate Report* for low (RCP2.6) and high (RCP8.5) emissions scenarios (Figure 6-2). Additional scenario-based projections, including higher resolution downscaled projections, and those based on the recent generation of global climate models featured in the IPCC *Sixth Assessment Report* (CMIP6 models) are available to Canadians through Environment and Climate Change Canada's Climate Data and Scenarios website.

Continued amplification of warming at high latitudes compared to the global average is projected under all scenarios of future climate change. Within Canada, climate change is not projected to be uniform, with both seasonal and geographic differences in rates of projected warming. The strongest warming is projected for winter and for northerly latitudes—a robust result consistent across all scenarios.[8]

Figure 6-2: Projected annual temperature change for Canada under a low emission scenario and a high emission scenario for the late century



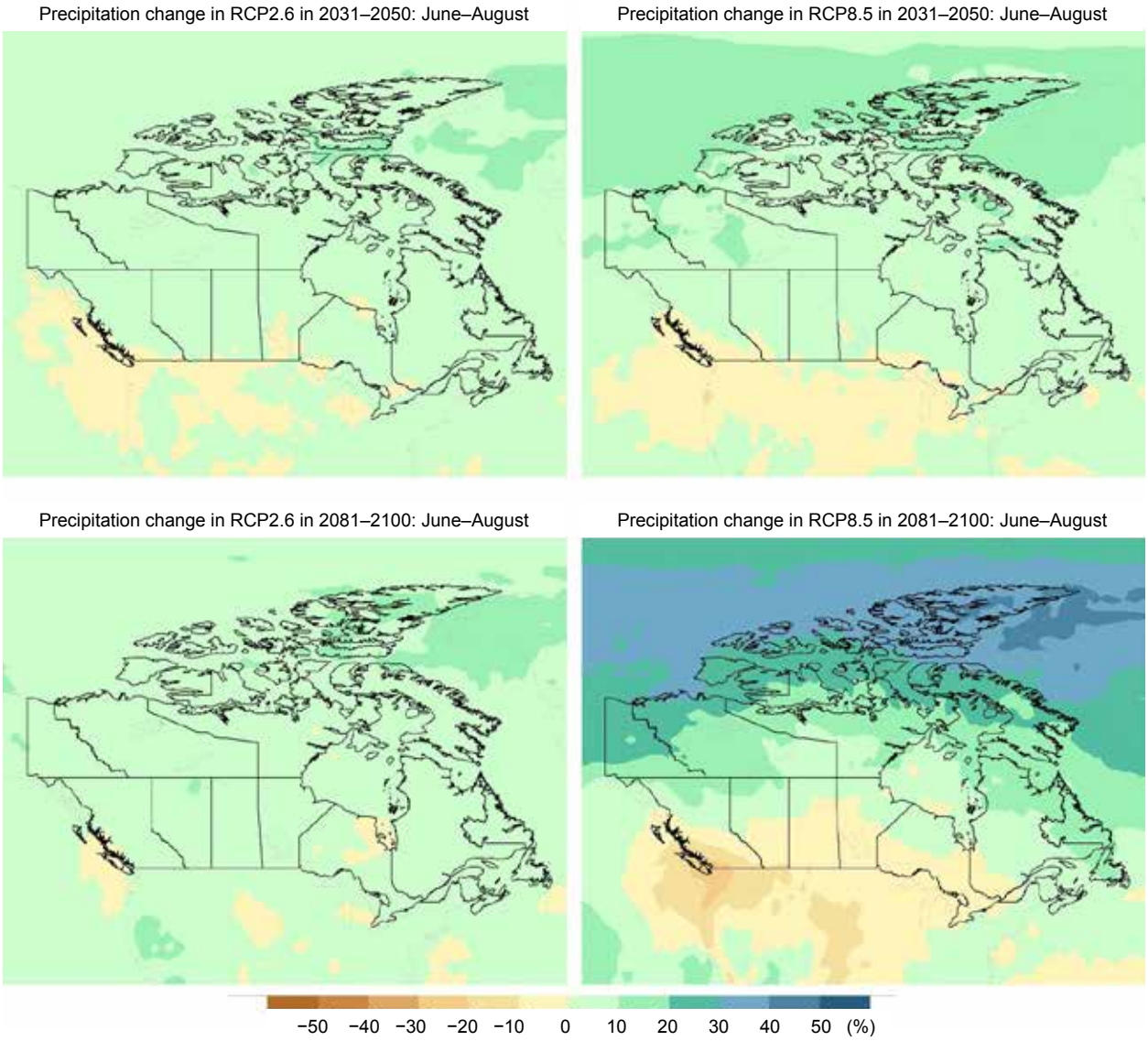
Notes:

Projections are based on the Coupled Model Intercomparison Project (CMIP5) multi-model ensemble. Changes are relative to the 1986 to 2005 period.

Source: CCCR Figure ES.10, from CCCR Chapter 4 Figure 4.8 (Zhang et al., 2019).[9]

While, in general, precipitation is projected to increase in the future, summer precipitation in parts of southern Canada is projected to decrease by the late 21st century under a high-emission scenario (Figure 6-3). However, there is lower confidence in this projected summer decrease than in the projected increase in annual precipitation.[10] The lower confidence for summer decreases in southern Canada is due to its location at the northern tip of the continental interior of North America, where precipitation is projected to decrease, and at the transition to a region where precipitation is projected to increase. There is high confidence that future daily extreme precipitation will increase.[11]

Figure 6-3: Maps of projected precipitation change (percent) for June, July, and August, as represented by the median of the fifth phase of the Coupled Model Intercomparison Project (CMIP5) multi-model ensemble



Notes:

Changes are relative to the 1986 to 2005 period. The upper maps show precipitation change for the 2031 to 2050 period and the lower maps, for the 2081 to 2100 period. The left-hand maps show changes resulting from the low emission scenario (RCP2.6), whereas the right-hand maps show changes from the high emission scenario (RCP8.5).

Source: CCCR Chapter 4, Figure 4.18 (Zhang et al., 2019).[12]

The most severe impacts of climate change are often related to changes in climate extremes (see Section 6.2). As concluded in *Canada's Changing Climate Report*, Canada is projected to experience increases in extreme hot temperatures, intensifying heatwaves, and increased drought and wildfire risks.[13] More intense rainfalls are also projected for the future, which can lead to increased urban flood risks, and coastal flooding is expected to increase in many areas of Canada owing to local sea-level rise.[14]

6.2. Assessment of Risk and Vulnerability to Climate Change Impacts

With the impacts of climate change projected to increase in frequency and intensity across all regions of Canada, a comprehensive knowledge base is foundational to reduce climate risks and build resilience. Assessments of climate change impacts and adaptation address this need by providing decision-makers with the information necessary for evidence-based decisions. Additionally, climate change assessments help to inform and engage citizens and stakeholders, building awareness of impacts and providing options on how to respond to the challenges of climate change.

Since Canada's *Seventh National Communication*, Canadian governments and communities have continued to conduct climate change assessments to identify evolving climate risks and adaptation needs for their region, sector, or organization. Jurisdictions across Canada have begun to incorporate vulnerability and risk assessments into their programs and policies, with some having mandated the development of regular, cyclical assessments through legislation (see Section 6.4. for more information).

The following section outlines assessments conducted by Canadian jurisdictions and organizations, and provides a brief summary of key impacts facing communities and sectors in Canada.

6.2.1. National and Sector-Specific Assessments

Over the past two decades, Canada has produced three broad, national climate change assessments, as well as sector- and region-specific assessments on human health, transportation, and marine coasts. These reports communicated to Canadians the risks and opportunities climate change presents, and focused on assessing the country's readiness to adapt to potential impacts.

In 2017, the Government of Canada launched the current National Knowledge Assessment process, *Canada in a Changing Climate: Advancing our Knowledge for Action*. This multi-year, collaborative initiative is delivering a series of authoritative reports, outlined below, that focus on how and why Canada's climate is changing, and how Canadians are adapting. Hundreds of subject matter experts supported the development of the reports, comprising all orders of government, Indigenous organizations, universities, professional and non-governmental groups, and the private sector.

The 2021 *National Issues Report* builds on the findings of *Canada's Changing Climate Report* (see Section 6.1.), focusing on climate change impacts and adaptation issues that are of national importance. The report shows that climate change is already affecting the lives of people living in Canada, that those impacts will persist—and, in most cases, intensify—over time, and that additional efforts are needed to effectively prepare and adapt to the changing climate.

Key Findings of the *National Issues Report*

1. Communities of all sizes across the country are experiencing the impacts of climate change on their infrastructure, health and well-being, cultures and economies.
2. Changes in climate are threatening the vital services that Canada's ecosystems provide and are negatively impacting water resources.
3. While climate change will bring some potential benefits, overall, it will result in increasing economic costs for Canada.
4. Canada must look beyond its borders when assessing the impacts of a changing climate.
5. Large gaps remain in Canada's preparedness for climate change, as demonstrated by recent impacts of extreme weather events, such as floods and wildfires.
6. Lessons on good practices are continuing to emerge and are helping to guide successful adaptation.

The *Regional Perspectives Report*, released on a rolling basis between 2020 and 2022, provides a picture on how climate change is impacting Canada's communities, environment and economy, and the actions that are being taken to adapt. The report is divided according to six broad regions: Atlantic provinces, Prairie provinces, Northern Canada, Québec, British Columbia and Ontario. Each chapter contains regionally tailored knowledge that supports a greater comprehension of climate risks on a more granular level, enabling better adaptation, resilience planning, and policy development.

The 2022 *Health of Canadians in a Changing Climate* report provides a climate risk assessment and evidence-based information to help Canadians understand how climate change is affecting health and health care systems. The report is divided into chapters that reflect the different impacts and risks of climate change in Canada. Among these is a chapter dedicated to health system resilience, detailing the climate vulnerabilities of health and health systems, and the actions necessary to adapt and build resilience. The report concluded that, without concerted action, climate change will continue to result in the injury, illness, and death of people living in Canada, and that greater warming will bring greater health risks. Rapidly scaling up efforts and the use of inclusive and equitable actions will be critical to adapt to the growing threats to human health.

Future reports in the national assessment series are planned to be released in the near-term. Among those planned is a stand-alone Indigenous report, which draws upon Indigenous Science and Knowledge, as well as the perspectives and experiences of First Nations, Inuit, and the Métis Nation. Additionally, the *Canada in a Changing Climate: Enhanced Synthesis* report, to be released in 2023, will draw from, and provide additional value to, the findings of all previous reports in the series.

Reports led by external organizations are also helping to identify key climate impacts, vulnerabilities and risks across Canada. The Council of Canadian Academies (the Council) is a not-for-profit organization that convenes subject matter experts to assess the evidence on complex scientific topics of public interest to inform decision-making in Canada.

In 2019, at the request of the Government of Canada, the Council convened a panel of experts to develop a report titled *Canada's Top Climate Change Risks*, which identifies the top risk areas facing significant losses, damages, or disruptions over the next 20 years as a result of climate change. The panel identified physical infrastructure, coastal communities, northern communities, human health and well-being, ecosystems, and fisheries as the top six areas of risk. The report also recognized the severe impacts to Indigenous Peoples' ways of life caused by climate change and the need to further assess this risk area with Indigenous Peoples. In addition, the report provides an assessment of which risk areas possess the greatest potential to reduce adverse impacts through adaptation. In 2021, a subsequent report, *Building a Resilient Canada*, was released by the Council which identified key opportunities to enhance disaster resilience in Canada through better integrating climate change adaptation and disaster risk reduction. The report highlighted several areas of focus, including improving disaster data, integrating Indigenous and Local Knowledge into risk management planning, removing knowledge silos, and identifying levers to build resilience.

The Canadian Climate Institute (the Institute) is an independent research organization established in January 2020, through Government of Canada funding, to provide analysis and help Canada move toward clean growth in all sectors and regions of the country. The Institute has a program of work focused on the costs of climate change, with a series of reports focusing on overall impacts to Canada, as well as the health, infrastructure, and northern infrastructure sectors.

In 2020, the Institute released the initial report in its series, *Tip of the Iceberg: Navigating the Known and Unknown Costs of Climate Change for Canada*. Beyond acute hazards and associated costs, the Institute noted that slow-onset climate change impacts are also expected to result in significant and growing costs. In 2022, the Institute released *Damage Control: Reducing the Costs of Climate Impacts for Canada* as the final instalment of the series. Through a macroeconomic assessment, the Institute concluded that climate change is a significant risk to economic prosperity in Canada in both the short and long terms. For example, Canada is projected to experience $25 billion in losses relative to a stable-climate scenario—equal to 50 percent of projected GDP growth—by 2025. These costs could rise as high as $391 and $865 billion annually by the end of the century under low- and high-emissions scenarios, respectively. Climate change will also result in significant job losses, reduced economic productivity and increased prices, which will ultimately lower incomes and affordability for households in Canada.

However, the Institute's macroeconomic analysis also showed that spending on proactive adaptation may have major economy-wide benefits. For example, $1 spent on certain adaptation measures is estimated to generate between $13 and $15 in total benefits by avoiding direct damages and indirectly supporting economic stability and productivity.

The Government of Canada also supports sectors, provinces, territories, and communities in conducting their own assessments. For example, through the First Nation Adapt Program, Crown-Indigenous Relations and Northern Affairs Canada is providing funding to First Nation communities for climate change risk and adaptation assessment projects to help evaluate and respond to climate change impacts unique to those communities.

In Yukon, the federal Climate Change Preparedness in the North Program supported a permafrost study to assess potential risk and damage to Yukon government facilities in eight communities. The study findings are informing the development of a plan to monitor the structural condition of Government of Yukon buildings located on permafrost.

Many provinces and territories have also completed, or are in the process of completing, regional climate risk and vulnerability assessments. For example, British Columbia, Prince Edward Island, Newfoundland and Labrador, and the Yukon have conducted province-/territory-wide climate risk assessments, identifying top risks within their jurisdictions, and are using the results of the assessments to feed into adaptation planning and preparedness. Many other provinces and territories are committed to completing risk assessments to meet the needs of their jurisdictions (see Section 6.4.).

6.2.2. Climate Change Impacts

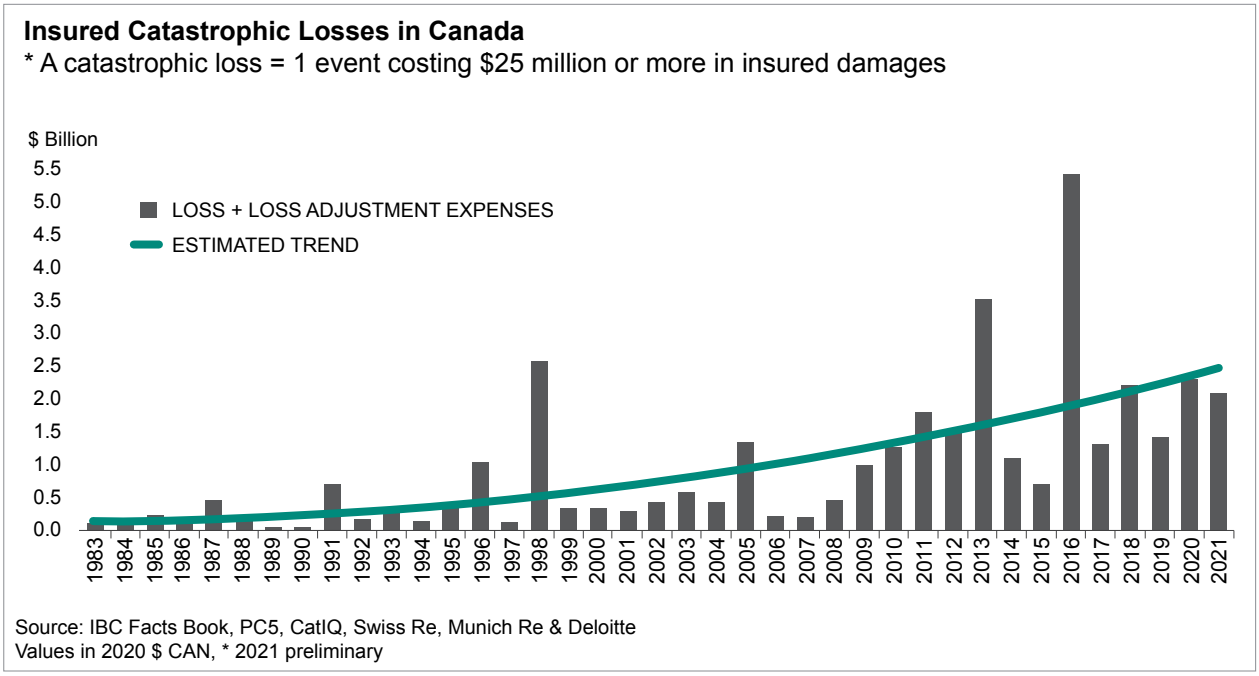
Climate change is already resulting in social, health, environmental, and economic impacts across Canada, and impacts are likely to increase in the future. The following section provides a snapshot of the latest knowledge of key climate impacts affecting Canadians, derived from recent national assessments.

6.2.2.1. Extreme Weather Events and Climate-Related Disasters

In Canada, there has been an increasing trend in extreme weather events and other climate-related hazards in recent decades. Extreme heat events have become more commonplace while extreme cold events have become less frequent.[15] The likelihood of some extreme events, such as wildfires and floods, has increased, which can lead to injury, displacement of communities, and increasingly large economic disruptions and damages.[16] The rapid pace at which these events are occurring is often overwhelming the adaptive capacity of communities to prepare for and respond to the risks posed by climate change.

While climate-related disasters have always occurred throughout Canada's history, Canadians are experiencing an increasing frequency and intensity of disasters. For example, the Canadian Disaster Database, which tracks significant disasters, including weather-related disasters, has shown that the annual number of disasters has increased steadily since the 1970s and especially in the last decade. However, the costs of climate-related disasters have increased even more quickly, rising from an average of $8.3 million per event in the 1970s to an average of $112 million in the 2010s—an increase of more than 1,250 percent.[17] Insured damages as a result of catastrophic weather events have also risen, averaging over $2 billion per year in the last decade, with uninsured damages estimated to be even higher.[18] This represents an over four-fold increase compared with the previous three decades (Figure 6-4). While this steep rise in costs can be attributed to more extreme weather events, the concentration of wealth and infrastructure in built-up areas is also a contributing factor.

Figure 6-4: Annual insured losses plus adjustment expenses (in 2020 dollars) from extreme weather events in Canada over the period 1983 to 2021



Source: Insurance Bureau of Canada (2022).[19]

Climate projections show that some types of extreme weather events will become commonplace in the future. For example, by mid-century, a once-in-20-year extreme precipitation event is projected to become a once-in-15-year event and once-in-ten-year event under low (RCP2.6) and high (RCP8.5) emissions scenarios, respectively.[20]

Extreme heat events are also anticipated to become more frequent. For example, under a high emissions scenario, the annual highest daily temperature that would currently be experienced once every 20 years will become a once-in-2-year event by 2050—a ten-fold increase in frequency; a once-in-50-year event is projected to become more than ten times more frequent by mid-century under a high emission scenario.[21]

Recent examples demonstrate the real and devastating impacts of extreme weather on Canadian communities. In September 2022, Hurricane Fiona swept through Atlantic Canada and Eastern Quebec, an unprecedented storm registering the lowest-ever recorded air pressure in Canada. Fiona brought devastating high winds and extreme precipitation, with some regions receiving nearly 200 mm, which resulted in severe infrastructure damage, the displacement of residents, and left hundreds of thousands of people without power.[22]

On June 29, 2021, the village of Lytton, British Columbia, set a national temperature record of 49.6°C as part of a heatwave experienced in Western Canada. This heatwave was followed by a record-breaking wildfire which caused severe damages and two fatalities. These compounded events led to heat-related illnesses, deaths, and the displacement of thousands.[23] Just months later, the same region of Canada experienced record-breaking rainfall, with some areas seeing up to 250 mm of precipitation in a three-day period, causing flooding and landslides resulting in multiple fatalities, evacuations, as well as damage to critical infrastructure and disrupted supply chains.

Event attribution analysis, which evaluates how the probability or intensity of an extreme event has changed as a result of climate change, has been increasingly used to study extreme events in Canada. For example, analysis of the 2021 Western Canada heatwave suggests that those temperatures would have been virtually impossible without human-induced climate change.[24] In addition, climate change has increased the likelihood of extreme events such as the extreme precipitation that produced the 2013 Southern Alberta flood, which displaced 100,000 people and resulted in $6 billion in damages, and the 2016 Fort McMurray Wildfire, which led to the evacuation of 80,000 people and to $9 billion in direct and indirect economic losses.[25]

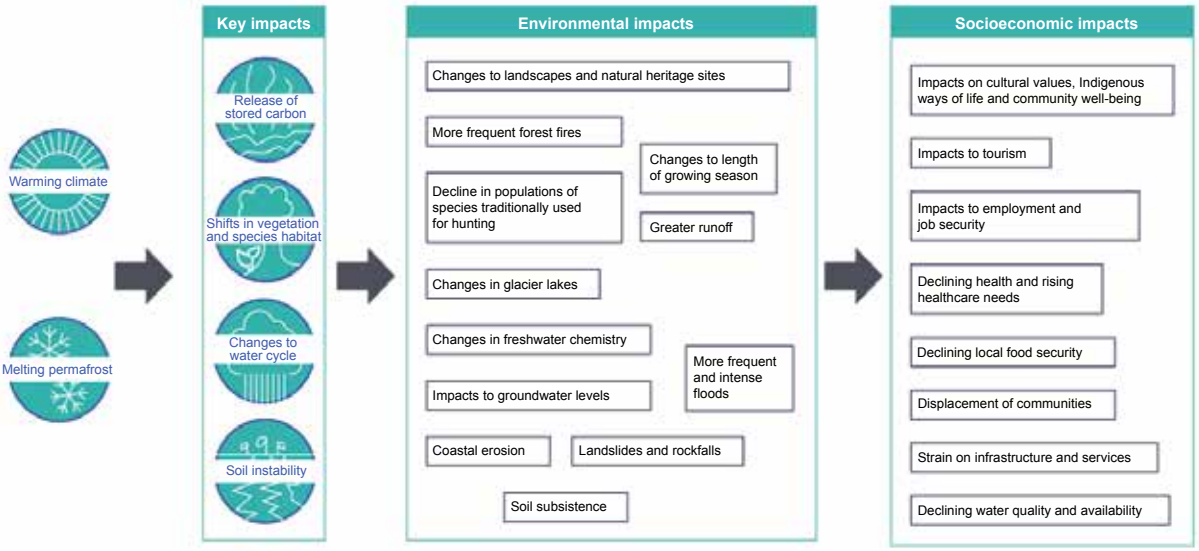
6.2.2.2. Ecosystems and Ecosystem Services

Canadian ecosystems and their capacity to provide services are already being negatively affected by climate change. The increasing trend in extreme weather (e.g., extreme heat, storms, wildfires), as well as shifting climate patterns, will continue to impact ecosystems in a variety of ways, such as species geographical-distribution shifts[26] and disruption of the timing of critical life events.[27] These impacts affect the ability of ecosystems to provide services to communities, with impacts expected to grow in severity under a changing climate.

Climate change is already affecting the geographical ranges of plants and animals in land and marine ecosystems. For example, northward range shifts have been observed in tree species in Canada (red maple, sugar maple, and paper birch)[28] and the sub-Arctic tree line.[29] Shrubification has been observed in the Canadian Arctic, where vegetation in the region is irreversibly transitioning from tundra to shrubland.[30] There is also a risk of a northward shift of insect and disease species, and new invasive species, which can harm biodiversity and the health of habitats. These changes will affect the provision of ecosystem services such as carbon storage capacity, recreational services, timber production, food provisions, and water quality regulation.[31] Similarly, northward range shifts have affected many marine species because of ocean warming,[32] impacting fisheries production and increasing the risk of fish exploitation.[33]

Climate change has the potential to induce changes in the timing of critical life events, known as phenological shifts, among species. Examples include timing changes in migration and breeding behaviours in certain species (e.g., birds, fish, insects), which can have cascading effects on species interaction and the food chain. Phenological changes in species, although not well documented in Canada, have the potential to adversely impact the provision of ecosystem services.[34] For example, there is evidence that rising temperatures negatively impact pollinators, such as bumblebees,[35] threatening pollination services for agriculture, and, in all ecozones, climate change impacts will put food security at risk, especially for Indigenous and northern communities,[36] where climate change is adversely affecting traditional food sources such as polar bear, seal,[37] and caribou populations.[38]

Figure 6-5: The effects of climate change on permafrost and their cascading impacts throughout society and environment



Note: This figure provides examples of the cascading environmental and socioeconomic impacts associated with a warming climate and melting permafrost, and is not intended to be comprehensive.

Data source: IPCC, 2019b from NIR Chapter 5 Figure 5.9 (Molnar et al., 2021).[39]

Depending on the geographical location, impacts on ecosystems and ecosystem services will vary. For example, the degradation of coastal ecosystems will also negatively affect the services they provide, such as coastal protection and resources for fisheries. Furthermore, key mountain and northern ecosystem services, including recreational services, food provisions, erosion control, and water quality regulation, are also expected to be adversely affected by loss of ice cover, permafrost thaw, and northward shift of animal and plant species (Figure 6-5).[40] Communities inhabiting these regions rely on those ecosystem services, resulting in greater vulnerability to climate change impacts.

6.2.2.3. Critical Infrastructure

Safe and reliable infrastructure is essential to life in Canada. Climate change is anticipated to impact Canada's infrastructure, with multiple factors, such as age and historical design practices, increasing the exposure and vulnerability of these assets. Impacts could cause structural failure and disruption of services that can negatively affect health and well-being, reduce the reliability of services, and threaten public safety.

Impacts to infrastructure are not distributed equally across Canada. Remote and northern communities, many of which are home to Indigenous Peoples and have small populations spread over large areas, face issues of limited road access, funding, and potential isolation in the event of a disaster. Sixty-eight communities across the North can only be reached by air year-round, and many other remote and northern communities rely heavily on air travel, seasonal winter roads, and marine sealift for essential supplies and services. Infrastructure failure in these communities can have significant consequences for food security, access to medical care, and fuel supplies. Risks to infrastructure in these communities are further compounded by climate warming-induced permafrost thaw.[41]

Ageing infrastructure in Canada is highly vulnerable to climate change, particularly urban infrastructure—risks such as overheated buildings, direct infrastructure damage (e.g., from extreme weather events), and power outages will increase further as the climate continues to warm. In addition, these risks will decrease capacity to deliver services (e.g., water, transportation, utilities) and be a detriment to the health and well-being of affected communities. Although the Infrastructure Sector in Canada faces some of the greatest climate change risks, the sector also possesses the greatest potential to adapt to climate change and mitigate impending risks.[42]

Transportation infrastructure in Canada (road, rail, marine, and air) is critical as it provides movement of goods, services and people across the country. Extreme weather can directly damage infrastructure and render transportation unsafe and unreliable, leading to significant operational costs. Climate change has the potential to not only directly impact transportation infrastructure, but also present cascading risks that can affect other economic sectors (e.g., energy, water, telecommunications). For example, transportation infrastructure that is interdependent with energy systems (e.g., railway signals, traffic control systems) is at greater risk from the impacts of climate change.[43]

6.2.2.4. Indigenous Peoples and Communities

First Nations, Inuit, and the Métis Nation in Canada, especially those living in remote and/or coastal areas and those in Inuit Nunangat (Inuit Homeland), are particularly affected by the negative social, economic, cultural and environmental impacts of climate change because of a close and enduring relationship with the land for sustenance, livelihood, culture, and well-being.

Impacts of climate change such as coastal erosion and sea-level rise can threaten important traditional and cultural sites. Impacts on connection to community, knowledge sharing, and informal economies such as hunting, fishing, trapping and gathering threaten livelihoods and food security. Residents often rely on these culturally significant activities to supplement wage income sources in locations where wage sector employment prospects may be limited.[44] In addition, changes in local species distribution and the prominence of extreme weather events (including floods and wildfires) will adversely affect the ability to perform land-based activities.

Given the remote locations of many Indigenous communities, communities can become isolated in the event of a disaster or slow-onset event, such as permafrost thaw, cutting off access to essential supplies and services. First Nations communities are also 18 times more likely to be evacuated because of disasters and emergency events than non-First Nations municipalities, leading to further displacement and loss of community connection.[45]

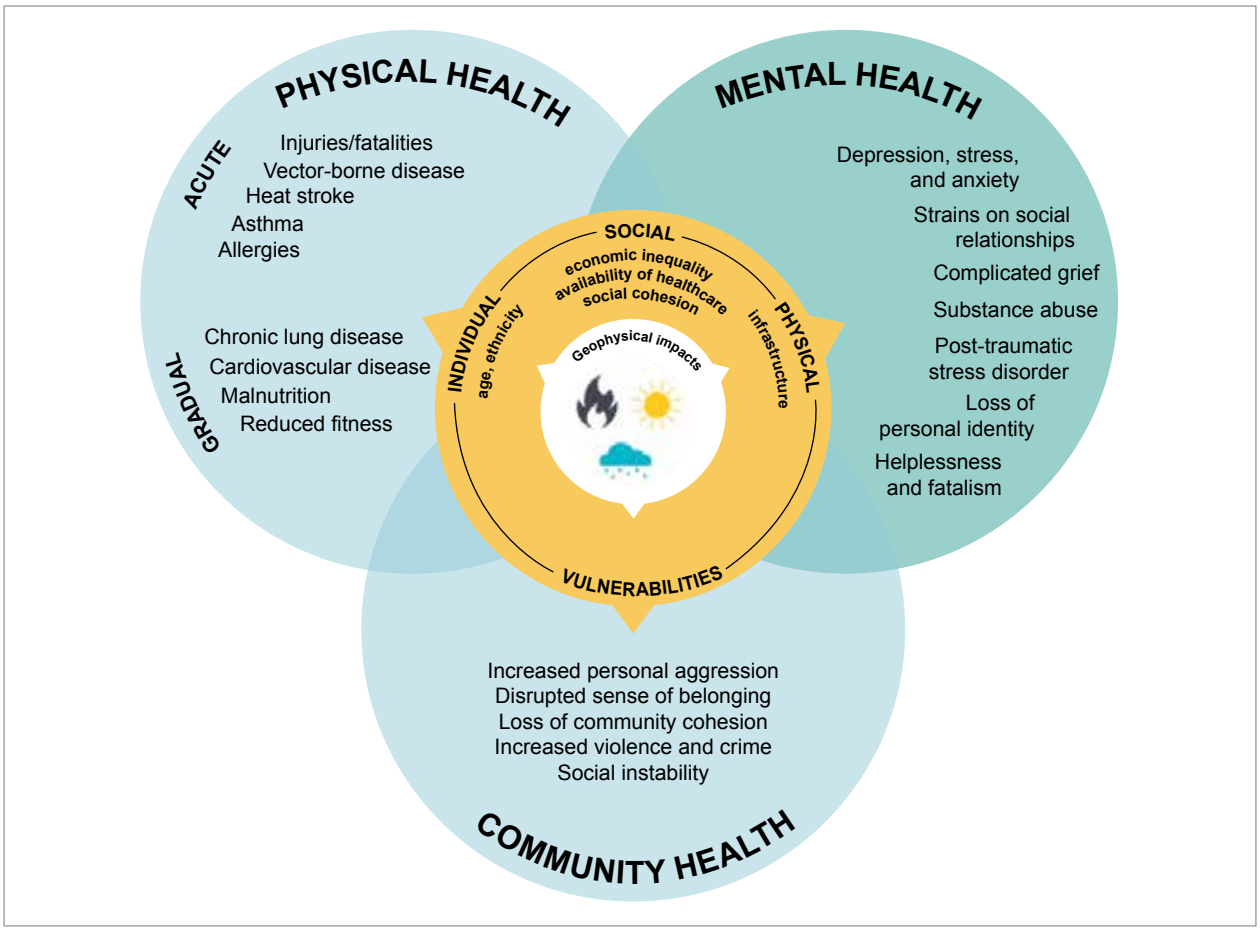
6.2.2.5. Health and Well-Being

Climate change is already negatively impacting the health of Canadians and their health systems, with health risks expected to rise as warming continues. Climate change is a driver of direct health effects related to rising temperatures and extreme heat, wildfires, and the expansion of zoonotic diseases, such as Lyme disease, into Canada. It also contributes to health effects indirectly through a range of social, environmental, cultural, and economic pathways.

Natural hazards, such as heatwaves, floods, wildfires and droughts, are projected to lead to a range of adverse health effects and deaths.[46] For example, deaths in Canada are projected to increase significantly as a result of the effects of heatwaves and rising temperatures. Other direct health effects of extreme weather include increases in accidental injuries, anxiety and depression, water-borne diseases, cardiovascular problems, and respiratory illnesses (Figure 6-6). Workers exposed to extreme events are already experiencing an increased burden of illness and injuries.

Additionally, climate change is increasing the risk of infectious disease. As a result of climate warming, Canada is becoming an increasingly receptive environment for ticks that carry and spread Lyme disease. Infectious diseases new to Canada may spread northward from the United States, and from elsewhere in the world, as the Canadian environment becomes more suitable for vectors.[47] For example, mosquito-borne diseases already present in Canada such as West Nile virus, which usually cause a limited number of infections each year, may produce epidemics under a more variable climate.[48]

Figure 6-6: Linkages among climate change and physical, mental, and community health



Source: Clayton et al., 2017.[49]

All Canadians are affected by climate change; however, the distribution of these impacts and related health risks are not uniform across the population. Seniors, children, racialized populations, low-income individuals, individuals with chronic health conditions, and Indigenous Peoples often experience greater health impacts from climate change. Existing health and social inequities and can drive this increased risk, including differences in an individual's sensitivity (such as pre-existing health conditions) and exposure (such as geographic location, occupation, and housing) to climate hazards.[50] For example, in June 2021, British Columbia experienced one of its most deadly heatwaves, resulting in over 600 deaths. Most of those who died were seniors, people with chronic health conditions, and people who were materially and socially disadvantaged.[51]

The burden of mental illness in Canada is also likely to rise as a result of climate change; however, further research is required to fully assess mental health impacts in Canada. Climate change may exacerbate existing mental illnesses such as psychosis, post-traumatic stress disorder, and mental health stressors such as grief, worry and anxiety (Figure 6-6).[52] Given the current high costs of mental illness to society and the breadth of mental health impacts that are related to climate change, future costs borne by Canadians and health systems are expected to be significant as the climate continues to warm.

6.2.2.6. Economic Prosperity

Virtually every sector of the Canadian economy is affected, directly or indirectly, by climate change, and these impacts will increase in the future. The natural resource-based sectors of Canada's economy are particularly sensitive to climate change impacts. For example, the Forest Sector is dealing with a wide range of risks, including pest outbreaks, wildfires, and long-term species shifts, leading to the decreased health and resilience of Canada's forests and constraining timber supply.[53]

Canada's Fisheries, Aquaculture, and Agricultural Sectors are anticipated to experience growing impacts, and while climate change may provide new opportunities, it also presents many challenges. Rising ocean temperature and changes in dissolved oxygen and acidity are already affecting fish populations, having consequences for the productivity of Canadian fisheries and presenting challenges to economic livelihoods. Increasing temperatures, shifting precipitation patterns, and extreme weather will affect crops and livestock operations. For example, warming temperatures may cause northward expansions of insect and disease species, increasing risks of pests and diseases which can disrupt agriculture productivity.[54] Additional risks to the Agricultural Sector arise from a strong dependence on transportation systems for market access, since those systems are also vulnerable to a changing climate.[55]

Climate change will bring new challenges to energy production in Canada, creating operational, social and environmental risks. Energy production and supply and hydropower are sensitive to a wide range of climate impacts, including permafrost thaw, precipitation patterns, river flows, and extreme weather, and can present risks to infrastructure. Additional strain on electrical generation will result from changing demands, with warmer summers leading to increased electricity demand for cooling.[56]

The Canadian Transportation Sector, including road, rail, marine, and air transportation, is vulnerable to climate impacts. Northern transportation systems, in particular, are experiencing some of the greatest impacts from permafrost thaw, reduced ice cover, coastal erosion and flooding.[57] As transportation is interdependent with other key sectors, such as energy, telecommunications, water supply, and buildings, a disruption in transportation can lead to cascading consequences for critical infrastructure services. Disruptions and delays in domestic and international supply chains from climate change impacts can also spread across networks, leading to negative social and economic impacts.

6.3. Climate Information and Services

Climate data and information can help inform decision-making in key sectors such as health, agriculture, infrastructure, and natural resource management. This information is foundational for assessing climate vulnerabilities and risks, as well as developing appropriate adaptation strategies. Climate services include climate data, information, tools, and support to inform adaptation decision-making. Climate services in Canada bring together many actors, such as the federal, provincial, and territorial governments, as well as regional climate organizations.

Sustained, iterative, and inclusive climate change information is critical to deepening understanding of how the changing climate will impact Canada, and how to best adapt. The Government of Canada is implementing a number of actions to meet this challenge and provide the foundational supports needed to build resilience across all sectors, regions, and priorities.

The Government of Canada generates world-class climate change science and research, and is delivering broad national assessments, such as reports produced under the Canada in a Changing Climate process and expert panel reports, to help raise awareness and understanding of climate change and guide Canada's adaptation responses. The federal government also supports a network of regional climate services organizations across the country to equip Canadians with the data, tools, and information they need to incorporate climate change into their decisions.

Environment and Climate Change Canada is the core department that collects climate data. The Department is responsible for climate information products and services including seasonal outlooks (e.g., bulletins and consultation process), value-added long-term historical climate data sets, past climate change and variability assessments, climate change projections and downscaled scenarios, and assessments of future climate change, with an emphasis on extremes. Environment and Climate Change Canada also provides some tailored climate information products and services, namely through the Canadian Centre for Climate Services.

In addition, the Department provides long-term historical climate data sets for internal and external users through its engineering climate services. Examples include historical snow and ice conditions, which are incorporated into the development of rooftop snow-load requirements for the National Building Code of Canada; wind-pressure analysis that informs the telecommunications and renewable energy industries; and analysis on the intensity, duration, and frequency of extreme rainfall to support storm and wastewater management.

Other federal departments are also building the knowledge base for sector-specific information and developing decision-making tools to help protect Canada's economy, its people, and its environment. Programs are advancing research and services related to how the changing climate affects permafrost and northern landscapes, coastlines and aquatic ecosystems, as well as agriculture and food production. Examples of sector-specific actions are provided in section 6.3.2.

6.3.1. Canadian Centre for Climate Services

In 2018, the Canadian Centre for Climate Services (CCCS), within Environment and Climate Change Canada, was established to provide information and support to those seeking to understand, and reduce their vulnerability to, climate change. The CCCS leads a Government of Canada-wide approach, collaborating with provinces, territories, and climate science experts to provide credible, useful and timely climate data, information, and tools for Canadians to consider climate change in their decisions.

Recognizing that regional approaches are required to address the unique needs of users across the country, the CCCS created a national system of climate services by developing a network of regional climate expert organizations. This approach aims to ensure that Canadians have access to the locally relevant expertise, advice, and information needed for decision-making. Regional organizations that are part of the national system of climate services include:

- Pacific Climate Impacts Consortium (PCIC), a regional climate service centre at the University of Victoria (British Columbia) that conducts quantitative studies on the impacts of climate change and climate variability in the Pacific and Yukon region. Results from this work provide regional climate stakeholders with the information they need to develop plans for

reducing the risks associated with climate variability and change. In this way, PCIC plays an important bridging function between climate research and its practical application by decision-makers.

- ClimateWest, a non-profit organization and a regional hub for climate services in Manitoba, Saskatchewan and Alberta that empowers people, communities, businesses and governments to address risks and opportunities caused by a changing climate. ClimateWest provides credible, useful, and timely climate information, data, and tools tailored to the Prairie region in support of positive adaptation to climate change.
- Ouranos, which provides Québec and the rest of Canada with expertise in both climate science and adaptation strategies. Ouranos engages in focused, practical science, and actively involves a broad network of researchers, experts, practitioners, and policy-makers to support sound decision-making in relation to climate change and its impacts. Ouranos specializes in co-financing for interdisciplinary and multi-institutional projects that bring together diverse stakeholders to promote and support adaptation to climate change, and provides climate scenarios and services.
- CLIMAtlantic, which facilitates access to regionally relevant climate information and supports its effective use in planning and decision-making for the provinces of New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador. CLIMAtlantic focuses on the needs of Indigenous communities, academia, provincial governments, municipalities, local service districts, non-profits, industry, and land owners, working with regional and local groups to ensure that there is a strong network of collaboration, and that data and tools are easily accessible.

To serve the needs of users with various capacities, the CCCS supports a series of climate data portals. These portals provide a range of information and functionalities from broad, directional climate change trends to tools for analyzing high-resolution climate data. These portals include:

- The CCCS Climate data viewer and Climate data extraction tool: CCCS's Climate data viewer and Climate data extraction tool allow users to view mapped climate data or download subsets of climate data from a selection of Environment and Climate Change Canada datasets including future climate simulations, value-added historical datasets, and historical climate and river data.
- The Climate Atlas of Canada: This portal, developed by the Prairie Climate Centre, combines climate science, mapping and storytelling to bring the global issue of climate change closer to home for Canadians. It provides basic climate modelling and historical data through maps, graphs, and tables so that users can explore local climate projections. To complement the data, the tool also provides summaries and videos with real stories of climate change that support climate action.
- The Platform for the Analysis of Visualization of Climate Science (PAVICS): This project is a tool for expert users. Led by Ouranos in collaboration with the Computer Research Institute of Montréal, Environment and Climate Change Canada, Canarie, and the Government of Québec, PAVICS aims to streamline climate scientist workflows. The platform integrates a network of supercomputers to provide the tools needed to analyze and visualize large amounts of climate data.
- ClimateData.ca: This portal enables Canadians to access, visualize, and analyze high-resolution climate data. Additionally, this portal provides information and tools to support adaptation planning. ClimateData.ca is intended for informed users such as municipal planners and engineers who require access to local climate data, including a range of climate indices. Environment and Climate Change Canada, the Computer Research Institute of Montréal, Ouranos, PCIC, the Prairie Climate Centre, and HabitatSeven collaborated to create this portal.

Further, there are a number of other reputable sources of climate data and information in Canada, including the Pacific Climate Impact Consortia's Data Portal; the Canadian Climate Data and Scenarios data portal; and the Meteorological Service of Canada's Weather, Climate and Hazard Services and Information webpage.

The CCCS operates a Support Desk that provides personalized support and guidance to help Canadians find, interpret, and use the data and information suitable for their individual needs. The Support Desk draws on a network of experts to respond to inquiries and support adaptation decision-making.

6.3.2. Sector-Specific Climate Services

Agriculture and Agri-Food Canada provides a variety of climate data products, information, and services specifically for Canada's agriculture and agri-food sector. For example, the National Agroclimate, Geomatics and Earth Observation Service is an authoritative source for a wide variety of agroclimate data, indices, information, tools, and models for monitoring and assessing climate-related risks to agricultural production, analyzing changing land suitability, and forecasting crop production. See Drought Watch for current product offerings.

Through its Aquatic Climate Change Adaptation Services Program, Fisheries and Oceans Canada is advancing research in the area of aquatic climate change science in support of adaptation efforts across three priority areas: ocean chemistry; vulnerability of fisheries and coastal infrastructure to climate change; and applied ocean models. The program has developed a number of tools to help coastal infrastructure owners and fisheries managers make better decisions in the face of climate impacts, such as sea level rise, storm surge, and changing biodiversity.

Polar Knowledge Canada is responsible for advancing knowledge of the Canadian Arctic and strengthening Canadian leadership in polar science and technology. Through its *Science and Technology Framework 2020–2025*, Polar Knowledge Canada is advancing knowledge creation and mobilization in the North. The Framework's three interrelated goals include improving knowledge of dynamic terrestrial, freshwater, and marine ecosystems in the context of rapid change; increasing understanding of the connections between northern community wellness and environmental health; and advancing energy, technology, and infrastructure solutions for the unique environmental, social, and cultural conditions in the North.

Additionally, Crown-Indigenous Relations and Northern Affairs Canada's Indigenous Community-Based Climate Monitoring program provides funding for long-term climate monitoring projects in Indigenous communities. Specifically, the program supports community-led projects to monitor climate and the environmental effects of climate change on communities and traditional territories. The program also facilitates access to tools and best practices, enhances collaboration and coordination among initiatives, and supports Indigenous participation in program oversight. Information gathered through community-based climate monitoring initiatives can be used to inform Indigenous community adaptation actions and address climate data gaps.

6.4. Domestic Adaptation Policies, Plans, and Actions

Effective action on adaptation requires a whole-of-society effort. Over the past two decades, all orders of government, Indigenous Peoples, businesses, and civil society are increasingly taking individual and collective action to address climate risks.

In 2016, First Ministers adopted the *Pan-Canadian Framework on Clean Growth and Climate Change*, Canada's first-ever national climate plan—with adaptation as one of four pillars. Built through collaboration on climate change across government jurisdictions, federal, provincial, and territorial governments have been implementing programming to share knowledge, build capacity and invest in on-the-ground adaptation initiatives.

Building on the Pan-Canadian Framework, Canada released its first National Adaptation Strategy in 2022. The Strategy establishes a shared vision for climate resilience in Canada, identifies key priorities for increased collaboration, and establishes a framework for measuring progress at the national level. Building upon the successes of the Pan-Canadian Framework, the Strategy offers the opportunity to scale up ongoing actions and advance new initiatives and leadership through the help of shared priorities and collaborative action.

Building climate resilience is a long-term challenge that requires ambitious and sustained action. The National Adaptation Strategy is designed to be iterative as climate risks and adaptation needs evolve. Regular evaluation and refinement of the Strategy will build on the achievements and lessons learned from previous actions and set a flexible pathway to enable Canada to adapt into the future.

At the same time, jurisdictions, organizations, and individuals across the country have been developing and advancing their own climate adaptation plans, strategies, and programs tailored to the diverse geographic, demographic, and economic needs of their communities. Collectively, these actions are providing the necessary adaptation knowledge, capacity, and investments to make meaningful progress. A brief summary of actions is outlined in the following sections.

6.4.1. Federal Adaptation Policies, Plans, and Programs

The federal government's role in adaptation has progressively evolved over time. In the late 1990s to early 2000s, the federal government provided foundational information, such as weather monitoring, research into climate impacts and vulnerabilities, and targeted knowledge generation and capacity-building activities. Since then, the federal approach has expanded to include setting long-term national policy direction; convening and coordinating partners and stakeholders throughout the country; and enabling on-the-ground investments in adaptation.

Through the National Adaptation Strategy, the federal government is committed to continued collaboration and partnerships with jurisdictions and organizations to support stronger adaptation action. Adaptation efforts must respect the jurisdictions of local, provincial, territorial, national, and Indigenous governments, while accelerating and building upon their existing initiatives. Action should include a focus on opportunities for collaboration and aligning these efforts, in order to advance more efficient and shared outcomes while also contributing to building local, regional, and institutional capacity.

To help implement the *National Adaptation Strategy*, Canada released the *Government of Canada Adaptation Action Plan* in 2022. The Action Plan is part of a comprehensive federal approach to addressing the climate change crisis and transitioning toward a cleaner, low-carbon, and more resilient Canada. It is intended to complement adaptation efforts of provinces, territories, and Indigenous partners. Like the *National Adaptation Strategy*, the Action Plan will be updated over time to ensure that actions continue to meet Canada's needs as the climate changes.

The Action Plan includes a total of 68 new and ongoing actions across 22 federal departments and agencies, illustrating the depth and breadth of adaptation action being taken. New investments under the Action Plan totalling $1.6 billion support a suite of initiatives, including building climate-resilient public infrastructure, enhancing wildfire and flooding preparedness activities, supporting locally-led adaptation measures in municipalities and Indigenous communities, and supporting Canada's healthcare system adapt to a changing climate. These actions build on investments made through successive federal budgets in 2021[58] and 2022,[59] which earmarked $2.2 billion to support a number of adaptation policies and programs led by federal departments and agencies:

- Agriculture and Agri-Food Canada supports innovation and adoption of technologies and practices that enhance the sector's resilience and sustainability;
- Crown-Indigenous Relations and Northern Affairs Canada supports co-development of an Indigenous Climate Leadership Agenda with Indigenous Peoples;
- Indigenous Services Canada supports First Nations and Inuit as they manage the health impacts of climate change;
- Infrastructure Canada supports investments in climate-resilient infrastructure through a top-up of the Disaster Mitigation and Adaptation Fund;
- Infrastructure Canada supports natural and hybrid infrastructure projects by establishing a Natural Infrastructure Fund;
- Health Canada provides guidance and resources to help protect Canadians from extreme heat and supports health authorities across Canada in creating climate-resilient health systems;
- Natural Resources Canada reduces the risks of wildfires by enhancing community prevention and mitigation activities, supporting innovation in wildland fire knowledge and research, and establishing a Centre of Excellence for Wildland Fire Innovation and Resilience;
- Natural Resources Canada, Environment and Climate Change Canada, and Public Safety Canada work with provinces and territories to complete flood maps for high-risk areas and ensure all Canadians have access to free, up-to-date and authoritative flood hazard mapping;
- Parks Canada Agency enhances wildfire preparedness in Canada's National Parks;
- The Standards Council of Canada and National Research Council develops and updates climate-informed codes, standards, and guidelines for resilient infrastructure; and,
- The National Research Council Ocean Program has invested in targeted, collaborative research projects to develop solutions for effective climate change adaptation, risk management and mitigation along Canada's coasts and rivers.

These programs build on the existing suite of federal adaptation investments made in 2016 ($245 million)[60] and 2017 ($441 million)[61] related to information and capacity-building, resilient infrastructure, human health and well-being, and the reduction of climate-related disasters and risks. Investments in 2017 also included the establishment of the Disaster Mitigation and Adaptation Fund ($2 billion) to support large-scale infrastructure projects and enhance the resilience of communities to climate change impacts.

A number of initiatives support the provision of climate change science and inform concrete action. Federal, provincial, and territorial governments, National Indigenous Organizations, and others worked together to develop *Climate Science 2050: Advancing Science and Knowledge on Climate Change*—a national synthesis report to better understand the breadth of climate change science and knowledge needs that exist in Canada, including the need to mobilize the full spectrum of Indigenous leadership, participation, and science and knowledge systems. To build adaptive capacity, the Building Regional Adaptation and Capacity Expertise program has worked with provinces to support the development and delivery of a range of activities that equip workers and professionals with the necessary skills to deliver adaptation solutions, such as training, internship programs, workshops, webinars, and the creation of new networks.

In the Health Sector, the Government of Canada has supported the expansion of heat alert and response systems, and the HealthADAPT program has partnered with ten health authorities across five provinces and territories to address climate-driven health risks. Since the launch of the Infectious Disease and Climate Change Fund in 2017, the program has supported 32 projects to help investigate, analyze, and improve knowledge gaps related to climate-driven food-borne, water-borne, and zoonotic diseases. In addition, the Infectious Disease and Climate Change Fund has advanced public health efforts to prevent and control zoonotic diseases, with a focus on tick- and mosquito-borne diseases, through risk communications, surveillance and monitoring activities, and knowledge synthesis and awareness activities.

In the Agriculture and Agri-Food Sector, the Government of Canada has supported climate resilience efforts through programming under the Canadian Agriculture Partnership Policy Framework, a $3 billion investment by federal, provincial, and territorial governments. Programs are designed to increase farmers' awareness and management of on-farm environmental risks and support adoption of beneficial management practices and technologies that reduce risks, including those affected by climate change. Additionally, a suite of Business Risk Management programs provides producers with critical protection against income and production losses, including from severe weather events (e.g., droughts, wildfires, floods).

Action to advance resilient infrastructure includes the development of new and updated building and construction codes and standards to make buildings, bridges, roads, transit, water, and wastewater infrastructure more climate-resilient. For example, the Climate Resilient Building and Core Public Infrastructure initiative's work integrating climate resilience into Canada's building codes is estimated to provide cost savings of up to $12 for every $1 invested.[62] Published through this initiative, the National Guide for Wildland-Urban Interface Fires provides guidance on steps that communities can take to reduce their risk. The National Research Council of Canada commissioned an Impact Analysis of the guide and estimated an average benefit-cost ratio of 4:1 across Canada.[63] Infrastructure Canada has since committed an additional $35 million over five years (2021–2026) to advance work regarding research-based guidance, codes and standards through the Climate Resilient Built Environment initiative.

Through the Transportation Asset Risk Assessment initiative, 20 projects have been funded to improve the understanding of climate change-related risks and vulnerabilities to federal transportation infrastructure. In addition, direct funding for on-the-ground projects has taken place through the Disaster Mitigation and Adaptation Fund, and, as of October 2022, the program has invested $2.2 billion in 72 infrastructure projects in communities of all sizes across Canada. For example, with funding from this program, the City of Montréal is creating one of the largest urban green spaces in the world to strengthen wetlands ecosystem health and improve flood resilience in vulnerable parts of the city.

Assessing Climate Risks to Public Infrastructure

The Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol is a tool to systematically assess infrastructure vulnerability and risk from current and future climate impacts. Developed by Engineers Canada with support from the Government of Canada, the PIEVC Protocol is designed to assist infrastructure owners, operators, and decision-makers in managing uncertainty in the face of a changing climate. The PIEVC Protocol relies on the use of multidisciplinary, multi-stakeholder teams and engagement to assure complete, credible, and defensible assessments.

As of 2022, over 90 PIEVC Assessments have been successfully completed for a wide range of public infrastructure systems in Canada, including buildings, stormwater/wastewater systems, roads and bridges, electricity distribution, and airport infrastructure. The merits of the Protocol are also being realized internationally, with PIEVC Assessments completed in Costa Rica, Honduras, Vietnam, and Brazil.[64]

The Government of Canada is also continuing to support Indigenous and northern communities in adapting to climate change impacts through a number of targeted programs. The First Nation Adapt Program, Climate Change Preparedness in the North Program, and Indigenous Community-Based Climate Monitoring Program are working with communities to identify region-specific climate change priorities and opportunities to address impacts. This includes support for risk assessments, adaptation planning, implementation of structural and non-structural adaptation measures, and the co-application of western science and Indigenous Science and Knowledge for community-based climate monitoring. Progress has been made through the Climate Change and Health Adaptation Program, which, as of March 2022, has supported 40 percent of First Nations and Inuit communities in identifying, assessing, and responding to the health impacts of climate change through funded projects.[65]

The federal government is leading by example through the implementation of the *Greening Government Strategy* to help transition Government of Canada operations to be net-zero and climate-resilient. Through the Strategy, federal departments must regularly assess and take action to reduce climate risks to federal assets, services and operations; apply climate-resilient building design; and increase training and support for public service employees on adaptation. In addition, departments with real property (either owned or leased) must develop portfolio plans in order to achieve climate-resilient real property operations by 2050.

Other initiatives are also advancing climate resilience. For example, the *Emergency Management Strategy for Canada* is Canada's official emergency management and disaster risk reduction strategy until 2030. In order to advance the Emergency Management Strategy and its iterative Action Plans, federal, provincial and territorial governments are working on a number of important initiatives, including the National Risk Profile, which will create a forward-looking national picture of disaster risk and emergency management capabilities; the creation of a national high-risk residential flood insurance program to protect homeowners at high-risk of flooding and without adequate insurance protection; a national action plan to assist homeowners with potential relocation in areas of highest risk of repeat flooding; and the review of the Disaster Financial Assistance Arrangements, an important federal disaster financial relief program. In addition, adaptation is a co-benefit of the $4 billion Natural Climate Solutions Fund, which includes commitments to supporting organizations to plant 2 billion trees over ten years; to conserve and sustainably manage wetlands, peatlands, grasslands and agricultural lands; and to develop and implement farming practices to tackle climate change.

6.4.2. Provincial and Territorial Adaptation Policies, Plans, and Programs

In the Canadian context, provinces and territories play a significant role in adaptation given their authority over regional and local decision-making, natural resource management, and community planning. Many are implementing stand-alone adaptation strategies or are integrating their efforts into broader climate change action plans. In recent years, multiple provinces and territories have completed, or are in the process of completing, regional climate risk and vulnerability assessments. Several provincial governments have introduced new legislation that mandates regular adaptation planning and implementation to take place. The following section provides a brief overview of provincial and territorial adaptation initiatives.

Canadian Council of Ministers of the Environment

The Canadian Council of Ministers of the Environment (CCME) is an inter-governmental organization composed of members of federal, provincial and territorial governments. The purpose of the CCME is to discuss national environmental priorities and achieve results through cooperative action.

Several committees support the work of the CCME, including an Adaptation Policy Committee, which promotes improved coordination of adaptation policy across federal, provincial, and territorial governments. This collaboration has advanced shared adaptation priorities, such as the development of guidance for climate risk assessment and best practices for the use of climate-resilient natural infrastructure.

6.4.2.1. British Columbia

The 2022 *Climate Preparedness and Adaptation Strategy* guides adaptation in British Columbia. The Strategy addresses foundational needs for data, training and capacity, and presents targeted actions that support Indigenous nations and communities, local governments, business and industry, so they can better prepare for and adapt to the changing climate. Actions include establishing a consistent approach to floodplain mapping, wildfire prevention, developing an extreme heat preparedness framework, and protecting and restoring watersheds to address complex ecosystem changes. The Strategy seeks to ensure that the knowledge and priorities of Indigenous Peoples are brought into decision-making, while enhancing data collection, monitoring and risk assessments, to build a thorough understanding of climate impacts. This work builds on broader investments by the provincial government to help people and communities recover from recent disasters and prepare for climate impacts in the future.

The *Climate Preparedness and Adaptation Strategy* was informed by the 2019 *Preliminary Strategic Climate Risk Assessment*, which was the first report of its kind in Canada to examine provincial-scale climate risks. The assessment examined some of the greatest risks to the province as a result of climate change, including severe wildfires, flooding, seasonal and long-term water shortages, heatwaves, ocean acidification, and glacier mass loss. Actions under the adaptation strategy are helping to prepare for and address these risks.

In 2019, the Government of British Columbia passed the *Climate Change Accountability Act*, which introduced a number of climate change-related mandates for the province. Regarding adaptation, the Act requires British Columbia to prepare annual reports on climate change actions and progress, and to report on climate change risks every five years. The Act also establishes an independent advisory committee to provide advice on an annual basis to the minister on climate change issues.

6.4.2.2. Alberta

The Government of Alberta is implementing a suite of adaptation programs to address climate risks across the province, which includes building resilience in communities and the agricultural sector, reducing climate-related disaster risks, and protecting water resources as key areas of action. For example, the Watershed Resiliency and Restoration Program builds long-term resilience to flooding and drought by improving natural watershed functions, and engaging Albertans in the conservation, restoration, enhancement and stewardship of wetlands, riparian areas, floodplains, and other critical watershed features. Alberta also recently published the online Flood Awareness Map Application, allowing users to view flood maps to improve community planning and adaptation decision-making.

Alberta's Technology Innovation and Emissions Reduction (TIER) regulation system is a foundational element in the province's approach to climate change. Through this system, large industrial greenhouse gas emitters have the option to pay into the TIER Fund, with revenues from the fund being used for emissions reduction and climate change adaptation initiatives. For example, in 2020 the TIER Fund provided $45 million to ten high-priority flood mitigation projects through the Alberta Community Resilience Program.

The Government of Alberta also works closely with municipal partners to enable locally-led climate action. The Municipal Climate Change Action Centre is a collaborative initiative led by Alberta Municipalities in partnership with Rural Municipalities of Alberta and the Government of Alberta. The Action Centre delivers funding, technical assistance, and education to help municipalities and community organizations advance actions that lower energy costs, reduce GHG emissions, and improve climate resilience. This includes the $4.5 million Climate Resilience and Capacity-Building Program, which supports Alberta municipalities and Indigenous communities in assessing adaptation measures and creating climate resilience plans.

6.4.2.3. Saskatchewan

Saskatchewan adopted the *Prairie Resilience: A Made-in-Saskatchewan Climate Change Strategy* in 2017 as the province's comprehensive approach to climate change, focusing on strengthening resilience in natural systems, physical infrastructure, economy, and communities. Through the Strategy, the Government of Saskatchewan is implementing a number of measures including building resilience through transportation infrastructure design, completing flood mapping for communities at highest risk, and engaging communities to develop adaptation and preparedness plans.

In 2018, the Government of Saskatchewan released the *Climate Resilience Measurement Framework*, which tracks progress on 25 resilience measures across five key areas of focus: natural systems, physical infrastructure, economic sustainability, community preparedness, and human well-being. The first resilience report, released in 2019, presented a baseline and future targets for these measures, with annual reports being released to report on the status and trends for each measure. As of 2021, a total of 18 measures (82 percent) were designated as good status, with the four remaining measures designated as fair; no measures had a status of poor.

To continue to improve resilience across the province, Saskatchewan is working in partnership with stakeholders to pursue complementary programming. For example, the Saskatchewan Water Security Agency is working with communities to support local flood planning needs, including advancing modern flood mapping, as well as developing flood risk and response plans. In addition, Saskatchewan is implementing its *Protected and Conserved Areas Roadmap* to make progress on the protection and conservation of natural areas.

6.4.2.4. Manitoba

The Government of Manitoba's approach to climate change is outlined in the *Made-in-Manitoba Climate and Green Plan*, which includes specific priorities for addressing climate change, jobs, nature, and water.

In 2018, Manitoba became one of the first provinces in Canada to implement climate accountability legislation through *The Climate and Green Plan Act*. The Act requires the Government of Manitoba to develop a plan with a broad framework of programs, policies and measures related to climate change mitigation, adaptation and environmental protection. The Act also established an Expert Advisory Committee as an independent group of experts to provide advice and recommendations on Manitoba's Climate and Green Plan, as well as a Youth Advisory Council.

Manitoba continues to take action to support climate change adaptation across the province through a suite of programs. Actions include creating the Conservation and Climate Fund—which provides funding for projects that address, and adapt to, climate change—and working with local partners through the Growing Outcomes in Watersheds initiative—which focuses on improved watershed resilience to climate change (e.g., flood and drought vulnerability) and improved water quality (e.g., sediment and nutrient management). Additional actions involve investing in networks of water control and flood mitigation infrastructure to protect communities, supporting on-farm water management practices, and supporting professional development and capacity for better adaptation decision-making.

6.4.2.5. Ontario

Through the *Made-in-Ontario Environment Plan*, Ontario is taking a number of steps to build resilience across the province. For example, the Government of Ontario launched the Build Back Better pilot project, under the Municipal Disaster Recovery Assistance Program, to help municipalities affected by spring flooding make climate resilience improvements when rebuilding damaged infrastructure after the natural disaster. To support local decision-making, Ontario updated its Provincial Policy Statement to guide planning authorities in preparing for the impacts of climate change, and to require municipalities to consider climate change through infrastructure asset management.

The Government of Ontario is also taking action to address flood risks through *Protecting People and Property: Ontario's Flooding Strategy*. Building on expert advice from Ontario's Special Advisor on Flooding, the Strategy outlines over 90 actions to improve resilience to flooding through a better understanding of flood risks, strengthened governance, and enhanced flood preparedness, response, recovery and risk reduction. Initiatives such as the Home Flood Protection Program are helping homeowners make informed decisions on practical and affordable actions to lower their risk of flooding.

Ontario's next steps include publishing the province's first-ever broad, multi-sector provincial climate change impact assessment, to better understand where and how climate change is likely to affect communities, critical infrastructure, economies and the natural environment, while helping to strengthen the province's resilience to the impacts of climate change. The Government of Ontario also established an advisory panel on climate change, consisting of climate resilience experts across various sectors, to provide advice on the implementation of Ontario's climate change actions, with a focus on how Ontarians can prepare for the costs and impacts of climate change.

6.4.2.6. Québec

The Government of Québec adopted the *2030 Plan for a Green Economy* in 2020 to lay the groundwork for achieving a prosperous green climate-resilient economy by 2030. The Plan sets out clear principles to guide the directions and actions of the government, and emphasizes collaborative efforts with Indigenous communities, municipalities, researchers, companies, and citizens to implement actions. Adapting to climate change is one of four key actions under the Plan, with a focus on protecting the health and safety of citizens, adapting infrastructure, building resilience in Québec's economy, and protecting ecosystems and biodiversity.

Québec employs a dynamic and scalable approach to implement its 2030 Plan, which is achieved through the development of five-year implementation plans that are updated annually. Québec is currently following its second implementation plan, which covers the period of 2022–2027. Examples of initiatives under the 2022–2027 implementation plan are the new Adaptation Challenge, which enables businesses to better manage climate change risks and seize new opportunities, and the OASIS program, which aims to address extreme heat and heavy precipitation in communities using green infrastructure solutions. The Government of Québec also supports research for northern communities, as well as the healthcare and infrastructure sectors, to better understand climate change risks and develop adaptation measures.

These actions build on many ongoing programs and initiatives to mainstream adaptation into government processes. For example, the Government of Québec developed the *Territorial Flood Protection Plan* in response to major flooding in 2017 and 2019. The Plan presents 23 flood mitigation measures including establishing flood maps, modernizing legal and regulatory frameworks, implementing actions at watershed-scale, and providing up-to-date information to support decision-making.

6.4.2.7. New Brunswick

New Brunswick released *Transitioning to a Low-Carbon Economy-New Brunswick's Climate Change Action Plan* in 2016. The Plan includes a comprehensive list of adaptation actions grouped into six themes: 1) understanding climate change impacts; 2) building climate-resilient infrastructure; 3) supporting community adaptation planning; 4) adapting natural resources and agriculture; 5) reducing climate-related hazards; and 6) reducing climate change impacts on public health.

Since the Action Plan's release, the Government of New Brunswick has made significant progress on its commitments, as outlined in the final *2020 Progress Report*. All New Brunswick cities and high-risk coastal municipalities have completed vulnerability assessments and adaptation plans, and the province has developed an interactive flood hazard map tool to assist decision-makers in reducing flood-related risks to people and property. New Brunswick also developed a public health communication strategy in 2019 to educate government staff, the public, and other stakeholders about climate change impacts on human health. Other examples include acquiring up-to-date climate projections for the province, supporting the agriculture sector through beneficial management practices, incorporating climate change knowledge into forest management plans, and funding a number of adaptation projects, including adaptation capacity-building, dike maintenance, and riparian protection and restoration.

New Brunswick has also legislated action on climate change through the *Climate Change Act, 2018.* Through the Act, the province is mandated to review its Climate Change Action Plan at least every five years and establish a Climate Change Fund, which uses revenue from New Brunswick's carbon pricing system to support climate change actions, such as reducing GHG emissions and building resilience to climate impacts. In fiscal year 2021–22, the Fund directed $36 million in revenues to projects, including riparian area protection, risk assessments and climate-resilient upgrades to critical infrastructure.

In 2022, building on the 2016 plan and in keeping with the *Climate Change Act*, New Brunswick released a new climate action plan for 2022–2027 called *Our Pathway Towards Decarbonization and Climate Resilience*. The plan contains a new set of adaptation actions grouped into three sections: (1) Understanding and communicating climate change risks and opportunities; (2) Adaptation planning and implementation; and (3) Biodiversity and nature-based solutions. Annual progress reports will be released in the coming years to ensure accountability and successful implementation of the plan.

6.4.2.8. Nova Scotia

In 2009, the Government of Nova Scotia released the province's first long-term climate change strategy, *Toward a Greener Future: Nova Scotia's Climate Change Action Plan*. The Plan is designed as a set of short-term (2009 to 2013), medium-term (2013 to 2020), and long-term actions (2020 and beyond) to reduce GHG emissions and prepare for a changing climate. Adaptation actions under the Plan are focused on increasing staff education and awareness, developing a climate lens for programs, minimizing climate-related disruptions, building climate data, and supporting industry preparedness. Nova Scotia has made significant progress under the Plan.

Key achievements include establishing the Climate Adaptation Leadership Program, which helps government departments better plan for climate-related risks and opportunities by moving away from short-term adaptation projects in favour of mainstreaming adaptation through intentional capacity-building. In 2019, Nova Scotia introduced the *Coastal Protection Act*, which sets out clear rules to protect Nova Scotia's coastline from the impact of climate change, and to ensure new homes and businesses are safer from sea level rise and coastal flooding and erosion. The province has also developed and revised standards to dike design based on projected sea level scenarios.

Under Nova Scotia's *Environment Goals and Climate Change Reduction Act, 2021*, the province is required to complete a province-wide climate risk assessment and strategic climate change plan every five years, work with municipalities and First Nations communities on climate change priorities, and incorporate adaptation planning across all government departments. The Act also establishes the Sustainable Communities Challenge Fund, which recently committed $15 million over three years to help communities adapt to the impacts of climate change and reduce GHG emissions.

In December 2022, Nova Scotia released a new climate change plan, *Our Future, Our Climate: Nova Scotia's Climate Change Plan for Clean Growth*, to fulfil the goals in the *Environmental Goals and Climate Change Reduction Act.* The plan includes a number of adaptation actions to increase access to climate data and information, build capacity for planning and implementation, and minimize climate impacts by restoring natural areas and ecosystems. Actions were informed by Nova Scotia's province-wide climate change risk assessment, *Weathering the Storm: Climate Change Risk and Nova Scotia's Well-being*, also released in December 2022, which identifies key areas of concern, as well as opportunities and priorities for climate change adaptation moving forward.

6.4.2.9. Prince Edward Island

In 2018, Prince Edward Island released its five-year *Climate Change Action Plan* as a framework for both adapting to the changing climate and reducing greenhouse gas emissions. The Action Plan contains commitments across five action areas, including adaptation, with a focus on better understanding coastal impacts, building more resilient infrastructure, and protecting land and water resources.

The Government of Prince Edward Island has also implemented a number of adaptation actions since the release of the Action Plan. Examples include launching the Coastal Hazards Information Platform, which allows users to explore and visualize coastal hazards, such as extreme flooding and coastal change. The province also provides coastal hazard assessments for current and prospective property owners, and offers a free online course, called Protecting PEI Homes from Flooding and Erosion, to disseminate information on climate impacts and adaptation options to the public.

Prince Edward Island completed a province-wide climate change risk assessment to better understand climate-related risks and develop appropriate measures to respond. The study determined that the most significant climate risks to the province include coastal erosion, post-tropical storms, heatwaves, and intense rain and flooding. The assessment includes information on the consequences of these hazards to various sectors, and information on the unique risks to Indigenous communities. The findings of the assessment formed the basis of Prince Edward Island's *Climate Adaptation Plan*, released in 2022.

The Prince Edward Island *Climate Adaptation Plan* provides a roadmap for improving equity and building resilience in the province by reducing the impacts of climate change. The Climate Adaptation Plan contains adaptation actions across six themes: (1) disaster resilience and response; (2) resilient communities; (3) climate ready industries; (4) health and mental well-being; (5) natural habitat and biodiversity; and (6) knowledge and capacity.

6.4.2.10. Newfoundland and Labrador

The Government of Newfoundland and Labrador released its five-year climate change action plan, *The Way Forward on Climate Change Adaptation,* in 2019. The action plan guides the province's approach to reduce GHG emissions, stimulate clean innovation and growth, and build resilience to climate change impacts. The plan contains 45 commitments that require action in every sector of the economy, from businesses and large industry to households, transportation, and government including 17 items related to adaptation. As of December 2021, a total of 30 actions (67 percent) have been completed, including 12 (71 percent) of the adaptation actions, and progress has been made on the remaining 15 (33 percent).

In 2021, Newfoundland and Labrador conducted a climate change risk assessment focused on identifying climate-related vulnerabilities and impacts, and potential opportunities for the benefit of municipalities and natural resource-based industries. The assessment identified a number of priority measures to address risks, and help guide adaptation and resilience planning in the province.

Newfoundland and Labrador has taken significant steps to support better adaptation decision-making across the province. These range from disseminating downscaled climate projections, updating flood risk maps for at-risk communities and publishing daily flood alert information during peak precipitation seasons, to publishing user-friendly guidance and information about coastal erosion and sea-level rise and supporting a public infrastructure resilience project to build awareness among municipalities, the engineering community, and other stakeholders. Newfoundland and

Labrador continues to work with sector-specific industries, building capacity in the agriculture, aquaculture, fisheries, forestry, mining, tourism, and municipal operation sectors. Since 2005, 11 flood risk maps have been developed that incorporate climate projections, with two more in development as of 2022. The province also introduced a climate lens for provincial infrastructure funding and environmental assessment to help ensure that climate change considerations, including mitigation and adaptation, are appropriately integrated into the planning, design and development of projects.

6.4.2.11. Yukon

In 2019, two governments in the Yukon—Vuntut Gwitchin First Nation and the Government of Yukon — declared a climate change emergency. In 2020, Yukon First Nations also declared a climate emergency as a result of the threat that climate change poses to the culture and way of life of First Nations communities. In the declaration, Yukon First Nations called on all governments, corporations and individuals to act in the best interests of the planet and future generations as they come together to address climate change.

The Government of Yukon released *Our Clean Future* in 2020 after three years of collaboration with Yukon First Nations, transboundary Indigenous groups, and Yukon municipalities. The ten-year strategy sets out shared objectives with Indigenous and municipal partners across the territory, and lays out specific, tangible actions to address the climate emergency. One of the four goals of the plan is to adapt to the impacts of climate change, with the target of the Yukon being highly resilient to the impacts of climate change by 2030. To work towards this target, the territory is committed to reducing community exposure to climate hazards, such as flooding and wildfire, and increasing capacity to adapt. Actions are being informed by Indigenous ways of knowing, doing and being, as well as local and scientific knowledge.

Adaptation actions include developing a system to gather and track food insecurity across the territory, completing geohazard mapping for all communities at high-risk of permafrost thaw, and conducting climate risk assessments for community infrastructure projects. In 2022, the Yukon completed a territory-wide climate risk assessment, which reviewed the impacts of climate change that pose the highest risk to Yukoners, where adaptation actions are contributing to resilience, and recommendations to take further action. The assessment looked at how climate change impacts affect different elements of Yukoners' lives, and found priority areas for adaptation: building resilience into Yukon's transportation infrastructure, building resilience to floods, fires and permafrost thaw, building resilience to changes to ecosystems and biodiversity, and safeguarding health and well-being, access to the land, and the economy.

6.4.2.12. Northwest Territories

The Government of the Northwest Territories released the *2030 NWT Climate Change Strategic Framework* in 2018 as a comprehensive and coordinated response to the challenges and opportunities associated with a changing climate. The Framework focuses on three key goals: 1) transitioning to a lower carbon economy; 2) improving knowledge of climate impacts occurring in the Northwest Territories; and 3) building resilience and adapting to a changing climate.

In 2019, the territory released an accompanying *2019–2023 Action Plan* as the first of two five-year plans to achieve the Framework's goals. Over 100 action items are identified within the Plan, with a focus on improving knowledge of climate change impacts through planning, management and use of information, and enhanced research and monitoring. Adaptation actions also aim to support ecosystem viability, managing the natural environment, protecting and supporting people, and building resilient infrastructure. Partnerships with other levels of government, Indigenous organizations, non-governmental organizations, industry, and academia are essential in accomplishing these actions.

The Government of the Northwest Territories established the Northwest Territories Climate Change Council in 2020 to provide guidance and advance climate change and environmental programs in alignment with Indigenous and community perspectives, interests, and knowledge. The Council consists of non-elected staff of Indigenous governments and Indigenous organizations, representatives of Northwest Territories communities and the territorial government, with input from external partners.

The territory also held the first Climate Change Advisory Group Annual Conference in fall 2021, a forum that brings together climate change partners to share knowledge and identify challenges and opportunities to climate actions in the Northwest Territories.

Furthermore, the Government of the Northwest Territories will conduct a climate change risks and opportunities assessment in the coming years that will determine the likelihood and severity of regional climate change impacts across the territory and inform the next action plan.

6.4.2.13. Nunavut

The Government of Nunavut has been working in partnership with Nunavut communities, local and national organizations, academia, and governments to help Nunavummiut (the people of Nunavut) adapt to climate change. Collaborative adaptation efforts are based on the integrated application of Inuit Qaujimajatuqangit, the system of Inuit traditional knowledge and societal values that is based upon a long and close relationship with the land and environment. Inuit Qaujimajatuqangit provides detailed insight into adaptation action, and provides context to help understand how climate change will impact Inuit culture, communities, and individuals.

Nunavut's Climate Change Secretariat, established in 2016, develops programs, policies, and partnerships that enable Nunavummiut to take leadership on adaptation, and promotes knowledge sharing of community-based climate change adaptation solutions. The Secretariat hosts a web-based climate change resource that shares climate change knowledge in Nunavut, while making information more accessible to the public. The website houses a wealth of resources, including climate change publications, updates on adaptation projects, and a community map where users can find community-specific climate change information and programs.

The Government of Nunavut is continuing to make progress in identifying and assessing climate hazards related to permafrost thaw, sea ice melting and food insecurity, and in implementing adaptation solutions for communities and infrastructure. A risk and resiliency assessment of climate change impacts has commenced which will identify priority areas for action.

6.4.3. Municipal Adaptation Policies, Plans, and Programs

Municipalities are on the frontlines of climate change impacts, while also driving adaptation solutions. As of 2022, over 640 municipalities across Canada have declared a state of emergency regarding the climate crisis, and have committed to take measures to protect Canadians.[66] Local governments are increasingly taking action to build resilience to climate risks through adaptation plans and risk assessments, regulatory interventions such as by-laws and land-use planning, training and communications initiatives, and the building of protective and resilient infrastructure.

In 2019, more than 50 mayors and councillors from across Canada gathered in Victoria, British Columbia, as part of the Livable Cities Forum, to discuss and share ideas on building social resilience, community belonging and inclusion as a key resilience strategy. The session culminated with elected officials finalizing a collective call to action for local leaders to advance work on the health, well-being, and social cohesion aspects of resilience. The *Victoria Call to Action* was endorsed by those locally elected officials present and calls on all local leaders to commit to six points of action:

- Ensure that all actions are taken through a lens of decolonization, health and well-being, equity and inclusion, racial and social justice, and ecological integrity.
- Empower and resource communities, and use their role as leaders to create opportunities for education, connection, belonging, and community-building.
- Enrich the fabric of communities by building towns and cities that create a sense of place and a strong connection to neighbourhoods.
- Leverage the interconnection of issues and look for opportunities to solve complex challenges that generate multiple benefits and solutions.
- Seize the pockets of brilliance in communities coming from youth and residents as bottom-up solutions to collective challenges.
- Invest collective resources to deliver short- and long-term solutions that will have the greatest impact and help communities go further, faster together.

The following sections highlight select examples of local-level adaptation. Additional case studies can be found on the Map of Adaptation Actions website.

6.4.3.1. Municipal Adaptation Planning

Municipalities, both large and small, have developed plans to guide adaptation action within their jurisdictions. For example, in 2018, the City of Toronto, Ontario, released *Toronto's First Resilience Strategy*. Toronto's strategy was developed through an inclusive, community-led process and includes a set of goals and actions organized into three areas of focus: people and neighbourhoods, infrastructure, and leadership for a resilient city. Advancing equity is a core component of the strategy and recognizes that resilience is as much about the strength of its communities and neighbourhoods as it is about the design and management of its infrastructure and buildings.

The Town of Churchill, Manitoba, is a northern community facing a number of challenges not experienced by many Canadians living in the south, including remoteness, periods of inaccessibility, ageing and inefficient infrastructure, and a strong dependence on the land to support livelihoods. Churchill used the *Building Adaptive and Resilient Communities* framework developed by ICLEI Canada to develop its *Climate Change Plan* in 2020. The Plan includes risk, vulnerability and opportunity assessments of projected climate impacts, as well as an adaptation action plan for implementation that takes into account multiple co-benefits for residents and surrounding areas.

Municipalities are also tackling particular climate hazards to meet the specific needs of their communities. In response to devastating flooding in 2013, the City of Calgary, Alberta, has identified flood resilience as a top priority. Calgary is taking a holistic approach to flood reduction, employing multiple lines of defence at the watershed, community, and property levels. The City's 2022 *Flood Resilience Plan* focuses on increased protection in critical areas such as the downtown area and neighbourhoods at highest risk from similar flood events. The plan is supported by a combination of initiatives such as community flood barriers, bridge and stormwater management upgrades, and new forecasting and mapping tools.

In addition to developing new or stand-alone plans and strategies, many communities are incorporating climate change considerations into a wide array of municipal operations, policies, and services, including infrastructure decisions, asset management, land-use plans, and emergency management frameworks. The City of Vancouver's *Climate Change Adaptation Strategy* is linked to a web of programs and plans, along with dedicated governance to support the institutionalization of adaptation across municipal business. For example, Vancouver incorporates adaptation as a core component of its stormwater management approach under the *Rain City Strategy*.

6.4.3.2. Municipal Adaptation Programs and Initiatives

The City of Fredericton, New Brunswick, experienced severe back-to-back spring floods in 2018 and 2019. During the flooding, transportation networks were disrupted, leading to challenges in accessing hospitals and businesses, and other activities. Fredericton is leveraging asset management planning to build resilience across the city. This has led to changes such as culverts that are sized 20 percent above a 1-in-100-year return period; the promotion of active transportation (e.g., cycling); and rail-corridor trails that have been used as sites for water mains to increase redundancy and act as alternative transportation routes when flooding disrupts vehicle traffic.

Located in the boreal forest of Northern Saskatchewan, the Community of Napatak has embraced voluntary citizen participation in order to improve the resilience of the community to wildfires. The community established an Emergency Preparedness Team to help plan and coordinate emergency preparation activities throughout the community, such as organizing lines of communication during a fire, and creating a system for quickly identifying which homes have been evacuated.

The City of Brampton, Ontario, launched the Lighthouse Project, a collaboration between the City and 20 of its faith-based organizations (FBOs). This collaboration allows FBOs to provide support to vulnerable populations during extreme weather events and non-climate-related emergencies. FBOs provide pre-screened volunteers, places of refuge, wellness checks, emotional counselling, and donation management. The City provides resources, including training, promotional material, equipment, and support for community grants.

Municipalities are also recognizing the value of nature as a key tool in addressing the climate change and biodiversity crises. Natural infrastructure can reduce impacts associated with extreme heat, drought, flooding, and sea level rise. For example, the City of Montréal has created one of the most ambitious municipal tree-planting plans in Canada, aiming to increase its tree cover to 25 percent by 2025, plus an additional 500,000 trees by 2030. The *Plan d'action Forêt Urbaine* set out a ten-year budget and tree planting targets for each of Montréal's boroughs and other municipalities on the island. Montréal also works with a network of non-governmental organizations to increase canopy cover on private lands.

In many cases, communities are adopting new regulatory measures to better address climate change impacts. Examples include:

- Rosemont–La Petite-Patrie, a borough located in the centre of Montréal, Québec, which revised its zoning by-law to include measures to address the urban heat island effect, such as increasing the reflectivity of building surfaces and strengthening tree-planting requirements.
- Halifax Regional Municipality, Nova Scotia, which enforces a vertical setback for residential ground floors of all new buildings along its coastline to accommodate sea level rise, based on predictions and modelling out to the year 2100.
- Toronto's Green Roof by-law, which requires developments with a roof space larger than 2,000 square metres to have green roofs—estimated to have saved over 9 million litres of stormwater from their drainage systems and mitigated 120 tonnes of GHG emissions.
- The Town of Swan Hills, Alberta, which introduced by-laws based on FireSmart principles to reduce the risk of wildfire and was the first community in Canada to enact a law requiring new roofing to be made of fire-resistant materials.

Many local jurisdictions have also adopted measures to reduce disaster risk through building design, despite limited authority to regulate construction beyond provincial code requirements. For example, most municipalities in Alberta and major cities in Ontario have adopted building code interpretations that have resulted in the installation of sewer backflow protection in most new homes to reduce sewer backup risk.[67]

6.4.4. Indigenous Adaptation Policies, Plans, and Initiatives

First Nations, Inuit, and the Métis Nation are leaders in the fight against climate change. Indigenous Peoples have been living on and acting as stewards of Turtle Island, including the lands that we call Canada, since time immemorial. The depth of intergenerational knowledge, values, and worldviews are foundational in understanding the living landscape and guiding climate action. The enduring connections to the lands, waters, and ice, and the cultures and ways of being of Indigenous Peoples and communities are a source of strength, helping to foster adaptive capacity and resilience in the face of a changing climate.

Indigenous Peoples are not passive recipients of climate impacts, but are active drivers of change. They are responding to climate change impacts in diverse ways, reflecting their distinct nationhoods and cultures, to meet the needs of their communities and natural environments. This includes actions such as community resilience planning, the development of climate action networks and capacity-building tools, climate monitoring and observation, community-led research, and the provision of culturally safe support systems and services during times of climate-related disasters.

At the same time, inequalities and policies of assimilation have resulted in intergenerational inequities that can exacerbate the impacts of climate change on Indigenous Peoples and communities. Many Indigenous Knowledge Keepers have made it clear that climate change cannot be addressed without a societal transformation addressing the legacies and realities of colonialism—one that recognizes Indigenous self-determination, is holistic and inclusive, and supports renewed connections to traditions, cultures, and knowledge.[68]

Indigenous Science and Knowledge

Indigenous Science and Knowledge encompasses intergenerational wisdom that is flexible, fluid, and adaptive. This knowledge evolves from and is responsive to the natural world, which offers invaluable insight for developing and advancing meaningful climate change action.

There is no universally accepted definition of Indigenous Science and Knowledge. The term describes complex knowledge systems embedded in the unique cultures, languages, values, legal systems, and worldviews of Indigenous Peoples. First Nations, Inuit, and the Métis Nation have distinct science and knowledge systems but share certain common characteristics.

Indigenous Science and Knowledge tends to be nation- or community-specific and place-based. It is generally understood to be collective practices and knowledge that encompasses community values, teachings, relationships, ceremony, and governance. It is cumulative and dynamic, building upon the experiences of earlier generations, and evolving in the context of contemporary society. Indigenous women, gender-diverse, and two-spirit peoples are often relied upon for their knowledge and perspectives about specific subjects.

Spirituality, ceremony, reciprocity, and relationships with and responsibilities towards the earth are an integral part of Indigenous Science and Knowledge. Indigenous Peoples are inseparable from their knowledge. Indigenous Science and Knowledge is not limited to land-use, nor is it relegated to the past. Indigenous Science and Knowledge Systems are diverse, living value systems that need to be considered alongside other knowledge, including western science.

To help support Indigenous Peoples advance their climate priorities and adapt to the changing climate, the Government of Canada is committed to renewed nation-to-nation, Inuit-to-Crown, and government-to-government relationships with First Nations, Inuit, and Métis based on the recognition of rights, respect, cooperation, and partnership.

The Government of Canada also supports, without qualification, the *United Nations Declaration on the Rights of Indigenous Peoples*, including free, prior, and informed consent. Supporting self-determined climate action is critical to advancing Canada's commitment to reconciliation with Indigenous Peoples.

Respecting and upholding Indigenous rights is a guiding principle of Canada's *National Adaptation Strategy: Building Resilient Communities and a Strong Economy* and is a cornerstone of other federal climate-related plans and strategies. The Government of Canada is committed to partnering with First Nations, Inuit, and the Métis Nation to set an agenda for climate action and a framework for collaboration. Recognizing Indigenous climate leadership means investing in the agency of Indigenous Peoples and communities, supporting Indigenous-led and -delivered solutions, equipping Indigenous Peoples with equitable resources, and ensuring appropriate access to funding to implement self-determined climate action.

In support of this commitment, the federal government's 2022 Budget announced $29.6 million over three years for the co-development of an Indigenous Climate Leadership Agenda to support self-determined action in addressing Indigenous Peoples' climate priorities, and support the phased implementation of distinctions-based climate strategies.

In addition, following joint commitments made by the Prime Minister and the National Leaders of the Assembly of First Nations, Inuit Tapiriit Kanatami, and the Métis National Council, the federal government established three distinctions-based senior bilateral tables on clean growth and climate change in 2016. These tables are based on the recognition of rights, cooperation, and partnership. They help foster a collaborative approach to ongoing engagement with Indigenous Peoples, and help support the Indigenous Climate Leadership Agenda.

The following sections provide examples of adaptation action supporting, and led by, Indigenous organizations and communities, using a distinctions-based lens. Additional case studies can be found using the Map of Adaptation Actions website.

6.4.4.1. First Nations

The Assembly of First Nations (AFN) is a national advocacy organization that represents over 900,000 people living in 634 First Nation communities as well as in urban and rural areas across Canada. In 2019, the AFN Chiefs-in-Assembly officially declared a First Nations Climate Emergency, which recognizes that "climate change constitutes a state of emergency for our lands, waters, animals, and peoples."[69] As part of the resolution, the AFN committed to developing a First Nations-led National Climate Strategy, and to host a National Gathering on climate change.

In March 2020, the AFN hosted its first-ever National Climate Gathering with more than 400 First Nations from across Canada gathered on the traditional territory of the Ta'an Kwächän and the Kwanlin Dün. Participants discussed the urgency of the climate crisis, and explored First Nations perspectives on climate impacts, risks, and opportunities at a local, regional, national, and international level.

A second National Climate Gathering, *Preserving our Earth, Land and Water for Future Generations*, was held in September 2022. Over four hundred participants attended the Gathering to discuss, collaborate, and advance First Nations-led climate solutions, including First Nations experts, leadership, youth, women, Knowledge Keepers, and other professionals, as well as partners from governments and academia. The sessions held during the Gathering underscored the critical role of First Nations leadership in climate action; discussed a First Nations Climate Lens; and demonstrated holistic and multi-dimensional solutions that First Nations communities, youth, Knowledge Keepers, and others are advancing to connect environmental action with health, culture, language, water, food security, housing and overall well-being.

In 2021, the AFN launched development of an AFN National Climate Strategy Survey to gather knowledge and best practices from First Nations to inform the development of an AFN National Climate Strategy. Information collected from the survey is helping to identify key themes of action, priorities, and expectations as the strategy is developed. The National Climate Strategy is meant to be complementary and build on First Nations climate strategies in British Columbia, Yukon, and the Atlantic region.

First Nations communities are taking action. For example, Mistawasis Nêhiyawak, a First Nation located in central Saskatchewan, undertook an adaptation planning exercise to reflect on and explore how climate change would affect health and lands, and to adapt to climate change impacts. Through conversations with community members, leadership, and Elders, the community decided that the best way to prepare for the impacts of climate change was to be connected and strongly rooted in traditional ways. This led to the implementation of partnerships and culturally-relevant actions, such as workshops on traditional teachings and collaboration with regional environmental organizations to share resources, expertise, and knowledge.

Another example is the Semiahmoo First Nation, which has partnered with the nearby municipalities of Surrey and Delta, British Columbia, to create a living dike, which seeks to elevate and restore areas of salt marsh to protect habitats and mitigate flood risks in the face of sea level rise. In addition, the Tłı̨chǫ Dǫtaàts'eedı program—meaning to share food among the people—pairs young adults with experienced harvesters to participate in fishing, hunting, trapping, snaring, and berry picking. The program is helping to preserve Tłı̨chǫ values and culture, as well as enhance food security, which is increasingly at-risk because of climate change impacts on the ekwò, or barrenland caribou, a culturally and socially important animal for the Tłı̨chǫ people. Programs such as these are enabling communities to adapt to the impacts of climate change through cultural knowledge transfer, working with the land, using traditional skills, and empowering youth.

6.4.4.2. Inuit

In 2019, the Inuit Tapiriit Kanatami (ITK), a national representative organization for the 65,000 Inuit in Canada, released the *National Inuit Climate Change Strategy* as an Inuit-driven approach to dealing with the global climate crisis. The Strategy presents a vision for Inuit self-determination with respect to climate action. It identifies practical actions in five priority areas: 1) knowledge and capacity-building; 2) health, well-being, and the environment; 3) food systems; 4) infrastructure; and 5) energy. The Strategy also emphasizes the need for domestic and international partnerships to achieve climate objectives, and to support the development of regional Inuit climate strategies to better reflect diverse and varied experiences across Inuit Nunangat.[70]

Examples of adaptation initiatives taking place in Inuit communities include partnerships between regional governments and organizations in the Nunavik region and the Government of Québec, to design housing that is culturally-responsive and better adapted to climate change. Using a prototype duplex structure, the project is gathering data to assess and enhance the liveability and environmental sustainability of housing design, as well as to undertake a socio-cultural evaluation through discussions with tenants. The pilot housing project is on track to demonstrate best practices to guide future sustainable housing development throughout Nunavik.

SmartICE is a community-based organization that provides adaptation tools and services that integrate Inuit knowledge of sea ice with monitoring and technology. The SmartICE program engages partners with communities in the North to contribute to more informed decision-making regarding sea ice travel. As a result, Inuit hunters and trappers are able to safely hunt and gather nutritious country food, travel between communities, and train youth. By augmenting local knowledge and supporting traditional sea ice use, SmartICE also promotes Inuit culture, intergenerational learning, and community well-being.

6.4.4.3. The Métis Nation

Protection of the environment is a core value of the over 580,000 Métis Nation citizens across Canada. The Métis National Council, which serves as the national and international advocacy organization for the Métis Nation, is working to promote Métis Nation climate leadership as a path forward to help Métis communities lead and implement climate action Canada-wide. Using multi-generational knowledge, skills, and experience, Métis citizens are making meaningful decisions and taking important actions to build resilience to climate change and conserve the environment.

For example, the Métis Nation Saskatchewan has launched a number of programs intended to bring together the strengths of Elders, youth, Knowledge Keepers, and Western science to weave a syncretic view of climate change and to create a testimonial of its impacts on the Métis people of the province.

In February 2022, the Province of British Columbia hosted the Métis Climate Resilience Gathering in collaboration with Alderhill Planning Inc. and the Métis Nation of British Columbia to explore themes of climate resilience through discussions and presentations.[71]

To help improve Métis health in the face of climate change, the Métis Nation of Ontario held its first Climate Change Forum in 2022 to support open discussions with Métis peoples on climate change impacts and provide direction on adaptation responses. In addition, the Métis Nation of Alberta launched a Health and Climate initiative to help educate, build awareness, and offer resources to navigate climate change impacts, culminating in a comprehensive Health and Climate Toolkit for Métis community members.

In addition to the ongoing work at the Metis National Council and its Governing members, the Manitoba Métis Federation is also undertaking important climate change adaptation work. The Manitoba Métis Federation's Métis Environmental Leaders of Tomorrow project is helping youth gain knowledge of Métis culture and traditions in partnership with Elders and Traditional Knowledge Holders in their region. Through workshops and an annual symposium, Métis youth will gain a stronger sense of community and culture, and learn about climate change and environmental stewardship. These activities will help empower Métis youth to be community leaders in climate action.

6.5. International Adaptation Policies and Strategies

Adaptation is a key aspect of the Paris Agreement, which aims to achieve a balance between adaptation and mitigation, taking into account the needs and priorities of developing countries, particularly those who are most vulnerable to climate change, such as the least developed countries and small island developing states. Recognizing the urgent need to accelerate adaptation efforts, the Glasgow Climate Pact includes a call for developed countries to at least double their collective provision of climate finance for adaptation from 2019 levels by 2025.

Canada welcomed the launch of the Glasgow–Sharm el-Sheikh Work Programme on the Global Goal on Adaptation at COP26. The global goal on adaptation provides a guiding vision for enhancing adaptation actions, while recognizing that many countries experience unique impacts, challenges, and needs in adapting to climate change and building resilience.

6.5.1. Canada's Climate Finance and Adaptation

Canada recognizes that climate change adaptation is critical for developing countries, especially the poorest and most vulnerable, as climate change is having increasing and profound impacts on all sectors and aspects of well-being. One of the key objectives of Canada's climate finance commitment is to enhance the adaptive capacity of vulnerable communities and countries in responding to the impacts of climate change.

More information on Canada's climate change support to developing countries can be found in Chapter 7.

6.5.1.1. Canada's Feminist International Assistance Policy

In line with *Canada's Feminist International Assistance Policy*, Canada's climate finance integrates gender equality considerations. Gender equality considerations were integrated into 85 percent of the projects under Canada's $2.65 billion climate finance commitment (2015–16 to 2020–21) and will remain a priority for Canada's $5.3 billion commitment (2021–22 to 2025–26).

6.5.1.2. Canada's $2.65 Billion Climate Finance Commitment (2015–16 to 2020–21)

As of 2021, Canada had fully delivered on its 2015 commitment to provide $2.65 billion in climate finance over five years to help developing countries transition to low-carbon, climate-resilient economies. Climate adaptation and gender equality integration were key priorities for the program.

For example, Canada contributed $4 million to the National Adaptation Plan (NAP) Global Network to advance national climate adaptation processes in developing countries through technical assistance, peer learning and knowledge development. To date, it is estimated that 6.6 million people have already benefitted from effective, gender-responsive national adaptation plan processes in a number of countries. In addition, to amplify the voices of underrepresented groups and communities, particularly women, the National Adaptation Plan Global Network and Lensational (a non-profit social enterprise) trained women in Ghana and Kenya to communicate to national policy-makers the impacts of climate change on their lives and on their communities through visual storytelling.

6.5.1.3. Canada's $5.3 Billion Climate Finance Commitment (2021–22 to 2025–26)

Canada is scaling up its efforts to support developing countries' climate action, with increased emphasis on adaptation, biodiversity and nature-based solutions. At the 2021 G7 Leaders' Summit, Canada announced a climate finance commitment of $5.3 billion over five years. This commitment dedicates a minimum of 40 percent of funding to adaptation—more than double the adaptation funding under the previous commitment.

Canada has announced several adaptation initiatives that will be supported through the $5.3 billion commitment, including new funding for the Adaptation Fund, and additional funding for the Least Developed Countries Funds and the National Adaptation Plan Global Network. In addition, $315 million for the Partnering for Climate initiative will fund projects from Canadian civil society, as well as Indigenous and other organizations to support climate change adaptation in developing countries, with dedicated funding for sub-Saharan Africa, advancing women's rights and climate change adaptation, and supporting Indigenous partners in developing countries.[72]

6.5.2. Beyond Canada's Climate Finance Commitment

Beyond providing climate finance support, Canada co-led with Germany the development of a *Climate Finance Delivery Plan*, in the lead up to COP26, and a *Climate Finance Delivery Plan Progress Report*, in the lead up to COP27, to demonstrate how and when developed countries are going to meet the collective US$100 billion-per-year goal. A key focus of the progress report is demonstrating progress on increasing finance for adaptation. This is informed by the work of the Champions Group on Adaptation Finance, which Canada joined in June 2022, to advance climate adaptation priorities and solutions. In May 2021, Canada also joined the Adaptation Action Coalition with a view to working with international partners to help advance adaptation efforts.

The Parties to the Paris Agreement recognized the need to strengthen knowledge, technologies, practices and efforts of local communities and Indigenous Peoples related to addressing, and responding to climate change. Accordingly, Canada has been actively engaged in advancing the Local Communities and Indigenous Peoples Platform (LCIPP), which was designed as a space under the United Nations Framework Convention on Climate Change (UNFCCC) for the exchange of experiences and sharing of best practices on mitigation and adaptation in a holistic and integrated manner. The Government of Canada, in partnership with First Nations, Inuit, and the Métis Nation, took on a leadership role in working with the international community to create the Facilitative Working Group, which further operationalizes the LCIPP. Canada was one of the inaugural members of the Facilitative Working Group and served as Party co-chair in 2021 to 2022. Canada also provided funding from 2019 to 2022 to establish an Indigenous Peoples Focal Point within the UNFCCC Secretariat to support the work of the Platform, as well as to enhance the engagement of Indigenous Peoples and consideration of their rights and knowledge by supporting the operationalization of UNFCCC mandates related to Indigenous Peoples.

6.5.3. Adaptation Under the Convention on Biological Diversity

In 2010, Canada and other Parties to the Convention on Biological Diversity adopted the global *Strategic Plan for Biodiversity 2011–2020*. The Strategic Plan comprises a shared vision, a mission, strategic goals, and 20 targets, collectively known as the Aichi Targets. These international targets acknowledge the linkages between biodiversity and climate change mitigation and adaptation.

As a Party to the Convention on Biological Diversity, Canada has developed national biodiversity goals and targets. The 2020 Biodiversity Goals and Targets for Canada were developed collaboratively by federal, provincial, and territorial governments, with input from Indigenous organizations and others, and are intended to encourage and promote collective action toward the achievement of the global Aichi Targets.

Canada has met Biodiversity Target 5, which also relates to climate change adaptation: "By 2020, the ability of Canadian ecological systems to adapt to climate change is better understood, and priority adaptation measures are underway." The Government of Canada is committed to continue building on the work achieved under Target 5, including filling information gaps and exploring expanded adaptation measures for ecological systems across the country.

6.6. Oversight and Reporting

A key component of Canada's National Adaptation Strategy is a monitoring and evaluation framework. It is made up of a series of indicators that can track national adaptation progress and build a better understanding of resilience in Canada. Since climate change impacts are broad, from the economy and infrastructure to human health and the environment, the framework represents data and information from across sectors to capture a more complete picture of adaptation progress.

A series of initial indicators that align with National Adaptation Strategy priorities has been developed from available sources of quantitative information through ongoing coordination with partners and key stakeholders. Regular reporting at the national level will provide information on where efforts are yielding results and where more work is needed. Efforts to develop the monitoring and evaluation framework will continue as the Strategy evolves and as new indicators, partnerships, and data-collection methods, including qualitative and other ways of knowing, are explored.

Under the *Pan-Canadian Framework for Clean Growth and Climate Change*, the Government of Canada reports regularly on the progress of federal adaptation programs through the Horizontal Management Framework for Clean Growth and Climate Change. Regular public reporting of progress using financial and outcome-based indicators helps to ensure that the Government of Canada remains accountable to Canadians.

In addition, federal, provincial, and territorial governments report annually, to both First Ministers and the public, on progress in collectively implementing the Pan-Canadian Framework. Four progress reports have been released to date, providing relevant information on policies and initiatives helping Canadians achieve climate resilience.

The Government of Canada is collaborating with Indigenous Peoples through three distinctions-based senior bilateral tables to collectively advance clean growth and climate change (see Section 6.4.4. for more detail). Each table regularly shares relevant information with its members and works to jointly produce proposals, options, and recommendations to pursue shared goals and commitments. For example, the First Nations-Canada Joint Committee on Climate Action releases annual reports which document positive steps taken towards reconciliation, forging stronger climate partnerships, as well as shared strategies and challenges in accelerating positive, rights-based climate outcomes.

The Government of Canada also reports on adaptation efforts through the *Federal Sustainable Development Strategy*. The 2022–2026 Strategy supports Canada's efforts to advance the 17 Sustainable Development Goals of the United Nations 2030 Agenda for Sustainable Development, including Climate Action. Taking a whole-of-government approach, the Strategy sets out the Government of Canada's sustainable development goals, targets, milestones, and implementation strategies from an environmental perspective.

Provinces, territories, and municipalities are also leading efforts to report on adaptation progress through their plans and strategies. This includes the development of adaptation indicators and metrics to measure climate resilience within jurisdictions. For example, Saskatchewan's *Climate Resilience Report* shares trends and progress in meeting the province's climate change goals through a series of 25 resilience indicators. Additional information on jurisdictional progress reporting is provided in Section 6.4.

6.7. Conclusion

The years leading up to 2022 saw unparalleled domestic and global events. The COVID-19 pandemic has shown that governments, communities, and individuals are willing to rise to the occasion in times of global crisis. However, climate change will continue to impact communities long after the pandemic subsides. Recent extreme events in Canada have caused billions of dollars in damages, displaced thousands, and disrupted supply chains. Projections also indicate that today's record-breaking events will be tomorrow's new normal.

Impacts are building upon each other and leading to additional effects such as increased demand for emergency assistance, loss of biodiversity, reduced food and economic security, and increased demands on physical and mental health services. Climate change often worsens existing inequalities and vulnerabilities, leaving some people living in Canada more exposed than others.

Governments and communities recognize that adaptation is a key priority area moving forward. Since Canada's *Seventh National Communication*, all sectors of society have made significant progress and strengthened their response to climate change impacts. Actions are moving beyond the planning stage and enabling greater resilience through the provision of national knowledge assessments and climate services to improve decision-making, building the capacity and skills needed to adapt, and supporting community-led projects. However, as noted in Canada's *National Issues Report*, additional efforts are required to effectively prepare for projected impacts.

Adaptation requires sustained and collaborative action. The National Adaptation Strategy will help respond to climate change by advancing a shared vision for climate resilience in Canada based on guiding principles and focused goals and objectives. The Strategy brings together all orders of government, Indigenous Peoples, municipalities, private companies, academia, civil society, youth, and all Canadians in a whole-of-society approach to climate change adaptation. By employing a flexible and adaptive approach, the Strategy will make it possible to better prepare for and adapt to climate impacts.

Canada will continue to build on the commitments, plans, and actions being advanced by all orders of government and Indigenous Peoples, while respecting their unique needs and circumstances. Through strategic partnerships and investments, this approach is advancing shared priorities across jurisdictions and sectors to promote a more equitable, just, and resilient Canada.

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Chapter 7: Financial, Technological and Capacity-Building Support

7.1. Introduction

Canada is in the midst of unprecedented global challenges owing to the dual crises of climate change and biodiversity loss, which together threaten the foundations of the economy, food systems, peace and security, health, and quality of life. Developing countries are particularly exposed to the effects of climate change and biodiversity loss, especially the poorest and most vulnerable countries, such as Least Developed Countries (LDCs) and Small Island Developing States (SIDS).

Under the United Nations Framework Convention on Climate Change (UNFCCC), Canada's international engagement on climate change includes its climate finance commitment to support developing countries in their climate mitigation efforts and to foster resilience among those most at risk from the effects of climate change. Canada is steadfast in its commitment to the objectives of the Paris Agreement, including to jointly mobilize US$100 billion in climate finance per year through to 2025 from a wide variety of sources.

This chapter provides information on Canada's climate finance support provided over 2019 and 2020. Canada is providing and mobilizing climate finance from a variety of sources: delivering on Canada's public climate finance commitment; integrating climate change considerations into Canada's international assistance; providing core contributions to multilateral development banks (MDBs) that are increasing their climate support; using public finance to mobilize climate investments from the private sector in developing countries; and deploying innovative climate resources, such as climate investments through Export Development Canada (EDC) and Development Finance Institute Canada (FinDev Canada).

Canada's public climate finance support over 2019 and 2020 totalled more than $2.12 billion and included:

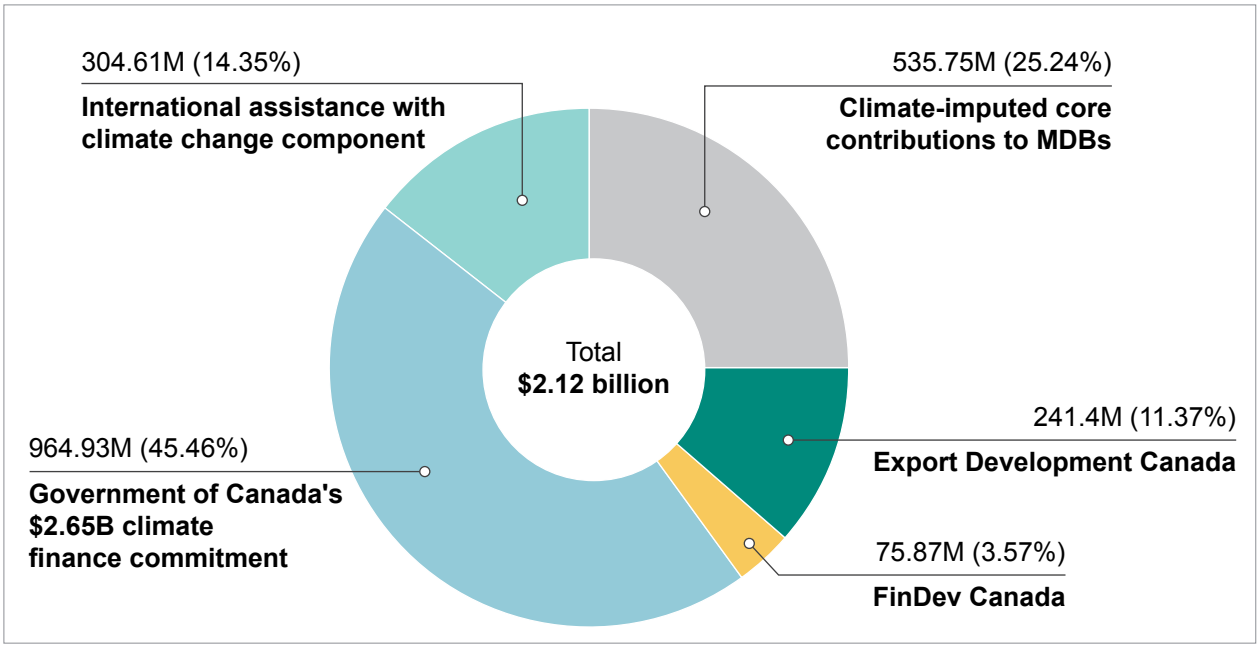
- $964.93 million from Canada's $2.65 billion climate finance commitment (delivered between 2016 and 2021);[1]
- $535.75 million in climate shares from core contributions to MDBs;
- $304.61 million from Canada's international assistance with a climate change component, including $3.34 million in climate change support from other levels of government;
- $241.4 million in climate investments from EDC; and,
- $75.87 million in climate investments from FinDev Canada.

A breakdown of Canada's public climate finance delivery over 2019 and 2020 is shown in Figure 7-1.

In addition, Canada uses public finance to mobilize private sector investments. Over 2019 and 2020, Canada's public investments enabled the mobilization of US$149 million (approximately CAD $200.24 million) in private finance to support climate change efforts in developing countries.

Detailed project-level information is available in Common Tabular Format Tables 7(a) and 7(b).

Figure 7-1: Canada's total public climate finance delivered over 2019 and 2020



Beyond its climate finance contributions, Canada has demonstrated leadership by co-leading with Germany the development of a *Climate Finance Delivery Plan*, in the lead up to COP26, to demonstrate how and when developed countries will meet the collective US$100 billion per year goal. In 2022, Canada and Germany also prepared a *Climate Finance Delivery Plan Progress Report* to demonstrate continued progress towards the goal through collective actions such as increasing finance for adaptation and addressing barriers in accessing climate finance. This will be informed by the work of the Champions Group on Adaptation Finance, which Canada joined in

June 2022, to advance climate adaptation priorities and solutions, including scaling up adaptation finance, mobilizing private sector finance, and enhancing the quality and accessibility of finance, particularly for LDCs and SIDS.

7.1.1. Delivering on Canada's Public Climate Finance

As of March 2021, Canada had fully delivered on its 2015 commitment to provide $2.65 billion in climate finance over five years to help developing countries, in particular the poorest and most vulnerable, transition to low-carbon, climate-resilient economies. Canada's $2.65 billion in climate finance was delivered through a variety of multilateral and bilateral channels. Canada's support targeted sectors such as clean technology and renewable energy, climate-smart agriculture and forest management, risk insurance, and climate governance.

Building on the success of this commitment, Canada is scaling up its support to $5.3 billion over the fiscal year 2021-22 to 2025-26 period.[2] This commitment dedicates a minimum of 40 percent of funding towards adaptation, which represents a more than doubling of adaptation finance compared to the previous commitment. This aligns with the Glasgow Climate Pact, which urges developed countries to at least double their collective provision of climate finance for adaptation from 2019 levels by 2025. This commitment also increases the proportion of grant contributions to 40 percent, from 30 percent previously. Canada will also allocate at least 20 percent of funding to projects that leverage nature-based climate solutions and projects that contribute biodiversity co-benefits. In line with Canada's Feminist International Assistance Policy (FIAP), Canada will ensure that at least 80 percent of projects will integrate gender equality considerations.

Gender Equality and Empowerment of Women and Girls

The poorest, most vulnerable, and marginalized often bear the brunt of climate change and biodiversity loss. Women and girls are particularly vulnerable to the negative impacts of climate change, yet their strong leadership and expertise is also critically valuable in the fight against climate change. That is why gender equality and women's empowerment is an integral part of Canada's climate finance.

In 2017, Canada established the FIAP to integrate gender equality and women's empowerment into its international assistance. In line with the FIAP, Canada's $2.65 billion climate finance commitment integrated gender equality considerations in 85 percent of projects under the programming. Gender equality considerations will continue to be a priority for Canada's $5.3 billion commitment. This will help to identify the barriers women face in accessing climate finance and promote good practices to support women entrepreneurs in climate-related value supply chains, while developing a roadmap for international development stakeholders to provide further gender-responsive support to women in climate adaptation and mitigation.

7.1.1.1. Delivering Canada's $2.65 Billion Climate Finance Pledge

Over 2019 and 2020, Canada delivered $964.93 million from the $2.65 billion climate finance pledge. Of this amount, $604.7 million was delivered through bilateral and multi-bi[3] channels. The remainder was delivered through multilateral channels. It also included support to the organizations and financial mechanisms of the UNFCCC.[4] These organizations play an instrumental role in facilitating the delivery of climate finance and scaling up climate change action globally. For example, as part of Canada's $2.65 billion commitment, in 2019 and 2020, Canada provided:

- **$167.41 million to the Green Climate Fund (GCF):** Since 2015, Canada has pledged $600 million to the GCF. Of this pledge, $167.41 million was provided in 2019 and 2020. The GCF is the world's largest international climate fund dedicated to helping developing countries in their climate action. To date, the GCF has committed US$10.4 billion for 200 projects around the world. These investments are expected to avoid 2 billion tonnes of greenhouse gas (GHG) emissions and help over 600 million people increase resilience to climate change. For example, the GCF is implementing a project with the goal of improving the climate resilience of vulnerable small-scale farmers in El Salvador by investing in innovative agroecosystem models and practices for resilient landscape management, sustainable production, and to improve environmental governance. With GCF grant funding of US$35.8 million and a total project value US$127.7 million, the funding crowds-in both public financing and funding from other sources. The project is expected to directly benefit 225,000 people on 50,000 family farms, with at least 52 percent expected to be women, and indirectly benefit 1 million people through improved flows of environmental services. The project is also expected to sequester 4.3 million tonnes of GHGs, the equivalent of 4.2 billion pounds of coal being burned.
- **$36.9 million to the Global Environment Facility (GEF):** In total, Canada contributed $216.57 million to the GEF 7th replenishment (GEF-7) (2018–2022). For this contribution, over 2019 and 2020, Canada provided $115.71 million in climate finance to the GEF-7, of which $36.9 million was from the $2.65 billion climate finance commitment. By supporting the GEF, Canada helps developing countries implement their multilateral environmental agreements and environmental priorities in areas such as climate change, biodiversity, chemicals and waste, land degradation, international waters, and sustainable forest management. For example, in 2020, the GEF approved the Conservation Areas for Biodiversity Conservation and Development II in Mozambique, with US$23.12 million in GEF financing and US$113 million in additional co-financing. The project aims to support the conservation of Mozambique's wildlife, biodiversity, and ecosystems and contribute to the livelihood of local communities. The project will bring 387,300 hectares of terrestrial protection areas under improved management; restore 6,700 hectares of degraded agricultural lands and forests lands; mitigate 10.85 million tonnes of GHG emissions, and benefit 35,000 people.

Canada's $2.65 billion commitment also included bilateral support for the implementation of developing countries' Nationally Determined Contributions (NDCs) and National Adaptation Plans (NAPs). For example:

- In 2019, Canada provided $173,693 of its $2.12 million commitment to Côte d'Ivoire and Senegal to support the implementation of their NDCs by helping to strengthen policy frameworks to reduce short-lived climate pollutants in the solid waste sector; enhancing technical and operational capacities for monitoring, reporting and verification (MRV) in the sector; and implementing biogas and compost pilots. Canada's support to Côte d'Ivoire resulted in installing a biodigester plant to convert organic waste into green energy—which is estimated to avoid 369 tonnes of GHG emissions per year—and organic fertilizer to reduce the use of chemical fertilizers and enrich poor soils. Canada supported Senegal in installing 2,000 organic waste bins at standardized collection points, along with a composting centre, to generate a supply chain of high quality compost feedstock.

- In 2020, Canada provided $1 million of its $4 million commitment to the NAP Global Network to advance national climate adaptation processes in developing countries through technical assistance, peer learning and knowledge development. In 2020-21, Ghana, Côte d'Ivoire, the Republic of the Marshall Islands, Somalia and Kenya were able to improve the effectiveness and gender-responsiveness of their processes. As a result, 2.25 million people in these countries, approximately half of whom are women, benefitted from adaptation initiatives.

7.1.1.2. Integrating Climate Considerations into Development Assistance

Canada's climate-related development assistance is consistent with the 2030 Agenda for Sustainable Development, in particular the Sustainable Development Goal (SDG) 13—taking urgent action to combat climate change and its impacts. Beyond its public climate finance commitment, Canada seeks to address climate change through its international development funding to developing countries. Over 2019 and 2020, $304.61 million of Canada's international assistance was delivered with a climate change component.[5] All of this programming is guided by Canada's FIAP. Environment and Climate Action is one of the six priorities under the FIAP and guides Canada's climate finance support. FIAP also guides the mainstreaming of environment, climate change and biodiversity loss considerations in all sectors of Canadian international assistance programming to ensure environmental degradation does not erode development gains.

For example, Canada contributed a total $12.49 million to the Canada–Honduras Value-Added Agroforestry initiative to support the social and economic development of associative enterprises and the expansion of markets for agroforestry products. Of this contribution, Canada provided $1.56 million in 2019 and 2020. The project is expected to sustainably improve living conditions of 9,000 direct beneficiaries and 54,000 indirect beneficiaries. This includes increasing sustainable processing and providing training in good environmental practices and sustainable management for agroforestry.

Support from Sub-National Governments

Canada's sub-national governments are playing an important role in responding to climate change and scaling up climate finance. Out of Canada's total international assistance over 2019 and 2020, Canada's sub-national governments provided a total of $3.34 million in climate finance. Most notably, in 2019, the Government of Québec contributed $3 million to the Adaptation Fund, in support of the Paris Agreement goals. Following this, at COP26 in 2021, the Government of Québec announced a second contribution of nearly $10 million to the Adaptation Fund. This contribution is part of a set of international climate cooperation measures implemented since 2016 by the Government of Québec.

7.1.1.3. Core Contribution to Multilateral Development Banks

Multilateral development banks (MDBs) play a critical role in the global climate finance landscape, particularly in reaching the US$100 billion goal and the transition towards low-carbon, climate-resilient and sustainable development. They are not only an important channel for public finance, but also a key mechanism to mobilize private finance. It is also essential that MDBs align their investments in a way that is consistent with the Paris Agreement. Canada continues to encourage MDBs to scale up climate finance and private finance mobilization, and works with them to ensure

transformational change. Over 2019 and 2020, Canada provided an estimated $535.75 million in climate-related imputed core contributions to MDBs that are increasing support towards climate change.[6] This funding is not part of Canada's climate finance commitment, but comes from core support to institutions. The imputed multilateral contributions are based on each institution's estimated climate-related share within its portfolio.

7.1.1.4. Action by Export Development Canada and FinDev Canada

Canada's efforts to scale up climate finance includes climate-related investments in developing countries by Canada's export credit agency, EDC,[7] and development finance institution, FinDev Canada. Over 2019 and 2020, EDC provided $241.4 million and FinDev Canada provided $75.87 million in climate finance.[8]

Export credit agencies can advance global efforts to address climate change by spurring investments in climate activities around the world. To this end, EDC supports the Government of Canada's efforts by supporting investments in the global transition to a low-carbon economy in line with the objectives of the Paris Agreement. Climate-relevant investments by EDC actively support clean technology deployment abroad and provide distinctive financing in areas such as water treatment, energy efficiency, the waste-to-energy sector, renewable energy generation, and smart-grid infrastructure. EDC's climate finance support consists of various financing solutions, including larger scale corporate lending, structured and project finance solutions, and smaller scale buyer financing. EDC is striving to improve its tracking and reporting methodology as it continues to improve its understanding of the impact of indirect financial solutions (e.g., guarantees and insurance) on climate and how these may be more accurately counted as climate finance going forward.

Green bonds are another growing financing vehicle used to drive private climate finance. EDC has been issuing green bonds since 2014 and was the first Canadian financial organization to do so. Funds raised by those green bonds have financed nearly 30 transactions worth more than $2 billion in a range of sectors, each contributing to environmental protection or climate change mitigation. As appropriate, EDC will include qualifying climate finance eligible investments in its green bond issuances. Furthermore, in 2022, EDC released a new, third-party reviewed Sustainable Bond Framework to enable greater support for initiatives that create a more equitable and sustainable world.

Development finance institutions play a key role in reaching the US$100 billion goal as they are direct channels for development finance to mobilize private investments. FinDev Canada has the mandate to provide financial services to the private sector in developing countries with the aim of combatting poverty through economic growth. Climate change mitigation and adaptation is one of FinDev Canada's three development impact goals and plays a key role in the realization of its mandate.

At COP26, FinDev Canada committed to increase its climate finance allocation to 35 percent of its total investments by 2025, from 24 percent at the end of 2021. FinDev Canada has built a portfolio with net-negative GHG emissions for both annual GHG emissions from its 2021 portfolio and cumulative GHG emissions since its inception in 2018. The three main factors contributing to this are: an investment strategy focused on low-carbon sectors, no carbon-intensive investments, and investments in the Forestry Sector, which contribute to carbon removal from the atmosphere.

Launched in 2021, FinDev Canada's *Climate Change Strategy* articulates how FinDev's climate change policy is implemented across its activities. An important pillar of this strategy is the nexus between gender and climate action. FinDev Canada applies a gender lens to the entirety of its climate finance portfolio, conducting gender assessments and collaborating closely with its clients

to identify opportunities to enhance gender inclusion and diversity practices. As an example, FinDev Canada is supporting Miro Forestry & Timber Products in enhancing its gender action plan, to enable the company to meet its ambitious target associated with providing quality jobs for women in Ghana and Sierra Leone. The company has a significant climate mitigation impact as it has reforested more land in Africa than any other organization over the past five years, with over 20 million trees planted over 20,000 hectares of degraded land.

7.1.1.5. Sectoral Distribution of Public Support

Canada's climate finance supports a wide range of sectors, such as renewable energy, climate-smart agriculture, forestry, disaster risk reduction, biodiversity, and more. Of Canada's public climate finance delivered through bilateral and regional channels in 2019 and 2020, 21 percent targeted adaptation, 46 percent targeted mitigation, and 33 percent targeted crosscutting activities. Crosscutting activities address mitigation and adaptation simultaneously. Canada's climate finance support through multilateral channels in 2019 and 2020 was mainly delivered as crosscutting support through core contributions to multilateral organizations with a wide variety of activities. All climate-related investments from FinDev and EDC supported climate mitigation activities in developing countries.

Adaptation

Canada recognizes that support for climate change adaptation is critical for developing countries, in particular the poorest and most vulnerable, as they face climate shocks and other changes with profound impacts on agriculture, infrastructure and well-being. That is why Canada is committed to enhancing the adaptive capacity of vulnerable communities and countries in responding to the impacts of climate change. Canada's support for adaptation under the $2.65 billion commitment included contributions to: the Least Developed Countries Fund (LDCF), which provides support to LDCs for the preparation and implementation of National Adaptation Programs of Action (NAPAs) and National Adaptation Plans (NAPs); the Climate Risk Early Warning System (CREWS), which intends to protect lives and property through capacity-building activities and strengthening early warning services in LDCs and SIDS; and the International Fund for Agriculture Development (IFAD), which supports gender-transformative climate-smart agriculture by addressing interlinked challenges of food security and climate change.

Canada's adaptation finance also includes bilateral support to climate-vulnerable countries, for example the $3.86 million contribution to the Climate Adaptation and Economic Development of Agricultural Sectors in Haiti. Of this contribution, Canada provided $3.04 million to the project in 2019 and 2020. The project seeks to improve the economic well-being and reduce the vulnerability of approximately 4,200 rural households with a focus on women and youth empowerment. Through a strategy to promote good agricultural practices, the project is working to promote climate change adaptation and resilience in the targeted agri-food value chains. As of 2021, 15 farmer field schools (FFS) with 366 producers (55 percent women, 45 percent youth) were established and taught the establishment of more productive and climate-resilient agroforestry plots, production of quality plant materials, and production techniques to improve fertility and yield. Moreover, a total of 428.37 hectares of cocoa agroforestry plots were regenerated to the benefit of 716 producers.

Clean Energy

International collaboration is critical in order to ensure that the world's future energy needs are met on a sustainable basis and in line with the Paris Agreement. Recognizing the need to support the energy transition ambition of developing countries, clean energy transition and coal phase-out is one of the key priorities of Canada's climate finance. Canada is working with developing countries to boost investment and cooperation in clean technology innovation to promote affordable, reliable and sustainable energy access for all. Canada's $2.65 billion commitment included significant support to clean energy in developing countries, for example:

- $275 million ($156 million of which was provided in 2020) to the World Bank to establish the Energy Transition Program to assist developing countries to phase out their dependence on traditional coal-fired electricity while supporting energy efficiency and renewable energy as alternatives;
- $154 million ($1 million of which was provided in 2019) to the Africa Renewable Energy Initiative to improve access to affordable and sustainable energy services in Sub-Saharan Africa; and,
- $60 million ($40 million of which was provided in 2020) to the Renewable Energy in SIDS Program to increase their renewable energy capacity and improve energy efficiency, while pursuing gender equality across the energy value chain.

Canada also provided bilateral support to promote reliable, low-carbon energy systems and sustainable economic development in developing countries. For example, Canada's $2.65 billion commitment included $10.49 million for the Sustainable Economic Growth and Energy in the Boucle du Mouhoun Region project in Burkina Faso. In this region, only 7 percent of the population has access to electricity. Of this contribution, Canada provided $6.6 million to the project in 2019 and 2020. The project installed solar systems in 30 health and social promotion centres, constructed the extension of the electricity grid for 16 communities reaching an estimated 40,000 people, and provided solar equipment to over 88 rural agricultural enterprises (54 of which are managed by women) and 20 cooperatives reaching 986 members (948 of which are women).

Cross-Cutting

Cross-cutting climate change activities can integrate both mitigation and adaptation components and other co-benefits, such as biodiversity and gender equality, towards a sustainable pathway to development. Cross-cutting contributions include the Green Climate Fund (GCF), which aims to allocate funding 50/50 for adaptation and mitigation, as well as core contribution to MDBs where contributions are not earmarked for any particular type of support.

Canada also provided bilateral support to cross-cutting projects through its $2.65 billion commitment. For example, Canada contributed $2 million to the Building Community Resilience to Climate Change Project in Senegal. Of this contribution, $211,790 was provided in 2020. This project is improving rural communities' resilience to climate change, especially for women, and supporting food security by increasing climate-smart agriculture in the Kedougou region. Activities include training on improved planting techniques, providing seeds and agricultural inputs, training on forest product harvesting and bushfire prevention, and promoting agroforestry and the use of indigenous tree species to enhance forest carbon sinks.

7.1.1.6. Geographical Distribution of Public Support

Canada's climate finance support over 2019 and 2020 covered a wide geographical area, with 63 countries bilaterally benefitting from Canada's climate finance. Canada also provided regional support to Asia and the Pacific, Latin America and the Caribbean, and Africa, through, for example, the Canada–African Development Bank Climate Fund. Various other countries are benefitting from Canada's support through multilateral funds, such as the Green Climate Fund and Global Environment Facility.

Figure 7-2 Global map of countries directly receiving climate finance from Canada in 2019 and 2020

7.1.2. Scaling Up Climate Finance

Public finance alone is not sufficient to meet the level of investments needed to achieve the objectives of the Paris Agreement. Delivering on the US$100 billion climate finance goal requires tapping into a wide variety of sources of finance and all financial instruments, including private finance. As such, the private sector plays an essential role in addressing climate change and there is significant potential for investment in climate solutions by the private sector. That is why a key priority of Canada's climate finance support is to mobilize private finance through public investments.

Addressing climate change requires shifting capital flows on a massive scale and at unprecedented speed. In this context, it is essential to use public resources strategically to mobilize additional climate finance from all sources, notably the private sector. In this regard, choosing the right financial instrument is key to engaging the private sector and ensuring transformational impacts and efficient use of public finance to deliver on climate finance. Over 2019 and 2020, Canada mobilized an estimated US$149.43 million in private finance through US$178.61 million in public finance for climate-related activities.[9]

Canada is a leader in innovative approaches to mobilize private climate finance, by blending its concessional finance, which is provided on more generous terms (i.e., longer grace periods and lower-than-market interest rates), with commercial resources to more effectively catalyze investments by absorbing risks and removing barriers to private investment in developing countries.

Canada uses grant financing where cost-effective market-based financing is not viable, such as for most adaptation projects in the poorest and most vulnerable countries. Blended finance can play a critical role in mobilizing private investments that otherwise would not occur by de-risking investments, as well as helping to create new markets by addressing market failures. These instruments can be adapted to local contexts and are consistent with the ambition of the Paris Agreement, which affirms the role of mobilizing private finance in achieving NDCs.

7.1.2.1. Partnering with Multilateral Development Banks and Other Development Partners

As part of its effort to mobilize private finance, Canada has pioneered an approach with MDBs by establishing Canadian facilities at these institutions designed to catalyze private sector investments. Through these funds, Canada is using targeted concessional finance to demonstrate the commercial viability of projects and unlock future private investments in similar initiatives. To date, Canada's facilities established under the $2.65 billion commitment have invested US$300.07 million in projects.[10] The funds that are part of the $2.65 billion commitment include:

- $223.5 million to the second phase of Canadian Climate Fund for the Private Sector in the Americas (C2FII), managed by the Inter-American Development Bank, which aims to catalyze private sector investments in climate change mitigation and adaptation across Latin America and the Caribbean region, while promoting gender-responsive, sustainable economic development for projects that need concessional financing to be viable. In 2019 and 2020, Canada provided $161.5 million of the contribution to the Fund. The second phase (C2FII) of the Fund is expected to leverage up to US$1 billion in public and private finance mobilized and reduce up to 15 million tonnes of GHG emissions, over their 25-year tenure.
- $200 million to the second phase of the Canadian Climate Fund for the Private Sector in Asia (CFPS II), managed by the Asian Development Bank, which aims to catalyze greater private sector investment in climate change mitigation and adaptation projects in low- and lower-middle income Asian and Pacific countries and upper middle income SIDS in the region. In 2019 and 2020, Canada provided $51.5 million of the contribution to the Fund. Over the life of the Fund, Canada's contribution is expected to leverage up to two times its amount in private sector investment, help reduce or avoid GHG emissions of up to 20 million tonnes, and support up to 100,000 beneficiaries to adapt to the effects of climate change.

Annex 3 provides the full list of Canadian facilities at MDBs.

Through these established Canadian facilities at MDBs, Canada also encourages co-benefits in projects supported through Canada's investments. For example, the C2FII uses performance-based incentives to encourage its private sector clients to integrate gender equality considerations into their operations. Companies that meet co-defined and agreed-upon gender targets can apply for a discount rate on their loans.

Canada estimates that repayable contributions of approximately $1.4 million in 2019 and $6.3 million in 2020 have been returned to Canada from Canadian climate facilities at MDBs. Tracking these repayable contributions can help to determine the successful performance of these projects and demonstrates how using public funding can catalyze investments in climate change action in developing economies.

7.1.3. Effectively Addressing the Needs and Priorities of Developing Countries

Canada's climate finance supports developing countries in making the transition to sustainable, low-carbon economies by strengthening their capacity in alignment with their own, country-driven priorities. Projects supported by Canada respond to the adaptation and mitigation needs of the people and communities who are most vulnerable to climate change, particularly those living in LDCs, SIDS and coastal communities. Canada's climate finance is delivered through a range of financial instruments and channels to address the complex set of needs and priorities of developing countries across sectors and regions, to ensure transformational and efficient delivery of climate finance, and to maximize access to finance.

7.1.3.1. Support for Nationally Determined Contributions

Canada's mitigation support is consistent with the needs identified in developing partners' NDCs. This support focuses on developing countries' transition to clean energy by phasing out coal-powered emissions and promoting equitable access to reliable and cost-effective clean energy solutions and energy efficient technologies. In addition, Canada's mitigation finance also supports sustainable forest and agricultural management, to reduce GHG emissions from these sectors. Canada also supports capacity-building to help developing countries in the implementation of their NDCs.

For example, through bilateral support under the $2.65 billion commitment, Canada contributed $5.1 million (providing $2.5 million in 2019 and 2020) to the Pacific Alliance (Chile, Colombia, Mexico and Peru) and 15 countries in West Africa to strengthen their Measurement, Reporting and Verification (MRV) systems for GHG emissions, mitigation actions and climate finance investments. The initiative also supported experience-sharing within and between the two regions to explore opportunities for the replication of best practices. Canada supported over 30 MRV baseline reports, 90 stakeholder dialogues, 12 sessions of South-South trainings, and 1,500 hours of technical capacity-building courses on GHG accounting to improve domestic MRV relevance and effectiveness, while fostering inclusive engagement and network growth.

7.1.3.2. Support for National Adaptation Plans

Canada also recognizes that adaptation is a priority for many developing countries and efforts need to be scaled up to respond to the increasingly adverse effects of climate change. That is why Canada is bolstering its adaptation support, including by increasing the proportion of adaptation finance in its $5.3 billion climate finance (2021–2026) commitment to a minimum of 40 percent. This commitment builds on the success of the $2.65 billion commitment, which supported some of the poorest and most vulnerable countries with their adaptation needs.

In 2020, Canada's bilateral support for adaptation finance included $20 million to establish the Canada-Caribbean Community (CARICOM) Climate Adaptation Fund to provide support adapted to the needs and capacities of CARICOM countries by enhancing post-disaster response through the Caribbean Catastrophe Risk Insurance Facility (CCRIF). To date, the Fund has covered disaster insurance premiums for seven eligible countries—Antigua and Barbuda, Belize, Dominica, Grenada, Jamaica, St. Lucia, St. Vincent and the Grenadines—and supported ongoing engagement with Guyana and Suriname to facilitate their future membership to the CCRIF.

7.1.3.3. Access to Climate Finance

Canada recognizes that barriers and challenges in accessing climate finance persist for developing countries. Canada is proud to have partnered with the Rocky Mountain Institute to launch the Climate Finance Access Network (CFAN). The CFAN is a country-driven global network of highly trained climate finance advisors that help developing countries build their capacity to structure and secure public and private finance for their priority climate investments. As part of the $2.65 billion commitment, Canada provided $9.5 million to support the launch of CFAN, and specifically its deployment in Pacific SIDS. Since then, CFAN has confirmed the first cohort of advisors for eight Pacific countries and is planning to expand its scope to additional Pacific SIDS, Africa and the Caribbean. While CFAN is a good step forward in identifying and addressing the barriers to accessing climate finance, Canada recognizes the need to develop a holistic and multifaceted approach that takes into account various dimensions of the issue of access to climate finance.

7.1.4. National Approach to Tracking

Canada tracks and reports its climate finance contribution from the various sources to ensure a comprehensive and accurate representation of Canada's climate finance flows.

Canada strives for transparent reporting through project-level tracking and reporting of climate finance provision. Additional information on results is tracked through a set of indicators to allow for evaluating the effectiveness and impacts of Canada's climate finance. These include: expected and achieved outcomes, expected and actual GHG emissions reduced or avoided, expected and actual number of people benefitting from adaptation projects, and private finance mobilized through public investments.

Canada tracks both expected and achieved results at the project-level to assess the success of a project based on achievement of planned outcomes and impacts, as well as assessing what type of activities are the most effective in the ultimate impact of transition to low-carbon, climate-resilient economies. Canada works with trusted partners that have clear accountability frameworks and can measure and evaluate project results.

Canada's tracking and reporting of its climate finance adheres to international standards and requirements for official development assistance and the UNFCCC. Canada uses the Organisation for Economic Co-operation and Development—Development Assistance Committee (OECD-DAC) Rio Markers for Climate to identify and report climate finance projects as "principal" (i.e., entirely dedicated to climate) or "significant" (i.e., funded for other objectives but designed to meet climate concerns). For projects with the "significant" climate change marker, Canada counts 30 percent of the funding to the project as climate finance.

Additionally, Canada tracks and reports the climate-share of its core contribution to multilateral institutions by applying climate-related imputed shares of multilateral institutions, where available, based on the data from the OECD. Canada also reports on climate-relevant investments by EDC and FinDev by using the IFC-Definitions and Metrics for Climate-Related Activities to identify eligible transactions and projects.

Canada is committed to continuously improving its climate finance tracking and reporting, recognizing the importance of promoting good reporting practices, strengthening accountability and effectively informing global climate action. As such, since the *Fourth Biennial Report*, Canada has made some adjustments to its methodology for reporting contributions through multilateral contributions. Multilateral contributions are reported as "climate-specific" where imputed share of the organization is available or if the contribution has a "principal" climate change marker based on the OECD-DAC Rio Markers for Climate. Contributions are reported as "core/general" if the imputed share of the organization is not available but its portfolio includes some amount of climate finance and climate related activities. Where possible, and in consultation with multilateral organizations, Canada seeks to self-determine the climate share of multilateral institutions that are increasing their climate change support but are not yet reporting to the OECD-DAC. The changes in accounting approach improve the transparency of Canada's reporting by clearly identifying climate-specific support and core contributions to multilateral institutions with climate-related project portfolios.

Additional information on Canada's climate finance support is available on Canada's climate finance website, where users can access information on recipient countries or regions, priority sectors, types of support, financial mechanisms, years of contribution, project descriptions, and results.

7.1.4.1. Private Finance Mobilization

The OECD-DAC Working Party on Development Finance Statistics has developed a robust methodology for measuring mobilized private climate finance through official development finance interventions, including for climate. This international standard attributes private finance mobilized to official actors based on the financing mechanism, level of risk, role and amount invested. Mobilized private finance is now included as part of the OECD-DAC's regular data collection. In accounting for mobilized private climate finance, Canada assesses the amount of private finance mobilized on an activity-level basis and applies the OECD principals and attribution methodologies. Amounts mobilized are reviewed by the OECD-DAC at the project-level to ensure consistency and to ensure there is no double counting.

Canada continues to engage with the OECD-DAC and its members to enhance the methodologies and processes for reporting on private sector mobilization.

7.2. Technology and Capacity-Building Support

Canada recognizes the critical role that clean, affordable and accessible technologies continue to play in global efforts to mitigate and adapt to climate change. Developing countries pursuing an economic transition alongside a climate agenda need support to not only access the right technologies, but also to develop the domestic capacity needed to support development that is sustainable, low-carbon, climate-resilient, nature-positive and inclusive.

Canada actively engages with international partners, bilaterally and multilaterally, sharing Canadian technologies, expertise, and providing financial and technical support to facilitate the adoption and use of climate technologies. This chapter provides key examples[11] of technology transfer and capacity-building support provided by Canada for both mitigation and adaption actions across a variety of sectors during the 2019 and 2020 reporting period.[12]

7.2.1. Technology Development and Transfer

7.2.1.1. Forests and Land Use

Canada has provided knowledge, mentoring and guidance on forest GHG emissions mitigation and forest management adaptation through the provision of the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) and Generic Carbon Budget Model (GCBM) to Belize (2019-present), Chile (2019–2020), Colombia (2019), Ecuador (2019), Honduras (2019), India (2019–2020), Korea (2013–present), Mexico (2003–present), Mongolia, (2019), Nicaragua (2019), Peru, (2019), and Uruguay (2019). The CBM-CFS3 and GCBM are frameworks that support the analysis of past and projected GHG emissions and removals in the forest sector. The spatially-explicit GCBM is based on the same science as the CBM-CFS3, but functions on moja global's open source, Full Land Integration Tool (FLINT) software platform.

Moja global is a collaborative project under the Linux Foundation (initiated by the Australian Government and supported by the Canadian Forest Service at Natural Resources Canada) that supports climate action by bringing together a community of experts to develop open-source software—including the FLINT software—which allows users to accurately and affordably estimate GHG emissions and removals from forestry, agriculture and other land uses (AFOLU).

Moja global promotes domestic and international collaboration on open source tools to estimate emissions and removals from forests and harvested wood products and developing uncertainty estimates in support of policy. Through the collaboration with moja global, the Canadian Forest Service has advanced and implemented the Generic Carbon Budget Model on the FLINT platform to support developing countries in the establishment of advanced measurement, reporting and verification (MRV) systems to quantify forest sector carbon balances.

The Global Fire Early Warning System was developed and operated by Canada and is a project of the Global Observation of Forest Cover and Landcover Dynamics Fire Implementation Team. This system supported coarse-resolution Fire Danger Rating forecasting for the entire globe based on Canadian Global Deterministic Prediction System (GDPS) input and the Canadian Forest Fire Weather Index System as output. This was the first tool to be developed specifically for the purpose of providing short- and long-term planning for fire management personnel in locations that do not have access to fire danger forecasting.

Since the last reporting period, Canada continues to collaborate internationally on science and technology exchanges and capacity-building workshops to further develop and apply the Canadian Forest Fire Weather Index System as the foundation for strengthening wildland fire management capacity in other countries. This includes assistance to support the development of Early Warning and Fire Danger Rating Systems in Costa Rica and Argentina.

7.2.1.2. Energy Management

Canada has continued to grow capacity in energy management by disseminating the RETScreen Clean Energy Management Software platform developed by Natural Resources Canada's CanmetENERGY lab in Varennes, Québec. RETScreen empowers professionals and decision-makers to rapidly identify, assess and optimize the technical and financial viability of potential clean energy projects. This decision intelligence software platform also allows managers to easily measure and verify the actual performance of their facilities and helps find additional energy savings/production opportunities.

RETScreen has helped developing countries significantly reduce costs associated with clean energy projects, as well as with ongoing energy performance analysis. RETScreen continues to be provided to more than 750,000 users free-of-charge and in 37 languages, and includes comprehensive capacity-building through integrated training materials including video training. During the reporting period of 2019 and 2020, Canada led various capacity-building activities around RETScreen in developing countries, including training materials, workshops, and technical support. This support is also relevant under the Capacity-Building section of this chapter.

7.3. Capacity-Building

7.3.1. Forests and Land Use

The International Model Forest Network (IMFN) is a voluntary global community of practice whose members and supporters work toward the sustainable management of forest-based landscapes and natural resources through the Model Forest approach. The IMFN's vision is to support, through Model Forests, the management of the world's forest resources in a sustainable manner, reflecting environmental and socio-economic issues from the perspective of local needs and global concerns.

The primary goal of the IMFN is to establish a global network of Model Forests that represents the majority of the major forest ecosystems of the world. It also strives to ensure that all partners, regardless of political or economic status, can contribute to, and share in, the benefits of the Network as they work toward the sustainable management of forest-based landscapes. The IMFN has been in operation for 30 years—established in 1992 and ongoing—with more than 60 Model Forests in over 30 countries and with several international capacity-building initiatives.

From 2019 to 2020, Canada trained over 80 participants from developing and developed countries through Carbon Budget Model training workshops. Three in-person Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) training workshops and one Generic Carbon Budget Model (GCBM) training workshop were open to the global forestry community. The CBM-CFS3 and GCBM support scientists working on projects in many countries, including Belize, Canada, Chile, China, India, and South Korea.

7.3.2. International Energy Agency

Canada supports the International Energy Agency (IEA)'s Clean Energy Transitions Programme (CETP) as a concrete way forward on the IEA's transition to a clean energy hub and to deeper engagement with associate member countries. With an emphasis on support for the energy transition in major emerging economies, the CETP's work focuses on providing collaborative analytical work, technical cooperation, training and capacity-building, and strategic dialogues.

Canada supported the CETP through a number of grants totalling $575,000 to support new IEA research as well as existing publications during 2019 and 2020:[13]

- Fuel Switching and the Role of Natural Gas in Clean Energy Transitions
- Buildings in the Clean Energy Transition: Lessons from the Canadian Provinces
- Putting CO_2 to Use
- IEA Innovation and RD&D Investment Tracking
- IEA's Tracking Clean Energy Progress reports
- IEA Innovation Web Portal through Mission Innovation and the Clean Energy Ministerial

For the reporting period, Canada also continued its support and collaboration under the IEA's Technology Collaboration Programmes (TCPs), participating in a wide range of TCPs addressing issues including advanced fuel cells, electric smart grids, and hydrogen. The TCPs support the work of independent, international groups of experts from IEA member countries, as well as many from IEA Association countries such as China, India and Brazil.

7.3.3. International Renewable Energy Agency

In January 2019, Canada officially became a member of the International Renewable Energy Agency (IRENA), which promotes the widespread adoption and sustainable use of all forms of renewable energy in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity. For the reporting period, Canada supported IRENA through membership contributions of $1.8 million.

By 2020, Canada was participating in five new Collaborative Frameworks, on green hydrogen, hydropower, countries with high shares of renewable energy, geopolitics of the energy transformation, and offshore renewables. Another key direction of Canada's engagement with IRENA has been to bring forward Canadian initiatives that will enable Canada to share its expertise with the world. A key achievement in this area was reaching an agreement to launch a new global, multi-stakeholder platform on Transitioning Remote Communities to Renewable Energy, which represents the culmination of the collaborative work done with IRENA on this topic over the course of 2020.

7.3.4. Short-Lived Climate Pollutants

Canada is funding the project *"Canada-Pacific Alliance collaboration to support Nationally Determined Contribution (NDC) commitments for Short-Lived Climate Pollutant reductions from oil and gas production"* which is in operation from 2017 to 2023. In 2019, Canada provided and demonstrated comprehensive measurement of baseline black carbon emissions from flaring associated with heavy oil production, and collaborated with Colombian oil and gas producers, energy and environmental researchers, federally-funded Canadian small and medium-sized enterprises, and government policy developers to strengthen their emissions measurement, reporting and verification capacities. This work is in support of Pacific Alliance objectives for member country NDC implementation and to develop regional exchange of internationally transferred mitigation outcomes (ITMOs) under Article 6.2 of the Paris Agreement. Funding in 2019 amounted to $3.4 million.

One of the key success factors of this initiative is the strong focus on developing technical and policy capacity in an integrated manner, to support development of economically, environmentally and socially sustainable options for NDC implementation in a coordinated manner among industry and government stakeholders.

7.3.5. Climate Technology Centre and Network

Under the UNFCCC, Canada has actively engaged with the Climate Technology Centre and Network (CTCN) since its inception in 2013. The CTCN is a body under the UNFCCC mandated to provide technical assistance for technology development and transfer and capacity-building support for developing countries. The CTCN's assistance is demand-driven, and works with each country's focal point for climate technology to develop tailored solutions that match local needs based on

the country's NDC. The CTCN delivers support in a number of ways, including assessments of technology needs and barriers; capacity-building on policy and regulations; and development and training on tools, methodologies, and implementation plans. In 2019 and 2020, Canada supported the CTCN by serving as Chair of the CTCN Advisory Board, which provides guidance on operations, and approves the CTCN's annual budget, annual reports to the UNFCCC COP, and operating plans.

7.3.6. Energy Efficiency

As a member of the IEA, Canada works to advance the global energy efficiency agenda. Through membership in the IEA's Energy Efficiency Working Party, Canada helps determine the IEA's energy efficiency analytical priorities. For example, Canada shares input on the themes and priorities of the IEA's annual Energy Efficiency Market Report, and provides comments on drafts of the Report. Canada is also a founding member and Vice Chair of the IEA-affiliated Energy Efficiency Hub (EE Hub), which is the primary mechanism for international collaborative action on energy efficiency. The membership of the EE Hub is broader than the IEA,[14] allowing Canada greater opportunities to engage on policy best practices with emerging economies within the EE Hub's membership. In 2020, Canada contributed $120,500 in membership fees. In addition, Canada joined the IEA's User-Centered Energy Technology Collaboration Platform (Users TCP) in January 2020 as an Executive Committee member. The Users TCP is a platform for collaboration on socio-technical energy issues for a clean, efficient, and secure energy transition grounded in an understanding of the role of users in energy systems. Canada participates in the Users TCP Behavioural Insights (BI) Platform Task Group, which studies the interactions of human behaviour with energy policies.

7.3.7. Clean Energy Ministerial and Mission Innovation

In 2019, Canada hosted the Tenth Clean Energy Ministerial (CEM10) and Fourth Mission Innovation (MI-4) in Vancouver. At CEM10/MI-4, Canada outlined principles to achieve a cleaner energy future, while promoting sustainability, resilience and energy security, and the need to be inclusive and harness the leadership of women, Indigenous peoples and youth in developing the most innovative solutions.

The CEM was created in 2010 as a global forum of 26 major economies, including major emerging economies, and the European Commission who work together to share best practices and promote policies and programs that encourage and facilitate the transition to a global clean energy economy. Canada is also one of the major funders of the CEM, contributing CAD $1 million over three years ($333,333 annually from 2018 to 2021) to support the Secretariat function. Canada is actively involved in 19 out of 21 of the CEM's work streams, of which Canada co-leads 10. This includes co-leading the CEM's efforts on electric vehicles, hydrogen, nuclear energy, bioenergy, and just and inclusive energy transitions. At CEM10, Canada signed a clean energy memorandum of understanding (MOU) with Chile, driving collaboration on: accelerating clean energy innovation and technology deployment; trade and investment; renewable energy integration; energy efficiency; and engaging women, Indigenous peoples, workers, and communities in energy resource development. In 2019, Canada also led the launch of new CEM Hydrogen Initiative (H2I), which welcomed participating countries including Brazil, Chile, China, India, and South Africa. Since launching, the CEM H2I has actively engaged members in activities to advance policies, programmes and projects that accelerate the commercialization and deployment of hydrogen fuels and technologies across all aspects of the economy.

Mission Innovation (MI) has become a catalyst for strengthened global cooperation on clean energy innovation to lead to widely affordable and reliable clean energy solutions that will revolutionize energy systems throughout the world over the next two decades and beyond. In the first phase of MI (2015 to 2020), Canada regularly collaborated with Brazil and India, as joint co-leads of Innovation Challenge 4 on Sustainable Biofuels, and with Mexico, as joint co-leads of Innovation Challenge 6 on Clean Energy Materials. Through the Innovation Challenge model, Canada strengthened connections between clean energy researchers and policymakers around the world and contributed to knowledge exchange on best practices and lessons learned. As a founding member of MI, Canada showed leadership in supporting the first phase of MI, announcing that it exceeded its target to double spending in clean energy research, development and demonstration.

References

1 This funding includes bilateral and multilateral contributions. The other sources of public climate finance are not part of Canada's public climate finance commitment.

2 Canada plans its climate finance commitment by fiscal year (i.e., from April to March).

3 Multi-bi funds are intended for a specific program and/or countries, but channeled via multilateral institutions (e.g., World Bank).

4 Canada also contributed $1.24 million as institutional support to the UNFCCC. Canada's support to the UNFCCC budget is not counted as part of Canada's climate finance pledge.

5 The 'Canadian Contribution' reported here represents the portion of the international assistance project that contributed to climate change benefits.

6 Calculated based on OECD stats on MDB imputed climate shares in 2019. 2020 shares are assumed constant from 2019 levels, in the absence of 2020 data at the time of this report.

7 EDC is a self-financing Crown corporation that operates at arm's length from the Government of Canada.

8 Eligible transactions and projects are identified by using the International Finance Corporation (IFC) – Definitions and Metrics for Climate-Related Activities.

9 Canada tracks and reports on private finance mobilized in line with the principles and methodologies established by the Organisation for Economic Co-operation and Development (OECD) Working Party on Development Finance Statistics.

10 Project investments from Canada's facilities at MDBs are financed and reported in USD.

11 Examples provided are outside Canada's climate finance envelope, which includes many projects supporting technology and capacity-building as outlined in the Finance portion of this chapter.

12 Due to certain tracking limitations, the information presented here is not inclusive of all support from across the Government of Canada. Canada is committed to continuous improvement of its tracking and reporting, and is working on a strengthened approach aligned with the reporting requirements under the Enhanced Transparency Framework, including linkages between climate finance support and technology transfer and capacity-building support.

13 Greater detail on each study available in Table 7-5.

14 Non-Annex 1 countries that are also founding members of the Hub include Argentina, Brazil, China, Korea and Saudi Arabia.

Annex 1: Financial Tables (2019 and 2020)

Table 7-1: Summary of Public Financial Support (2019 and 2020)

ALLOCATION CHANNELS	2019									
	DOMESTIC CURRENCY (CAD)					USD				
	Core/ general	Climate-specific				Core/ general	Climate-specific			
		Mitigation	Adaptation	Cross-cutting	Other		Mitigation	Adaptation	Cross-cutting	Other
Total contributions through multilateral channels:	11,729,804	83,285,531	3,835,324	473,552,801		8,840,719	62,772,061	2,890,672	356,915,360	
Multilateral climate change funds		70,101,800	3,000,000	132,000,000			52,835,522	2,261,091	99,488,014	
Other multilateral climate change funds										
Multilateral financial institutions, including regional development banks				322,003,613					242,693,181	
Specialized United Nations bodies	11,729,804	13,183,731	835,324	19,549,187		8,840,719	9,936,540	629,581	14,734,165	
Total contributions through bilateral, regional and other channels		78,243,978	58,523,902	132,292,503			58,972,257	44,109,293	99,708,472	
Total	11,729,804	161,529,509	62,359,226	605,845,304		8,840,719	121,744,318	46,999,966	456,623,832	

Table 7-1: Summary of Public Financial Support (2019 and 2020, continued)

ALLOCATION CHANNELS	2020									
	DOMESTIC CURRENCY (CAD)					USD				
	Core/ general	Climate-specific				Core/ general	Climate-specific			
		Mitigation	Adaptation	Cross-cutting	Other		Mitigation	Adaptation	Cross-cutting	Other
Total contributions through multilateral channels:	16,152,970	58,023,875	835,324	418,943,844		12,044,092	43,264,173	622,840	312,375,877	
Multilateral climate change funds		45,888,165		36,652,200			34,215,459		27,328,873	
Other multilateral climate change funds										
Multilateral financial institutions, including regional development banks				213,748,825					159,376,913	
Specialized United Nations bodies	16,152,970	12,135,710	835,324	168,542,819		12,044,092	9,048,714	622,840	125,670,091	
Total contributions through bilateral, regional and other channels		295,620,262	115,139,867	135,287,415			220,422,474	85,851,403	100,873,960	
Total	16,152,970	353,644,137	115,975,191	554,231,259		12,044,092	263,686,646	86,474,243	413,249,837	

Table 7-2: Finance Delivered through Multilateral Channels (2019 and 2020)

2019									
Donor funding	Total Amount				Status	Funding source	Financial instrument	Type of support	Sector
	Core/general		Climate-specific						
	CAD	USD	CAD	USD	Committed Disbursed	ODA OOF Other	Grant Concessional Loan Non-Concessional Loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Cross-cutting Other Not Applicable
Multilateral Climate Change Funds			**205,101,800**	**154,584,626**					
Adaptation Fund†			3,000,000	2,261,091	Disbursed	ODA	Grant	Adaptation	Cross-cutting
Global Environment Facility (GEF)			70,101,800	52,835,522	Disbursed	ODA	Grant	Mitigation	Cross-cutting
Green Climate Fund (GCF)			110,000,000	82,906,678	Disbursed	ODA	Concessional Loan	Cross-cutting	Cross-cutting
Green Climate Fund (GCF)			22,000,000	16,581,336	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Multilateral financial institutions, including regional development banks			**322,003,613**	**242,693,181**					
African Development Bank			35,816,000	26,994,414	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Asian Development Bank (ADB)			9,227,937	6,955,069	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Inter-American Development Bank			5,188,633	3,910,657	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Other									
Asian Infrastructure Investment Bank (AIIB)			16,807,166	12,667,512	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting

Inter-American Development Bank Fund for Special Operations (IDB FSO)			499	376	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
International Development Association (IDA)			152,771,100	115,143,131	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
IBRD			85,134,829	64,165,871	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Caribbean Development Bank			17,057,450	12,856,150	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Specialized United Nations bodies	**11,729,804**	**8,840,719**	**33,568,243**	**25,300,286**					
United Nations Development Programme			2,560,000	1,929,465	Disbursed	ODA	Grant	Mitigation	Cross-cutting
United Nations Environment Programme	1,000,000	753,697			Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Other									
United Nations Convention to Combat Desertification (UNCCD)	97,416	73,422			Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Multilateral Fund for the Implementation of the Montreal Protocol			10,623,731	8,007,075	Disbursed	ODA	Grant	Mitigation	Environmental Management
Consultative Group on International Agricultural Research (CGIAR)	10,000,000	7,536,971			Disbursed	ODA	Grant	Cross-cutting	Agriculture
World Meteorological Organisation (WMO)	97,416	73,422			Disbursed	ODA	Grant	Adaptation	Cross-cutting

World Meteorological Organisation—Climate Risk Early Warning Systems (CREWS)+			835,324	629,581	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness
International Renewable Energy Agency (IRENA)	534,972	403,207			Disbursed	ODA	Grant	Cross-cutting	Energy
Food and Agriculture Organization of the United Nations (FAO)			19,549,187	14,734,165	Disbursed	ODA	Grant	Cross-cutting	Agriculture
Total contributions through multilateral channels	**11,729,804**	**8,840,719**	**560,673,656**	**422,578,093**					

Notes:

2019: Information covers calendar year January 2019 to December 2019.

Exchange rates based on OECD/DAC Rates for 2019: (USD-CAD) 1.326793. Amounts are rounded to the available level of confidence.

(+) Contribution targeting the Rio Conventions as a “principal objective”.

(*) Contribution targeting the Rio Conventions as a “significant objective”.

(†) Contribution was provided by provincial government.

Core contributions to multilateral organizations are calculated based on OECD stats on MDB imputed climate shares in 2019.

Table 7-2: Finance Delivered through Multilateral Channels (2019 and 2020, continued)

2020									
Donor funding	Total Amount				Status	Funding source	Financial instrument	Type of support	Sector
	Core/general		Climate-specific						
	CAD	USD	CAD	USD	Committed Disbursed	ODA OOF Other	Grant Concessional Loan Non-Concessional Loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Cross-cutting Other Not Applicable
Multilateral Climate Change Funds			**82,540,365**	**61,544,332**					
Global Environment Facility (GEF)+			45,888,165	34,215,459	Disbursed	ODA	Grant	Mitigation	Cross-cutting
Green Climate Fund (GCF)+			35,410,000	26,402,655	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Other									
United Nations Framework Convention On Climate Change			1,242,200	926,218	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Multilateral financial institutions, including regional development banks			**213,748,825**	**159,376,913**					
African Development Bank			41,044,544	30,603,924	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Asian Development Bank (ADB)			7,827,269	5,836,223	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Inter-American Development Bank			546,604	407,563	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Other									
Asian Infrastructure Investment Bank (AIIB)			9,940,528	7,411,927	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting

Inter-American Development Bank Fund for Special Operations (IDB FSO)			96,551	71,991	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
International Development Association (IDA)			142,722,752	106,417,949	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Caribbean Development Bank			11,570,578	8,627,337	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Specialized United Nations bodies	**16,152,970**	**12,044,092**	**181,513,853**	**135,341,645**					
United Nations Development Programme (UNDP)			1,728,000	1,288,444	Disbursed	ODA	Grant	Mitigation	Cross-cutting
United Nations Environment Program (UNEP)	1,545,000	1,151,994			Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Other									
United Nations Convention to Combat Desertification (UNCCD)	313,600	233,829			Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
United Nations University—Institute for Water, Environment and Health (UNU-INWEH)	2,000,000	1,491,254			Disbursed	ODA	Grant	Adaptation	Water
International Renewable Energy Agency (IRENA)	668,280	498,288			Disbursed	ODA	Grant	Cross-cutting	Energy
International Fund for Agricultural Development (IFAD)			9,107,250	6,790,612	Disbursed	ODA	Grant	Cross-cutting	Agriculture
International Fund for Agricultural Development (IFAD)+			150,000,000	111,844,063	Disbursed	ODA	Concessional Loan	Cross-cutting	Agriculture

Multilateral Fund for the Implementation of the Montreal Protocol			10,407,710	7,760,270	Disbursed	ODA	Grant	Mitigation	Environmental Management
Consultative Group on International Agricultural Research (CGIAR)	9,000,000	6,710,644		0	Disbursed	ODA	Grant	Cross-cutting	Agriculture
World Meteorological Organisation (WMO)	2,626,090	1,958,084		0	Disbursed	ODA	Grant	Adaptation	Cross-cutting
World Meteorological Organisation—Climate Risk Early Warning Systems (CREWS)+			835,324	622,840	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness
Food and Agriculture Organization for the United Nations (FAO)			9,435,569	7,035,416	Disbursed	ODA	Grant	Cross-cutting	Agriculture
Total contributions through multilateral channels	**16,152,970**	**12,044,092**	**477,803,043**	**356,262,890**					

Notes:

2020: Information covers calendar year January 2020 to December 2020.

Exchange rates based on OECD/DAC Rates for 2020: (USD-CAD) 1.341153. Amounts are rounded to the available level of confidence.

(+) Contribution targeting the Rio Conventions as a “principal objective”.

(*) Contribution targeting the Rio Conventions as a “significant objective”.

(†) Contribution was provided by provincial government.

Core contributions to multilateral organizations are calculated based on OECD stats on MDB imputed climate shares in 2020. 2020 shares are assumed constant from 2019 levels in the absence of 2020 share for a multilateral institution.

Table 7-3: Finance Delivered through Bilateral, Regional, and Other Channels (2019 and 2020)

2019								
Recipient country/ Region/ Project/ Program	Total Amount		Status	Funding source	Financial Instrument	Type of support	Sector	Additional Information
	Climate-specific							
	CAD	USD						
Africa/Supporting Renewable Energy in Africa+	1,000,000	753,697	Disbursed	ODA	Grant	Mitigation	Energy	Support advisory services to renewable energy clients, African governments and other partners to develop an equitable and enabling environment for renewable energy.
Africa/Improving Bean Markets in Africa*	521,467	393,028	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Aims to improve food security, income and health in Sub-Saharan Africa by helping farmers and SMEs to take advantage of the regional commercial opportunities of the bean crop, including research and production of climate-smart seeds to support and distribute to farmers.
Africa/Challenges to Regional Cooperation III*	3,341	2,518	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to increase the contribution of African partner organizations to social and economic development of the continent, reducing poverty and improving the quality of life of Africans.
Africa/FinDev: Africa Forestry Fund II	9,950,948	7,500,000	Committed	OOF	Equity	Mitigation	Forestry	Africa Forestry Fund II is an investment fund focused on forestry and forestry-related assets in Sub-Saharan Africa.
Asia, Oceania/ Canadian Climate Fund for the Private Sector in Asia – II+	20,622,576	15,543,176	Disbursed	ODA	Concessional Loan	Cross-cutting	Cross-cutting	Catalyze greater private sector investment in climate change mitigation and adaption projects in low and lower middle income Asian and Pacific countries and upper-middle income small island developing states in the region.

Bangladesh/ Environmental Rehabilitation and Improving Livelihoods in Cox's Bazar+	10,000,000	7,536,971	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to secure a safe and healthy environment for the affected host community population in Cox's Bazar in Bangladesh by addressing cooking fuel needs, economic wellbeing and food security; and rehabilitation of the natural resource base while preventing further environmental degradation in the region.
Bangladesh, Colombia, Cuba, Dominican Republic, El Salvador, Mexico, Panama/Supporting implementation of the Kigali Amendment on the phase-down of Hydrofluorocarbons (HFCs)+	1,112,888	838,780	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Support the implementation of HFCs phase-down in developing countries, including in areas such as the manufacturing of refrigeration equipment.
Belize/Support to the Alliance of Small Island States (AOSIS)+	50,000	37,685	Disbursed	ODA	Grant	Cross-cutting	Environmental policy and administrative management	Support to the Alliance of Small Island States (AOSIS) in building the economic and climate resilience of small island developing states (SIDS). This project contributes to the hiring of a Technical Expert on Sustainable Development to provide technical support to the Lead Negotiator on sustainable development, the Chair of the AOSIS and member states in relation to AOSIS priorities related to climate change and oceans.
Belize, St. Vincent and the Grenadines, Suriname/Community Resilience Building+	1,671,439	1,259,759	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Aims to enhance community resilience and to mainstream a comprehensive disaster management approach in three Caribbean countries.

Belize, Dominica, Jamaica, Grenada, Guyana, Saint Lucia/ Skills to Access the Green Economy*	441,800	332,984	Disbursed	ODA	Grant	Cross-cutting	Vocational training	Aims to develop training for employment with counterpart institutions in six Caribbean countries where youth, women and the most vulnerable face challenges accessing skills training and employment. In these countries, coastal degradation and other climate change effects are the focus of government and, increasingly, industry-led adaptation efforts that are hampered by the lack of skilled technical workers.
Benin/Support for Women's Entrepreneurship Within the Rice Sector*	593,357	447,212	Disbursed	ODA	Grant	Adaptation	SME development	Improving women parboilers' living conditions in the southern part of Benin through assisting professional rice steaming organizations, taking into consideration the cross-cutting themes which are gender equality, governance and environmental sustainability.
Benin/Support for the Structuring of a Profitable, Fair and Sustainable Family Agriculture*	430,761	324,663	Disbursed	ODA	Grant	Adaptation	Agriculture	Improve farms' production and profitability and support the creation of an environment that fosters investment and innovation, and the establishment of more inclusive practices that will help women become more empowered and help family farms adapt to the effects of climate change.
Bolivia/Supporting Agro-Industrial Production and Exports*	588	443	Disbursed	ODA	Grant	Adaptation	Agriculture	Strengthening of climate-resilient agriculture in Bolivia through crop production to withstand climate fluctuation and instability, and through new investments in irrigation to combat periodic drought conditions.

Bolivia/Improving Living Conditions and Health in Rural and Indigenous Communities in Chuquisaca*	761,695	574,088	Disbursed	ODA	Grant	Adaptation	Rural development	Strengthen income generation and address health challenges affecting maternal and child health, including through the adoption of good nutritional and environmental health practices.
Bolivia, Burkina Faso, Peru/Food Security Innovation and Mobilization*	945,918	712,936	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Increase food security and promote sustainable livelihoods in rural semi-arid areas in Burkina Faso, Bolivia and Peru, through the transfer of technology and practical leadership training. Climate change resilience is a key element of the project in the three targeted countries. The chosen approach for the project therefore focuses on soil and water conservation, and on reducing crop vulnerability to unpredictable climate events.
Burkina Faso/ Sustainable energy and economic growth in la Boucle du Mouhoun in Burkina Faso+	3,637,139	2,741,301	Disbursed	ODA	Grant	Mitigation	Energy	Foster sustainable green economic growth and women empowerment through rural electrification, promotion of solar energy, business development and revenue generating activities, training and governance.
Burkina Faso, Ghana, Mali, Senegal/Scaling Her Voice on Air in Burkina Faso, Ghana, Mali and Senegal*	250,878	189,086	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to scale up interactive rural radio, reaching 61 radio stations and engaging at least 70 stakeholder groups including farmer-based and women's organizations, providing information on topics such as climate-smart agriculture and climate adaptation.

Cameroon/Climate Resilience of Women Farmers in Cameroon*	3,380	2,547	Disbursed	ODA	Grant	Adaptation	Agriculture	Supports women farmers to adopt agriculture technologies that will allow them to become more resilient to the effects of climate change, improve food security and improve standard of living for these small scale farmers.
Caribbean/ Supporting Renewable Energy and Energy Efficiency in the Caribbean+	1,150,000	866,752	Disbursed	ODA	Grant	Mitigation	Energy	Enable microfinance institutions to develop financial products suitable for micro, small and medium sized enterprises and low-income households to take advantage of renewable energy and energy efficiency solutions.
Caribbean/ Cooperation for Climate Change Adaptation and Resilience in the Caribbean*	97,500	73,485	Disbursed	ODA	Grant	Adaptation	Environmental policy and administrative management	Support to Food and Agriculture Organization (FAO) for Cooperation for Climate Change Adaptation and Resilience in the Caribbean.
Caribbean/ Caribbean Disaster Risk Management Program*	112,564	84,839	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Aims to increase the capacity of regional organizations, national governments and local communities in the Caribbean to respond to and manage natural disasters through institutional support and gender-equal programming, disaster risk management and community resilience strategies.
Caribbean/ Caribbean Disaster Risk Management Program – Knowledge Sharing*	22,341	16,838	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Generate, manage and share knowledge of comprehensive disaster management to inform the decision-making of governments, local communities and the private sector in the Caribbean.

Caribbean/ Caribbean Disaster Risk Management Program – Health Sector*	148,350	111,811	Disbursed	ODA	Grant	Cross-cutting	Disaster prevention and preparedness	Aims to increase the capacity of regional organizations, national governments and local communities in the Caribbean to respond to and manage natural disasters.
Caribbean/Climate Change Action for Gender-Sensitive Resilience+	1,500,000	1,130,546	Disbursed	ODA	Grant	Cross-cutting	Environmental policy and administrative management	Aims to strengthen governance of climate change and disaster recovery through improved coordination mechanisms and increased engagement of women's groups.
Caribbean/ Community Disaster Risk Reduction Program+	800,000	602,958	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Supports community resilience in the face of natural disasters by undertaking demonstration projects that help determine which prevention or mitigation measures are most effective.
Caribbean/ Compete Caribbean Partnership Facility*	1,200,000	904,436	Disbursed	ODA	Grant	Cross-cutting	SME development	Aims to increase the productivity and contribution of SMEs to inclusive green economic growth in Caribbean region.
Caribbean/Support to the Caribbean Disaster Emergency Management Agency (CDEMA)*	750,000	565,273	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Aims to improve comprehensive disaster management in the Caribbean Region with a focus on vulnerable populations, particularly women and girls.
Central America/ Climate Smart Agriculture in Central America+	1,500,000	1,130,546	Disbursed	ODA	Grant	Adaptation	Agriculture	Sustainably increase agricultural productivity in support of food security while adapting and building resilience to climate change in Central America.

Colombia, Mexico, Peru/Support to enhance measurement, reporting and verification with the Pacific Alliance+	152,512	114,948	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Support Pacific Alliance countries' efforts to strengthen Measurement Reporting and Verification (MRV) activities in order to reduce SLCP emissions, and attract investments that support NDC implementation.
Colombia/ Colombian Cacao Agropreneurs*	469,332	353,734	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Aims to create sustainable livelihood for smallholder farmers of cacao and expand new areas of climate resilient cacao crops.
Côte d'Ivoire, Senegal/ Cooperation project between Canada, Côte d'Ivoire and Senegal for emission reduction in the waste management sector+	173,693	130,912	Disbursed	ODA	Grant	Mitigation	Waste management	Support implementation of Senegal and Côte d'Ivoire's Nationally Determined Contribution (NDC) in the Waste Sector, by strengthening the policy and regulatory framework and enhancing the technical and operational capacity for data monitoring and validation in the sector.
Côte d'Ivoire, Ethiopia, Ghana, Kenya, Malawi, Uganda, Zambia/ Engineers Without Borders – Volunteer Sending 2015-2020*	647,111	487,726	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to support capacity-building of public service institutions and SMEs to adapt to changing circumstances, incorporating environmental sustainability and gender equality.
Côte d'Ivoire, Ghana, Senegal/The Cooperative Model: Building Inclusive and Sustainable Communities in Côte d'Ivoire, Senegal and Ghana*	882,179	664,896	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Support inclusive and green growth by strengthening co-operatives, with particular focus on vulnerable populations and women, including by fostering climate-smart economic activities in the housing and agri-food sectors.

Cuba/Contributing to Sustainable Food Production in Cuban Municipalities*	390,570	294,371	Disbursed	ODA	Grant	Adaptation	Agriculture	Increase sustainable agricultural production in five urban and suburban municipalities in Cuba, strengthen the municipal management of the sector and increase production in a sustainable manner, especially by women.
Cuba/Strengthening the Fruit Production Chains in Cuba*	570,000	429,607	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to increase food security in Cuba through strengthening three fruit production chains (mangos, guava and papaya) in order to satisfy demand, and generate sustainable development that allows import substitution.
Democratic Republic of Congo, Haiti, Senegal/Knowledge of the People of the Earth*	731,003	550,955	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Increase food security and promote sustainable livelihoods to increase climate resilience.
Dominica/Support to the Development of Dominica's Climate Resilience and Recovery Plan (CREAD)+	92,000	69,340	Disbursed	ODA	Grant	Cross-cutting	Environmental policy and administrative management	Support to the Government of Dominica to develop an enhanced, strategic, gender-sensitive and inclusive Climate Resilience and Recovery Plan (CRRP) that aims to guide resilience-building and reconstruction of Dominica.
Dominica/Support to the Climate Resilience Execution Agency of Dominica (CREAD)+	559,362	421,590	Disbursed	ODA	Grant	Cross-cutting	Environmental policy and administrative management	Supports the Climate Resilience Execution Agency of Dominica (CREAD)'s in implementation of key recovery and reconstruction projects, and provide technical assistance to transform systems and build capacity in the civil service so that Dominica is able to manage recovery from future disaster events more effectively.

East Asia/ Strengthening Community Resilience to Natural Disasters*	86,119	64,907	Disbursed	ODA	Grant	Cross-cutting	Disaster prevention and preparedness	Help communities establish effective risk reduction plans and policies to reduce people's vulnerability to natural disasters, by working to ensure that disaster risk reduction policy and law considers vulnerable communities, gender equality, and the environment.
Ethiopia/Food Sufficiency for Farmers*	178,548	134,571	Disbursed	ODA	Grant	Adaptation	Agriculture	Improve resilience of communities to vulnerabilities by improving food capacity through increased incomes or greater ability to grow food, and implementing community plans to address common challenges such as climate change and barriers to gender equality.
Ethiopia/Integrated Approach to Maternal, Newborn and Child Health in Rural Ethiopia*	1,438,874	1,084,475	Disbursed	ODA	Grant	Cross-cutting	Food security	Addressing malnutrition by increasing access to quality nutrition, water, and sanitation services, for the most vulnerable populations affected by climate change in Ethiopia.
Ethiopia/Agricultural Growth Program – Phase II*	2,250,000	1,695,818	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to increase agricultural productivity and public agricultural services, including through the promotion of climate-smart agriculture.
Ethiopia/Resilient Landscapes and Livelihoods for Women in Ethiopia*	750,000	565,273	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve the food security, livelihoods and economic well-being of women and men small holder farmers through sustainable land management practices, climate change adaptation and climate-smart income-generating activities.

Ethiopia/Rural Social Protection: Productive Safety Net Program (2016–2021)*	1,650,000	1,243,600	Disbursed	ODA	Grant	Cross-cutting	Food security	Enhance household and community resilience to shocks, such as droughts, and improve household food security, nutrition and economic well-being in Ethiopia's most vulnerable communities.
Ethiopia, Ghana, Senegal/4R Nutrient Stewardship Project*	927,784	699,268	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Aims to improve the agricultural productivity and farm income of smallholder farmers and their resilience to climate change, including strengthening women's leadership in agricultural cooperatives, improving their access to productive resources, and promoting best practices in integrated soil fertility management and conservation agriculture.
Ethiopia, Guatemala, Honduras, Mali, Nicaragua/Seeds Survival Program*	855,308	644,643	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to increase food security and agricultural training among small-scale farmers who are experiencing food security challenges for various reasons, including climate change.
Ethiopia, Kenya, Tanzania/Scale-up of Conservation Agriculture in East Africa*	904,791	681,939	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Support to farmers to address issues such as soil fertility and climate change to increase food security and support conservation agriculture.

Fiji, Solomon Islands, Vanuatu/ Markets for Change Pacific Islands*	300,000	226,109	Disbursed	ODA	Grant	Adaptation	Policy	Aims to promote gender equality and the social and economic empowerment of women vendors across Pacific Island markets, ensuring that selected marketplaces in rural and urban areas are safe, inclusive and non-discriminatory environments, promoting gender equality and women's empowerment. The projects also aims to improve physical infrastructure and operating systems to make markets more sustainable, more resilient to disaster risks and climate change, safer and more accessible.
Ghana/Farmers' Economic Advancement Through Seedlings*	248,364	187,191	Disbursed	ODA	Grant	Adaptation	Agriculture	Support to enhance the productivity of small farmers in tree crops, including through increased environmentally sustainable farming in Ghana's tree crop industry.
Ghana/Greater Rural Opportunities for Women (GROW)*	184,426	139,001	Disbursed	ODA	Grant	Adaptation	Agriculture	Help farmers overcome constraints and become viable economic partners, targeting women and their families to improve production, post-harvest handling (including processing such as solar drying), and facilitation of market linkages.

Ghana/Modernizing Agricultural Production*	7,172,657	5,406,011	Disbursed	ODA	Grant	Mitigation	Agriculture	Seeks to implement a comprehensive market-oriented approach to farming to strengthen agricultural extension services and make the agriculture sector more modern, equitable and sustainable, including by updating and reorienting a standardized curriculum for agricultural colleges and farm institutes to be more market-focused, gender-sensitive and climate-smart.
Guatemala/ Economic Empowerment of Indigenous Women and Youth in Alta Verapaz*	149,283	112,514	Disbursed	ODA	Grant	Cross-cutting	Business Policy and Administration	Aims to increase the economic empowerment of Indigenous women and youth in Alta Verapaz by strengthening business practices and skills of small-scale enterprises led by Indigenous women and youth, including training on business and financial administration, environmentally and climate-resilient production practices, and social responsibility.
Guatemala/ Sustainable Economic Growth for Women and Youth in Alta Verapaz*	150,000	113,055	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Aims to improve agricultural entrepreneurship in the sectors of organic cardamom and turmeric, and contribute to strengthening clean and sustainable practices by improving their inclusive governance and supporting adoption of green practices.
Guatemala, Honduras/Promoting Sustainable Economic Growth in Coffee-growing Regions*	50,323	37,928	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to improve the lives of smallholder coffee farmers by increasing the productivity and profitability of their farms, and promoting environmentally sustainable agricultural practices.

Guyana, Saint Lucia, Dominica, Jamaica/Promotion of Regional Opportunities for Produce through Enterprise and Linkages (PROPEL) – WUS*	303,198	228,520	Disbursed	ODA	Grant	Adaptation	Agriculture	Supports economic growth in the Caribbean through increased sales of fresh produce by small-scale local producers to high value markets.
Haiti/Adaptive and Innovative Solutions for Agri-Food Market Opportunities in Haiti*	738,722	556,772	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Aims to strengthen the maize value chain through expanded commercialization and sustainable crop production, promoting added value and climate change adaptation in the targeted value chains, and enhancing rural farm families' resiliency to recurrent natural disaster through disaster risk reduction awareness-raising.
Haiti/Cashew, Mango and Gardening Value Chains Development for the Benefit of Women and Youth+	649,736	489,704	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve the economic well-being and reduce the vulnerability of Haitian women and men living in rural areas, including climate change adapted value chains and agro-ecological practices.
Haiti/Creole Garden Revalorisation+	298,690	225,122	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to develop value chains in the coffee- and cacao-based agroforestry systems, improve producers' ability to adapt to climate change, encourage the creation of skills to adapt agroforestry to climate change, and build the governance capacity of local and departmental bodies with regard to climate change adaptation.

Haiti/Climate Adaptation and Economic Development of Agricultural Sectors in Haiti+	672,206	506,640	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve the economic well-being and reduce the vulnerability of rural households through its strategy to promote climate change adaptation and resilience in agricultural practices and value chains.
Haiti/Counter drought and climate change in northeastern Haiti by installing water pumps and building local capacities*	36,000	27,133	Disbursed	ODA	Grant	Adaptation	Agriculture	Support provided by Programme québécois de développement international (PQDI).
Haiti/Local capacity building for agroforestry development and sustainable mountain agriculture in the North*	27,627	20,823	Disbursed	ODA	Grant	Adaptation	Forestry	Support provided by Programme québécois de développement international.
Haiti/Transforming the Market for Stoves and Clean Energy in Haiti+	2,000,000	1,507,394	Disbursed	ODA	Grant	Mitigation	Energy	Restructure and boost the market for efficient stoves and clean energy in order to protect the environment, improve the health of women and children and strengthen women's economic power within new value chains for producing and marketing stoves and clean energy.
Haiti/Productive and Inclusive Coffee Value Chain Adapted to Climate Change in Haiti+	800,000	602,958	Disbursed	ODA	Grant	Adaptation	Agriculture	Seeks to adapt this value chain to climate change and supports applied research, activities to enhance sustainable seed management mechanisms and activities to promote/introduce green technologies.

Honduras/Canada-Honduras Value Added Agroforestry Project*	844,671	636,626	Disbursed	ODA	Grant	Cross-cutting	Agriculture and Forestry	Implementation of agroforestry practices to mitigate carbon emissions through carbon sequestration and diverse planting for soil preservation, as well as promoting varieties of climate-resilient crops to withstand climate change impacts and yield more products available to markets.
Honduras/ Rural Market Opportunities in the Gulf of Fonseca in Honduras*	296,577	223,529	Disbursed	ODA	Grant	Cross-cutting	Cross-Cutting	Improve the economic well-being of small-scale entrepreneurs and producers in the Dry Corridor of Honduras, especially women, youth and marginalized people living in poverty.
Honduras/Promoting Rural Economic Development for Women and Youth in the Lempa Region – PROLEMPA*	458,470	345,547	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	Improve the economic well-being of small-scale entrepreneurs and producers in the tourism and coffee sectors, in particular women, youth and indigenous people in the Dry Corridor of Honduras.
Jordan/Sustainable Economic Development Through Renewable Energy+	6,412,203	4,832,859	Disbursed	ODA	Grant	Mitigation	Energy	Aims to improve livelihoods through the introduction of renewable energy and energy efficiency solutions at the household level.
Jordan/Sustainable Development in Jordan*	192,191	144,853	Disbursed	ODA	Grant	Mitigation	Energy	Introducing cost-saving renewable energy-efficient solutions for poor households, supporting low-carbon development in Jordan.

Kenya/More Food: Empowering Kenyan Women*	61,578	46,411	Disbursed	ODA	Grant	Adaptation	Agriculture	Improved food and nutrition security of farm families by integrating a number of innovative approaches to increase agricultural productivity, income, nutritional knowledge and skills among the target population. This includes training on best agriculture and livestock practices, as well as biogas, rain water harvesting and solar power technologies.
Kenya/Equitable Prosperity Through Private Sector Development*	983,247	741,070	Disbursed	ODA	Grant	Adaptation	SME Development	Aims to create sustainable economic growth by supporting the development of competitive small- and medium-sized enterprises (SMEs), applying environmentally sustainable and green business in the agriculture and construction sectors.
Latin America/ FinDev: EcoEnterprises Fund III	16,584,913	12,500,000	Committed	OOF	Equity	Mitigation	Agriculture and Forestry	EcoEnterprises Fund III provides a variety of financing instruments to biodiversity-based small and medium enterprises (SMEs) in several sectors including sustainable agriculture and forestry, agroforestry and wild-harvested products, aquaculture and ecotourism.
Latin America and the Caribbean/ Canadian Climate Fund for the Private Sector in the Americas II+	95,500,000	71,978,070	Disbursed	ODA	Concessional Loan	Cross-cutting	Cross-cutting	Aims to catalyze private sector investments in climate change mitigation and adaptation across the Latin America and Caribbean region, while promoting gender-responsive, sustainable economic development.

Latin America and the Caribbean/ Sustainable Energy Access for Latin American and Caribbean Region*	15,840	11,939	Disbursed	ODA	Grant	Cross-cutting	Energy	Support for improved access to sustainable and affordable energy needed to promote economic growth in the region, by improving capacities for energy planning and regulation across countries in the region.
Latin America and the Caribbean, South of Sahara/ FinDev Canada Technical Assistance Project*	110,565	83,333	Disbursed	ODA	Grant	Cross-cutting	Business Policy and Administration	Aims to address the capacity gaps experienced by target Investors to help them reach their full impact potential in areas of: gender equality; corporate governance and leadership; environmental and social risk management; inclusive human capital development; and impact measurement and reporting. The objectives include delivering climate-specific gender equality for partner companies in the green growth sector and enhancing business operations' environmental, social and governance practices.
Malawi/Farmer-to-Farmer Agroecology*	4,259	3,210	Disbursed	ODA	Grant	Adaptation	Agriculture	Support to organic smallholder farms through farmer-to-farmer teaching methods, the development of farmer associations and a pilot youth-led small business initiative to train households on sustainable agro ecological methods.
Mali/Rehabilitation of Agricultural Irrigation Infrastructures in the Zone of the Office du Niger (PAON)*	2,752,431	2,074,499	Disbursed	ODA	Grant	Adaptation	Agriculture	Helping to develop and rehabilitate agricultural irrigation infrastructure and hydro-agricultural development to increase agricultural production in Mali, including implementing agriculture, water management, reforestation practices to help build resilience to climate-induced vulnerabilities.

Mali/Strengthening Irrigated Agriculture in Mali (REAGIR)*	3,544,516	2,671,492	Disbursed	ODA	Grant	Adaptation	Agriculture	Support to sustainably develop irrigated agriculture to increase food security through the construction and rehabilitation of productive infrastructure, such as irrigated fields and micro dams.
Mexico/NDC Implementation Mexico (Oil and gas)+	581,584	438,338	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Aims to support NDC implementation focusing on addressing emissions from Mexico's Oil and Gas Sector.
Multiple Countries/ IDRC-Adaptation+	9,883,785	7,449,380	Disbursed	ODA	Grant	Adaptation	Cross-cutting	International Development and Research Centre support for adaptation action.
Multiple Countries/ IDRC-Adaptation*	588,165	443,298	Disbursed	ODA	Grant	Adaptation	Cross-cutting	International Development and Research Centre support for adaptation action.
Multiple Countries/ IDRC-Cross-cutting+	25,217	19,006	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	International Development and Research Centre support for climate change action.
Multiple Countries/ IDRC-Cross-cutting*	504,088	379,930	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	International Development and Research Centre support for climate change action.
Multiple Countries/ IDRC-Mitigation+	423,361	319,086	Disbursed	ODA	Grant	Mitigation	Cross-cutting	International Development and Research Centre support for mitigation action.
Multiple Countries/ IDRC-Mitigation*	24,030	18,112	Disbursed	ODA	Grant	Mitigation	Cross-cutting	International Development and Research Centre support for mitigation action.
Multiple Countries/ Climate and Clean Air Coalition Trust Fund (CCAC)+	1,000,000	753,697	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Support the implementation of initiatives that reduce the emissions of short-lived climate pollutants (SLCPs) in various sectors such as agriculture, waste and household energy.

Multiple Countries/ International Group on Earth Observations Secretariat (GEO)+	10,000	7,537	Disbursed	ODA	Grant	Adaptation	Environmental policy and administrative management	Support to the Global Earth Observation System of Systems, which aims to provide comprehensive coordinated Earth observations using worldwide instruments and is expected to yield significant benefits to society. In particular, GEO helps to build national capacity in developing countries by enabling human, technical and institutional capacity for coordinating, accessing, using and sharing environmental data, information and services.
Multiple Countries/ FinDev: JCM Power	26,535,860	20,000,000	Committed	OOF	Equity	Mitigation	Energy	JCM Power is a Canadian-based renewable energy company that focuses on the development, construction, acquisition and operation of utility scale renewable energy projects in Africa, Latin America and South Asia.
Multiple Countries/ The Human Face of Climate Change+	18,875	14,226	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Support provided by Programme d'éducation à la citoyenneté mondiale (PECM).
Myanmar/Climate Change and Disaster Resilience in Myanmar+	1,500,000	1,130,546	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Contribute to building disaster-ready and financially resilient national and local government and private sector institutions, and increase resilience in communities in Ayeyarwady, a disaster-prone and highly populated delta region of Myanmar.
Nepal/ Reconstruction of Water, Sanitation and Hygiene Services*	191,319	144,197	Disbursed	ODA	Grant	Adaptation	Water	Increasing access to and use of safe drinking water, sanitation and hygiene (WASH) services in severely and crisis-hit earthquake affected areas in Nepal.

Nepal/Nepal Earthquake – Recovery Assistance to Sindhupalchok – Oxfam Canada 2017–2019*	114,136	86,024	Disbursed	ODA	Grant	Adaptation	Water	Improve the well-being and resilience of communities living in earthquake-affected areas of Sindhupalchok, Nepal, by meeting their needs for potable water, sanitation and hygiene (WASH) services and practices and ensuring that they are resistant to future natural disasters.
Nepal/RENEW*	50,280	37,896	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to enhance the social and economic empowerment of women and girls and most vulnerable groups by implementing poverty reduction measures, bringing a human rights-based approach to economic and social growth, focusing on climate change adaptation, and enhanced performance of micro/small-scale enterprises.
Nicaragua/ Technolinks+: Advancing Inclusive Prosperity in Nicaragua's Agri-food Export Sector*	342,842	258,399	Disbursed	ODA	Grant	Adaptation	Agriculture	Facilitate the access, promotion and adoption of environmentally-sustainable agricultural technologies with the objective of increasing agricultural productivity, quality, and profitability for smallholder farmers and agribusinesses, cooperatives and producers associations.
Nicaragua/Towards climate change resilient life*	22,770	17,162	Disbursed	ODA	Grant	Adaptation	Agriculture	Support provided by Programme québécois de développement international (PQDI).

Nigeria/Livelihoods and Nutrition Empowerment*	587,867	443,074	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve the lives and incomes of poor and vulnerable farming households through agriculture-driven economic growth, incorporating training and related technical support in modern farming methods. Environmental sustainability and climate adaptation have been integrated in the various activities, including agrochemcial inputs, value chain enhancement, leadership training, household resilience, and community strategies.
Peru/Agricultural Training Program and Support of Youth Entrepreneurship in Peru*	741,786	559,082	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve and strengthen sustainable agriculture practices and to develop adaptation measures including efficient water management, water conservation, crop diversification, green infrastructure for water conservation, and improved climate-resilient pasture management.
Peru/Participatory Water Management and Climate Resilience for Andean Women and Men+	4,200,000	3,165,528	Disbursed	ODA	Grant	Adaptation	Water	Ensure the water supply of the poorest through appropriate water management, by promoting innovative and accessible solutions (green infrastructure), which are implemented in pilot regions and then taken up nationally.
Philippines/Haiyan Reconstruction Assistance: Restoring, Empowering and Protecting (REAP) Livelihoods Post Haiyan	249,575	188,104	Disbursed	ODA	Grant	Adaptation	Reconstruction relief and rehabilitation	Support for reconstruction and the restoration of lost assets and livelihoods after Typhoon Haiyan, including increased participation of women and men in affected regions, resilient agriculture, disaster risk reduction planning capacity, and improved access to business development services.

Senegal/Adaptation and Valorization of Entrepreneurship in Irrigated Agriculture+	957,708	721,822	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve the socio-economic well-being and resilience of farming households through climate friendly agricultural and irrigation practices.
Senegal/Expansion of Agricultural Insurance Index in the Casamance Region+	386,339	291,183	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to extend the network of rain-gauges to collect basic rainfall data that is required to roll out agricultural index insurance in this region.
Senegal/Women, Agriculture and Resilience in Senegal+	1,174,181	884,977	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to transform gender and age group relations, increase access to economic opportunities that are adapted to climate change in irrigated crop sectors, and facilitate cooperation for water resources through irrigated crops adapted to climate change.
South Africa/Building Inclusive Green Municipalities* (funded by Global Affairs Canada)	327,513	246,846	Disbursed	ODA	Grant	Cross-cutting	Policy	Aims to strengthen the capacity of South African municipal governments to support effective service delivery, strengthen women's empowerment, inclusive local green economic growth and enhanced climate change mitigation and adaptation measures.
South Pacific/The Pacific Catastrophe Risk Assessment and Financing Initiative+	600,000	452,218	Disbursed	ODA	Grant	Adaptation	Disaster preparedness and prevention	Support the provision of disaster risk assessment and financing tools, including sovereign insurance, for enhanced disaster risk management and climate change adaptation.

South Sudan/ Fortifying Equality and Economic Diversity*	18,291	13,786	Disbursed	ODA	Grant	Adaptation	Agriculture	Support smallholder farmers to protect natural resources and become more food secure in seven South Sudanese states. The project seeks to reduce vulnerability of the most marginalized people in the local population and increase the resilience of the population to shocks, including climate-induced shocks.
South Sudan/ Building Resilience Through Safety Nets in South Sudan*	1,230,000	927,047	Disbursed	ODA	Grant	Adaptation	Food security	Aims to meet the immediate food needs of vulnerable people, while promoting longer-term food security through community projects that increase food production, including training to participants on climate-smart agriculture, crop diversification, and reduction of post-harvest losses.
West Bank and Gaza Strip/ Supporting Economic Growth through Value Chain Development in the West Bank*	2,100,000	1,582,764	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to confront the constraints facing the agricultural community by providing smallholder producers of fruit and vegetables and livestock herders with the technical assistance required to lift them from subsistence operations that yield little or no profit, into sustainable semi-commercial enterprises.

Vietnam/Reducing Short Lived Climate Pollutants through Improved Municipal Solid Waste (MSW) Practices in Vietnam+	140,000	105,518	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Support implementation of Vietnam's Nationally Determined Contribution (NDC) in the solid waste sector, supporting municipalities to assess their solid waste management practices, identity solutions to reduce short lived climate pollutants and leverage funding to implement climate actions.
Total contributions through bilateral, regional, and other channels	**269,060,382**	**202,790,022**						

Notes:

2019: Information covers calendar year January 2019 to December 2019.

Exchange rates based on OECD/DAC Rates for 2019: (USD-CAD) 1.326793. Amounts are rounded to the available level of confidence.

(+) Contribution targeting the Rio Conventions as a "principal objective".

(*) Contribution targeting the Rio Conventions as a "significant objective".

Core contributions to multilateral organizations are calculated based on OECD stats on MDB imputed climate shares in 2019.

Table 7-3: Finance Delivered through Bilateral, Regional, and Other Channels (2019 and 2020, continued)

2020								
Recipient country/ Region/ Project/Program	Total Amount		Status	Funding source	Financial Instrument	Type of support	Sector	Additional Information
	Climate-specific							
	CAD	USD						
Africa/Climate Change in Africa: Impacts and Responses For Women and Girls+	220,000	164,038	Disbursed	ODA	Grant	Adaptation	Research and Scientific Institutions	Works to strengthen the evidence base in order to improve the design and implementation of gender-responsive climate change policies in Sub-Saharan Africa, and to contribute to the empowerment of women and girls as beneficiaries and leaders in national climate strategies.
Africa/Mathematical Sciences for Climate Change Resilience in Africa+	1,500,000	1,118,441	Disbursed	ODA	Grant	Adaptation	Education	The project aims to build a critical mass of mathematical scientists in Africa who can address the continent's complex development challenges, specifically focusing on climate change.
Africa/FinDev: M-KOPA	2,682,306	2,000,000	Committed	OOF	Equity	Mitigation	Energy	M-KOPA provides solar lighting and other products to off-grid households on a pay-as-you-go basis.
Africa/ Strengthening Climate Risk Management in Africa+	8,000,000	5,965,017	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Support to the African Risk Capacity (ARC) Agency which supports African governments to immediately assist populations affected by extreme weather events and natural disasters by improving their capacities to plan, prepare and respond using climate risk insurance, early warning tools and national disaster response plans.

Africa/Supporting Gender-Centered Climate Resilience in Africa+	1,900,000	1,416,691	Disbursed	ODA	Grant	Adaptation	Cross-cutting	This project supports the Africa Climate Change Fund (ACCF), which focuses on gender equality and climate action in Africa. The ACCF supports small-scale, climate-resilient projects working towards increasing women's economic empowerment, as well as initiatives enhancing women's participation in climate negotiations in countries across Africa.
Africa, America, Asia/CGIAR Institutional Support 2019-2025 – GENDER Platform+	1,000,000	745,627	Disbursed	ODA	Grant	Cross-cutting	Agriculture	This initiative supports CGIAR's efforts to put gender equality and women's empowerment at the forefront of global agricultural research for development by leveraging, synthesizing, and filling evidence gaps in its work on gender and climate change, and developing options to integrate gender within climate-focused projects and policies.
Africa, America, Asia/Energy Transition Program+	156,000,000	116,317,825	Disbursed	ODA	Concessional Loan	Mitigation	Energy	Aims to reduce the expansion of coal in the electricity sector by developing low-carbon alternatives (including solar, wind, and geothermal) and improving energy efficiency and grid upgrades in targeted developing countries. This initiative is one of four programs under the Canada-World Bank Clean Energy and Forests Climate Facility.

Africa, America, Asia/Gender Equality in the Renewable Energy Sector in Small Island Developing States Program+	10,000,000	7,456,271	Disbursed	ODA	Grant	Mitigation	Energy	This technical assistance program aims to improve gender equality in the renewable energy sector in small island developing states (SIDS) by supporting activities that increase employment opportunities for women, and the productive use of energy for women's enterprises and livelihoods. This initiative is one of four programs under the Canada-World Bank Clean Energy and Forests Climate Facility.
Africa, America, Asia/Integrating Gender Equality in the United Nations Convention to Combat Desertification (UNCCD)*	360,000	268,426	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	Support UNCCD in implementing its 2017 Gender Action Plan in order to more effectively achieve combat desertification and land degradation. Accelerating rates of desertification and land degradation in developing countries exacerbate poverty, vulnerability, and insecurity and reduce resilience to the impacts of climate change.
Africa, America, Asia/Renewable Energy in Small Island Developing States Program+	30,000,000	22,368,813	Disbursed	ODA	Concessional Loan	Mitigation	Energy	The Renewable Energy in Small Island Developing States Program aims to scale up renewable energy production, improve energy efficiency, facilitate the integration of variable renewable energy, and improve energy sector resilience in small island developing states (SIDS). This initiative is one of four programs under the Canada-World Bank Clean Energy and Forests Climate Facility.

Africa, America, Asia/Ocean Risk and Resilience Action Alliance+	1,187,150	885,171	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to improve the state of coastal resilience for vulnerable populations, particularly women and girls in small island developing states (SIDS) and coastal developing countries, and to foster collaboration amongst the finance and insurance sectors, governments and environmental organizations.
Africa, America, Asia/PROBLUE – Global Program for the Blue Economy*	2,700,000	2,013,193	Disbursed	ODA	Grant	Cross-cutting	Waste Management	Aims to help developing countries to sustainably build their coastal economies while ensuring the protection and sustainable use of marine and coastal resources.
Africa, America, Asia, Oceania/ Supporting Low-Carbon & Sustainable CIGI*	900,000	671,064	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	The initiative will target developing countries and projects that align with countries' National Determined Contribution (NDC) and support sustainable goals (SDGs), with highest priority given to projects that reduce GHG emissions and protect local communities that are vulnerable to the impact of climate change, while empowering women and girls.
Africa/Challenges to Regional Cooperation III*	900	671	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to increase the contribution of African partner organizations to social and economic development of the continent, reducing poverty and improving the quality of life of Africans.

America, Asia/ Forests and Landscapes Program+	40,000,000	29,825,083	Disbursed	ODA	Concessional Loan	Mitigation	Forestry	Supports the transition to sustainable land use to reduce greenhouse gas emissions in developing countries. It aims to reduce deforestation, forest degradation, restore and enhance forest resources. This initiative is one of four programs under the Canada-World Bank Clean Energy and Forest Climate Facility (CCEFCF).
Asia, Oceania/ Canadian Climate Fund for the Private Sector in Asia – II+	30,877,420	23,023,041	Disbursed	ODA	Concessional Loan	Cross-cutting	Cross-cutting	Catalyze greater private sector investment in climate change mitigation and adaption projects in low- and lower-middle income Asian and Pacific countries and upper middle income small island developing states in the region.
Bangladesh/ Environmental Rehabilitation and Improving Livelihoods in Cox's Bazar+	10,000,000	7,456,271	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to secure a safe and healthy environment for the affected host community population in Cox's Bazar in Bangladesh by addressing cooking fuel needs, economic wellbeing and food security; and rehabilitation of the natural resource base while preventing further environmental degradation in the region.
Bangladesh, Belize, Colombia, Cuba, Dominican Republic, El Salvador, Jamaica, Mexico, Panama, Peru/Supporting implementation of the Kigali Amendment on the phase-down of Hydrofluorocarbons (HFCs)+	765,880	571,061	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Support the implementation of HFCs phase-down in developing countries, including in areas such as the manufacturing of refrigeration equipment.

Bangladesh, Colombia, Egypt, Ethiopia, Fiji, Jamaica, Kenya, Vietnam/Initiative on Closing the Investment Gap in Sustainable Infrastructure (CIGI)*	139,500	104,015	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	Aims to support funding of sustainable infrastructure initiatives in developing countries and add in-country capacity-building and match-making with investors.
Belize, St. Vincent and the Grenadines, Suriname/ Community Resilience Building+	708,990	528,642	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Aims to enhance community resilience and to mainstream a comprehensive disaster management approach in three Caribbean countries.
Belize, Dominica, Jamaica, Grenada, Guyana, Saint Lucia/Skills to Access the Green Economy*	508,704	379,303	Disbursed	ODA	Grant	Cross-cutting	Vocational training	Aims to develop training for employment with counterpart institutions in six Caribbean countries where youth, women and the most vulnerable face challenges accessing skills training and employment. In these countries, coastal degradation and other climate change effects are the focus of government and, increasingly, industry-led adaptation efforts that are hampered by the lack of skilled technical workers.

Benin/Support for Women's Entrepreneurship Within the Rice Sector*	688,557	513,407	Disbursed	ODA	Grant	Adaptation	SME development	Improving women parboilers' living conditions in the southern part of Benin through assisting professional rice steaming organizations, taking into consideration the cross-cutting themes which are gender equality, governance and environmental sustainability.
Benin/Support for the Structuring of a Profitable, Fair and Sustainable Family Agriculture*	346,524	258,378	Disbursed	ODA	Grant	Adaptation	Agriculture	Improve farms' production and profitability and support the creation of an environment that fosters investment and innovation, and the establishment of more inclusive practices that will help women become more empowered and help family farms adapt to the effects of climate change.
Bolivia/Improving Living Conditions and Health in Rural and Indigenous Communities in Chuquisaca*	658,044	490,655	Disbursed	ODA	Grant	Adaptation	Rural development	Strengthen income generation and address health challenges affecting maternal and child health, including through the adoption of good nutritional and environmental health practices.
Bolivia/'Purispa Yakuwan' (Walking with Water): Integrated water management and adaptation to climate change in Bolivia+	53,530	39,913	Disbursed	ODA	Grant	Adaptation	Environmental policy and administrative management	Improved resilience of residents, mainly women and girls, to the impacts of climate change.

Burkina Faso/ Building Resilience to the Impacts of Climate Change and COVID-19+	3,000,000	2,236,881	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to strengthen the resilience of agro-sylvo-pastoral communities in the Boucle du Mouhoun region, which now struggles soil, forest and water resource degradation, by focusing on greater empowerment through the mastery of practices and measures to mitigate the effects of COVID-19 and climate change.
Burkina Faso/ Sustainable Energy and Economic Growth in the Boucle du Mouhoun in Burkina Faso+	2,959,260	2,206,504	Disbursed	ODA	Grant	Mitigation	Energy	Foster sustainable green economic growth and women empowerment through rural electrification, promotion of solar energy, business development and revenue generating activities, training and governance.
Burkina Faso, Ghana, Mali, Senegal/Scaling Her Voice on Air in Burkina Faso, Ghana, Mali and Senegal*	649,515	484,296	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to scale up interactive rural radio, reaching 61 radio stations and engaging at least 70 stakeholder groups including farmer-based and women's organizations, providing information on topics such as climate-smart agriculture and climate adaptation.
Caribbean/ CARICOM Climate Adaptation Fund+	20,000,000	14,912,542	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	This fund contributes to insulating Caribbean Community (CARICOM) member countries from disaster risks by enhancing post-disaster response through the coverage of premiums to the Caribbean Catastrophe Risk Insurance Facility and assisting in developing gender-sensitive innovative financing instruments to mobilize private capital for climate adaptation and disaster mitigation.

Caribbean/Support to the Energy Sector in the Caribbean+	1,196,250	891,956	Disbursed	ODA	Grant	Mitigation	Energy	Supports Caribbean countries in their pursuit of energy independence through renewable energy and energy efficiency solutions.
Caribbean/ Compete Caribbean Partnership Facility*	845,100	630,129	Disbursed	ODA	Grant	Cross-cutting	SME development	Aims to increase the productivity and contribution of small- and medium-sized enterprises (SMEs) to inclusive green economic growth in Caribbean region.
Caribbean/ Caribbean Disaster Risk Management Program*	25,569	19,065	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Aims to increase the capacity of regional organizations, national governments and local communities in the Caribbean to respond to and manage natural disasters through institutional support and gender-equal programming, disaster risk management and community resilience strategies.
Caribbean/Climate Change Action for Gender-Sensitive Resilience+	3,000,000	2,236,881	Disbursed	ODA	Grant	Cross-cutting	Environmental policy and administrative management	Aims to strengthen governance of climate change and disaster recovery through improved coordination mechanisms and increased engagement of women's groups.
Caribbean/ Community Disaster Risk Reduction Program+	1,700,000	1,267,566	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Supports initiatives that seek to improve communities-based disaster risk management and climate adaptation across the Caribbean.
Caribbean/ Support to the Caribbean Disaster Emergency Management Agency (CDEMA)*	300,000	223,688	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Aims to improve comprehensive disaster management in the Caribbean Region with a focus on vulnerable populations, particularly women and girls.

Caribbean/Support to the 7th Regional Platform on DRR in the Americas and the Caribbean*	75,000	55,922	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Support to the 7th Regional Platform on Disaster Risk Reduction (DRR) in the Americas and the Caribbean.
Central America/ Climate Smart Agriculture in Central America+	1,800,000	1,342,129	Disbursed	ODA	Grant	Adaptation	Agriculture	Sustainably increase agricultural productivity in support of food security while adapting and building resilience to climate change in Central America.
China/Contribution to the China Council for International Cooperation on Environment and Development (CCICED – China Council)*	253,830	189,263	Disbursed	ODA	Grant	Cross-cutting	Environmental policy and administrative management	The China Council for International Cooperation on Environment and Development (the China Council) is a high-level international advisory body that provides China's State Council (Cabinet) with research-based policy recommendations on environment and development issues.
Colombia/ Colombian Cacao Agropreneurs*	1,075,896	802,217	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Aims to create sustainable livelihood for smallholder farmers of cacao and expand new areas of climate resilient cacao crops.
Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Mexico, Panama, Peru/Developing a Strategic Framework for Collaborative Conservation of Neotropical Migratory Birds and Other Important Species and Habitats in the Central and South America*	4,512	3,364	Disbursed	ODA	Grant	Mitigation	Biodiversity	Aims to highlight the importance of conservation business planning and will present the migratory birds project to developing countries and invite them to participate.

Côte d'Ivoire, Senegal/ Cooperation project between Canada, Côte d'Ivoire and Senegal for emission reduction in the waste management sector+	418,000	311,672	Disbursed	ODA	Grant	Mitigation	Waste Management	Support implementation of Senegal and Côte d'Ivoire's Nationally Determined Contribution (NDC) in the waste sector, by strengthening the policy and regulatory framework and enhancing the technical and operational capacity for data monitoring and validation in the sector.
Côte d'Ivoire, Ghana, Senegal/ The Cooperative Model: Building Inclusive and Sustainable Communities in Côte d'Ivoire, Senegal and Ghana*	1,141,785	851,346	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Support inclusive and green growth by strengthening co-operatives, with particular focus on vulnerable populations and women, including by fostering climate-smart economic activities in the housing and agri-food sectors.
Côte d'Ivoire, Marshall Islands, South of Sahara/ Advancing National Adaptation Planning in Developing Countries+	1,000,000	745,627	Disbursed	ODA	Grant	Adaptation	Environmental policy and administrative management	Aims to reduce vulnerability to climate change for women and men, by improving the quality and integration of gender equality into national adaptation planning and action in developing countries.
Cuba/Contributing to Sustainable Food Production in Cuban Municipalities*	260,415	194,172	Disbursed	ODA	Grant	Adaptation	Agriculture	Increase sustainable agricultural production in five urban and suburban municipalities in Cuba, strengthen the municipal management of the sector and increase production in a sustainable manner, especially by women.

Cuba/Enhancing Women's Leadership and Involvement in Cuba's Renewable Energy Sector*	46,266	34,497	Disbursed	ODA	Grant	Mitigation	Energy	Supports vulnerable communities by improving their access to renewable energy (RE) technology and enhancing women's involvement in the RE sector.
Cuba/Strengthening the Fruit Production Chains in Cuba*	390,000	290,795	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to increase food security in Cuba through strengthening three fruit production chains (mangos, guava and papaya) in order to satisfy demand, and generate sustainable development that allows import substitution.
Democratic Republic of the Congo, Ethiopia, Kenya, Uganda, Zimbabwe/ Supporting Smallholder Farmers in Response to Coronavirus (COVID-19)*	690,000	514,483	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to protect and strengthen the livelihoods and food security for smallholder farming households affected by coronavirus (COVID-19), including increasing access to agricultural extension services and inputs, producing messages on climate-smart agricultural production, and training on agricultural techniques.
Democratic Republic of Congo, Haiti, Senegal/Farmers' Knowledge*	487,707	363,648	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Increase food security and promote sustainable livelihoods to increase climate resilience.

Democratic Republic of the Congo, Uganda, Zimbabwe/Gender Equality in Artisanal Mining*	170,490	127,122	Disbursed	ODA	Grant	Adaptation	Vocational training	Aims to support women working in the Artisanal and Small-Scale Mining (ASM) sector to tackle the barriers they face, with respect to achieving full gender equality in the ASM sector. The project also aims to ensure that the ASM physical environment is better protected to ensure that mining is carried out in ways that do not have a negative impact on women and their communities.
Dominica/Disaster Recovery and Resilience to Schools and Institutions in Dominica*	1,185,000	883,568	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Aims to rehabilitate five elementary schools in Dominica that were severely impacted by Hurricane Maria, including designing, equipping and servicing the schools to incorporate climate resiliency and building the capacity of the Government of Dominica to respond to climatic events by providing climate risk insurance coverage through the Caribbean Catastrophe Risk Insurance Facility (CCRIF).
Dominica/Support to the Development of Dominica's Climate Resilience and Recovery Plan+	8,000	5,965	Disbursed	ODA	Grant	Cross-cutting	Government and Civil Society	Support to the Government of Dominica to develop an enhanced, strategic, gender-sensitive and inclusive Climate Resilience and Recovery Plan (CRRP) that aims to guide resilience-building and reconstruction of Dominica.

Dominica/Support to the Climate Resilience Execution Agency of Dominica (CREAD)+	753,120	561,547	Disbursed	ODA	Grant	Cross-cutting	Environmental policy and administrative management	Supports the Climate Resilience Execution Agency of Dominica (CREAD)'s in implementation of key recovery and reconstruction projects, and provide technical assistance to transform systems and build capacity in the civil service so that Dominica is able to manage recovery from future disaster events more effectively.
Ethiopia/Improving Access to Clean Water – Zala Dola*	4,317	3,219	Disbursed	ODA	Grant	Adaptation	Water	Aims to provide clean water in areas affected by drought, and to provide basic health and hygiene education.
Ethiopia/Integrated Approach to Maternal, Newborn and Child Health in Rural Ethiopia*	807,813	602,327	Disbursed	ODA	Grant	Cross-cutting	Food security	Addressing malnutrition by increasing access to quality nutrition, water, and sanitation services, for the most vulnerable populations affected by climate change in Ethiopia.
Ethiopia/Resilient Landscapes and Livelihoods for Women in Ethiopia*	720,000	536,852	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve the food security, livelihoods and economic well-being of women and men small holder farmers through sustainable land management practices, climate change adaptation and climate-smart income-generating activities.
Ethiopia/Rural Social Protection: Productive Safety Net Program 2016–2021*	7,950,000	5,927,735	Disbursed	ODA	Grant	Cross-cutting	Food security	Aims to enhance household and community resilience to climate shocks, such as droughts, and improve household food security, nutrition and economic well-being in Ethiopia's most vulnerable communities.

Ethiopia, Ghana, Senegal/4R Nutrient Stewardship Project*	1,498,122	1,117,040	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Aims to improve the agricultural productivity and farm income of smallholder farmers and their resilience to climate change, including strengthening women's leadership in agricultural cooperatives, improving their access to productive resources, and promoting best practices in integrated soil fertility management and conservation agriculture.
Fiji, Solomon Islands, Vanuatu/ Markets for Change: Empowerment of Women in the Pacific Islands*	465,000	346,717	Disbursed	ODA	Grant	Adaptation	Policy	Aims to promote gender equality and the social and economic empowerment of women vendors across Pacific Island markets, ensuring that selected marketplaces in rural and urban areas are safe, inclusive and non-discriminatory environments, promoting gender equality and women's empowerment. The projects also aims to improve physical infrastructure and operating systems to make markets more sustainable, more resilient to disaster risks and climate change, safer and more accessible.
Gambia, Guinea, Guinea-Bissau, Senegal/Adaptation of Coastal Communities and the Blue Economy (APOCEB)*	1,080,000	805,277	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	Aims to improve the economic, social and environmental development of coastal communities in a sustainable way, as well as the resilience of vulnerable populations to climate change.
Ghana/Farmers' Economic Advancement Through Seedlings*	472,290	352,152	Disbursed	ODA	Grant	Adaptation	Agriculture	Support to enhance the productivity of small farmers in tree crops, including through increased environmentally sustainable farming in Ghana's tree crop industry.

Ghana/Modernizing Agricultural Production*	7,825,893	5,835,198	Disbursed	ODA	Grant	Mitigation	Agriculture	Seeks to implement a comprehensive market-oriented approach to farming to strengthen agricultural extension services and make the agriculture sector more modern, equitable and sustainable, including by updating and reorienting a standardized curriculum for agricultural colleges and farm institutes to be more market-focused, gender-sensitive and climate-smart.
Ghana/Women's Innovation for Sustainable Enterprises (WISE)*	631,800	471,087	Disbursed	ODA	Grant	Cross-cutting	Agriculture	The project seeks to establish women-friendly business hubs (HerHubs) which will serve as a 'one-stop shop' for women to access gender-responsive services to start and grow small enterprises, especially in the soybean and green sectors.
Ghana, Tanzania, Uganda/Youth Challenge International – Volunteer Cooperation 2020-2027*	493,911	368,273	Disbursed	ODA	Grant	Adaptation	Business Policy and Administration	Supports volunteer placements with the aim to improve the economic and/or social well-being of the poorest, most marginalized and vulnerable people in developing countries, with a view to contributing to the Sustainable Development Goals, and to increase the performance of developing country partners to deliver more inclusive, innovative and environmentally sustainable development initiatives that advance gender equality.

Guatemala/ Economic Empowerment of Indigenous Women and Youth in Alta Verapaz*	353,502	263,581	Disbursed	ODA	Grant	Cross-cutting	Business Policy and Administration	Aims to increase the economic empowerment of Indigenous women and youth in Alta Verapaz by strengthening business practices and skills of small-scale enterprises led by Indigenous women and youth, including training on business and financial administration, environmentally and climate-resilient production practices, and social responsibility.
Guatemala/ Sustainable Economic Growth for Women and Youth in Alta Verapaz*	150,000	111,844	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Aims to improve agricultural entrepreneurship in the sectors of organic cardamom and turmeric, and contribute to strengthening clean and sustainable practices by improving their inclusive governance and supporting adoption of green practices.
Guatemala, Honduras, Nicaragua/ Supporting Coronavirus (COVID-19) Response in Rural and Indigenous Communities*	600,000	447,376	Disbursed	ODA	Grant	Adaptation	Agriculture	The project aims to increase the resilience of local food systems against the food, health, and economic impacts of coronavirus (COVID-19) in vulnerable rural and Indigenous communities in Guatemala, Honduras, and Nicaragua, including access to locally-produced, agro-ecologically adapted grain seeds and fruit trees.
Haiti/Adaptive and Innovative Solutions for Agri-Food Market Opportunities in Haiti*	430,695	321,138	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Aims to strengthen the maize value chain through expanded commercialization and sustainable crop production, promoting added value and climate change adaptation in the targeted value chains, and enhancing rural farm families' resiliency to recurrent natural disaster through disaster risk reduction awareness-raising.

Haiti/Strengthening agri-food value chains*	4,407	3,286	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Monitoring and evaluation of five projects coming from the call for proposals "Haiti: Strengthening agri-food value chains and adaptation to climate change" as well as for administrative purposes, coordination activities, knowledge building and technical assistance.
Haiti/Cashew, Mango and Gardening Value Chains Development for the Benefit of Women and Youth+	167,900	125,191	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve the economic well-being and reduce the vulnerability of Haitian women and men living in rural areas, including climate change-adapted value chains and agro-ecological practices.
Haiti/Creole Garden Revalorisation+	1,027,130	765,856	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to develop value chains in the coffee- and cacao-based agroforestry systems, improve producers' ability to adapt to climate change, encourage the creation of skills to adapt agroforestry to climate change, and build the governance capacity of local and departmental bodies with regard to climate change adaptation.
Haiti/Climate Adaptation and Economic Development of Agricultural Sectors in Haiti+	2,370,620	1,767,598	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve the economic well-being and reduce the vulnerability of rural households through its strategy to promote climate change adaptation and resilience in agricultural practices and value chains.
Haiti/Improving Gender Equality, Waste Management and Clean Energy in Haiti*	257,889	192,289	Disbursed	ODA	Grant	Cross-cutting	Waste Management	Aims to integrate waste management through allowing the sale of carbon credits and the production of green energy through the recovery of biogas produced by the decomposition of waste.

Haiti/Transforming the Market for Stoves and Clean Energy in Haiti+	1,508,530	1,124,801	Disbursed	ODA	Grant	Mitigation	Energy	Restructure and boost the market for efficient stoves and clean energy in order to protect the environment, improve the health of women and children and strengthen women's economic power within new value chains for producing and marketing stoves and clean energy.
Haiti/Productive and Inclusive Coffee Value Chain Adapted to Climate Change in Haiti+	1,352,950	1,008,796	Disbursed	ODA	Grant	Adaptation	Agriculture	Seeks to adapt this value chain to climate change and supports applied research, activities to enhance sustainable seed management mechanisms and activities to promote/introduce green technologies.
Haiti/Yon pyebwa ka fe diferans: United to fight climate change+	49,530	36,931	Disbursed	ODA	Grant	Adaptation	Forestry	Aims to strengthen the capacities of farmers' organizations for environmental protection and agroforestry, a model of agriculture that is more resilient to climate change.
Honduras/Canada-Honduras Value Added Agroforestry Project*	717,522	535,004	Disbursed	ODA	Grant	Cross-cutting	Agriculture and Forestry	Implementation of agroforestry practices to mitigate carbon emissions through carbon sequestration and diverse planting for soil preservation, as well as promoting varieties of climate-resilient crops to withstand climate change impacts and yield more products available to markets.

Honduras/ Empowerment of Women for Climate Action in Honduras+	1,732,420	1,291,739	Disbursed	ODA	Grant	Mitigation	Forestry	Aims to improve the quality of life of rural and Indigenous women and youth whose livelihoods depend on forest resources, including improving the governance for the conservation and sustainable management of the forest and its associated biodiversity, and aligning the use of forest resources and biodiversity with municipal climate change and development plans.
Honduras/ Rural Market Opportunities in the Gulf of Fonseca in Honduras*	1,068,693	796,846	Disbursed	ODA	Grant	Cross-cutting	Cross-Cutting	Improve the economic well-being of small-scale entrepreneurs and producers in the Dry Corridor of Honduras, especially women, youth and marginalized people living in poverty.
Honduras/ Promoting Rural Economic Development for Women and Youth in the Lempa Region – PROLEMPA*	566,658	422,516	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	Improve the economic well-being of small-scale entrepreneurs and producers in the tourism and coffee sectors, in particular women, youth and Indigenous People in the Dry Corridor of Honduras.
Jordan/Sustainable Economic Development Through Renewable Energy+	5,056,160	3,770,010	Disbursed	ODA	Grant	Mitigation	Energy	Aims to improve livelihoods through the introduction of renewable energy and energy efficiency solutions at the household level.
Jordan/Sustainable Development in Jordan*	14,664	10,934	Disbursed	ODA	Grant	Mitigation	Energy	Introducing cost-saving renewable energy-efficient solutions for poor households, supporting low-carbon development in Jordan.

Kenya/More Food: Empowering Kenyan Women*	124,431	92,779	Disbursed	ODA	Grant	Adaptation	Agriculture	Improved food and nutrition security of farm families by integrating a number of innovative approaches to increase agricultural productivity, income, nutritional knowledge and skills among the target population. This includes training on best agriculture and livestock practices, as well as biogas, rain water harvesting and solar power technologies.
Kenya/Equitable Prosperity Through Private Sector Development*	1,028,256	766,696	Disbursed	ODA	Grant	Adaptation	SME Development	Aims to create sustainable economic growth by supporting the development of competitive small- and medium-sized enterprises (SMEs), applying environmentally sustainable and green business in the agriculture and construction sectors.
Latin America and the Caribbean/ Canadian Climate Fund for the Private Sector in the Americas II+	66,000,000	49,211,388	Disbursed	ODA	Concessional Loan	Cross-cutting	Cross-cutting	Aims to catalyze private sector investments in climate change mitigation and adaptation across the Latin America and Caribbean region, while promoting gender-responsive, sustainable economic development.
Latin America and the Caribbean/ Sustainable Energy Access for Latin American and Caribbean Region*	18,597	13,866	Disbursed	ODA	Grant	Cross-cutting	Energy	Support for improved access to sustainable and affordable energy needed to promote economic growth in the region, by improving capacities for energy planning and regulation across countries in the region.

Latin America and the Caribbean, South of Sahara/ FinDev Canada Technical Assistance Project*	251,226	187,321	Disbursed	ODA	Grant	Cross-cutting	Business Policy and Administration	Aims to address the capacity gaps experienced by target Investors to help them reach their full impact potential in areas of: gender equality; corporate governance and leadership; environmental and social risk management; inclusive human capital development; and impact measurement and reporting. The objectives include delivering climate-specific gender equality for partner companies in the green growth sector and enhancing business operations' environmental, social and governance practices.
Mali/Rehabililtation of Agricultural Irrigation Infrastructures in the Zone of the Office du Niger (PAON)*	308,979	230,383	Disbursed	ODA	Grant	Adaptation	Agriculture	Helping to develop and rehabilitate agricultural irrigation infrastructure and hydro-agricultural development to increase agricultural production in Mali, including implementing agriculture, water management, reforestation practices to help build resilience to climate-induced vulnerabilities.
Mali/Strengthening Irrigated Agriculture in Mali (REAGIR)*	10,770	8,030	Disbursed	ODA	Grant	Adaptation	Agriculture	Support to sustainably develop irrigated agriculture to increase food security through the construction and rehabilitation of productive infrastructure, such as irrigated fields and micro dams.

Mali/Strengthening the Nutritional Resilience and Food Security of the Most Vulnerable in Mali*	2,550,000	1,901,349	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to improve the food, nutrition, and health situation, increase agricultural productivity and incomes of target populations, while tackling the effects of climate change on food security in their communities.
Mexico/Support for the NDC Implementation in Mexico (Oil and Gas)+	593,770	442,731	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Aims to support NDC implementation focusing on addressing emissions from Mexico's Oil and Gas Sector.
Mongolia/CHIPS for Kids: Improving child health through reducing air pollution in Mongolia's cities*	6,000	4,474	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Aims to address the health risks to children of air pollution through community awareness and citizen-driven initiatives to reduce air pollution and increase demand for cleaner and more efficient Cooking, Heating, and Insulation Products and Services (CHIPS) for households.
Morocco/ Empowering Women Through the Development of Forestry Cooperatives in Morocco+	700,000	521,939	Disbursed	ODA	Grant	Adaptation	Agriculture and Forestry	Aims to improve the living conditions of women and men in rural communities who are members of forestry cooperatives by supporting sustainable management and processing of rosemary and cedar, taking into account climate change and environmental sustainability.
Mozambique/ Mozambican Rural Women's and Girls' Economic Empowerment (PAEF)*	375,006	279,615	Disbursed	ODA	Grant	Adaptation	Agriculture	Supports women's and girls' economic empowerment in rural districts through a multi-faceted approach that highlights women's and girls' constraints with regard to climate change-friendly income-generating activities.

Multiple Countries/ Agroecology and ancestral knowledge for the respect of the environment*	15,261	11,379	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Aims to strengthen the use of agroecological practices that respect the environment.
Multiple Countries/ Canadian Crossroads International – Volunteer Cooperation 2020–2027*	961,944	717,251	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to improve the economic and social well-being of the poorest, most marginalized and vulnerable people by supporting volunteer placement, capacity-building, and special thematic funds to promote gender equality, environmental sustainability, economic empowerment, and human rights.
Multiple Countries/ Centre for International Studies and Cooperation – Volunteer Cooperation 2020–2027*	1,766,124	1,316,870	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	Aims to improve the economic and social well-being of the poorest, most marginalized and vulnerable people, including providing training and financial and technical support on the economic empowerment of women and young women and their rights and the design and delivery of sustainable products and services.
Multiple Countries/ CESO – Volunteer cooperation 2020–2027*	1,284,030	957,408	Disbursed	ODA	Grant	Adaptation	Cross-cutting	This project supports volunteer placements, and aims to improve the economic and/or social well-being of the poorest, most marginalized and vulnerable people, with a view to contributing to the Sustainable Development Goals. This project also aims to increase the performance of developing country partners to deliver more inclusive, innovative, and environmentally sustainable development initiatives that advance gender equality.

Multiple Countries/ Contributions to the Inter-American Institute for Global Change Research (2019–2020)*	57,171	42,628	Disbursed	ODA	Grant	Cross-cutting	Research and Scientific Institutions	Contribution enables the IAI to administer environmental change research projects and advance work on scientific capacity-building, communication and data access.
Multiple Countries/ FinDev: Corporación Interamericana para el Financiamiento de Infraestructura, S.A. (CIFI)	20,117,295	15,000,000	Committed	OOF	Non-concessional loan	Mitigation	Energy, Water and Sanitation	FinDev Canada's loan to Corporación Interamericana para el Financiamiento de Infraestructura, S.A. (CIFI) is earmarked to finance the building of renewable energy projects, including solar, wind, mini-hydroelectric and biomass power plants, as well as water and sanitation infrastructure.
Multiple Countries/ Climate and Clean Air Coalition Trust Fund (CCAC)+	1,000,000	745,627	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Support the implementation of initiatives that reduce the emissions of short-lived climate pollutants (SLCPs) in various sectors such as agriculture, waste and household energy.
Multiple Countries/ Climate change mitigation in agriculture internship in the Climate and Environment Division of the Food and Agriculture Organization of the United Nations (FAO), Rome (2019 -016)+	15,000	11,184	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Administered by the Ministère des Relations internationales et de la Francophonie.

Multiple Countries/ Internship in the field of sustainable land, soil and water management, in the land and water division at the Food and Agriculture Organization of the United Nations (FAO) in Rome (2019- 002)*	9,000	6,711	Disbursed	ODA	Grant	Mitigation	Agriculture	FAO's Land and Water Division is responsible for implementing this integrated landscape management approach using comprehensive strategies for sustainable land, soil and water management.
Multiple Countries/ Climate Finance Access Service (CFAS) (cross-cutting)+	81,000	60,396	Disbursed	ODA	Grant	Cross-cutting	Environmental policy and administrative management	The Climate Finance Access Service (CFAS) aims at helping developing countries unlock funding for climate support by deploying a network of trained, independent climate finance investment facilitators into Least Developed Countries (LDCs), Small Island Developing States (SIDS), and African countries to help secure finance for these countries' priority projects pursuant to Paris Agreement.
Multiple Countries/Climate Finance Access Service (CFAS) (mitigation)+	29,000	21,623	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	The Climate Finance Access Service (CFAS) aims to Improve the capacity of low-income countries to unlock funding for green investment.
Multiple Countries/ Contribution to the Intergovernmental Science-policy Platform on Biodiversity and Ecosystem Services (IPBES)+	40,000	29,825	Disbursed	ODA	Grant	Cross-cutting	Research and Scientific Institutions	The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) aims to strengthen the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development.

Multiple Countries/ Cuso International – Volunteer Cooperation 2020-2027*	1,845,240	1,375,861	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to improve the economic and social well-being of the poorest, most marginalized and vulnerable people, especially women and girls, in developing countries by supporting volunteer placements and enhancing the performance of developing country partners to deliver more inclusive, innovative and environmentally sustainable development initiatives that promote gender equality. Partners include key climate change organizations that promote women's participation, climate change mitigation and adaptation measures and sustainable management of natural resources.
Multiple Countries/ IDRC-Adaptation+	8,657,430	6,455,214	Disbursed	ODA	Grant	Adaptation	Cross-cutting	International Development and Research Centre support for adaptation action.
Multiple Countries/ IDRC-Adaptation*	1,023,168	762,902	Disbursed	ODA	Grant	Adaptation	Cross-cutting	International Development and Research Centre support for adaptation action.
Multiple Countries/ IDRC-Cross-cutting+	870	649	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	International Development and Research Centre support for climate change action.
Multiple Countries/ IDRC-Cross-cutting*	769,689	573,901	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	International Development and Research Centre support for climate change action.
Multiple Countries/ IDRC-Mitigation+	464,150	346,083	Disbursed	ODA	Grant	Mitigation	Cross-cutting	International Development and Research Centre support for mitigation action.

Multiple Countries/ International Union for Conservation of Nature (IUCN)* (Adaptation)	170,367	127,030	Disbursed	ODA	Grant	Adaptation	Environmental policy and administrative management	Annual State Party membership fees to the International Union for Conservation of Nature (IUCN) for support of the delivery of conservation programs (for 2021 fees).
Multiple Countries/ International Union for Conservation of Nature (IUCN)* (Cross-cutting)	4,773	3,559	Disbursed	ODA	Grant	Cross-cutting	Environmental policy and administrative management	Annual membership of IUCN to support the implementation of the Programme and governance of the Union, the facilitation of global networking and communications, and the sharing of knowledge and expertise.
Multiple Countries/ Contribution to the Group on Earth Observations (GEO) Trust Fund*	30,000	22,369	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Support to the Global Earth Observation System of Systems, which aims to provide comprehensive coordinated Earth observations using worldwide instruments and is expected to yield significant benefits to society. In particular, GEO helps to build national capacity in developing countries by enabling human, technical and institutional capacity for coordinating, accessing, using and sharing environmental data, information and services.
Multiple Countries/ Oxfam-Québec – Equality in Action – Volunteer Cooperation 2020-2027*	968,322	722,007	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to improve the economic and/or social well-being of the poorest, most marginalized and vulnerable people by supporting volunteer placement, peer learning initiatives, and public events for key global issues in support of gender equality, empowerment of women ad girls, and inclusive governance.

Multiple Countries/ Solar energy as a partner in a healthy life*	32,118	23,948	Disbursed	ODA	Grant	Mitigation	Energy	Improve food security as well as the environmental and economic resilience of households.
Multiple Countries/ Strengthening Food Systems in Response to Coronavirus (COVID-19)*	1,800,000	1,342,129	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Aims to increase the food security and resilience of farmers and rural communities impacted by coronavirus (COVID-19), including providing gender-equitable agricultural inputs and timely information on agricultural markets, weather, production techniques, remote training, and COVID-19 updates.
Multiple Countries/ SUCO – Volunteer Cooperation 2020–2027*	232,383	173,271	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	Aims to support volunteer placement and improve the economic and social well-being of the poorest, most marginalized and vulnerable people in targeted developing countries in order to contribute to the Sustainable Development Goals, including climate change, food insecurity, and social and economic inequalities.
Multiple Countries/ Support to Address Short-Lived Climate Pollutant (SLCP) Emissions in the Pacific Alliance and West Africa+	2,332,560	1,739,220	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Canada is helping countries in the Pacific Alliance and West Africa define regional priorities to address greenhouse gas and SLCP emissions and to pursue opportunities for harmonizing measurement, reporting and verification (MRV) systems. Funding is supporting cooperation within and between the two regions, to facilitate the exchange of best practices that align with regional MRV priorities and help seed opportunities for replication of best practices generated from bilateral projects in the region.

Multiple Countries/ Support to TaxCOOP 2020*	66,765	49,782	Disbursed	ODA	Grant	Cross-cutting	Financial services	Supports TaxCOOP 2020, an international conference on tax competition and collaboration, to discuss issues of taxation equity, wealth distribution and fiscal reform, including themes such as climate change.
Multiple Countries/ United to fight climate change*	13,572	10,120	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Support provided by Carrefour de solidarité internationale.
Multiple Countries/UPA Développement international – Volunteer cooperation 2020–2027*	234,960	175,193	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Supports volunteer placements and aims to improve the economic and social well-being of the poorest, most marginalized and vulnerable people with a view to contributing to the Sustainable Development Goals, including establishing thematic funds to support the development of agri-food activities by women and girls, agri-environment, agroforestry, and adaptation to climate change.
Multiple Countries/ Workshop on Climate Change Negotiations for Francophone Women Leaders*	4,050	3,020	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Support 250 francophone women leaders from Organisation internationale de La Francophonie in building the knowledge, the skills, and personal abilities necessary to participate in climate change decision-making (as member of national delegations) and to advance international negotiations related to gender and climate change.

Multiple Countries/ Science investments in agri-environmental resilience and preparedness (Adaptation)+	10,236,802	7,632,837	Disbursed	OOF	Grant	Adaptation	Agriculture	AAFC research on climate change adaptation to address global agri-environmental challenges. Projects include improving soil, water and air quality and/or quantity, protecting/enhancing biodiversity, adapting to climate change (through breeding, new farm management practices, etc.).
Multiple Countries/ Science investments in agri-environmental resilience and preparedness (Cross-cutting)*	3,284,447	2,448,972	Disbursed	OOF	Grant	Cross-cutting	Agriculture	Research projects include, desertification, improving soil health, sustainable land management, reversing land/soil degradation.
Multiple Countries/ Science investments in agri-environmental resilience and preparedness (Mitigation)+	9,851,124	7,345,265	Disbursed	OOF	Grant	Mitigation	Agriculture	AAFC research on Climate change mitigation to address global agri-environmental challenges. Projects include improving carbon sequestration and/or mitigating greenhouse gas emissions.
Multiple Countries/ The Economic and Environmental Consequences of Confronting Climate Change in the Agriculture Sector Through Trade*	7,500	5,592	Disbursed	OOF	Grant	Mitigation	Agriculture	The project's implementing partner is the Organisation for Economic Co-operation and Development (OECD).

Multiple Countries/ Supporting the Powering Past Coal Alliance Secretariat+	155,000	115,572	Disbursed	OOF	Grant	Mitigation	Environmental policy and administrative management	The PPCA is the world's leading coalition of national and sub-national governments, businesses and organisations working to advance the transition away from unabated coal power. Launched in 2017, the PPCA brings together more than 100 members and is widely recognized as a driver for ambition on climate action. The secretariat supports Canada and the UK as co-leads of the PPCA by providing operational, technical and administrative support.
Multiple Countries/ Collaboration with the Pan American Health Organization (PAHO) on Climate Change and Health*	435	324	Disbursed	OOF	Grant	Mitigation	Health	Support the PAHO Biennial Work Plan on Climate Change and Health and PAHO Strategy and Plan of Action on Health, Environment and Climate Change 2020–2030.
Myanmar/Climate Change and Disaster Resilience in Myanmar+	2,500,000	1,864,068	Disbursed	ODA	Grant	Adaptation	Disaster prevention and preparedness	Contribute to building disaster-ready and financially resilient national and local government and private sector institutions, and increase resilience in communities in Ayeyarwady, a disaster-prone and highly populated delta region of Myanmar.
Myanmar, Niger, Sudan/Breaking barriers, Improving Girls' education, Hope and Totality (BRIGHT)*	618,867	461,444	Disbursed	ODA	Grant	Adaptation	Education	The project aims to increase community-led actions in breaking multi-dimensional barriers to gender equal education for vulnerable girls and women, including improved availability of inclusive, innovative, gender and climate-responsive education systems and increased access to gender-responsive, environment-sensitive market-driven learning opportunities for livelihood and life skills.

Nepal/ Reconstruction of Water, Sanitation and Hygiene Services*	35,208	26,252	Disbursed	ODA	Grant	Adaptation	Water	Increasing access to and use of safe drinking water, sanitation and hygiene (WASH) services in severely and crisis-hit earthquake affected areas in Nepal. The project is training local government officials and community organizations to respond to the current and future WASH needs of these communities, building resilience for the long-term.
Nepal/Support to Rights and Economic Development for Nepal's Empowered Women (RENEW)*	6,945	5,178	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to enhance the social and economic empowerment of women and girls and most vulnerable groups by implementing poverty reduction measures, bringing a human rights-based approach to economic and social growth, focusing on climate change adaptation, and enhanced performance of micro/small-scale enterprises.
Nicaragua/Gender-Responsive Climate-Smart Agriculture in Nicaragua*	1,701	1,268	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve the resilience of women, men, girls and boys to climate change-related food insecurity, especially addressing its gendered impacts through gender-responsive climate-smart agriculture.
Nicaragua/ Technolinks+: Advancing Inclusive Prosperity in Nicaragua's Agri-food Export Sector*	488,157	363,983	Disbursed	ODA	Grant	Adaptation	Agriculture	Facilitate the access, promotion and adoption of environmentally-sustainable, climate-resilient agricultural technologies with the objective of increasing agricultural productivity, quality, and profitability for smallholder farmers and agribusinesses, cooperatives and producers associations.

Nigeria/Livelihoods and Nutrition Empowerment*	899,781	670,901	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve the lives and incomes of poor and vulnerable farming households through agriculture-driven economic growth, incorporating training and related technical support in modern farming methods. Environmental sustainability and climate adaptation have been integrated in the various activities, including agrochemcial inputs, value chain enhancement, leadership training, household resilience, and community strategies.
Oceania/Kiwa Initiative+	3,600,000	2,684,258	Disbursed	ODA	Grant	Adaptation	Biodiversity	Aims to make Pacific Island ecosystems, economies and communities who are heavily dependent on land and marine biodiversity, especially Indigenous women, more resilient to the impacts of climate change.
Oceania/ Strenghtening Small-Scale Fisheries in the Pacific Islands*	300,000	223,688	Disbursed	ODA	Grant	Adaptation	Fishery	Aims to increase the resilience and adaptability of fishermen and fisherwomen to the climate changes affecting their livelihoods and food security, in the vulnerable coastal communities of Fiji, Vanuatu and Solomon Islands.
Peru/Agricultural Training Program and Support of Youth Entrepreneurship in Peru*	430,860	321,261	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve and strengthen sustainable agriculture practices and to develop adaptation measures including efficient water management, water conservation, crop diversification, green infrastructure for water conservation, and improved climate-resilient pasture management.

Peru/Canada – Peru Webinar on Pollutant Release and Transfer Registers (PRTR)*	1,212	904	Disbursed	ODA	Grant	Cross-cutting	Environmental policy and administrative management	A webinar that aims to help Peru develop its legislation to create a Pollutant Release and Transfer Registers (PRTR) system.
Peru/Participatory Water Management and Climate Resilience for Andean Women and Men+	4,000,000	2,982,508	Disbursed	ODA	Grant	Adaptation	Water	Aims to promote the conservation, restoration, and rehabilitation of natural ecosystems (“natural infrastructure”) to improve water security and climate risk resilience in Peru.
Peru/Solar energy as a partner in a healthy life*	16,059	11,974	Disbursed	ODA	Grant	Mitigation	Energy	Improve food security as well as the environmental and economic resilience of households.
Philippines/Haiyan Reconstruction Assistance: Restoring, Empowering and Protecting (REAP) Livelihoods Post Haiyan*	213,393	159,112	Disbursed	ODA	Grant	Adaptation	Reconstruction relief and rehabilitation	Support for reconstruction and the restoration of lost assets and livelihoods after Typhoon Haiyan, including increased participation of women and men in affected regions, resilient agriculture, disaster risk reduction planning capacity, and improved access to business development services.
Senegal/Adaptation and Valorization of Entrepreneurship in Irrigated Agriculture+	1,108,300	826,378	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to improve the socio-economic well-being and resilience of farming households through climate-friendly agricultural and irrigation practices.
Senegal/Building Community Resilience to Climate Change in Senegal+	211,790	157,916	Disbursed	ODA	Grant	Cross-cutting	Agriculture and Forestry	Aims to improve rural communities’ resilience to climate change, especially for women, in the Kedougou region of Senegal.
Senegal/Clim'action for Khalambasse*	13,389	9,983	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Aims to reduce the negative effects of climate change in the community of Khalambasse in Senegal, including improving soil quality and crop yields and increasing forest cover in the community.

Senegal/Feminine Governance and Innovation in Senegal*	300,000	223,688	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Aims to enhance the economic, social and environmental development of these communities in a sustainable way and to improve the living, working and health conditions of the inhabitants, including young people's role governance methods and the adaptation of these coastal communities to climate change.
Senegal/Women, Agriculture and Resilience in Senegal+	1,203,130	897,086	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to transform gender and age group relations, increase access to economic opportunities that are adapted to climate change in irrigated crop sectors, and facilitate cooperation for water resources through irrigated crops adapted to climate change.
South Africa/ Building Inclusive Green Municipalities* (funded by Global Affairs Canada)	297,717	221,986	Disbursed	ODA	Grant	Cross-cutting	Policy	Aims to strengthen the capacity of South African municipal governments to support effective service delivery, strengthen women's empowerment, inclusive local green economic growth and enhanced climate change mitigation and adaptation measures.
South of Sahara/ Improving Bean Markets in Africa*	476,673	355,420	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Aims to improve food security, income and health in Sub-Saharan Africa by helping farmers and SMEs to take advantage of the regional commercial opportunities of the bean crop, including research and production of climate-smart seeds to support and distribute to farmers.

South Sudan/ Fortifying Equality and Economic Diversity for Resilience in South Sudan*	1,664,022	1,240,740	Disbursed	ODA	Grant	Adaptation	Agriculture	Aims to advance gender appropriate and climate-smart agricultural training, including providing training to women and their communities on natural disaster planning and response, natural resource management, and conflict resolution.
South Sudan/ Fortifying Equality and Economic Diversity*	2,538	1,892	Disbursed	ODA	Grant	Adaptation	Agriculture	Support smallholder farmers to protect natural resources and become more food secure in seven South Sudanese states. The project seeks to reduce vulnerability of the most marginalized people in the local population and increase the resilience of the population to shocks, including climate-induced shocks.
South Sudan/ Building Resilience Through Safety Nets in South Sudan*	2,460,000	1,834,243	Disbursed	ODA	Grant	Adaptation	Food security	Aims to meet the immediate food needs of vulnerable people, while promoting longer-term food security through community projects that increase food production, including training to participants on climate-smart agriculture, crop diversification, and reduction of post-harvest losses.
Tanzania/ Broadcasting for Change: Empowering Young Women Through Media in Tanzania*	358,815	267,542	Disbursed	ODA	Grant	Cross-cutting	Health	Aims to empower young women and girls across Tanzania to make their own decisions regarding their social, economic and political rights.

Tanzania/ Supporting Systems to Achieve Improved Maternal Newborn and Child Health in Kigoma Region*	434,838	324,227	Disbursed	ODA	Grant	Mitigation	Health	Aims to strengthen the capacity of health facility management teams to deliver services by training local health managers on evidence-informed program planning, decision-making, and supply chain management.
Vietnam/Reducing Short Lived Climate Pollutants through Improved Municipal Solid Waste (MSW) Practices in Vietnam+	270,000	201,319	Disbursed	ODA	Grant	Mitigation	Environmental policy and administrative management	Support implementation of Vietnam's Nationally Determined Contribution (NDC) in the solid waste sector, supporting municipalities to assess their solid waste management practices, identity solutions to reduce short lived climate pollutants and leverage funding to implement climate actions.
Zimbabwe/ Supporting Transition, Retention, and Training for Young Women and Girls*	593,928	442,849	Disbursed	ODA	Grant	Adaptation	Education	The project aims to strengthen the capacities of adolescent girls and young women, and the broader education system that supports them.
Total contributions through bilateral regional and other channels	**546,047,544**	**407,147,837**						

Notes:

2020: Information covers calendar year January 2020 to December 2020.

Exchange rates based on OECD/DAC Rates for 2020: (USD-CAD) 1.341153. Amounts are rounded to the available level of confidence.

(+) Contribution targeting the Rio Conventions as a "principal objective".

(*) Contribution targeting the Rio Conventions as a "significant objective".

(†) Contribution was provided by provincial government.

Core contributions to multilateral organizations are calculated based on OECD stats on MDB imputed climate shares in 2020. 2020 shares are assumed constant from 2019 levels in the absence of 2020 share for a multilateral institution.

Documentation Box

1: Core/general
Core funding is reported for several additional institutions whose project portfolios may include some climate objectives. The figures represent support to multilateral institutions that Canada cannot specify as climate-specific. This in keeping with the UNFCCC Biennial Reporting Guidelines for developed country Parties.
2: Climate-specific
Climate finance contributions are clearly identified as being entirely dedicated to climate or significantly dedicated to climate, using the OECD-DAC Creditor Reporting System (CRS). Through the CRS, activities are marked as either principal or significant. Activities marked with a principal climate change objective are counted in their totality. Recognizing the importance of integrating climate considerations into developed assistance, Canada counts 30 percent of the funding to projects with a significant climate change marker. In tracking contributions to multilateral organizations, Canada uses the climate-related imputed multilateral shares, calculated annually by the OECD Development Assistance Committee (DAC). For public financial support provided in 2020, Canada used the OECD DAC 2020 imputed multilateral shares. For some multilateral organizations, imputed shares were assumed constant from 2019 if no new value were provided by the OECD DAC for 2020. Canada draws on this imputed multilateral contribution (inflow) data from the OECD, to report on the climate-specific share of its core contributions to multilateral institutions. Canada has determined the climate-specific share of its core contribution to the UNDP based on calculation provided by the UNDP on its 2019 and 2020 resources for climate activities. This is in line with Canada's evolving methodological approach to tracking, which includes self-determining climate-specific shares of contributions if the OECD DAC does not provide share values for climate-related imputed shares for multilateral organizations that are increasing their climate change support.
3: Status
Canada reports climate finance disbursements to the UNFCCC, except for Canada's Development Finance Institution, FinDev Canada, for which its reports on amounts committed. Disbursements record the transfer of financial resources and are defined as the releasement of funds to a recipient or implementing partner; by extension, the amount spent. Committed is defined as a firm written obligation to provide resources of a specific amount under specified financial terms and conditions and for specified purposes.
4: Funding source
Projects with climate change activities supported through Canada’s Official Development Assistance (ODA) and other official flows (OOF) are part of Canada’s climate finance. Canadian ODA is defined in the Official Development Assistance Accountability Act. This definition is compatible with the international definition created by the DAC of the OECD. When support does not qualify as ODA, it is classified as OOF.

5: Financial instrument
Canada uses a blend of financial instruments to deliver its climate finance, including: grant, concessional loans, equity, among others in line with UNFCCC commitments. All instruments are accounted for at face value.
6: Type of support
Canada defines a climate project as a project with one of the following objectives or co-benefits: mitigation, adaptation, and cross-cutting. Canada's definition of these sectors is based on the ones of the OECD-DAC. When funded activities support both adaptation and mitigation equally, support is identified as "cross-cutting" programming.
7: Sector
Sectors are determined at a project level for bilateral contributions using OECD-DAC definitions.
New and Additional: Canada's $2.65 billion climate finance commitment is a substantial increase from Canada's past levels of climate funding, scaling up to $800 million per year by 2020. Through this commitment, Canada is supporting climate projects that are above and beyond what was planned prior to the Convention and Copenhagen Accord. Looking forward, a key goal of the Paris Agreement is to ensure financial flows are consistent with low GHG emission and climate resilient development. While finance to developing countries to enhance their climate action will continue to play an important role, success in achieving this goal will also depend on strategically using all available public resources and smart climate policies to mobilize private finance as well as aligning these investments with the goals set out in the Paris Agreement and the 2030 Sustainable Development Agenda.

Annex 2: Technology and Capacity-Building Tables

Table 7-4: Provision of technology development and transfer support

Recipient Country and/or Region	Targeted Areas	Measures and activities related to technology transfer	Sector	Source of funding	Activities undertaken by	Status	Additional Information
Global	Mitigation	Provision of the Carbon Budget Model of the Canadian Forest Service	Forest	Public	Public	On-going	Provision of the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) and spatially explicit Generic Carbon Budget Model (GCBM) for adapting to national forest ecosystems in recipient countries. Each model, once adapted, allows users to examine the impact of forest management on carbon stocks and stock changes. The open-source GCBM functions on moja global's Full Lands Integration Tool (FLINT) software platform, co-developed by Australian Greenhouse Gas experts and the CFS, under the Linux Foundation.
Global	Mitigation	RETScreen Clean Energy Management Software	Energy	Public	Public	On-going	World's leading clean energy decision-making software which has helped significantly reduce costs associated with identifying and assessing potential clean energy projects as well as with ongoing energy performance analysis. Provided to users free-of-charge and in 37 languages, and includes comprehensive integrated training materials. More information available at www.retscreen.net.
Malaysia Costa Rica Argentina	Mitigation and Adaptation	Regional and national Fire Danger Rating Systems (FDRS)	Forest	Public	Public	On-going	Canada operates the Global Fire Early Warning System, a project of the Global Observation of Forest Cover and Landcover Dynamics (GOFC-GOLD) Fire Implementation Team. Each country has a different level of understanding and technological capabilities, thus each installation or knowledge exchange activity is tailored to the event. Malaysia – updating FDRS to a newer version of software to calculate the Fire Weather Index System. Work is ongoing. Costa Rica – adapted the Fire Weather Index System to their local environment to incorporate into a Fire Early Warning System and Wildland Fire application. Argentina – Cooperated with Argentina to assist in the design of a national Early Warning and Fire Danger Rating System.

Table 7-5: Provision of capacity-building support

Recipient country / region	Targeted area	Programme or project title	Description of programme or project
Pacific Alliance Members	Mitigation	Canada-Pacific Alliance collaboration to support Nationally Determined Contribution (NDC) commitments for Short Lived Climate Pollutant (SLCP) reductions from oil and gas production	Comprehensive measurement of baseline black carbon emissions from flaring associated with heavy oil production, in support of Pacific Alliance objectives for member country NDC implementation and to develop regional exchange of internationally transferable mitigation outcomes (ITMOs) under Article 6.2 of the Paris Agreement. Includes collaboration with Colombian oil and gas producers, energy and environmental researchers, and government policy developers to strengthen emissions measurement, reporting and verification capacities. COVID-19 travel lockdown truncated all scheduled baseline emissions measurement, and post-mitigation project emissions measurement activities in Colombia after March 2020. This work is a Project in operation from 2017 to 2023, including $3.4 million in 2019.
Global	Mitigation	IEA CETP: Fuel Switching from Coal to Natural Gas in Clean Energy Transitions	$125,000 CAD to support IEA analysis on the benefits of switching from coal to natural gas in emerging economies as a way to meet CO_2 reduction targets and improve air quality. This study assessed the economic, infrastructure, technology and policy drivers needed for this switch in selected markets, as well as the short-term and longer-term implications for emissions. The study identified business models that can encourage infrastructure investments to help both gas importers and exporters meet Paris commitments as well as air quality concerns, using innovation and best-in-class technologies. It also analysed the role of natural gas in supporting emerging economies increase the share of renewable energy sources in their electricity mix, ensuring equitable access to clean, sustainable and affordable energy to its population, including women and youth. The study also looked at measures that can be taken by both private and public sectors to reduce emissions from natural gas and LNG, to further support global emissions reduction and the global energy transition.
Global	Mitigation	IEA CETP: “Buildings in the Clean Energy Transition: Lessons from the Canadian Provinces”	NRCan, in collaboration with the National Energy Board (NEB), undertook a multi-year IEA project focusing on heating and cooling technologies in the Buildings Sector. This sector represents 55 percent of global energy demand and 40 percent of total GHG emissions. Canada has a wealth of historical data series, which was analyzed to provide the basic understanding of relationships between building and equipment stocks, energy policies and energy demand patterns. Technical insights, inferred from the modelling exercises, will be valuable in discussions around Buildings Sector strategies and initiatives, such as those under the Clean Energy Ministerial and Mission Innovation platforms. Initial project results were showcased during Canada’s hosting of CEM/MI in 2019. Total funding $250,000.

Global	Mitigation	IEA CETP: Putting CO_2 to Use	A study to consider the near-term market potential for five key categories of CO_2-derived products and services: fuels, chemicals, building materials from minerals, building materials from waste, and CO_2 use to enhance the yields of biological processes. Total funding $49,000.
Global	Mitigation	IEA CETP: Innovation and R&D Tracking	IEA Innovation and RD&D Investment Tracking which enhanced assistance for tracking technology innovation and RD&D investment in emerging economies. This included direct and tailored engagement with Brazil, India, and China and other CETP relevant countries. Total funding $50,000.
Global	Mitigation	IEA CETP: Clean Energy Tracking	Support for IEA's Tracking Clean Energy Progress assessment, included an assessment of 45 critical energy technologies and sectors, and in-depth analysis on how to address more than 100 key innovation gaps. Total funding $50,000.
Global	Mitigation	IEA CETP: IEA Innovation Web Portal	Support for enhancing the IEA Innovation Web Portal as a central innovation repository. The project also enhanced the visibility of TCPs, and mapped out possible synergies through Mission Innovation and the Clean Energy Ministerial. Total funding $50,000.
Global	Multiple Areas	IRENA	As a member of IRENA, Canada provides financial support and in-kind expertise through the participation in various steams of work to share Canadian experiences. In 2020, Canada and IRENA agreed to work together on a new global multi-stakeholder platform on Transitioning Remote Communities to Renewable Energy.
Global	Multiple Areas	Climate Technology Centre and Network	Engagement in the CTCN Advisory Board to support the UNFCCC's Technology Mechanism and accelerate action on technology development and transfers. Canada chaired the Advisory Board from Spring 2019 to Spring 2020.
Mission Innovation Members	Multiple Areas	Mission Innovation	In 2019 Canada hosted the 10th Clean Energy Ministerial (CEM10) and 4th Mission Innovation (MI-4) in Vancouver. At CEM10/MI-4 Canada outlined principles to achieve a cleaner energy future, while promoting sustainability, resilience and energy security, and that this needs to be inclusive and harness the leadership of women, Indigenous peoples and youth in developing the most innovative solutions. Canada is engaged throughout CEM and MI initiatives and workstreams, including leading or co-leading on several of these.

Global	Multiple Areas	International Model Forest Network (IMFN)	The IMFN is a voluntary global community of practice whose members and supporters work toward the sustainable management of forest-based landscapes and natural resources through the Model Forest approach. The IMFN's vision is to support, through Model Forests, the management of the world's forest resources in a sustainable manner, reflecting environmental and socio-economic issues from the perspective of local needs and global concerns. The primary goal of the IMFN is to establish a global network of Model Forests that represents the majority of the major forest ecosystems of the world. It also strives to ensure that all partners, regardless of political or economic status, can contribute to, and share in, the benefits of the Network as they work toward the sustainable management of forest-based landscapes.
Global	Mitigation	IEA Technology Collaboration Programmes (TCPs)	Canada participates in the IEA TCPs to enable governments and industries from around the world to lead programmes and projects on a wide range of energy technologies and related issues. The experts in these collaborations work to advance the research, development and commercialization of energy technologies.

Annex 3: Project-Level Breakdown of Canadian Facilities at Multilateral Development Banks Under Canada's $2.65 Billion Climate Finance Commitment

Canadian Facility	Canadian Contribution (million $US)
Canadian Climate Fund for the Private Sector in Asia (Asian Development Bank)	**149.5**[1]
PHASE II	
Eastern Indonesia Renewable Energy Project (Phase 1 and 2)	30
Floating Solar Power Project (Viet Nam)	4
Kandahar Solar Power Project (Afghanistan)	3.9
Upper Trishuli 1 Hydropower Project (Nepal)	30
Spectra Solar Power Project (Bangladesh)	4.4
Navoi Solar Power Project (Uzbekistan)	8
National Solar Park IPP (Cambodia)	4.2
Canadian Climate Fund for the Private Sector in the Americas (Inter-American Development Bank)	**167.1**[1]
PHASE II	
Sicredi Green Financing (Brazil)	10
Nicaragua Sugar	12.5
New Juazeiro Solar PV (Brazil)	7.5
Davivienda Subordinated (Colombia)	20
Casablanca Solar PV (Brazil)	5
SEAF Equity Investment and Blended Finance Loan for Climate Resiliency	10
Capella Solar BESS (El Salvador)	6.4
Providencia Solar BESS (El Salvador)	4.4
Guerrero Green Park (Costa Rica)	3
Canada-IFC Blended Finance Program (International Finance Corporation, World Bank)	**198.3**[1]
Sri Lanka Agri-Finance Program (Sri Lanka)	5
Belgrade Waste-to-Energy (Serbia)	23
BBVA Leasing (Mexico)	15
Scaling Solar UZ (Uzbekistan)	18
Neolpharma (Mexico)	15
Canada Clean Energy and Forest Climate Facility (World Bank)	
Forest and Landscape Program	56.5[1]
Landscapes and Livelihoods Project (Lao PDR)	16
Renewable Energy in Small Island Developing States	37.4[1]
Renewable Energy Sector Development Project (Saint Lucia)	3.7

Sustainable Electricity Service Project (Cabo Verde)	7
Energy Transition Program	206.6[1]
None approved to date	-
IFC Africa Renewable Energy Initiative (International Finance Corporation, World Bank)	**115.0**[1]
Asonha Energy (Gabon)	25
Daystar Power (Nigeria)	10
Canada-African Development Bank Climate Fund (African Development Bank)	**98.3**[1]
None approved to date	-

[1] The sum of the subproject amounts is not equal to the committed total for the facility as some projects have yet to be approved and are therefore not listed here.

Annex 4: Methodological Approach for Measuring Canada's Climate Finance

In line with 2/CP.17, Annex I, section VI UNFCCC biennial reporting guidelines for developed country Parties, this annex provides background information on the underlying assumptions and methodologies used to produce information on finance for Canada's *Eighth National Communication and Fifth Biennial Report*. Additional definitions are provided in the documentation box as part of reporting guidelines and the Common Tabular Format.

Definitions

- Repayable Contributions: Canada tracks flows that have been returned to Canada from past repayable contributions. These flows are tracked in the year they are received.
- Year of Measurement: Canada is reporting its climate finance by calendar year.
- Reporting Currency/Exchange Rates: Data is reported in Canadian dollars and United States dollars based on OECD Development Assistance Committee (DAC) exchange rates for each relevant year.
- Avoiding Double Counting of Financial Contributions: In line with best international practice, Canada tracks climate finance at the project level. This level of granularity allows for a comprehensive picture of Canada's climate finance and avoids double counting of public flows.
- Climate Finance Provided: Canada refers to "provided" as disbursed in all cases but for FinDev Canada for which "provided" refers to amounts that have been committed. Committed is defined as a firm written obligation to provide resources of a specific amount under specified financial terms and conditions and for specified purposes.
- Support through Export Development Canada: Eligible transactions and projects are identified by EDC using the International Finance Corporation (IFC) "Special Climate" category within the IFC-Definitions and Metrics for Climate-Related Activities.[2] The transaction or project must take place in non-Annex I countries.
- Support through FinDev Canada: Eligible transactions and projects are identified by FinDev Canada using the IFC Definitions and Metrics for Climate Related Activities. Based on committed, the transaction or project must take place in countries listed on the ODA eligibility.

References

2 For more information, please see: IFC's Definitions and Metrics for Climate-Related Activities.

Chapter 8: Research and Systematic Observation of Climate Change

Climate system observations and research are critical for understanding how the climate system works, how natural and anthropogenic forcers combine to cause climate change, and how feedbacks within the climate system can modify the response to climate forcers. In turn, such information is critical for informing action on climate change mitigation and adaptation. In Canada, climate system observation and research activities are undertaken jointly through core government programs, academic institutions, and collaborative research networks.

This chapter provides an overview of climate science research and observation activities in Canada, with an emphasis on developments since the 2017 publication of Canada's *Seventh National Communication on Climate Change*. Recognizing the importance of sustained research and monitoring programs and the Government of Canada's role in providing the essential infrastructure for these programs, the perspective presented here is largely from the federal government. However, the collaborative nature of climate research and monitoring in Canada is described at the start of this chapter to provide a broader perspective.

Research related to climate change impacts and adaptation is captured in Chapter 6, Vulnerability Assessment, Climate Change Impacts and Adaptation Measures, of this report.

8.1. Policy Context

8.1.1. Overview

In Canada, climate science research and monitoring approaches involve federal, provincial, municipal, academic, and private sector partners. There is no single, overarching policy on or fund for research and systematic observation. The federal government provides most of the essential infrastructure for climate system research and long-term systematic observations programs. This work is complemented primarily by research and observation activities undertaken by the Canadian academic community, whose focus is on enquiry-driven science. Productive partnerships have been established between the two communities and both continue to make substantial contributions to

Canadian and international programs. The federal programs then play a major role in the provision of scientific findings and services to inform decision-making on climate change mitigation and adaptation domestically, as well as internationally.

Recognizing that meeting the Paris Agreement objectives on mitigation and adaptation requires coordinated efforts, First Ministers adopted the first ever federal-provincial-territorial climate change plan on December 9, 2016—the *Pan Canadian Framework on Clean Growth and Climate Change* (the Pan-Canadian Framework). Subsequently, in December 2020, the Government of Canada introduced the strengthened climate plan *A Healthy Environment and a Healthy Economy*.

The *Climate Science 2050: Advancing Science and Knowledge on Climate Change* report was prepared in December 2020 to strengthen the coordination and development of mitigation and adaptation relevant science. Following this, work is now underway to develop an associated plan, titled *Climate Science 2050: Canada's Climate Change Science and Knowledge Plan*, to identify priorities for new research and knowledge, as well as the synthesis and mobilization of current knowledge to inform how to achieve a net-zero, resilient Canada. The Science Plan priorities are intended to guide investments over the next five years, acknowledging the incremental and long-term evolution of science and knowledge that informs ongoing evaluation and refinement of climate action. This Plan is aligned with the objectives of *A Healthy Environment and a Healthy Economy,* the *2030 Emissions Reduction Plan* and the first National Adaptation Strategy. The following sections highlight some of the existing organizational mechanisms for climate research and systematic observations within Canada, recognizing that additional funding for the Science Plan would be needed to fully realize all the priorities in the plan.

8.1.2. Research and Systematic Observation efforts within the Government of Canada

Research and systematic observation of the climate system is the shared responsibility of multiple departments within the Government of Canada. Federal government climate scientists, leveraging the collaborative research of national and international partners, generate and disseminate new knowledge and data to understand climate system behaviour, the human influence on climate, and future climate change. Funding for this work is embedded within annual departmental budget allocations, and priorities for climate research and monitoring in Canada are determined largely by consultative processes between federal and provincial government departments and academia, with some input from industry and other stakeholder groups. In addition to federal departments' core programs, the Government of Canada funds targeted initiatives to enhance climate-related research and monitoring.

The following sections provide additional details on some highlights of Government of Canada programs and initiatives.

8.1.2.1. Environment and Climate Change Canada

Environment and Climate Change Canada houses the Climate Research Division, the core federal program dedicated to enhanced understanding of past and future climate change. The program focuses on developing a deepened understanding of the Earth system, which is then used to develop comprehensive models to make quantitative climate predictions and projections, which then inform adaptation and mitigation planning and decisions, both domestically and internationally. The Climate Research Division has a world-class modelling centre, which has developed the Canadian Earth System Model, the Canadian Regional Climate Model, and the Canadian Land Surface Model, as well as part of the Canadian Seasonal and Interannual Prediction System. The

division also performs research on climate processes, including the cryosphere, permafrost, sea ice and snow cover, and climate chemistry such as the carbon cycle and GHG sources and sinks. The research produced by the Climate Research Division is then disseminated to the public and policy- and decision-makers to inform adaptation and mitigation actions by the Canadian Centre for Climate Services. Details on the research is provided in Section 8.3, and information on climate services is found in Sections 8.5 and 6.3.1.

A major new initiative, led by Environment and Climate Change Canada's Climate Research Division, has been the effort to retrofit the climate observatory located at Alert, Nunavut (82.5°N, 62.3°W). A total of $16.3 million was provided by the Government of Canada to retrofit the existing 40-year-old laboratory site. The funds will be used to construct a new laboratory facility to modern standards, enabling the continued systematic observation of GHGs and other atmospheric pollutants (including persistent organic pollutants, ozone, and mercury) at the most northerly permanent settlement on Earth. The observatory measures unique polar atmospheric processes and directly supports the World Meteorological Organization (WMO) Global Atmospheric Watch program by providing high Arctic atmospheric chemistry data to the global community. Data from Alert represents one of the longest GHG in-situ measurement records available. In addition to supporting Global Atmospheric Watch, the data produced at the facility supports measurement inter-comparison studies, thereby promoting consistency across other global monitoring sites. The facility also supports nuclear radiation and permafrost measurements and collaborates with several international science partners including National Aeronautics and Space Administration, Japan's National Institute of Environmental Studies, and Australia's Commonwealth Scientific and Industrial Research Organisation.

The revitalisation of the Meteorological Service of Canada's atmospheric monitoring networks has continued via the 10-year Renewal II initiative launched in 2013. Through this initiative, the Meteorological Service of Canada's Surface Weather and Climate Network has been modernized and expanded, the Weather Radar network has been enhanced, and Upper Air and Canadian Lightning Detection Network operations have been sustained and improved. These investments have mitigated risks to mission critical infrastructure, improved data access and quality, and established a strong foundation for future modernisation and transformation.

Modernisation of the hydrometric monitoring system is underway through the National Hydrological Service Renewal initiative launched in 2018. This initiative involves an $89.7 million investment over five years in forecasting water quantity, infrastructure, rebuilding capacity, and innovation. The broad objective of the innovation component is to enhance monitoring and hydrological services by evaluating and testing innovations in measurement technology and data quality management.

Environment and Climate Change Canada's Water Science and Technology Directorate has a national, interdisciplinary program of ecosystem-based research in the aquatic sciences, which includes research on hydrological and ecosystem processes that contribute to our understanding of the vulnerabilities of freshwater systems to climate variability and change.

8.1.2.2. Fisheries and Oceans Canada

Aquatic Climate Change Adaptation Services Program

The Aquatic Climate Change Adaptation Services Program (ACCASP) is an internal science-funding program within Fisheries and Oceans Canada that supports scientific research and monitoring activities necessary to identify climate change impacts and vulnerabilities, to improve ocean forecasting and to develop adaptation information and tools for vulnerable coastal regions. The objectives of this program are to inform Fisheries and Oceans Canada's adaptation decisions related to fisheries, ocean management, and coastal infrastructure focussing on three priority areas:

- Monitoring activities to understand the state and extent of changing ocean conditions and climate change, including temperature, ocean acidification, and hypoxia;
- Research to understand the vulnerability of our fisheries, ecosystems and coastal infrastructure to changing ocean conditions and climate change; and
- Refinement of applied ocean models to improve provision of information on past, present and future ocean conditions.

The Aquatic Climate Change Adaptation Services Program contributes to the objectives and activities of Fisheries and Oceans Canada and the Pan-Canadian Framework for Clean Growth and Climate Change by supporting the aquatic climate change science necessary to inform evidence-based decision-making and respond to climate change commitments from a departmental and federal government perspective. Currently the program is providing funding to support ocean chemistry monitoring activities across Canada, as well as nine research projects through Fisheries and Oceans Canada's Competitive Science Research Fund. These projects focus on relevant topics such as building resilience of coastal communities to offset climate change and conducting vulnerability assessments of key species, such as lobster and sea scallops.

8.1.2.3. Natural Resources Canada

Geological Survey of Canada

The Geological Survey of Canada of Natural Resources Canada conducts long-term permafrost and glacier monitoring. This research is carried out to quantify the variability and change in permafrost thermal state, active layer thickness and glacier dynamics and mass balance, and to attribute these changes. Other relevant permafrost research includes efforts to assess permafrost landscape change and to improve mapping of permafrost and ground ice distribution to better inform climate change impact assessments and prediction of future conditions.

Forest Climate Change Program

The Canadian Forest Service's Forest Climate Change Program aims to advance adaptation and mitigation strategies related to Canada's forests. The program delivers science-based expertise, information, methods, tools and data that support climate change adaptation in Canada's forests and forest sector. The program's mitigation activities deliver analyses and projections for how forest mitigation actions can make long-term contributions to meeting Canada's greenhouse gas emission reduction targets, and ensure that greenhouse gas reporting requirements are met.

8.1.2.4. Agriculture and Agri-Food Canada

Agriculture and Agri-Food Canada has ongoing research and operational activities internally and in partnership with others across the spectrum of soil, water, climate and biodiversity systems. Much of the output from these activities is available online on departmental websites and on Government of Canada open data sites, such as Climate change and air quality – agriculture.canada.ca.

Canada is one of the founding members of the Global Research Alliance on Agricultural Greenhouse Gases, an international network of more than 40 member-countries, devoted to collaboration in agricultural research on GHG mitigation and beneficial management practices for farmers in Canada and around the world.

The Agricultural Greenhouse Gases Program represented Canada's initial contribution to the Global Research Alliance on Agricultural Greenhouse Gases and provided Canadian farmers with technologies to manage their land and livestock in a way that will mitigate GHG emissions. This federally funded program supported $27 million in research projects from 2010 to 2015, and again in 2016 to 2021 towards the program's objective of enhancing the understanding and accessibility of agricultural technologies; Beneficial Management Practices (agricultural practices aimed at reducing the environmental impact and increasing the resiliency of farming activities on the landscape); and processes that can be adopted by farmers to mitigate GHG emissions.

Agriculture and Agri-Food Canada's Living Laboratories Initiative is a $70 million, five-year program (2018 to 2023) that creates living labs to accelerate the co-development, testing, adoption, and monitoring of innovative Beneficial Management Practices and technologies to address environmental issues including climate change on working farms. The Agricultural Climate Solutions—Living Labs program (2021 to 2031) is a $185 million, 10-year program that expands the living labs network across Canada with a special focus on beneficial management practices that sequester carbon and reduce GHG emissions, while also producing other environmental co-benefits. In July 2022, the Government of Canada announced nine new living labs, creating a national network with a living lab in each of Canada's ten provinces.

The Agricultural Clean Technology Program's Research and Innovation Stream supports pre-market innovation, including research, development, demonstration, and commercialization activities, to develop transformative clean technologies and enable the expansion of current technologies under three priority areas: green energy and energy efficiency, precision agriculture, and bioeconomy.

The Government of Canada has committed to providing $100 million over six years, starting in 2023, to universities through the Natural Sciences and Engineering Research Council and Social Science and Humanities Research Council to develop a path toward zero-emissions agriculture. This funding will support fundamental and applied research, transferring science and technology knowledge, and developing metrics to understand and report on environment and climate impacts of production and government programming.

8.1.2.5. Canadian Space Agency

Canada's Strategy for Satellite Earth Observation

Satellites provide a unique perspective of our planet, support cutting-edge science, and enable applications and services in many areas critical to the health and well-being of Canadians. In early 2022, Environment and Climate Change Canada, the Canadian Space Agency, and Natural Resources Canada released a national satellite Earth Observation strategy titled *Resourceful, Resilient, Ready: Canada's Strategy for Satellite Earth Observation*. This strategy outlines a

coordinated, long-term vision for satellite Earth observation data and technologies in our country. The information we need to study the climate, like methane and carbon dioxide emissions and changes to sea ice, can be gathered by satellites more effectively than ever before, and the data from satellites has become critical to taking action on and adapting to climate change.

For example, the Government of Canada is working with industry and academia to test new technology for monitoring greenhouse gases from space. Canadian industry leads the world in Fourier Transform Spectrometer (FTS) technology and is currently advancing it to better observe atmospheric gases from space. FTS enables satellite imaging of critical gases such as carbon dioxide (CO_2) and methane (CH_4) that are leading causes of climate change. The technology also supports the surveillance of other important greenhouse gas emissions from sources such as permafrost thaw and forest fires in a warming climate. Canada is targeting application of this new technology as part of future missions, particularly to monitor the Arctic more closely.

smartEarth Applications Development Activity

smartEarth is a renewed funding initiative that supports the development of downstream applications from satellite-based Earth observations. Targeting downstream stakeholders from government, as well as industry and academia, the initiative considers the full value-chain of activities from data access to final solutions. smartEarth brings together Canadian Space Agency development efforts for achieving best value for Canadians from the use of space capacities in an increasingly digitized society and economy. It is Canada’s response to new trends and disruptive market forces influencing the downstream space sector. The smartEarth value proposition is to contribute to societal benefits with space while fostering a collaborative Canadian downstream sector conducive to accelerate innovation, stimulate data uptake, develop capacities, and establish and foster the sector to a world-class leadership level. For more information on contributions, grants and contracts awarded, visit Contributions, grants and contracts awarded | Canadian Space Agency (asc-csa.gc.ca).

Sun-Earth System Sciences Program

The Sun-Earth System Sciences Program supports Canada's contribution to the advancement of the scientific knowledge concerning the Sun-Earth system, and the application of this scientific knowledge in a range of policy areas, including environmental monitoring and climate change. Expanding technological capabilities, particularly through ever more sophisticated satellite missions, are enhancing our understanding of the evolving composition of the Earth's surface and atmosphere. Some of the missions undertaken through this program are pursuing research and development goals while others are primarily operational in nature. The Canadian Space Agency collaborates with other departments and agencies, and with a range of space agencies, institutions, and stakeholders. Financial support, via various funding mechanisms, is provided by this program to external partners and stakeholders for exploratory work on potential scientific missions, the development of new missions, ongoing operational missions (including calibration and validation activities) and analysis of data provided through scientific missions.

Data Contribution in Support of Polar and Forest Carbon Science

The Canadian Space Agency continues to play a key role in supporting the WMO’s Polar Space Task Group in its efforts to collect and compile satellite radar data over Polar Regions to support the scientific community to better understand the current and potential impacts of climate change. Canadian Earth observation satellites have been used for monitoring sea ice and ice sheet conditions over polar regions for the past 20 years. In addition to the polar images, a significant

number of images were processed to support the understanding of forest-related activities within the circum-tropical belt regions. The C-Band radar dataset represents an archive of approximately 10 years of systematic high-resolution data acquisition over distributed tropical regions of the world. This long-term time series will help scientists to better understand how C-Band radar can help in understanding the effects of forest degradation, deforestation, afforestation, and the impacts that changes in land cover and land use can have on carbon accounting activities.

8.1.2.6. National Research Council

The National Research Council of Canada is Canada's federal research and development organization that partners with Canadian industry to take research impacts from the lab to the marketplace. The National Research Council invests in strategic research and development programming to support action on critical issues such as the Government of Canada's response to climate change.

The National Research Council's Ocean program is part of its supercluster support programs to deliver research, technical services and knowledge mobilization to support Canada's industrial clusters, including those related to the blue economy. The ocean plays a significant role in global climate regulation, and all efforts for improving its health directly relate to regulate climate, as well as absorb and store carbon.

The National Research Council has continued its collaboration with United Kingdom's Catapult Centre to develop satellite-based monitoring technologies to increase resiliency of new and existing infrastructure to climate change and other environmental hazards.

The National Research Council's Low Emission Aviation Program works to transition Canadian aviation sector to a net-zero GHG future by developing market-ready solutions, participating in collaborative ecosystems with industry, and supporting federal government departments in developing green technology policies and regulations.

The National Research Council's Clean and Energy Efficient Transportation Program works with Canada's ground transportation sectors to develop, optimize and test solutions to reduce GHG emissions, including electrification technologies and low- and zero carbon fuels.

The National Research Council's Advanced Clean Energy Program supports multiple industrial sectors in their transition to a low-carbon economy by accelerating the development of clean renewable fuels and energy storage materials.

8.1.3. Research Granting Agencies and Funded Initiatives in Canada

Canada has three major research funding agencies, known collectively as the Tri-Councils: the Natural Sciences and Engineering Research Council of Canada (NSERC), the Social Sciences and Humanities Research Council of Canada (SSHRC) and the Canadian Institutes of Health Research (CIHR). Of the three, NSERC is the most closely linked to climate science research programs. NSERC is concerned with administering funds for university research and training in the fields of science and engineering. It also fosters innovation by encouraging Canadian companies to participate and invest in postsecondary research projects. The Council fulfills its mission by awarding scholarships and research grants through peer-reviewed competition and by building partnerships among universities, colleges, governments, not-for-profits, and the private sector. On behalf of the Tri-Councils, NSERC also administers the College and Community Innovation Program to support applied research, training and research collaborations linked to a wide variety of private sector, non-governmental and community partners.

A number of dedicated climate-related research initiatives and networks in Canada have been funded by NSERC. Academic climate science researchers have funding opportunities through a variety of grant programs, including, but not limited to:

- Advancing Climate Change Science in Canada (NSERC in partnership with Environment and Climate Change Canada and Health Canada). $4.8 million to strengthen collaborative efforts among federal scientists and the academic community to advance policy-relevant climate change science that supports work of the Pan-Canadian Framework. This granting program has a focus on development of energy efficient cooling technologies, enhancing knowledge on forest ecosystem services for climate resilience, and improved understanding of carbon dynamics in Canadian ecosystems.
- Discovery Grants program, including its Northern Research Supplement (NSERC). The Discovery Grants program supports ongoing programs of research with long-term goals rather than a single short-term project or collection of projects. Discovery Grants are typically five years in duration. Northern Research Supplements augment and promote Canadian university-based northern research and training by recognizing the added costs unique to conducting research in the Canadian North, which typically has a strong focus on environmental sciences, including climate change research.
- Alliance Grants (NSERC). Alliance grants support partnership projects of varying scale and complexity, from short-term, smaller projects involving one researcher to long-term projects involving researchers across several universities, and from one-on-one collaborations with one partner organization to projects involving many partner organizations across multiple sectors.
- Alliance Mission Grants (NSERC). A new call for 2022 is focused on anthropogenic GHG research, with a nominal budget of $22 million. The call targets interdisciplinary, collaborative research projects supporting net-zero GHG emission targets to fund projects up to three years, for a total of $66 million. Alliance Mission grants aim to address critical science and technology challenges. The GHG challenge supports the goals of Federal Budget 2022 and prioritizes Canada's efforts to fight climate change and take immediate action to reduce GHG emissions, while strengthening the Canadian economy with sustainable jobs and clean industrial growth.
- Belmont Forum, through the Collaborative Research Action initiative. NSERC has been involved with the Belmont Forum since its inception in 2009, and became a member in 2018. The Belmont Forum is a high-level group of the world's major and emerging funders of global environmental change research and international science councils. In 2019, NSERC set aside $300,000 per year over three years for the Collaborative Research Action initiative—Resilience in Rapidly Changing Arctic Systems.

In fiscal year 2020-21, Discovery and Alliance programming provided $38.5 million in support of climate change research.

One notable NSERC funded initiative is the NSERC Permafrost Partnership Network for Canada (NSERC PermafrostNet). PermafrostNet, initiated in 2019, is supported by partners and participating institutions along with $5.5 million from NSERC Strategic Partnership Grants for Networks. It unites researchers from 11 universities, government, industry and Indigenous community partners, in order to boost Canada's ability to monitor, predict and adapt to large-scale permafrost thaw and its consequences. The network aims to understand the interactions between climate, permafrost and infrastructure by involving knowledge holders across complementary domains, while also connecting small-scale findings from field sites with national-scale predictions.

In 2020, through its Collaborative Research and Training Experience program, NSERC awarded $1.65 million to the Earth Observation to Decision Information Services program to increase students' scientific, technical, and professional skills, where they concern social problems, natural resources, and the environment or climate change. The program includes a network of six universities and research institutions across Canada.

Among other federal funding programs for climate change research, the Climate Action and Awareness Fund is providing funds to support climate science research through the Advancing Climate Change Science and Technology theme of the Fund. The call for proposals was issued in 2021 with $64 million available to support climate change science and knowledge projects that strengthen Canada's science capacity to identify, accelerate, and evaluate mitigation actions towards achieving net-zero GHG emissions by 2050 in Canada, including improved understanding of GHG sources and sinks. Project applications are currently under review.

In addition, two other federally funded programs target nature-based solutions to climate change:

- Nature Smart Climate Solutions Fund (administered by Environment and Climate Change Canada, $631 million) to reduce 2 to 4 Mt of GHG emissions annually.
- Agricultural Climate Solutions—Living Labs (administered by Agriculture and Agri-Food Canada, $185 million) accelerates co-development, testing, adoption, dissemination, and monitoring of beneficial management practices that sequester carbon and mitigate GHG emissions with environmental co-benefits, establishing a Canada-wide network of living labs.

8.1.3.1. Networks of Centers of Excellence

Created in 1989, the Networks of Centers of Excellence program supports large-scale academically-led research networks, delivering multidisciplinary research partnerships with industrial expertise and strategic investment through the involvement of academic, industry, government and non-for-profit partners.

The Networks of Centers of Excellence initiative is supported by the three major Canadian federal granting councils: the Natural Sciences and Engineering Research Council of Canada, the Social Sciences and Humanities Research Council of Canada and the Canadian Institutes of Health Research. There are currently three Networks of Centers of Excellence funded networks that are directly related to climate research and monitoring: ArcticNet, the Marine Environmental Observation Prediction and Response Network and the Canadian Mountain Network. As of December 2018, funding for the Networks of Centers of Excellence program is gradually being transitioned to the New Frontiers in Research Fund (see Section 8.1.3.2.).

ArcticNet

Since 2004, ArcticNet has been an essential hub for Arctic research in Canada. Currently, a fifth phase is underway covering the period 2019 to 2024. The five core research themes remain: marine ecosystems; terrestrial ecosystems; Inuit health, education and adaptation; northern policy development; and knowledge transfer. This integrated research approach brings together scientists and managers in the natural, human health and social sciences with their partners from Inuit organizations, northern communities, federal and provincial agencies and the private sector to study the impacts of climate change in the coastal Canadian arctic.

Marine Environmental Observation Prediction and Response Network

Established in 2012, the Marine Environmental Observation Prediction and Response (MEOPAR) Network facilitates efforts to observe, predict and respond to evolving marine hazards arising from climate change, chemical/biological change, geophysical events and direct human impacts. Primary activities include support for interdisciplinary research, providing training to bolster the Canadian workforce, and mobilizing scientific knowledge, technology and people through cross sector engagement. MEOPAR has received a total of $53.5 million in direct federal support over two funding cycles (2012 to 2017 and 2017 to 2022). Projects have focused on developing disaster and risk reduction tools and identifying adaptation measures for Canada to better manage ocean influences on coastal environments. This has been achieved through partnerships with academia, governmental departments, non-governmental organizations, and industries such as insurance and shipbuilding. Cycle II activities have included calls for research proposals partnered with Polar Knowledge Canada (for projects aligned with the Year of Polar Prediction), Ocean Networks Canada, and Réseau Québec maritime. The proposed initiatives include a Modular Ocean Research Infrastructure initiative to provide seagoing research capacity using non-specialized vessels, and a Tracer Release Experiment (TReX) to study transport and mixing of potential contaminants in the Gulf of St. Lawrence. MEOPAR also facilitates Communities of Practice that enable communication and sharing of knowledge across Canada on topics such as ocean acidification. Following Cycle II, MEOPAR is seeking to secure ongoing support under realigned federal funding mechanisms.

Canadian Mountain Network

The Canadian Mountain Network was established in 2019 through a five-year, $18.3 million grant and is the country's first formal research organization dedicated to advancing our understanding of mountain systems. Canadian Mountain Network supports research that uses a holistic research approach based on Indigenous and Western ways of knowing. Through coordinated research, training, knowledge mobilization, networking and partnerships programs, the network is increasing capacity to comprehensively observe, study, forecast, and adapt to rapid changing mountain systems in Canada.

8.1.3.2. New Frontiers in Research Fund

The New Frontiers in Research Fund (NFRF) was launched in December 2018 to fund interdisciplinary, high-risk/high-reward, transformative research led by Canadian researchers working with Canadian and international partners. Three main funding streams exist under the NFRF: Exploration (innovative, high-risk, high-reward and interdisciplinary research); Transformation (large-scale support to build strength and leadership in interdisciplinary and transformative research) and International (enhances opportunities for researchers to participate with international partners), as well as special calls to fund research requiring rapid-response. The annual budget for the NFRF program is $124 million. The Exploration and Transformation streams have provided funding for research pertinent to climate change. Currently, a multilateral call on climate change adaptation and mitigation is being developed with major international research funding agencies partners under the International stream. Projects will be international, interdisciplinary, focus on vulnerable communities, and are expected to be impactful.

8.1.3.3. Canada Research Chairs

The Canada Research Chairs program aims to achieve research excellence in engineering and the natural sciences, health sciences, humanities, and social sciences by funding academic positions at universities in Canada. The program is funded by the Tri-Councils—NSERC, SSHRC and CIHR. The program offers eligible Canadian degree-granting institutions the opportunity to nominate outstanding researchers for senior professorships, and offers exceptional emerging researchers support to kick-start their careers in faculty positions at Canadian universities. The program spans a wide range of research areas and supports 138 Chairs addressing various aspects of climate change some of which contribute to advancing climate science research including but not limited to, Chairs in:

- Climate Dynamics
- Climate Change Impacts
- Forests and Global Change
- Global Change and Ecotoxicology
- Water Resources and Climate Change
- Glacier Change
- Arctic Ice, Freshwater Marine Coupling and Climate Change
- Arctic Marine Biogeochemistry
- Ocean Sustainability and Global Change

8.1.3.4. Canada First Excellence Research Fund

Launched in 2014, the Canada First Excellence Research Fund (CFREF) is a Tri-Council initiative that invests approximately $200 million per year to support Canada's post-secondary institutions in their efforts to become global research leaders. Two CFREF initiatives directly support academic research related to the climate system. Global Water Futures is a university-led research network awarded with $77.8 million, which aims to place Canada as a global leader in water science for cold regions and address strategic needs of the Canadian economy in adapting to change and managing risks of uncertain water futures and extreme events. Sentinelle Nord is another CFREF initiative awarded $98 million with a major research axis dedicated to better understand the impact of climate change on the ecosystems and infrastructures of the Arctic and sub-Arctic regions through transdisciplinary approaches. A new 2022 competitive funding opportunity was recently announced offering funding for seven years to successful applicants. Under the competition, applicants must address one of the newly established Science Technology and Innovation Priorities, which includes the priority for a Clean and Resource-Rich Canada. The priority notes the need to fight climate change and protect Canada's environment, while harnessing the potential of our natural resources to support a resilient, sustainable economy and high quality of life.

8.1.3.5. Canada Excellence Research Chairs and Canada 150 Research Chairs

The Canada Excellence Research Chairs (CERC) and Canada 150 Research Chairs (C150) programs are funded by CIHR, NSERC and SSHRC and offer eligible Canadian, degree-granting institutions an opportunity to establish highly funded research chairs in the Government of Canada's Science Technology and Innovation priorities. Through these programs, $10 million were awarded in 2018 for a CERC in Arctic Ice, Freshwater Marine Coupling and Climate Change, $7 million were awarded in 2018 for a C150 Hydrology and Remote Sensing in the context of a warming climate, and $7 million were awarded in 2018 for a C150 in Climate Sea Ice Coupling.

8.1.4. Other Initiatives

8.1.4.1. Atmosphere-Related Research in Canadian Universities

The Atmosphere-Related Research in Canadian Universities Working Group is a group of Canadian university faculty who undertake research in weather, climate, and air quality under the general framework of atmosphere-related research. Atmospheric-related research considers the whole atmosphere, from the surface to space, and its interaction with land-surface, hydrologic, ocean, cryosphere, and space systems. Work in this area connects atmospheric and related sciences to many other areas of environmental and social science. The Working Group was ad-hoc until June 2017, when it became established as a Special Interest Group of the Canadian Meteorological and Oceanographic Society.

The Atmosphere-Related Research in Canadian Universities Working Group has initiated a strategic planning process in Canadian atmospheric-related research across the university, government, and industrial sectors. The group seeks to help configure academic atmospheric-related research to most benefit Canada in a time of rapid environmental and socio-economic change. Efforts are aimed at benefitting atmospheric-related research activities within and outside the wide range of university departments and disciplines where such research takes place.

8.1.5. Open data and information policies

In 2013, Canada and the other G8 members adopted the Open Data Charter, committing to a set of open data principles: open data by default; quality and quantity; usable by all; releasing data for improved governance; and innovation. The Government of Canada's general *Directive on Open Government* has been in effect since October 9, 2014 and requires government departments and agencies to make their eligible-for-release information resources more easily discoverable and reusable. The Government of Canada Open Government Licence (designated by the Treasury Board of Canada) promotes the reuse of published Government of Canada content as widely as possible.

Canada's approach to open government is also driven by international agreements and collaboration, and in that regard, Canada has been a member of the Open Government Partnership since 2012. This community-led partnership is based on the premise that an open government is more accessible, more responsive, and more accountable to citizens by improving the relationship between citizens and government. Canada assumed co-chair responsibilities for the Open Government Partnership from 2018 to 2019. In September 2022, Canada's *2022–24 National Action Plan on Open Government* was released. The 2022–24 Action Plan outlines a series of initiatives to give people access to the information and tools they need to better understand the impacts of climate change, to protect against misinformation and disinformation, to advance corporate transparency, to address their legal problems, and to encourage participation in fair,

democratic processes. The 2022–24 National Action Plan builds on the successes of past plans, notably the 2018–20 Plan, *Canada's Fourth National Action Plan*. Initiatives to promote open access to data and information include:

- Open Government Portal (open.canada.ca): Launched in 2014, this portal is a one-stop access to information provided by federal departments and agencies, including scientific data related to peer-reviewed publications.
- Open Maps: Provides access to comprehensive collections of accurate and authoritative geospatial information.
- Multi-Stakeholder Forum on Open Government: Launched in January 2018, this forum brings together government and civil society representatives to provide strategic direction, input and advice on the Government of Canada's commitments on open government.

In March 2021, Canada's three federal agencies released the *Tri-Agency Research Data Management Policy*. Although not an open data policy, the policy requires researchers and institutions to plan and strategize the responsible use of research data to better promote research, knowledge training and innovation in Canada.

On February 27, 2015, the Tri-Councils announced a harmonized "Open Access Policy on Publications" that requires research publications supported by public funds to be made openly available for the benefit of the community at large. These approaches are aligned with Canada's commitments to the Open Government Partnership.

Among the requirements of the *Directive on Open Government* is an ongoing responsibility to identify any significant difficulties to ensuring open access to data and information and taking steps to address these. While the Government of Canada is committed to utilizing existing and new mechanisms to resolving outstanding barriers, some do still exist, related to ownership, security, privacy and confidentiality of information. As one example, our ability to make some types of information available (e.g., movies/model simulations), is currently limited.

Section 8.2.1 contains some additional information related to open data for systematic observations of the climate system.

8.2. Systematic Observation

8.2.1. Overview

Systematic climate observations are essential for understanding the mean states of various climate components over time and the natural variability around these means, for detecting changes in means and extremes, and for attributing these changes to specific causes. Observations can also help to clarify the processes by which components of the climate system interact, and the sensitivity of these processes to natural and anthropogenic influences. Accurate observations can also provide an objective basis for verifying reported emissions. Observations also feed into climate system models used for the prediction and projection of future climate. These data are used to improve the representation of important physical processes in models, and to evaluate model performance.

Data management is an important aspect of any systematic observations endeavor. The long-term systematic collection, quality assurance, and dissemination of climate system data in Canada is primarily the responsibility of the federal government, and arises from a broad spectrum of program obligations. Environment and Climate Change Canada manages data and metadata for Canada's

authoritative climate database containing data collected over the last 170 years. Through Canada's involvement in international organizations, agreements, and commitments, climate data is collected, quality controlled, and disseminated according to international standards, and is discoverable through Canada's Open Government Portal.

In relation to Open Data, Environment and Climate Change Canada will lead a national effort to comply with the requirements of the World Meteorological Organization's (WMO) Unified Data Policy over the coming years. Its aim is to share data across seven Earth system domains openly and freely without any restrictions. The policy was recently ratified (October 2021) by WMO, and endorsed by Canada.

Environment and Climate Change Canada is working with the WMO on initiatives to address global and regional observation network gaps through the Global Basic Observing Network (GBON). Canada is committed to meeting the requirements of GBON to the greatest extent possible, taking into account challenges associated with systematic observations in sparsely populated northern regions. Further, at the meeting of the WMO's Infrastructure Commission in 2019, following an intervention from Canada, Resolution 4 requested that the future development of GBON address the environmental impact of observing technologies. As a result, Canada now leads the global effort to consider the environmental sustainability of observations and observing networks, especially in the context of increases in network density to meet Global Basic Observing Network requirements.

Canada is a significant contributor to the Global Climate Observing System, an internationally coordinated network of observing systems and a program of activities that support and improve the network. Environment and Climate Change Canada's contribution is the production and dissemination of climate products such as the CLIMAT monthly climatological datasets and support for WMO Climate Normals. Canada also makes significant contributions to the related Global Ocean Observing System, and the Global Terrestrial Observing System. Canada is a member of the Group on Earth Observations, which seeks to coordinate international efforts to build a Global Earth Observation System of Systems. The Global Climate Observing System contributes the climate component to the Global Earth Observation System of Systems. Canada is also a participant in the international Sustaining Arctic Observing Networks initiative. Moreover, in 2024 Canada will assume the Presidency of the Committee on Earth Observations Satellites, whereby the role of Earth observations for climate action and the protection of biodiversity will be key priorities.

8.2.2. Monitoring Networks

Many of the departments of the Canadian federal government collect observations related to climate. Environment and Climate Change Canada operates a total of seven observation networks, including the Surface Weather and Climate network, marine observing networks, Upper Air network, Canadian Weather Radar network, Canadian Lightning Detection Network, the federal portion of the National Hydrometric Network for water quantity, and the network of satellite receiving stations collecting space-based observations. Agriculture and Agri-Food Canada and Fisheries and Oceans Canada also monitor and observe the environment and climate, as it pertains to their mandates, as detailed in the following sections.

Canada also performs Earth observations from space, as part of the Canadian Space Agency's mandate. There are important connections between satellite and in-situ observations, used together to improve reliability of the observations, strengthen their robustness and increase confidence, through the use of reliant, complementary observations from independent sources.

8.2.2.1. Atmosphere

Surface Weather and Climate

Environment and Climate Change Canada's national ground-based weather, climate, upper air, and meteorological marine observation networks follow well-defined operating standards and procedures in accordance with the climate monitoring principles and standards of the Global Climate Observing System and related programs. While network spatial densities and station distributions are relatively stable, lower densities are found in the sparsely populated northern regions. To address these spatial gaps, Environment and Climate Change Canada continues to make it a strategic priority to transform its monitoring capabilities in collaboration with other federal departments and levels of government in Canada through a network of networks approach. This Canadian collaborative monitoring initiative is an efficient and sustainable approach to monitoring that aims to improve the overall accessibility, quality and interoperability of weather and climate data in Canada.

As of 2022, the Surface Weather and Climate Network includes approximately 583 fully automated stations. Within this broader atmospheric monitoring program, Environment and Climate Change Canada operates two surface networks specific to climate change—the Meteorological Service of Canada Automatic Weather Station (AWS) network and the Co-operative Climate Network. As of 2022, the AWS network consists of approximately 583 stations. Out of these, 262 are Reference Climate network stations. The Reference Climate Stations are primarily intended for determining climate trends on regional and national scales. The network was initially established by identifying and designating stations with continuous, high-quality observations of 30 plus years in duration, along with other important climate criteria. Stations in the AWS network measure solid and liquid precipitation, atmospheric pressure, surface temperature, water vapor, surface wind speed and direction, which are all Global Climate Observing System Surface Essential Climate Variables, on hourly (or by the minute, for some stations) and synoptic reporting frequencies.

In addition, the Co-operative Climate Network (CCN) is a network of climate observing stations comprised of volunteers who, through an agreement with Environment and Climate Change Canada's Meteorological Service of Canada, report daily temperature and/or precipitation values once or twice per day, using high quality manual sensors provided and maintained by the Meteorological Service of Canada. As of April 2022, the CCN consists of 354 stations where observations of temperature (minimum and maximum), precipitation (rainfall or snowfall), and snow depth are recorded once or twice daily. Modernized data entry systems now allow observers to submit their observations via the internet, resulting in timely access and better quality of daily climate data from these stations. Renewal investments have allowed Environment and Climate Change Canada to install and upgrade surface monitoring stations to reduce third-party dependency for climate observations. In addition to these stations, Environment and Climate Change Canada has commissioned new automated meteorological observation sites in Squamish, B.C. (since 2016) and Toronto Pearson airport (since 2007) that provide enhanced surface and vertical profile observations of weather and climate in the vicinity of airports for research and development purposes.

There is a demonstrated need for enhanced meteorological observations in the Arctic to evaluate and improve the performance of numerical weather prediction systems, which is one of the themes of the World Meteorological Organization's Year of Polar Prediction project (core phase: 2017 to 2019). To address this need, Environment and Climate Change Canada commissioned two supersites, in Iqaluit (64°N, 69°W) and Whitehorse (61°N, 135°W) in 2015 to provide automated and continuous observations of altitude-resolved winds, water vapour, clouds and aerosols,

visibility, radiation fluxes, and precipitation as part of the Canadian Arctic Weather Science project. Throughout the Year of Polar Prediction, Environment and Climate Change Canada collaborated with several international partners, including the United States' National Oceanic and Atmospheric Administration, the European Centre for Medium-Range Weather Forecasts, Météo-France, United Kingdom Met Office and Met Norway, to perform numerical weather prediction model validation and process studies.

Environment and Climate Change Canada and the United States' National Oceanic and Atmospheric Administration have a bilateral agreement to coordinate standards, procedures, equipment, and measurement programs between the Canadian Reference Climate Stations and the United States' Climate Reference Network. The objective is to establish and maintain an integrated North American climate reference network.

Canada also contributes to the international Voluntary Observing Ship Climate Project through its Automated Volunteer Observing Ships. The Canadian moored buoy network, with 39 buoys located in the Atlantic and Pacific oceans and in inland waters, contributes hourly observations to the Global Telecommunication System, following Data Buoy Cooperation Panel and WMO guidelines. Environment and Climate Change Canada also operates five moored buoys (three in Atlantic Canada, and two in the Pacific) as part of the Ocean Protection Plan, which is a comprehensive, transformative strategy to build a world-leading marine safety system and protect Canada's marine ecosystems on all of its three coasts. In addition to these networks, Environment and Climate Change Canada annually deploys 10 to 15 drifting buoys to provide marine observations from data sparse areas in the Arctic, north Atlantic, and north Pacific oceans. Environment and Climate Change Canada also contributes to the Global Drifter Program by upgrading approximately six drifting buoys with barometers every two years.

Agriculture and Agri-Food Canada has contributed to the enhancement of weather and climate monitoring networks in the Prairies and Atlantic Canada and, with Environment and Climate Change Canada and the private sector, has helped establish the Community Collaborative Rain, Hail, and Snow project in Canada to increase community participation in monitoring. This network, started in 2011, is now national.

Upper Air Networks

Canada maintains 30 of the approximately 1,300 upper air radiosonde stations and five of the estimated 171 Global Climate Observing System Upper Air Network stations operating under the global World Weather Watch/Global Observing System program. The Canadian Global Climate Observing System Upper Air Network stations are located in Alert, Goose Bay, Moosonee, Fort Smith, and Cambridge Bay.

At the radiosonde stations, balloon borne radiosondes are released twice daily to measure and simultaneously transmit data on temperature, humidity, and pressure to automated ground systems. Wind direction and speed are determined by using Global Positioning System technology to track the radio signal transmitted by the radiosonde. New commercially available remote sensing technologies that complement existing radiosonde observations are currently being investigated to supplement Environment and Climate Change Canada's upper air network.

Upper air observations from the Canadian upper air radiosonde network are supplemented by the Canadian Aircraft Meteorological Data Relay program, which generates approximately 300 wind and temperature soundings per week from 18 Canadian airports and 25 aircraft of a commercial

airline fleet. The quality of the data is monitored in near-real-time by the Canadian Meteorological Centre before the data are used in the Canadian Meteorological Centre's national data assimilation system and distributed internationally.

The Canadian Lightning Detection Network is fully integrated with the United States' National Lightning Detection Network, thus forming the largest precision lightning detection network in the world with 189 sensors (84 in Canada and 106 in the United States). This entire network provides detailed lightning strike information for an area in excess of 20 million square kilometres. It is also possible to obtain long-range lightning location information outside of the network itself (e.g., over the western Atlantic and eastern Pacific Oceans).

Atmospheric Composition

Environment and Climate Change Canada operates the long-term observing network for near-real-time atmospheric measurements of CO_2 and other greenhouse gases (GHGs) (CH_4, N_2O, and SF_6), with a subset of these stations also providing additional CO_2 and CH_4 stable carbon isotope measurements. These long-term monitoring stations are located across Canada to provide regional scale information on GHG emissions from local and regional natural (forests, wetlands) and anthropogenic (coal, oil and gas, agriculture, waste) sources. As of June 2022, there were 16 long-term and four shorter-term project measurement sites located in coastal, interior, and Arctic regions in Canada. A major focus of the GHG measurement program since the *Seventh National Communication* has been to enhance observations at the sub-national scale. Observations have been made in Toronto, the Windsor-Sarnia corridor and Montréal to quantify methane sources and test mobile and in-situ methodologies targeted at natural gas and landfill sources. Environment and Climate Change Canada's Global Atmosphere Watch Observatory at Alert continues to be one of three WMO Global GHG inter-comparison sites, providing continuous measurements since 1985.

Detailed measurements of aerosol chemistry and microphysics are conducted at four sites in Canada to monitor short- and longer-term changes in concentrations of the atmospheric aerosol. A long-term baseline location at Alert (1980 to present) represents the high Arctic. Much shorter-term stations in the high arctic were at Resolute Bay (2013 to 2016) and Pond Inlet, Nunavut (2018 to 2020). The four decades of long-term measurements at Alert provides valuable information for understanding linkages to the changes in emissions and atmospheric transport when compared with observations conducted at other southern stations. Aerosol measurements at different stations vary. Currently, the Alert (Nunavut), East Trout Lake (Saskatchewan), Egbert (Ontario) and Whistler (British Columbia) stations have comprehensive instrumentation for aerosol measurements (i.e., particle number and size distributions, light scattering and absorption, refractory and equivalent black carbon mass concentrations, submicron particle inorganics, carbonaceous mass and stable carbon isotope; although not all measurements are conducted at all sites). In addition, carbonaceous aerosol measurements are also conducted at two more station locations at Fraserdale and Downsview (Ontario). Since 2019, aerosol inorganic speciation measurements were shut down at East Trout Lake and Egbert. Chemical composition and total aerosol mass measurements of aerosols are conducted at 16 sites of the Canadian Air and Precipitation Monitoring Network.

Environment and Climate Change Canada also operates the AEROCAN (AEROsol CANada) network, 19 sites across Canada that are part of the global AERONET (AErosol RObotic NETwork) network. The objective of AEROCAN is to acquire data on aerosol optical properties, e.g., aerosol optical depth, and derive aerosol characteristics such as size distribution and mass. AEROCAN provides data that can be used for aerosol optical depth trend analysis, optical properties characterization, and validation of satellite retrievals, potentially helping to reduce uncertainty of the aerosol radiative forcings.

Stratospheric ozone measurements support Canada's international obligations as a party to the Montréal Protocol on Substances that Deplete the Ozone Layer, and as a party to the Vienna Convention for the Protection of the Ozone Layer. More specifically, total ozone column measurements are being taken to study the temporal trends of the ozone layer thickness and monitor the recovery of the ozone layer and springtime polar stratospheric ozone depletion events (Arctic and Antarctic ozone holes). In addition, the total ozone and spectral ultraviolet irradiation measurements by the Brewer network are used by modellers to generate ultraviolet index forecasts, which are then validated by Brewer ultraviolet measurements. Complementary to total ozone column observations are vertical ozone profiles from the Ozonesonde network. The long-term stratospheric and tropospheric ozone data from ozonesondes is used for assessing the state of the ozone layer and identifying the layers where ozone destruction occurs as well as for studying current and emerging issues such as climate change. Surface ozone measurements are also made at 17 regionally representative sites across Canada by the Canadian Air and Precipitation Monitoring Network, a regional scale network that measures air and precipitation chemistry across the country.

Data management among Environment and Climate Change Canada's atmospheric composition measurement networks adheres to principles set out by the WMO Global Atmosphere Watch Program. Ozone, GHG, and aerosols data are reported to the relevant WMO World Data Centers. Ground level ozone data and aerosol composition data collected by the Canadian Air and Precipitation Monitoring Network are reported through the Government of Canada Open Data Portal. The World Ozone and Ultraviolet Radiation Data Center is operated by Environment and Climate Change Canada and located in the city of Toronto. GHG and aerosols data are archived in the Canadian National Atmospheric Chemistry Database and Analysis System. Ultimately, these data will be made publicly available through the Government of Canada Open Data Portal, pending resolution of third party licensing issues. Canada's participation in these national and international data archives ensures open access to the first-order data collected under the various monitoring programs.

8.2.2.2. Oceans

Fisheries and Oceans Canada is responsible for the collection, management and interpretation of data on the physical, chemical, and biological variables describing the climate of the three oceans that surround Canada. This includes the northeast Pacific, northwest Atlantic, Hudson Bay, the Beaufort Sea, the Canadian Arctic Archipelago, Baffin Bay and the Labrador Sea. Observations are made using ships, moored instrumentation, autonomous platforms, and satellite remote sensing. Collaborations are established with universities, other government departments (primarily Environment and Climate Change Canada) both national and international, and agencies to include oceanographic activities for which the responsibility falls outside Fisheries and Oceans Canada.

Fisheries and Oceans Canada's core responsibilities fall into four categories: Fisheries, Aquatic ecosystems, Marine navigation, and Marine operations and response. The department conducts research and long-term monitoring of key ocean parameters (e.g., salinity, temperature, dissolved oxygen, carbonate system, nutrients), and manages the resulting data to ensure integrity and accessibility. In turn, the generation of new knowledge allows the department to provide advice, products and services that support ecosystem management decisions, adaptation to climatic change and its consideration for food security, marine conservation targets, emergency preparedness, search and rescue, the mitigation of oil spills, and at-sea operations such as fisheries and offshore energy exploration. Ocean monitoring is a crucial requirement for achieving the goals of these core responsibilities.

Pacific and Atlantic Ocean Monitoring

The Atlantic Zone Monitoring Program was established in 1998 and includes a network of six stations sampled bi-weekly, 17 seasonal cross-shelf sections sampled one to three times annually, and fisheries resource surveys. The data collected on these ship-based surveys includes temperature, salinity, oxygen, nutrients, carbonate system, phytoplankton and zooplankton. Since 2016, the Atlantic Zone Monitoring Program has integrated new technologies to supplement data collection including moored Viking buoys and autonomous underwater gliders. The Atlantic Zone Off-shelf Monitoring Program includes a Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP) section across the Labrador Sea sampled annually for temperature, salinity, oxygen, nutrients, carbon system variables, chlorofluorocarbons, and microbial, phytoplankton, and zooplankton abundance and production. The Atlantic Zone Monitoring Program also collects data in the deep water south of the Scotian Shelf. This is an important ocean monitoring program for climate research because each year it samples the water masses that contribute to the Atlantic branch of the ocean's global thermohaline circulation. In the northeast Pacific, a transect from Vancouver Island to Ocean Station Papa (Line P) is surveyed three times per year for temperature, salinity, oxygen, carbon system variables, chlorophyll, nutrients, and zooplankton. This is a cornerstone of long-term observations of the effects of climate variability and change on ocean ecosystems in Canadian Pacific waters. The Line P program celebrated its 65th anniversary in 2021. Line P sampling is coordinated with other collaborative groups including local, national and international academia incorporating metagenomics, biogeochemistry, plankton ecology, physical and chemical oceanography into Line P data and publications.

Other Fisheries and Oceans Canada monitoring programs in the Pacific Ocean include surveys of the west coast of Vancouver Island (twice a year, late spring and late summer), the Salish Sea (three times per year for physical and chemical variables, spring, summer, and fall, and twice a year for zooplankton and phytoplankton, spring and summer), and B.C. coastal inlets (once a year, spring). Shore stations (mainly staffed lighthouses) have monitored temperature and salinity year-round for over a century. A network of moored sensors continuously monitors physical and some chemical oceanographic parameters. The mooring program began on the shelf off the west coast of Vancouver Island in the 1970s. It has expanded over the last decade and now covers the whole British Columbia coast.

Carbon system variables are also being sampled in coastal British Columbia in collaboration with the academic-led Marine Environmental Observation Prediction and Response network. Other academic and non-profit initiatives (e.g., Hakai Institute and Oceans Networks Canada) are providing valuable data in physical, biological and chemical oceanography. Fisheries and Oceans Canada has partnered with the University of Victoria under the Canadian-Pacific Robotic Ocean Observing Facility project to use underwater gliders to supplement ocean monitoring in the Pacific coastal regions as well as along Line P.

Satellite data images are processed by the satellite ocean colour and phytoplankton ecology group at the Bedford Institute of Oceanography at Fisheries and Oceans Canada. Sea-surface temperature images are derived from Advanced Very High Resolution Radiometer on the United States' National Oceanic and Atmospheric Administration series of polar orbiting weather satellites and from the Moderate Resolution Imaging Spectroradiometer (MODIS) and merged with an archived product to produce a long term dataset (since 1982) that is used for state of the ocean reports. Chlorophyll-a concentration images have been produced from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS, 1998 to 2010), the Visible Infrared Imaging Radiometer Suite (VIIRS, 2012 to present), the MEdium Resolution Imaging Spectrometer (MERIS, 2002 to 2012) and the Moderate Resolution Imaging Spectroradiometer (MODIS, 2003 to present) to calculate

phytoplankton bloom metrics. Online archives of ocean colour imagery, as well as archives of sea-surface temperature and primary production composite images are publicly available. SeaWiFS, as well as up-to-date MODIS and VIIRS satellite chlorophyll-a imagery, is available for viewing in the shiny R app PhytoFit which is also used to calculate phytoplankton bloom metrics.

Canada also contributes to the international Argo program, which now has over 3,800 operational profiling submersible floats in the world's oceans and provides ongoing coverage of global ocean temperature and salinity variability. The Argo Program also provides a unique dataset for the development and testing of ocean circulation models, creation of modern temperature–salinity climatology for the global ocean, and time series of variability in heat and freshwater storage and transports, used for analysis of the dominant patterns and modes of variability. Real-time Argo data are assimilated into operational coupled forecast models run by Environment and Climate Change Canada. The Argo program is implementing two new initiatives: the first will expand to include additional ocean variables (Biogeochemical Argo) and the second will collect data over the full ocean depth (Deep Argo). Canada's contribution since the Argo program began in 2001 has included deployment of over 652 floats, with an ongoing contribution in the Atlantic and Pacific Oceans of approximately 10 to 20 floats per year.

The Arctic

Arctic Ocean observing programs include year-round monitoring of oceanographic conditions via subsurface moorings and annual ship-based surveys. Moorings, recording sea-ice thickness and drift, ocean currents, temperature and salinity, are located to measure through-flow in key straits of the Canadian Arctic Archipelago (e.g., Barrow Strait Monitoring Program), and oceanographic conditions over the Canadian Beaufort Shelf, in Amundsen Gulf, within the Beaufort Gyre Region and north of the Chukchi Sea. Two annual ship-based surveys are recognized by the Global Ocean Ship-Based Hydrographic Investigations Program:

1. The Joint Ocean Ice Study program monitors sea-ice, oceanographic and ecosystem conditions in the Beaufort Gyre Region of the Canada Basin in the Arctic Ocean via an annual month-long, scientific expedition aboard the Canadian icebreaker Louis S. St-Laurent. This study program is a collaboration between the United States and Canada that has provided these oceanographic surveys of the central Beaufort Gyre annually since 2003, and is supported by a team of scientists from across Canada, the United States and Japan.

2. Canada also partners with the United States and European Union nations in monitoring key ocean climate variables along the Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP) section in the Davis Strait.

Relative Sea Level

Fisheries and Oceans Canada also has responsibility for monitoring relative sea level using the National Sea Level Network of coastal stations. This network is maintained by the Canadian Hydrographic Service, as part of Fisheries and Oceans Canada. Vertical land motion is a significant component of relative sea level change in certain regions of Canada. In regions experiencing coastal subsidence (Atlantic Canada, Pacific and Beaufort coasts), relative sea level is increasing faster than global mean sea level resulting from climate change. In the eastern Arctic and Hudson Bay, upward movement of the earth's crust is resulting in small (or even negative) changes in relative sea level. Natural Resources Canada (Canadian Geodetic Survey) monitors vertical land movement with a high accuracy network of global positioning system stations. Accounting for this region variability in sea level change is important for future planning of coastal infrastructure, which supports navigation and fisheries.

Ocean Observations Data Management

At Fisheries and Oceans, the Marine Environmental Data Section provides long-term data stewardship for Canadian oceanographic data acquired from the many Fisheries and Oceans Canada programs in the three oceans (e.g., Argo, drifting buoys, autonomous gliders, ship cruises), through collaboration with other national and international programs as well as other government agencies and departments. The Marine Environmental Data Section, as a recognized International Oceanographic Data Exchange (IODE) National Oceanographic Data Center (NODC), develops and maintains data applications to acquire the data from various data sources and formats, performs quality control, integration into the data archive, and provides access to all Canadians and international partners to the data and data products. The Marine Environmental Data Section has a role in international committees on oceanographic data through the IOC's IODE, the Global Temperature and Salinity Profile Programme and Global Ocean Surface Underway Data, and also provides national coordination through the Ocean Science Data Management subcommittee of the several regional offices. Environment and Climate Change Canada also collects and manages over 20 years of historical ocean climate data, which further supports Fisheries and Oceans Canada programmes.

8.2.2.3. Cryosphere

Sea Ice

Environment and Climate Change Canada's Canadian Ice Service observes sea ice conditions on a daily basis and publishes daily and weekly ice charts in the ice-encumbered waters within and adjacent to Canada's exclusive economic zone, including the Great Lakes. The RADARSAT Constellation Mission is the primary satellite observing platform, with approximately 1,500 Synthetic Aperture Radar images manually analyzed annually. Radar data are complemented by visual and infrared satellite images and ship and aircraft reports. Aircraft reconnaissance is also conducted in active marine areas. Daily charts of the limit of all known icebergs along the east coast of Canada are also produced, in partnership with the United States' Coast Guard's International Ice Patrol. Weather permitting, this limit is monitored with satellite imagery (in sea-ice free areas) and aerial reconnaissance, while icebergs inside the limit are surveyed less frequently.

The sea ice information gathered through these observations and analyses provide invaluable data on ice type and distribution for climate studies. An archive of weekly ice charts has been digitized back to 1968, and is available freely on the Canadian Ice Service website and in the Global Digital Sea Ice Data Bank. Environment and Climate Change Canada produces 30-year ice climate normals for Northern Canadian Waters, the east coast of Canada, and the Great Lakes. These ice normals represent a statistical compilation of ice data for 1971 to 2000, 1981 to 2010 and 1991 to 2020. The Canadian Ice Chart Digital Archive and graphing tools for 50 ice climate regions in Canadian Waters, available on the Canadian Ice Service website, can be used to analyze sea ice variability, trends, and current departures from normal.

Environment and Climate Change Canada conducts manual measurements of ice thickness at several sites across the Canadian Arctic. These sites have unique long-term measurement records spanning 50 to 60 years, which are important for climate change monitoring and support climate analyses and model development (climate, numerical weather prediction) and validation. These sites are part of the WMO Global Cryosphere Watch program, five are landfast sea ice and one is lake ice. Environment and Climate Change Canada contributes to the International Arctic Buoy

Program with buoy deployments under the Metareas Arctic Program. On-ice buoys provide information on the drift and location of multi-year ice floes. The data collections of the Canadian Ice Service are available on its website: Canadian Ice Thickness Program.

Environment and Climate Change Canada has developed and implemented an Automated Sea Ice Tracking System that generates sea ice motion products from sequential RADARSAT Constellation Mission and Sentinel-1 Synthetic Aperture Radar images. These products are used in studies examining ice fluxes through the Canadian Arctic Archipelago undertaken within Environment and Climate Change Canada. Environment and Climate Change Canada's ice data is also being used in the development and validation of various sea ice and ice–atmosphere–ocean models.

Environment and Climate Change Canada generates global sea-ice analysis fields produced from its operational Global Deterministic Prediction System and interpolated to a rotated latitude-longitude grid with 0.09 x 0.09 degree resolution. The Global Sea-Ice Analysis System is an analysis system covering all waters (ocean and lakes) at a 10 km horizontal resolution. This analysis assimilates satellite remote sensing data and Canadian Ice Service ice charts four times a day.

Environment and Climate Change Canada's Global Ice-Ocean Prediction System produces global sea ice and ocean analyses and 10-day forecasts daily. This product contains time-mean sea ice and ocean forecast fields interpolated to two grids. One of the grids is a 0.2° resolution regular latitude-longitude grid covering the global ocean (north of 80° S). The other grid is in north-polar stereographic projection with a 5 km spacing at the standard parallel 60° N and covers the Arctic Ocean and the neighbouring sub-polar seas. The Regional Ice Ocean Prediction System provides 84-hour ice and ocean forecasts four times per day on a 1/12° resolution grid (3 to 8 km). The regional system is initialized using analyses from the global system.

Lake and River Ice

Dates of freeze-up and break-up of ice cover on lakes and rivers are useful indicators of climate change, being well correlated with air temperature during the transition seasons, and are important ecological indicators. There are Global Climate Observing System requirements for daily observations of ice conditions in spring and fall for selected large lakes and several hundred medium-sized lakes distributed across middle and high latitudes. There are also associated needs for the selection of a set of the Global Climate Observing System reference lakes for assessing long-term variability, development of methods for merging in situ and remotely sensed information on this parameter, and for a central or several regional archive(s) of information.

Canada has contributed significantly to the Global Climate Observing System in this area. In situ observations exist at several hundred Canadian lake and river sites for various periods. The Canadian Ice Service monitors over 130 lakes in Canada and the United States for ice concentration based on visual interpretation of Synthetic Aperture Radar and optical satellites. Environment and Climate Change Canada has also added the Canadian River Ice Database that goes beyond freeze-up and break-up dates and provided comprehensive information over the whole ice-affected flow season at a network of 196 National Hydrologic Program's hydrometric stations across Canada. The Canadian River Ice Database holds information on water levels, discharges and dates corresponding to ice-affected river events, such as during the fall freeze-up, under-ice low flows and low water levels, midwinter break-ups, secondary freeze-up, spring break-up and maximum ice thickness at each of those stations. In addition, a volunteer "Icewatch" program, a partnership between several academic and non-government organizations, provides lake and river ice reports for locations across Canada.

Snow on Ground

Canada's national snow on ground in-situ measurement program involves a composite of inputs including automatic and manual stations that are part of Environment and Climate Change Canada's Reference Climate Stations and Surface Weather Network (described in Section 8.2.2.1). In addition, volunteer climate observing networks and other government departments (e.g., Department of National Defence) continue to operate a small portion of the Canadian Reference Climate Stations. Reports from contracted aviation service providers also contribute data to the program. Efforts continue to improve measurement of snow depth and derivation of snowfall from auto-stations, and Canada has had a leadership role in the WMO Solid Precipitation Intercomparison Experiment. Environment and Climate Change Canada produces a daily global snow depth analysis based on real-time observations from synoptic and hourly meteorological reports. Improving the resolution of the analysis continues to be an area of focus.

Environment and Climate Change Canada has produced a Canadian Historical Snow Water Equivalent dataset which is a compilation of manual and automated pan-Canadian snow water equivalent observations collected by national, provincial and territorial agencies as well as hydropower companies. The current version of this dataset includes observations from 1928 to July 2020.

Environment and Climate Change Canada has made progress in developing satellite passive microwave capabilities for deriving snow water equivalent information over western and sub-Arctic regions of Canada. Weekly satellite snow water equivalent maps are generated each winter for the Canadian Prairies region and provided to a number of operational agencies in support of flood forecasting, hydropower production, and other water resource management activities. Environment and Climate Change Canada has also developed capabilities to assimilate satellite-derived information on snow cover fraction and water equivalent with the Canadian Land Data Assimilation System in support of enhanced numerical weather prediction. Natural Resources Canada continues to produce daily snow cover derived from the United States' National Oceanic and Atmospheric Administration's Advanced Very High Resolution Radiometer observations.

Permafrost

Permafrost is an important priority for Canada with one third of the permafrost regions of the northern hemisphere lying within Canada and the permafrost zone covering about half of the Canadian landmass. Measurements for two key indicators, permafrost thermal state and active layer thickness, are acquired through in situ observations. At most thermal monitoring sites, ground temperatures are measured to depths of 20 m. At active layer monitoring sites, regular measurements are made of the thickness of the soil layer above the permafrost that freezes and thaws annually.

Natural Resources Canada continues to maintain, in collaboration with partners, a network of reference sites. The network consists of over 150 thermal and/or active layer monitoring sites with observation periods ranging from about 10 years to more than 30 years, with Alert (initiated in 1978) having the longest record. Travel restrictions during the pandemic limited site visits in 2020 and 2021 but territorial governments and other collaborators conducted visits at some sites to ensure timely data acquisition.

The current observation network covers the major ecoclimatic zones with transects in western, central and eastern portions of Canada's northern territories, as well as an elevational transect in the Yukon. Through recent research projects, additional instrumented sites have been established such as those in the Inuvik-Tuktoyaktuk highway corridor and the Rankin Inlet area.

The Canadian monitoring sites contribute to the Global Terrestrial Network for Permafrost established by the International Permafrost Association under the WMO and the Global Climate Observing System. Natural Resources Canada continues to play a leadership role in the coordination of the network and provides Canadian representation on the Executive Committee. The Global Terrestrial Network for Permafrost includes two components, the Thermal State of Permafrost and the Circumpolar Active Layer Monitoring Program. The Global Terrestrial Network for Permafrost website is currently maintained by European partners; summary data for Canadian thermal monitoring sites has been submitted for dissemination through this website. However, there have been some issues recently regarding website maintenance and stability, which limits the ability to ensure data are updated. Active layer data are submitted annually to Circumpolar Active Layer Monitoring Program and posted on the website hosted by George Washington University, which is also accessible through the Global Terrestrial Network for Permafrost website. Natural Resources Canada's Geological Survey of Canada has also been working to make its data more accessible through an online portal.

Glaciers

In Canada, some 200,000 km^2 of glacier cover is found throughout the Western Cordillera region and in the Arctic Islands. Glaciers in both regions have recently experienced accelerated retreat and thinning, having significant impacts on freshwater inputs to stream flow and sea-level rise. Monitoring rates of change of glaciers in both regions thus remains a major priority for the Government of Canada.

Natural Resources Canada is the lead federal department responsible for measuring and reporting on the state of health of Canada's glaciers. Canada's Glacier–Climate Observing System is delivered through a multi-lateral initiative of collaborative monitoring and research coordinated by Natural Resources Canada and involving other federal departments and agencies, as well as universities.

Mass balance measurements were initiated for some glaciers and ice caps in Canada during the late 1950s and early 1960s. Data and supporting metadata on Canada's reference glacier measurements are submitted to the World Glacier Monitoring Service (WGMS). Digital data are accessible through the World Glacier Monitoring Service and its mirror site at the United States' National Snow and Ice Data Center. Of Canada's 15 reference observing sites, seven of these have sufficiently long data records (over 30 years) to provide data to the World Glacier Monitoring Service.

In addition to the monitoring of reference glaciers, work at various levels of frequency and intensity is ongoing in various regions of the country. For example, with the prospect of some of Canada's smaller reference glaciers in more southern mountainous regions (e.g., the Peyto Glacier) becoming drastically reduced in area, work initiated in 2010 continues to augment existing observation and assessment in the region to include larger icefield settings such as the Columbia Icefield, Wapta Icefield, and the Britnell-Bologna Ice field in the Nahanni National Park Reserve, Northwest Territories.

Earth Observation strategies have been integrated into the in-situ mass balance monitoring program to improve the spatial and temporal resolution of glacier mass balance. For example, results from the CryoSat-2 and IceSat-2 satellite altimeters provide preliminary assessments of select glaciers, allowing routine assessment of glacier change beyond the traditional long-term in-situ network. Data telemetry capabilities allow near-real time (one to two days) retrieval of glacier mass balance measurements, reporting, and analysis. Both strategies complement the existing in-situ measurement program to provide timely access to data essential for characterising climate system dynamics and global glacier change analysis.

8.2.2.4. Terrestrial Systems

Responsibility for systematic observation of the terrestrial sector in Canada is shared among multiple departments and programs. The work includes multiple networks and involves both ground-based and satellite-based observing platforms.

Hydrometric Monitoring

Environment and Climate Change Canada is responsible for the collection, interpretation, and dissemination of standardized water level and river discharge (flow) data and information in Canada. The data are collected under a national program jointly administered and paid for under federal–provincial and federal–territorial cost-sharing agreements. The national hydrometric monitoring network consisted of 2,872 hydrometric monitoring stations and Environment and Climate Change Canada operated 2,274 of these hydrometric stations. Both real-time and final archived data are made available online through the Government of Canada's Water website, which also provides content on Environment and Climate Change Canada's water-related activities and program areas as well as general information on a wide range of water-related topics. Similar to the ground-based national meteorological networks, the hydrometric program is well established, has defined standards and operating procedures, and is ISO-9001 certified.

Environment and Climate Change Canada supports the WMO's focus on water within the WMO governance structure which aims to integrate water data into Earth System science and services through continued engagement with WMO on water initiatives at a global, regional (Region IV) and national level. In support of the Global Terrestrial Network for Rivers, Canada provides data from discharge stations located at or near the mouth of large rivers.

Environment and Climate Change Canada led the Arctic Hydrological Cycle Observing System (HYCOS) initiative from 2012 to the conclusion of Phase I in 2019, which focused on assessing freshwater flux into the Arctic Ocean. Environment and Climate Change Canada will continue to support global access to arctic streamflow data and metadata as well as model outputs and products. This work supports Arctic science across multiple domains as well as WMO initiatives.

Most of Canada's hydrometric stations are located in the southern half of the country where the density of the population and economic activities are greatest. As a result, the adequacy of the hydrometric network to describe hydrologic characteristics, both spatially and temporally, decreases significantly in the north. A subset of stations is included in the Reference Hydrometric Basin Network. These stations typically have long data series and they represent locations with little or no upstream regulation (i.e., natural flow conditions).

Environment and Climate Change's National Hydrological Service also has a Memorandum of Understanding with the United States' Geological Survey for cooperation in the earth sciences, under which training and standards for hydrometric monitoring are shared.

Forests

Natural Resources Canada's National Forest Inventory provides ongoing monitoring of Canada's forests. The National Forest Inventory is a collaborative effort of federal, provincial, and territorial governments from across Canada. The National Forest Inventory is currently monitoring a network of 13,158 remote sensing survey plots across Canada on a 10-year re-measurement cycle (2018 to 2027). A 20 km by 20 km sampling grid is used in southern Canada with less intensive sampling in northern Canada. Detailed ground measurements are taken at a subset of the National Forest

Inventory plots. The ongoing 10-year re-measurement cycle provides a continuous record of forest change. The re-measurement strategy is designed for flexibility, alignment with jurisdictional inventory activities, and integration with other relevant forest information products.

The National Forest Inventory provides national and regional scale estimates of aboveground forest biomass and biomass estimation models. Updated biomass estimation models were embedded in an updated version of the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) which was released in January 2015. The biomass calculation tools used in this model are available through the National Forest Information System.

Natural Resources Canada is engaged in several research and development initiatives to develop improved monitoring of forest biomass stocks and stock changes. Special focus is being placed on improving national mapping and monitoring of forest disturbances (cover losses) and post-disturbance forest recovery. Disturbances have a high impact on the carbon balance of Canada's forests. Tree cores collected at National Forest Inventory plots are also being used to investigate forest growth responses to changing climate.

Agricultural Soils and Vegetation and Agroclimate

Since 2011, Agriculture and Agri-Food Canada has produced weekly maps of soil moisture condition and anomalies over North America, which are used as input to other monitoring systems for drought monitoring, flood forecasting and climate-related production risk assessment.

Agriculture and Agri-Food Canada and Environment and Climate Change Canada are partners in the operation of a soil moisture and temperature network of 28 stations. Agriculture and Agri-Food Canada has played a leadership role in advancing soil moisture monitoring by use of satellite microwave data to assess surface moisture conditions and by the development of a small in situ network to calibrate and validate surface and rooting zone moisture conditions. The network was initially installed in 2011 and 2012. Routine public data dissemination began in 2013 and is ongoing. These data are important to Environment and Climate Change Canada's land surface assimilation modelling and the United States' National Aeronautics and Space Administration's calibration and validation of satellite moisture assessment systems.

Agriculture and Agri-Food Canada has monitored agricultural land use and cover on a national scale since 2011 through its Annual Space-Based Crop Inventory. The inventory maps with high accuracy the crop type of every field in Canada, along with other non-agricultural land use and cover found within the Canada's agricultural extent. Agriculture and Agri-Food Canada has also developed a Semi-Decadal Land Use Time series (1990, 2000, 2005, 2010, 2015 and 2020) that is used by Agriculture and Agri-Food Canada for its international reporting on state and change of Canada's agricultural landscape (e.g., Canadian Environmental Sustainability Indicators, National Inventory Reporting, etc.). Agriculture and Agri-Food Canada is working with Environment and Climate Change Canada and Natural Resources Canada to develop a terrestrial monitoring framework for Canada.

Agriculture and Agri-Food Canada's Canadian Ag-Land Monitoring System has been providing weekly Normalized Difference Vegetation Index composites and their anomalies (i.e., differences from normal conditions) across Canada's agricultural extent in near real-time since 2009. These data are openly and freely available for the full observational period 2000 to the present day. This system is based on the use of MODIS-Terra daily satellite observations (with MODIS-Aqua as backup) acquired at a 230 m spatial resolution.

Agriculture and Agri-Food Canada has developed a monthly crop production forecasting system using real-time weather and satellite vegetation condition data. Monthly forecasts are produced for major crops in Canada during the growing season. The datasets and models have been adopted for estimating yield production by Statistics Canada, replacing traditional telephone surveys for the late growing stage assessment. This program was an experimental research and development program until 2015, and is now operational. This model is used operationally by Statistics Canada for its July and August national production estimates and Agriculture and Agri-Food Canada produces maps, data and tools released through the Canadian Crop Metrics application.

Agriculture and Agri-Food Canada is the lead for drought monitoring and reporting for the Government of Canada. Agriculture and Agri-Food Canada has developed new tools and indices to enhance its monitoring of drought conditions on Canada's agricultural landscapes. The Drought Watch website has been updated with a section dedicated to the Canadian Drought Monitor and an associated Drought Outlook, which forecasts changes in drought conditions for the following month. This section features a geospatial application, a timeline tool and embedded maps. Drought forecasts were developed using 23-day forecasts from the Meteorological Service of Canada's Global Ensemble Prediction model.

Agriculture and Agri-Food Canada also produces a Canadian version of the Vegetative Drought Response Index, initially developed by the United States. Adoption of this index by Canada is improving the homogeneity of integrated North America drought assessments.

The Agroclimate Impact Reporter was launched in 2013 to automate reporting of agroclimate impacts, including the capture of crowd-sourced observations. The Agroclimate Impact Reporter is currently used to validate extent, location, and severity of the impacts of drought and other extreme weather and climate conditions and events on agriculture. Agriculture and Agri-Food Canada, through the Canadian Soil Information Service, continues to work closely with provincial governments, other federal departments, and academia to ensure Canadians have access to the best available soil data, for use in modelling the potential impact of a changing climate on agricultural soils.

As a member of the Global Soil Partnership, Agriculture and Agri-Food Canada worked with partners to develop the first National Soil Organic Carbon Map, released in December 2017. The National Map contributed to the Global Soil Organic Carbon Map.

Agriculture and Agri-Food Canada's near real-time crop assessment activities feed into monthly assessments of global crop production through the Group on Earth Observation's Global Agricultural Monitoring initiative. The global assessments also support early warning for food scarcity in food insecure nations.

8.2.3. Space-Based Observations

Satellites are valuable tools used to increase our knowledge and understanding of climate processes and climate change impacts, thus providing information to inform action plans and response activities. They are being used to track more than half of the 54 Essential Climate Variables (ECV) as set out by the United Nation's Global Climate Observing System (GCOS).

Canada's *Strategy for Satellite Earth Observation: Resourceful, Resilient, Ready*, released in January 2022, will guide Canada's actions and investments related to satellite Earth observation data, technology and partnerships. Following international best practises and a commitment to open and transparent digital data, Canada will participate in global initiatives for open data and science, the development of data standards and collaborative missions with international partners to leverage world-wide open Earth observation data streams.

The Government of Canada utilizes a variety of satellite imagery to deliver on critical government services, operations and priorities, including in environmental monitoring and disaster response. The observations collected by satellites are used by the Canadian government, and other Canadian public and private sector entities, to study climate, GHG emissions, crop yield and the cryosphere, among other important matters.

8.2.3.1. Canadian Satellites and Missions

SCISAT-1 Atmospheric Chemistry Experiment

Launched in August 2003, SCISAT Atmospheric Chemistry Experiment assists Canadian and international scientists in improving our understanding of the depletion of the ozone layer, with a special emphasis on the changes occurring over Canada and in the Arctic. A partnership of universities, government and industry, it was originally intended to last two years, but the satellite is still operational and its mission has been extended. Tracking the presence of more than 60 different gases, SCISAT is providing long-term data related to ozone, climate change and air quality, including datasets on CFCs, HCFCs and HFCs – a potent greenhouse gas. SCISAT data is also used for reporting on many international treaties, including the Montréal Protocol.

SCISAT data is used by academia, space agencies, governmental and scientific organizations around the world. All registered users can access data openly and freely through Canadian University of Waterloo data portal.

RADARSAT-1 and RADARSAT-2

RADARSAT-1 was Canada's first Earth Observation radar satellite. It acquired data all around the world from 1995 to 2013 for the Government of Canada and commercial users. Open data from RADARSAT-1 provided information for use by Canadian users in environmental monitoring and natural resource management, particularly over Canada's North. Internationally, the satellite's images were used to manage and monitor the Earth's resources and to monitor global climate change, as well as in many other commercial and scientific applications.

In 2019, the Government of Canada provided public access to over 36,500 historical RADARSAT-1 synthetic aperture radar images of Earth. This open dataset has been made available to researchers, industry and the Canadian public at no additional cost. Comparisons derived from this dataset have been used by Canadians to analyze sea ice cover, forest growth or deforestation and the effects of climate change, particularly in the Arctic.

RADARSAT-2 was launched in 2007 and it is still operational today, providing a high resolution, enhanced repeat imaging capacity, shortened programming and processing-delivery timelines, superior data storage and more precise measurements than its predecessor. Data gathered from RADARSAT-2 is used to enhance marine surveillance, ice monitoring, disaster management, environmental monitoring, resource management and mapping in Canada and around the world. Additionally, commercial and scientific users with access to accessible RADARSAT-2 have used this information to support the development of agriculture, cartography, hydrology, forestry, oceanography, and ice studies. RADARSAT-2 data is available commercially and is still being used by the Government of Canada to complement RADARSAT Constellation Mission data.

RADARSAT Constellation Mission

Launched in June 2019, the RADARSAT Constellation Mission, comprised of three satellites, represents an evolution of the RADARSAT program and ensures C-Band Synthetic Aperture Radar data continuity. The mission is designed to meet Government of Canada data needs, supporting the government's mandate to monitor the impacts of climate change, protect our environment and foster sustainable development, manage natural resources, and support disaster relief. The constellation model allows for a more frequent revisit of the same area. This allows for a range of applications that are based on the regular collection of data and creation of composite images that highlight changes in the same area over time. Such applications are particularly useful for monitoring climate change, land use evolution, coastal change, urban subsidence and even human impacts on local environments.

Most of the RADARSAT Constellation Mission image products, made from imagery acquired over Canada, are freely and openly available to users outside the Government of Canada, subject to security, privacy and confidentiality exceptions. International government users receive data as part of operational and/or strategic partnerships between departments and foreign governments. RADARSAT Constellation Mission data continues to be acquired and made available for all International Charter “Space and Major Disasters” activations requested since June 2, 2020.

WildfireSat

In 2022, the Government of Canada committed funding to build, launch and operate WildfireSat—a satellite-based monitoring system that will support wildfire management and emergency response, provide Canadians with more precise information on smoke and air quality conditions, and further enable us to more accurately measure carbon, aerosols and other particles emitted by wildfires. Planned for launch in 2028, WildfireSat will be equipped with infrared sensors that will measure the energy emitted by wildfires known as Fire Radiative Power. With this information, essential characteristics of wildfires such as fire intensity and rate of spread can be derived. By providing a daily key observation of wildfire activity and Fire Radiative Power during the peak burn period (i.e., afternoon and early evening), WildfireSat will work with existing satellites to significantly broaden our understanding of how wildfires behave and how that behaviour is changing alongside climate change.

Proposed Future Canadian Missions

A number of satellite missions are in the initial development stage, or are to be proposed for future implementation. Ongoing activities include advancing technological and scientific readiness, engaging partners and potential stakeholders – internationally and domestically, and demonstrating socio-economic relevance. These proposed missions include:

- Terrestrial Snow Mass Mission would address observational gaps for snow mass (snow water equivalent) at the resolution needed to advance climate, weather and hydrological predictions and meet climate services related to water security and flood/drought risks.
- Arctic Observing Mission envisions an international, Canadian-led mission providing continuous observations in the North using four different measurements: GHG emissions, weather, air quality and space weather.
- WaterSat would observe Canada every five to seven days to gather information on water quality to better support coastal and inland waters management, monitoring and science.

8.2.3.2. Canadian Instruments Aboard International Satellites and Missions

CLOUDSAT

Launched in 2006, CloudSat is a National Aeronautics and Space Administration (NASA) led mission to which the Canadian Space Agency contributed important radar subsystems. CloudSat supports the first comprehensive three-dimensional study of clouds by using a Cloud Profiling Radar to provide three-dimensional data on the structure, occurrence and volume. Data gathered by CloudSat helps scientists and researchers analyze the influence of atmospheric aerosols and contributes to improved understanding of how clouds influence weather and their effect on climate.

Measurements of Pollution in the Troposphere (MOPITT)

MOPITT is one of five instruments aboard NASA's Terra satellite. Since 1999, this Canadian instrument, a key contribution to NASA's Earth Observing System, continues to scan the Earth's atmosphere and collect profile measurements of carbon monoxide to support air quality and climate studies. MOPITT's specific focus is on the distribution, transport, sources, and sinks of carbon monoxide in the troposphere. It is the longest-running pollution monitor in space today and the longest continuously operating space mission in Canadian history.

Optical Spectrograph and InfraRed Imaging System (OSIRIS)

Canada's OSIRIS instrument was launched in February 2001 onboard Sweden's Odin satellite to monitor signs of climate change from space. Canada's OSIRIS instrument has been measuring and mapping ozone and detecting aerosols and nitrogen dioxide in the atmosphere since 2001. In particular, OSIRIS captures detailed vertical profile measurements of ozone, nitrogen dioxide and aerosol concentrations and the formation of ozone holes in the upper atmosphere in both the Northern and Southern Hemispheres. In addition to providing high-quality data for climate science and climate modelling, OSIRIS contributes to improved understanding of how human activities and volcanic emissions affect the atmospheric environment.

Surface Water and Ocean Topography (SWOT)

The Surface Water and Ocean Topography satellite mission is a collaborative project led by NASA and the Centre National d'Études Spatiales in France, with contributions from the Canadian Space Agency and the United Kingdom Space Agency. Planned for a launch in late 2022, the mission will provide measurements of surface water elevation with unprecedented spatial coverage and provide valuable information that will assist in developing the first global survey of freshwater storage and its change over time. Canada's contribution to the mission is a set of Enhanced Interaction Klystrons—a critical component of the Ka-band Radar Interferometer and a core instrument on the mission. Additionally, Canada contributes to the Surface Water and Ocean Topography science team through support to hydrology and oceanography research.

8.2.3.3. Canadian Involvement in International Missions

While the Government of Canada hosts significant portions of the Earth observation expertise in Canada, knowledge and experience from academia, private companies, and provincial, territorial, local and Indigenous governments play an important role. Internationally, satellite Earth observation capabilities in Canada currently benefit from collaborations with American and European partners, with Canadian researchers involved in the following, but not limited to, internationally-led satellite Earth observation missions:

- **European Commission's Sentinel satellites:** Data from the Sentinel satellites, exploited by Copernicus Services, augments RADARSAT Constellation Mission data to support Government of Canada priorities, including climate action and resilience, sustainable agriculture and food security, clean water and national security.
- **European Space Agency's Soil Moisture Ocean Salinity (SMOS) satellite:** Launched in November 2009, this is the first satellite designed to both map sea surface salinity and monitor soil moisture on a global scale. The satellite provides a better understanding of Earth's water cycle and provides observations over snow and ice-covered regions, which supports research on the cryosphere. Canada is an active participant in the SMOS mission. Canada's participation and funding of Earth observation applications and utilization programs has enabled Canadian companies to contribute advanced technology for demonstration on this satellite. The Canadian Space Agency has invested in this mission and provided support to the scientific exploitation of SMOS data.
- **National Aeronautics and Space Administration Landsat satellites:** Natural Resources Canada has been receiving, archiving and distributing Landsat data since 1972. Open data provided by Landsat satellites provides a continuous global record of Earth's land surface used by Canadian public and private sector entities to develop and distribute value added Landsat data products and services, such as Canadian annual crop inventories.
- **National Aeronautics and Space Administration Orbiting Carbon Observatory 2 (OCO-2):** satellite, launched in 2014, makes global high precision CO_2 measurements or carbon cycle science and climate studies. NASA's OCO-3, launched in 2019 to the International Space Station, benefitted from the Canadarm2 participating in its installation. Environment and Climate Change Canada scientists are members of the OCO mission's science team and have collaborated on a number of OCO-2 and OCO-3 projects. The Government of Canada contributes infrastructure and/or partial funding support for ground-based spectrometer observations at two sites in Canada that are part of the Total Carbon Column Observing Network and also used for OCO-2 validation, and special observations are carried out in various locations across Canada.
- **National Aeronautics and Space Administration Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2):** This mission, launched in 2018, provides high precision measurements of the height/thickness of ice, including glaciers, ice sheets, sea ice and permafrost. Environment and Climate Change Canada had "Early Adopter" status for this mission, with early access to data for sea ice and climate applications, weather prediction and operational monitoring. A field campaign was conducted at Eureka in April 2022 to collect in situ measurements to support ICESat validation, including a new sea ice thickness product for the Canadian Arctic Archipelago region developed by Environment and Climate Change Canada for use in climate, weather and operational sea ice monitoring programs.
- **Global Precipitation Measurement (GPM):** This mission, led by Japan's Aerospace Exploration Agency and the United States' NASA, is an international network of satellites that provide next-generation global observations of rain and snow. In collaboration with these organisations, Environment and Climate Change Canada scientists conducted satellite calibration/validation field campaigns across Canada (2015 to 2020), including in Victoria, Iqaluit, and Toronto, using ground-based radar and LIDAR observations.

Canada also collaborates on upcoming missions. The goal of NASA's upcoming Atmosphere Observing System mission is to optimize study of the links among aerosols, clouds, atmospheric convection and precipitation. In collaboration with the Canadian Space Agency, this mission will deliver key data for improved forecasts of weather, air quality and climate by providing unmatched

insight into the vertical structure of our atmosphere with observations from space, our skies, and on the ground. Environment and Climate Change Canada scientists are involved in the mission planning, sub-orbital activities and defining user requirements. The Canadian academic community is also playing an integral role in the planning and development of this mission.

In addition to involvement in the aforementioned international missions, Canada works closely with international partners as part of disaster relief programs, making its Earth observation data available in times of crisis and helping to assess impact and mitigate risk for disaster events, including those attributed to a changing climate. While supporting domestic disasters, Canada continues to actively support the International Charter "Space and Major Disasters"—a collaboration founded by the European Space Agency, Centre National d'Études Spatiales (National Centre for Space Studies) in France and Canadian Space Agency.

8.3. Research

8.3.1. Overview

Numerous scientific disciplines from a range of government and academic institutions are involved in research on the climate system and climate change in Canada (see also Section 8.1.3). The key federal departments involved in such research are Environment and Climate Change Canada, Fisheries and Oceans Canada, Natural Resources Canada, the National Research Council, and Agriculture and Agri-Food Canada. The Canadian Space Agency is also a key provider of satellite-based earth observations, which, together with other remotely sensed observations and in-situ observations, improve the reliability of observations for climate research. Government activities are frequently undertaken in close collaboration with other science-based institutions, primarily within the university community. Many Canadian research programs are also linked to larger international efforts. Climate science research in Canada contributes to increasing the understanding of the carbon cycle (and other biogeochemical cycles), analysis of climate trends and variability, climate change detection and attribution studies, understanding the physical processes that govern climate system dynamics, and developing advanced global and regional climate models to project future climate change.

8.3.2. International Cooperation & Collaboration

International coordination of climate research and assessment of climate change science is achieved through the closely interconnected programs of the World Meteorological Organization (WMO), the Intergovernmental Panel on Climate Change (IPCC) and the World Climate Research Programme (WCRP).

As noted in Section 8.2, many Canadian observation and monitoring programs feed directly into international networks coordinated by the WMO, allowing Canadian data to be combined with others to provide accessible and scientifically valuable global datasets. This involves extensive international collaboration on data standards, quality control, archival and dissemination, and engages developing countries in the global climate and environmental data enterprise.

In 2016, Environment and Climate Change Canada became the lead for the Canadian National Committee to the World Climate Research Programme, facilitating coordination and communication with respect to the WCRP in Canada. The WCRP has a Capacity Development program which aims to empower long-term achievements in climate research. This program supports and engages Early Career Researchers (ECR) from all regions around the world, and encourages connection and dialogue between the new generation of climate researchers and senior scientists. WCRP actively seeks a regional and gender balance, and prioritizes support for ECRs from developing and under-

represented countries. The ECRs bring a fresh perspective to the table, which is valued by the WCRP, to create inspiring dialogues and challenge the status-quo (for more information, visit https://www.wcrp-climate.org/wcrp-capacity-development). Canada makes significant contributions to, and benefits strongly from, the leadership, participation and collaboration opportunities presented by these programs.

Canada is a member of the IPCC, and contributes on an ongoing basis to the IPCC assessment reports. The details of Canada's contribution to the latest assessment cycle can be found in Section 8.4. The IPCC has dedicated roles of chapter scientists, which are targeted to early career researchers, as well as having a Gender Policy and Implementation Plan to advocate equal opportunity and participation. The IPCC also advocates balanced representativeness from developing and developed countries, thus advancing international capacity-building.

Canada is a member of the Arctic Council. The council promotes cooperation, coordination and interaction between the Arctic States and inhabitants, including Indigenous Peoples. The activities focus on issues of sustainable development and environmental protection in the Arctic. Canada participates in the Arctic Monitoring and Assessment Programme, which focuses on measuring and monitoring pollutants and climate change effects on ecosystems and human health in the Arctic (see Section 8.4 for more information).

8.3.3. Trends and Variability

Climate observations (physical and chemical), proxy climate data, and climate model outputs are used to analyze historical changes in the climate system over a variety of time and space scales and their causes. Topics of investigation include analysis of trends, temporal and spatial variability, extremes, and the detection and attribution of climate change. Long-term research on understanding Canadian climate trends and variability is shared among multiple departments of the Government of Canada.

8.3.3.1. Atmosphere

Climate Data Analysis and Research

Environment and Climate Change Canada maintains an active research focus on climate trend and variability analysis on various temporal and spatial scales. Research on the development of statistical techniques is undertaken to produce high quality homogenised historical climate data, indices, and metadata bases for a wide range of climate variables, including gridded data products and marine wind and wave hindcasts. These data products are used in climate research and climate impact studies. This includes climate trend and variability analyses, the development of statistical downscaling techniques and scenarios of climate extremes at regional and local scales, climate change detection and attribution and climate model validation. Particular attention is on assessing and understanding trends in the Canadian and global climate with respect to extreme events, and investigation and explanation of climate anomalies.

Climate data homogenization and analysis research includes the development of long-term homogenised monthly climate data for temperature, precipitation, and wind and national gridded time series of monthly climate anomalies (temperature, precipitation) dating back to the early 1900s. These data are also included in the production of North American gridded datasets for global and regional climate model validation. Since 2010, these time series have been updated and improved, using new and improved methods for data validation, correction and fusion. Since 2017, several new datasets have become available including a new homogenized monthly and daily temperature

dataset and updated marine wind/wave datasets. The latter include the Environment Canada Davis Strait Baffin Bay Wind and Wave Reanalysis, Meteorological Service of Canada North Atlantic Hindcast (MSC50), and Meteorological Service of Canada Beaufort Wind and Wave Reanalysis to the end of 2018. Environment and Climate Change Canada's methods and computer programs for homogenization of climate data and calculation of extremes are freely available) and have been widely used around the world.

Environment and Climate Change Canada's climate data analysis research provides specialised assessments of projected changes in climate variables relevant to infrastructure design in a changing climate (e.g., temperature, precipitation, wind, snow and ice). This information is used to guide the development of codes and standards for climate-resilient buildings and core public infrastructure.

8.3.3.2. Oceans

Ocean Climate and Marine Ecosystems

Interactions between the oceans, sea ice, snow pack, and the atmosphere are a fundamental part of the Earth's global climate system. Understanding the role of oceans in global climate and the impacts of climate change on aquatic ecosystems is of critical importance to Canada, which borders three inter-connected oceans. The Ocean and Climate Change Branch of Fisheries and Oceans Canada encompasses analysis, process, and modelling research on Canada's three oceans and their ecosystems. This includes variability in physical and chemical oceanographic properties and in biodiversity, biological distributions and production from bacterioplankton to fish. Ocean regions of interest are the Northeast Pacific, Northwest Atlantic, Hudson Bay, and the Arctic. Observations from Fisheries and Oceans Canada monitoring programs, remote sensing, and field programs are used to provide state-of-the-ocean descriptions for these regions and historical ocean climate variability. The field programs involve moored measurements, annual ship-based surveys, and remotely operated and autonomous underwater vehicles.

In 2011, Fisheries and Oceans Canada initiated the Aquatic Climate Change Adaptation Services Program (ACCASP), under the Oceans and Climate Change Science Branch, to focus on the impacts of climate change on fisheries, ecosystems, and coastal infrastructure. This research provides both decision-makers and Canadians with the information they need to plan and adapt to a changing climate (see Section 8.1.2.2). Research funded through the ACCASP addresses the changing chemistry of our three oceans, the vulnerability of fish species and coastal infrastructure to a changing climate and refinement of applied ocean models.

Knowledge of the physical state of Canada's oceans is the cornerstone of advice provided by Fisheries and Oceans Canada. Climate change trends and variability are analyzed for Canada's aquatic environments as part of the ACCASP, and made public through various national reporting initiatives such as Canada's *Changing Climate Report* and the *State of the Ocean* reports (see Section 8.4).

8.3.3.3. Cryosphere

Environment and Climate Change Canada and Natural Resources Canada share the lead within the federal government for analysing the state of the Canadian cryosphere. The Canadian Cryospheric Information Network, led by the University of Waterloo, is a partnership among the Government of Canada, Canadian academia, and the private sector to manage research data and enhance awareness and access to information and data on the Canadian cryosphere.

Snow and Ice

In 2007, at Canada's request, the WMO Congress requested the Inter-commission Task Group on the International Polar Year to establish an ad-hoc expert group to explore the feasibility of creating a Global Cryosphere Watch (GCW) to promote sustained polar/cryosphere observations, and the development of an authoritative information database on past, present, and future changes of our global snow and ice resources. The initiative is now a full program under the WMO and is currently in a pre-operational phase (for more information, visit http://globalcryospherewatch.org/). Canada continues to support the implementation of the GCW program through participation of scientists in the Program's Working Groups and Expert Teams and nominating cryosphere monitoring sites for inclusion as stations in the GCW CryoNet surface-based observational network. Environment and Climate Change Canada is partnered with international agencies, including GCW and European Space Agency, on a Satellite Snow Product Intercomparison and Evaluation Experiment (SnowPEX) to assess the quality of current satellite-based snow extent and snow water equivalent products and develop guidelines for improvement. Canadian reference snow datasets have contributed to the product evaluations (for more information, visit http://snowpex.enveo.at).

Environment and Climate Change Canada carries out research on variability and change in the physical processes within the cryosphere and the role of these changing processes in the climate system based on analysis of data collected by both Environment and Climate Change Canada and other research partners. Additionally, research focuses on making improvements to snow–ice surface/atmosphere processes in the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC) model, which contributes to global and regional climate model development. Environment and Climate Change Canada's research also contributes to improved characterization of solid precipitation (snow/ice) for weather forecasting, climate analyses, and characterization of current and future water availability in the Canadian Arctic and other regions in Canada.

Permafrost

Natural Resources Canada is the primary Government of Canada department responsible for conducting permafrost-related research. Data collected over the last 30+ years through the permafrost monitoring network are used to characterize recent trends and variability in permafrost conditions across the Canadian Arctic.

Since the *Seventh National Communication*, data collected between 2016 to 2018 (about a decade after the International Polar Year, 2007 to 2009), was compared to the International Polar Year baseline to assess recent changes in permafrost for a range of ecoregions from the boreal forest to the tundra and polar desert. The quantification of long-term trends has also contributed to, for example, the IPCC's *Sixth Assessment Report*, annual State of Climate reporting, *Canada's Changing Climate Report* (see Section 8.4) as well as other scientific syntheses and reviews with international colleagues. Other related research has focussed on improving the assessment of ground subsidence and landscape change associated with increasing thaw depths.

The continued data collection since the *Seventh National Communication* has allowed the extension of time series beyond 35 years for some sites. The analysis of these data shows that permafrost continues to warm across the Canadian permafrost region and increases in thaw depth in ice-rich permafrost is leading to landscape change. The continued data collection from the monitoring network is facilitating a better understanding of permafrost-climate linkages and assessments of the response of permafrost to a changing climate as well as providing critical data to validate models for predicting future changes.

Glaciers

Natural Resources Canada conducts collaborative research on Canada's glaciers with partners and researchers from other Canadian and international government departments and industry. Since the *Seventh National Communication*, results from this work have contributed spatially referenced datasets regarding the state of Canada's changing glaciers to international bodies (i.e., World Glacier Monitoring Service, American Meteorological Service, National Oceanographic and Atmospheric Administration, and the Arctic Monitoring and Assessment Programme). Assessments over this period have contributed to national (e.g., Canada's 2019 *Changing Climate Report*) and international (e.g., annual State of the Climate Reports, IPCC's 2019 *Special Report on the Ocean and Cryosphere in a Changing Climate*) reports, and peer-reviewed journal publications.

Recent trends towards extremely negative mass balance of Canada's glaciers and ice caps has motivated collaborative research efforts related to the role of glaciers in water availability, and assessing the impacts of enhanced glacier melt on marine ecosystems where traditional food sources are harvested. For example, intradepartmental collaborations including the Groundwater Geoscience Programme, Climate Change Geoscience Programme, and the Canadian Geodetic Survey, provided the first study to investigate the potential for groundwater systems in western Canada to be potential sinks for runoff from glaciers in this region. Ongoing collaborative efforts between the University of Alberta and Hamlet of Grise Fiord, NU focus on establishing a community-based glacier monitoring program to enable self-management of water resources available to this high Arctic Indigenous community.

Integration of aircraft and satellite altimetry observations with in-situ mass balance and snow accumulation records are used to validate satellite-based records and provide a more robust historical record of glacier change in Canada. Re-analysis of the long-term mass balance time series for reference glaciers in the Western/northern Cordillera and the Arctic regions is currently being facilitated through collaborations with the World Glacier Monitoring Service and participating international space agencies, i.e., Germany, Canada and France. Finally, computer modelling and remote sensing techniques are being used to investigate the relative contribution of iceberg calving versus surface melt on total mass loss from glaciers and ice caps in the Canadian Arctic. Through publication in peer-reviewed journal articles, this work contributes knowledge concerning Canada's contributions to global sea-level rise and their predicted response to future climate scenarios.

8.3.3.4. Paleoclimate

The majority of paleoclimate research conducted in Canada is undertaken by researchers based at academic institutions. Faculties at a number of Canadian universities have established research programs and laboratories that use a variety of paleoclimate archives to develop records of past climate and environmental change in Canada. There are a number of laboratories that collect and analyze information in sediment records and other natural archives (such as tree-ring records) to study climate history, glacier history and ecological and environmental changes. These include, for example, the Paleoecological Environmental Assessment and Research Laboratory at Queen's University, the Laboratory for Paleoclimatology and Climatology at the University of Ottawa, the Paleoecology Laboratory at the University of Toronto, the Paleolab at the University of Toronto Mississauga, the University of Northern British Columbia, the University of Regina Tree-Ring Lab and The Water and Environment Laboratory at Brock University. Ice cores from a number of Canadian sites are stored in the Canadian Ice Core Archive housed at the University of Alberta.

Funding for these laboratories and research programs is provided primarily through NSERC and other sources, and some of these data are available through the Paleoclimatology Search Engine, established by the United States' National Oceanic and Atmospheric Administration's National Centres for Environmental Information.

Natural Resources Canada's Delta Laboratory, utilizes tree-ring records for reconstruction of hydro-climatological parameters. Other research at the Geological Survey of Canada has been utilizing a paleo-environmental perspective and accounting for effects of past climate in assessment of present-day ground ice abundance in permafrost regions.

8.3.3.5. Forest Systems

Natural Resources Canada supports a comprehensive, multidisciplinary, and growing climate change research agenda that integrates the biophysical and social sciences, links them to policy, and places a strong emphasis on knowledge exchange. Natural Resources Canada's forest carbon mitigation and climate change adaptation science is delivered with the end goal of providing knowledge and tools to members of Canada's forest sector to enable them to make informed mitigation and adaptation decisions.

Ongoing research efforts aim to improve the understanding of climate change impacts on forest growth and mortality rates using long-term data from permanent sample plots. Work is also ongoing to improve the spatial detail and resolution of national forest carbon monitoring and change estimation procedures. The Canadian Forest Service website contains research on climate change effects on forests, including studies on specific commercially valuable tree species such as Trembling Aspen (Populus tremuloides) and White Spruce (Picea glauca).

Five regionally-focused assessments were undertaken across Canada in partnership with local, regional and federal agencies, academia, industry, and Indigenous communities. Each of these studies focused on forests and the forest sector in different eco-regions of Canada to establish baseline conditions, monitor climate change impacts and generate new models.

8.3.4. Greenhouse Gas Sources and Sinks

The section below highlights research activities aimed at improved understanding of GHG fluxes from ecosystems in Canada. Elsewhere, this communication provides Canada's report on anthropogenic emissions and removals of GHGs.

8.3.4.1. Agricultural Ecosystems

Agriculture and Agri-Food Canada's strategic plan for science focuses on four missions that support a continued understanding and development of tools for a sustainable and resilient food production system. Research activities lead to mitigating and adapting to climate change, accelerating digital transformation, advancing circular economy and increasing resiliency of agro-ecosystems.

Identifying trends since 1981, Canada's agri-environmental indicators measure key environmental conditions, risks, and changes resulting from agriculture and from the management practices that producers use to mitigate these risks. Agriculture and Agri-Food Canada continues research and development of agri-environmental indicators and associated models, including annual GHG emissions and removals from agriculture and soil carbon storage. Agriculture and Agri-Food Canada is also continuing to make improvements to Holos, a farm-level software tool for estimating the mitigation potential of changes in agricultural practices and working with industry and provincial partners to ensure it meets the needs of the sector.

8.3.4.2. Forest Ecosystems

Natural Resources Canada's *Blueprint for Forest Carbon Science in Canada* is designed to develop scientific knowledge, modelling, reporting, and policy advice on the management of forest carbon and GHG fluxes. This work also makes a large contribution to improved understanding and representation of the carbon cycle in climate projections. Natural Resources Canada develops scientific knowledge about the key natural determinants of changes in forest carbon/GHG balances across various scales and the impacts of management. This knowledge contributes to reducing uncertainty about the impact of key natural influences on carbon dynamics and estimates of carbon stock changes and GHG emissions: natural disturbances, forest growth, soils/decomposition, interannual variability, and climate change.

Canada's National Forest Carbon Monitoring Accounting and Reporting System continues to build on information in the National Forest Inventory and provincial and territorial forest inventory information. Natural Resources Canada developed and maintains the Carbon Budget Model of the Canadian Forest Sector, a Tier 3 forest carbon dynamics estimation tool fully compliant with the IPCC reporting guidelines. With the Carbon Budget Model of the Canadian Forest Sector as its core model, the System continues to provide annual estimates of annual GHG emissions and removals as affected by forest management, natural disturbances, and land-use change. Natural Resources Canada continues to use remote sensing and other data to monitor the area annually disturbed by wildfires. The Department also maintains the National Deforestation Monitoring system, a program that estimates the area annually affected by conversion of forest to non-forest land uses in both the managed and unmanaged forest area.

8.3.4.3. Ocean Systems

Fisheries and Oceans Canada's research programs focus on understanding the processes that control the variability of the carbon system and the flows within it. These flows include the flux of carbon into and out of ocean systems, and significant focus is on assessing the potential and verifiability of mitigation of climate change by ocean processes. The key scientific considerations being addressed are whether the oceans will continue to sequester CO_2 at the same rate, the pathways to ocean acidification including local nearshore anthropogenic sources, and the effects acidification has on ocean life. Making progress in this area requires an integrated approach of observations, experiments, and model development from local to global scales.

Fisheries and Oceans Canada and the United States' National Oceanic and Atmospheric Administration developed a Collaborative Framework for Joint Ocean Acidification Research and Monitoring. The governance model includes a working group for Monitoring and a working group for a working group for Research, Experimentation and Modelling, with the intent to progress and integrate multidisciplinary ocean-acidification science efforts, promote collaboration, and facilitate effective resource management.

8.3.4.4. Observation-Based Approaches to Carbon Source Estimation

The increase in regional-scale GHG observations, increasing availability of space-based GHG observations, and application of atmospheric transport models have enabled the development of inversion methods to provide additional constraints to nationally reported GHG emissions. These observations-based estimates allow for an improved understanding of the seasonal and interannual variability in natural and anthropogenic GHG sources and sinks. Canada is building its capacity to

monitor sources and sinks at regional scales using atmospheric observations and inverse modelling through approaches that target various temporal and spatial scales. On the national scale, a new inverse modelling system using particle dispersion models is intended to provide budgets of CO_2 on annual and monthly scales. Once model validation is completed, CH_4 will be added. An ensemble of meteorological inputs and prior fluxes will be used. A similar particle dispersion approach is used for regional estimates of CH_4 fluxes from natural and anthropogenic sources across Canada and regions of interest, e.g., the Western Canadian Sedimentary Basin where oil and gas extraction is a dominant source. On the urban scale, Bayesian-inversion methods are being applied to both in situ and remote sensing observations in order to assess and monitor sector-based emissions of CO_2 and CH_4. Finally, on the global, interannual scale, a traditional Bayesian inversion system based around the operational environmental prediction model is being developed. The fluxes inferred from the global system can be integrated with the environmental prediction model to provide boundary conditions to the national, regional and local inversion systems using a nested model approach.

8.3.5. Climate Processes

Climate process research addresses both the physical and chemical processes by which the climate system functions. These issues include, but are not limited to the role of clouds, oceans, sea ice, permafrost, and land surface processes in the climate system, as well as the function of forests, agriculture, wetlands, and oceans in the global carbon, water, and energy cycles. Improved understanding of these processes contributes to development of more robust climate projections, which are used to support climate adaptation. Expertise in this area is divided between universities and Government of Canada departments, and there are extensive collaborative research relationships between the two.

8.3.5.1. Land and Cryosphere

Much of the research with respect to cryospheric processes within the climate system has been led by Environment and Climate Change Canada and Natural Resources Canada. New satellite capabilities for retrieval of snow cover information have been developed and validated through intensive field campaigns in northern Canada involving ground-based measurements and aircraft remote sensing. Environment and Climate Change Canada's cold climate processes research has led to the implementation of improved process information on energy and water cycles in climate models through the development, testing, and enhancement of the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC) model, which is the land surface component of the Canadian Earth System (CanESM) climate model. This includes research on snow cover variability and evaluation of the simulation of snow cover using regional climate models. Part of the ongoing effort towards climate model development within Environment and Climate Change Canada includes enhancing the representation of snow, soil, and vegetation in Environment and Climate Change Canada's climate models. Recent developments include new physical and biogeochemical parameterizations for peatland and permafrost landscapes and a Canadian Small Lake Model to characterize sub-grid lake processes including ice cover.

Natural Resources Canada's Geological Survey of Canada conducts research to better characterize permafrost landscapes and improve understanding of processes active in these environments. New national scale ground ice models and maps have been produced to improve characterization of ground ice abundance in permafrost regions. Work is also in progress to develop regional ground ice maps. This research is critical for improved representation of permafrost landscapes in climate change models.

Canadian universities are also active in climate process research, with various programs having a particular sector and/or geographic focus with respect to land processes and biogeochemical cycling. Some of these projects have contributed to advancing cryosphere and land surface modelling. Environment and Climate Change Canada collaborates with Canadian universities on the ongoing development of its CLASSIC model, which is facilitated by an open community version of the model. An example of this is the COHERENT-C (Canadian Optimized High-Resolution Representation of the National Terrestrial Carbon Cycle) research partnership, which has been funded under the NSERC Alliance Grant program (see Section 8.1.3). COHERENT-C involves 19 university and government researchers working together to advance Canada's skill at representing and predicting its terrestrial carbon cycle as climate, disturbances and atmospheric GHG concentrations evolve.

8.3.5.2. Oceans

Research teams have been investigating the storage and transport of heat, freshwater, and carbon in the North Atlantic, North Pacific, and Arctic Oceans through field expeditions, data analysis, and model simulations. These studies have provided better knowledge of the transports through the Canadian Arctic Archipelago in recent decades, the production of intermediate-depth water masses in the Labrador Sea, and the linkages of these processes to the larger-scale circulation in the North Atlantic. This is important since Arctic outflows and Labrador Sea water play important roles in the strength of the global oceanic thermohaline circulation, which is expected to be an important factor to climate impacts in Canada and Europe. Fisheries and Oceans Canada scientists have also conducted research funded by the Aquatic Climate Change Adaptation Services program (ACCASP) to address knowledge gaps in ocean climate processes; this research has ranged from physical/chemical climate to marine ecosystem and fisheries studies as well as the development of adaptation tools.

8.3.5.3. Hydrological Processes

Environment and Climate Change Canada's Water Science and Technology Directorate continues to lead a national, interdisciplinary program of ecosystem-based research in the aquatic sciences, which includes research on hydrological and ecosystem processes that contribute to our understanding of the biophysical sensitivities and vulnerabilities of freshwater systems to climate variability and change. For example, scenarios of future climate change indicate continued and possible increases in the extreme variability (high and low water levels) of future water levels for the Great Lakes–Saint Lawrence system—a consequence of particular concern for coastal ecosystems such as wetlands, for shoreline communities, and for activities such as shipping.

Environment and Climate Change Canada has developed an integrated hydrological land, lake, and atmospheric prediction system, which makes it possible to simulate the Great Lakes water level dynamics on daily to decadal time scales, as well as forecast water levels on weekly to seasonal time scales. This climate modelling and analyses related to future hydrodynamic variables and lake levels for the Great Lakes, along with projected coastal wetland response, have formed the foundation for efforts to assess and enhance the resilience of coastal wetlands in coping with climate change disturbances.

In the Arctic, Environment and Climate Change Canada has led an assessment of climate change impacts on Arctic freshwater ecosystems and hydrology, and on river flow to the circumpolar Arctic Ocean. Environment and Climate Change Canada is conducting research for advancing our knowledge on the effects of permafrost degradation on biogeochemical, aquatic ecosystem and hydroclimatic processes across the range of permafrost conditions (discontinuous and continuous

as well as ground ice-rich and ground ice-poor). There have been changes in Mackenzie River streamflow and water quality particularly during the spring freshet. Environment and Climate Change Canada research further shows that biogeochemical variations are strongly influenced by underlying geology in the region and the rate of climate warming. They further identified gaps in monitoring, which is limiting the analyses of variability and trends across the region. Water resource vulnerability to permafrost loss has been mapped across Canada, which showed the Taiga Plains of the Northwest Territories and the Hudson Bay Lowlands are particularly vulnerable regions. Across Canada's permafrost regions, scientists are analyzing the role of climate in the compounding role of wildfires and catastrophic lake drainage in altering permafrost and subsequent effects on water resources. They are also working to improve models for assessing climate change impacts on lakes and rivers; establishing surface energy balance over heterogeneous terrain and comparing with tower and aircraft estimates; and conducting analysis of the heat and mass exchanges of lakes.

Across western Canadian watersheds, Environment and Climate Change Canada is conducting research to evaluate current and future freshwater vulnerabilities associated with changing freshwater quantity, quality, and associated aquatic ecosystem health. For example, comprehensive process-based modelling studies in the Liard and Athabasca river basins provided information on the potential impacts of climate change on the hydrologic regimes and extreme flow events including the effects of climate change-induced snowpack loss on streamflow predictability. In the Lake Winnipeg basin, process-based modelling studies in the Red and Assiniboine watersheds are underway to identify nutrient hotspots in the watershed, and to assess the individual and combined impacts of climate change and land-use management scenarios on nutrient transport regime to Lake Winnipeg. These vulnerabilities will require various adaptation measures in response to alterations in the timing and amount of future freshwater supplies, and associated changes to water quality and ecosystem health.

8.3.5.4. Atmospheric Physics and Chemistry

Environment and Climate Change Canada carries out research in atmospheric physics and chemistry with the goal of improving the understanding of these processes and better representing them in models used to predict weather, climate and air quality. Atmospheric physics and chemistry research includes both tropospheric and stratospheric processes linking to other components of the Earth system (e.g., land, ocean, cryosphere, and the carbon cycle).

Parameterizations for chemistry, aerosols, and clouds are continually being developed and tested by Environment and Climate Change Canada. A particular priority is improving the simulation of the effects of short-lived climate pollutants on climate and future air quality. Work is underway to interactively simulate methane sources and its sink in the troposphere based on atmospheric chemistry processes in Environment and Climate Change Canada's Canadian Earth System Model. Atmospheric physics development also addresses the need for improved parameterizations of subgrid-scale processes related to three-dimensional inhomogeneities in the atmospheric boundary layer and convective clouds since they have important implications for calculations of radiation, precipitation, and turbulent mixing in climate models.

8.3.6. Climate Modelling and Applications

Environment and Climate Change Canada develops and applies the Canadian Earth System Model to predict and project global climate on timescales of seasons to a century. The development and application of regional models and statistical downscaling methods is undertaken in collaboration with other federal departments, universities, and regional climate modelling consortia. Canadian scientists are also extensively engaged in research collaborations with international colleagues, working on projects to improve the representation of various physical processes in global and regional climate models. For example, Canadian scientists play an important leadership role in international climate research coordination and assessment bodies, such as the World Climate Research Program and the IPCC.

As part of the development and evaluation of climate models, scientists gain insights and improved understanding of the climate system and the influence of human activities on climate. This is achieved through the application of global and regional models, individually and as part of internationally-coordinated, multi-model ensemble or model intercomparison projects.

8.3.6.1. Ocean Modelling

Environment and Climate Change Canada and Fisheries and Oceans Canada, among other departments, use ocean models, as components of linked or coupled atmosphere-ocean-ice prediction systems, to improve understanding of ocean processes and how these influence and are impacted by climate change. Such models are also used to provide information on past, present, and possible future ocean conditions for planning and decision-making (e.g., weather forecasting, ecosystems and fisheries management, risk assessments, infrastructure planning and navigation). This is achieved with a range of modelling and analytical tools and techniques that provide data and information of various sets of ocean parameters at multiple spatial and temporal scales and resolutions.

Global and regional operational ocean models serve as a key component of overall modelling activities. Fisheries and Oceans Canada including the Canadian Coast Guard, Environment and Climate Change Canada, the Department of National Defence, and the National Research Council collaborate under the Canadian Operational Network of Coupled Environmental PredicTion Systems (CONCEPTS) Memorandum of Understanding to develop, maintain, and implement an operational global coupled atmosphere–ocean–ice data assimilation and prediction system suitable for data reanalysis, hindcasts, nowcasts, and forecasts, as well as associated operational marine services. This work:

- Advances the effectiveness of marine–environmental assessments;
- Leads to more effective observations, understanding, and prediction of the marine system; and
- Improves ocean-observing and forecast products for management and other clients, including in relation to climate change.

CONCEPTS operational ocean prediction systems provide regular comprehensive information on the state of physical ocean and sea ice conditions for the global ocean and, at higher resolution, Canada's three oceans. The global and regional systems also provide key inputs for additional applications, for example high-resolution models of localized water levels and currents in key Canadian ports for navigation and incident response and models of biogeochemical parameters such as acidity, oxygen levels, and plankton biomass.

Common environments, tools, and standards ensure interoperability for the systems and their applications. For example, CONCEPTS and many of its partner programs implement and contribute to the Nucleus for European Modelling of the Ocean model, enabling applications to benefit from the synergies associated with a unified ocean modelling framework, including collaborations with the Canadian university community (for example, under the Network of Centers of Excellence project Marine Environmental Observation Prediction and Response), and internationally on model development, implementation, and user support.

8.3.6.2. Forest Modelling

The government of Canada coordinates and conducts collaborative research on both empirical and process-based forest models. Empirical forest growth models make it possible to predict the future forest conditions depending on forest management and the occurrence of natural disturbances. At the moment, most of these models are not climate-sensitive or only partly climate-sensitive. Consequently, the reliability of long-term forest growth projections can be challenged.

In collaboration with provincial, territorial and academic partners, the Canadian Forest Service is developing a strategy for nationwide climate-sensitive projections of forest growth, recruitment and mortality. The framework aims to provide climate-sensitive forest growth projections in terms of merchantable volume, biomass and carbon. Decision support tools, such as the Carbon Budget Model, will rely on these projections to provide an assessment of the forest resource under different scenarios of climate change.

In the process-based modelling area, Environment and Climate Change Canada develops the Canadian Terrestrial Ecosystem Model, which simulates structural vegetation attributes such as vegetation height, canopy mass and rooting depth. The Canadian Terrestrial Ecosystem Model is a component of the Canadian Land Surface Scheme Including biogeochemical Cycles (CLASSIC) to simulate the exchanges of energy, water, carbon, and momentum at the earth's surface, as part of the global fully coupled Canadian Earth System Model. The Canadian Forest Service and Environment and Climate Change Canada are conducting collaborative research to evaluate and improve the predictions of empirical and process-based ecosystem models.

8.3.6.3. Global Climate Models

Global climate models are the primary tool for making quantitative projections of future climate change. These models are based on mathematical representations of physical processes that include the three-dimensional atmosphere and ocean, along with sea ice and the land surface (and its vegetation). Global climate models are used to simulate climate change in response to specified changes in forcing such as GHG concentration and aerosol loading. This kind of simulation is used to understand (and attribute) historical climate change, and to make future climate change projections.

The core Canadian global climate modelling effort is housed within Environment and Climate Change Canada, where an increasingly comprehensive progression of global climate models has been developed since the 1970s. Environment and Climate Change Canada plays a central role in collaborative climate research with Canadian university partners and other government departments, notably Fisheries and Oceans Canada, who contribute expertise in ocean carbon cycle modelling. Environment and Climate Change Canada scientists serve on a variety of national and international steering committees and working groups related to climate model development, evaluation, and applications.

Model development at Environment and Climate Change Canada is based on scientific innovations related to the inclusion and improved representation of fundamental Earth System processes that occur in the atmosphere, ocean, and land surface. Model development regularly updates these components, which are then combined to form Environment and Climate Change Canada's suite of climate models (the Canadian Earth System Model, CanESM, Canadian Regional Climate Model, CanRCM, the Canadian Seasonal to Interannual Prediction System, CanSIPS, and the Canadian Middle-Atmosphere Model, CMAM). Current attention is focused on analysis of CanESM5 and its recent contribution to the Sixth Coupled Model Intercomparison Project, which has informed the *Sixth Assessment Report of the IPCC* (2021). Relative to its predecessors, CanESM5 includes significant advances in the representation of both ocean and atmospheric physical processes among other innovations. Future, longer-term development work is focused on the inclusion of methane sources and the integration of CMAM tropospheric and stratospheric chemistry in CanESM. In addition, future development efforts will place emphasis on the sharing of dynamical and physical components between weather and climate applications within Environment and Climate Change Canada, to exploit common expertise and support improved efficiency on new supercomputing resources.

Researchers in Environment and Climate Change Canada's model application stream design and execute experiments employing the suite of Environment and Climate Change Canada's climate models to provide information on past, present, and future states of the climate. Environment and Climate Change Canada's participation in international Model Inter-comparison Projects represents its largest application commitment. Such international Model Inter-comparison Projects are designed to understand the role of physical processes (e.g., convection, clouds, aerosols, and their interactions) in climate change and represent the primary source of climate change information, which informs government policy and regulatory decisions.

8.3.6.4. Regional Climate Modelling and Scenarios

Climate change adaptation planning, impact assessments, and policy development all require access to scientifically credible, quantitative information about past and future climate change. Ideally, this information should be available at sufficiently high spatial scales to be relevant to particular applications. Within Canada, Environment and Climate Change Canada develops and applies the Canadian Regional Climate Model (CanRCM), drawing upon collaborations with the regional climate modelling consortium Ouranos and the Université du Québec à Montréal.

Environment and Climate Change Canada's research in regional downscaling has focused on the development of a new regional climate model version, CanRCM5, which makes use of the Global Environmental Multiscale model dynamical core (developed for numerical weather prediction) and the same physical processes package as the Canadian Earth System Model, CanESM5. Environment and Climate Change Canada will use CanRCM5, driven by its global model CanESM5, to undertake a variety of historical and future projection experiments based on a range of emission scenarios for regional- and local-scale applications (e.g., North American and Arctic domains) at higher spatial resolution (0.44°, 0.22°, and 0.11°, approximately 50–12 km scale). Climate information from its predecessor, CanRCM4, has been used for more than 90 national and international peer-reviewed scientific studies and assessments involving university partners, regional climate impacts consortia, and multiple federal departments and agencies.

8.3.6.5. Seasonal to Decadal Prediction

Coupled global climate models are applied to seasonal prediction due to their ability to represent and predict ocean-atmosphere and other Earth system interactions that strongly influence climate variations on seasonal and longer time scales, leading for example to El Niño and La Niña episodes having far-reaching global effects. Similarly, decadal predictions, which derive their skill from both observation-based initial conditions and changes in radiative forcings, have been developed to bridge the gap between seasonal predictions and long-term climate change projections. Intensive work has been conducted to adapt Environment and Climate Change Canada's climate models to these applications. This has led to their operational implementation in Environment and Climate Change Canada's Canadian Seasonal to Interannual Prediction System (CanSIPS), which produces Environment and Climate Change Canada's official probabilistic seasonal forecasts over the coming one to 12 months and contributes to multi-model predictions compiled by the WMO, Copernicus Climate Change Service, and other organizations. In addition, yearly decadal forecasts out to 10 years contribute to the WMO's multi-model annual to decadal climate predictions and Global Annual to Decadal Climate Updates. Environment and Climate Change Canada research continues to focus on developing user-relevant seasonal to decadal data products including land variables such as soil moisture relevant to agriculture and water management, timings of sea ice advance and retreat relevant to shipping and other interests, and sector-relevant indices such as heating and cooling degree days. Further fulfilling societal needs through dialogues with users, leading to co-designed tailoring of forecast information, is an objective of this research.

8.3.6.6. Detection and Attribution of Climate Change

The comparison of observed climate change with simulated climate change, in response to changes in anthropogenic and natural climate drivers, is central to understanding the causes of climate change, validating climate models, and constraining and improving projections of future climate change. Environment and Climate Change Canada continues research to improve understanding of the detection and causes of long-term climate trends and extreme events for a range of variables through climate model applications. Regional detection and attribution analysis using climate models is applied to aid understanding of the causes of climate change over Canada and North America, and detect changes in relevant hydro-climatic variables including extremes. Event attribution analysis using large ensembles of climate models is applied to understand the role of anthropogenic climate change in the occurrence of extreme events and ongoing research contributes to improving understanding of the methods used in this rapidly expanding field.

8.4. Climate Science Assessment

Formal assessments of the state of scientific understanding on environmental issues have become an important mechanism to convey information to decision-makers. Canada recognizes the value of such activities and continues to support the involvement of Canadian experts in international and national assessments related to climate change.

Canada is supporting Canadian experts during the IPCC *Sixth Assessment Report* cycle (2015 to 2022). This includes participation in both the comprehensive Assessment Reports and Special Reports. Environment and Climate Change Canada has the lead financial responsibility for supporting federal and non-federal government Canadian science experts to the IPCC. For the sixth assessment cycle, Canada supported two lead authors and one review editor for the 2018 *Special Report on Global Warming of 1.5°C*, four lead authors and one review editor to the 2019 *Special Report on Oceans and Cryosphere in a Changing Climate*, two lead authors and one review editor to the 2019 *Special Report on Climate Change and Land* and seven lead authors and one review

editor for the *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Canada supported 23 coordinating lead authors, lead authors and review editors to the Working Group Reports of the Sixth Assessment and the Synthesis Report. In addition, Canada's annual contributions to the IPCC Trust Fund help support the participation of developing country experts in IPCC assessment processes (Canada's contribution makes up 2 percent of the total IPCC Trust Fund).

Canada also supports the Canadian member of the IPCC Working Group I Bureau and the Canadian member of the Task Force on National Greenhouse Gas Inventories representing Region IV. Further to these contributions, Canada hosted a meeting of the IPCC Plenary in 2017, an IPCC-sponsored Cities and Climate Change Science Conference in 2018, and a Working Group I Lead Author meeting in 2019.

Canada is a member of the Arctic Council and participates actively in scientific assessments undertaken through programmes of Arctic Council Working Groups. The Arctic Council's Arctic Monitoring and Assessment Programme (AMAP) undertakes regular scientific assessments on topics related to Arctic pollution and climate change. Canadian input occurs on various levels. Government of Canada scientists contribute as members of AMAP expert groups (e.g., expert groups on short-lived climate pollutants), Canadian experts contribute as authors to specific Technical Reports, and scientific information and data from Canadian networks and projects with an Arctic focus provide important contributions to AMAP reports. Canada contributed to the recent AMAP assessments: *Arctic Climate Issues Update* (2019), *Arctic Climate Change Update 2021: Key trends and Impacts* (2021)*, Impacts of Short-lived Climate Forcers on Arctic Climate, Air Quality and Human Health* (2021), *Mercury in the Arctic* (2021), and *POPs and Chemicals of Emerging Arctic Concern: Influence of Climate Change* (2021).

Canada has a national-scale climate change assessment process, the current cycle of which is titled *Canada in a Changing Climate: Advancing our Knowledge for Action* (for further details, see Chapter 6: Vulnerability Assessment, Climate Change Impacts, and Adaptation Measures). Historically, national assessment reports have focused on impacts of and adaptations to climate change. The current assessment cycle marks the first time that a comprehensive assessment of physical changes in Canada's climate was undertaken and published as a stand-alone contribution to the national assessment. *Canada's Changing Climate Report* (CCCR) (2019) assessed the state of knowledge on how and why Canada's climate has changed and what changes are projected for the future and thus laid a climate science foundation for other reports in the national assessment series. The CCCR was a collaborative effort between experts within Environment and Climate Change, Fisheries and Oceans Canada, Natural Resources Canada and university experts. This report, along with all other contributions to the national assessment are available to the public on a dedicated website at http://www.changingclimate.ca. Also available at this site is a recent supplement to the CCCR, *Canada's Changing Climate Report in Light of the Latest Global Science Assessment* (2022). Key findings of the Working Group I Contribution to the IPCC Sixth Assessment Report are provided and compared to the conclusions and headline statements of the CCCR. Good agreement and a high level of consistency between CCCR conclusions and relevant conclusions from the IPCC AR6 is demonstrated, confirming that CCCR findings continue to be a robust source of information for understanding changes in Canada's climate.

Natural Resources Canada's Canadian Forest Service participated in the NSERC-supported Boreal 2050 project, which looked at climate change and other stressors on the boreal system, and built on the earlier Natural Resources Canada reviews of the state of the Boreal zone published in Environmental reviews. The Boreal 2050 project culminated in a set of nine papers that were published in 2018 and

2019 in Environmental Reviews that examined drivers of change creating risks for the boreal zone, scenarios for the future of the Canadian boreal zone and a risk evaluation for the future sustainability of the Canadian boreal zone as Canada transitions towards a low carbon economy.

Additionally, Fisheries and Oceans Canada initiated a new national process for *State of the Ocean* reporting in 2016 to present regular information to Canadians on the health of Canada's oceans. This process operates on a four-year cycle that is comprised of three Ocean reports (Pacific, Atlantic, and Arctic) and a national report. One cycle is complete including technical and public reports on the Atlantic (2018), Arctic (2019), and Pacific (2021) marine ecosystems as well as a national summary report (2020).

In addition to the comprehensive science assessment activities reported on above, Canada contributes to international and national state of the environment reporting to track progress on key environmental sustainability issues including climate change. Canada contributes to the annual *State of the Climate Report* and *Arctic Report Card* led by the United States' National Oceanic and Atmospheric Administration. Data from Canadian observing networks as well as direct involvement of Canadian researchers as report authors form Canada's annual contributions to these international reporting activities on current trends for key climate-related indicators.

Environment and Climate Change Canada, in collaboration with other Government of Canada departments, reports to Canadians on the state of the environment and describes Canada's progress on key environmental sustainability issues using the Canadian Environmental Sustainability Indicators. The indicators, built on rigorous methodology, are added to and updated as new, high-quality data become available. The Canadian Environmental Sustainability Indicators series includes the following climate change indicators: temperature (updated 2021), precipitation (last updated in 2016), sea ice (updated in 2021) and snow cover (updated in 2022).

8.5. Climate Services

In 2018, the Canadian Centre for Climate Services, at Environment and Climate Change Canada, was established to provide information and support to those seeking to understand and reduce their vulnerability to climate change. The Canadian Centre for Climate Services leads a Government of Canada-wide approach, collaborating with provinces, territories, and other climate science experts to provide credible, useful and timely climate data, information and tools for Canadians to consider climate change in their decisions. The Canadian Centre for Climate Services is a dedicated multi-disciplinary team with expertise across a broad range of climate-related disciplines. We work with partners and stakeholders to support the implementation of the Pan-Canadian Framework on Clean Growth and Climate Change.

The Canadian Centre for Climate Services works with partners and stakeholders to provide Canadians with information and support to consider climate change in their decisions. The Canadian Centre for Climate Services does this by:

- Transforming core climate science and data into "ready to use" climate information products;
- Increasing awareness of and providing easy access to core climate data and information;
- Providing training and guidance on using climate data;
- Engaging with users to understand needs; and
- Developing new products collaboratively with experts and users.

The Canadian Centre for Climate Services supports a number of climate data portals where Canadians can access information on future climate projections for a variety of variables, including those related to temperature and precipitation. Included in this suite of portals is:

- ClimateData.ca, which provides climate model projections at a local scale (6 x 10 km resolution), across all of Canada;
- Climate Atlas of Canada, which combines climate science, mapping, and storytelling together with Indigenous Knowledge and community-based research and video to inspire awareness and action; and
- Power Analytics and Visualization for Climate Science (PAVICS) provides advanced tools for academia, climate scenarios development, and other expert users.

The Canadian Centre for Climate Services' Support Desk is another service that provides personalized support and guidance to help Canadians find, interpret, and use the data and information suitable for their individual needs.

For additional information on climate services offered by the Canadian Center for Climate Services, refer to Chapter 6: Vulnerability Assessment, Climate Change Impacts and Adaptation Measures.

Other areas of Environment and Climate Change Canada produce core climate-science related information that support climate-smart decision-making. Examples of such products include:

- The Climate Trends and Variations Bulletin, an informational product based on adjusted and/or homogenized Canadian climate data. Environment and Climate Change Canada produces five Bulletins each year (four seasonal and one annual bulletin) and provides the product on its website. The bulletin summarizes recent national and regional climate information and presents it in an historical context. Visit https://www.ec.gc.ca/sc-cs/default.asp?lang=En&n=A3837393-1 for more information.
- Output from both the global and regional models, available to the public via Environment Canada's Canadian Centre for Climate Modelling and Analysis website. This website allows a user to select specific model variables, from all or part of the model domain, and download it for use in climate change research and impact assessments. Visit http://climate-modelling.canada.ca/climatemodeldata/ for more information.
- Climate change scenarios are provided by Environment and Climate Change Canada to a broad range of users, through the Canadian Climate Data and Scenarios website. The scenarios are based on climate projections from different Coupled Model Intercomparison Project Phase 6 climate models. A range of variables are available on a common grid, primarily aimed at supporting climate change adaptation in the Canadian federal government, but also publicly available to other stakeholders. This website also provides access to the historical Adjusted and Homogenized Canadian Climate Data Records, by station and for gridded data products. Seasonal forecasts are also available here, which include forecasts out to one year, for several climate variables (temperature, precipitation, sea surface temperature, snow water equivalent, surface solar radiation, cloud fraction and specific humidity). Visit http://climate-scenarios.canada.ca for more information.
- Environment and Climate Change Canada's Historical Climate Data Website at https://climate.weather.gc.ca/ provides access to historical weather, climate data, and related information including temperature, precipitation, degree days, relative humidity, wind speed and direction, monthly summaries, averages, extremes and Climate Normals, for numerous locations across Canada going back more than 100 years.

The breadth of climate services and climate-science related information products support climate evidence-based decision-making across Canada.

Chapter 9: Education, Training and Public Awareness

Awareness and education on climate change in Canada is undertaken by all levels of government, with many activities led by non-governmental organizations. This includes increasing the understanding of climate change science, efforts to fight climate change, and adaptation to climate impacts. This chapter on education, training, and public awareness highlights key examples of these initiatives in Canada.

9.1. General Policy Towards Education, Training, and Public Awareness

Education is a responsibility allocated to Canada's provincial and territorial jurisdictions, under Canada's Constitution. Consequently, no overarching, national education policy or curriculum exists in Canada. Given that responsibilities lie with provincial and territorial governments, education requirements and curricula are established independently—with coordination between provinces and territories taking place through the Council of Ministers of Education.

9.2. Primary and Secondary to Post-Secondary Education

Education in Canada follows four phases: early childhood learning and development; primary to secondary education; post-secondary education; and adult learning and skills development.

9.2.1. Primary and Secondary Education

Climate change is taught across a range of subjects and grades, but is traditionally has been included in studies related to science and geography. The depth and breadth of climate education increases as students progress in their education, with the later grades exploring the more complex nature of climate change including global impacts and anthropogenic drivers.

Materials to guide teachers as they introduce climate change to their students are developed by a number of organizations—including environmental youth groups, non-governmental organizations, and government agencies. Several organizations focus specifically on environmental education, which provide education resources, and expertise to support educators.

9.2.2. Post-Secondary Education

Canadian universities have increasingly developed more environmental studies-related programs in past years, including more advanced degrees at the graduate level to help develop a workforce with expertise in climate change mitigation and adaptation policy and science. For example, the University of Waterloo offers a Master of Climate Change program, while the University of Prince Edward Island offers a Bachelor of Science in Applied Climate Change and Adaptation.

Post-secondary education institutions and government agencies have undertaken many partnerships on climate change in Canada. This includes research and networks to leverage expertise and resources to drive climate research in Canada, and contribute to training new generations of Canadian policymakers, scientists, and researchers. For example, the Canadian Centre for Climate Services, Canada's national approach to climate services delivery, involves key partnerships with regional climate service organizations across the country—a number of which are based partially in universities.

9.3. Public Information Campaigns

9.3.1. Web and Social Media

Governments and others, including both profit and non-profit organizations, use the web and social media extensively to deliver information about climate change. For example, the federal government has an environment and natural resources theme on its Canada.ca website. Environment and natural resources – Canada.ca features key information on weather and hazards, energy, natural resources, agriculture and the environment, fisheries, wildlife, plants and species, pollution and waste management, environmental conservation and protection, environment statistics, water and the environment and climate change.

Under the section dedicated to climate change, Climate change – Canada.ca, information is provided on actions the Government of Canada has taken both domestically and internationally to address climate change. For examples, it includes up-to-date information on topics such as the causes and effects of climate change, climate plans and targets, international action on climate change, progress reports, and funding programs. It features key reports, such as the National Inventory Report, which provides annual updates on Canada's estimated historical GHG emissions. It also provided detailed information on federal climate change science and research, and disseminated information on how to take climate action as well as information to promote resilience in the face of climate change. In 2022, a dedicated page under this section was launched, to provide information on programs and ways on how Indigenous organizations and the federal government are working together to combat climate change.

Also under the environmental and natural resources theme, in 2021, the Government launched a searchable database of federal resources to help Canadians take individual actions to fight climate change and protect the environment. This was presented in the section, Our environment – Canada.ca, and was promoted through a public advertising campaign and Environment and Climate Change Canada's social media channels.

National Media Campaign

In summer 2021, Environment and Climate Change Canada launched the *Our Healthy Environment and Economy* advertising campaign. The campaign intended to raise awareness and uptake of Canada's environmental programs and incentives, as well as to increase use of the new website portal, which provided one-stop access to a variety of environmental funding opportunities and programs to further encourage climate action.

The campaign was launched again in February 2022 with a mix of media including TV, cinema, out-of-home, video pre-roll, digital banners, mobile banners, search engine marketing and social media, as well as an increased presence for Earth Day in April. The campaign ended mid-June 2022.

Overall, the campaign achieved its objectives. A post-campaign survey revealed that 63 percent of respondents said they were likely to increase their personal efforts to protect the environment in the next 6 months.

Canadian youth continue to be an important voice in the fight against climate change. Young Canadians have the determination and creativity needed to find bold, innovative solutions to today's environmental challenges and are already setting examples in their communities by promoting sustainable practices and lifestyles to help move the country towards a greener economy and a safer environmental future.

The Climate Kids – Climate Kids website was launched August 31, 2017. Aimed at kids between the ages of 8 and 15, it is a centralized space for them to get informed, get involved, play and learn about climate change on a user-friendly platform.

Calls for proposals to the Climate Action and Awareness Fund wrapped up throughout 2021 and 2022. This program promotes youth climate awareness and community-based climate action, supports climate research at Canadian think tanks and in academia, and advances climate change science and technology. Calls were promoted through social media and users directed to the website for more information.

On August 12, 2022, International Youth Day, the Minister of Environment and Climate Change announced the inaugural members for a newly established Environment and Climate Change Youth Council (Environment and Climate Change Youth Council – Canada.ca) charged with advising the Minister and departmental officials on key environmental and climate issues, promoting intergenerational solidarity. In its first year, the Youth Council will initially focus on advancing the national climate plan to achieve net-zero emissions by 2050, youth participation in international summits, and nature-based solutions to fight climate change and biodiversity loss. In early October, the Minister of Environment and Climate Change met with Youth Council members during their first in-person meeting in Ottawa, Ontario. The Minister and members discussed a shared vision for the Council and priorities for the upcoming year. In November, one member of the Council joined Canada's delegation to COP27.

9.3.2. Conferences and Trade Shows

National and international conferences and trade shows are excellent events to share Canada's best practices on climate action, and learn about new technologies, scientific advancements, and new opportunities in the low-carbon economy. These events include Americana and GLOBE, which focus on finding new and innovative solutions to help build a sustainable future, as well as the Government's attendance at international auto shows in Montréal and Toronto.

In addition, the Government of Canada hosted a Canada Pavilion at COP27, which provided an opportunity to profile the diversity of Canadian actions and perspectives on climate change. The Canada Pavilion highlighted domestic climate commitments and efforts from a variety of partners and stakeholders, including: provinces and territories, Indigenous Peoples, municipalities, civil society organizations, private sector companies, and youth among others. Other objectives included amplifying international support for developing countries and leadership on international initiatives, highlighting synergies with climate action and protection of nature, profiling Canadian leadership and innovation in clean technology and the energy sector, promoting Indigenous climate leadership, and driving further climate ambition.

9.4. Training Programs

Programs that provide training on climate change in Canada cover a number of topics. This can include fleet and building operations, business practices, energy literacy, climate risk management, and adaptation decision-making. These programs are delivered by a number of groups, including post-secondary institutions, non-governmental organizations, specialist groups, and government agencies.

The Government of Canada promotes community-level participation in the clean energy sector through two programs at Natural Resources Canada (NRCan). The Clean Energy for Rural and Remote Communities (CERRC) program supports community driven activities aimed at reducing diesel use for heat and power in rural, remote and Indigenous communities. The program works to reduce the use of fossil fuels for heating and electricity by increasing the use of local renewable energy sources and energy efficiency. The capacity-building stream of this program funds projects that feature knowledge and skill-building activities towards this objective, including curriculum and technical training, peer-to-peer networking, community energy planning, energy efficiency, and other innovative ideas. CERRC has also included specific requirements for applicants to demonstrate how they will encourage and integrate the greater participation of Indigenous women and youth in clean energy projects.

Delivered in collaboration with the Indigenous Clean Energy Social Enterprise and the Pembina Institute, the Impact Canada Clean Tech's Indigenous Off-Diesel Initiative provided tailored renewable energy training, access to expertise and mentors, and funding to support 14 Indigenous Clean Energy Champions and their communities in community-driven renewable energy and energy efficiency projects to reduce diesel in their communities. Following approvals by a distinguished all-Indigenous panel of jurors, in 2022 NRCan issued 14 final grants of up to $1.6 million each for Indigenous Clean Energy Champions and their communities to continue to implement their projects.

NRCan's Smart Renewables and Electrification Pathways (SREPs) program provides funding for smart renewable energy and electrical grid modernization projects. The program also has a capacity-building stream that funds projects to build knowledge and skills related to clean energy and grid modernization technologies, while supporting equity, diversity and inclusion activities. This includes

funding for post-secondary institutions as well as organizations that target knowledge building and skills development in youth. Many of the projects focus on engagement with underrepresented groups in the clean energy sector, including women, youth, persons with disabilities, Indigenous Peoples and racialized people.

The Government of Canada offers training for Canadian consumers and businesses on the skills they need to improve energy use through NRCan's Office of Energy Efficiency initiatives. Since 1997, more than 30,000 representatives of industrial, commercial, and institutional organizations from across Canada have enrolled in Dollars to $ense workshops offered by the Office of Energy Efficiency. These workshops provide energy-saving tips so that industry and commercial entities can lower operating and production costs, improve economic competitiveness, reduce GHGs, increase operational efficiency, and create a better work environment. In 2016, NRCan expanded and completely remodeled and updated the Dollars to $ense training material before selecting the Canadian Institute for Energy Training as the sole licensee for delivering the workshops across the country.

After three decades of financial support for the local delivery of building science and energy efficiency training in residential construction under the R-2000 Standard[1]/EnerGuide Rating System/ENERGY STAR for New Homes banners, NRCan's Office of Energy Efficiency continues to collaborate with industry to support the development and training of energy advisors (EAs). The EA qualification process is based on competency profiles and associated learning objectives, and is delivered in all provinces and territories in both official languages. This ensures a consistent level of knowledge across the country and promotes a high standard in the field of energy efficiency assessments.

In the transportation sector, NRCan's Clean Fuel Branch offers training initiatives include the Smart*Driver* training series and Auto$mart.

- The Smart*Driver* suite of seven training curricula promote energy efficiency as a cost-effective and responsible way to reduce fuel costs and the environmental impact of fleet operations. These include: Smart*Driver* for Highway Trucking, Smart*Driver* in the City, Smart*Driver* for Forestry, Smart*Driver* for Transit, Smart*Driver* for School Bus, Smart*Driver* for Motor Coach, and Smart*Driver* for Work Truck.
- An updated web-based version of Smart*Driver* for Highway Trucking offered in English, French and now in Spanish, presents fuel-efficient driving strategies in a flexible suite of online, in-class, and on-road training formats for drivers of tractor-trailers. Additionally, Smart*Driver* for Forestry and Work Truck are also available online.
- Auto$mart provides driver educators with information kits to teach students critical defensive driving techniques and relate road safety to fuel efficiency, the mitigation of climate change, and other environmental concerns. The new Auto$mart curriculum continues to engage new student drivers while an enhanced ecoDriving online course has been developed and includes multimedia components for personal vehicle drivers and improved online functionality for smartphone access.

In the residential housing sector, NRCan's Office of Energy Efficiency training initiatives include the recruitment, training and mentoring of energy advisors under the Canada Greener Homes Initiative.

- The Canada Greener Homes Initiative provides grants for homeowners to undertake home retrofits that are supported by an EnerGuide home energy evaluation, as well as interest-free loans to help Canadians make their homes more energy efficient, climate-resilient, and comfortable.

- Qualified energy advisors must conduct pre- and post- home energy retrofit energy evaluations for each applicant to the Initiative and in 2021 a campaign was conducted to recruit, train and mentor energy advisors for the Initiative, adding green jobs to the economy while also supporting diversity and inclusion in the recruitment of new energy advisors.
- In addition to supporting the delivery of the Canada Greener Homes initiative, NRCan administers a licensing program that authorizes service organizations and energy advisors to deliver the R-2000 standard, the EnerGuide home rating system, and ENERGY STAR for New Homes. Licensees must pass an initial set of exams to become a registered service organization or energy advisor, and then pass a re-qualification exam every three years to remain licensed. Re-qualification supports ongoing learning and training as building science evolves over time.

In the federal government sector, NRCan's Clean Fuel Branch also provides input and expertise into training for federal procurement officers and federal executives to ensure that energy efficiency, conservation, and sustainability are core considerations in their policies and practices.

9.5. Resource or Information Centres

Resources and information on climate change are available to Canadians through a number of domestic and international sources. In Canada, this includes federal departments (including Environment and Climate Change Canada), as well as provincial, territorial, and municipal governments. Utilities also provide resources, as do non-governmental organizations that are focused on climate.

In 2018, the Canadian Centre for Climate Services was established at Environment and Climate Change Canada to provide information and support to those seeking to understand and reduce their vulnerability to climate change. The Canadian Centre for Climate Services leads a government-wide approach, collaborating with provinces, territories, and other climate science experts to provide credible, useful and timely climate data, information, and tools to help Canadians consider climate change in their decisions. The Canadian Centre for Climate Services does this by:

- Transforming core climate science and data into "ready to use" climate information products;
- Increasing awareness of and providing easy access to core climate data and information;
- Providing training and guidance on using climate data;
- Engaging with users to understand needs; and
- Developing new products collaboratively with experts and users.

The Canadian Centre for Climate Services supports a number of climate data portals where Canadians can access information on future climate projections for a variety of variables, including those related to temperature and precipitation. Included in this suite of portals is:

- ClimateData.ca, which provides climate model projections at a local scale (6 x 10 km resolution), across all of Canada;
- Climate Atlas of Canada, which combines climate science, mapping, and storytelling together with Indigenous Knowledge and community-based research and video to inspire awareness and action; and
- Power Analytics and Visualization for Climate Science (PAVICS), which provides advanced tools for academia, climate scenarios development, and other expert users.

The Canadian Centre for Climate Services also operates a Support Desk, which provides personalized support and guidance to help Canadians find, interpret, and use the data and information suitable for their individual needs.

The Map of Adaptation Actions, created by the Canadian Centre for Climate Services and NRCan, highlights examples from across Canada of how communities and sectors are adapting to a changing climate to inspire others to act. The Map includes examples from a variety of Canadian sources, and allows users to apply filters to explore Map content.

For additional information on services offered by the Canadian Center for Climate Services, refer to Section 6.3.1.

In addition, Canada is a member of the Clean Energy Solutions Centre, an initiative of the Clean Energy Ministerial global forum, designed to help governments design and adopt policies and programs that support the deployment of transformational low-carbon technologies. Canada brings clean energy solutions to decision-makers globally, by providing technical expertise through the Centre's Ask an Expert service on its world-leading RETScreen Clean Energy Management Software (RETScreen). Developed by NRCan, RETScreen is the world's foremost clean energy decision-making software which has helped to significantly reduce costs associated with identifying and assessing potential clean energy projects.

9.5.1. Providing Energy Efficiency Information

Accessibility of information is an important consideration to enable Canadians to make energy efficient choices. NRCan's Office of Energy Efficiency gathers a wide range of energy efficiency data and maintains a variety of energy efficiency resources including analysis, reports, information directories, and tools which are available to public and private sector organizations and the Canadian public. Energy management information is accessible from the Office of Energy Efficiency's website.

Online information directories, such as the Directory of Energy Efficiency and Alternative Energy Programs in Canada and the EnerGuide Appliance Directory, are maintained by the Office of Energy Efficiency. Comprehensive reports and documents are also available both in print and online. For example, the Office of Energy Efficiency provides a handbook for homeowners called *Keeping the Heat In* that describes energy saving strategies with "how-to" instructions on how to make their homes more energy efficient.

The Office of Energy Efficiency also offers a wide range of tools to make energy efficiency information more easily accessible. For example, a national building energy benchmarking tool enables building owners and facility managers to compare their building's energy performance, which is a key first step to understanding and making decisions about how to save energy and reduce a building's carbon footprint. The EnerGuide home rating system provides customized energy upgrade reports for home owners to guide them to smart home energy renovation actions. Finally, a Searchable Product List shows energy consumption data for all products regulated in Canada for Energy Efficiency and for products eligible for ENERGY STAR certification, which helps consumers make wise purchase decisions.

Energy Efficiency Labelling Programs

The Office of Energy Efficiency supports two major labelling programs to promote consumer awareness—EnerGuide and ENERGY STAR.

EnerGuide is a Government of Canada energy performance rating and labeling program which covers the following key consumer items: houses, light-duty vehicles, and certain energy-using products. The EnerGuide home rating system is used in many energy efficiency programs across Canada. Homeowners are provided with detailed, home-specific information of energy consumption and retrofit measures that could be considered to improve their home's performance. Estimated home GHG emissions are also included in the label. Energy using-products covered by EnerGuide include household appliances (e.g., dishwashers, refrigerators, etc.), as well as larger heating and cooling products (e.g., furnaces, water heaters, central air conditioners, etc.). Product labels include useful information, such as annual energy consumption of the model in kilowatt hours (kWh) and an energy consumption indicator, which compares the model with the most efficient and least efficient models in the same class.

EnerGuide labels can be affixed to the product alone or placed in product information books, and have a standardized design. For new and existing houses, the EnerGuide rating label shows useful information about the home's energy use and provides the name and address of an EnerGuide energy advisor.

For vehicles, the EnerGuide vehicle label gives model-specific fuel consumption information for new light-duty vehicles available for sale in Canada (e.g., passenger cars, vans, pickup trucks and SUVs). Information includes a vehicle's city, highway, and combined fuel-consumption rating, as well as annual fuel costs and environmental indicators for carbon dioxide emissions and smog ratings. This vehicle-specific data can also be found within the Fuel Consumption Guide and the Fuel Consumption Ratings Search Tool found on NRCan's website. Canadians using these resources have the ability to compare and find the most fuel-efficient vehicle that meets their everyday needs.

The ENERGY STAR mark complements the EnerGuide label in many cases, and identifies specific models that are tested and certified to meet or exceed stringent levels of energy efficiency. For "early adopter" consumers who seek premium energy efficiency performance, ENERGY STAR offers its Most Efficient designation every year to a select number of product categories. In the residential sector, the ENERGY STAR for New Homes initiative promotes construction of new homes that are more energy efficient than those built to minimum building code requirements. The increased efficiency of these homes translates into reduced energy costs for homeowners.

Each year, the Canada's ENERGY STAR issues awards to top performers among its 1,000+ public and private sector participants, including Canadian utilities, home builders, retailers, manufacturers, and advocacy organizations.

The SmartWay Transport Partnership program

Originally administered by the United States Environmental Protection Agency (EPA), the SmartWay Transport Partnership program was launched in Canada in 2012 to help reduce fuel costs, emissions, and increase efficiency in the transportation industry. The SmartWay program is a collaboration designed to help businesses reduce fuel costs while transporting goods in the cleanest, most efficient way possible.

SmartWay works with freight carriers and shippers committed to benchmarking their operations, tracking their fuel consumption and improving their annual performance. More than 3,600 North American companies have signed on to the SmartWay Transport Partnership, and are invested in reducing fuel costs, improving efficiency, and encouraging best practices in their freight supply chains.

Zero Emission Vehicle Awareness Initiative

The Zero Emission Vehicle Awareness Initiative (ZEVAI) supports projects that aim to increase awareness, knowledge and public confidence in zero-emission vehicles (ZEV) and public charging and refueling infrastructure.

The ZEVAI helps fund outreach, education, and capacity-building activities, ultimately enabling greater adoption of ZEVs by Canadians in all regions of the country. Since 2019, the initiative has invested over $8 million and supported over 45 projects coast-to-coast-to-coast.

Clean Fuel Awareness

In 2022, NRCan launched a pilot initiative that aims to fund clean fuel awareness and education projects. NRCan is looking to support projects that increase knowledge and understanding about the opportunities, benefits, and considerations related to adopting clean fuels in industrial operations, across the economy and for consumers. Additionally, NRCan is looking for projects that support industry with capacity-building and training opportunities to enable increased use of all clean fuels across the economy, including:

- Biofuels such as cellulosic ethanol;
- Renewable diesel;
- Synthetic fuels and sustainable aviation fuels; and
- Gaseous fuels such as clean hydrogen and renewable natural gas.

9.6. Involvement of the Public and Non-Governmental Organizations

9.6.1. Public Engagement

The Government of Canada has engaged the public, along with other levels of government, civil society, and industry, in the development of its climate plans and targets. This built on the consultation efforts launched to inform the *Pan-Canadian Framework on Clean Growth and Climate Change* in 2016.

This included the development of Canada's enhanced Nationally Determined Contribution, announced in 2021. To inform this enhanced 2030 target, Canadians were invited to share their views. Of the more than 1,000 submissions received, respondents were overwhelmingly in support of faster and deeper emissions reductions. This new and ambitious target is consistent with those submissions.

Acknowledging the need for public input to inform Canada's approach to climate change, the *Canadian Net-Zero Emissions Accountability Act* explicitly requires the Minister of Environment and Climate Change to provide interested persons with the opportunity to make submissions that inform the development of future targets and plans. In line with this legislated commitment, the Government of Canada launched a public engagement process for the *2030 Emissions Reduction Plan* to seek submissions from interested persons, communities, and organizations.

Views were sought through an online portal launched in early December 2021, with submissions collected until late January 2022. These submissions were focused on measures to meet Canada's enhanced 2030 target, opportunities and challenges associated with reaching net-zero by 2050, and how to engage the public in future consultations required under the Act. The portal received 15,788 responses, 90 percent of whom were individuals, from all provinces and territories. An additional 14,380 submissions were received via email from Canadians and stakeholders.

Canadians were also consulted on Canada's draft *2019–2022 Federal Sustainable Development Strategy* (FSDS), and the draft 2022–2026 FSDS. Canadians shared feedback on the strategy in multiple ways, including through interactive online engagement websites, the online version of the strategy, public webinars, social media posts, and written and video comments submitted by email. During the most recent consultations on the draft 2022–2026 FSDS, more than 700 people joined the conversation, providing constructive suggestions to strengthen the strategy and better reflect Canadians' aspirations while building on the work of previous strategies. The Government of Canada also heard from partners and stakeholders across the country, including other levels of government, Indigenous governments and organizations (including five National Indigenous Organizations—Assembly of First Nations, Congress of Aboriginal Peoples, Inuit Tapiriit Kanatami, Métis National Council, and the Native Women's Association of Canada), environmental non-governmental organizations, academics, businesses and youth organizations, as well as individual Canadians. Canadians were looking for the Government of Canada to take more action on climate change and biodiversity. They were also concerned about social and economic issues such as the cost of living and housing prices and shortages.

Hydrogen Strategy for Canada

Following extensive national consultations, NRCan released the *Hydrogen Strategy for Canada* in December 2020, as a call to action and an important demonstration of the Government's resolve to achieve net-zero by 2050. Through eight pillars and 32 recommendations over the short-, medium- and long-term, the strategy guides Canada on how to fully seize the economic and environmental opportunities across all emitting sectors of the economy. The Hydrogen Strategy relies on Canadian expertise throughout the entire value chain to build new hydrogen supply, distribution, and end uses that will support a low-carbon energy ecosystem with benefits beginning now. The Strategy will strengthen Canada's economic competitiveness, grow export potential, attract investment, and create good, sustainable jobs across the country. To deliver on the recommendations, an Implementation Framework has been formalized in order to operationalize activities and actions across the country. The implementation of Canada's Hydrogen Strategy will require collaborative efforts across jurisdictions, including Indigenous Peoples. NRCan is in the process of launching 16 working groups and three executive committees which include government and industry co-chairs and numerous stakeholders focused on developing a hydrogen society across major sectors of the economy (e.g., transport, heavy industry, ports, and export).

Just Transition

The Government of Canada is committed to moving forward with comprehensive action—including legislation—to support workers and communities through the transition to a low-carbon economy. In 2018, the Government of Canada established the Task Force on Just Transition for Canadian Coal Power Workers and Communities. The Task Force was mandated to engage stakeholder groups, provinces, and municipal governments, report on what was heard, and provide recommendations on how the government could support coal power workers and communities.

Throughout the summer of 2018, the Task Force travelled to four provinces, visited 15 communities, toured several facilities, hosted eight public town hall style sessions, and met with more than 80 stakeholder groups. Stakeholder groups included employers, labour union representations, provinces, municipalities, community members, and workers and their families. In 2019 the Task Force delivered their final report, which included recommendations for the government to consider.

In response, the Government of Canada has committed $185 million to support impacted communities in Alberta, Saskatchewan, Nova Scotia and New Brunswick. To date, the federal government has invested over $83 million in 79 projects across the four provinces through the Canada Coal Transition Initiative and the Canada Coal Transition Initiative-Infrastructure Fund.

Building on the work of the Task Force, public consultations were launched in July 2021 on proposed just transition legislation, and the Government of Canada has consulted with a broad range of stakeholders and is seeking the views of Indigenous groups and provinces and territories. Over 30,000 email submissions were received from Canadians and 17 roundtable sessions were held with a range of stakeholders, including workers and labour organizations, industry, academia, non-governmental organizations, youth, and experts in skills, training, and diversity and inclusion. The proposed legislation will be guided by the feedback received from the consultations.

At the same time, measures announced in Budget 2021 were aimed at delivering almost 500,000 new training and job opportunities for Canadians, enabling them to take advantage of new job growth, including in clean energy sectors. These investments included the $960 million Sectoral Workforce Solutions Program that is helping both workers and employers by supporting solutions to address current and emerging workforce needs.

Budget 2022 expanded on these efforts by making it more affordable for workers to move where the jobs are and breaking down barriers to build a more inclusive workforce.

Finally, the Government's 2022 Fall Economic Statement added another $250 million in new investments to:

- Fund a Sustainable Jobs Secretariat, a one-stop shop to provide information on federal programs, funding, and services across government departments to support workers;
- Create a new sustainable jobs stream under the Union Training and Innovation Program to support union-based training for apprentices and journeypersons in skilled trades; and,
- Establish a new Sustainable Jobs Training Centre, which will help workers in key sectors and occupations improve their skills or gain new ones for the net-zero economy.

Regional Energy and Resource Tables

On June 1, 2022, the Government of Canada launched the Regional Energy and Resource Tables to identify and pursue opportunities for economic growth, energy transformation, and sustainable job creation in each region of the country. This collaborative initiative will involve close partnerships between federal, provincial and territorial governments, a tailored approach to engagement with Indigenous partners and a process to seek input from municipal governments, experts, industry, labour, non-profit organizations and others.

As of November 2022, nine provinces and territories had launched their Tables. Efforts from this initiative will culminate into the development of comprehensive place-based economic strategies that consider pathways to achieving economic growth opportunities and the enabling conditions such as building the workforce needed to advance these opportunities.

Critical Minerals Strategy

In developing Canada's first Critical Minerals Strategy, the Government released a discussion paper online with a period for public comment lasting from mid-June 2022 to September 15, 2022. Over 118 submissions were received, including input from mining companies, industry associations, academia, environmental groups, and the public. *Canada's Critical Minerals Strategy* was released in December 2022.

Small Modular Reactors (SMR) Leadership Table

In April 2022, NRCan hosted the inaugural SMR Leadership Table meeting in Ottawa, Ontario. The SMR Leadership Table is composed of multidisciplinary nuclear representatives from the federal government, interested provincial and territorial governments, Indigenous communities, utilities, and non-governmental organizations.

The Leadership Table meets bi-annually. The second meeting of the Leadership Table was held in Toronto, Ontario on October 3, 2022. During the meeting, participants reviewed progress and discussed strategic priorities related to developing and deploying small modular reactors. The next meeting is scheduled to take place in spring 2023.

The SMR Leadership Table was convened in response to a recommendation made in Canada's 2018 SMR roadmap and 2020 SMR action plan, to establish a forum to discuss the development and deployment of SMRs in Canada. The first SMR Action Plan Progress Update was publicly released on October 20, 2022.

9.6.2. Involvement of Non-Governmental Organizations

Public education and awareness campaigns, and encouraging citizens to act on climate change, involve significant contributions from non-governmental organizations in Canada. They focus on informing Canadians about climate change and its impacts, and advance both the policy debate and collective action on climate in Canada. Programs provided by these organizations included research and analysis, public advocacy, education and awareness, and social media campaigns.

Selection of climate change focused nongovernmental organizations in Canada:

Canadian Climate Institute

The Canadian Climate Institute (previously known as the Canadian Institute for Climate Choices) is a non-partisan, independently governed and registered Canadian charity. The Institute focuses on climate change policy research, producing rigorous analysis and evidence-based recommendations that are needed to advance climate resilience, chart net-zero pathways, and drive long-term prosperity.

Pembina Institute

The Pembina Institute is a national non-profit think tank focused on developing innovative sustainable energy solutions through research, education, consulting and advocacy. The Institute conducts research and provides policy and technical analysis to various levels of government, businesses and other organizations.

Smart Prosperity Institute

The Smart Prosperity Institute is a national research network and policy think tank delivering research and work with public and private partners to advance practical policies and market solutions for a stronger, cleaner economy. A key initiative of the Institute, the Smart Prosperity Initiative, was launched in 2016 by Canadian leaders from business, think tanks, labour, Indigenous Peoples, youth, and nongovernmental organization communities to advocate for Canada's transition to a green economy.

Clean Energy Canada

Clean Energy Canada is a climate and clean energy think tank within the Centre for Dialogue at Simon Fraser University, British Columbia. The organization works to accelerate Canada's transition to clean and renewable energy systems through the production and distribution of original research and analysis, including economic modelling and public-opinion research.

9.7. Participation in International Activities

Canada engages in a number of collaborative international initiatives that involve sharing experiences and best practices, and working towards common climate change goals. For example:

- The Climate and Clean Air Coalition, which seeks concerted action on short-lived climate pollutants. Canada held a seat as a member of the Board from 2020 to 2022.
- The Clean Energy Ministerial, a high-level global forum that brings together member countries and key partners to facilitate international collaboration to promote policies and best practices that accelerate the transition to a global clean energy economy.
- The Arctic Council, the leading intergovernmental forum promoting cooperation, coordination, and interaction among the Arctic States, Arctic Indigenous communities and permanent participants, and other Arctic inhabitants on common Arctic issues such as sustainable development and environmental protection.
- The Petersburg Dialogue, which provides the opportunity for countries to engage in an informal exchange of experiences on international climate policy in support of the UNFCCC negotiating process.
- Mission Innovation (MI), a global partnership of 22 countries and the European Commission to catalyse action and investment in research, development and demonstration to make clean energy affordable, attractive and accessible for all. In June 2021, Canada joined other members in launching MI 2.0, a decade of clean energy innovation.
- The Global Methane Initiative (GMI), a voluntary partnership that aims to accelerate the development and the deployment of clean energy technologies to help meet Canada's climate change objectives and address clean energy security concerns. Canada currently co-chairs the GMI Steering Committee.
- The Organisation for Economic Cooperation and Development (OECD), an international economic organization that provides a unique forum where governments work together on public policy issues, compare and exchange experiences and best practices, and seek answers to common problems through enhanced global cooperation. Canada supports the OECD's work on the environment.
- The Carbon Pricing Leadership Coalition, where Canada is taking an active and high profile approach, both domestically and internationally, in championing carbon pricing as an important policy instrument for combatting climate change.
- The Carbon Market Platform, a forum for a strategic dialogue on developing carbon markets and pricing mechanisms for the successful implementation of the Paris Agreement. The Platform brings together a diverse group of countries with a common interest in developing effective, sustainable, and ambitious carbon markets.
- Annually since 2017, Canada, China, and the EU have co-convened major economies and key players on climate change through the Ministerial on Climate Action (MoCA) to build common ground on multilateral negotiations to advance the implementation of the Paris Agreement.

- Canada is also an active participant in the Action for Climate Empowerment (ACE) Negotiations and the ACE Dialogue under the UNFCCC and Paris Agreement. ACE plays a key role in promoting the changes in lifestyles, attitudes, and behaviours needed to foster low-emission, climate resilient, and sustainable societies. In the UNFCCC, Parties and Observers exchange good practices and lessons learned on implementing and enhancing ACE both domestically and internationally. Participants share strategies to enhance public awareness of climate change, methods to engage youth in the development of climate policies, and ways to increase international cooperation in this field.

Internationally, Canada is sharing its expertise, innovation, and clean technology to help developing countries achieve their climate change goals and reduce air pollution. One of the core aims of the Paris Agreement is to make all financial flows consistent with a pathway towards low-emission, climate-resilient development. This goal requires all actors—public and private—to transition to green and sustainable investments and accelerate clean growth. In 2021, Canada delivered on its five-year climate finance commitment of $2.65 billion to support developing countries—especially the poorest and most vulnerable—in their transition to low-carbon and climate-resilient economies. More information on Canada's climate financing can be found in Chapter 7: Financial Resources and Transfer of Technology.

Canada's Advancement of Gender in International Climate Change Negotiations

Gender equality and climate change are key priorities for the Government of Canada and are paramount to the successful implementation of the Paris Agreement. In support of the Lima work programme on gender,[2] which calls on Parties to assist with training and raising awareness for female and male delegates on issues related to gender balance and to build the skills and capacity of female delegates, Canada encourages the participation of women in the UNFCCC process and climate negotiations whenever possible. Canada supported the delivery of five capacity-building workshops for women negotiators; one in the Caribbean and four in francophone Africa (two delivered virtually), in partnership with France and the Organisation internationale de la Francophonie. Between 2018 and 2021, these workshops supported women leaders from 23 developing countries in building the knowledge and skills necessary to participate in climate change decision-making and to advance international negotiations related to gender and climate change. Canada also provided funding to support women negotiators' travel and participation in UNFCCC sessions. The Government of Canada is also committed to meaningful representation within its own delegation, prioritizing diversity and inclusion, including of Indigenous Peoples, in the selection of Canadian delegates to the UNFCCC.

Local Communities and Indigenous Peoples Platform

Canada is proud to have played a leadership role in enhancing the engagement of Indigenous Peoples under the UNFCCC, including by advancing the Local Communities and Indigenous Peoples Platform—launched in 2017—and its governing body, the Facilitative Working Group (FWG)—created the following year to guide implementation of the Platform. Canada has served as a member and Party co-chair of the FWG, which is unique within the UN system as it sees equal representation of Parties and Indigenous Peoples, both in membership and decision-making. Canada also supported the creation of an Indigenous Peoples Focal Point within the UNFCCC Secretariat to support the work of the Platform, as well as to enhance the engagement of Indigenous Peoples and consideration of their rights and knowledge through the operationalization of UNFCCC mandates related to Indigenous Peoples. At the 26th Conference of the Parties (COP26) of the UNFCCC, Parties adopted a new three-year (2022–2024) workplan for the Platform and renewed the mandate of the FWG, which will help ensure Indigenous climate leadership remains at the forefront of international climate action.

Further information on Canada's international activities is included in other chapters of this report.

References

1 R-2000 is an official mark of Natural Resources Canada.

2 UNFCCC. 2017. Decision 21/CP 22, Gender and Climate Change, in *Report of the Conference of the Parties on its twenty-second session, held in Marrakech from 7 to 18 November 2016*. Available online at: https://unfccc.int/documents/9674.

Annex I: Canada's *Fifth Biennial Report* to the UNFCCC

Section 1 – Introduction

Canada is pleased to present its *Fifth Biennial Report* (BR) to the United Nations Framework Convention on Climate Change (UNFCCC). For 2022, Canada is presenting its BR as an annex to the *Eighth National Communication*. Given the complementarity between these two documents, where information required by the BR is already reported in the National Communication, including tabular information, cross-references to relevant sections of the National Communication are provided below. Please also refer to Canada's BR common tabular format (CTF) to view information required by the BR guidelines.

Section 2 – Canada's Greenhouse Gas Emissions and Trends

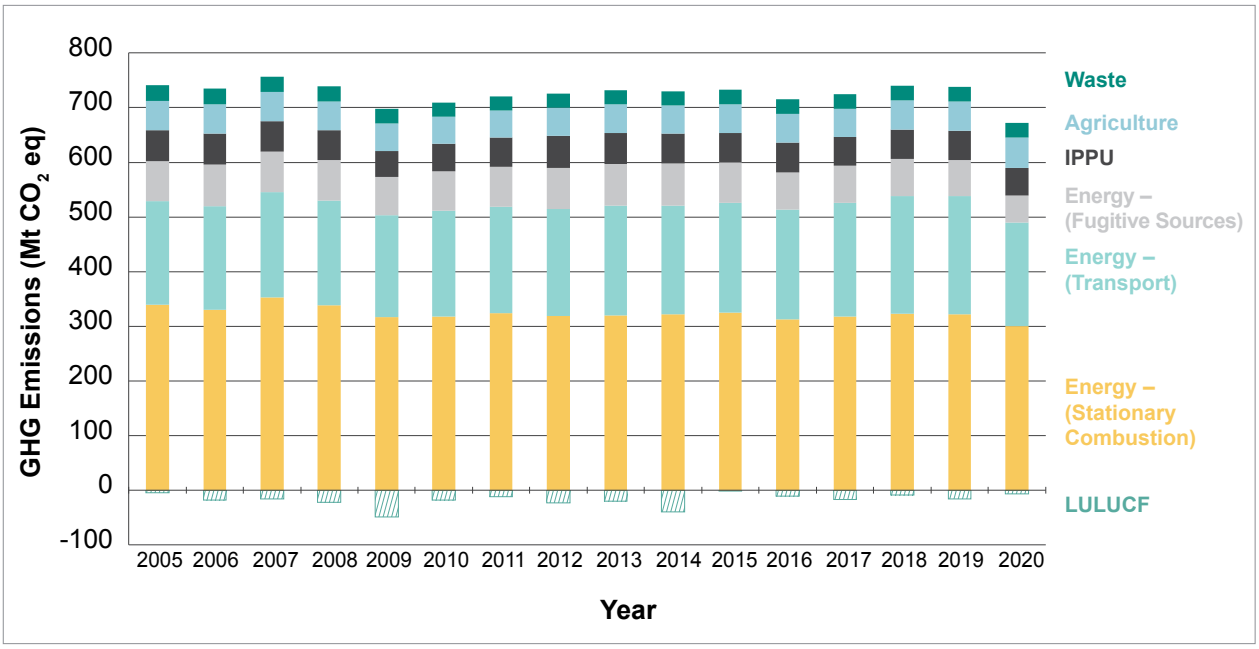
Canada's National Greenhouse Gas Inventory is prepared and submitted annually to the United Nations Framework Convention on Climate Change (UNFCCC) by April 15 of each year, in accordance with the revised *Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories* (UNFCCC Reporting Guidelines), adopted through Decision 24/CP.19 in 2013. The annual inventory submission to the UNFCCC consists of the National Inventory Report (NIR)[1] and the Common Reporting Format (CRF) tables.

The GHG inventory includes emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3) in the following five sectors: Energy, Industrial Processes and Product Use (IPPU), Agriculture, Waste, and Land Use, Land-Use Change and Forestry (LULUCF). The GHG emission and removal estimates contained in Canada's GHG inventory are developed using methodologies consistent with the Intergovernmental Panel on Climate Change's (IPCC) 2006 *Guidelines for National Greenhouse Gas Inventories*. In line with the principle of continuous improvement, the underlying data and methodology for estimating emissions are revised over time; hence, total emissions in all years are subject to change as both data and methods are improved.

In 2020, the most recent annual dataset available for this report, Canada's greenhouse gas (GHG) emissions were 672 megatonnes of carbon dioxide equivalent (Mt CO_2 eq). The Energy Sector (consisting of Stationary Combustion Sources, Transport, and Fugitive Sources) emitted 540 Mt of GHGs, or 80 percent of Canada's total GHG emissions. The remaining emissions were largely generated by the Agriculture (8.2 percent) and IPPU (7.5 percent) Sectors, with contribution from the Waste Sector (4.1 percent). The LULUCF Sector was a sink in 2020, with net removals of 6.8 Mt.

Over the 2005 to 2020 period, total emissions have decreased by 69 Mt or 9.3 percent. Two sources of the Energy Sector dominated this trend, with emission decreases of 39 Mt (12 percent) in Stationary Combustion Sources and 23 Mt (32 percent) in Fugitive Sources. Over the same period, emissions have decreased by 6.3 Mt (11 percent) in the IPPU Sector and 1.4 Mt (4.8 percent) in the Waste Sector. Moreover, emissions from Transport (also in the Energy Sector) have generally increased from 2005 to 2019 and decreased between 2019 and 2020, bringing the 2020 emissions in this subsector to a level similar to 2005 (0.07 Mt or 0.0 percent increase). The Agriculture Sector emissions have remained relatively stable with a 0.98 Mt or 1.8 percent increase (Figure BR2-1). The net removals in the LULUCF Sector have fluctuated between relatively low values of 4.2 Mt in 2005, 0.1 Mt in 2015 and 6.8 Mt in 2020, and high peaks of 49 Mt in 2009 and 39 Mt in 2014, representing a net increase of 2.5 Mt between 2005 and 2020.

Figure BR2-1. Trends in Canadian GHG Emissions by IPCC Sector (2005 to 2020)



Source: *National Inventory Report 1990–2020: Greenhouse Gas Sources and Sinks in Canada*

2.1. Canadian Economic Sectors

For the purposes of analyzing economic trends and policies, it is useful to allocate emissions to the economic sector from which they originate. In general, a comprehensive emission profile for a specific economic sector is developed by reallocating the relevant proportion of emissions from various IPCC subcategories. This reallocation simply re-categorizes emissions under different headings and does not change the overall magnitude of Canadian emissions estimates.[2] In addition, Canadian economic sectors presented in Canada's GHG Inventory are used to project Canada's future GHG estimates.

GHG emissions trends in Canada's economic sectors have remained consistent with those described for IPCC sectors, with the Oil and Gas and Building economic sectors showing emission increases of 7.5 Mt or 4.4 percent and 4.1 Mt or 4.9 percent, respectively, since 2005. These increases have been more than offset by emission decreases in Electricity (-61 Mt or -52 percent), Heavy Industry (-15 Mt or -18 percent) and Waste and Others (-5.0 Mt or -9.0 percent) (Table BR2-1).

Table BR2-1. Canada's GHG Emissions by Economic Sector, for selected years, excluding LULUCF

	2005	2015	2016	2017	2018	2019	2020
	Mt CO_2 equivalent						
National GHG Total	**741**	**733**	**715**	**725**	**740**	**738**	**672**
Oil and Gas	171	205	194	196	205	203	179
Electricity	118	80	74	73	63	62	56
Transport	160	172	173	179	184	185	159
Heavy Industry[a]	87	78	76	76	77	77	72
Buildings	84	84	82	87	93	92	88
Agriculture[b]	66	65	65	64	66	67	69
Waste and Others[c]	55	50	50	50	51	52	50

Notes:

Totals may not add up due to rounding.

Estimates presented here are under continuous improvement. Historical emissions may be changed in future publications as new data becomes available and methods and models are refined and improved.

a. Heavy Industry represents emissions arising from non-coal, -oil and -gas mining activities, smelting and refining, and the production and processing of industrial goods such as fertilizer, paper or cement.

b. Emissions associated with the production of fertilizer are reported in the Heavy Industry Sector.

c. "Others" includes Coal Production, Light Manufacturing, Construction and Forest Resources.

Source: *National Inventory Report 1990-2020: Greenhouse Gas Sources and Sinks in Canada.*

Information of Canada's GHG emissions and trends is provided in Chapter 3 of Canada's *Eighth National Communication*. For a more elaborate analysis of recent historical GHG emission and removal trends, please see Chapter 2 of Canada's 2022 NIR.

2.2. Canada's National Inventory Arrangements

Environment and Climate Change Canada is the single national entity with responsibility for preparing and submitting the National GHG Inventory to the UNFCCC and for managing the supporting processes and procedures.

The institutional arrangements for the preparation of the inventory include formal agreements on data collection and estimate development; a quality management plan, including an improvement plan; the ability to identify key categories and generate quantitative uncertainty analysis; a process for performing recalculations due to improvements; procedures for official approval; and a working archive system to facilitate third-party review.

Canada's inventory arrangements have not changed since the submission of its *Fourth Biennial Report*.

Submission of information regarding Canada's national inventory arrangements, including details on institutional arrangements for inventory preparation, is also an annual requirement under the UNFCCC reporting guideline on annual inventories. Therefore, such information can be found in Chapter 1, Section 1.2 of Canada's 2022 NIR and Chapter 3 of Canada's *Eighth National Communication*.

More information on Canada's GHG Inventory is available at www.canada.ca/ghg-inventory.

Section 3 – Quantified Economy-Wide Emission Reduction Target

3.1. Canada's Emissions Reduction Targets

In its updated 2021 Nationally Determined Contribution under the Paris Agreement, Canada committed to reducing its GHG emissions by 40 to 45 percent below 2005 levels by 2030. Additionally, Canada is committed to reducing its emissions to net-zero by 2050. Under the 2009 Copenhagen Accord, Canada committed to reducing its emissions by 17 percent below 2005 levels by 2020 (Table BR3-1).

Table BR3-1: Canada's emission reduction targets

Target year	Base year	Percent reduction	Mt target	Established
2020	2005	17 percent	606	Copenhagen Accord (2009)
2030	2005	40 to 45 percent	406.5 to 443.4	Paris Agreement (2021)

Canada's GHG emission reduction targets are economy-wide, covering all sectors and gases. Global warming potential values for all covered gases are those established in the *IPCC Fourth Assessment Report*. In addition to reporting information by IPCC sector, Canada also reports information on historical and projected emissions according to the following economic sector categories: electricity, transportation, oil and gas, heavy industry, buildings, agriculture, and waste and others (Table BR3-2). This sectoral categorization allows for a better understanding of emissions as they relate to economic trends and policies in Canada, and is developed by reallocating the relevant proportion of emissions from various IPCC subcategories.

Additional information on the IPCC and economic sector definitions, as well as a detailed cross-walk between IPCC and Canadian economic sector categories can be found in Table A10-3 of Part 3 of Canada's *2022 National Inventory Report* submission to the UNFCCC.

Table BR3-2: Gases and Sectors Covered

Gases	IPCC Sectors	Economic Sectors
CO_2	Energy	Oil and Gas
CH_4	Transportation	Electricity
N_2O	Industrial Processes	Transportation
HFCs	Agriculture	Heavy Industry
PFCs	Waste	Buildings
SF_6	LULUCF	Agriculture
NF_3		Waste and Others
		LULUCF

*LULUCF = Land Use, Land-Use Change and Forestry

3.2. Approach to the Land Use, Land-Use Change and Forestry (LULUCF) Sector

Canada's LULUCF accounting contribution is calculated in accordance with UNFCCC guidelines and Canada's Nationally Determined Contribution submitted to UNFCCC in July 2021, where a reference level approach is used for managed forest and associated Harvested Wood Products, and a net-net approach is used for all the other LULUCF sub-sectors. Canada updates LULUCF accounting contributions every year. As noted in Canada's Greenhouse Gas and Air Pollutant Emissions Projections 2021, Canada continues to estimate the accounting contribution from LULUCF using the same general methodologies as in previous years, but using updated data and some methodological improvements. This approach applies to Canada's 2020 emission reduction target as well.

3.3. Approach to Market-Based Mechanisms

Canada is committed to working with Parties under the Paris Agreement to ensure the full robust implementation of Article 6 in order to foster credible and efficient international carbon markets. With the adoption of the rules and guidelines for Article 6 at COP26 and COP27, Canada will continue to work with partners to ensure international carbon markets promote greater ambition and environmental integrity.

Canada's enhanced NDC, submitted in 2021, noted that Canada will continue to advocate for strong international rules for ITMOs to ensure transparency and the avoidance of double-counting, consistent with Article 6 of the Paris Agreement. As identified in the enhanced NDC, Canada will continue to work with international and subnational partners to ensure robust accounting of all international cooperative approaches authorized by the participating Parties to the Paris Agreement. This will take into account the applicable guidance under the UNFCCC and the Paris Agreement as well as other relevant input and programs (e.g., the International Civil Aviation Organization's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)).

Québec remains a participant in the Western Climate Initiative (WCI), and its cap-and-trade system has been fully linked with California's since 2014. Québec and California have developed an accounting mechanism that identifies and accounts for compliance instruments traded between jurisdictions and retired in the WCI linked carbon market.[3]

Canada's GHG Inventory does not include emissions reductions associated with international market mechanisms.

Section 4 – Progress in Achievement of Quantified Economy-Wide Emission Reduction Targets and Relevant Information

4.1. Mitigation Actions and Their Effects[4]

4.1.1. Domestic Institutional Arrangements

In Canada, the environment and climate change are policy areas of shared jurisdiction. To support a coordinated national approach to climate action, Canada continues to implement the *Pan-Canadian Framework on Clean Growth and Climate Change* (PCF), which is Canada's first comprehensive national climate plan and was adopted by Canada's federal, provincial and territorial governments in 2016. The PCF was developed by the Government of Canada in collaboration with provinces and territories, and with input from Indigenous Peoples.

Since Canada's *Fourth Biennial Report*, Canada has continued to take significant action to reduce emissions and help Canadians and communities adapt to the impacts of climate change. In 2020, the Government of Canada released a strengthened climate plan, *A Healthy Environment and a Healthy Economy*, to deepen emissions reductions across the economy, create new, well-paying jobs, make life more affordable for households, and build a better future.

In 2021, Canada increased its ambition under the Paris Agreement by committing to an enhanced 2030 emissions reduction target of 40 to 45 percent below 2005 levels. Canada also passed the *Canadian Net-Zero Emissions Accountability Act,* which enshrined Canada's 2030 target, and the need to reach net-zero emissions by 2050 in legislation. The Act sets legal requirements for current and future federal governments to plan, report, and course correct on the path to net-zero emissions by 2050. Key elements of the Act include setting targets every five years from 2030 to 2050; establishing emissions reduction plans for each target; and new reporting requirements, including progress and assessment reports associated with each emissions reduction plan.

As a key early requirement of that Act, in 2022 Canada published the *2030 Emissions Reduction Plan*. The Plan includes $9.1 billion in new investments and provides a road map that goes sector by sector to identify climate action and strategies to reach Canada's 2030 emissions target and lay the foundation for net-zero emissions by 2050. The Plan is an evergreen document that will adapt as new opportunities arise and promising pathways to Canada's 2030 target and net-zero emissions continue to emerge. Full implementation of the measures and strategies in the plan will rely on close collaboration with other levels of government, Indigenous Peoples, experts, industry, financial sector, stakeholders, and civil society.

Mechanisms to support interjurisdictional coordination on environmental policies play a key role in the implementation of Canada's climate plans. For example, the Canadian Council of Ministers of the Environment is Canada's collective forum for intergovernmental cooperation where federal, provincial, and territorial counterparts promote collaborative actions by governments to advance shared climate change objectives, undertake analysis to develop best practices, and make recommendations to enhance governments' climate action. In addition to other multilateral fora, the Government of Canada continues to engage provinces and territories on a bilateral and regional basis, to explore and pursue opportunities and issues of mutual interest.

To further partnerships and advance broader clean growth and climate change priorities with Indigenous partners, the Prime Minister of Canada and the national leaders of the Assembly of First Nations, Inuit Tapiriit Kanatami and the Métis National Council established three distinction-based, Senior Bilateral Tables on Clean Growth and Climate Change in 2016. More than five years later, these tables continue to demonstrate the benefits of sustained collaboration.

4.1.2. Policies and Measures to Reduce Emissions

The four main pillars of the 2016 PCF continue to serve as the foundation for Canada's climate action: pricing carbon pollution; complementary measures to reduce emissions across the economy; measures to adapt to the impacts of climate change and build resilience; and actions to accelerate innovation, support clean technology, and create jobs.

Canada's *2030 Emissions Reduction Plan* provides a detailed road map that goes sector by sector to identify climate action and strategies. For example, the Government of Canada is making it easier for Canadians to switch to zero-emission vehicles and retrofit homes and buildings to reduce emissions. Canada is helping industries to develop and adopt clean technology to reduce their emissions, and is working with the oil and gas sector to drive down carbon pollution. Communities are being empowered to pursue climate action projects through the Low Carbon Economy Fund, and farmers are supported with funding to help make their operations more sustainable. The Government of Canada is also investing in nature and natural climate solutions, and is committed to maintaining Canada's approach to pricing carbon pollution.

For a comprehensive narrative description of Canada's key policies and measures by economic sector, with an emphasis on those measures that have been recently adopted, please see Chapter 4 of Canada's *Eighth National Communication*.

National Communication Table 1 within the annex of Chapter 4: Policies and Measures provides information on core mitigation measures planned or already implemented by federal, provincial, and territorial governments, including those committed to under the *2030 Emissions Reduction Plan*, the Strengthened Climate Plan and the PCF. Policies and measures are presented in accordance with Canada's economic sector categories, with cross-cutting measures appearing first. In each sector, key measures from provincial and territorial governments have also been highlighted.

Priority has been given to those policies and measures that have the most significant impact on sectoral GHG emissions. As much as possible direct mitigation impacts have been estimated for key policies, provided by the implementing entity. In some cases, mitigation estimates were not available, for example for measures that are still under development, and/or for those measures where it is difficult to estimate the direct mitigation impact, such as for supporting measures. The methodology for estimating expected emissions reductions from individual measures may vary by implementing entity and have been included on an as-provided basis. An estimate of the total mitigation impact of policies and measures—including interactive effects—is provided in Chapter 5: Projections and the Total Effects of Policies and Measures of Canada's *Eighth National Communication*.

4.2. Estimates of Emissions Reductions and Removals and the Use of Units From the Market-Based Mechanisms and LULUCF

Canada's LULUCF accounting contribution is calculated in accordance with UNFCCC guidelines and Canada's Nationally Determined Contribution submitted to the UNFCCC in July 2021, where a reference level approach is used for managed forest and associated Harvested Wood Products, and a net-net approach is used for all the other LULUCF sub-sectors.

Canada's GHG Inventory does not include emissions reductions associated with international market mechanisms.

Section 5 – Projections

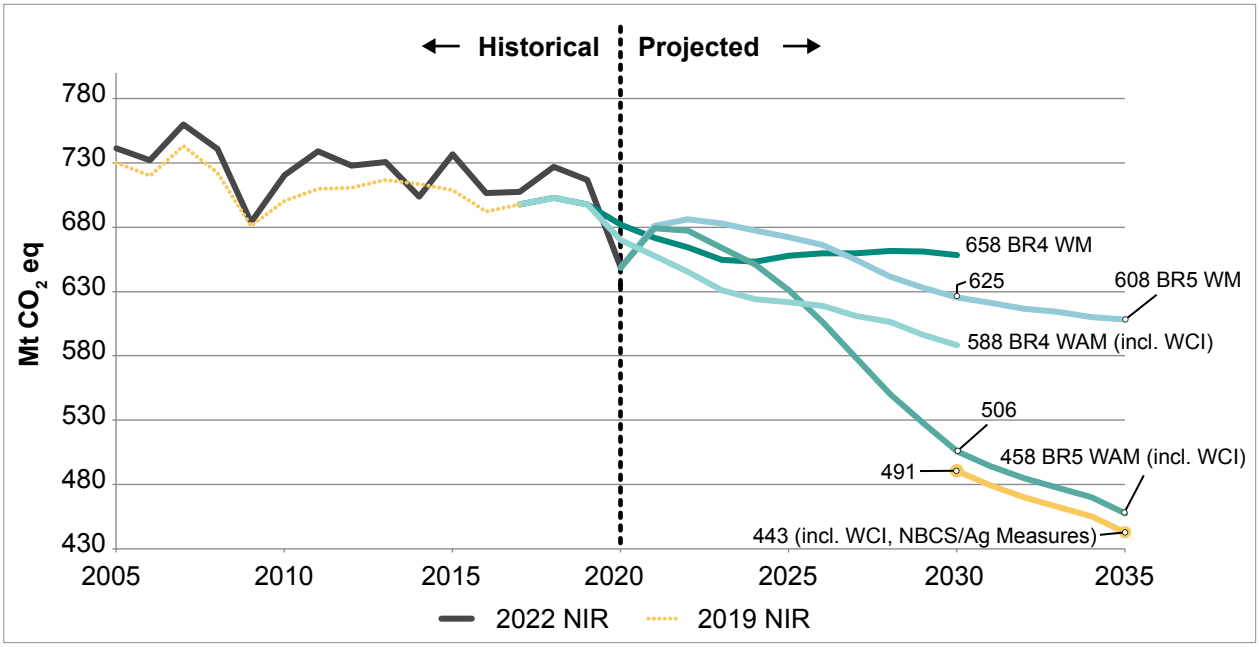
Projections provide important insight into the expected impacts of the suite of existing measures and can be a valuable tool when identifying where more effort is needed. Canada's GHG projections are derived using a detailed bottom-up simulation model where energy data is allocated to individual subsectors using the North American Industrial Classification System. These subsectors are then aggregated into the economic sectors presented in this report. Projections are based on ECCC's Energy, Emissions and Economy Model for Canada (E3MC), which is internationally recognized and incorporates external data from consistent sources. ECCC consults extensively with other government officials, selected experts and provinces and territories on annual emissions projections.

For its *Eighth National Communication and Fifth Biennial Report*, Canada has presented projections that include both a "with measures" scenario (WM) and a "with additional measures" scenario (WAM, both outlined in Section 5.2).

- The WM scenario builds on the WM projections presented in the *Fourth Biennial Report*, and now includes all policies and measures funded, legislated and implemented by federal, provincial and territorial governments over the last three years, up to November 2022.
- The WAM scenario accounts for those additional policies and measures that are under development but have not yet been fully implemented, some of which were announced as part of the 2030 ERP (e.g., Clean Electricity Regulations, strengthened methane regulations in the oil and gas sector targeting 75 percent reduction by 2030 and proposed landfill gas regulations). This scenario is provided for the purposes of representing progress to Canada's 2030 target and to better demonstrate the full impact of Canada's climate policies.

Under the WAM scenario, emissions in 2030 decline to 491 Mt including contributions from Land Use, Land-Use Change and Forestry (LULUCF), Nature-Based-Climate Solutions (NBCS) and Agriculture Measures, and credits purchased under the Western Climate Initiative (WCI). This is 97 Mt below the 2030 WAM projection in the *Fourth Biennial Report*. Post-2030, the WAM scenario sees emissions continuing to decline, reaching 443 Mt in 2035. Figure BR5-1 shows the "with measures" and "with additional measures" projections, as well as the projections presented in Canada's *Fourth Biennial Report*.

Figure BR5-1: Scenarios of Canadian Emissions (Including LULUCF) to 2035 (Mt CO_2 eq)



While every effort is made to be as complete as possible in what is included in the model, there will always be measures that are not included. This includes the aforementioned federal measures that have not been sufficiently developed to support inclusion, such as the oil and gas cap on emissions, elements of the Green Buildings Strategy, as well as additional mitigation measures that could be implemented by the provinces and territories between now and 2030. Emissions reductions from additional future actions will be assessed as new measures are implemented.

Uncertainty is an inherent and unavoidable aspect of any model that is generating long-term projections. The current global context further complicates the development of projections given the extent of global change in recent years, notably due to the COVID-19 pandemic, the worsening impacts of the climate crisis including large scale flooding and heat waves, and the emerging and related dual inflation and energy supply crises in 2022. The scenarios presented reflect recent events that could impact future emissions, using expert and data driven forecasts. These forecasts can change dramatically from year to year, driven by global conditions. A notable change in 2022 has been global energy prices, which are forecast to drive higher natural gas production in Canada's energy sector, which is a shift from the natural gas price and demand forecasts in recent years.

The uncertainty inherent in projections is addressed via modelling and analysis of alternate cases that focus on variability in: future economic growth, population projections, and oil and natural gas production and prices. The sensitivity analyses generated through these alternate cases are used to identify a range of possible emissions projections. Under the WM scenario, emissions reductions in Canada are projected to be 625 Mt in 2030. Through the sensitivity analysis, emissions reductions in 2030 under the WM scenario are projected to range from between 612 and 664 Mt. Environment and Climate Change Canada also updates emissions projections annually, reflecting the latest historical data and up-to-date future economic and energy market assumptions.

Section 6 – Provision of Financial, Technological and Capacity-Building Support to Developing Country Parties[5]

6.1. Finance

6.1.1. Introduction

We are in the midst of unprecedented global challenges owing to the dual crises of climate change and biodiversity loss, which together are threatening the foundations of our economy, food systems, peace and security, health, and quality of life. Financial investments are needed to help developing countries, particularly the poorest and most vulnerable, such as Least Developed Countries (LDCs) or Small Island Developing States (SIDS), as they are the hardest hit by climate change and biodiversity loss.

Under the United Nations Framework Convention on Climate Change, Canada is committed to working with the international community to meet the objectives of the Paris Agreement and to scale up climate finance to support developing countries in their climate mitigation efforts, and to foster resilience among those most at risk from the effects of climate change. Canada's international climate action includes its contributions and commitment to jointly mobilize US$100 billion in climate finance per year through to 2025 from a wide variety of sources.

Beyond its climate finance contribution, Canada has demonstrated leadership by co-leading with Germany the development of the Climate Finance Delivery Plan in the lead up to COP26 to demonstrate how and when developed countries are going to meet the collective US$100 billion goal. In 2022, Canada and Germany also prepared a Climate Finance Delivery Plan Progress Report to demonstrate continued progress towards the goal through collective actions identified in the original plan.

6.1.2. Overview of Canada's Climate Finance Over 2019 and 2020

This section provides an overview of Canada's climate finance support provided to developing countries over 2019 and 2020. Canada's climate finance support is provided and mobilized from a variety of sources. This includes delivering on the $2.65 billion public finance commitment over fiscal years 2015–16 to 2020–21 and doubling the commitment to $5.3 billion for the fiscal years 2021–22 to 2025–26.[6] Canada also seeks to integrate climate change into its international assistance, including from other levels of government, and provides core contributions to multilateral development banks (MDBs) that are increasing their climate support. Further, Canada is deploying innovative climate resources, such as climate investments through Export Development Canada (EDC) and Development Finance Institute Canada (FinDev Canada).

Canada's public climate finance support over 2019 and 2020 totalled more than $2.12 billion[7] and includes:

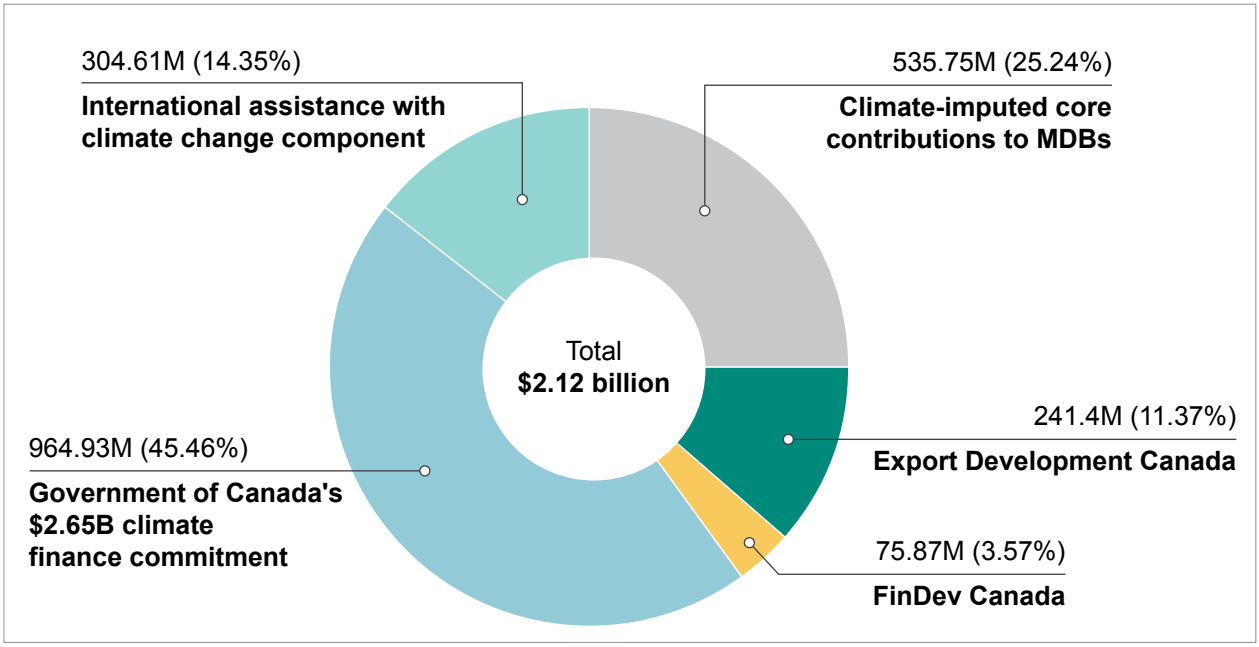
- $964.93 million from Canada's $2.65 billion climate finance commitment (delivered between 2016 and 2021);[8]
- $535.75 million in climate shares from core contributions to MDBs;

- $304.61 million from Canada's international assistance with a climate change component, including $3.34 million in climate change support from other levels of government;
- $241.4 million in climate investments from EDC;
- $75.87 million in climate investments from FinDev Canada.

A breakdown of Canada's public climate finance delivery over 2019 and 2020 is shown in Figure BR6-1.

In addition, Canada uses public finance to mobilize private sector investments. Over 2019–2020, Canada's public investments enabled the mobilization of US$149 million (approximately CAD $200.24 million) in private finance to support climate change efforts in developing countries.

Figure BR6-1: Canada's total public climate finance delivered over 2019 and 2020



6.1.3. Key Focus Areas

Canada's climate finance supports developing countries as they transition to a cleaner economy and adapt to climate change. Of Canada's public climate finance through bilateral and regional channels in 2019 and 2020, 46 percent targeted mitigation, 21 percent targeted adaptation, and 33 percent targeted crosscutting activities. Cross-cutting activities address mitigation and adaptation simultaneously.

Mitigation

Canada's climate finance supports developing countries' transition to clean energy by phasing out coal-powered emissions and promoting equitable access to reliable and cost-effective clean energy solutions and energy-efficient technologies. Canada's mitigation finance also supports sustainable forest and agricultural management, to reduce greenhouse gas (GHG) emissions from these sectors.

Under the $2.65 billion commitment, Canada's support for a transition to clean energy in developing countries included, for example:

- $275 million ($156 million of which was provided in 2020) to the World Bank to establish the Energy Transition Program to assist developing countries in phasing out their dependence on traditional coal-fired electricity while supporting energy efficiency and renewable energy as alternatives;
- $154 million ($1 million of which was provided in 2019) to the International Finance Corporation (IFC) for the Africa Renewable Energy Initiative to improve access to affordable and sustainable energy services in Sub-Saharan Africa; and
- $60 million ($40 million of which was provided in 2020) to the World Bank for the Renewable Energy in SIDS Program to increase their renewable energy capacity and improve energy efficiency, while pursuing gender equality across the energy value chain.

Canada's mitigation finance also includes bilateral support. For example, Canada's $200 million Canadian Climate Fund for the Private Sector in Asia Phase II (CFPS II) contributed to the Eastern Indonesia Renewable Energy project through a US$8.1 million loan (for the first phase) and US$21.9 million loan (for the second phase).[9] The more recent second phase of this project is expected to avoid 41,400 metric tonnes of carbon dioxide equivalent emissions (t CO_2 eq) per annum. Canadian funds for this phase of the project contributed to leveraging an additional US$31.7 million in co-financing from various actors, including private sector entities.

Adaptation

Canada seeks to improve the adaptive capacity of vulnerable communities through its climate finance commitment, recognizing that support for climate change adaptation is critical for developing countries, in particular the poorest and most vulnerable, as they face climate shocks and other changes with profound impacts on agriculture, infrastructure and well-being.

Under the $2.65 billion commitment, Canada's support for adaptation included:

- $10 million ($1.67 million of which was provided in 2019 and 2020) to the Climate Risk Early Warning System (CREWS), which protects lives and property through capacity-building activities and strengthening of early warning services in LDCs and SIDS;
- $340 million ($150 million of which was provided in 2020) to the International Fund for Agriculture Development (IFAD), which supports gender-transformative climate-smart agriculture by addressing interlinked challenges of food security and climate change; and
- $4 million ($1 million of which was provided in 2020) to the National Adaptation Plan (NAP) Global Network to advance national climate adaptation processes in developing countries through technical assistance, peer learning and knowledge development.

Canada's adaptation finance also includes bilateral support to climate-vulnerable countries. For example, Canada contributed $40 million ($8 million of which was provided in 2020) to the Strengthening Climate Risk Management project implemented by the World Food Programme. The project helps the African Risk Capacity Agency to enable member states to better plan, prepare and respond to extreme weather events and natural disasters. In 2020–2021, 11 countries benefited from this initiative, including Côte d'Ivoire, Zimbabwe and Madagascar. For instance, Madagascar received more than US$2 million to cover anticipated losses from a crop failure in the just-concluded farming season. This funding enabled the Government of Madagascar to respond quickly to the drought and provide 15,000 vulnerable households with unconditional cash transfers and "cash for work", nutritional support for 2,000 children under the age of 5 years, and water for 84,000 households.

Looking ahead, Canada will bolster its adaptation support to respond to the increasingly adverse effects of climate change. This includes increasing the proportion of adaptation finance in Canada's $5.3 billion climate finance commitment (2021–22 to 2025–26) to a minimum of 40 percent, which represents a more than doubling of adaptation funding compared to the previous commitment. This aligns with the Glasgow Climate Pact, which urges developed countries to at least double their collective provision of climate finance for adaptation from 2019 levels by 2025. Canada is also demonstrating its commitment to working collectively to advance adaptation efforts, for example by joining the Champions Group on Adaptation Finance in June 2022. This group works to advance climate adaptation priorities and solutions, including scaling up adaptation finance, mobilizing private sector finance, and enhancing the quality and accessibility of finance, particularly for LDCs and SIDS.

Gender Equality and Empowerment of Women and Girls

Through its climate finance commitment, Canada advances key priorities, including gender equality and the empowerment of women and girls. As the most vulnerable and marginalized often endure the brunt of climate change and biodiversity loss, women and girls continue to be disproportionately impacted by climate shocks. Yet, their leadership and expertise often remains overlooked. Women and girls can be powerful agents of change when given access and control over environmental resources, and when supported to use their knowledge and expertise in climate change mitigation and adaptation strategies. That is why gender equality and women's empowerment is an integral part of Canada's climate finance. In 2017, Canada established its Feminist International Assistance Policy (FIAP) to integrate gender equality and women's empowerment into Canada's international assistance. In line with the FIAP, Canada's $2.65 billion climate finance integrated gender equality considerations in 85 percent of projects under the programming.

For example, the Building Community Resilience to Climate Change project in Senegal is improving rural communities' resilience to climate change, especially for women. As of March 2021, 74 women (out of 122 community members) were trained on sustainable forest management and bushfire prevention and 12 women had become community-based forest monitors. The project also aims to train women-led cooperatives on the creation and marketing of biomass briquettes. Furthermore, through the Canadian Climate Fund for the Private Sector in the Americas (C2F I and II), the Inter-American Development Bank (IDB) Group created an innovative performance-based incentive program to achieve strong gender outcomes, whereby private sector companies that agree to co-defined and agreed-upon gender targets can apply for a reduction in the interest rate of their loans. This program has sparked a cultural change in many companies, for example by providing

internship opportunities for women undergraduates in the science, technology, math and engineering (STEM) fields, where women are traditionally under-represented, improving their human resources policies, and signing on to the UN's Women Empowerment Principles.

6.1.4. Scaling Up Climate Finance

Public finance alone is not sufficient to meet the level of investment needed to achieve the objectives of the Paris Agreement. Delivering on the US$100 billion climate finance goal requires tapping into a wide variety of sources of finance and all financial instruments, including private finance. The private sector plays an essential role in addressing climate change and there is significant potential for further investment in climate solutions by the private sector. That is why a key priority of Canada's climate finance support is to mobilize private finance through public investments. Over 2019 and 2020, Canada mobilized an estimated US$149.43 million in private finance through US$178.61 million in public finance for climate-related activities.[10]

Canada is a leader in innovative approaches to mobilize private finance by blending its concessional finance with commercial resources, while using grant financing where cost-effective market-based financing is not viable, such as for most adaptation projects in the poorest and most vulnerable countries. Blended finance can play a critical role in mobilizing private investments that otherwise would not occur by de-risking investments and helping to create new markets by addressing market failures. These instruments can be adapted to local contexts and are consistent with the ambition of the Paris Agreement, which affirms the role of mobilizing private finance in achieving nationally determined contributions (NDCs).

MDBs are key partners in Canada's efforts to mobilize private finance. As part of its efforts to mobilize private finance, Canada has pioneered an approach with MDBs—including the Asian Development Bank, the IDB Group, the African Development Bank and the World Bank Group—by establishing Canadian facilities at these institutions designed to catalyze private sector investments. Through these funds, Canada is using targeted concessional finance to demonstrate the commercial viability of projects and unlock future private investments in similar initiatives through a demonstration effect. For example, as part of its $2.65 billion climate finance commitment, Canada contributed $223.5 million in loans ($161.5 million of which was provided in 2019 and 2020) to the second phase of the Canadian Climate Fund for the Private Sector in the Americas (C2F II) with the IDB, aimed at catalyzing private sector investments in climate change mitigation and adaptation across the Latin America and Caribbean region. This Fund is expected to leverage up to US$1 billion public and private financing.

Canada estimates that repayable contributions of approximately $1.4 million in 2019 and $6.3 million in 2020 have been returned to Canada from Canadian climate facilities at MDBs. Tracking these repayable contributions can help to determine the successful performance of these projects and demonstrates how using public funding can catalyze investments in climate change action in developing economies.

Annex 3 to Chapter 7of Canada's *Eighth National Communication* provides the full list of Canadian facilities at MDBs.

6.1.5. Canada's National Approach to Tracking

Canada tracks and reports its climate finance contributions from the various sources to ensure a comprehensive and accurate representation of Canada's climate finance flows.

Canada tracks and reports its climate finance through project-level data to increase transparency; this includes both expected and achieved results to assess the effectiveness and impacts of Canada's climate finance. Canada's tracking and reporting of its climate finance adheres to international standards and best practices for official development assistance, such as the UNFCCC and the Organisation for Economic Co-operation and Development – Development Assistance Committee (OECD-DAC). Canada is committed to continuously improving its climate finance tracking and reporting. Since the *Fourth Biennial Report*, Canada has made some adjustments to its methodology for reporting contributions through multilateral contributions to improve transparency of its climate finance. More detailed information on the methodologies used for reporting Canada's climate finance commitment can be found in Chapter 7 of the *Eighth National Communication* (Section 7.1.4 and Annex 4).

The most up-to-date information on Canada's climate finance support is available on Canada's climate finance website, where users can access information on recipient countries and regions, priority sectors, types of support, financial mechanisms, years of contribution, project descriptions, and results. For more detail and project-level information on Canada's climate finance, see Chapter 7 of the *Eighth National Communication* (Annex 1).

6.2. Technology and Capacity-Building Support

Canada's technology and capacity-building activities span a broad range of mitigation and adaptation technologies across a variety of sectors. In 2019 and 2020, Canada continued to share its world-leading technology and expertise, most notably in the areas of forest management (e.g., carbon budget and model forests), energy management systems, and measurement of carbon emissions. Canada also took a leadership role in a number of areas over the reporting period, including hosting of the Clean Energy Ministerial and Mission Innovation in 2019, and serving as Chair of the Advisory Board to the UNFCCC's Climate Technology Centre and Network (CTCN) in 2019–20. During this period, Canada also supported multilateral energy collaboration through funding studies and sharing expertise within the IEA and IRENA. Additional details of projects and activities funded under Canada's climate financing can be found in Chapter 7 of Canada's *Eighth National Communication*.[11]

Section 7 – Other Reporting Matters

7.1. Domestic Arrangements for Self-Assessment of Emissions Reductions

There are several processes in Canada that help support self-assessment of progress toward emissions reduction goals. Since the *Fourth Biennial Report*, a critical development in this area is the passing of the *Canadian Net-Zero Emissions Accountability Act (2021)*, legislation which introduced legal requirements for current and future federal governments to plan, report, and course correct on the path to net-zero emissions by 2050. With regards to self-assessment of emissions reductions, the Act sets new reporting requirements including progress and assessment reports associated with each emissions reduction plan. The Act also includes requirements for third parties to hold the Government to account: Canada's Commissioner of the Environment and Sustainable Development must examine and report on the Government's implementation of climate-change mitigation measures at least once every five years; the Minister of Finance, in cooperation with the Minister of Environment and Climate Change, must publish an annual report outlining key measures that federal departments and crown corporations have taken to manage the financial risks and

opportunities related to climate change, and a Net-Zero Advisory Body established in law through the Act will provide independent advice on targets and emissions reduction plans, including measures and sectoral strategies that the Government of Canada could implement. For more information about how the *Canadian Net-Zero Emissions Accountability Act* will help Canada ensure accountability and transparency on the path to net-zero by 2050, see Canada's *Eighth National Communication*, Chapter 4, (Section 4.1.1. and Section 4.2.1.).

On behalf of the Auditor General of Canada, the Commissioner of the Environment and Sustainable Development (CESD) is mandated to provide objective, independent analysis and recommendations on the federal government's efforts to protect the environment and foster sustainable development. The Commissioner conducts performance audits and is responsible for assessing whether federal government departments are meeting their sustainable development objectives, including on climate change. Reports and audits are tabled in Parliament and provide observations and recommendations for initiatives that require improvement. In addition to arrangements at the federal level, provinces and territories also have their own respective arrangements to audit the effectiveness of environmental policies and programs. For information about other accountability mechanisms, see Canada's *Eighth National Communication*, Chapter 4, Section 4.2.3.

In addition, *Canada's Federal Sustainable Development Act* provides a legal framework for developing and implementing a Federal Sustainable Development Strategy that makes environmental decision-making transparent and accountable to Parliament. The Act requires the development of a Federal Sustainable Development Strategy every three years and it provides a whole-of-government view of federal actions to achieve environmental sustainability, including progress on GHG emission reductions. Performance measurement and reporting is an essential part of the strategy, and indicators to track progress at the goal and target level are drawn largely from the Canadian Environmental Sustainability Indicators (CESI).

The CESI publishes data and interpretation to track Canada's performance on key environmental sustainability issues including climate change and greenhouse gas emissions. Data and information sources include Canada's *National Inventory Report* and the presentation allows for easy comprehension by citizens and decision-makers while providing technical background and links to the sources.

Progress Reports on the *Federal Sustainable Development Strategy* are published at least once every three years to review progress towards these indicators. The Progress Report on the *2019 to 2022 Federal Sustainable Development Strategy* was published in 2021. The *2022–2025 Federal Sustainable Development Strategy* was tabled in November 2022. Amendments to the Act came into force December 1, 2020 through *An Act to amend the Federal Sustainable Development Act*. These amendments shift the focus of the Act from an environmental focus to one of sustainable development decision-making, and expand the number of federal organizations required to contribute to the development of the strategy and report on its progress (from 26 to more than 90 federal organizations).

Regular reporting allows Canada to assess its progress in reducing emissions and combatting climate change, including Canada's *National Inventory Report*, as well as its *National Communications* and *Biennial Reports*. In addition to reporting to the UNFCCC, in 2021 *Canada's GHG Emissions Reference Case* report presented analysis and projections of Canada's GHG emissions in the context of its emission targets that includes updated data and assumptions as well as all policies and measures funded, legislated and implemented by federal, provincial, and territorial governments as of November 2021.

At the federal level, environmental regulations are enforced under relevant legislative authorities. Regulations to reduce greenhouse gas emissions are established under the *Canadian Environmental Protection Act, 1999*. Environmental enforcement officers enforce federal legislation dealing with risks to the environment and biodiversity, and enforce these laws in collaboration with provincial and territorial governments and national and international agencies and organizations. For more information about the legislative instruments that help address Canada's climate change commitments, see Canada's *Eighth National Communication*, Chapter 4, Section 4.1.4.

7.2. UNFCCC Transparency Requirements

Accurate and transparent reporting of Canada's GHG emissions and removals are a requirement under the UNFCCC. This reporting, includes Canada's *National Inventory Report* as well as its *National Communications* and *Biennial Reports*, and allows Canada to assess its progress in reducing emissions and combatting climate change. In addition to biennial reporting to the UNFCCC, in non-Biennial Report years Canada publishes supplementary analysis and projections of its GHG emissions in the context of its 2020 and 2030 emissions targets. Most recently, this information was published in 2021 as Canada's Greenhouse Gas and Air Pollutant Emission Projections.

7.3. Other Information

In recent years, Canada has also established a number of external expert advisory bodies to provide analysis and recommendations to the Government on climate change mitigation and related issues.

The Net-Zero Advisory Body (NZAB) was launched in February 2021 and formally established through the *Canadian Net-Zero Emissions Accountability Act*. With up to 15 members, the NZAB brings together a range of experience and knowledge from across the country and provides independent advice to the Minister through annual reports on how Canada can achieve net-zero emissions in 2050. The Minister must publicly respond to the advice in the NZAB's annual reports. The Net-Zero Advisory Body sets its own agenda and activities, with the Minister playing a limited role by publicly issuing terms of reference, recommending members, meeting regularly with its members, and referring matters for advice. In July 2021, the NZAB released its *Net-Zero Pathways: Initial Observations* report, which summarizes ten values and principles to guide the development of net-zero pathways. The NZAB provided advice in advance of Canada's *2030 Emissions Reduction Plan*, and moving forward, the NZAB will continue to undertake research and engage Canadian society in an effort to develop advice that will be provided in public annual reports to the Minister of Environment and Climate Change Canada.

The Canadian Climate Institute is an independent not-for-profit focused on clean growth and climate change. The Institute represents more than 15 diverse and reputable organizations across Canada and works to generate, communicate, and mobilize trusted information, research, advice, and best practices to Canadians, governments, and stakeholders. The Institute is supported by highly credible and inclusive research, analysis, and engagement with leaders, experts, and practitioners from across Canada. Launched in January 2020, this Institute will help fulfil Canada's commitment under the Pan-Canadian Framework to engage external experts to assess the effectiveness of its measures and identify best practices.

References

1 The most recent report is entitled *National Inventory Report 1990-2020: Greenhouse Gas Sources and Sinks in Canada,* and is available online at: https://unfccc.int/documents/461919.

2 Tables in Annex 10 of Canada's NIR show the distribution of national emissions into the Canadian economic sectors for years 1990 to 2020 and the relationship between economic and IPCC sectors.

3 For full details on the accounting mechanism, see: Government of Quebec and California Air Resources Board. 2022. Accounting Mechanism for Article 8 of the Linkage Agreement. Available online at: https://www.environnement.gouv.qc.ca/changements/carbone/methode-comptabilisation-echanges-ges-en.pdf.

4 For further information on mitigation actions and their effects, please see Chapter 4: Policies and Measures of Canada's 8th National Communication.

5 Tabular information on finance, technology, and capacity building required by the BR guidelines can be found in Canada's BR CTF submission, as well as in Chapter 7: Financial, Technology and Capacity Building Support of Canada's *8th National Communication.*

6 Canada plans its climate finance commitment by fiscal year (i.e., from April to March).

7 All amounts in Canadian dollars unless specified otherwise.

8 This funding includes bilateral and multilateral contributions. The other sources of public climate finance are not part of Canada's public climate finance commitment.

9 Project investments from Canada's facilities at MDBs are financed and reported in USD.

10 Canada tracks and reports on private finance mobilized in line with the principles and methodologies established by the Organisation for Economic Co-operation and Development (OECD) Working Party on Development Finance Statistics.

11 As technology transfer and capacity-building are often inextricably linked, many of the initiatives highlighted fit into both of these categories, as highlighted throughout Chapter 7 of the 8th National Communication.