

Sweden's Fifth Biennial Report under the UNFCCC



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Government Offices of Sweden
Ministry of the Environment

Preface

Climate change remains the greatest challenge of our times with immense consequences for societies, health, and security for people across the globe. We need to transition towards sustainable societies and circular economies. It is a challenging task, but Sweden also recognises the opportunities the transformation provides. New industries and business opportunities are developing in Sweden as part of the efforts to combat climate change.

The objective of the Paris agreement is clear, and governments are responsible for setting societies on a path to achieve it. Sweden is willing to lead the way and has long worked to achieve a transformation of all sectors towards a sustainable society. By 2045 at the latest Sweden is to have net zero emissions of greenhouse gases into the atmosphere, by 2030 emissions from domestic transport, excluding domestic aviation, shall be reduced by 70 % and emissions from sectors outside of the EU emissions trading scheme should be at least 63 % lower in 2030 and at least 75 % lower in 2040 as compared to 1990.

But our efforts and commitments does not stop at 2045. Beyond 2045 we must continue working until we reach all the way to zero emissions and combine it with carbon removal to minimise the negative impacts of climate change. Therefore, we are working towards both reducing emissions in the short term and creating the necessary conditions for a sustainable society.

Sweden is committed to achieving these ambitious goals and we are continuously working to achieve the necessary transformation of our society. We encourage all countries to do the same so that we can achieve the goals of the Paris agreement together.

In this eighth National Communication and the fifth Biennial Report to the United Nations Framework Convention on Climate Change (UNFCCC), a comprehensive summary of Sweden's efforts to combat climate change is provided. Emissions and removals of greenhouse gases are reported for each sector and adopted and planned policy measures and their impact on emissions are described. The report contains projections for emissions up to 2030 and 2040. According to these projections emissions will continue to decrease, but further reductions are needed in order to reach Sweden's climate goals.

The National Communication and also describes Sweden's vulnerability and efforts to adapt to climate change. Sweden's contributions to climate finance are presented, as are research and development. Finally, a description is provided of Sweden's work on education, training and public awareness regarding climate change.

The material on which the National Communication and the Biennial Report is based has been obtained through extensive activity and input from around ten government agencies, led by the Swedish Environmental Protection Agency.

Stockholm, 2023.

A handwritten signature in black ink, appearing to read 'Romina Pourmokhtari', is centered on the page. The signature is written in a cursive style with a horizontal line underneath.

Romina Pourmokhtari

Minister for Climate and Enterprise

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Information on GHG emissions and removals and trends, GHG inventory including information on national system

The information in this chapter is a summary of the 2021 inventory of emissions and removals of greenhouse gases for the years 1990 to 2020, submitted under the UN Framework Convention on Climate Change and the Kyoto Protocol (National Inventory Report Sweden 2022). The chapter also includes information on the national system for GHG inventory and policies, measures and projections.

1.1 Total emissions and removals of greenhouse gases

In 2020, greenhouse gas emissions (excluding LULUCF) in Sweden was 46.3 million tonnes of carbon dioxide equivalents (Mt CO₂-eq.), see Figure 1.1. Between 2019 and 2020 the total greenhouse gas emissions decreased by 9 %, largely due to the COVID-19-pandemic. Total emissions have decreased by 25.2 Mt, or 35 %, between 1990 and 2020. Emission levels have varied between a low of 46.3 Mt CO₂-eq. in 2020 and a high of 77.3 Mt CO₂-eq. in 1996. Annual variations are largely due to fluctuations in temperature, precipitation and to the economic situation. The net sink attributable to the land use, land-use change and forestry (LULUCF) sector has varied over the period. In 2020 it amounted to nearly 40 Mt CO₂-eq., which corresponds to 86 % of total greenhouse gas emissions.

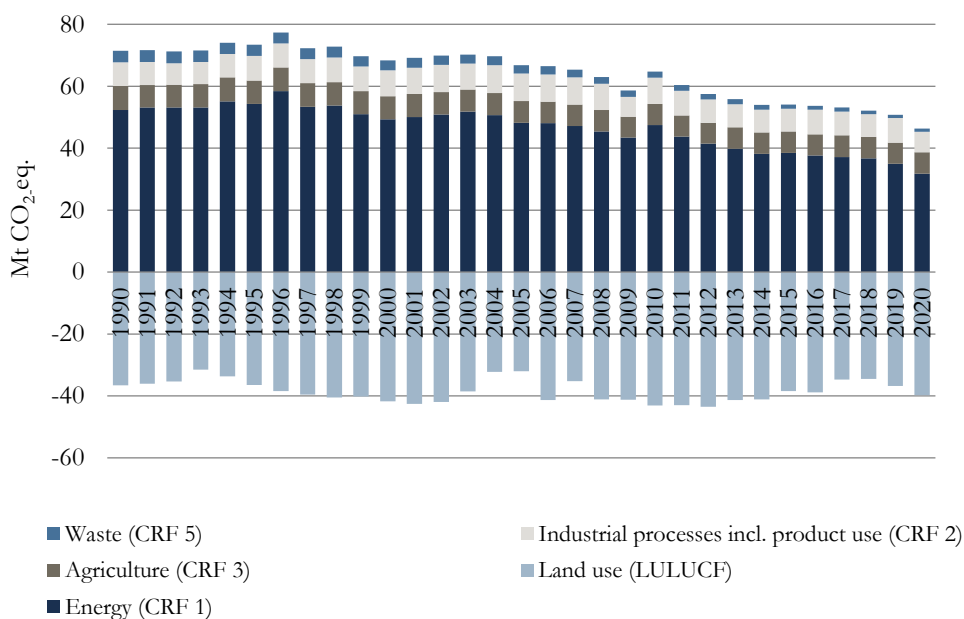


Figure 0.1 Total Greenhouse gas emissions 1990-2020 from different sectors

In 2020, emissions (excl. LULUCF) of carbon dioxide (CO₂) amounted to 36.5 Mt CO₂ in total, which is equivalent to 79 % of total greenhouse gas emissions, calculated as CO₂-eq. Emissions of methane (CH₄) accounted for 4.1 Mt of CO₂-eq. (about 9 % of total emissions), emissions of nitrous oxide (N₂O) 4.6 Mt (10 %), fluorinated greenhouse gases (HFCs, PFCs and SF₆) 1 Mt (2 %), see Figure 1.2. The shares of the different greenhouse gases have remained stable over the period 1990 to 2020.

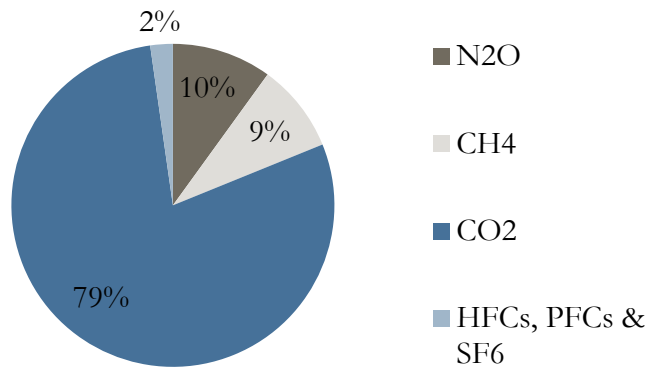


Figure 0.2 Greenhouse gas emissions in 2020 (excl. LULUCF) by gas, in carbon dioxide equivalent

1.2 Emissions and removals of greenhouse gases by sector

The largest sources of emissions in 2020 was the energy sector (69 %), agriculture (15 %) and industrial processes and product use (14 %), as shown in Figure 1.3.

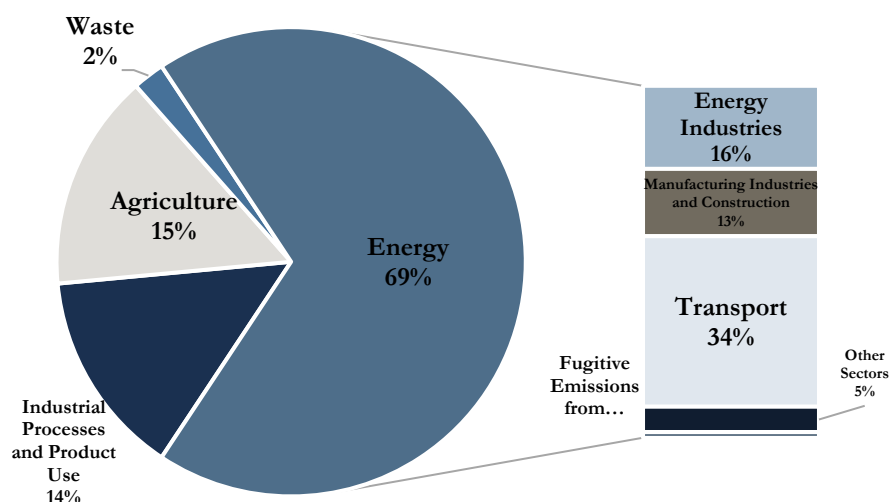
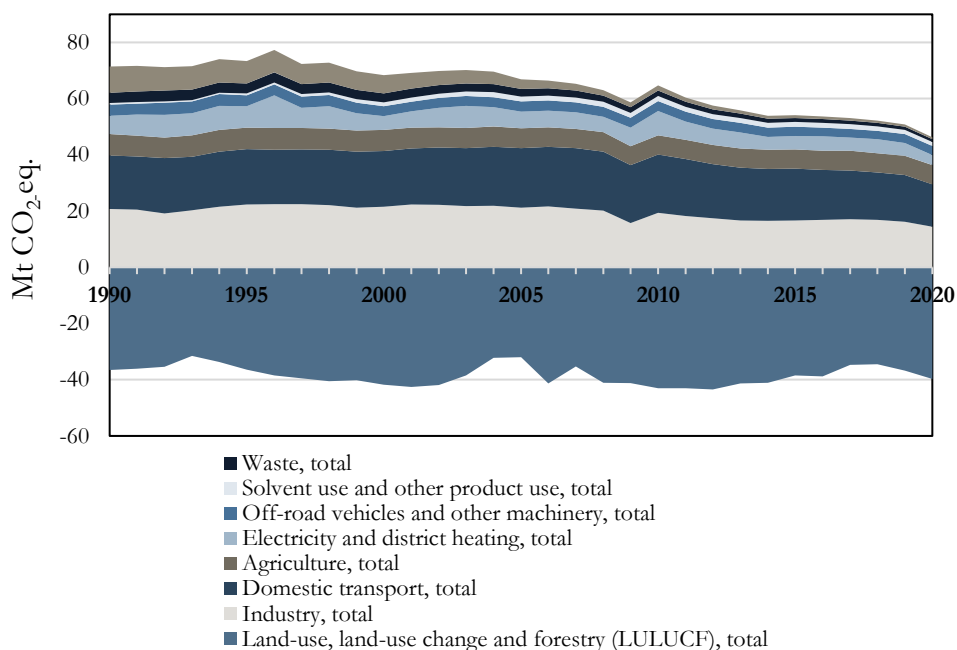


Figure 0.3 Greenhouse gas emissions in 2020 (excl. LULUCF), by sector

In recent years there has been a decreasing trend in greenhouse gas emissions. The largest reductions in absolute terms are due to a transition from oil-fuelled heating of homes and commercial and institutional premises to electricity, e.g. heat pumps and district heating. Increased use of biofuels in district heating generation and industry has also contributed to the reductions together with reductions in landfilling of waste. Fluctuations in production levels of manufacturing industries following changes in the economic development of specific industries have also had significant impacts on the national trend.

BOX 1. 1 The Swedish national sectorial breakdown

The Swedish greenhouse gas inventories are published using a national sectorial breakdown for the purpose of tracking progress with national targets and tracking the effect of implemented policies and measures. The sectorial breakdown is designed to allocate emissions and removals in line with the design of national policies and measures. The aggregation of all industrial emissions in one main sector that is subdivided by type of industry is the largest difference between the national sectorial breakdown and the IPCC sectors in the Common Reporting Format.



Emissions from **domestic transport** correspond to about one third of Sweden's total emissions (excluding LULUCF and international transport). The other main emission sources in Sweden are agriculture as well as electricity and district heating according to this breakdown. Emissions from domestic road transport respond to 32 % of Sweden's total emissions and have decreased by 21 % since 1990. Emissions from domestic transport, a sector dominated by road transport, increased after 1990 and reached a peak in 2007. Since then, emissions have been declining as a result of a transition to sustainable biofuels and more efficient vehicles. Emissions of greenhouse gases from domestic transport decreased by almost 10 % in 2020. The reduction in emissions is mainly due to reduced car traffic, which is largely a result of the COVID-19-pandemic.

Emissions from **industry** corresponds to 31 % of Sweden's total emissions and have decreased by 31 % since 1990, while changes in the economic development of different industries have resulted in annual variations. The emissions reductions are mainly related to decreased use of oil due to shifts towards biofuels, mainly in the pulp and paper industry. New processes in the chemical industry have also contributed to the decreasing trend. Shifting production levels in response to changing economic conditions in certain industries significantly impacts the trend as well. Since 2017, emissions from industry have decreased and particularly in 2020 as a consequence of the COVID-19-pandemic as the demand within the iron and steel industry was lower.

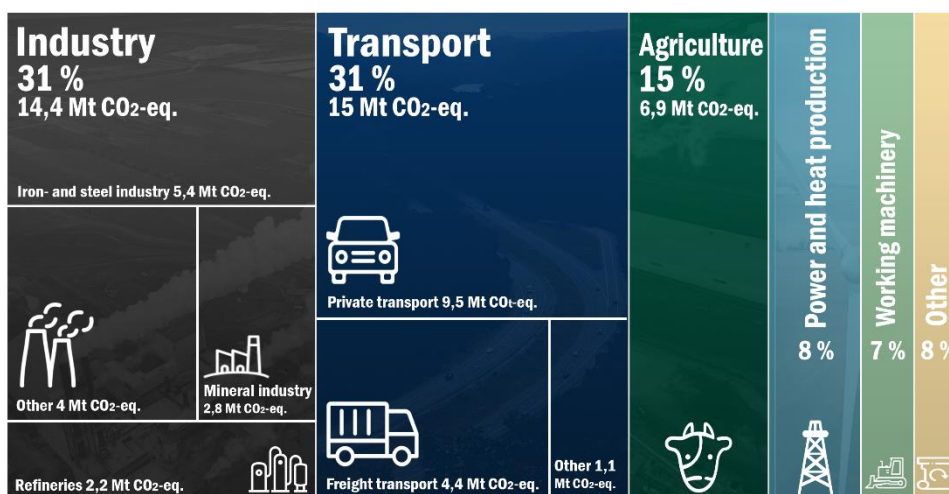
Greenhouse gas emissions from **agriculture** have been declining slowly and are now about 10 percent lower than in 1990. The decrease is mainly due to a reduced amount of animals and partly to a reduced use of mineral fertilizers. The number of dairy cows in Sweden has almost halved (47 %) since 1990. This has resulted in that methane emissions from dairy cows' feed digestion have decreased by about one third.

Approximately 50 % of the sector's emissions are related to the production of animal foods such as meat, dairy products and eggs.

Electricity and district heating show a trend of decreasing emissions despite the increased demand for district heating. The decrease in emissions is due to a shift towards combustion of more waste and biofuels, and less fossil fuels. Combustion of industry-derived gases is allocated to the industry.

Sweden's territorial GHG emissions 2020

46,3 million tonnes CO₂-equivalent



SOURCE: SWEDISH EPA

More information about the national breakdown including how different CRF-categories are allocated is available at:

- [Sweden's territorial greenhouse gas emission](#) (in Swedish).
- [Detailed data and reference to CRF-categories](#) (in English).

1.2.1 Energy industries

Energy industries are dominated by the electricity and heat production with by far the largest part of the emissions and also the only subsector where emissions fluctuate over the years. The fluctuations between different years are large, due to the weather conditions' influence on the electricity and heat production (CRF 1A1a). In 2020, there was a decrease in emissions from the energy industries by 8 % compared to 2019. Sweden's electricity and heat production is to a large extent composed by renewable energy and district heating is mainly based on biofuels and waste. Therefore, these emissions are 31 % lower than in 1990, even though the supply of district heating has increased with about 50 % in the same period.

Total emissions from energy industries (CRF 1A1) were 7.5 Mt CO₂-eq. in 2020 (Figure 1.4), which is 24 % lower than in 1990. Electricity and heat production (CRF 1A1a) account for the larger part of the emissions with 72 % (5.4 Mt CO₂-eq) in 2020. Emissions from Refineries (1A1b) and Manufacture of solid fuels (CRF 1A1c) amounted to 2.1 CO₂-eq in 2020.

Emissions from production of electricity and heat production totalled 5,4 Mt of CO₂-eq. in 2020. The emissions from electricity and heat production vary over time but have been reduced by 31 % between 1990 and 2020. There is a decrease in emissions in 2020 of 10 % compared 2019 due to decreased usage of fossil fuels and peat because of very warm weather, but also because of decisions by certain facilities to decrease the usage of fossil fuels or to not use certain fossil fuels at all.

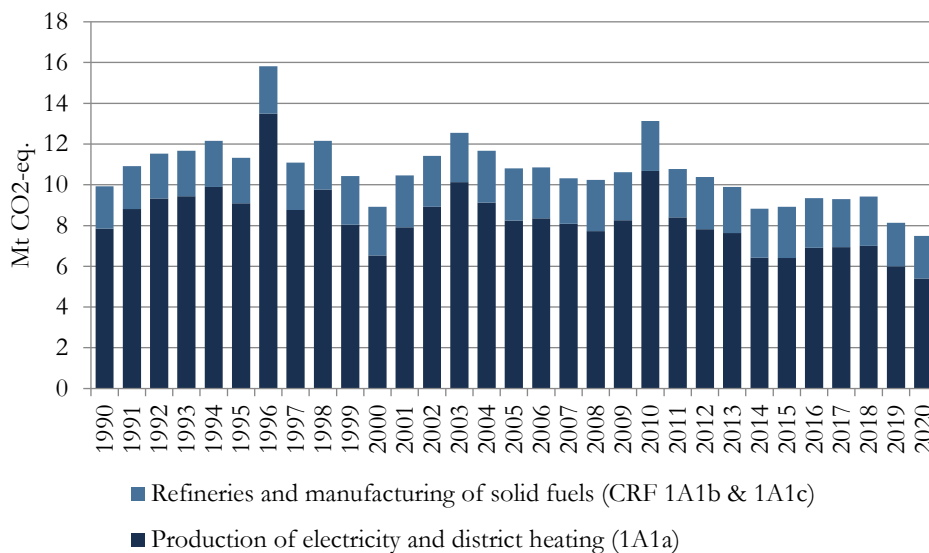


Figure 0.4 Greenhouse gas emissions 1990-2020 from the energy industries (CRF 1A1)

1.2.2 Residential and commercial/institutional

Greenhouse gas emissions from fuel combustion in the residential, commercial and institutional sectors were 79 % lower in 2020 compared to 1990 mainly due to a strong decrease in combustion of fossil fuels for heating in the residential and commercial/institutional sectors, see Figure 1.5. The emissions were approximately 2.3 Mt of CO₂-eq. in 2020. In comparison with 2019 the total emissions from the residential sector decreased by 3 %. Emissions from the commercial/institutional sector decreased with 8 % between 2019 and 2020. The emissions from agriculture,

forestry and fisheries (CRF 1A4c) were 1.2 Mt CO₂-eq. in 2020, which is 37 % less than in 1990.

Emissions are primarily due to stationary combustion in homes, non-residential premises or within agriculture, forestry and fisheries. Emissions also come from mobile machinery, off-road vehicles and fishing boats. Oil-fired furnaces have been replaced by district heating, and electricity, including the increased use of heat pumps. Since emissions from stationary combustion for heating purposes have decreased significantly, the main emissions within the sector now come from non-road mobile machinery.

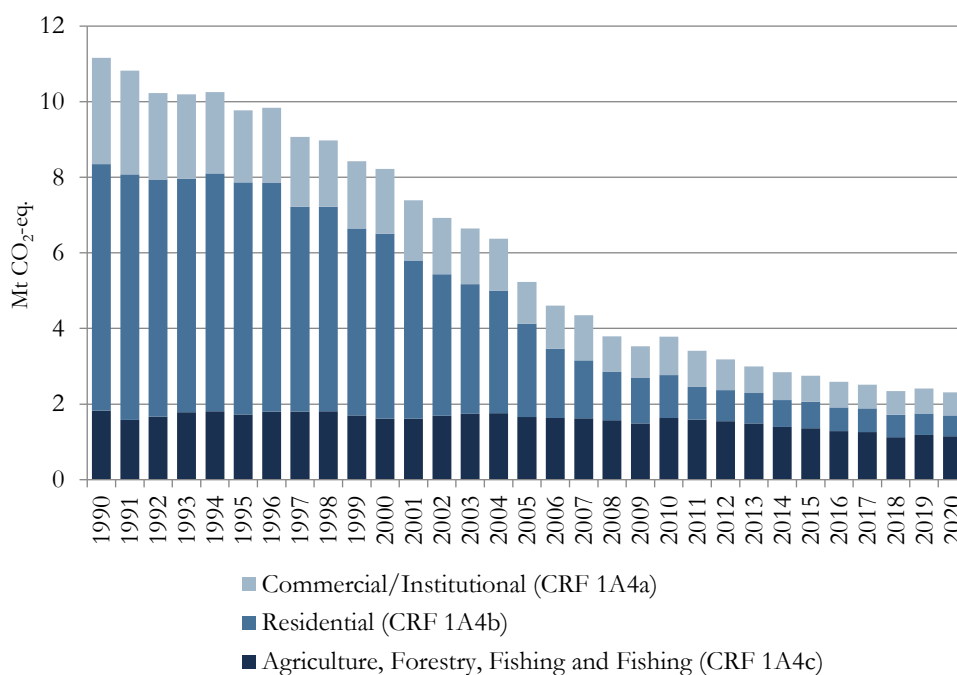


Figure 0.5 Greenhouse gas emissions 1990-2020 from combustion in the commercial and institutional, residential, and agriculture, forestry and fisheries sectors

1.2.3 Industrial combustion

To cover all industry-related emissions it is necessary to include process emissions and emissions from combustion and fugitive emissions. These are to be reported under separate CRF (Common Reporting Format) categories according to UNFCCC guidelines.

The mining, iron and steel as well as pulp and paper industries are examples of historically important industries for Sweden. Emissions from combustion in manufacturing industries and construction were 6.1 Mt CO₂-eq. in 2020 (Figure 1.6). Emissions in 2020 were 44 % lower than in 1990. Emissions in

2020 decreased by 12 % compared to 2019. Although increasing slightly up until 1997, the emissions have a steady decreasing trend until 2014. The lower emissions in 2009 and higher emissions in 2010 were due to the financial crisis impact on production levels and their subsequent recovery. The decreasing trend is primarily related to a lower use of oil. Oil has been replaced by electricity or biofuels, partly depending on the difference in relative prices between electricity and oil.

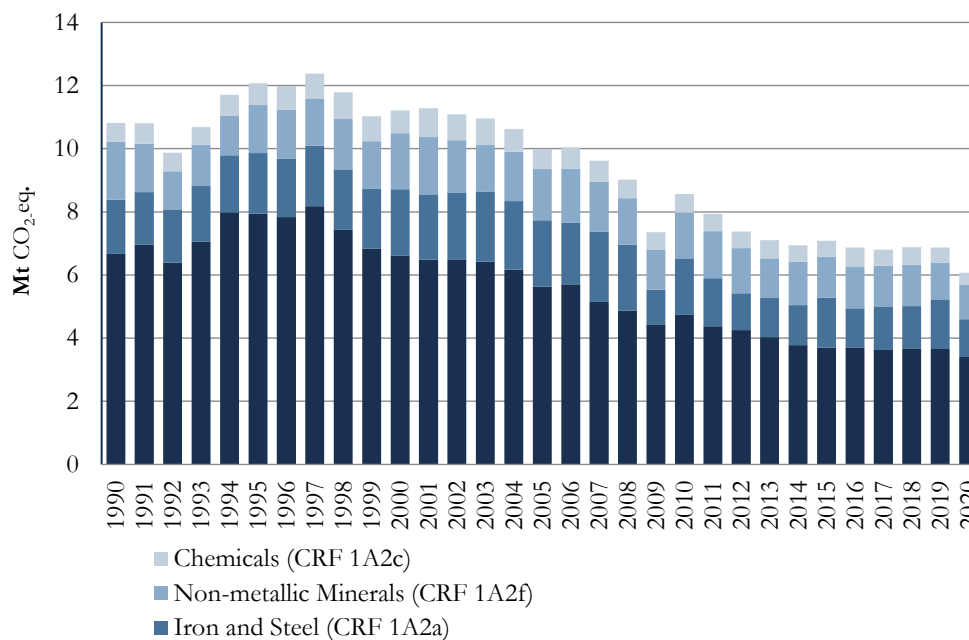


Figure 0.6 Greenhouse gas emissions 1990-2020 from industrial combustion

1.2.4 Fugitive emissions

Fugitive emissions occur for example in processing, storage and use of fuels, flaring of gas, transmission and distribution of gas. Emissions were around 0.49 Mt of CO₂-eq. in 2020, which is an decrease of 15 % compared to 2019, which already was at a low level compared to earlier years, see Figure 1.7. The decrease in emission during 2019 is mainly an effect of reduced production due to maintenance at two facilities. During 2020 demand from the sector has been low due to the covid-19-pandemic, and therefor production has also been low. The increase of fugitive emissions from oil (CRF 1B2a), observed in the time series from 2006, is related to the establishment of hydrogen production facilities at two oil refineries. In total, the emissions from CRF 1B are 38 % higher compared to 1990.

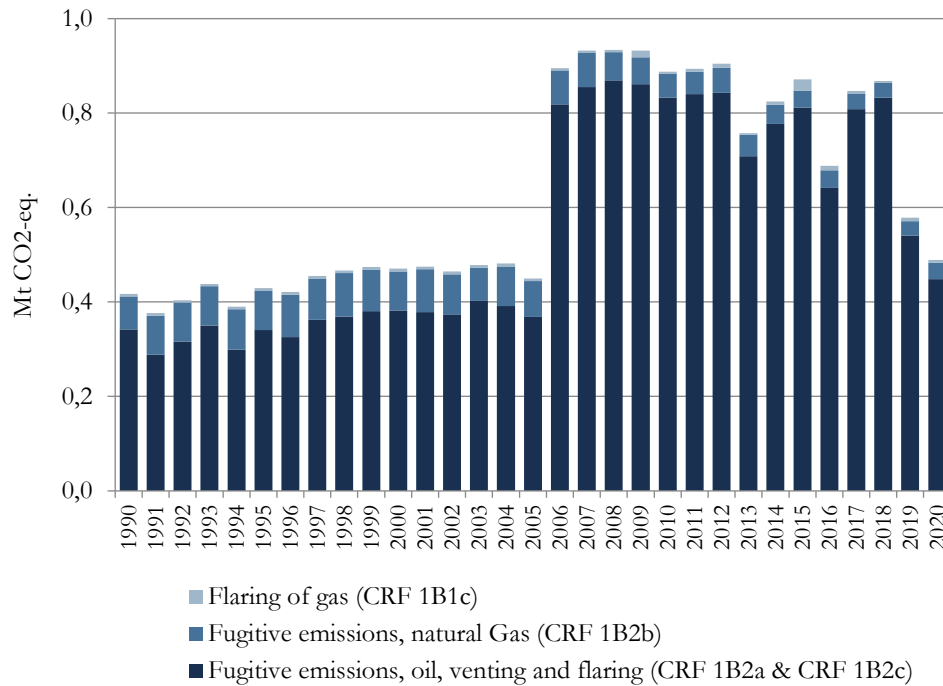


Figure 0.7 Fugitive emissions 1990-2020

1.2.5 Industrial processes including product use

Emissions from the industrial processes and products use sector represented 14 % of the total national emissions in 2020, The main sources of emissions in the industrial processes and product use sector is the production of iron and steel (included in metal industry; 2C) and the cement and lime industries (included in mineral industry; 2A), see Figure 1.8. Greenhouse gas emissions from the industrial processes and product use sector have decreased by 14 % 2020 compared to 1990. Emissions from the sector did however increase during the 90's and early 00's but peaked in 2004 and has since had an overall decreasing trend with some interannual variations, see Figure 1.8.

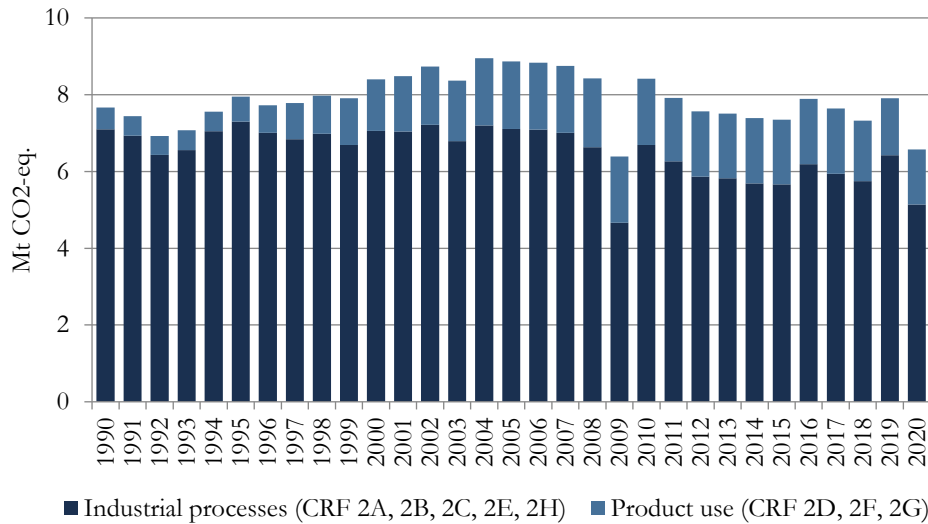


Figure 0.8 Greenhouse gas emissions 1990-2020 from the industrial processes and product use.

Greenhouse gas emissions from industrial processes (CRF 2A, 2B, 2C, 2E, 2H) have many interannual variations, but show an overall decreasing trend since 1995. Between 2019 and 2020 emissions decreased with 20 %, which led to a decrease in emissions from industrial processes by 26 % in 2020 compared to 1990, see Figure 1.8. Greenhouse gas emissions from product use (CRF 2D, 2F, 2G) showed an increasing trend that has stabilised since 2004, with a small decrease. Nevertheless, greenhouse gas emissions from product use were about three times higher in 2020 compared to 1990.

1.2.6 Transport

In 2020, emissions of greenhouse gases from domestic transport totalled 15.4 Mt CO₂-eq., equivalent to a third of the national total. The total emissions of greenhouse gas emissions were 23% lower in 2020 compared with 1990, see figure 1.9. The reduction in emissions in the sector during the period is primarily due to the fact that the proportion of biofuels used in road traffic has increased during the period, and that vehicles have become more energy efficient. However, the reduction in emissions has been dampened by an increase in traffic. Emissions from the transport sector decreased by 9 % between 2019 to 2020, which largely is a result of the reduced car traffic during the covid-19 pandemic.

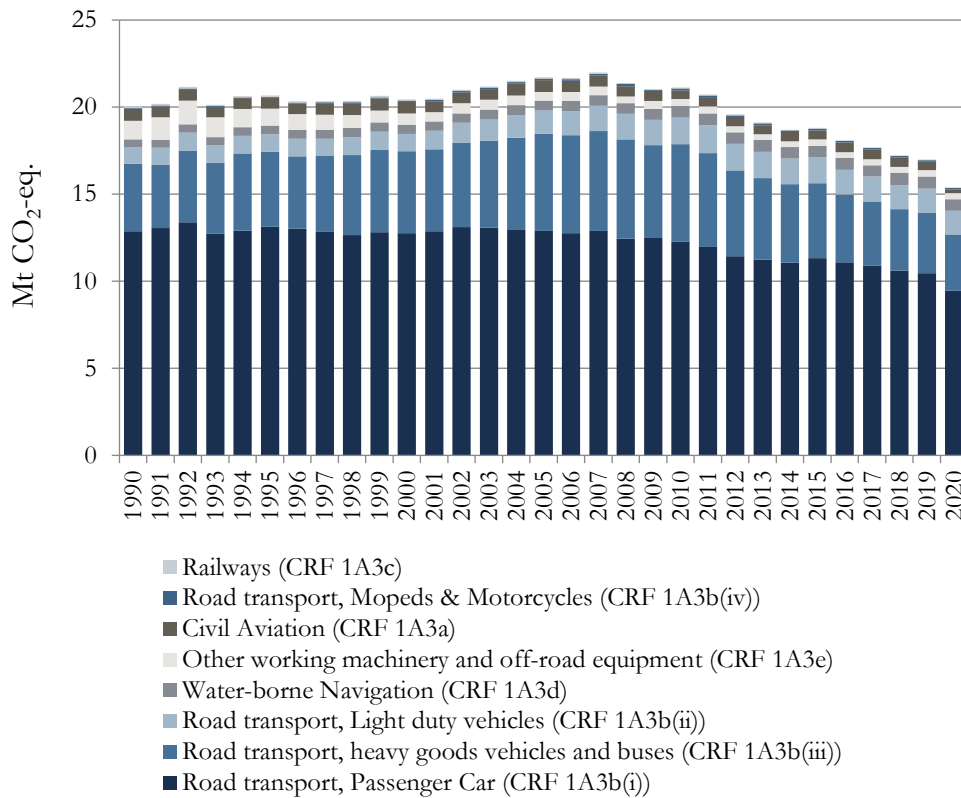


Figure 0.9 Greenhouse gas emissions 1990-2020 from domestic transport

In addition to emissions from road transport, emissions from transport include emissions from domestic civil aviation, railways, national navigation as well as non-road mobile machinery. In 2020, the greenhouse gas emissions from road transport were 14.3 Mt CO₂-eq., 0.2 Mt CO₂-eq. from domestic aviation, 0.3 Mt CO₂-eq. from domestic navigation, 0.02 Mt CO₂-eq. from railways, and 0.36 Mt CO₂-eq. from non-road mobile machinery.

1.2.7 Waste

Greenhouse gas emissions from the waste sector amounted to 1.02 Mt CO₂-eq. in 2020, or 2 % of the national total of greenhouse gas emissions. Emissions from the waste sector have decreased by about 73% compared to 1990. From 2019 to 2020, emissions have been reduced by 6 % due to continued reduced emissions from landfills. Emissions from waste (CRF 5) include emissions from solid waste disposal (CRF 5A), wastewater treatment and discharge (CRF 5D), biological treatment of solid waste (CRF 5B) and incineration and open burning of waste (CRF 5C). The shares of the sub sectors of the total emissions of the sector are shown in Figure 3.10.

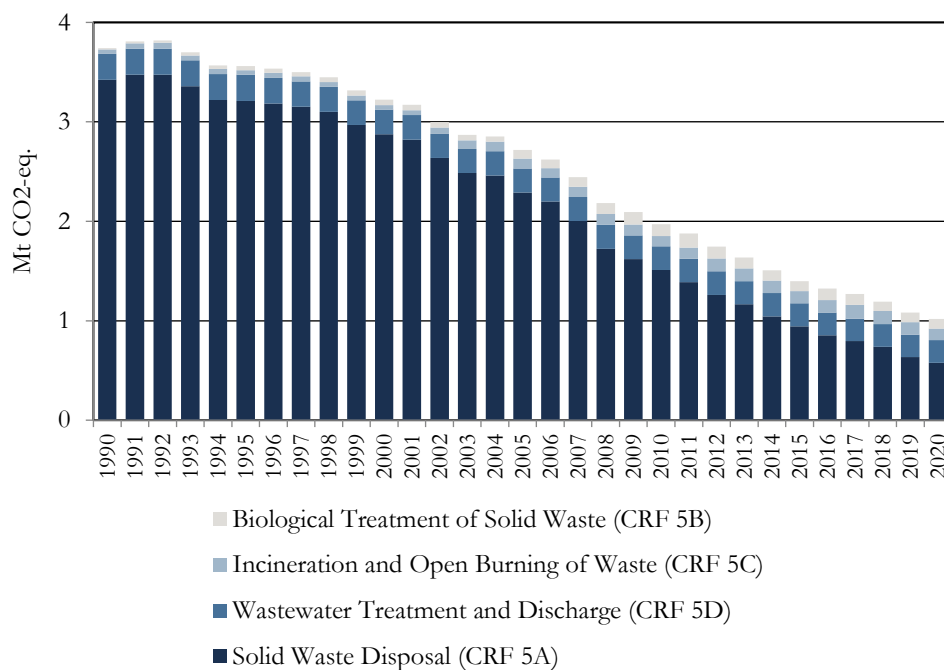


Figure 0.10 Greenhouse gas emissions 1990-2020 from the waste sector, per subsector

Emissions from the waste sector are dominated by methane gas from waste landfills. Methane emissions account for 58 % of emissions, while nitrous oxide emissions from wastewater treatment and biological treatment of solid waste account for 22 % and carbon dioxide emissions from waste incineration account for the rest. A ban has been introduced on landfill which has created a shift towards incineration of waste for energy recovery. Emissions from the incineration of waste for electricity and heat production are allocated to the energy sector and not to the waste sector.

1.2.8 Agriculture

The total greenhouse gas emissions from Agriculture (CRF 3) amounted to about 6.9 Mt CO₂-eq in 2020., which equals to about 15 % of the *total national* greenhouse gas *emissions*. Emissions in 2020 were about 10 % lower compared with 1990 levels. The historical emission reduction was due to decline in numbers of livestock, especially dairy cattle as well as decreased emissions from agriculture soils, particularly from the use of mineral fertilizers.

In 2020, agriculture soils (3D) and enteric fermentation (3A) were the dominant sources of the greenhouse gas emission in the sector, accounted for about 47.3 % and 42.4 %, respectively. Manure management (3B) and

liming (3G) accounted for about 8,6 % and 1.8 % of the sector's emission, respectively. Emission from urea application (3H) is insignificant (Figure 1.11).

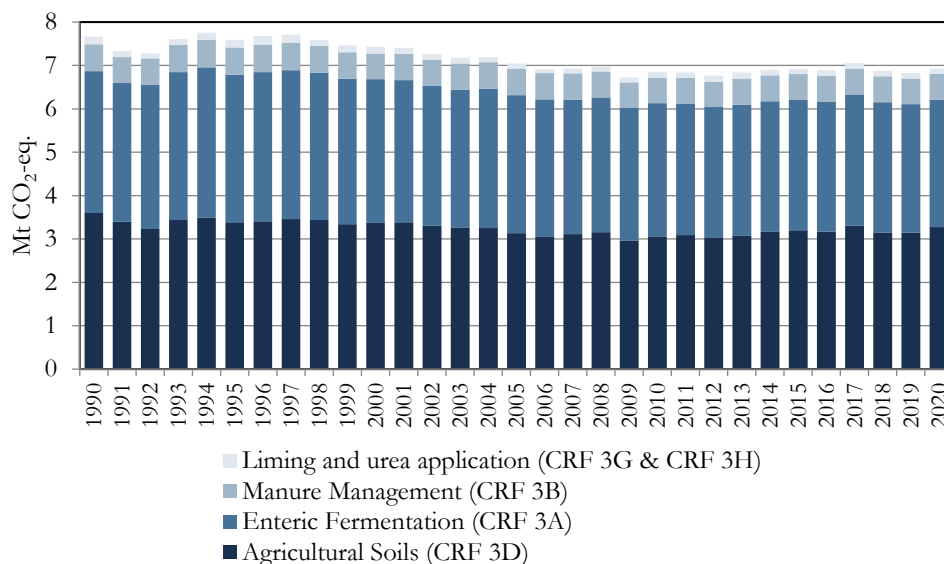


Figure 0.11 Greenhouse gas emissions 1990-2020 from agriculture

Greenhouse gas emissions related to agriculture originate from a range of sources and activities and are dominated by emissions from soil management, enteric fermentation, and manure management. In addition, there are emissions related to the energy use within the sector but reported in the energy sector. The main sources of CH₄ and N₂O emission in Sweden are animal husbandry and crop production. Emission from animal husbandry in Sweden is dominated by beef and dairy cattle but also has significant swine, sheep, and poultry components. Other livestock farming species includes goats, horses, reindeer, and fur-bearing animals. Crop farming includes predominantly the production of cereals, sugar beet and oilseeds.

1.2.9 Land use, Land use change and Forestry

The LULUCF sector has generated annual net removals in Sweden during the whole period 1990-2020 (Figure 1.12). In 2020 total net removal from the sector was estimated to 40 Mt CO₂-eq. During the period total net removals have varied between around 32 to 43 Mt of CO₂-eq. Between 2019 and 2020 the total net removals increased about 8 %.

The total size and variation of net removals in the LULUCF-sector is mainly affected by the carbon stock change in forest land, and changes in the carbon pool living biomass constitute the major part of these changes in net removals followed by carbon stock changes in mineral soils and dead organic matter. Net removals in this sector are heavily influenced by harvests and natural disturbances such as storms, drought and fires on forest land.

The majority of the net removals are in the carbon pools living biomass and mineral soils and the dominating category is forest land. Forest land accounts for 63% of Sweden's land area. Within forest land, the total net removal has varied during the period from 1990 to 2020 and has been on averaged 38 million tonnes CO₂-equivalents. The lowest net removal in living biomass in forest land was 28 Mt of CO₂-eq in 2005 and the highest about 44 Mt of CO₂-eq. in 2012. Between 2019 and 2020 the total net removal on forest land increased slightly.

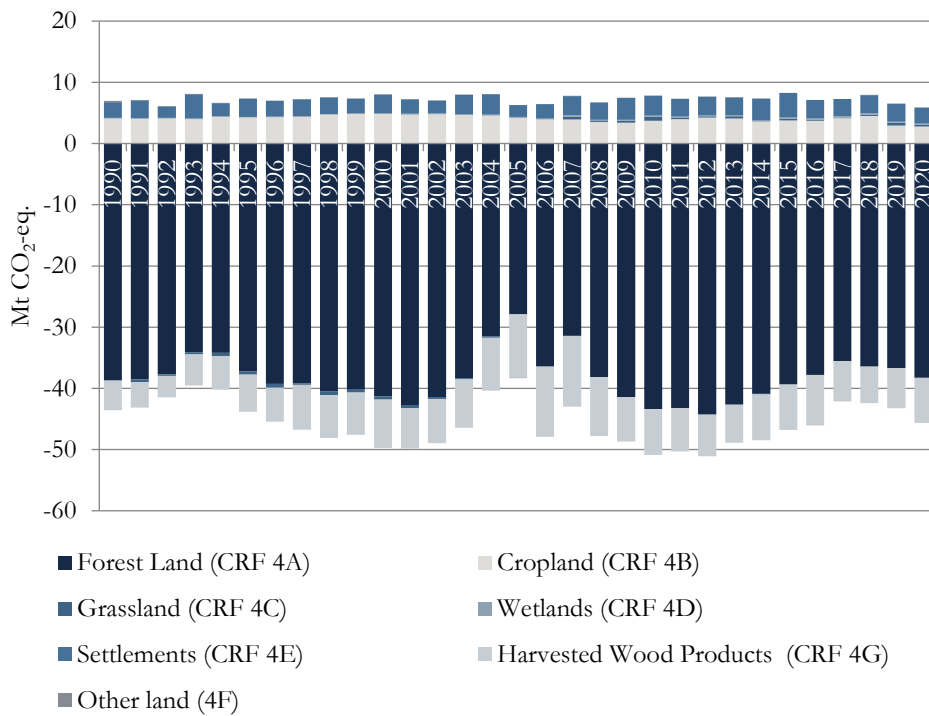


Figure 0.12 Greenhouse gas emissions 1990-2020 and removals from land use

The lowest net removal in living biomass in forest land was 28 Mt of CO₂-eq in 2005 and the highest about 44 Mt of CO₂-eq. in 2012. Between 2019 and 2020 the total net removal on forest land increased slightly. There are two dips in the trend, in 2005 and 2007, because of two severe storms.

According to the Swedish National Board of Forestry, the felling, including wood felled by storms, was estimated at 122 Mm³sk in 2005. However, the decrease in the living biomass in 2005, resulted in an increase in the HWP-pool in 2006. The HWP-pool increased slightly from 6,5 Mt of CO₂-eq in 2019 to 7,3 Mt of CO₂-eq in 2020. The increase was mainly in the pulp and paper fraction caused by a higher demand.

1.2.10 International transport

Greenhouse gas emissions from international shipping and aviation, also known as international bunkers, are considerably larger than those from domestic shipping and aviation. In 2020, they amounted to 9.3 Mt of CO₂-eq, which is a decrease of 4 % since 2019 (Figure 1.13). The overall decrease in emissions from international bunkers is a result of the reduced air traffic during the covid-19-pandemic. On the contrary, greenhouse gas emissions from international shipping increased during 2020.

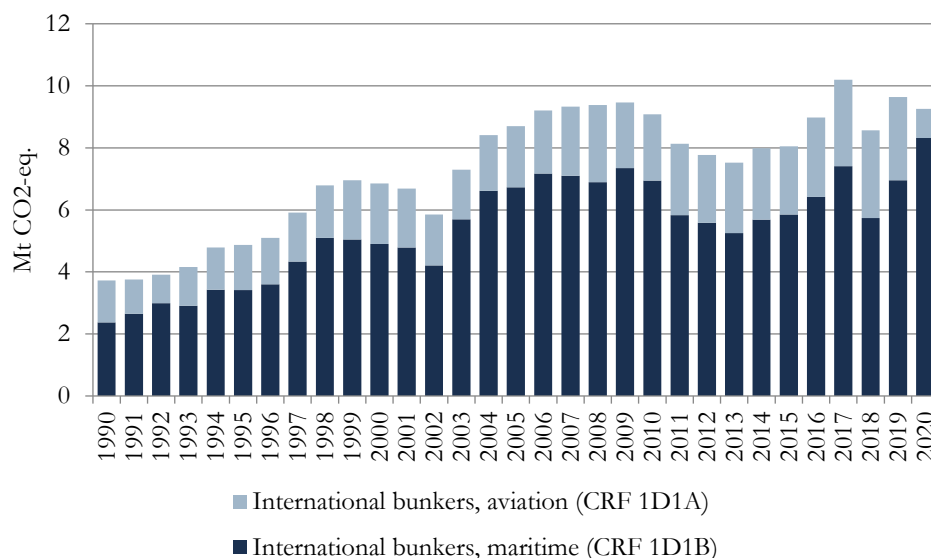


Figure 0.13 Greenhouse gas emissions 1990-2020 from international bunkers.

Emissions from international shipping reached a total of 8.3 Mt of CO₂-eq. in 2020. This is an increase of 20 % compared with 2019 and 251 % higher than in 1990. Greenhouse gas emissions from international aviation bunkers were 0.9 Mt of CO₂-eq. in 2020. This is a decrease of 65 % compared to 2019 and 30 % lower than in 1990. The large reduction in emissions from international aviation during 2020 is a result of the covid-19-pandemic. During the years before the pandemic, emissions were twice as high as in 1990. Emissions from international bunkering of aviation have varied over

time, but the trend points to a rise in these emissions, owing to growth in travel abroad.

The national system for the GHG inventory and for policies and measures and projections

In accordance with the Kyoto Protocol, as well as the associated Decision 24/CP.19, as well as EU Monitoring Mechanism Regulation (EU/No/525/2013), Sweden has established a national system for greenhouse gas inventory. The Swedish national system for policies and measures and projections aims to ensure that the policies, and measures and projections to the Secretariat of the Convention (UNFCCC), the Kyoto Protocol and the European Commission are reported in compliance with specified requirements.

The Swedish national system for GHG inventory came into force on 1 January 2006, and a national system for policies and measures and projections was set up in 2015. In relation to legal arrangements, the information is the same for the two systems.

On 29 December 2014, the Ordinance on Climate Reporting (SFS 2014:1434) came into force in Sweden. The ordinance describes the roles and responsibilities of government agencies in the context of climate reporting and concerns both the GHG inventory and the reporting of policies, measures and projections. This led to several changes in Swedish reporting such as enlarging the national system, adding other agencies, as well as adding responsibilities for agencies already included. The ordinance requires that sufficient capacity be available for timely reporting.

1.3 The national system for preparing the Swedish GHG inventory

The Swedish national system for GHG inventory was established in 2006 in accordance with 19/CMP.1, 20/CP.7 and decision 280/2004/EC. In 2013, EU decision No 280/2004/EC was replaced by the Monitoring Mechanism Regulation 525/2013/EC. The Monitoring Mechanism Regulation has the same demands for national systems as the Monitoring Mechanism decision. The aim is to ensure that climate reporting to the secretariat of the Convention (UNFCCC), the Kyoto Protocol, and the European Commission complies with specified requirements. The national system for GHG inventory is described in detail every year in Sweden's annual National Inventory Report, submitted to the UNFCCC Secretariat. The KP reporting

of LULUCF uses the same institutional arrangements, national system and corresponding QA/QC procedures as for the UNFCCC reporting.

1.3.1 Legal arrangements

The legal basis for Sweden's national system is provided by the Ordinance on Climate Reporting (2014:1434), which describes the roles and responsibilities of the relevant government agencies in this area. The ordinance ensures that sufficient capacity is available for reporting. The previous ordinance concerning climate reporting (2005:626) was updated and expanded to fulfil the reporting requirements under the second commitment period under the Kyoto Protocol and the EU Monitoring Mechanism Regulation 525/2013/EC. It also includes other improvements needed on the national level. The new ordinance came into force in December 2014, superseding the previous ordinance.

Supplemental to the new ordinance, formal agreements between the Swedish Environmental Protection Agency and other national agencies have been signed, listing in detail what is required regarding content and timetable from each responsible agency. Sweden also has legislation indirectly supporting climate reporting efforts by providing a basis for estimating greenhouse gas emissions and removals.

Environmental reports are submitted under the Environmental Code (SFS 1998:808), and the Official Statistics Act (SFS 2001:99) imposes an obligation for large industries to submit annual data. In addition, government agencies in Sweden must comply by the Information and Secrecy Act (SFS 2009:400).

The General Statistics Act (SFS 2001: 99) and the associated Ordinance (2001:100) Concerning Official Statistics impose an obligation on companies and other organizations to submit annual data. The data then serve as a basis for estimating greenhouse gas emissions and removals in several sectors.

According to Directive 2003/87/EC and national Act (2004:1199) on emission trading, emission data for plants included in the emission trading system should be reported annually. These data are used as a supplementary source within this greenhouse gas inventory.

1.3.2 Institutional arrangements

Preparing the annual inventory and other reports is done in collaboration between the Ministry of the Environment, the Swedish Environmental Protection Agency and other government agencies and consultants. Sections 13-27 of the Ordinance on Climate Reporting (2014:1434) describe the tasks of the government agencies in the context of the yearly inventory and reporting activity. The illustration in Figure A3.1 and the associated text below describe in broad terms which organizations are involved in the work of compiling documentation for the yearly inventory report and for other reporting to the European Commission and the UNFCCC.

Depending on the role of the government agencies in climate-reporting activity, this responsibility may range for example from supplying data and producing emission factors/calorific values to carrying out calculations to estimate emissions. Agencies that have a responsibility to participate in the national peer review are indicated in bold text in Figure A3.1 In addition to what is described in the Ordinance, the Swedish Environmental Protection Agency (Swedish EPA) engages the SMED¹ consortium as consultants to conduct the greenhouse gas inventory.

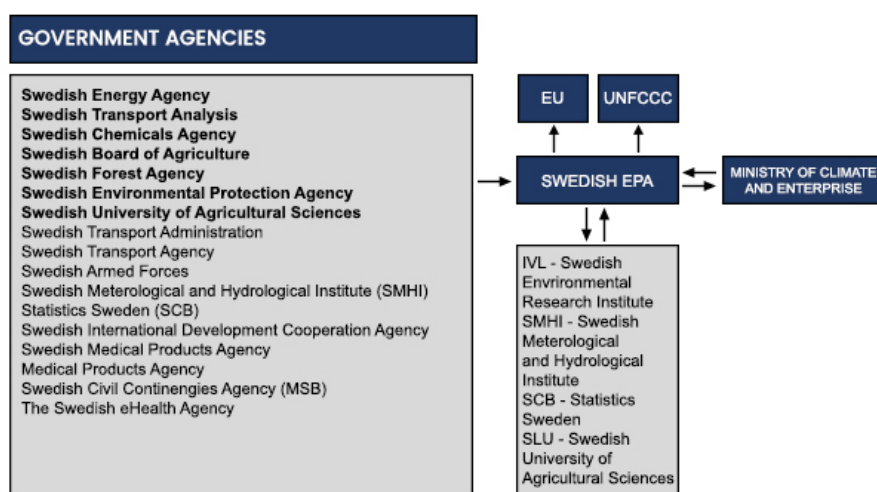


Figure 0.14 The Swedish national system for GHG inventory

To be able to report according to decision 24/CP.19 and IPCC methodology guidelines from 2006 and in accordance with 525/2013/EC the national

¹ SMED = Svenska MiljöEmissionsData (Swedish Environmental Emissions Data), a consortium comprising Statistics Sweden (SCB), the Swedish Meteorological and Hydrological Institute (SMHI), IVL Swedish Environmental Research Institute and the Swedish University of Agricultural Sciences (SLU).

system has been enlarged by three governmental agencies; the Medical Products Agency, the Swedish Civil Contingencies Agency and the Geological Survey of Sweden.

1.3.3 Contact details or organisation responsible

The Swedish Ministry of the Environment and Energy is the single national entity and has overall responsibility for the inventory.

Postal address SE 103 33 Stockholm, Sweden
telephone +46 8 405 10 00

UNFCCC focal point:

Mr. Mattias Frumerie

M.climate@regeringskansliet.se

1.3.4 Inventory planning, preparation and management

The Swedish greenhouse gas inventory is compiled in accordance with the reporting guidelines drawn up by the Intergovernmental Panel on Climate Change (IPCC), KP and the UNFCCC. The national system is designed to ensure the quality of the inventory, i.e. to ensure its transparency, consistency, comparability, completeness and accuracy. The Swedish quality system is based on the structure described in UNFCCC decision 20/CP.7 and applies a PDCA (plan–do–check–act) approach. This is an adopted model for how systematic quality and environmental management activity is to be undertaken according to international standards to ensure that quality is maintained and developed.

Planning and development

In any given year, priorities are set since recommendations received from international and national reviews, the results of key category analysis, uncertainty analysis, ideas for improvements from the Swedish EPA and SMED consultants, and new requirements arising from international decisions, amongst others.

Based on these criteria, the Swedish EPA commissions development projects, which are undertaken by SMED consultants. On completion of these projects, the results are implemented in the inventory.

Preparation

Government agencies supply activity data to the Swedish EPA and SMED, which also gather activity data from companies and sectoral organisations, and from environmental reports. Emission factors may be plant-specific, developed at a national level, or IPCC default factors. Methods used to estimate emissions comply with current requirements and guidelines.

Quality control and quality assurance

All data are subjected to general inventory quality control (Tier 1), as described in the IPCC Good Practice Guidance (2000), Table 8.1. Certain sources also undergo additional checks (Tier 2). All quality control is documented by SMED in checklists. Data are also validated using the checks built into the CRF Reporter tool.

Quality assurance is carried out in the form of a national peer review by government agencies, as provided in the Ordinance on Climate Reporting (2014:1434). This national review covers choice of methods, emission factors and activity data and is a guarantee of politically independent figures. The reviewers also identify potential areas for improvement in future reporting. Their findings are documented in review reports. The timetables for quality assurance are included in the agreements between the government agencies and the Swedish EPA. The government authorities conducting the national review are marked in bold in Figure 1.19. From the 2016 submission, quality assurance is conducted in two steps, with an annual quality control and verification of the trends, national statistics used and changes in methods, if any. Every year there is also an in-depth review of one sector. In addition, reporting is reviewed annually by the EU and UNFCCC.

An in-depth review of each sector will take place every five years as long as there are no specific recommendations from the EU or UNFCCC reviews, there were no changes in methodology, or the first-step review did not signal any problems. Sweden has also initiated meetings with experts from Denmark, Finland and Norway where GHG inventory compilers discuss problems, the need for revised methods and other relevant matters.

Finalisation, publication and submission

The results are published nationally by the Swedish Environmental Protection Agency in late November or early December each year. The Swedish EPA delivers the greenhouse gas inventory to the Ministry of

Environment five working days before the preliminary reporting to European Commission (January 15th).

The Swedish EPA, on behalf of the Ministry of Environment, submits the inventory to the European Commission on January and March 15th and to the UNFCCC on April 15th. Reported data in the submission of year t relates to the series of emissions years from 1990 up to and including year $t-2$, in other words emissions which took place during 2019 are reported in early 2021.

Follow up improvements

Each year, all comments received from national and international reviews that are not already addressed and also ideas from SMED and the Swedish EPA are compiled into a list for suggestions on improvements. From this list, development projects are formed each year. All suggestions not implemented one year is kept on the list for next year. In addition, improvements related to transparency of the NIR are continuously addressed in response to questions raised by national experts during the national peer review, and in response to previous ERT recommendations.

1.3.5 Information on changes in the national system for GHG inventory

There have been no changes in the Swedish national system since the previous Biennial Report.

1.4 The national system for policies and measures and projections

According to Article 12 of Regulation (EU) No 525/2013 of the European Parliament and the Council on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change, every member state needs to have a national system for policies and measures and projections. The Swedish national system for policies and measures and projections was established in 2015. Its aim is to ensure that policies and measures and projections are reported in compliance with specified requirements to the Secretariat of the Convention (UNFCCC), the Kyoto Protocol (19/CMP.1) and the European Commission.

1.4.1 Legal arrangements

The legal basis for Sweden's national system for policies and measures and projections is the same as for the annual greenhouse gas inventory and is

provided by the Ordinance on Climate Reporting (SFS 2014:1434). See more information on the Ordinance under section 1.2.1.1. The Ordinance includes all reporting according to EU/No 525/2013/EC on a mechanism for monitoring and reporting greenhouse gas.

Accompanying the Ordinance on Climate Reporting, formal agreements between the Swedish EPA and the agencies concerned have been established, specifying in detail the content and timeframe for each agency for providing information on policies and measures and projections.

1.4.2 Institutional arrangements

To prepare the reporting on policies and measures and projections, cooperation takes place between the Ministry of the Environment, the Swedish EPA and other government agencies, see Figure A3.2).



Figure 0.15 Government agencies included in the Swedish national system for reporting on policies, measures and projections.

The Ministry of the Environment is responsible for the national system and for ensuring that Sweden meets international reporting requirements in the area of climate change.

The Swedish EPA is responsible for producing the reports for the required reporting. The agency is thus responsible for coordinating Sweden’s national system and for maintaining the necessary reporting system.

The other government agencies are responsible for providing the data and documentation necessary for reporting. In some cases, the agencies are responsible for peer review of different sectors.

The same contract with consultants (SMED²) as for the GHG inventory is used in the institutional process of policies and measures and projections.

1.4.3 Contact details or organisation responsible

The contact details are the same as for Sweden's national system for the GHG inventory (section 9.1.3).

1.4.4 Inventory planning, preparation and management

The national system is designed to ensure the quality of the reporting on policies and measures and projections, i.e. to ensure its transparency, consistency, comparability, completeness, accuracy and timeliness. The process for reporting applies a plan-do-check-act approach.

Planning and development

The national system is designed to ensure the quality of the reporting on policies and measures and projections, i.e. to ensure its transparency, consistency, comparability, completeness, accuracy and timeliness. The process for reporting applies a plan-do-check-act approach.

The report on policies and measures and projections is planned in due time before reporting. The report is compiled and includes quality control activities.

Work on the report on projections starts one year ahead of submission and includes planning and defining assumptions and sensitivity analysis.

Underlying projections on activity data are provided by several government agencies. The projections on emissions are then produced and compiled by the Swedish EPA.

Work on the policies and measures (PaMs) report starts one year before submission and includes planning activities. The information on policies and

² SMED = Svenska MiljöEmissionsData (Swedish Environmental Emissions Data), a consortium comprising Statistics Sweden (SCB), the Swedish Meteorological and Hydrological Institute (SMHI), IVL Swedish Environmental Research Institute and the Swedish University of Agricultural Sciences (SLU).

measures is gathered by the Swedish EPA. Government agencies, in accordance with the Ordinance, then perform quality assurance activities.

Preparation

The relevant assumptions, methodologies and models for producing the report on policies and measures and projections, are selected when planning the report. The work is based on established methods and models that have been used for many years and assessed to be the most relevant and suitable. The methodologies and models are continuously assessed and improved. Assumptions are made based on available data and on expert knowledge. Several government agencies are responsible for providing data according to the Ordinance and agreements. The Swedish EPA collects the additional data needed for reporting on policies, measures and projections and produces the reports.

Quality control and quality assurance

To ensure timeliness, transparency, accuracy, consistency, comparability and completeness, quality control activities are performed in parallel with work on projections and compilation of the information on policies and measures. Quality assurance activities are then performed according to the Ordinance before the report is finalised and submitted.

The timetables for quality assurance are included in the agreements between the government agencies and the Swedish EPA.

All data are subjected to general quality control activities throughout the process before submission. Quality assurance is carried out in the form of a national peer review by relevant government agencies, as provided in the Ordinance. The national review covers transparency, completeness, consistency, accuracy and comparability.

Finalisation and submission

After quality assurance activities and, if necessary, adjustments of the report, the Swedish EPA submits the reports to the EU on 15 March biennially.

Follow-up and improvements

The review identifies potential areas for improvement in future reporting. The findings are documented in the review report. For projections, sensitivity analysis are performed by applying a range of lower and higher estimates to the key assumptions.

1.4.5 Information on changes in the national system

There have been no changes in the Swedish national system since the previous Biennial Report.

1.5 References

National Inventory Report Sweden 2022, Greenhouse gas emission Inventory 1990 – 2020, Submitted under UNFCCC and the Kyoto Protocol.



2. Quantified economy-wide emission reduction target

This chapter explains the pledge of the EU and its Member States under the Climate Change Convention, the achievement of the EU pledge and the Swedish national targets for 2020, 2030, 2040 and 2045.

2.1 The EU target under the Convention

Under the UNFCCC, the EU and its Member States committed to achieving a joint quantified economy-wide greenhouse gas emission reduction target of 20 per cent below the 1990 level by 2020 (“the Cancun pledge”). It is therefore a joint pledge with no separate individual targets for Member States under the Convention. The UK remains part of the joint EU 2020 target together with the 27 EU Member States.

2.1.1 The EU target compliance architecture

The EU has jointly committed to its UNFCCC target and implemented it internally through EU legislation in the 2020 EU Climate and Energy Package. In this package, the EU introduced a clear approach to achieving the 20 % reduction in total GHG emissions from 1990 levels, by dividing the effort between the sectors covered by the EU Emissions Trading System (EU ETS) and the sectors under the Effort Sharing Decision (ESD). Binding national targets were set for Member States under the Effort Sharing Decision. More details are described below in chapter 2.2. The achievement of EU internal compliance under the 2020 Climate and Energy Package including the national targets under the ESD is not subject to the UNFCCC assessment of the EU’s joint commitment under the Convention.

2.1.2 Conclusion on achievement of joint 2020 target

The EU has substantially overachieved its reduction target under the Convention, which means that also its Member States and the UK have fulfilled their emission reduction obligations. As stated in the 2022 EU GHG inventory submission to the UNFCCC, total GHG emissions, excluding LULUCF and including international aviation, decreased by 34 % in the EU-27 + UK compared to the base year 1990 or 1.94 billion tons of CO₂-eq. More is to be read in the Fifth European Union Biennial Report.

2.2 The pledge of the European Union and its Members States under the Climate Change Convention

The EU submitted a pledge under the United Nations Framework Convention on Climate Change (UNFCCC) in 2010 to reduce GHG

emissions by 20 % compared with 1990 levels by 2020 (FCCC/CP/2010/7/Add.1). As this target under the Convention was submitted by the EU and its 28 Member States together (EU-28) and not by each Member State, there are no specified Convention targets for individual Member States. For this reason, Sweden, as part of the EU-28, takes on a quantified economy-wide emission reduction target jointly with all other Member States. See Table 2.1 below for key facts on the Convention target for the EU-28. In addition to the Convention target, the EU and its Member States have a commitment under the Kyoto protocol for the period 2013–2020. For the EU as a whole, the Kyoto commitment is the same as the Convention target except that it also includes LULUCF (excluding aviation emissions).

The definition of the Convention target for 2020 is documented in the revised note provided by the UNFCCC secretariat³. In addition, the EU provided additional information relating to its quantified economy-wide emission reduction target in a submission as part of clarifying the developed country Parties' targets in 2012⁴. In a workshop that also formed part of this clarification process, the EU gave a presentation of its target in May 2012⁵

Table 2.1 Key facts on the Convention of the EU-27, (including Sweden).

Parameters	Targets
Base year	1990
Target year	2020
Emission reduction target	-20 % in 2020 compared with 1990
Gases covered	CO ₂ , CH ₄ , N ₂ O, HFCs, PFCs, SF ₆
Global warming potential	AR4
Sectors covered	All IPCC sources and sectors, as measured by the full annual inventory, partly international aviation.
Land Use, Land-Use Change, and Forests (LULUCF)	Excluded

³ FCCC/SB/2011/INF.1/Rev.1 of 7, June 2011

⁴ The EU submission is documented in FCCC/AWGLCA/2012/MISC.1 from 24 April 2012 with the title "Additional information relating to the quantified economy-wide emission reduction targets contained in document FCCC/SB/2011/INF.1/Rev.1"

⁵ Presentation provided by Arthur Runge-Metzger on 'Clarification of developed country Parties' pledges' at UNFCCC workshop on clarification of the developed country Parties quantified economy-wide emission reduction targets and related assumptions and conditions (AWG-LCA 15) on 17 May 2012, available at: https://unfccc.int/files/bodies/awg-lca/application/pdf/02_eu.pdf.

Use of flexible mechanisms	Possible to certain extent under the EU Emissions Trading System (EU ETS) and the Effort Sharing Decision (ESD).
Others	Conditional offer to move to a 30 % reduction by 2020 compared with 1990 levels as part of a global and comprehensive agreement for the period beyond 2012, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities.

With the 2020 climate and energy package, the EU has set internal rules which underpin the implementation of the target under the Convention. The 2020 climate and energy package introduced a clear approach to achieving the 20 % reduction of total GHG emissions from 1990 levels, which is equivalent to a 14 % reduction compared with 2005 levels. This 14 % reduction objective is divided between two sub-targets, where two thirds (21 %) of the reduction effort was assigned to the EU Emission Trading System (ETS) (EU Directive No 2009/29) and one third (10 %) to sectors covered by the Effort Sharing Decision (ESD) (EU Decision No 406/2009).

Under the revised EU ETS Directive⁶ (EU Directive No 2009/29), one single EU ETS cap covers all EU Member States and the three participating non-EU Member States (Norway, Iceland and Liechtenstein), i.e. there are no further differentiated caps by country. For allowances allocated to the EU ETS sectors, annual caps have been set for the period from 2013 to 2020; these decrease by 1.74 % annually, starting from the average level of allowances issued by Member States for the second trading period (2008–2012). The ESD target was adjusted in 2013 in accordance with the third ETS period relevant for 2013 – 2020⁷. The annual caps imply interim targets for emission reductions in sectors covered by the EU ETS for each year until 2020. For more information on the EU ETS, see the fifth Biennial Report of the European Union.

In 2020⁸, verified emissions from stationary installations covered under the EU ETS in Sweden totalled 16.7 Mt CO₂-eq. with total GHG emissions of

⁶ Revision for the period 2013 - 2020

⁷ 2013/634/EU

⁸ Submission 2022

46.3 Mt CO₂-eq (without LULUCF), the share of ETS emissions is 36 %. Emissions included in EU ETS in Sweden are mainly coming from industry and district heating.

The monitoring process for the ETS is harmonized for all EU Member States (Commission Regulation No 601/2012). The use of flexible mechanisms is possible under the EU ETS. For more information on the use of CER and ERU credits under ETS, see the fifth Biennial Report from the EU.

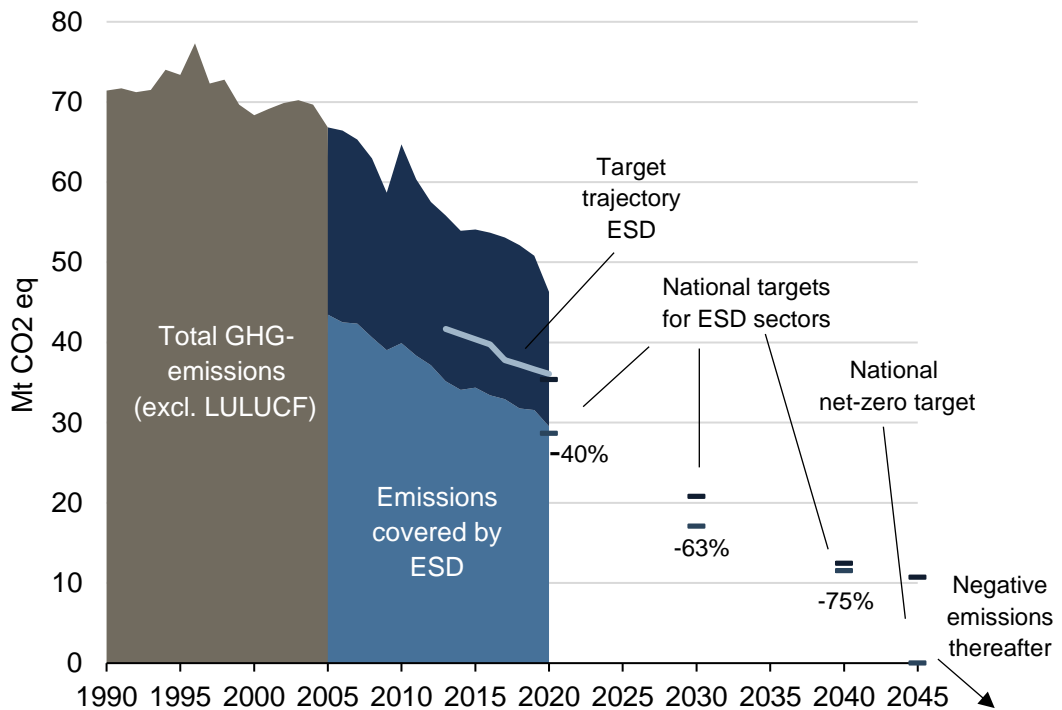


Figure 2.1 Historic GHG emissions⁹¹⁰, separated into emissions included in the EU ETS and emissions covered by ESD1011. ESD trajectory 2013 - 2020 and the Swedish national targets under the Swedish climate policy framework. The Climate targets include possibilities to attain parts of the targets through supplementary measures visualized in the figure. Such measures may be used to achieve up to 8 per cent of the 2030 target and 2 per cent of the 2040 target. For the long-term target such measures can be used for the remaining reductions down to zero¹¹.

Emissions not covered by the ETS are addressed under the Effort Sharing Decision (ESD) (Decision No 406/2009). The ESD covers emissions from

⁹ GHG emissions (submission 2022) excluding sources and sinks of LULUCF.

¹⁰ ETS emissions are corrected to take account of the extended scope of the EU ETS for the third trading period.

¹¹ Achieving zero net emissions of greenhouse gases means that the emissions of greenhouse gases from activities in Sweden shall be at least 85 per cent lower in 2045 compared to 1990. The remaining reductions down to zero can be achieved through supplementary measures. Such measures can also contribute to negative net emissions after 2045.

all sources outside the EU ETS, except for emissions from international maritime, domestic and international aviation (which are included in the EU ETS since 1 January 2012) and emissions and removals from LULUCF. It thus includes a diverse range of small-scale emitters in a wide range of sectors: transport (cars, trucks), buildings (heating in particular), services, small industrial installations, emissions of fluorinated gases from appliances and other sources, agriculture and waste. Such sources currently account for more than 60 % of total GHG emissions in the EU¹² and for about 62 % in Sweden¹³.

While the EU ETS target is to be achieved by the EU as a whole, the ESD target was divided into national targets to be achieved individually by each Member State. In the ESD, national emission targets for 2020 are defined as shares of the emission levels in 2005. These shares have been translated into binding quantified annual reduction targets for the period 2013 to 2020 (EU Commission Decision of 26 March 2013) (Commission Implementing Decision of 31 October 2013), expressed in Annual Emission Allocations (AEAs). Sweden has committed to reducing emissions in sectors covered by the ESD by 17 % in 2020 compared with 2005 emissions. The quantified annual emission target is 41.7 million AEAs for 2013, decreasing to 37.2 million by 2020 (adjusted to 2013–2020 ETS period). The binding quantified annual reduction targets were revised (Commission Decision No 2017/1471), for the years 2017–2020, in August 2017, which means that the allocation for 2020 was reduced from 37.2 million AEAs to 36.1 million AEAs for Sweden.

The modalities and procedures for monitoring and review under ESD are harmonised for all EU Member States by the Monitoring Mechanism Regulation ((EU) No 525/2013). The use of flexible mechanisms is possible under the ESD.

The ESD allows Member States to make use of flexibility provisions for meeting their annual targets, with certain limitations. There is an annual limit of 3 % for the use of project-based credits for each Member State. These are not used in any specific year; the unused credits for that year can be transferred to other Member States or banked for own use until 2020. Because Sweden (together with Austria, Belgium, Cyprus, Denmark, Finland,

¹² <https://www.eea.europa.eu/data-and-maps/indicators/progress-towards-national-greenhouse-gas/assessment>

¹³ Submission 2022

Ireland, Italy, Luxemburg, Portugal, Slovenia and Spain) fulfils the criteria for using additional credits as stipulated in ESD Article 5(5), an additional use of credits is possible from projects in Least Developed Countries (LDCs) and Small Island Developing States (SIDS) up to an additional 1 % of their verified emissions in 2005. For Sweden these are 0.456 million ERs and ERUs. These credits are not bankable or transferable.

2.3 Sweden's national emission reduction targets exceeding EU targets

2.3.1 National environmental quality objectives

Sweden's overall environmental objective, called the generation goal, is intended to guide environmental action at every level of society. The generation goal indicates that *"the overall goal of Swedish environmental policy is to hand over to the next generation a society in which the major environmental problems in Sweden have been solved, without increasing environmental and health problems outside Sweden's borders"*.

To provide a clear structure for environmental efforts in Sweden, the Swedish Parliament has adopted 16 environmental quality objectives¹⁴ that describe the quality of the environment that Sweden wishes to achieve. Sweden's environmental quality objectives cover different areas – from zero eutrophication to sustainable forest and a varied agricultural landscape. For each objective there are a number of 'specifications', clarifying the state of the environment to be attained.

One of these, Reduced Climate Impact, forms the basis for climate change action in the country. The objective is specified in line with the Paris Agreement's temperature goal "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. Sweden will work internationally for global action to address this goal." (Govt. Bill 2016/17:146).

2.3.2 The Swedish national targets for 2020

Current climate policy for 2020 is also set out in two Government Bills, entitled *An Integrated Climate and Energy Policy*, passed by Parliament in June 2009 (Govt. Bills 2008/09:162 and 163). The first of these Bills sets a

¹⁴ <https://www.naturvardsverket.se/en/environmental-work/environmental-objectives/>

national target for climate, calling for a 40 % reduction in emissions by 2020 compared with 1990. This is a more ambitious target than Sweden's commitment to ESD. If the target in 2020 is met, greenhouse gas emissions from the non-ETS sector would be around 20 million tonnes of carbon dioxide equivalent lower than in 1990. This target applies to activities not included in the EU ETS and does not include the LULUCF sector. One third of the reduction may be met by international reductions, Clean Development Mechanism under the second commitment period of the Kyoto protocol. In addition, the Bills also set targets for energy efficiency and renewable energy (see Boxes 2.1 and 2.2).

BOX 2.1 Sweden's renewable energy target for 2020

The EU has adopted a mandatory target requiring a 20 % share of energy from renewable sources in overall energy consumption by 2020. The responsibility for meeting the target has been divided among the Member States. Based on the agreed burden sharing, the target for Sweden's renewable energy share in 2020 is 49 %. Parliament has decided that, by 2020, renewable sources are to provide at least 50 % of the total energy consumed. Meanwhile, the share of renewable energy in the transport sector is according to an EU target to be at least 10 %.

BOX 2.2 Sweden's energy efficiency target for 2020

The EU has adopted a target of a 20 % improvement in energy efficiency by 2020. This target has not been divided among the individual Member States. Sweden has chosen to express its national target for improved energy efficiency by 2020 as a 20 % reduction in energy intensity between 2008 and 2020, which means that the energy supplied per unit of GDP at constant prices shall decrease over that period.

2.3.3 The Swedish targets for 2030, 2040 and 2045

In June 2017, the Swedish Parliament adopted a proposal on a climate policy framework for Sweden which gives Sweden an ambitious, long-term and stable climate policy. The climate policy framework consists of a climate act, new climate targets and a climate policy council. For more information about the climate policy framework, see chapter 3.1.2.

The specific national targets are:

- By 2045 at the latest, Sweden is to have no net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions. This means emissions from activities on Swedish territory are to be at least 85 % lower by 2045 at latest compared

with 1990. Supplementary measures may count towards achieving zero net emissions, such as increased uptake of carbon dioxide in forests and land, investments in other countries or bioenergy with carbon capture and storage (BECCS). The effect of the supplementary measures shall be calculated in accordance with internationally agreed regulations.

- Emissions in Sweden outside of the EU ETS should, by 2030 at latest, be at least 63 % lower than emissions in 1990, and by 2040 at latest at least 75 % lower. To achieve these targets by 2030 and 2040, no more than 8 and 2 percentage points, respectively, of the emissions reductions may be realised through supplementary measures.
- Greenhouse gas emissions from domestic transport are to be reduced by at least 70 % by 2030 compared with 2010. Domestic aviation¹⁵ is not included in the target since this subsector is included in the EU ETS.
- International transport (aviation and shipping) is excluded from the abovementioned targets.

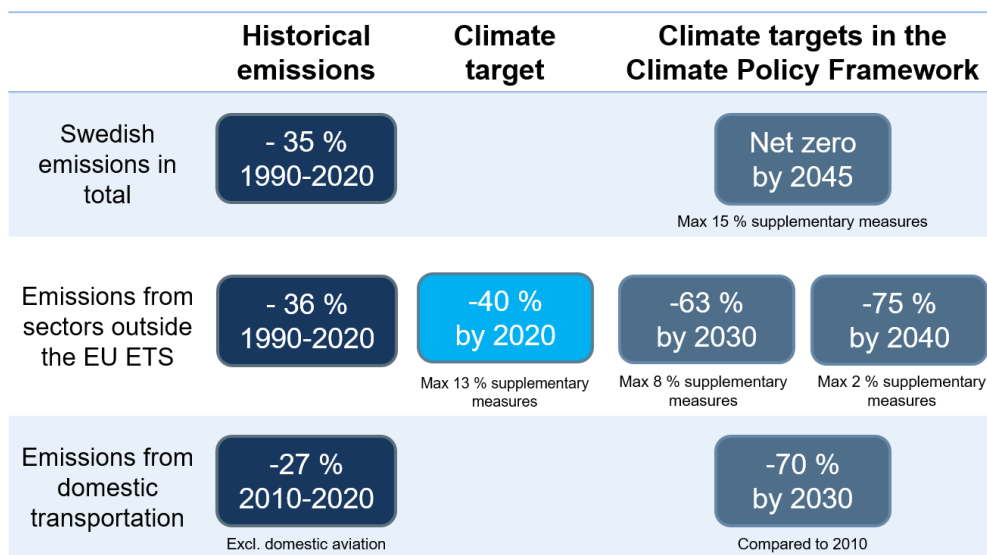


Figure 2.2 Sweden's national targets included in the climate policy framework.

¹⁵ The emissions only include CO₂.

2.4 References

FCCC/SB/2011/INF.1/Rev.1 of 7, June 2011, Compilation of economy-wide emission reduction targets to be implemented by Parties included in Annex I to the Convention.

EU Directive 2009/29, of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (OJ L 140, 05.06.2009, p. 63) (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0063:0087:en:PDF>).

Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council EU Commission decision of 26 March 2013 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC of the European Parliament and of the Council.

Decision (EU) No 406/2009/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

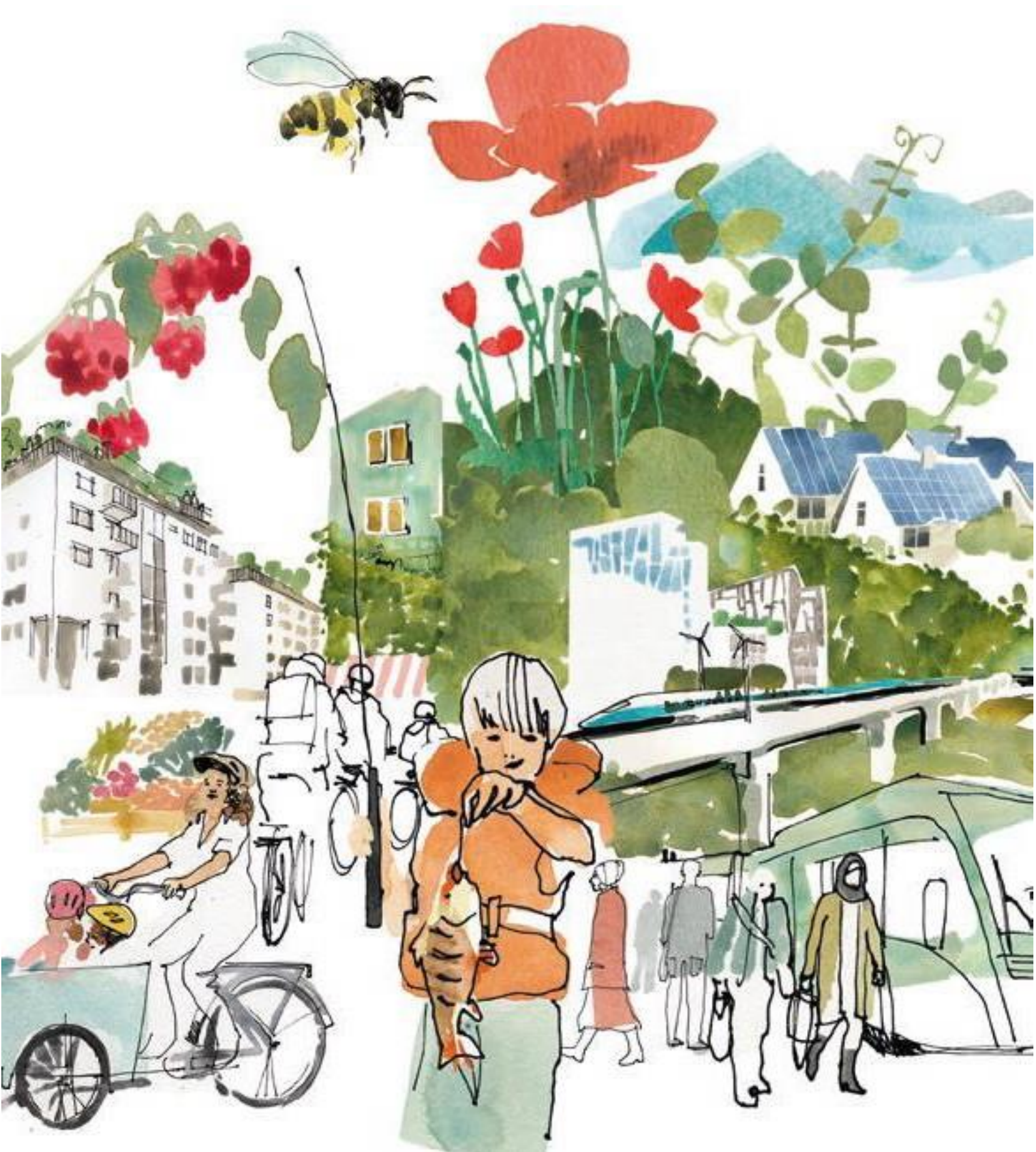
(2013/162/EU) Commission Implementing Decision of 31 October 2013 on the adjustments to Member States' annual emission allocations for the period 2013 to 2020 pursuant to Decision No 406/2009/EC of the European Parliament and of the Council (2013/634/EU).

Commission Decision (EU) 2017/1471 of 10 August 2017 amending Decision 2013/162/EU to revise Member States' annual emission allocations for the period from 2017 to 2020 (notified under document C (2017) 5556).

EU/No/525/2013, Regulation No 525/2013/EC on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information and Union level relevant to climate change and repealing decision No 280/2004/EC.

Govt. Bill 2008/09:162: En sammanhållen klimat- och energipolitik – Klimat. Ministry of the Environment.

Govt. Bill 2008/09:163: En sammanhållen klimat- och energipolitik –
Energi. Ministry of Enterprises, Energy and Communications.



3. Policies and measures

3.1.1 Background

This chapter provides information on the Swedish climate strategy as well as key policies and measures implemented or decided in Sweden to reduce greenhouse gas emissions. The policies and measures are included in the projections on greenhouse gas emissions reviewed in chapter 5¹⁶. Further, the chapter includes information on the efforts to avoid adverse effects of policies and measures and work on project-based flexible mechanisms under the Kyoto Protocol. At the end of the chapter the policy instruments and their effects are summarized in a table.

3.1.2 Swedish climate strategy

Sweden's climate strategy has progressively developed since the late 1980s. It consists of objectives, policy instruments and measures, together with regular follow-up and evaluation. In 2017 a new National Climate Policy Framework, ensuring long term order and stability in climate policy, was adopted by the Riksdag (Swedish Parliament).¹⁷

3.1.3 The Swedish Environmental quality objective-Reduced Climate impact

To provide a clear structure for environmental efforts in Sweden, the Riksdag has adopted 16 environmental quality objectives. One of these, Reduced Climate Impact, forms the basis for climate change action in the country. The interpretation of the objective is “Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. Sweden will work internationally for global work to address this goal.” (Govt. Bill 2016/17:146)

3.1.4 Sweden's national climate policy framework

In June 2017, the Riksdag adopted a proposal on a national climate policy framework for Sweden (Govt. Bill 2016/17:146). The climate policy framework consists of a Climate Act, national climate targets and a climate policy council. The climate policy framework is the most important climate

¹⁶ Some of the policy instruments are, due to recent date of decision, not included in the projections in chapter 5. Those are marked with a “*” in the summarizing table at the end of the chapter.

¹⁷ The Swedish climate policy is also presented to the EU in the National Energy and Climate Plan (NECP). For the draft for 2023, see https://commission.europa.eu/system/files/2023-07/EN_SWEDEN%20DRAFT%20UPDATED%20NECP.pdf. This includes targets as well as policies and measures for the five dimensions of EU's energy union of which GHG emissions is one.

reform in Sweden's history. It creates order and stability in climate policy and sets long-term conditions for the business sector and society at large.

The climate act impose responsibility on the current Government, and on future governments, to pursue a climate policy that is based on the national climate targets and to provide clear feedback on the progress. As a result Sweden now has long-term climate targets and a council that independently reviews climate policy. The reform is a key component of Sweden's efforts to live up to the Paris Agreement. Information on the climate policy framework is publicly accessible at the website of the Swedish Environmental Policy Framework.¹⁸

Targets

- By 2045, Sweden is to have no net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions. This means emissions from activities in Swedish territory are to be at least 85 % lower by 2045 compared with 1990. Supplementary measures may count towards achieving zero net emissions, such as increased uptake of carbon dioxide in forests and land, and investments in other countries. International accounting guidelines will be followed for this.
- Emissions in Sweden outside of the EU ETS should, by 2030, be at least 63 % lower than emissions in 1990, and by 2040 at least 75 % lower. To achieve these targets by 2030 and 2040, no more than 8 and 2 percentage points, respectively, of the emissions reductions may be realised through supplementary measures.
- Emissions from domestic transport are to be reduced by at least 70% by 2030 compared with 2010. Domestic aviation¹⁹ is not included in the goal since this subsector is included in the EU ETS.

¹⁸ <https://www.naturvardsverket.se/en/topics/climate-transition/sveriges-klimatarbete/swedens-climate-act-and-climate-policy-framework/>

¹⁹ The emissions only includes CO₂.

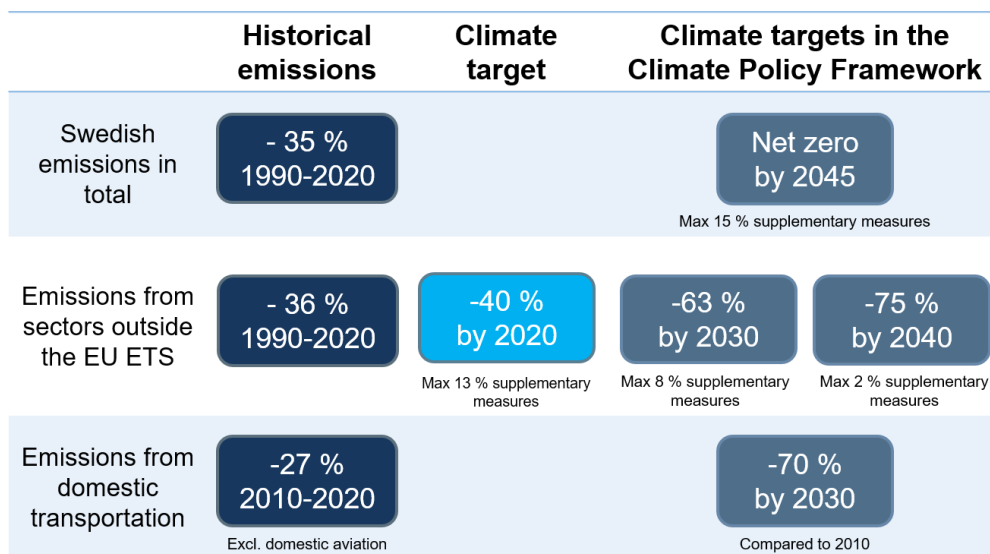


Figure 3.1 Sweden's national targets included in the climate policy framework.

Climate Act

- The Climate Act legislates that the Government's climate policy must be based on the national climate targets and specifies how the work should be carried out.
- In its Budget Bill, the Government must submit a climate review to the Riksdag every year. The climate review must contain:
 - A report on emissions development.
 - A report on the key political climate decisions taken during the year.
 - An assessment to identify the need for additional policies and measures, and when and how decisions about such policies and measures can be adopted.
- Every fourth year, the Government must develop a climate policy action plan which provides information on planned policies and measures to achieve emission reductions. The Swedish EPA supports the Government with data and analysis.
- The Climate Act entered into force on 1 January 2018.

3.1.5 Climate Policy Council

The climate policy council²⁰ provides independent assessments of how the overall policy presented by the Government is compatible with the national climate goals.

3.1.6 The Swedish target for 2020

Current climate policy is also set out in two Government Bills, entitled An Integrated Climate and Energy Policy, passed by the Riksdag in June 2009 (Govt. Bills 2008/09:162 and 163). The first of these Bills sets a national milestone target for climate, calling for a 40% reduction in emissions by 2020 compared with 1990. Emission statistics shows that the target was reached mainly through domestic emission reductions (36 percent reduction between 1990 and 2020) in combination with investments in flexible mechanisms. This target applies to activities not included in the EU Emissions Trading System and does not include the LULUCF sector. In addition, the Bills also set targets for energy efficiency and renewable energy.

3.1.7 Institutional arrangements

At the national level, the Swedish Environmental Protection Agency is responsible for the environmental quality objective Reduced Climate Impact and for Sweden's regular climate reporting to the UNFCCC and the EU. Its role thus includes ensuring that new statistics are produced annually on emission trends in the country, and that projections and reports on policies and measures forming part of Sweden's climate strategy are prepared every two years. This work is done in collaboration with the responsible sectoral authorities. The Swedish Energy Agency has a broad sectoral remit covering the supply and use of energy in society and is responsible, among other things, for the action plans being drawn up to achieve further improvements in energy efficiency and increase the use of renewable energy, as well as for Sweden's work on flexible mechanisms. The Swedish International Development Cooperation Agency (Sida), Swedish Transport Administration, Swedish Transport Agency, Swedish Forest Agency, Swedish Board of Agriculture and Swedish National Board of Housing, Building and Planning also have key roles in following up and developing the country's climate strategy. No specific legislation or special administrative procedures have been introduced to implement the Kyoto Protocol. The existing structure of central government administration and government

²⁰ www.klimatpolitiskaradet.se/en/

3.1.8 Framework agreement on the Swedish energy policy

The Riksdag has decided on an overall goal for energy policy, which is based on the same three pillars as the energy cooperation in the EU and aims to unite security of supply, competitiveness and ecological sustainability. The energy policy will thus create the conditions for an efficient and sustainable energy use and a cost-effective Swedish energy supply with a low negative impact on health, the environment and the climate, and facilitate the transition to an ecologically sustainable society.²¹

In addition, the Riksdag has decided on energy policy goals linked to certain years based on an energy agreement reached in 2016 between five of the Riksdag political parties.²² After the agreement was concluded two of the parties have left the agreement. The energy policy goals are:

- In 2020, the share of renewable energy shall be at least 50 percent of the total energy use, the share of renewable energy in the transport sector shall be at least 10 percent and the energy use shall be 20 percent more efficient.
- By 2030, Sweden will have 50 percent more efficient energy use compared to 2005.
- By 2040, the goal is 100 percent renewable electricity production. This is a target, not a deadline for banning nuclear power, nor does it mean closing nuclear power plants through political decisions.

Box 4.1 Riksdag decisions of significance for Swedish climate policy

- In 1988, Sweden's first climate objective was adopted. It covered carbon dioxide only and called for emissions to be stabilised at 'present-day levels'.
- In 1991, the 1988 objective was extended to include all greenhouse gases and all sectors.
- In 1993 a national climate strategy was adopted in line with the UN Framework Convention on Climate Change (UNFCCC) objective of stabilising emissions in developed countries. The new national objective called for carbon dioxide emissions from fossil fuels to be stabilised at 1990 levels by 2000.
- The energy policy guidelines adopted by the Riksdag in 1997 included a strategy to reduce the climate impact of energy use and energy production.
- As part of its 1998 transport policy decision, the Riksdag adopted the goal of stabilising carbon dioxide emissions from transport at 1990 levels by 2010.
- In 1999 the Riksdag decided to introduce a system of 15 environmental quality objectives, including one relating to the greenhouse effect: the environmental objective *Reduced Climate Impact*. In 2005 the Riksdag decided on one additional environmental quality objective A Rich Diversity of Plant and Animal Life.

²¹ Government Bill 2017/18:228, bet. 2017/18:NU22, rskr. 2018/19:411

²² Government Bill 2017/18:228, bet 2017/18:NU22, rskr. 2018/18:411

- In 2002 a Government Bill entitled *Sweden's Climate Strategy* was passed, including climate goals for 2010 and 2050.
- The same year, the Riksdag decided to further develop the system of environmental quality objectives, among other things regarding the responsibilities of different stakeholders for attaining the objectives.
- The 2002 energy policy decision included a climate strategy related to that area.
- A climate policy decision in 2006 evaluated and retained the national target for 2010.
- In 2009 Government Bills proposing *An Integrated Climate and Energy Policy* were passed. They included climate targets, targets for an increased share of renewable energy and improved energy efficiency by 2020, a vision for 2050, and a new interpretation of the overall wording of the climate objective.
- The Government Bills on *An Integrated Climate and Energy Policy* also set out policy for the areas of fossil energy, efficient energy markets, and research and development..
- The Government Bills proposing *An Integrated Climate and Energy Policy* also set out policy on nuclear power. The Riksdag subsequently passed Govt. Bill 2009/10:172, *Nuclear Power – Opening the Way to a Generation Change*, and Govt. Bill 2009/10:173, *Nuclear Power – Increased Liability*. These decisions repealed the Nuclear Phase-Out Act and made it possible to replace permanently closed reactors with new ones on the same site, as well as introducing unlimited liability for power producers for damage arising from nuclear accidents.
- The Government Bill 2016/17:179 *New target for renewable electricity and a check point review for the electricity certificate system 2017* includes a new target for the electricity certificate system by 2030 and a prolongation of the system to 2045.
- The Government Bill 2016/17:146 *A Climate Policy Framework for Sweden* consists of a climate act, new climate targets and a climate policy council. It creates order and stability in climate policy and sets long-term conditions for the business sector and society
- In the Climate Policy Action Plan (Govt. Bill 2019/20:65) the Government describes its plans to achieve the climate goals as decided by the Riksdag. The Climate Act requires the Government to draw up a Climate Policy Action Plan every fourth year.
- The Electrification Strategy addresses the conditions in the energy sector for an efficient electrification. This would contribute to reach Sweden's climate objectives.

3.1.9 Regional and local action on climate change

Since 1998, Sweden's county administrative boards (CABs) have been tasked with applying the national environmental quality objectives at the regional level. All 21 CABs have adopted regional climate objectives. As of 2005, their role also included developing regional action programs to achieve the environmental quality objectives. Since 2008, they have also been entrusted with strategic coordination and leadership in regional efforts to implement government policies for a transition to renewable energy and reduced

climate impact. The CABs develop and implement regional action plans in collaboration with other stakeholders. They support efforts by the business sector and municipalities in the area of climate and energy. Implementation of regional climate and energy strategies include a variety of measures, such as initiating cooperation and transferring knowledge between regional actors.

Regional energy offices also initiate and participate in a wide range of projects relating to energy efficiency and renewable energy sources, with funding from the Swedish Energy Agency, the EU, CABs, regional development councils and other organisations.

At the municipal level, a wide range of climate activities are being undertaken. Municipalities are obliged to have an energy plan, which is often combined with a climate strategy to reduce greenhouse gas emissions. As a consequence of the autonomy of local governments in Sweden, no local climate targets are formulated by the national government. Reaching the climate targets is the responsibility of the government and any local climate targets are initiated and followed up by the municipalities themselves.

Energy and climate change advisory services, which are partly funded by the Swedish state and municipalities, have been provided since 1998. The Swedish Energy Agency is responsible for the advisory service, including providing support in other languages than Swedish.

The regions have the task of preparing and establishing a strategy for the county's development (regional development strategy) and coordinating efforts to implement the strategy. Economic, social and environmental sustainability is an integral part of analyzes, strategies, programs and initiatives in the regional development work. The region initiates, implements and participates in a wide range of projects relating to climate energy efficiency, renewable energy and reduced climate impact.

3.1.10 Other institutional set-ups to implement the climate targets

The Climate Board

The government's goal is for Sweden to become one of the world's first fossil free welfare nations. To achieve this, all policy areas must move in the same direction and the climate issue must be integrated into all relevant

policy areas. For that reason, the government has established a climate board within the Government Offices²³.

The purpose of the Climate Board is to strengthen the government's work to achieve the climate goals and to implement the climate policy action plan. The Climate Board has regular meetings chaired by the Prime Minister. In addition to the Prime Minister and the Minister for the Environment and Climate, six other ministers are included, whose areas are crucial for climate change.

The Electrification Commission

In 2020, the Government set up an Electrification Commission to speed up the work of electrifying the heavy road transport and the transport sector in general. The Commission shall, in consultation with the actors concerned, identify measures that they can take to increase the pace of electrification in the field of transport. The analysis shall include passenger and freight transport within all modes of transport. The Commission focuses in particular on how regional freight transport, state roads, industrial routes and transport projects can be electrified.

3.2 Policies and measures in Sweden's climate strategy and their effects

3.2.1 Background and success factors

Sweden has introduced a range of policies and measures directly or indirectly affecting greenhouse gas emissions. The emphasis in the country's climate strategy is on the use of general economic instruments, but in many cases the general economic instruments are supplemented with targeted measures, for example to support the development and market introduction of technology and eliminate barrier effects. Many instruments which interact with carbon dioxide tax and emissions trading have also been adopted to achieve other policy goals than the climate objective, such as energy policy objectives.

Since the early 1990s, two key instruments in reducing Swedish emissions have been energy and carbon taxes. These taxes have been supplemented with other instruments, such as technology procurement, information, a differentiated annual vehicle tax and investment grants. Legislation, as those involving prohibitions, standards, and urban planning, also plays a part in

²³ Klimatkollegiet

curbing emissions. EU-wide policy instruments, in particular CO₂ emission performance standards for new vehicles and the Emissions Trading System (EU ETS), also have assumed growing importance in Sweden. At the same time, developments in recent decades have been defined by a framework for spatial planning and other long established instruments in Sweden. Of particular importance are earlier decades' investments in an expansion of district heating networks, public transport systems and carbon-free production of electricity.

Given the large number of policies and measures, many of them introduced with other primary objectives than climate mitigation, for example decreasing congestion or increasing the supply of energy from renewable sources, it can be difficult to estimate the progress quantitatively in terms of mitigation impact. Furthermore, picking out the effects of policy instruments from the impact of other, external changes, such as energy prices, is often complicated. For many of the policy instruments, we have not been able to provide a quantitative estimate of the mitigation impact. As several instruments interact, it is also hard to distinguish the effect of a single instrument. In order to ensure that the estimates of mitigation impacts add up, without risking double counting or underestimating mitigation impacts, Sweden has chosen to estimate policy effects for groups of policy instruments. The grouping is based on the degree of interaction between policy instruments.

Yet another difficulty in evaluating policies and measures in Sweden is that instruments which reduce electricity consumption or increase the production of carbon-free electricity have only a limited impact on carbon dioxide emissions inside Sweden's borders, owing to the fact that the electricity production in Sweden is largely fossil free albeit integrated with Nordic/north European market.

It should also be noted that, even before 1990, there were instruments in the Swedish energy sector with a similar steering effect to those used after 1990, and through those instruments incentives were created early on for the introduction of bioenergy and an expansion of district heating. For the energy supply sector and the residential and commercial/institutional sector it may, therefore, be difficult to disentangle the additional effects of policy instruments introduced in Sweden after 1990 from the effects that might otherwise have arisen if instruments had not been subsequently strengthened.

Figure 4.2 illustrates an overall assessment of the impact of economic instruments affecting Sweden’s stationary energy system. Forming the basis for the results is the TIMES-NORDIC energy system model, in which a scenario based on policy instruments in place in 1990 has been compared with a scenario reflecting the actual development of instruments (see box 4.2). Economic instruments introduced after 1990 have been important for the reduction of carbon dioxide emissions.

This is most evident for the electricity and district heating sector, see Figure 4.2. Not all policy instruments are included in the analysis why the total effect is underestimated (Profu 2021). The different sectors are described in more detail in the relevant sections of this chapter.

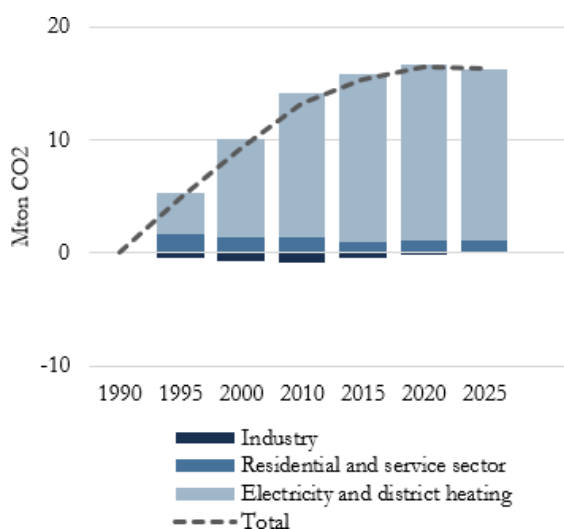


Figure 3.2 Difference in carbon dioxide emissions between a scenario based on 1990 policy instruments and actual development of policy instruments. The importance of policy instruments introduced after 1990 has increased over time, most notable for the electricity and district heating sector (Profu 2021).

Innovative policy measures

Two aspects of Swedish climate policy can be particularly highlighted as sources of inspiration for others, the reversed auctions for bio energy with carbon capture and storage (BECCS) as well as the mix of policy instruments and institutional factors enabling transitions in fossil intensive industries, here focusing on fossil free steel production.

Concerning BECCS, both the technology and the policy instruments associated with it can be seen as innovative in an international perspective. Reversed auctions is being used in order to ensure cost effective allocation of the funds set aside for the removal of carbon dioxide emissions that occur when capturing and permanently storing biogenic carbon dioxide emissions from the production of energy from biomass. The ambition is that BECCS will be up and running in the near future. With current policy measures, approx. 2 million tonnes of biogenic carbon will be separated by 2030. The experiences with Sweden's policy for BECCS is particularly relevant for other countries with large point sources of CO₂ emissions from sustainable bio energy.

As regard the policy mix for fossil intensive industries, this has been accelerated in Sweden through an effective mix of policies and measures consisting of long-term clear political ambitions, an increasing carbon dioxide price through the EU ETS, support through, for example, Industry Leap, and mobilisation within the dialogue initiative Fossil Free Sweden²⁴. In addition, there are important environmental success factors such as the availability of fossil-free electricity and low electricity prices. The climate effect for the transition to fossil free steel production specifically is in the short term negative (increase emissions) as a result of new establishments, but in the long term it can reduce Sweden's emissions by about 5 million tonnes CO₂.

3.2.2 Cross-sectoral instruments

EU Emissions Trading System Directive 2003/87/EC

The EU Emissions Trading System (EU ETS) is the EU's most important tool to combat climate change. It was introduced in 2005 and has since been expanded to cover more sectors and greenhouse gases. The rules for monitoring and reporting and for free allocation of allowances have subsequently been improved and harmonized between the EU member states.

The amount of emissions allowed within the system is limited by a cap, which is decreased every year. Almost half of the allowances are allocated for free to installations covered by the system, the rest are auctioned.

²⁴ See the following sections for more detailed descriptions of each policy instrument.

Free allocation is used in order to avoid risks of carbon leakage in specific industrial sectors such as steel and cement. As a rule, there is no free allocation for emissions from electricity production. Free allocation to sectors not exposed to carbon leakage will cease in 2030. However, free allocation to district heating and district cooling will continue on a low level.

At the outset, EU ETS covered emissions of carbon dioxide from combustion installations and energy-intensive industries (mineral oil refineries, coke ovens, iron and steel industry, pulp and paper industry, and mineral industry). The scope was extended in 2013 with new greenhouse gases (nitrous oxide and perfluorocarbons) and with some new industrial activities. At present, about 750 Swedish installations are included in the system. At the EU level in total, approximately 13,000 installations are covered, which corresponds approximately to 45 percent of the total EU GHG emissions.

To strengthen EU ETS, the EU has decided on a reform of the system. From 2021 onwards, the annual reduction of the cap will increase from 1.74 % to 2.2 %. A market stability reserve has been introduced to reduce the surplus of emission allowances on the market. From 2023 onwards, allowances held in the market stability reserve above the number of allowances auctioned the previous year will be cancelled. Finally, the auction share has been set to 57 % and free allocation will be focused on sectors highly at risk of carbon leakage.

Emissions from aviation were included in the system in 2012. Because of extensive protests from some countries outside the EU the EU decided on a temporary exemption for flights outside the EEA.

As the ICAO in September 2016 decided to implement a global measure, the Carbon Offsetting and Reduction Scheme for International Aviation (Corsia), the EU has decided to maintain the geographic scope of the EU ETS limited to intra-EEA flights from 2017 onwards. Corsia is implemented in EU law through a revision of the EU ETS legislation. Sweden is the administering Member State for approximately 90 aircraft operators, however only a few were subject to report their emissions in CORSIA in 2020.

In 2021, the European Commission released proposed amendments to the EU ETS as part of the “Fit for 55” package. Key proposed amendments involve tightening the emissions cap. For the sectors covered a -61% emissions reduction target is planned (by 2030 compared to 2005 levels).

The linear reduction factor would be increased from 2.2% to 4.2%. Moreover, the European Commission is proposing to extend the EU ETS to maritime transport, particularly for large ships (above 5000 gross tonnage) from 2023.

Energy tax and carbon tax

The Swedish system of energy taxation is based on a combination of a carbon tax, an energy tax on fuels, and an energy tax on electricity. The key taxes influencing greenhouse gas emissions in Sweden are the carbon tax and the energy tax on fuels, which are described below in general and more in detail for each sector.

Carbon tax

A carbon tax, based on the fossil carbon content in the fuel, was introduced in 1991 and aims at reducing the emissions of carbon dioxide in sectors outside the EU ETS. The tax has been raised in several steps since it was first implemented. In total, the tax has increased from SEK 0.25/kg (1991) carbon dioxide to SEK 1.20/kg (2021). In addition to specific tax increases stipulated in government bills, a yearly indexation of the tax level is applied to adjust for changes in the consumer price index and to take account of the development of the gross domestic product (GDP). The GDP-indexation is added to the energy tax. In 2021-2022 the GDP-indexation is put on hold (Gov. Bill 2020/21:196).

The tax level is proportionate to the calculated amount of carbon dioxide emissions based on the fuel’s fossil carbon content. This means that biofuels currently are not subject to carbon taxation, if not used within the reduction obligation scheme for motor fuels. With regard to motor fuels, changes to carbon taxation of biofuels were implemented on 1st July 2018 (see separate section on carbon and energy taxation in the transport sector). A reduced carbon tax and energy tax is applied for diesel used in, for example, agriculture, forestry and aquaculture.

Energy tax

Taxes on energy have been used in Sweden for a long time.²⁵ An energy tax on petrol and diesel was introduced in 1924 and 1937, respectively. Fuel used for heating and electricity became subject to an energy tax in the 1950s.

The aim of the energy tax is mainly fiscal. It does also have the effect to steer energy usage towards Sweden's energy efficiency, renewability and climate targets²⁶. The energy tax on motor fuels used in road vehicles and off-road machinery also internalises external costs from the traffic, such as road wear, noise, etc (National Institute of Economic Research, 2013). The energy tax on fuel varies depending on whether it is used as motor fuel or for heating purposes. The tax level on heating fuels also varies between households, industry and the energy conversion sector. A reduced energy tax is applied in some sectors.

Carbon tax and energy tax on motor fuels used for road vehicles and off-road machinery

Petrol and diesel are covered by both an energy tax and a carbon tax on fuels used in road vehicles, off-road machinery and private ships and boats. Since 1994, the energy tax on fuels and electricity as well as the carbon tax on fuels are adjusted to changes in the consumer price index (CPI), to take account of inflation. As of 2017, tax rates on petrol and diesel are also adjusted to take account of the development of the gross domestic product (GDP).²⁷ The Parliament has decided (Govt. Bill 2020/21:196) to put the GDP adjustment on hold during 2022 to compensate for increased prices due to the reduction obligation scheme, see below.

In December 2021, the energy tax on diesel (environmental class 1) was SEK 2.478 per liter and the carbon tax was 2.262 per liter, while the energy tax on petrol was SEK 4.13 per liter and the carbon tax was 2.61 per liter. In May 2022 the energy tax on both diesel and petrol was lowered by SEK 0.4 per litre (SEK 0.5 per litre including VAT). At the same time a temporary decrease of the tax rates by 1.05 SEK per litre was implemented (Govt. Bill 2021/22:84 and 2021/22:221).

²⁵ Tax on energy is a collective term for excise taxes for fuel and electrical power and is governed by the Act of Excise Duties on Energy (1994:1776).

²⁶ The energy efficiency target and the renewable target for 2020 are part of Govt. Bills 2008/09:162 and 163.

²⁷ This is achieved through a flat-rate increase of 2 percent per year. The combined change in the carbon and energy tax rates is, however, added exclusively to the energy tax rate (i.e. the carbon tax rate is only directly affected by the indexation to CPI).

Swedish Parliament decided to introduce an emission reduction obligation scheme in 2018. In 2021 the reduction levels within the reduction obligation scheme was decided until 2030. The scheme was accompanied by a number of tax rule changes for petrol and diesel. In particular, low-blended biofuels that are covered by the reduction obligation scheme are subject to carbon tax and energy tax rates that correspond to the rates of their fossil equivalents. At the same time, the carbon tax rates for petrol and diesel were adjusted downwards to take account of the share of low-blended biofuel per liter full blend, as a result of the emission reduction obligation scheme. The energy tax on petrol and diesel was also lowered. High-blended and pure biofuels are not covered by the reduction obligation scheme and such sustainable biofuels are still exempted from both the carbon tax and the energy tax.

If the biofuel is classified as petrol or diesel it needs to consist of more than 98 volume percent biomass to be covered by the tax exemption. As the exemption of the carbon and energy tax for these biofuels are not considered compatible with the EU state aid rule, Sweden has sought a prolongation of an exemption which was approved by the European Commission in the autumn 2021. The prolongation of the tax exemption is for one year.²⁸ Moreover the European Commission approved in the autumn 2020, under EU state aid rule, a 10-year prolongation of the tax exemption (2021-2030) for non food-based biogas and bio propane used for heating or as motor fuel in Sweden. The objective of the tax exemption is to increase the use of biogas and biopropane and to reduce the use of fossil fuels and their greenhouse gas emissions, while facilitating the transition towards advanced biofuels.

Carbon tax and energy tax for heat production

Fuels used for heat production are subject to energy tax as well as carbon tax. Fuels used for heat production in combined heat and power plants (CHPs) and in other heating plants within the EU ETS were subject to 11 % of the carbon tax and 30 % of the energy tax until 31 July 2019. Between 1 august 2019 and 31 December 2022 the tax levels were increased to 91 % of the regular carbon tax and 100 % energy tax. The Carbon tax for heat production within the EU ETS was abolished as of 1 January 2023 since carbon emissions are already priced through the EU ETS. The energy tax for fuels used to produce heat in CHPs outside the EU ETS was raised on the

²⁸ <https://www.regeringen.se/pressmeddelanden/2021/09/klart-med-fortsatt-skattebefrielse-for-flytande-biodrivmedel/> 3 September 2021

1st of August 2019 and is now subject to 100 % of the energy tax. These fuels are also subject to 100 % carbon tax.

Carbon tax and energy tax for electricity production

Fuel used for electricity production is exempted from both energy and carbon taxes. However, the use of electricity is generally subject to the energy tax on electricity.

Carbon tax and energy tax in the manufacturing industry sector

The manufacturing industry sector is subject to some exemptions and reductions in energy and carbon taxes, primarily due to the fact that most of the manufacturing industry is already covered by the EU ETS. One of the main reasons behind the tax reductions is to avoid the application of more than one policy instrument for the same purpose for cost-efficiency reasons.

The manufacturing industry, both covered and not covered by the EU ETS, used to pay 30 % of the general energy tax. As of 1 January 2022 fuels used for heat production in manufacturing processes in manufacturing industries are subject to 100 % of the energy tax no matter if the industrial activity is part of the EU ETS or not (Govt. Bill 2020/21:97). No carbon tax is charged for fuels used for heat production in manufacturing processes in industries if the industrial plant is part of the EU ETS.

Previously, industries not covered by the ETS had significant reductions in the carbon tax, but in recent years the tax has been raised. The carbon tax reduction was then totally rescinded from 2018. For so-called mining diesel (diesel that is used in working machinery in manufacturing processes in mining industrial activity), energy taxes and carbon taxes were levied with 11% and 60 % respectively of the general levels of taxation until 31 July 2019. This reduction of energy and carbon tax has now been rescinded since August 2019, meaning that the full energy and carbon tax rates are applied.

Carbon tax and energy tax in agriculture, forestry and aquaculture sectors

Up until 2014 the agriculture, forestry and aquaculture sectors paid 30% of the general energy and carbon tax rates for fossil fuel used for heating purposes. Since then, the carbon tax reduction in the sectors has been reduced in steps and was totally rescinded by 1 January 2018. The energy tax was 30 % of the general energy tax rate for heating fuels in these sectors until 1 July 2021. Since then, the reduction has been reduced. It was totally rescinded 1 January 2022 (Govt. Bill 2020/21:97). Diesel for machinery in

agricultural, forestry and aquaculture activities are subject to carbon and energy taxation. A special reimbursement has fluctuated over the years. The current level of reimbursement is for carbon tax SEK 2.292 per liter and for energy tax 2.111 SEK per liter.

National and international commercial shipping

Fuels for national and international commercial shipping are not targeted with any energy tax or carbon tax.

Local Climate Investment Program – The Climate Leap

To further stimulate the reduction of greenhouse gas emissions, a program for local investments was introduced in 2015, the Climate Leap. In total, SEK 7.7 billion has been granted for investments within the program (as of November 2021). The Swedish Environmental Protection Agency (Swedish EPA) administers grants for local and regional investments to cut greenhouse gas emissions. Investments in all sectors, except those included in the EU ETS, and all types of organisations are eligible to apply for grants. Some investments in sectors included in the EU ETS are also eligible for grants if these result in an increased utilisation of waste heat. Applicants compete based on the estimated greenhouse gas reduction of each investment.

Examples of investments that can be granted support are charging infrastructure for electric vehicles, biogas plants, infrastructure for biofuel and changes from fossil oil to biofuel or district heating. In 2022 the budget for the program amounts to SEK 2.8 billion. The budget is estimated to SEK 2.7 billion for 2023 and SEK 3.7 billion for 2024 (Govt. Bill 2021/22:1).

Effects of the Local Climate Investment Program

In total, the investments granted are expected to generate a reduction of approximately 1.5 Mt CO₂-eq. per year during the technical lifespan of the investments²⁹ (Govt. Bill 2021/22:1). Measures in the transport sector represents around 60 % of the total emission reductions while around 35 % of the reductions can be attributed to measures in the residential and service sector along with the industry. It should, however, be noted that the

²⁹ The technical lifespan of the investments is in average 16 years.

measures in the investment program are of different character, including enabling activities for vehicle shifts such as infrastructure investments,

Including charging infrastructure, and supply of biofuels with an indirect effect on emission reductions. Further, all emission reductions cannot not be attributed to this policy instrument alone, as other instruments will also affect the emissions³⁰. E.g. the electric vehicles need the infrastructure but are also affected by other national and EU policy instruments.

A national center for carbon dioxide capture and storage

In order to achieve net zero emissions by 2045, and enable negative emissions thereafter, the Swedish Energy Agency has been appointed as national centre for CCS-related issues.. Tasks include to promote the appropriate implementation of CCS in Sweden, for example by following the latest development, providing the government with necessary analysis and identifying legal barriers for CCS in Sweden. The Agency has also been appointed auctioneer for the support system, through reversed auctions, for BECCS.

National strategy for electrification

The government has decided on a national strategy for electrification. The strategy will contribute to a fast, smart and economically efficient electrification. In the strategy, the government takes a holistic approach to the conditions in the energy sector to enable increased electrification. Means has been allocated to enable the implementation of the strategy to meet society's needs and expectations. Among other things, the Government intends to set up an electrification council to support the implementation of the electrification strategy. A plan to deal with any obstacles to increased electrification will also be included. To implement the electrification strategy the Government has budgeted SEK 20 million for 2022, SEK 35 million for 2023 and SEK 25 million for 2024 (Govt. Bill 2021/22:1).

The Environmental Code and planning legislation

General legislation in the area of the environment has been collected in the Environmental Code since January 1999. Among other aspects, the Environmental Code contains general rules for consideration to be observed in all activities and measures that are not of negligible significance in individual cases and that can affect the environment. Environmentally

³⁰ This is also why the estimated effect is not included in the summary and CTF tables.

hazardous activities, as defined in the 9th chapter, require obtaining a permit. The permit application must include an environmental impact assessment as described in the 6th chapter. In 2018 changes were made in the 6th chapter in order to clarify that direct, indirect and cumulative impacts should be included in the environmental impact assessment. Greenhouse gas emissions form part of the permit assessment procedure and the Code also includes requirements to use the best available technology. However, effective 2005, issuing emissions limit values for carbon dioxide or limiting the use of fossil fuels for installations covered by the EU Emissions Trading Scheme is no longer permitted.

Measures in the area of public planning chiefly impact emission trends in the longer term and may have significance from this point of view. Measures in public planning are principally governed by the Planning and Building Act (PBL)(SFS 2010:900), but many measures are also covered by the Environmental Code. Since May 2011, the PBL introduced new requirements on considering the environmental and climate aspects of planning. The longer term significance of the development of the built environment for energy and transport needs has been increasingly highlighted, and the PBL also made it mandatory to consider inter-municipal and regional circumstances in planning. To enhance the implementation of the requirements in the PBL, the National Board of Housing, Building and Planning published new guidelines in 2017 for municipal structure planning, aimed at reducing greenhouse gas emissions.

In 2016 changes to annual report legislation came into force. Large corporations must now comply with new regulations for sustainability reporting. Sustainability reports must include information needed to understand a company's development, position, earnings and the consequences of their operations that concern the environment.

From 1 January 2022, the requirement for a climate declaration applies to the construction of new buildings. This means that builders must report the impact on the climate of a new building. The purpose of the law on climate declaration for new buildings (SFS 2021:78) is to help reduce the climate impact from the construction phase.

The Swedish Government has adopted the objective to make Sweden one of the world's first fossil-free welfare states. This ambition requires a mobilisation of the entire society, not least municipalities, cities and business.

The governmental initiative ‘Fossil Free Sweden’, launched in 2015, aims to strengthen the dialogue between the state and the business sector, municipalities and civil society. A national coordinator, appointed by the government, is the link between the actors and the government in efforts to remove obstacles and create conditions to speed up the reduction of greenhouse gas emissions. Fossil Free Sweden is open to all actors who support the declaration drawn up for the initiative. The declaration stipulates that actors participating in the initiative share the view that the world must become fossil free. It also stipulates that actors who participate must be able to present concrete measures to reduce emissions. So far, more than 500 actors have signed the declaration and 22 roadmaps from different sectors have been submitted to the government (Fossilfritt Sverige, 2021).

Climate change communication

Swedish governmental authorities have a long experience of using communication of knowledge as policy instruments for the public and business sectors and for citizens. Some examples:

The Swedish Environmental Protection Agency is a driving force and provides support in climate work in Sweden. The website www.naturvardsverket.se is a hub for statistics and facts on emissions and knowledge on effective mitigation activities. It is widely used by policymakers, media, business, organizations and researchers.

The Swedish Meteorological and Hydrological Institute (SMHI) develops and distributes information about the weather, water and climate change adaptation. The National Knowledge Centre for Climate Change Adaptation, set up at SMHI, launched the Swedish Portal for Climate Change Adaptation, with facts and guidance on adaptation to a warmer climate.

The Swedish Energy Agency is responsible for giving both citizens and businesses information and advice on more efficient energy use. On-line energy tests; the websites where you find energy tests of white goods for consumers, are the most visited on the Swedish Energy Agency’s web. Energy and climate advisers in Sweden’s municipalities reply free of charge to questions about heating, energy costs and efficiency, transport, climate and government grants relating to energy.

The Swedish Forest Agency and the *Swedish Board of Agriculture* focus on e-services and digital information to land and forest owners, forest officers and farmers on how to reduce the climate impact of forestry, agriculture as well as on climate adaptation.

The Swedish Civil Contingencies Agency are in charge of prevention and mitigation of the effects of natural accidents and support measures to adapt the work of social protection and preparedness to a changing climate.

Public awareness

Public awareness on climate change is generally high in Sweden. The Swedish Environmental Protection Agency regularly conducts surveys of Swedes' attitudes on climate issues. The purpose is to measure the public preparedness on cutting emissions based on their own lifestyle and consumption, and the general attitudes on public climate change instruments. The survey conducted in 2021 (SEPA/Gullers 2021) shows that there is a great commitment among the public in Sweden to solve the climate issue. Swedes are keen to contribute and very positive about societal climate initiatives and corporate climate work.

Education and training

In cooperation with the Swedish Environmental Protection Agency, The National Swedish Agency for Education has clarified the connection between curriculum and syllabus and the national environmental goal Reduced Climate Impact. In-depth teaching on climate issues is common in upper secondary level. The National Swedish Agency for Education is currently working towards goal 4 in the Agenda 2030: Ensure inclusive and quality education for all and promote lifelong learning. The work is carried out together with relevant stakeholders.

Higher education institutions offer courses on the scientific basics of the climate and/or climate-related subjects like energy and forestry. There are various networks and centers of competence, for example, the Centre for Climate and Safety at Karlstad University and the Centre for Climate and Environmental Research at Lund University.

Increased competence for climate transition

To meet future needs in the labour market as a result of the climate transition, there is a need for educational initiatives. Government-funded education aimed at key competences in the labour market can facilitate the

transition of industry and society to a circular economy and help reduce unemployment. The Government proposes that SEK 100 million be allocated for 2022. For 2023 and 2024 the allocation is estimated at SEK 100 million per year.

Research and development

Public investment in climate-related research and development are aimed at creating better prerequisites for achieving the substantial longer term emissions reduction required. Swedish climate-related research covers a broad spectrum, from natural sciences to humanities, but with an emphasis on technical and scientific research and development. Three important research areas are energy, transport and industry, for which the Government has decided to grant extensive funding.

Energy and climate issues are closely linked, and the solutions to the challenge of climate change are largely energy-related. The overall objective of energy research and innovation in Sweden is to contribute to fulfilling the national energy and climate objectives, the long-term energy and climate policy, and energy-related environmental objectives.

In the budget bill for 2022 (Govt. Bill 2021/22:1) the Government allocates SEK 1.43 billion for energy research in 2022. Estimated amounts for 2023 and 2024 are SEK 1.37 billion and SEK 1.38 billion respectively.

Alongside the contribution to energy research, climate-related research is also being financed by other national research funding programs. In Government Bill 2020/21:60 (Research, freedom, future – knowledge and innovation for Sweden) climate is listed as one of several societal challenges that require special contributions.

A national ten-year research program for climate was established in 2017 with an annual budget (from 2021) of SEK 230 million (Formas.se, 2021.11.13).

In order to reduce greenhouse gas emissions from working machineries and strengthen the competitiveness of the Swedish automotive industry, the Government has decided on targeted support for research, development and market introduction for working machineries in 2021 and 2022 (Government Bill 2020/21:1).

Sweden's strategy for a circular economy

Transforming production and consumption towards a circular economy has a large potential to reduce the use of materials and thus the negative impact on the climate. This requires a shift from virgin materials to circular material flows. This, in turn, requires toxic chemical to be removed (see section 4.2.7). To enable a circular economy the Swedish Government has presented a strategy³¹ as well as two more hands-on action³² plans for the transformation, the second focusing on plastics³³.

3.2.3 Energy – production of electricity and district heating and residential and service sector

Energy Efficiency Directive 2012/27/EU

The Energy Efficiency Directive came into force in December 2012, replacing the Energy Services Directive and the Cogeneration Directive 2004/8/EC. The Directive establishes a set of binding measures to help the EU reach its 20% energy efficiency target for 2020. Under the Directive, all EU countries are required to use energy more efficiently at all stages in the energy chain from production to final consumption.

To adapt Swedish regulations to the Directive, the following changes were implemented: i) Large enterprises must conduct an energy audit every fourth year; ii) electricity suppliers must invoice customers for the measured consumption of electricity, if the supplier has access to measurements; iii) new requirements are established on the measurement of energy consumption in apartments; and iv) requirements are tightened on authorities to use energy more efficiently. The main part of the new legislation came into force 1 June 2014 (Govt. Bill 2013/14:174). Moreover, changes were made in the Electricity Law (SFS 2014:1064) requiring network operators to adjust tariffs and other practices to promote energy efficiency.

On 30 November 2016, the European Commission presented a package of legislative proposals containing measures in the EU's energy policy, the so-called Clean-energy-for-all package. Putting energy efficiency first is an important goal in the package. The package included a proposal to amend the EED. The European Parliament and Council Directive (EU) 2018/2002

³¹ [Sverige strategi cirkulär ekonomi.pdf](#)

³² [Cirkulär ekonomi. Handlingsplan för omställning av Sverige.pdf](#)

³³ [Sveriges handlingsplan för plast.pdf](#)

of 11 December 2018 amending Directive 2012/27 / EU on energy efficiency (amending directive) entered into force on 24 December 2018.

The amending directive includes a headline target of at least 32.5% improved energy efficiency by 2030. The target can be reviewed and sharpened. The directive requires Member States to achieve cumulative energy savings obligations for the period 2021-2030. The directive also includes revised requirements regarding metering and billing of energy. In 2021, as part of the “Fit for 55”, the European Commission proposed amendments to the directive, introducing a higher target for reducing primary (39%) and final (36%) energy consumption by 2030 now binding at EU level, in line with the Climate Target Plan, up from the current target of 32.5% (for both primary and final consumption) (Commission proposes new Energy Efficiency Directive | European Commission (europa.eu)).

Renewable Energy Directive 2009/28/EC

The EU has adopted a binding target requiring an increase in the percentage of renewable energy, currently at 8.5%, to 20% of total energy use over the period 2005–2020. Responsibility for attaining this target has been shared among the Member States. According to this burden sharing, Sweden had to increase its share from just under 44% (2007) to 49% in 2020. Sweden reached the EU commitment (49%) and the national target (50%) back in 2012. Since then, the use of renewable energy has increased to a level of 56% in 2019.

The EU has adopted a revised Renewable Energy Directive that sets a new binding renewable energy target for the EU for 2030 of at least 32 %, including a review clause by 2023 for an upward revision of the EU level target. In 2021, as part of the “Fit for 55” package, the European Commission proposed amendments to the directive, increasing the current EU-level target to at least 40% by 2030, which represents doubling the current renewables share of 19.7% in a decade (Commission presents Renewable Energy Directive revision | European Commission (europa.eu)).

EU has also set a specific target for the share of renewable energy in the transport sector to increase to 10% in 2020 (Renewable Energy Directive 2009/28/EC). In 2019 the share of renewable energy in the transport sector

in Sweden according to the renewable directive's calculation methodology was already 30,3%.

Production of electricity and district heating

The production of district heating has risen approximately 50% since 1990. At the same time, emissions from this source have been significantly reduced, as the expansion largely has been achieved by the increased use of biofuels. The carbon tax is one of the main factors behind this trend, but the electricity certificate system has also been important in phasing out fossil fuels in the sector. The low emissions from electricity generation are explained by the fact that nuclear power and hydropower account for a dominant share of production, while additional production of electricity in recent years chiefly comes from biomass-fired combined heat and power plants (CHPs) and wind power.

Tax on waste incineration

Between 2020–2022 incineration of waste was taxed (SFS 2019:1274). The tax was gradually increased and in 2022 it was SEK 125 per ton. The tax excludes for example hazardous waste and bio energy. The tax was abolished as of 1 January 2023.

Electricity certificate system

An electricity certificate system aiming to support electricity based on renewable energy was introduced in 2003. Conceptually, the system works as follows. Electricity suppliers are obliged by law to submit electricity certificates corresponding to a certain share, or quota, of their electricity deliveries. The quota is gradually being increased yearly up to 2020.

Electricity producers are allocated a certificate from the central government for every megawatt-hour (MWh) of renewable electricity produced. The producers are allowed to sell the certificates in an open market where the price is set by the seller and buyer. The certificates thereby provide extra profit for the producers of renewable electricity (SFS 2011:1200).

The electricity certificate system was earlier prolonged up until 2045 (Govt. Bill 2016/17:179) but the rapid development with regard to the expansion of renewable electricity production has led to the electricity certificate system now fulfilling a limited function. Therefore, the government proposed, and the Parliament decided, that new electricity generation facilities may not be eligible for the electricity certificate system after the end of 2021 and the

electricity certificate system will be terminated by the end of 2035 (Government Bill 2020/21:16; Näringsutskottets betänkande 2020/21:NU6).

Initiatives for wind power

Research programs. Different programs have promoted the dissemination of knowledge and information about wind power. An example is the research program Vindval, which aims to collect and provide scientific knowledge about wind power's impacts on humans and on nature (Swedish EPA 2021, naturvardsverket.se/vindval).

Designation of areas of national interest for wind power. Since 2004, certain land and water areas in Sweden have been designated as areas of national interest for wind power. There are 313 such areas in Sweden, of which 284 are located onshore and 29 offshore. The most recent update was carried out in 2013 and four areas were added in 2015. The total area of these national interests for wind power is roughly 7,6000 km², representing about 1.5% of the country's land area, including Swedish waters (Swedish Energy Agency 2021).

A national strategy for sustainable wind power expansion. The Swedish Energy Agency and the Swedish Environmental Protection Agency have jointly developed a national strategy for sustainable wind power expansion, which was presented in January 2021. The strategy, which only covers land-based wind power, contains a regional distribution of a national development need and a national planning basis (Swedish Energy Agency, 2021)³⁴

Support for storage of self-produced electricity

During 2016-2020 support was available for private individuals for installation of systems for storage of self-produced electricity. Grants were awarded with a maximum of 60 percent of the eligible costs, however, with a maximum of SEK 50,000 (SFS 2016:899). In 2021 the support system was replaced by tax reduction for installation of green technology.

Tax reduction for installation of green technology

With the aim to reduce greenhouse gas emissions private individuals are, since 1 January 2021, eligible to a tax reduction for installation of green technology including solar cells, systems for storage of self-produced electricity and at home charging stations. The tax reduction is given on the

³⁴ Swedish Energy Agency, 2021. Nationell för hållbar vindkraft. <https://energimyndigheten.a-w2m.se/Home.mvc?ResourceId=183601>

cost of labour and materials. For installation of mains-connected solar cell systems the tax reduction is 20 %, for installation of a system for storage of electricity and for installation of at home charging stations for electric vehicles the deduction is 50 %. The tax reduction cannot be more than SEK 50,000 per person and year (Govt. Bill 2022/23:15).³⁵

Tax reduction for micro-production of renewable electricity

A tax reduction for households and businesses was introduced in 2015 to stimulate investment in the micro-production of renewable electricity. The income tax reduction is SEK 0.60/kWh renewable electricity fed into the grid in a connection point with a fuse size of up to 100 Amps, but limited to the amount of electricity received from the grid in the same connection point. The tax reduction is capped at SEK 18,000 per year.

Effects of policy instruments in the electricity and district heating sector

Estimates using the TIMES-NORDIC modelling tool (see Box 4.2) show that emissions from the electricity and district heating sector (including back-pressure power) could have been 9-15 Mt CO₂ higher per year in the time period 2005-2020 if policy instruments had remained at their 1990 levels (see Table 4.1). The difference in modelled emissions is due above all to significantly greater use of coal in the scenario based on 1990 instruments than in the one based on current levels of instruments, in which fossil fuels have been replaced by renewables.

In summary, the influence of policy instruments in the sector has led to increased costs for fossil fuels at the same time as the conditions for biofuels and wind power for electricity production have improved. After 2005 the impact of the policy instruments on the fossil fuels for CHP has been the same as, or even less than, in 1990. Low prices, until recently, in the EU ETS strengthen this picture. However, thanks to the electricity certificate system, which is bringing in incentives for renewable fuels, the fossil fuels are kept away. Even if the steering effect of electricity certificate system is reduced in recent years the total effect for the period 1990-2050 is a strong drive away from fossil fuels (Profu 2021).

Table 3.1 Estimated aggregate effects of policy instruments introduced since 1990 on emissions from electricity and district heating production in Sweden, compared with a scenario based on 1990 instruments (Mt CO₂ eq per year) (Profu 2021)

1995	2000	2010	2015	2020	2025	2030	2035	2040	2045	2050
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³⁵ Energimyndigheten.se, Så kan du få skattereduktion för grön teknik, 2021.01.22

3.6	8.7	12.8	14.8	15.5	15.1	6.2	3.2	4.1	6.0	6.2
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Residential and commercial/institutional

Greenhouse gas emissions from heating individual homes, and commercial and institutional premises (heating other than district heating), have fallen dramatically since 1990. The energy and carbon taxes are seen as the instruments contributing most to reducing the use of fossil fuels in this sector in recent decades. The aggregate level of taxes on fossil fuel use for heating in the sector has risen steadily since 1990, even though the increase in recent years is modest. This has made it considerably more expensive to use these fuels than if energy taxation was kept at its 1990 level (Profu 2021). Oil prices and the available technologies for fossil-fuel substitutes have also had significant impact on trends in the sector.

Alongside carbon and energy taxes, there are several instruments targeting energy use in homes, and commercial and institutional premises. Some of the most important ones include building regulations, energy performance certificates, and the Ecodesign, Energy Labelling and Energy Efficiency Directives. In addition, there are instruments such as technology procurement, network initiatives and information campaigns at the local, regional and national levels.

Ecodesign Directive (2009/125/EC), Energy Labelling Directive 2010/30/EU and the Ecodesign Act

Energy labelling is mandatory for the product groups that are regulated by the Energy Labelling Directive (2010/30/EU) and applies to all EU member states. Energy labeling makes the product's energy use visible and facilitates for consumers who want to make energy smart choices.

The Ecodesign Directive (2009/125/EC) aims to improve the products' environmental performance during their full life cycle. The requirements act as a floor to prohibit and remove the very worst products on the market, seen from an energy perspective. In principle, these rules can be applied to all energy-related products (except transport) and cover all energy sources. Sweden is particularly active in market surveillance activities, involving laboratory tests of products as well as supervision of distributors. The directive has been implemented in Sweden through the Ecodesign Act (SFS 2008:112).

Energy Performance of Buildings Directive 2010/31/EC

The Energy Performance of Buildings Directive is a framework within which EU Member States have decided on requirements for setting minimum energy performance standards, building energy certificates and inspections or advice on boilers and air conditioning systems. The aim of the directive is to reduce greenhouse gas emissions from the EU Member States and secure the energy supply in the medium and long-term.

Law on energy performance certificates for buildings

Based on the Energy Performance of Buildings Directive, Sweden has implemented a law on energy performance certificates for buildings (SFS 2006:985). The law includes an obligation for owners of single-family and multi-dwelling buildings and of commercial premises to declare the energy use of buildings and certain parameters regarding the indoor environment. The aim is to promote efficient energy use and a healthy indoor environment by requiring property owners to learn more about which measures are cost-effective to implement for improving building energy performance.

Building regulations

Building regulations have been used since the 1960s to set minimum requirements for energy use in new buildings in Sweden. Since 2009, building regulations for new production have included stricter requirements for electrically heated buildings. Stricter requirements for energy use in new buildings with other heating systems took effect in 2012. Regulations include requirements for specific energy use (kWh/m² and year) and average thermal transmittance (W/m²K).

Training programs in building for low energy consumption

Since 2016, the Swedish Energy Agency in cooperation with other actors has been responsible for a set of capacity building programs in the area of building for low energy consumption. The programs target different construction stakeholders, such as architects, engineers, clients, technicians, installers, site managers and teachers in building programs at upper secondary schools (National Board of Housing, Building and Planning and the Swedish Energy Agency 2016).

Support for market introduction, technology procurement and networks

Technology procurement is an instrument designed to initiate a market transition and disseminate new, more efficient technology, such as new

products, systems and processes. Network-based procurement of technology is an approach that encompasses the entire decision-making process, from feasibility study and purchaser group, to requirements specification and dissemination and further development of more energy-efficient technology. It is being used in areas like heating and control, ventilation and lighting. The Swedish Energy Agency coordinates procurement networks for housing (BeBo), commercial and institutional premises (BeLok), small houses (BeSmå), food distribution (ReLivs, and new construction of, and conversion to, energy-efficient buildings (LÅGAN).

Effects of policy instruments in the residential and service sector

Between the early 1990s and the present day, carbon and energy taxes have helped to phase out oil-based and electric heating. The aggregate level of taxes on fossil fuel use for heating in the residential and service sector has risen steadily since 1990, even though the increase in recent years has slowed down, making it considerably more expensive to burn these fuels than it would have been if energy taxation had been kept at its 1990 level (Profu 2021). This is shown in figure 4.3.

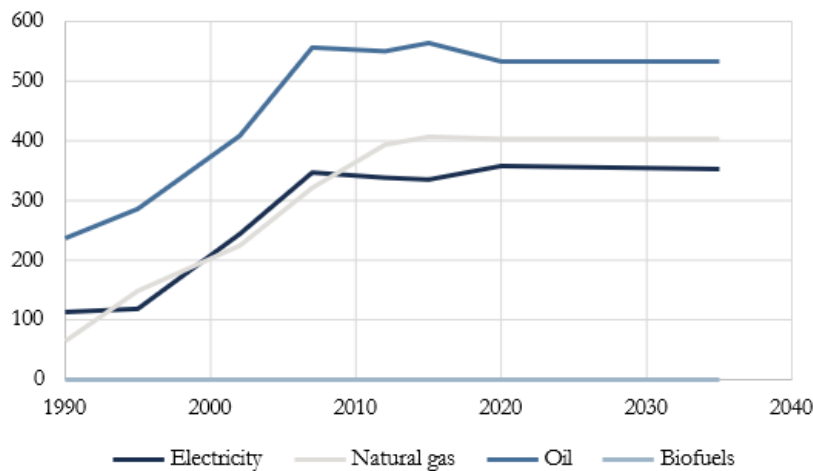


Figure 3.3 Policy instruments affecting light fuel oil, biofuels, natural gas and electricity in the residential and service sector: development between 1990 and 202015, and model assumptions for 20325 (constant 2015 2020 prices) (Profu 202117a).

3.2.4 Industrial emissions from combustion and processes (including emissions of fluorinated green house gases)

Total greenhouse gas emissions from combustion in manufacturing industries have decreased since 1997. The instruments affecting combustion emissions from the industrial sector are the EU ETS, energy and carbon

taxes, the electricity certificate system and the Environmental Code, the Energy Step, Energy Audits, Energy and climate coaches, and Energy efficiency networks.

Greenhouse gas emissions from industrial processes show an overall decreasing trend since 2006. The instruments primarily affecting process related emissions are the EU ETS, the Environmental Code, the Industrial Leap, the Energy Step and Energy Audits.

Industrial Leap

The Industrial Leap is a long-term reform which began in 2018 and continues until 2040. It consists of a government scheme that aims to support development of technology and processes to reduce the process-related greenhouse gas emissions in Swedish industry. Financial support, administered by the Swedish Energy Agency, may be provided for research, feasibility studies, pilot and demonstration projects as well as full-scale investments. Projects related to mitigation, as well as to negative emissions, are eligible for funding. The target group for support is industries with process-related emissions, along with universities and research institutes.

One example of a project funded is the initiative “Hydrogen Breakthrough Ironmaking Technology”, HYBRIT, which aims at ending the use of coal, traditionally needed for ore-based steel-making, and substitute it with hydrogen. The production of hydrogen is moreover planned to be produced from fossil-free electricity. The result would be fossil-free steel-making technology, which has potential to cut Swedish emissions by 10 percent.

In 2018, the government budgeted SEK 300 million for the program. The budget for the Industrial Leap increased the following years (Govt. Bill 2020/21:1). In the budget for 2022 the Government proposes allocations of SEK 909 million for 2022, SEK 754 million for 2023, and SEK 757 million for 2024 (Govt. Bill 2021/22:1).

Support scheme for BECCS

Following the budget for 2022 the Government proposes a support system designed as a reversed auction where the winning company (the company offering the most cost efficient solution) will receive support for capture, transport and storage of biogenic carbon dioxide. The Swedish Energy Agency has been appointed as auctioneer and is authorized up to SEK 36 billion for this purpose for the period 2026-2046. A first such auction will be launched

late 2022. The Swedish Energy Agency is also allocated SEK 15 million annually (from 2022) for administrative support of the system.

Energy audits and the Energy Step for large enterprises

The law on energy audit in large enterprises aims at promoting improved energy efficiency (SFS 2014:266)³⁶. The law requires large enterprises to conduct energy audits, including information of total energy use, as well as proposals of cost-efficient measures to improve energy efficiency. The audit must be conducted at least every fourth year.

Enterprises that are subject to the law, and have conducted an energy audit, have had the possibility to apply for support in terms of an in-depth projection of arrangements and additional costs in investment decisions to increase energy efficiency through the Energy Step Program. The program had a budget of totally SEK 125 million during the period 2018–2020. There is a need for further efforts to achieve the Swedish Parliament’s goal of 50 percent more efficient energy use by 2030.

A government green credit guarantee

In 2021 a state green credit guarantee was introduced with a limit of SEK 10 bn (Govt. Bill 2021/22:1). It was introduced to facilitate major industrial investments that contribute to achieving the goals in the Environmental quality objectives system and the Climate Policy Framework. In the budget bill for 2022 the Government proposes a limit of SEK 50 bn for 2022, SEK 65 bn for 2023 and SEK 80 bn for 2024 for the credit guarantee (Govt. Bill 2021/22:1, ch. 9.4, Table 9.8).

Effects of The Industry Leap combined with other instruments

The projects that have received support through the Industry Leap until 13 January 2021 is estimated to have a total potential to contribute to the reduction of greenhouse gas emissions by a further 11 million tonnes of carbon dioxide equivalents per year compared to the most recent reference scenario. Of these, just under 8 million tonnes refer to a further reduction in industrial emissions and 1-2 million tonnes refers to negative emissions through capture and storage of biogenic carbon dioxide emissions (BECCS). When industrial projects are also included in the reference scenario, the

³⁶ The law is part of fulfilling the EU Energy Efficiency Directive, EED (Directive 2012/27/EU)

potential for reduced industrial emissions rises to 9 million tonnes of carbon dioxide equivalents per year (Govt. Bill 2021/22:1).

The overall reduction potential mentioned above cannot be attributed as a potential future effect of the Industry Leap alone. The instrument operates in interaction with several others, that in combination may contribute to an overall emission reduction of the volume mentioned.

3.2.5 Regulations governing emissions of fluorinated greenhouse gases

EU Regulation (No 517/2014) on fluorinated greenhouse gases and BREF

The EU Regulation (No 517/2014) on fluorinated greenhouse gases (f-gases) entered into force on 1 January 2015. The regulation strengthens measures from former EU Regulation No 842/2006 on f-gases, including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆). The regulation aims to cut emissions by two-thirds from current levels by 2030, and includes provisions for the use, reuse and destruction of f-gases. Most importantly, the regulation includes a mechanism for quantified emission reductions of substances containing HFCs, with a gradual decreasing cap for the total HFC emissions.

The EU adopted a Best Available Techniques reference document (BREF) for the non-ferrous metal industry in June 2016. These could significantly reduce emissions from aluminium production.

Swedish Regulation 2016:1128 on fluorinated gases

Swedish Regulation 2016:1128 on fluorinated greenhouse gases complements the EU regulation. Provisions in Sweden for cooling and air conditioning and heat pump equipment include:

- Requirements on leak checks in conjunction with installation, reconstruction and other interventions.
- Requirements on leakage checks and certified competence, also applying to mobile equipment containing f-gases.
- The results of periodic inspections must be reported to the supervisory authority.

- The supervisory authority must be informed before the installation of equipment containing more than ten kilograms of refrigerants.
- It is prohibited to sell f-gases as refrigerants to recipients other than those stated in the regulation.
- Upon disposal, importers and those who transfer refrigerants are required to take back any refrigerants that they delivered, free of charge, and to provide containers for this purpose.
- Equipment manufactured, imported or brought into Sweden shall be provided with accurate and easy-to-understand operating and maintenance instructions.

3.2.6 Domestic transport

Emissions from domestic transport, where road transport dominates, increased after 1990, reaching a peak in 2007. Since then, emissions have been declining.

The decrease in emissions since 2007 can be attributed to policy instruments introduced both nationally and at the EU level. The most significant ones include carbon dioxide emission EU performance standards for new vehicles, vehicle taxes and vehicle fuel taxes, and more recently, a greenhouse gas emission reduction obligation for petrol and diesel. These have resulted in more energy-efficient vehicles and a greater use of renewable fuels. Reducing transport-related emissions is essential to meet the 2030 climate targets set by the Swedish Parliament. Consequently, the Government has implemented several policies and measures aimed at the transport sector in the last years.

Aviation

Tax on air travel

A tax on air travel was introduced in 2018. The tax aims to reduce the climate impact of aviation. For domestic flights the tax is SEK 64 for a one-way ticket and SEK 128 for a round trip. The tax is described further in section 4.2.10.

Reduction obligation scheme for aviation

In 2021 a reduction obligation scheme for aviation was introduced for renewable fuels. The level is 0,8 percent in 2021 and will increase to 27 percent³⁷ in 2030 (prop. 2020/21:135, bet. 2020/21:MJU20, rskr. 2020/21:303).

Differentiated take-off and landing fees for aviation

In 2021 a decision was taken to introduce differentiated take-off and landing fees. The fees are differentiated according to environmental performance of the aircrafts. Initially, the differentiated fees are introduced at the two largest airports, Landvetter and Arlanda.

Aviation in the EU Emissions Trading System

Aviation is included in the EU Emissions Trading System as of 2012 in accordance with EU Regulation No 421/2014 of the European Parliament and of the Council of 16 April 2014 amending Directive 2003/87/EC. As part of the Fit for 55 legislative package the European Commission is now proposing to revise the ETS aviation rules. This includes a reduced number of free allowances allocated to aircraft operators to reach full auctioning by 2027.

Road transport

Emission reduction obligation (Fuel change)*

In July 2018, a greenhouse gas emission reduction obligation for petrol and diesel in conjunction with fuel tax reforms, called the Fuel Change, was implemented. The emission reduction obligation establishes an obligation on petrol and diesel suppliers to reduce life-cycle carbon dioxide emissions. The obligation replaces the former tax exemption for low-blended biofuels, i.e. biofuels covered by the scheme will be subject to the same tax rate per liter as fossil equivalents. At the same time, both the carbon dioxide and energy tax rates for fuels covered by the Reduction obligation scheme have been reduced.

When implementing the scheme the adjustment of the carbon tax rate was implemented to reflect the reduced greenhouse gas emissions that the blend-in of sustainable biofuels entails. The energy tax rate was reduced to maintain a stable price-level for fuels, so that consumers would be largely

³⁷ 1% and 30% respectively in volume.

unaffected by the reform. High-blended biofuels are not covered by the scheme and are, if sustainable, completely exempt from both carbon dioxide and energy tax.

Bonus–malus system for new light-duty vehicles*

A bonus–malus system for new light-duty (max 3,5 tonnes) vehicles has been in place between July 2018 and November 2022. Vehicles with low carbon dioxide emissions qualified for a bonus at purchase, while vehicles with high carbon dioxide emissions are subject to an increased vehicle tax (malus) during the first three years from the date when the car first becomes taxable. The system covered purchases of new passenger cars, including campers, and vans. Cars adapted for alternative fuels such as ethanol and gas, except LPG, are exempted from the increased tax. The aim of the system has been to increase the proportion of environmentally friendly vehicles sold.

From 2021 a maximum bonus has been given to new vehicles with zero emissions from the exhaust pipe — SEK 70,000. At 60 grams of carbon dioxide per kilometer, the bonus ends. The maximum bonus for vehicles with emissions above zero amounts to SEK 45,000. Gas-powered cars received a bonus amount of SEK 10,000 regardless of their level of carbon dioxide emissions.

Vehicles with emission in the range of 60-90 grams of carbon dioxide per kilometer neither qualified for any bonus, nor have they been subject to malus. Vehicles with emissions exceeding 90 grams per kilometer are subject to malus. In the range of 90–130 grams per kilometer the increased annual vehicle tax is SEK 107 per gram. For emissions exceeding 130 grams per kilometer the increased annual vehicle tax is SEK 132 per gram.

As of 1 June 2022 vehicles with emissions exceeding 75 grams carbon dioxide per kilometer are subject to malus and emissions exceeding 125 grams per kilometer are taxed at SEK 132 per gram. The system was abolished in November 2022.

Requirements for renewable fuels at filling stations

The availability of renewable fuels has been subject to legislation requiring that filling stations with annual sales of petrol and diesel above a specified level must supply at least one kind of renewable fuel. The law (SFS 2005:1248) became effective 1 January 2006. This requirement has resulted

in an increased number of mainly E85 pumps. As of 2015, the legal requirements were loosened so that filling stations selling more than 1,500 m³ of petrol or diesel must supply at least one kind of renewable fuel.

EC Fuel Quality Directive

In 2009, Directive 2009/30/EC was adopted to revise the Fuel Quality Directive (98/70/EC). It introduces requirements for fuel suppliers to reduce the greenhouse gas intensity of energy supplied for road transport (low carbon fuel standard) by 6 percent until 2020. The emission reduction obligation in Sweden is more ambitious than this, see Table 4.3 above. In addition, the Renewable Energy Directive (2009/28/EC) establishes sustainability criteria that must be met by biofuels if they are to count towards the obligation to reduce greenhouse gas intensity.

Emission performance standards for new vehicles

Manufacturers selling vehicles in the EU are subject to EU regulations (Nos 443/2009 and 510/2011) that set emission performance standards for new passenger cars and vans as part of the Community's integrated approach to reducing CO₂ emissions from light-duty vehicles. Under these regulations, new passenger cars should not emit an average of more than 95 g CO₂/km by 2021. New vans should not emit an average of more than 147 g CO₂/km by 2020. New standards for 2025 and 2030 were adopted by the EU during 2019. Accordingly, CO₂-emissions from new passenger cars and new vans are to be reduced by 37.5 percent and 31 percent respectively by 2030 compared to average emissions 2021. Following the Fit for 55 package, the European Commission is preparing a revision of the standards. Proposed reduction levels, 2030 compared to 2021, are 55 percent for new passenger cars and 50 percent for vans. By 2035 the reduction target is 100 percent for both categories (European Commission 2021.07.14). In 2019 the EU also adopted CO₂-emissions standards for heavy-duty vehicles. Emissions from new heavy-duty vehicles in 2025 are to be 15 percent below the average for 2019, and 30 percent lower compared to 2019 by 2030.

CO₂-based vehicle tax

In 2006 Sweden implemented a CO₂-based vehicle tax system for passenger cars. For older vehicles the tax is weight-based. All vehicles in the system are subject to a basic charge of SEK 360 per year. In addition, vehicles are subject to a CO₂ component depending on their level of carbon dioxide emissions per kilometer in mixed driving. The CO₂ component is SEK 22 per gram carbon dioxide per kilometer exceeding 111 grams. For diesel cars

that first become taxable on 1 July 2018 or later, a fuel surcharge is added, together with an environmental surcharge. For other diesel cars in the CO₂-based system, the CO₂ component is multiplied by a fuel factor of 2.37 and an environmental surcharge is added. For cars adapted for alternative fuels such as ethanol and gas, except LPG, the CO₂ component is SEK 11 per gram carbon dioxide per kilometer exceeding 111 grams. Vans and campers are also included in the CO₂-based vehicle tax system since 2011. The main purpose of the CO₂-based differentiation is to reduce carbon dioxide emissions by making car buyers choose fuel efficient cars.

The CO₂-based vehicle tax system applied to cars that first became taxable before the bonus–malus system was introduced in July 2018, and also to any car “leaving” the bonus–malus system three years after it first became taxable.

Climate premiums for electric buses, heavy-duty vehicles and working machinery

Since January 2020 regional public transport agencies, public transport companies, municipalities and limited companies³⁸ are eligible to apply for climate premiums for electric buses. Companies and municipalities are also eligible to apply for climate premiums, for Electric and other renewable-fueled heavy-duty vehicles as well as for electric tractors and working machinery. The total budget for these premiums is SEK 1 430 million for 2022, SEK 330 million for 2023, and SEK 300 for 2024 (Govt. Bill 2021/22:1). The bulk (SEK 1100 million) of the premium for 2022 is earmarked for electric buses.

Local Climate Investment Program (Climate leap)

The Climate Leap is a comprehensive investment support scheme. Municipalities, companies, organisations and others can apply for investment support for measures to reduce climate impact. A large number of these investments relate to the transport sector, such as investments in biogas plants or the installation of charging points for electric vehicles. The program is prolonged until 2026 with a total budget for the period 2015-2026 of SEK 12.2 billion (Govt. Bill 2021/22:1). More about the Climate leap in section 4.2.2 Cross-sectoral instruments.

³⁸ Which by the regional public transport authorities have been given the authority to enter into public transport contracts.

Tax reduction for installation of green technology*

With the aim to reduce greenhouse gas emissions private individuals are, since 2021, eligible to a tax reduction for installation of green technology including solar cells, systems for storage of self-produced electricity and at home charging stations (Govt. Bill 2021/22:1). The tax reduction is given on the cost of labor and materials. For installation of home charging stations for electric vehicles the reduction is 50 % (Govt. Bill 2020/21:1).

Urban environment agreements

Urban environment agreements is a scheme for investments in public transport, cycling infrastructure or sustainable freight transport at the Regional and local level in Sweden. The scheme commenced in 2015. In the national plan for the transport infrastructure 2022-2033, SEK 6 billion for the period 2022-2027 is allocated to the urban environmental agreements.

Municipalities are eligible to apply for grants to cover part of the investment costs for public transport infrastructure. The investment should be coupled with other actions aiming at increasing the long-term sustainability of urban areas, including increased housing construction, and the transport system. The scheme is administered by the Swedish Transport Administration.

Research and demonstration

Swedish agencies are financing several large research programmes covering the entire chain from cultivation of raw materials for bio-based motor fuels to the use of new fuels. These include:

- FFI – Strategic vehicle research and innovation
- F3 – Collaboration program for renewable fuels and systems
- SFC – Research on biomass gasification
- Battery funding program
- Vinnova – Innovations for a sustainable society
- Triple F (Fossil Free Freight) focusing on three major challenges: A more transport efficient society; energy efficient and fossil-free vehicles and ships; increased share of renewable fuels.

Sweden is also involved in the EU Refuel project, which aims to develop strategies for introducing cost-effective alternative vehicle fuels. The project is also investigating potential effects on stationary installations using biofuels.

Consideration of climate in long-term infrastructure planning

In 2021, the Riksdag decided on an economic framework for a new twelve-year national infrastructure plan. In 2022 the government then adopted a new national plan for transport infrastructure for 2022-2033, to be implemented by The Swedish Transport Administration with other relevant actors. The Swedish Transport Administration is responsible for long-term planning of all modes of infrastructure for transport. Planning is undertaken in dialogue with local and regional planning bodies. Under the applicable legislation there is a clear requirement to take environmental consideration in the planning process.

Eco-bonus system to stimulate transfer from road to shipping*

In 2018, the government launched a temporary eco-bonus support aimed at stimulating the transfer of goods from road to shipping to reduce greenhouse gas emissions from heavy transport. The annual budget of the eco-bonus system for heavy transports is SEK 50 million for 2020-2022.

The eco-bonus system for heavy transports is prolonged for the period 2022-2024. This period the scope is broader, although minimize not yet decided, and the annual budget is SEK 100 million (Govt. Bill 2020/21:1; 2021/22:1).

Environmental compensation for railway transport of goods

In 2018 an environmental compensation scheme was introduced to stimulate railway transports of goods. SEK 550 million is budgeted per year between 2021-2025 (Govt. Bill 2021/22:1). An extra SEK 697 million was budgeted for 2022.

Congestion tax

Congestion tax is levied in the cities of Stockholm and Gothenburg since 2007 and 2013, respectively. The tax is levied during such hours and on such places where there is considered to be congestion. Various levels of tax are levied throughout the day (in Stockholm for 2022: SEK 11–45, in Gothenburg for 2022: SEK 9–22) with a maximum amount per day of SEK 135 in Stockholm and SEK 60 in Gothenburg.

Low emission zone

Eight municipalities in Sweden have already set up low emission zones, restricting access to lorries and buses that don't meet specific requirements. From 2020 and onwards municipalities also have the possibility to set restrictions on cars, based on two new environmental categories of low emissions zones.

State co-financing for certain regional public transport facilities

Government co-financing for certain regional public transport facilities is an investment support for infrastructure for regional public transport.

Investment support may also be provided for vessels in regional public transport as well as for improved environment and traffic safety on municipal roads and streets. Co-financing amounts to a maximum of 50 % of the costs (SFS 2009:237).

Support for electric charging infrastructure for heavy vehicles

The Government decided in its Budget Bill for 2021 on a support scheme for regional electrification pilots with charging infrastructure for heavy vehicles. The aim is to enable electrification of heavy road transport in the busiest areas. Tank infrastructure for hydrogen is also included in the support scheme (Government Bill 2020/21:1). SEK 400 million is allocated for 2021, SEK 550 million for 2022 and SEK 1 billion for 2023 (Govt. Bill 2021/22:1).

Support for electric fast charging infrastructure

In July 2020 the Government decided on a new support for public fast charging infrastructure in connection with major roads in areas where fast charging is missing. The support aims at ensuring basic access to charging infrastructure for fast charging of electric vehicles throughout the country. The support adds up to SEK 150 million for the period 2020-2022 and is administrated by Swedish Transport Administration (Govt. Bill 2021/22:1, UO 21; Trafikverket 2021).³⁴

National ticket system for public transport

The Government proposes additional funds for the introduction of a national ticket system for all public transport throughout Sweden. The system will make it easier for travelers to choose to travel by public transport, which is judged to have positive effects for both leisure travelers and work commuting and benefit local and regional labor market regions.

SEK 105 million is allocated for 2022 and 2023 respectively. SEK 1 million is allocated for 2024 (Govt. Bill 2021/22:1).

Night train traffic in Sweden and abroad

To bind Sweden together, and at the same time contribute to sustainable travel, opportunities are needed to continue night trains to and from upper Norrland and Jämtland in the future. New carriages and locomotives are also needed for traffic.

In July 2020, the Swedish Transport Administration was commissioned to carry out a procurement of night train traffic through Sweden and Denmark, which contributes to the establishment of international night train connections with daily departures from Sweden to other European countries. Traffic between Stockholm and Hamburg started in September 2022.

The effort contributes to meeting, and contributes to, a growing demand for travel by night train abroad so that the conditions are improved for continued night train traffic on commercial grounds. If train travel replaces travel by air and car, a great climate benefit can be achieved (Govt. Bill 2021/22:1).

Conversion premium

To reduce emissions from the existing vehicle fleet the Government proposed in its budget bill for 2021 that a conversion premium for cars from fossil fuels to biofuels or biogas should be introduced in 2022 (Govt. Bill 2020/21:1).

Effects of selected policy instruments in the transport sector

Emissions from domestic transport account for about one third of Sweden's total greenhouse gas emissions and about half of greenhouse gas emissions in the non-trading sector. The transport sector has a sector-specific intermediate target by 2030, which means that emissions from domestic transport (excluding domestic flights) will be reduced by at least 70% by 2030 compared to 2010. Greenhouse gas emissions from domestic transport (excluding domestic flights) amounted to 15 million tonnes of CO₂ equivalent in 2020, which is a decrease of 10% compared to 2019.

Road traffic accounts for by far the largest share (about 95%) of emissions from transport in the country, of which passenger cars account for about

63% and heavy and light trucks account for about 30%. Compared to 1990, emissions from domestic transport (excluding domestic flights) have decreased by 21%%. The reduction in emissions is mainly a result of an increase in the share of biofuels while at the same time making vehicles more energy efficient.

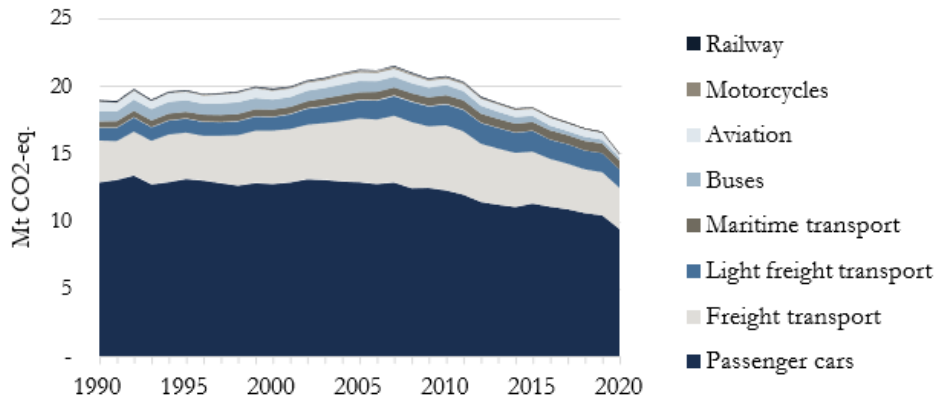


Figure 3.4 Greenhouse gas emissions from domestic traffic, excluding domestic aviation, 1990 -2020 (SEPA 2021).

The combined effects of the emission reduction obligation (Fuel change)* and policies affecting fuel efficiency and the introduction of electric vehicles

The final reduction effect and the total volumes of sustainable biofuels needed to meet the emission reduction obligation in 2030, depends on the development of the demand for petrol and diesel, which in turn depends on the level of traffic and the level of fuel efficiency in the vehicle fleet, including the amount of battery electric and plug-in hybrid electric vehicles.

The potential emission reduction effect that may be attributed to the reduction obligation depends therefore to a large degree on the assumptions made regarding other factors also influencing the fuel demand. .

Compared to the projection scenario, see chapter 5, where the assumed level of electric vehicles in 2030 is low compared to more recent estimates and the actual introduction shares in recent years, the Swedish EPA estimate an effect of approximately 5–6 million tonnes of carbon dioxide per year in 2030 resulting from the reduction obligation³⁹. The volumes of biofuels increase substantially in this assessment. The corresponding effect of the

³⁹ Estimates for 2025 and 2035 (see Tables 4.5 and 5.20) are based on extrapolation of the results of previous analysis.

reduction obligation in mobile machinery was estimated to 1,5-1,8 million tonnes.

However, there are challenges linked to the volumes of biofuels needed and the possibility of achieving targets for air quality regarding nitrogen dioxides. There is also uncertainty about how large volumes of biofuels can be available nationally and internationally in different time perspectives, depending on how demand develops in other countries and sectors, for example in aviation. Constraints in the supply of sustainable biofuels globally can also lead to higher costs.

The final reduction effect and the total volumes of sustainable biofuels needed to meet the emission reduction obligation in 2030, depends on the development of the demand for petrol and diesel, which in turn depends on the level of traffic and the level of fuel efficiency in the vehicle fleet, including the amount of battery electric and plug-in hybrid electric vehicles.

In a sensitivity analysis the rate of electrification in the vehicle fleet is assumed to be higher, more in line with the market development in recent years in Sweden (“elektrifieringsscenario” ER 2021:06). In this scenario the emissions decrease with approximately 2,7 million tonnes of carbon dioxide per year in 2030 compared to the projection in chapter 5, due to the increased energy efficiency in the vehicle fleet.

This effect may be attributed to national and EU-instruments in combination that affects the choice and the performance of new cars introduced to the market, see next section. National instruments and EU standards contribute and interact with policies enabling vehicle charging. The fuel price development is also of importance for the overall development.

The increase in demand for biofuels is lowered quite substantially in the scenario with a higher electrification rate and the overall effect of the reduction obligation is, accordingly, reduced to 3-4 million tonnes of carbon dioxide per year in 2030. When the estimated effect in mobile machinery is added this sensitivity analysis result in total in 4-6 million tonnes reduction of carbon dioxide per year in 2030 due to the reduction obligation.

When it comes to the rate of electrification of cars in Sweden it could be noted that the latest statistics show a significant increase in sales of rechargeable cars in Sweden. In 2020, the share of electric cars and plug-in

electric hybrids sold in Sweden was about 31 percent of sales of passenger cars. In 2021, the share had risen to 45 percent of new car sales. At the same time, the proportion of electric cars is increasing in relation to plug-in hybrids. The proportion is among the highest in EU member states in terms of the share of chargeable cars in new car sales (IEA 2021).

National and EU instruments for energy efficiency

New cars are becoming more and more energy efficient, and CO₂ emissions from the average car have steadily declined since the mid 1990's with an acceleration around 2005. In recent years an increasing share of chargeable cars in new cars sales contributes the most to the decrease in average CO₂-emissions from new cars.

There are several policy instruments that have interacted to promote the energy efficiency of new cars sold in Sweden. First, several national instruments⁴⁰ have been introduced since 2005. Second, the EU has introduced carbon dioxide emission standards for new cars. In the previous national communication, NC7, The Swedish Transport Administration assessed the effect on national emissions of the EU CO₂ standards for new cars and the national instruments introduced since 2005 that affect car choices. This assessment has been updated and revised by the SwEPA for this communication, since both the EU performance standards and the national instruments has been amended to stricter levels in recent years.

The updated assessment shows a greater effect of the EU CO₂ standards compared to the previous estimate. The increased effect can be explained by the amendment of the EU CO₂ standards on light duty vehicles, with stricter requirements in 2025 and 2030 in combination with the introduction of EU CO₂ standards also on heavy duty vehicles. The assessment also indicates that the national instruments has an additional effect on the emissions in 2030 when combined with EU CO₂ standards. The scenario “with EU CO₂ standards and national incentives”, builds on the development in “the electrification scenario” mentioned in the previous section.

The emission effect increases over time as the share of the fleet replaced by vehicles meeting stricter standards grows. In 2030, the total effect compared

⁴⁰ CO₂-based vehicle tax, green-car insurance premium, super-green car rebate, tax exemption for environmentally friendly vehicles, reduced taxable values for some company cars with environmentally friendly technology, bonus–malus system, grants for charging infrastructure etc.

to the scenario without EU-standards and national incentives is estimated to approximately 8 million tonnes CO₂/year.⁴¹

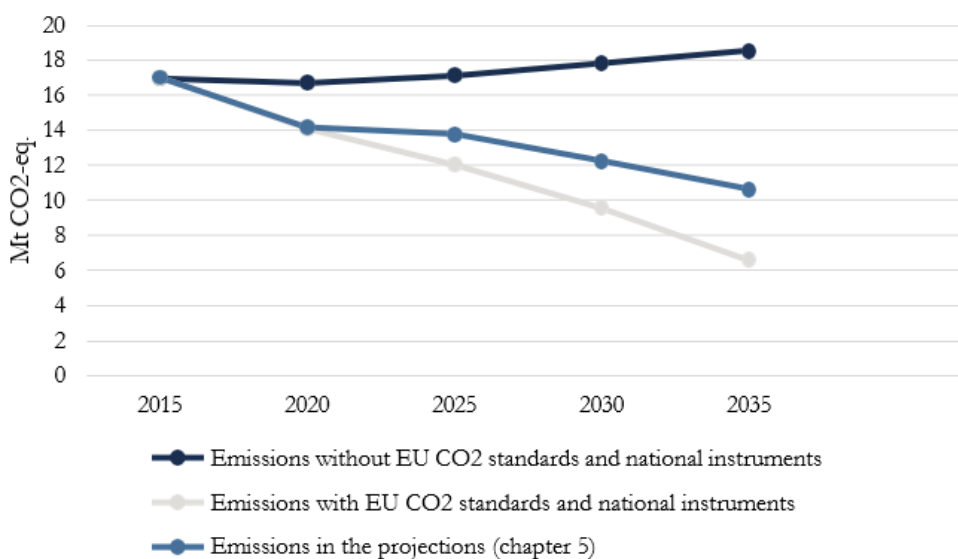


Figure 3.5 Historic and future CO₂ emissions from passenger cars, light duty and heavy duty vehicles in total, with and without implemented policy instruments for energy efficiency.

3.2.7 Waste

Emissions from waste have declined. There has been a series of policy instruments at both national and EU levels. Demand for waste as a fuel for district heating has also strongly encouraged diversion from landfill to incineration.

Landfill Directive (1999/31/EC)

The Landfill Directive requires landfilling of biodegradable waste to be reduced and for methane to be collected from landfills, preferably with energy recovery. Sweden has, however, introduced more far-reaching national instruments resulting in earlier attained emissions reductions.

Landfill tax

In 2000 a tax of 250 SEK per tonne landfilled waste was imposed on waste disposal to landfill (SFS 1999:673). The landfill tax has been increased

⁴¹ Estimates for 2025 and 2035 (see Tables 4.5 and 5.20) are based on extrapolation of the results of previous analysis.

gradually, and is today 555 SEK per tonne landfilled waste (Swedish Tax Agency 2021).⁴²

Ban on landfilling combustible and organic materials and methane collection

Under the Swedish Ordinance on the Landfill of Waste (SFS 2001:512), a ban on landfilling combustible materials was introduced in 2002 and a similar ban was imposed for organic material in 2005. The ordinance also regulates the collection and disposal of methane gas from landfills. The ordinance is intended to prevent and reduce adverse effects on human health and the environment from landfilling.

Extended producer responsibility

A set of ordinances mandates extended producer responsibility for producers of eight product groups. Producer responsibility promotes sorting, collection and recycling of certain waste flows⁴³. Producer responsibility aims to incentivise producers to develop more resource-efficient products that are easier to recycle and do not contain environmentally hazardous substances. It also aims to reduce the amount of waste. The legislation on extended producer responsibility contains national targets for recycling, and has resulted in increased separated collection of waste fractions and increased recycling (apart from pharmaceuticals and radioactive products, where there are no specific targets).

The municipal waste planning requirement

Since 1991, there has been a requirement that all the municipalities in Sweden must have their own municipal waste plan. A Swedish EPA regulation (NFS 2006:6) sets out the minimum requirements of what each municipality must include in its waste plan, such as a description of the current situation, recycling plants and landfills, environmental assessment, measures and monitoring. Both the national waste plan (Swedish EPA 2012) and the national prevention program (Swedish EPA 2015) act as guidance for the municipalities in developing their local plans and deciding on prioritised actions.

⁴²

<https://skatteverket.se/foretagochorganisationer/skatter/punktskatter/avfallsskatt.4.18e1b10334ebe8bc80002886.html>

⁴³ Extended producer responsibility has been developed for packaging, waste paper, end of life vehicles, tyres, electrical and electronic equipment, batteries, pharmaceuticals and radioactive products.

The Waste Directive, Regulation on shipment of waste and REACH

Several EU regulations and directives are crucial for facilitating the Swedish strategy for a circular economy (see above). These include the Directive on waste (2008/98/EC), the regulation on shipment of waste ((EC) No 1013/2006) and Regulation ((EC) No 1907/2006) concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). Transforming production and consumption towards a circular economy has a large potential to reduce the use of materials and thus the Negative impact on the climate. This requires a shift from virgin materials to circular material flows. This, in turn, requires toxic chemical to be removed.

Effects of policy instruments in the waste sector

An analysis of the combined effect of policy instruments influencing methane emissions from landfill sites showed that, in a scenario based on instruments decided on at the time of the analysis, emissions would end up around 1.7 Mt CO₂ eq lower in 2015 than in a scenario based on 1990. By 2020, the difference was assessed to be 1.9 Mt CO₂ eq (Swedish Environmental Protection Agency, 2001).

According to preliminary statistics from the Swedish Environmental Protection Agency, emissions from waste have decreased by 4.6 per cent in 2020 compared to the previous year. Behind this development are the landfill bans and taxation of landfilling of waste, which were introduced in the early 2000:s.

Common Agricultural Policy

In 2021 the European Parliament the Council of the EU and the European Commission agreed on the reform of the CAP. The new CAP for the period 2023-2027 aims to support the transition towards sustainable agriculture and forestry in the EU and to contribute to the goals of the European Green Deal. 40% of the CAP budget will have to be climate relevant (European Commission 2021).⁴⁴ The current CAP of 2013 is extended until 2023.

In 2013, the Council of EU Agriculture Ministers formally adopted the four Basic Regulations for a reformed CAP. Based on certain requirements,

⁴⁴ https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/new-cap-2023-27_en

farmers can receive support for measures aimed at producing non-profitable services delivered to the wider public, such as landscapes, farmland biodiversity and climate change mitigation. Through the CAP's second pillar for rural development member states have access to a wide range of measures to encourage higher environmental performance including climate mitigation and adaptation. The policy also requires member states to allocate a minimum share of the second pillar funds to such measures. According to the *Strategic plan for the implementation of the common agricultural policy in Sweden 2023-2027* “[c]limate-impacting emissions from the agricultural sector can be reduced but not completely removed”. Measures, mentioned in the Strategic plan, where agriculture can contribute to reduced climate impact include becoming more resource efficient per unit produced, increasing carbon storage in soil and contributing to increased production of renewable energy.

Rural Development Program (pillar 2 of the CAP)

The Swedish Government decided on a Rural Development Program in June 2014. The program for 2014–2020, extended until 2022, includes investment grants for young entrepreneurs, capacity building, cooperation and innovation, support to areas with natural constraints, animal welfare subsidies, ecological farming, and environmental and climate actions.

Measures specifically contributing to climate change mitigation include those aimed at: increasing energy efficiency; production and use of renewable energy (including biogas production and establishment of perennial energy crops); conversion from fossil to renewable energy sources; improved manure handling; more efficient use of nitrogen; climate and energy advice; measures to prevent the risk of nitrogen leakage; restoration and establishment of wetlands; promotion of grass ley and catch crop production in intensive cropping areas; conservation of semi-natural pastures; and other separate projects relating to climate and energy. The program budget for 2014-2020 totalled SEK 36 billion, of which 59% is financed by Sweden and

The program budget for 2014-2020 totalled SEK 36 billion, of which 59% is financed by Sweden and the remaining 41% by the EU. For the extension period 2021-2022 the program budget is SEK 10.5 billion (Swedish Board of Agriculture 2021).⁴⁵

⁴⁵ [Landsbygdsprogrammet - Jordbruksverket.se](https://www.landsbygdsprogrammet.se)

The rural network

The rural network complements the Swedish Rural Development Program, the Ocean and Fishery Program, and the program for local leadership development in the Social fund and Regional fund. The network brings together actors at the local, regional and central levels for exchanging information and experiences. The network is intended to reinforce implementation of these programs.

Support for biogas production

In 2015, the Government introduced a support scheme for biogas production through anaerobic digestion of manure. The support program ends in 2023. It aims to increase biogas production from manure and thereby gain two-fold environmental and climate benefits through reduced methane emissions from manure and the substitution of fossil energy.⁴⁶ The increased digestion of manure offers several environmental benefits. It reduces both emissions of greenhouse gases and eutrophication of fresh and marine waters as well as produces biogas for energy. The biogas generated can be used to generate electricity or heat, or as vehicle fuel. The subsidy amounts to a maximum of 0.40 SEK/kWh of biogas produced. The support amounts to SEK 30 million for 2021 and SEK 22.5 million per year for 2022-2023. Support for investments in new biogas plants can also be granted through the Rural Development Program.

3.2.8 Land use, land-use change and forestry (LULUCF)

Forest Policy and the Forest Act

The Swedish Forest Policy has two overarching, equal objectives: the production objective and the environment objective.

The production objective means that forests and forest lands should be used effectively and responsibly so they produce sustainable yields. The direction of forest production should be given flexibility in the use of what the forests produce.

The environment objective means that the natural productive capacity of forest land should be preserved. Biodiversity and genetic variation in forests should be secured. Forests should be managed in a manner that enables naturally occurring plant and animal species to survive in natural conditions

⁴⁶ [Jordbruksverket.se/stod/fornybar-energi/godselgasstod](https://jordbruksverket.se/stod/fornybar-energi/godselgasstod)

and in viable populations. Threatened species and habitats should be protected. Cultural heritage assets of forests and their aesthetic and social values should be safeguarded. Under the Forest Policy, there are no production subsidies, and forest owners have considerable freedom and responsibility to independently conduct long-term sustainable forest management. The regulations in the Forestry Act (as of 1993) concerning timber production cover the notification of felling, the lowest age for felling, requirements for reforestation, guidelines for thinning and measures to limit damage. Special regulations apply to certain types of forests, such as subalpine forests and deciduous forests. Examples of regulations concerning nature conservation and cultural heritage include not disturbing important biotopes, buffer zones and arable land, and leaving older trees, high stumps and dead wood in situ. Sustainable forest management influences carbon dioxide removals and emissions in various ways, through the production of renewable raw materials that can replace fossil fuels and materials that generate emissions of greenhouse gases while maintaining or increasing carbon stocks in biomass, soils and harvested wood products.

Regulation on land drainage in the Environmental Code

The Swedish Environmental Code is a coordinated and broad piece of environmental legislation aimed at promoting sustainable development so that present and future generations can live in a good, healthy environment. For example, chapter 11 of the Code contains regulations on land drainage, which can be used to reduce emissions from peat soils with large carbon stocks. Land drainage measures are actions taken to remove water from soil or protect against water. In order for the measure to be a land drainage measure according to the Environmental Code, the purpose of the measure is to permanently increase the soil's suitability for a specific purpose, such as cultivation, development, peat cover, road construction, garden plant or golf courses.

In central parts of the southern Swedish highlands and north of the limes norrlandicus (the biogeographical boundary of northern Sweden), drainage may only be undertaken with a permit. In the rest of the country, and on sites specially protected under the RAMSAR Convention, such schemes are prohibited. Land drainage has decreased since the beginning of the 1990s and is now occurring only to a very limited extent.

Provisions on nature reserves and habitat protection in the Environmental Code and nature conservation agreements

In Sweden, forests and land are allocated for the conservation of biodiversity, nurture and preserve valuable natural environments, protect, restore or create valuable natural environments and for outdoor recreation. These measures, for example in the form of nature reserves, nature conservation agreements and voluntary disposal of land, are also positive for carbon stocks in forest biomass and soil coal by allowing them to be maintained or continue to increase.

Nature reserves

In Sweden, nature reserves⁴⁷ are one of the most common ways of protecting valuable nature in the long term. At present, there are close to 5000 nature reserves in Sweden. The seventh chapter of the Environmental Code contains the regulations for the establishment of nature reserves. The work of establishing nature reserves is led by the Swedish Environmental Protection Agency.

Nature conservation agreements

Nature conservation agreement is a civil law agreement (Swedish Environmental Protection Agency 2019c). The property owner and the state or a municipality agree on a certain financial compensation for the property owner, for example, to refrain from, for example, forestry. The Swedish Forest Agency and the Swedish Environmental Protection Agency together guide how to go about it. For the landowner it should not matter what authority you agree with.

The Swedish National Forest Program

In 2015 the Government initiated a comprehensive dialogue with stakeholders within the Swedish National Forest Program.

In 2018, the Government adopted a strategy for Sweden's National Forest Program, followed by an action plan with specific measures. The action plan will be updated in dialogue with interested parties. The core of the National Forest Programme is the broad dialogue on the role forests play to ensure a sustainable society and a growing bioeconomy.

⁴⁷ <http://www.naturvardsverket.se/Var-natur/Skyddad-natur/Naturresevat/>

The strategy for the National Forest Programme focuses on objectives in five main areas:

- Sustainable forest management with greater climate benefits
- Multiple uses of forest resources for more jobs and sustainable growth throughout the country
- World-class innovation and processed forest products
- Sustainable use and conservation of forests as a profile issue in Sweden's international cooperation
- A knowledge leap to ensure the sustainable use and conservation of forests

Methods for increased carbon sinks

The Swedish Forest Agency receives SEK 1.5 million per year in 2021 and 2022 to develop methods for increased carbon sinks. In addition, the Agency receives an additional SEK 30 million for efforts to monitor, prevent and combat forest damage. Combating forest damage can contribute to reduced climate impacts by promoting forest growth and reducing natural emissions (Govt. Bill 2021/22:1).

Support for re-wetting of wetlands

Since 1990, the Swedish state has funded the rewetting of more than 3500 ha of drained wetlands on organic soils for purposes such as nutrient retention and biodiversity. Data of rewetting efforts from the period 1990 to 2019 vary in quality, and the total area of forest land (150 ha) is likely underestimated. Rewetting of much larger areas on forest land have been funded and reported, but they have not been registered into the utilized database.

In 2020 the Government decided on a new support scheme for re-wetting previously drained wetlands, which aims at providing climate benefits while also strengthening biodiversity, balance water flows, increase the addition to ground water and reduce eutrophication. The re-wetting of wetlands on peat soils are expected to reduce the CO₂ emissions caused by the drainage. The initiative is implemented primarily by raising funds within the local nature conservation initiative (LONA). The initiative is based on voluntary

participation by landowners (Government Bill 2020/21:1). SEK 350 million is allocated for the support in 2021. For 2022 and 2023 SEK 325 million and 100 million is proposed respectively (Govt. Bill 2021/22:1).

The Swedish Forest Agency has also received SEK 5 million in funding for the advice to forest owners regarding re-wetting previously ditched or drained wetlands.

Effects on LULUCF (re-wetting)

The investment in re-wetting measures is estimated to contribute to an emission reduction of a total of 1.5-3.6 million tonnes of CO₂-equivalents over a twenty-year period. For 2030, the emission reduction is estimated at 0.08-0.18 million tonnes of CO₂-equivalents depending on which land is re-wetted. The same emission reduction is expected for 2040 (Govt. Bill 2021/22:1).

Implementation of Articles 3.3 and 3.4 of the Kyoto Protocol

For the second commitment period of the Kyoto Protocol (2013–2020), Sweden has decided to account for changes in removals and emissions from mandatory activities: afforestation, reforestation, deforestation and forest management (Swedish EPA 2016). Sweden has not elected additional voluntary activities under Article 3(4) for the second commitment period of the Kyoto Protocol.

Sweden established the definition of forest back for the first commitment period under the Kyoto Protocol. The definition follows the criteria for forest land as derived from the FAO definition and the IPCC's good practice guidance. Sweden intends to apply the provisions to exclude emissions from natural disturbances for the accounting of afforestation and reforestation under Article 3(3) and forest management under Article 3(4) during the second commitment period of the Kyoto Protocol.

The forest management reference level for Sweden is -41.3 million tonnes of CO₂-equivalents per year, applying a first-order decay function for harvested wood products. The forest management reference level was based on averages of the projected emissions/removals for carbon pools and included sources for forest management data series for the period 2013–2020, taking into account policies implemented before mid 2009. Sweden is allowed to claim a maximum credit of 2.5 million tonnes of CO₂ per year in the second commitment period of the Protocol. For the years 2013-2019 Sweden has

reported a net sink from forest management that is significantly larger than the cap of credits from forest management of 2.5 million tonnes of CO₂ per year. The full description of the forest management reference level calculations can be found in Sweden's submission of information on forest management reference levels (Swedish Govt. 2011).

Under the Kyoto Protocol, the National Communication is to include information on national legislative or administrative procedures to ensure that implementation of Articles 3.3 and 3.4 also contributes to the conservation of biodiversity and sustainable use of natural resources.

Sweden's current forest policy puts great emphasis on using forests sustainably as a natural resource and on conserving biodiversity. Under the Forestry Act, forests are to be managed and harvested in such a way as to contribute to sustainable forestry. The provisions of environmental legislation on nature reserves and habitat protection areas provide long-term formal protection for forest areas of high biological value, and the Forestry Act stipulates that forests must be managed using measures that meet good environmental standards. There has therefore been no need for supplementary legislation to conserve biodiversity and ensure sustainable use of natural resources as a consequence of implementation of Articles 3.3 and 3.4.

3.2.9 Shipping water-borne navigation and aviation, including international bunkers in Sweden

Tax on air travel*

A tax on air travel was introduced in 2018. The tax aims to reduce the climate impact of aviation. The tax is regulated in the Swedish act SFS 2017:1200 regarding tax on air travel. It is designed as a tax on commercial

ICAO

Within the ICAO, Sweden and the EU have been pressing for action to limit greenhouse gas emissions from international aviation, using a unified global measure. ICAO decided in 2016 to develop a market-based mechanism, Carbon Offsetting and Reduction Scheme for International Aviation, CORSIA, to compensate for some of the CO₂ emissions from international aviation. The ICAO Council adopted this mechanism in 2018. Sweden is among the nations that have voluntarily participated in the scheme from its outset. Sweden is a long-standing member of the Committee on Aviation

Environment Protection (CAEP) and relevant subgroups that have been working on the technical parts of the proposal.

CAEP is also working with analyses and policy measures for sustainable aviation fuels, metrics and possible measures for reducing emissions through operative procedures and studies of non-CO2 effects from particles and nitrogen oxides.

International Maritime Organization (IMO)

Sweden has been working actively in the International Maritime Organization (IMO) for many years, pushing for the adoption of ambitious reduction measures.

The Energy Efficiency Design Index (EEDI), which is a standardized way to describe ships' energy efficiency, was made mandatory from 2013 for most (some 85 %) newly built vessels. All ships, to which the regulation applies, have to comply with the required EEDI level, which is set relative to a reference line, depending on ship type and size and year of building. The mandatory Ship Energy Efficiency Management Plan (SEEMP) was also introduced in 2013. The SEEMP is to be used in ships' management systems to improve energy efficiency in both existing and new ships. Both the EEDI and SEEMP applies to ships in international traffic with a gross tonnage of more than 400. Since 2019 the IMO data collection system for fuel oil consumption of ships (DCS) mandates all ships in international traffic with a gross tonnage of more than 5000 to collect and report data related to fuel consumption. The system is similar to the monitoring, reporting and verification system (MRV) of EU that entered into force in 2018.

In 2018 the IMO adopted an initial strategy on the reduction of greenhouse gas emissions from ships, setting out a vision to reduce GHG emissions from international shipping and phase them out, as soon as possible during this century. IMO is now focusing on developing measures to meet the ambitions in the initial strategy. A first measure, aiming to complement and strengthen the EEDI and SEEMP was approved in 2020 and, provided formal adoption in 2021, is expected to enter into force in 2022/2023.

Sweden actively promotes the use of batteries and alternative fuels as well as related infrastructure. In 2015, the IMO adopted the IGF Code, which is a regulatory framework for ships using gases or other low-flashpoint fuels.

Guidelines for using methanol as marine fuel (MSC.1/Circ.1621) were approved in 2020, and will be included in the IGF code after a test period of 3 to 5 years. Work on guidelines for fuel cells is also under way, which will allow for the use of hydrogen propulsion.

Many Swedish ports have invested in infrastructure allowing ships to use shore-side electricity, considerably reducing their emissions. The Port of Stockholm has introduced attractive incentives for ships using this infrastructure. All these measures form part of a national policy framework for development of alternative fuels and related infrastructure, implementing directive 2014/94/EU.

Part from greenhouse gases, emissions of black carbon from ships is also having considerable impact, not least in the Arctic. Black carbon emissions from shipping are now under review by the IMO, with a particular focus on the potential impacts of future Arctic shipping. Sweden was one of the countries that proposed to raise this issue on IMO's agenda.

3.2.10 Efforts to avoid adverse effects of policies and measures introduced as part of the country's climate strategy

Parties under the UN Framework Convention of Climate Change should strive to implement policies and measures in such a way as to minimise adverse effects. These include the adverse effects of climate change, effects on international trade, and the social, environmental and economic impact on other parties, especially developing countries.

Sweden has not made any changes since the seventh National Communication on climate change in the work to avoid adverse effects of policies and measures introduced as part of the country's climate strategy.

Under Sweden's policy for global development (PGD), all policy areas should interact in a coherent way so the country can make an effective contribution to equitable and sustainable global development. When decisions in a given policy area are judged to affect this goal of equitable and sustainable global development, an impact assessment must be carried out. The policy's two perspectives – a rights perspective and the perspective of poor people on development – should serve as a guide. In the framework of the PGD, for example, coordination and collaboration take place through a Reference group on trade policy at the Ministry for Foreign Affairs. Regular meetings of this group, which includes representatives of business, the

Swedish International Development Cooperation Agency (Sida) and civil society organisations have created a basis for broad consultation on trade policy.

In connection with decision making on policies and measures in Sweden and at the EU level, impact assessments are carried out, including environmental impact assessments. To the extent possible, such assessments include an appraisal of the risk of adverse effects on other countries. Both beneficial and adverse effects need to be taken into account. Sweden is helping to implement a range of measures that could improve the ability of developing countries to adapt to climate change and take action of their own to reduce their greenhouse gas emissions. Finally, Sweden has designed a broad-ranging climate strategy that encompasses many different types of measures and most sectors, both inside and outside the country. This, combined with all the greenhouse gases regulated by the Kyoto Protocol, represents a fundamental effort to minimise the risk of adverse effects.

As regard domestic economic and social consequences of climate policies and measures, this is addressed in several ways. An important component is impact assessment of policy changes which includes the description of how specific policy changes affects different groups. When it comes to the broader structural changes resulting from the country's climate policy, this is, for example, addressed by the government's Transition package, including reformation of labour laws, guidance and economic support for retraining (see Swedish Government, 2023b).

An example of how climate mitigation is addressed together with social and economic issues in a more integrated manner at the EU level is the Just Transition Fund. This is a financial instrument within the Cohesion Policy, which seeks to provide support to territories facing serious socio-economic challenges arising from the transition towards climate neutrality. Sweden has received €155 million to support transitioning not a green and competitive industry at the same time as maintaining employment. A particular focus is on steel industry in the region of Norrbotten, mineral industry in the region of Gotland and metal industry in Västerbotten. Measures and indicators for are detailed in Swedish Agency for Economic and Regional Growth (2022).

3.2.11 Policies and practices that encourage activities that lead to greater levels of anthropogenic GHG emissions

The latest inventory of policies and practices that encourage activities that lead to greater levels of anthropogenic GHG emissions than would otherwise occur was carried out by the Swedish Environmental Protection Agency in 2017 as part of an inventory of potentially environmental damaging subsidies (Swedish Environmental Protection Agency, 2017). Sweden is also involved in ongoing methodological work for enabling the analysis of potentially environmentally damaging (implicit and explicit) subsidies in various international contexts. Previously, the Swedish carbon and energy taxes have included several reductions. In recent years Sweden has been working on reforming these in order not to encourage activities that lead to greater levels of GHG emissions. This work is further described in NC8 section 4.2.2 Cross sectoral instruments.

3.3 Work on project-based flexible mechanisms under the Kyoto protocol

The core mission of the Swedish Program for International Climate Initiatives is to support the development of international climate cooperation, to achieve cost-effective greenhouse gas reductions and to contribute to sustainable development in developing countries. Initially, the program consisted solely of projects and multilateral funds generating emission reductions under the Kyoto Protocol. In 2018, the program was expanded to include the development of new types of cooperation under the Paris Agreement, in particular its Article 6.

3.3.1 The Swedish program for International Climate Initiatives

The Swedish Program for International Climate Initiatives was launched in the early 2000s and has led to emission reductions in developing countries while generating emission reduction units for Sweden. It supports the development of effective climate policy instruments through the implementation of market-based mechanisms which contribute to cost-effective greenhouse gas reductions, and also promotes sustainable development in host countries. The program has involved participation in individual projects for Clean Development Mechanism (CDM) and Joint Implementation (JI) as well as multilateral carbon funds and collaborations. The projects and the emissions reductions they generate are scrutinized and verified by the UNFCCC, ensuring the projects' additionality, cost effectiveness and promotion of sustainable development.

Throughout the program, Sweden has supported over 90 bilateral projects through CDM and JI and has participated in 11 multilateral carbon funds⁴⁸. By the end of 2020, SEK 1,8 billion had been granted, corresponding to approximately 31 Mt CO₂ -eq. The program has a total commitment of approximately SEK 1,9 billion⁴⁹ and is expected to generate emission reductions equivalent to a total of 35 Mt CO₂ -eq. The program is expected to close in 2025, with final payments in 2022.

All projects are carried out in developing countries, and priority has been given to projects in least developed countries (LDCs), small island developing states (SIDS) and in Sub-Saharan Africa. Overall, the program supports climate projects in more than 50 developing countries. A majority of the projects are in renewable energy, energy efficiency and waste management.

Sweden's participation in multilateral funds offers an opportunity to support a larger number of projects across several regions and project categories. Collaboration in multilateral funds has also provided a valuable knowledge exchange, network development and many insights into carbon pricing and implementation.

Sweden has decided to cancel all emission reduction units received up until the end of 2019. The cancelled international credits have not been used to fulfil commitments under the Kyoto Protocol. Instead, the financial support related to cancelled international credits has been reported as climate finance (see section 7.4.3.)

3.3.2 New market mechanisms under the Paris Agreement

Since 2018, the Swedish Energy Agency (SEA) has received funding aimed at supporting the development of new international forms of cooperation under the Paris Agreement, namely Article 6. The aim is to contribute to increased climate ambition and to provide results-based climate finance or, alongside other supplementary measures, contribute to the fulfilment of Sweden's national climate targets.

⁴⁸ Future Carbon Fund (FCF), Asia Pacific Carbon Fund (APCF), Transformative Carbon Asset Facility (TCAF), Carbon Initiative for Development (Ci-Dev), Carbon Partnership Facility (CPF), Pilot Auction Facility for Methane and Climate Change Mitigation (PAF), Umbrella Carbon Facility Tranche 2 (UCF T2), Prototype Carbon Fund (PCF), Multilateral Carbon Credit Fund (MCCF), Testing Ground Facility (TGF) and Partnership for Market Readiness (PMR).

⁴⁹ Calculated with currency rates from October 2021.

In 2018, the SEA commissioned nine virtual pilots to be developed in seven different countries. Each pilot resulted in a report, presenting a blueprint of a mitigation activity in a real-world Article 6 setting. In late 2019, efforts moved closer toward developing concrete, bilateral collaborations under Article 6 as the SEA launched a global call for proposals on international climate collaborations within the Article 6 framework. Over 60 proposals were received, out of which six activities were selected for further development of detailed mitigation activity design documents, focusing on compliance with the Article 6 framework. These project documents formed a foundation for future decisions on financing and implementation.

In parallel to the progress of these Article 6 activities, there are ongoing dialogues with the respective host countries to find agreement on the conditions and rules for the collaboration. In 2019, the SEA entered into an agreement with the Global Green Growth Institute (GGGI) for a tailor-made Article 6-program. The objective of the agreement is to develop ideas for feasible Article 6-activities and build the competence and institutional infrastructure necessary for host countries to trade with emission outcomes. In 2020, the program with GGGI resulted in four proposals for mitigation activities in three different countries, as well as blueprints for host country agreements and institutional infrastructure.

The work is also focused on methodological development with a special focus on monitoring, reporting and verification (MRV) and sustainable development. Representing Sweden in the negotiations of the rulebook for Article 6, the SEA is actively working for robust rules on sustainable development and environmental integrity. The SEA also participates in several capacity building initiatives aimed at supporting countries in entering collaborations under Article 6, such as the Article 6 Support Facility hosted by the Asian Development Bank and the Climate Market Club hosted by the World Bank.

3.4 Cost-effectiveness of policies and measures in Sweden's climate strategy and non-GHG mitigation benefits

3.4.1 Cost-effectiveness of policy instruments

The concept of cost-effectiveness refers in this context to achieving a given objective at the lowest possible cost. To be able to assess the cost-effectiveness of different policies and measures, there thus needs to be an objective and an estimate of the costs of the instruments concerned. In the

case of a national target for greenhouse gas emissions, the relevant costs are the economic costs, i.e. the change in current and future households' scope for consumption (in a wide sense) due to the instruments.

A given instrument may be intended to achieve a number of objectives, and it may therefore be difficult to correctly allocate the costs stemming from it. An instrument may for example – as is commonly the case in Sweden's climate strategy – be designed to be of significance for several environmental objectives at once, but also to help meet broader energy, waste and employment policy goals.

By and large, general, cross-sectoral policy instruments, such as a carbon dioxide tax or an emissions trading system, which impose the same marginal cost on emissions, have potential to be cost-effective. This is due to the flexibility they offer in the choice of measures to reduce emissions, resulting in low-cost actions being implemented.

It can be argued that there are two main reasons for supplementing general instruments with more targeted ones. The first has to do with the existence of other market failures than the actual emission of greenhouse gases. These include, for example, knowledge leakage from R&D investments, other obstacles to new technology and infrastructure, and various information failures. (Swedish EPA 2012).

The second reason is that there are sometimes factors restricting the implementation of the, in theory, most cost effective policy. This may mean that, instead of introducing the first choice of instrument, the second-best solution may be applied, such as a less cost effective instrument or several blunter ones. This may be because the first choice of instrument is not judged feasible to implement due to factors such as political feasibility or EU regulations such as the state aid rules and the energy tax regulation.

Following Sterner (2018): “In an ideal world, there would never be a need for anything other than carbon pricing. But according to the theory of “second-best”, sometimes, in the presence of several external effects and/or obstacles to decision-making, it can be optimal with completely different policy combinations – which would not be optimal in an ideal situation.”

Moreover, there is a risk that, because of conflicts with other goals, general policy instruments cannot be designed in a theoretically desirable way.

Targeted instruments can then help to increase awareness of the options for action available. This means that, in certain cases, it may be cost-effective to combine general and targeted instruments. In the words of Meckling et al. (2018): “As countries move toward deeper emissions cuts, combining and sequencing policies will prove critical to avoid environmental, economic, and political dead-ends in decarbonizing energy systems.”

3.4.2 Non GHG mitigation benefits

There are considerable non mitigation benefits of GHG mitigation in Sweden. One area where these are considerable relates to air pollution. These are presented in the recent concluded reporting under EU Governance regulation (2018/1999), where GHG relevant PaMs are viewed from an air quality perspective. The reported data will be made available by EEA.⁵⁰ The reporting is related to the national air pollution control program which sets out how Sweden intends to implement measures and instruments to meet the requirements for emission reductions under the cap directive. This was adopted by the Swedish government in March 2019.⁵¹

3.5 Progress to quantified economy-wide emission reduction target

This section presents estimates of emission reductions and removals and the use of units from the market-based mechanisms and land use, land-use change and forestry activities

For quantification of progress towards the 2020 targets, the change in greenhouse gas emissions is a key indicator. The Convention target for a reduction of emissions of 20 % from 1990 to 2020 refers only to emissions of the EU-27+UK as a whole. Greenhouse gas emissions of the EU-27+UK are calculated as the sum of all member states' emissions. The Swedish greenhouse gas emissions constitute 1.1 % of the entire EU-27+UK emissions when measured for the year 2020 (submission 2022).

Use of flexible mechanisms takes place by operators in the EU Emissions Trading System (ETS) on the one hand, and by governments on the other hand to achieve the Effort Sharing Decision (ESD) target. More information on use in the ETS is contained in the fifth Biennial Report of the European Union.

⁵⁰ See EEA Reportnet 3, <https://reportnet.europa.eu/>

⁵¹ In Swedish this is found at: Nationellt luftvårdsprogram (naturvardsverket.se)

The compliance assessment under the ESD⁵² for the years 2013, 2014, 2015, 2016, 2017, 2018 and 2019 will be completed in 2022. Sweden have not needed to use any other units than the Annual Emissions Allocations (AEA, EU-ESD units) for the compliance since Sweden overachieved our commitment. The same will apply to ESD emissions for the year 2020 but the accounting will not be completed before 2023. In CTF Table 4b Sweden report NE.

For the moment, Sweden does not foresee any need to make use of flexible mechanisms under the ESD.

⁵² Decision No 406/2009/EC

3.6 Summary of policies and measures⁵³

Cross-cutting

Name of policy/measure	Sectors primarily affected	GHG(s) primarily affected	Primary objective	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing agency	Estimate of mitigation impact in Mt CO ₂ eq per year compared with 1990 instruments ⁵⁴						
									2010	2015	2020	2025	2030	2040	2050
Local climate investment program (Climate leap)	Cross-cutting	All	Enhance and speed reduction of greenhouse gas emissions	Economic	Implemented	Grants for local and regional investments, in all sectors, except those included in the EU ETS to cut greenhouse gas emissions.	2015	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
Environmental Code	Cross-cutting	All	Ecologically sustainable development	Regulatory	Implemented	General rules for consideration to be observed in all activities and measures that are not of negligible significance and that can affect the environment	1999	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
Planning and Building Act (PBL)	Cross-cutting	All	Promote sustainable development of society	Regulatory	Implemented	In 2011, the PBL introduced new requirements on considering the environmental and climate aspects of planning.	2011	Swedish National Board of Housing, Building and Planning	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
Fossil-Free Sweden initiative	Cross-cutting	Carbon dioxide	Mobilize efforts from actors to reduce the use of fossil fuels.	Information, Voluntary Agreement	Implemented	Strengthen the dialogue between the state and the business sector, municipalities and civil society	2015	Fossil free Sweden	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.

⁵³ Some of the policy instruments are, due to recent date of decision, not included in the scenarios in chapter 5. Those are marked with a “*” in the table.

⁵⁴ For several policies/measures there is no reliable estimate of mitigation impact. This is indicated with “N.E.” in the table.

Climate and energy advice	Cross-cutting	All	Greater awareness of possible measures	Information	Implemented	Energy and climate advisers in municipalities reply free of charge to questions about heating, energy costs and efficiency, transport, climate and government grants relating to energy	1998	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
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Research and development	Cross-cutting	All	Development of technology with very low climate impact	Research	Implemented	Climate-related research and development aimed at achieving emissions reduction	1990	Swedish Energy Agency (mainly)	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
A national center for carbon dioxide capture and storage*	Cross-cutting	Carbon dioxide	Enable negative emissions	Information	Adopted	Promote the appropriate application of CCS in Sweden, enable the export of CO2 from Swedish operations for long term geological storage, ensures that transport and storage is safe	2021	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
National strategy for electrification*	Cross-cutting	Carbon dioxide	Contribute to a fast, smart and economically efficient electrification	Regulatory, information	Planned (2022-2024)	Contribute to a fast, smart and economically efficient electrification	2022	Government Offices	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
Increased competence for climate transition*	Cross-cutting	All	To meet future needs in the labour market as a result of the climate transition	Education	Planned	To meet future needs in the labour market as a result of the climate transition	2022	The Legal, Financial and Administrative Services Agency	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
Education and training	Cross-cutting	All	Education on climate related issues	Education	Adopted	Clarify the connection between curriculum and syllabus and the national environmental goal Reduced Climate Impact	2020	The National Swedish Agency for Education, Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.

Energy tax	Cross-cutting	Carbon dioxide	Fiscal, and to improve efficiency of energy use	Economic	Implemented	The aim is mainly fiscal. It also steer energy usage towards Sweden's energy efficiency, renewability and climate targets	1957	Swedish Tax Agency	See sectoral impact estimation impact in tables below
Carbon dioxide tax	Cross-cutting	Carbon dioxide	Reduce use of fossil fuels	Economic	Implemented	Based on the fossil carbon content in the fuel	1991	Swedish Tax Agency	See sectoral impact estimation impact in tables below
Strategy for a circular economy*	Cross-cutting	All	Transition to circular economy	Information	Adopted	The strategy aims at providing a vision and direction for different actors.	2020	Government Offices	N.E.
EU ETS	Cross-cutting	Carbon dioxide	Reduce use of fossil fuels in trading sector	Economic	Implemented	The amount of emissions allowed within the system is limited by a cap, which is decreased every year. Almost half of the allowances are allocated for free, the rest are auctioned.	2005	Swedish Environmental Protection Agency and Swedish Energy Agency	See sectoral impact estimation impact in tables below

Production of electricity and district heating

Name of policy/measure	Sectors primarily affected	GHG(s) primarily affected	Primary objective	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing agency	Estimate of mitigation impact in Mt CO ₂ eq per year compared with 1990 instruments ⁴⁶						
									2010	2015	2020	2025	2030	2040	2050
Energy tax	Cross-sectoral	Carbon dioxide	Fiscal, and to improve efficiency of energy use	Economic	Implemented	The aim is mainly fiscal. It also steer energy usage towards Sweden's energy efficiency, renewability and climate targets	1957	Swedish Tax Agency	12.8	14.8	15.5	15.1	6.2	4.1	6.2
Carbon dioxide tax	Cross-sectoral	Carbon dioxide	Reduce use of fossil fuels	Economic	Implemented	Based on the fossil carbon content in the fuel	1991	Swedish Tax Agency							
Electricity certificate system	Energy	Carbon dioxide	Increase supply of electricity from renewable energy sources	Economic	Implemented	Electricity suppliers are obliged by law to submit electricity certificates corresponding to a certain share of their electricity deliveries.	2003	Swedish Energy Agency							
EU Emissions Trading System (EU ETS)	Cross-sectoral	Carbon dioxide	Reduce use of fossil fuels in trading sector	Economic	Implemented	The amount of emissions allowed within the system is limited by a cap, which is decreased every year. Almost half of the allowances are allocated for free, the rest are auctioned.	2005	Swedish Environmental Protection Agency and Swedish Energy Agency							
Initiatives for wind power	Energy	Carbon dioxide	Increase supply of electricity from renewable energy sources	Regulatory, Information, Research	Implemented	This include research programs, designation of areas of national interest for wind power	2004	Swedish Energy Agency							

Support for solar power Income tax reduction for micro production of renewable energy	Energy	Carbon dioxide	Increase supply of electricity from renewable energy sources	Economic	Implemented	A subsidy for installations of solar power systems	2009	Swedish Energy Agency	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
Income tax reduction for micro production of renewable energy	Energy	Carbon dioxide	Increase micro production of renewable energy	Economic	Implemented	Tax reduction for households and businesses to stimulate investment in the micro-production of renewable electricity	2015	Swedish Tax Agency	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
Tax on waste incineration	Energy	Carbon dioxide	Reduce greenhouse gas emissions	Economic	Implemented	Incineration of waste is taxed. The tax has gradually been increased and is from 2022 SEK 125 per ton. The tax excludes for example hazardous waste and bio energy.	2020	Swedish Tax Agency	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
Tax reduction for installation of green technology*	Energy	Carbon dioxide	Reduce greenhouse gas emissions	Economic	Implemented	Individuals are eligible to a tax reduction for installation of green technology including solar cells, systems for storage of self-produced electricity and at home charging stations	2021	Swedish Tax Agency	N.E	N.E	N.E	N.E.	N.E	N.E	N.E

Residential and commercial/institutional sector

Name of policy/measure	Sectors primarily affected	GHG(s) primarily affected	Primary objective	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing agency	Estimate of mitigation impact in Mt CO2 eq per year compared with 1990 instruments ⁵⁵						
									2010	2015	2020	2025	2030	2040	2050
Energy tax	Cross-sectoral	Carbon dioxide	Fiscal, and to improve efficiency of energy use	Economic	Implemented	The aim is mainly fiscal. It also steer energy usage towards Sweden's energy efficiency, renewability and climate targets	1957	Swedish Tax Agency	1.3	1.0	1.1	1	1.0	1.0	1.0
Carbon dioxide tax	Cross-sectoral	Carbon dioxide	Reduce use of fossil fuels	Economic	Implemented	Based on the fossil carbon content in the fuel	1991	Swedish Tax Agency							
EU Emissions Trading System (EU ETS)	Cross-sectoral	Carbon dioxide	Reduce use of fossil fuels in trading sector	Economic	Implemented	The amount of emissions allowed within the system is limited by a cap, which is decreased every year. Almost half of the allowances are allocated for free, the rest are auctioned.	2005	Swedish Environmental Protection Agency and Swedish Energy Agency							
Building regulations	Energy	Carbon dioxide	More efficient energy use	Regulatory	Implemented	Requirements for energy use in new buildings	2009 (1960s)	Swedish National Board of Housing, Building and Planning							
Energy declarations (Law on energy performance certificates for buildings)	Energy	Carbon dioxide	More efficient energy use	Regulatory and information	Implemented	Obligation for owners to declare the energy use of buildings	2006	Swedish National Board of Housing, Building and Planning							

⁵⁵ For aggregated effects for the sector, see Table 4.2

Ecodesign Directive	Energy	Carbon dioxide	More efficient energy use	Regulatory	Implemented	Aims to improve the products' environmental performance during their full life cycle	2008	Swedish Energy Agency								
Mandatory energy labelling	Energy	Carbon dioxide	More efficient energy use	Information	Implemented	Makes the product's energy use visible and facilitates for consumers who want to make energy smart choices	1995	Swedish Energy Agency								
Training programs in building for low energy consumption	Energy	Carbon dioxide	More efficient energy use	Education	Implemented	Target different construction stakeholders, such as architects, engineers, clients, technicians, installers, site managers and teachers in building programs	2016	Swedish Energy Agency	N.E	N.E	N.E	N.E.	N.E	N.E	N.E	N.E
Technology procurement	Energy	Carbon dioxide	More efficient energy use and increased use of renewable energy	Economic	Implemented	An instrument designed to initiate a market transition and disseminate new, more efficient technology, such as new products, systems and processes	N.d.	Swedish Energy Agency	N.E	N.E	N.E	N.E.	N.E	N.E	N.E	N.E
Energy Performance of Buildings Directive 2010/31/EC	Energy	Carbon dioxide	More efficient energy use and reduce emissions	Regulatory	Implemented	A framework within which EU Member States have decided on minimum energy performance standards, building energy certificates etc	2010	Swedish National Board of Housing, Building and Planning	N.E	N.E	N.E	N.E.	N.E	N.E	N.E	N.E

Industrial emissions from combustion and processes

Name of policy/measure	Sectors primarily affected	GHG(s) primarily affected	Primary objective	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing agency	Estimate of mitigation impact in Mt CO2 eq per year compared with 1990 instruments ⁴⁶						
									2010	2015	2020	2025	2030	2040	2050
Energy tax	Cross-sectoral	Carbon dioxide	Fiscal, and to improve efficiency of energy use	Economic	Implemented	The aim is mainly fiscal. It also steer energy usage towards Sweden's energy efficiency, renewability and climate targets	1957	Swedish Tax Agency	-0.9	-0.5	-0.1	0.2	0.5	0.8	3.3
Carbon dioxide tax, incl. stepwise reduced carbon dioxide tax relief for industry outside EU ETS	Cross-sectoral	Carbon dioxide	Reduce use of fossil fuels	Economic	Implemented	Based on the fossil carbon content in the fuel	1991-	Swedish Tax Agency							
Electricity certificate system	Energy	Carbon dioxide	Increase supply of electricity from renewable energy sources	Economic	Implemented	Electricity suppliers are obliged by law to submit electricity certificates corresponding to a certain share of their electricity deliveries.	2003	Swedish Energy Agency							
EU Emissions Trading System (EU ETS)	Cross-sectoral	Carbon dioxide	Reduce use of fossil fuels in trading sector	Economic	Implemented	The amount of emissions allowed within the system is limited by a cap, which is decreased every year. Almost half of the allowances are allocated for free, the rest are auctioned	2005	Swedish Environmental Protection Agency and Swedish Energy Agency							
Energy audit for large enterprises	Industry/ industrial processes	Carbon dioxide	More efficient energy use	Regulatory and information	Implemented	Requires large enterprises to conduct energy audits, including information of total energy use	2014	Swedish Energy Agency							

Environmental Code	Industry/ industrial processes	All	Ecologically sustainable development	Regulatory	Implemented	General rules for consideration to be observed in all activities and measures that are not of negligible significance and that can affect the environment	1999	Swedish Environmental Protection Agency	N.E	N.E	N.E	N.E	N.E	N.E	N.E
Industrial Leap, in combination with several other policy instruments enabling the investments in low carbon technologies	Industry/ industrial processes	All	Reduce greenhouse gas emissions	Research, economic	Implemented	A government scheme that supports development of technology and processes to reduce the process-related greenhouse gas emissions in Swedish industry	2018	Swedish Energy Agency	N.E.	N.E	N.E.	N.E	N.E.	N.E.	N.E.
Operating aid for BECCS*	Industry/ industrial processes	Carbon dioxide	Reduce greenhouse gas emissions	Economic	Planned	A reversed auction where the company offering the most cost efficient solution will receive operating aid to operate a BECCS facility.	2022	Swedish Energy Agency	N.E.	N.E	N.E.	N.E.	.1-2	.1-2	.1-2

Product use

Name of policy/measure	Sectors primarily affected	GHG(s) primarily affected	Primary objective	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing agency	Estimate of mitigation impact in Mt CO2 eq per year compared with 1990 instruments ⁴⁶						
									2010	2015	2020	2025	2030	2040	2050
EU regulation on Fluorinated greenhouse gases and BREF	Industry/ industrial processes	HFCs	Reduce use of HFCs	Regulatory	Implemented	Includes a mechanism for quantified emission reductions of substances containing HFCs	2015	Swedish Environmental Protection Agency							
EU regulation on mobile air conditioning units in cars	Industry/ industrial processes	HFCs	Reduce use of HFCs	Regulatory	Implemented	Requirements for vehicles as regards emissions from, and the safe functioning of, air-conditioning systems fitted to vehicles.	2006	Swedish Environmental Protection Agency	0.2	0.5	0.7	N.E	N.E	N.E	N.E
Swedish regulation on fluorinated gases and ozone depleting substances	Industry/ industrial processes	HFCs	Reduce use of HFCs and ozone depleting substances	Regulatory	Implemented	Prohibition to sell f- gases as refrigerants to recipients other than those stated in the regulation etc	2016	Swedish Environmental Protection Agency							

Agriculture

Name of policy/measure	Sectors primarily affected	GHG(s) primarily affected	Primary objective	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing agency	Estimate of mitigation impact in Mt CO ₂ eq per year compared with 1990 instruments ⁴⁶						
									2010	2015	2020	2025	2030	2040	2050
Common Agricultural Policy	Agriculture	Nitrous oxide, methane and carbon dioxide	Sustainable agriculture	Economic	Implemented	Common Agricultural Policy of the EU	2021 (for the period 2023-2027)	Swedish Board of Agriculture	N.E	N.E	N.E	N.E	N.E	N.E	N.E
Measures under the Rural Development Program	Agriculture	Nitrous oxide, methane and carbon dioxide	Reduced Climate Impact, a varied agricultural landscape and zero eutrophication	Economic	Implemented	Support to areas with natural constraints, animal welfare subsidies, ecological farming, and environmental and climate actions, etc.	2014	Swedish Board of Agriculture	N.E	N.E	N.E	N.E	N.E	N.E	N.E
Support for biogas production	Agriculture	Methane	Reducing emissions of greenhouse gases and production of biogas for energy purposes	Economic	Implemented	Increase biogas production from manure and thereby gain two-fold benefits through reduced methane emissions from manure and the substitution of fossil energy	2015	Swedish Board of Agriculture	N.E	N.E	N.E	N.E	N.E	N.E	N.E
The rural network	Agriculture	Nitrous oxide, methane and carbon dioxide	Reinforce implementation of the Rural Development Program	Information	Implemented	Brings together actors at the local, regional and central levels for exchanging information and experiences	2007	Swedish Board of Agriculture	N.E	N.E	N.E	N.E	N.E	N.E	N.E
Focus on nutrients advisory service	Agriculture	Nitrous oxide, methane and carbon dioxide	GHG emission reductions and energy efficiency	Information	Implemented	Initial focus on reduced nutrient leaching. Today, it also provides advice targeting GHG emission	2001	Swedish Board of Agriculture	N.E	N.E	N.E	N.E	N.E	N.E	N.E

Transport

Name of policy/measure	Sectors primarily affected	GHG(s) primarily affected	Primary objective	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing agency	Estimate of mitigation impact in Mt CO ₂ eq per year compared with 1990 instruments ⁴⁶						
									2010	2015	2020	2025	2030	2040	2050
Energy tax, including stepwise increase of tax on diesel and petrol	Cross-sectoral	Carbon dioxide	Fiscal, and to improve efficiency of energy use	Economic	Implemented	The aim is mainly fiscal. It also steer energy usage towards Sweden's energy efficiency, renewability and climate targets	1924	Swedish Tax Agency	2	2	2.3	N.E	N.E	N.E.	N.E.
Carbon dioxide tax	Cross-sectoral	Carbon dioxide	Reduce use of fossil fuels	Economic	Implemented	Based on the fossil carbon content in the fuel	1991	Swedish Tax Agency							
Emission performance standards for new vehicles	Transport	Carbon dioxide	Reduce carbon dioxide emissions	Regulatory	Implemented	Manufacturers selling vehicles in the EU are subject to EU regulations that set emission performance standards	2015 (2017 and 2020)	Swedish Transport Administration							
CO₂-based vehicle tax	Transport	Carbon dioxide	Reduce carbon dioxide emissions	Economic	Implemented	All vehicles in the system are subject to a basic charge of SEK 360 per year. In addition, vehicles are subject to a CO ₂ component depending on their level of CO ₂ emissions per kilometer in mixed driving.	2006	Swedish Tax Agency	N.E	N.E	3	5	8	N.E	N.E.
Super-green car rebate (replaced by the bonus-malus system in 2018)	Transport	Carbon dioxide	Reduce carbon dioxide emissions	Economic	Expired	A subsidy aimed to contribute to technology development and to lower barriers for a large-scale introduction of environmental friendly cars	2012	Swedish Transport Agency							
Tax exemption for environmental friendly vehicles	Transport	Carbon dioxide	Reduce carbon dioxide emissions	Economic	Expired	Lower tax for vehicles with environmental friendly technology	2010	Swedish Tax Agency							

Reduced taxable values for some company cars with environmentally friendly technology	Transport	Carbon dioxide	Reduce carbon dioxide emissions	Economic	Implemented	To increase the incentive to purchase company cars that use environmental technologies, those who use green cars receive relatively favorable tax treatment	1990	Swedish Tax Agency								
Support for charging infrastructure	Transport	Carbon dioxide	Reduce carbon dioxide emissions	Economic	Implemented	Ensuring basic access to charging infrastructure for charging of electric vehicles	2020	Swedish Transport Administration	N.E	N.E	N.E	N.E.	N.E	N.E	N.E	N.E
Local climate investment program (Climate leap)	Transport	All	Enhance and speed reduction of greenhouse gas emissions	Economic	Implemented	Municipalities, companies, organisations and others can apply for investment support for measures to reduce climate impact	2015	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.	N.E	N.E.	N.E.	N.E ⁵⁶
Support for research and demonstration	Transport	Carbon dioxide	Develop technology for sustainable growth and reduced fossil fuel dependence	Research, economic	Implemented	Swedish agencies are financing several large research projects covering the entire chain from cultivation of raw materials for bio- based motor fuels to the use of new fuels	N.d.	Vinnova and Swedish Energy Agency (mainly)	N.E	N.E	N.E	N.E.	N.E	N.E	N.E	N.E
Consideration of climate in long-term infrastructure planning	Transport	Carbon dioxide	Take environmental and climate issues into account in planning all modes of transport	Regulatory	Implemented	Planning is undertaken in dialogue with local and regional planning bodies with a requirement to take environmental and climate issues into account	2018	The Swedish Transport Administration	N.E	N.E	N.E	N.E.	N.E	N.E	N.E	N.E
Tax on air travel	Transport	Carbon dioxide	Reduce greenhouse gas emissions	Economic	Implemented	A tax on commercial flights paid for passengers travelling from a Swedish airport	2018	Swedish Tax Energy	N.E	N.E	N.E	N.E.	N.E	N.E	N.E	N.E

⁵⁶ The program is expected to generate total reductions of 1.5 Mt CO₂-eq. per year during the technical lifespan of the investments. 60% of these, i.e. 0.9 Mt CO₂-eq. per year, are from the transport sector. The technical lifespan of the investments is in average 16 years.

Reduction obligation scheme for aviation*	Transport	Carbon dioxide	Reduce greenhouse gas emissions	Regulatory	Implemented	The level of renewable fuels was 0,8 percent in 2021 and will increase to 27 percent in 2030	2021	Swedish Energy Agency	N.E	N.E	N.E.	0.2	1 ⁵⁷	1 ⁵⁸	1.152 ⁵⁹ (2045)
Differentiated take- off and landing fees for aviation*	Transport	Carbon dioxide	Reduce greenhouse gas emissions	Economic	Implemented	The fees are differented according to environmental performance of the aircrafts	2021	Swedish Energy Agency	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
Aviation in the EU ETS	Transport	Carbon dioxide	Reduce greenhouse gas emissions	Economic	Implemented	Aviation is included in the EU Emissions Trading System	2012	Swedish Environmental Protection Agency	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
Emission reduction obligation*⁶⁰		Carbon dioxide	Reduce greenhouse gas emissions	Regulatory	Implemented	An obligation on petrol and diesel suppliers to reduce life-cycle carbon dioxide emissions, by gradually increasing blending with sustainable biofuels,	2018	Swedish Energy Agency	N.E	N.E	N.E	4.0	.4-6 ⁶¹	N.E	N.E.
Climate premiums for electrical buses, heavy-duty vehicles and working machinery	Transport	Carbon dioxide	Reduce greenhouse gas emissions	Economic	Implemented	Regional public transport agencies, public transport companies, municipalities and limited companies are eligible to apply for climate premiums	2020	Swedish Energy Agency	N.E	N.E	N.E	N.E	N.E	N.E	N.E
Tax reduction for installation of green technology*	Transport	Carbon dioxide	Reduce greenhouse gas emissions	Economic	Implemented	Private individuals are eligible to a tax reduction for installation of green technology	2021	Swedish Tax Agency	N.E	N.E	N.E	N.E.	N.E	N.E	N.E

⁵⁷ Domestic 0.1

⁵⁸ Domestic 0.1

⁵⁹ Domestic 0.1

⁶⁰ The reduction obligation is today more ambitious then assumed in the projections in chapter 5.

⁶¹ Including the effect from mobile machinery. The result is the additional effect compared to the development In the reference scenario in projections chapter.

Eco-bonus system for heavy transport	Transport	Carbon dioxide	Reduce greenhouse gas emissions	Economic	Implemented	Support aimed at stimulating the transfer of goods from road to shipping to reduce greenhouse gas emissions from heavy transport	2018	Swedish Transport Administration	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
Environmental compensation for railway transport of goods	Transport	Carbon dioxide	Reduce greenhouse gas emissions	Economic	Implemented	Support to stimulate railway transports of goods	2018	Swedish Transport Administration	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
Congestion tax	Transport	Carbon dioxide	Reduce congestion	Economic	Implemented	The tax is levied during such hours and on such places where there is considered to be congestion	2007	Swedish Transport Agency	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
Low emission zone	Transport	Carbon dioxide	Restrict traffic	Regulatory	Implemented	Restricting access to vehicles that don't meet specific requirements	2013 (2020 for cars)	Swedish Transport Agency	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
State co-financing for certain regional public transport facilities	Transport	Carbon dioxide	Support for infrastructure for public transport	Economic	Implemented	An investment support for infrastructure for regional public transport.	2009	Swedish Transport Administration	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
Urban environmental agreements	Transport	Carbon dioxide	Reduce carbon dioxide emissions and incentivise building of public transport	Economic	Implemented	A scheme for investments in public transport, cycling infrastructure or sustainable freight transport at the regional and local level	2015	Swedish Transport Administration	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
National ticket system for public transport*	Transport	Carbon dioxide	Facilitate travel by public transport	Economic	Planned	The system will make it easier for travelers to choose to travel by public transport	2022	Swedish Transport Administration	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
Conversion premium*	Transport	Carbon dioxide	Reduce emissions from cars	Economic	Planned	A conversion premium for cars from fossil fuels to biofuels or biogas	2022	Swedish Tax Energy	N.E	N.E	N.E	N.E	N.E	N.E	Conversion premium*

Night train traffic in Sweden and abroad*	Transport	Carbon dioxide	Replace travel by air and car	Economic	Adopted	Procurement of night train traffic through Sweden and Denmark	2022	Swedish Transport Administration	N.E	N.E	N.E	N.E.	N.E	N.E	N.E
Continued tax exemption for clean and highly mixed biofuels*	Transport	Carbon dioxide	Compensate for increased costs	Economic	Implemented	An exemption of the carbon and energy tax for biofuels are not considered compatible with the EU state aid rule why Sweden has sought a prolongation of an exemption	2020 (2021 for biogas)	Swedish Tax Energy	N.E	N.E	N.E	N.E	N.E	N.E	N.E

Waste

Name of policy/measure	Sectors primarily affected	GHG(s) primarily affected	Primary objective	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing agency	Estimate of mitigation impact in Mt CO ₂ eq per year compared with 1990 instruments ⁴⁶						
									2010	2015	2020	2025	2030	2040	2050
Landfill tax	Waste	Methane	Increase recycling and reduce total quantities of waste	Economic	Implemented	The tax has been increased gradually, and is today 555 SEK per tonne landfilled waste	2000	Swedish Tax Agency							
Bans on landfill of combustible waste (2002) and of organic waste (2005)	Waste	Methane	Improved landfill management, enhanced recycling, improved wastewater management systems	Regulatory	Implemented	Intended to prevent and reduce adverse effects on human health and the environment from landfilling.	2002	Swedish Environmental Protection Agency	1.4	1.7	1.9	2.0	2.2	N.E.	N.E.
Extended producer responsibility	Waste	Carbon dioxide	Increase resource efficiency	Regulatory	Implemented	Producer responsibility promotes sorting, collection and recycling of certain waste flows	1994	Swedish Environmental Protection Agency							
Rules on municipal waste planning	Waste	Methane, Carbon dioxide	Increase resource efficiency	Regulatory	Implemented	A requirement that all the municipalities in Sweden must have their own municipal waste plan	1991	Swedish Environmental Protection Agency							

Land use, Land use change and forestry (LULUCF)

Name of policy/measure	Sectors primarily affected	GHG(s) primarily affected	Primary objective	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing agency	Estimate of mitigation impact in Mt CO ₂ eq per year compared with 1990 instruments ⁴⁶						
									2010	2015	2020	2025	2030	2040	2050
Provisions of Forestry Act	Forestry/ LULUCF	Carbon dioxide	Achieve environmental and production objectives for sustainable forest management	Regulatory	Implemented	Regulations concerning nature conservation and cultural heritage include not disturbing important biotopes, buffer zones and arable land, and leaving older trees, high stumps and dead wood in situ.	1993	Swedish Forest Agency	N.E	N.E	N.E	N.E	N.E	N.E	N.E
Provisions of Environmental Code including land drainage	Forestry/ LULUCF	Carbon dioxide and methane	Biodiversity	Regulatory	Implemented	A coordinated, broad and strict piece of environmental legislation aimed at promoting sustainable development so that present and future generations can live in a good, healthy environment	1999	County administrative boards	N.E.	N.E	N.E	N.E	N.E	N.E	N.E
Provisions on nature reserves and habitat protection areas in Environmental Code, and nature conservation agreements	Forestry/ LULUCF	Carbon dioxide	Biodiversity	Regulatory	Implemented	The property owner and the state or a municipality agree on a certain financial compensation for the property owner, for example, to refrain from, for example, forestry	N.D	Swedish Environmental	N.E.	N.E	N.E	N.E	N.E	N.E	N.E
Swedish National Forest Program	Forestry/ LULUCF	Carbon dioxide	Increase the national supply of bio-based materials and energy	Information	Implemented	A broad dialogue on the role forests play to ensure a sustainable society and a growing bioeconomy	2018	Swedish Forest Agency	N.E.	N.E	N.E	N.E	N.E	N.E	N.E

Methods for increased carbon sinks*	Forestry/ LULUCF	Carbon dioxide	Promote forest growth and prevent damage	Information	Implemented	Develop methods for increased carbon sinks	2021	Swedish Forest Agency	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
Support for re-wetting of wetlands	Forestry/ LULUCF	Carbon dioxide	Provide climate benefits and strengthen biodiversity	Economic, information	Implemented	Rewetting of drained wetlands on organic soils for purposes such as nutrient retention and biodiversity.	1990	Swedish Forest Agency	N.E.	N.E.	N.E.	N.E.	0.08-0.18	0.08-0.18	N.E.

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4. Projections

This section presents projections of greenhouse gas emissions and removals for various sectors and in total. The information is based on Sweden's report on projections submitted to the EU⁶² in accordance with the requirements of the EU regulation on Governance of the Energy Union and Climate action⁶³. Projections with existing measures are based on policies and measures adopted by the EU and the Swedish Parliament up to June 2020. The base-year for the projections is 2018⁶⁴.

Model-based calculations and, to some extent, expert evaluations were used to produce the projections. The projections are based on a number of assumptions, all of which are characterised by uncertainty. This should be taken into account when interpreting the results. The projections can be mainly regarded as a consequential analysis of the assumptions made. The method for estimating the projections was mainly developed for medium-term or long-term projections, so the projections do not take account of shorter-term variations. However, the effects of the Covid-19 pandemic have partly been taken into account in the short term. The key parameters, assumptions and methodology used in the projections are presented in Annex A.

In addition to projections with existing measures, sensitivity projections have been calculated for emissions in the energy sector, for the road transportation sector and for the LULUCF sector. Projections with additional measures are not provided since there were no planned measures in Sweden when producing the projections. However, policies and measures are continuously developed, and new measures have been adopted and planned since the projections were produced, see chapter 3.

4.1 Greenhouse gas emissions projections

Total greenhouse gas emissions in Sweden in 2020⁶⁵ were 46.3 Mt CO₂-eq. (excluding The Land Use, Land Use Change and Forestry sector). Total emissions decreased by 25.2 million tonnes, or 35 %, between 1990 and 2020. The projection results point to a gradual decline in total emissions of

⁶² Ministry of the Environment, 2021

⁶³ Regulation EU No 2018/1999

⁶⁴ National Inventory Report Submission 2021 were used when producing the projections. For this Fifth Biennial Report the historical emissions and removals of greenhouse gases presented are based on National Inventory Report Submission 2022.

⁶⁵ National Inventory Report Sweden, Submission 2022

greenhouse gases (excl. LULUCF) over the projection period. Projected emissions for 2030 are 39 % below 1990 levels, and by 2040 total emissions are projected to be 45 % below 1990 levels. See Table 4.1 and Figure 4.1.

The LULUCF sector contributed to an annual net removal of carbon dioxide in Sweden during the period 1990–2020 and is expected to continue to do so during the projection period.

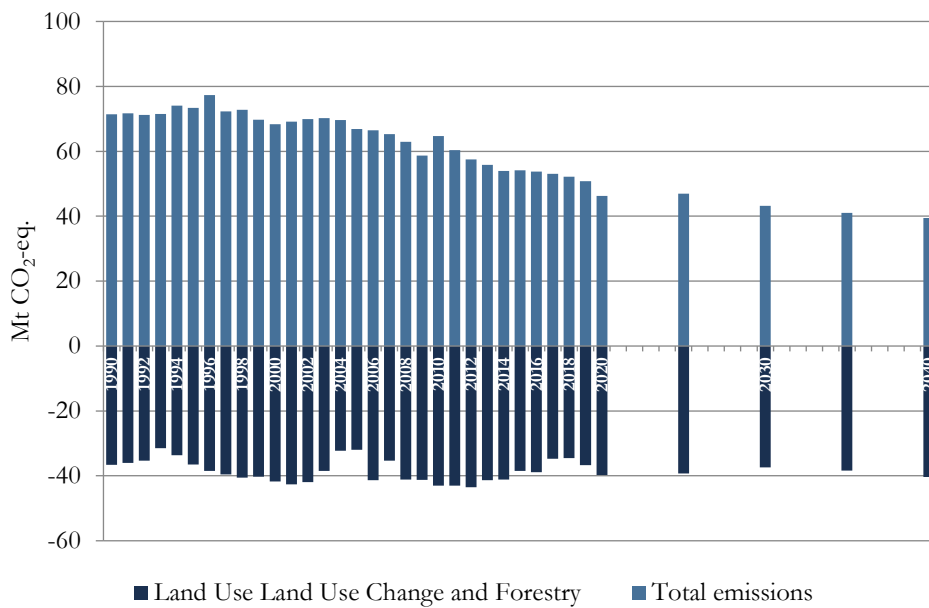


Figure 4.1 Historical emissions of greenhouse gases and projected emissions and removals of greenhouse gases.

Table 4.1 Historical and projected emissions and removals of greenhouse gases by sector (Mt CO₂-eq.)

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Energy excl. transport	32.3	16.4	17.4	16.6	16.3	16.2	-49%	-50%
Transport	20.0	15.4	15.2	13.6	12.0	10.7	-31%	-46%
Industrial processes and product use	7.7	6.6	7.2	6.1	6.0	6.0	-20%	-22%
Agriculture	7.7	6.9	6.3	6.1	6.0	5.9	-20%	-22%
Waste	3.7	1.0	0.9	0.8	0.7	0.6	-79%	-83%
Total emissions	71.4	46.3	47.0	43.2	41.0	39.4	-39%	-45%

LULUCF	-36.6	-39.8	-39.3	-37.4	-38.4	-40.4	2%	10%
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4.2 Projections by gas

In 2020, carbon dioxide emissions accounted for 79 % of greenhouse gas emissions, while methane emissions accounted for around 9 %, nitrous oxide for around 10 % and fluorinated greenhouse gases for just over 2 %. Between 1990 and 2040, emissions of all gases are projected to decrease. See Table 4.2.

Table 4.2 Historical and projected emissions of greenhouse gases per gas (Mt CO₂-eq.).

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	57.6	36.5	38.1	35.0	33.1	31.7	-39%	-45%
Methane	7.4	4.1	3.6	3.4	3.2	3.1	-55%	-58%
Nitrous oxide	5.8	4.6	4.5	4.4	4.3	4.3	-24%	-26%
HFC	0.006	0.9	0.7	0.5	0.3	0.3	7011%	4282%
PFC	0.6	0.07	0.04	0.04	0.04	0.04	-92%	-92%
SF ₆	0.1	0.04	0.03	0.03	0.03	0.02	-71%	-76%
Total emissions (excl. LULUCF)	71.4	46.3	47.0	43.2	41.0	39.4	-39%	-45%

4.3 Projections by sector

In the projections, the emissions from all sectors are decreasing until 2040. The largest reduction is projected for the energy and transport sectors, see Figure 4.2.

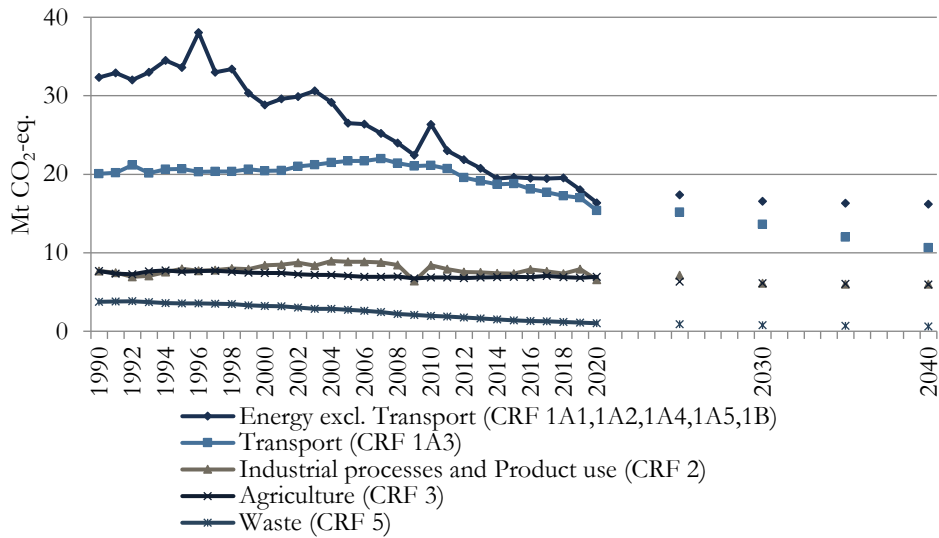


Figure 4.2 Historical and projected emissions of greenhouse gases by sector.

4.3.1 Energy industries (Electricity and heat production, Refineries, Manufacturing of solid fuels)

Emissions from energy industries, i.e. production of electricity and district heating, refineries and the manufacturing of solid fuels, are projected to decrease slightly to 2040. However, projections for subsectors show differing trends.

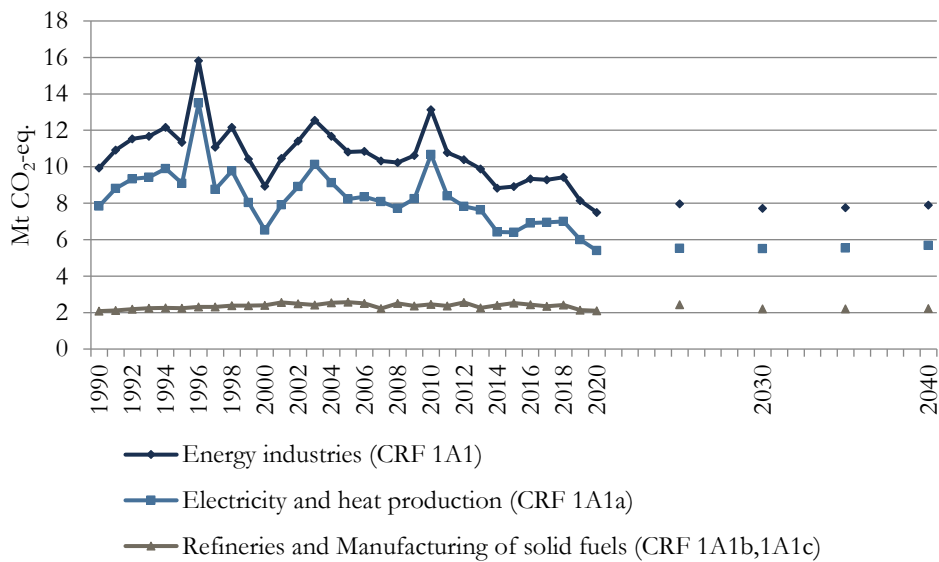


Figure 4.3 Historical and projected emissions of greenhouse gases from energy industries.

Emissions of greenhouse gases from electricity and heat production have varied since 1990, mainly due to temperature variations and precipitation. The production of electricity is expected to increase during the projection period while the productions of district heating is expected to remain stable.. However, emissions do not increase to the same extent as production, mainly due to biofuels and incineration of waste and also increased use of wind and solar power. Emissions are projected to decrease and then stabilize, see Table 4.3 and Figure 4.3. An increased use of waste contributes to the increase in emissions, but this increase is partly offset by increased use of biomass and wind and solar power, as well as decreased use of oil and coal. Production of electricity is assumed to grow more than consumption, resulting in a projected export of about 40 TWh by 2040.

Table 4.3 Historical and projected emissions of greenhouse gases from electricity and heat production (Mt CO₂-eq.).

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	7.7	5.2	5.3	5.3	5.3	5.4	-31%	-29%
Methane	0.02	0.05	0.05	0.04	0.04	0.04	159%	173%
Nitrous oxide	0.1	0.2	0.2	0.2	0.2	0.2	59%	68%
Total emissions	7.8	5.4	5.5	5.5	5.6	5.7	-30%	-28%

Emissions from refineries and manufacturing of solid fuels are projected to increase slightly during the projection period, see Table 4.4 and Figure 4.3. The emissions from refineries are expected to continue to increase slightly until 2040, compared to the 1990 level. The emissions from refineries are also accounted for in the sector of fugitive emissions. The emissions from manufacturing of solid fuels are estimated to remain stable until 2025 and then decrease due to an assumed shift to fossil free technology.

Table 4.4 Historical and projected emissions of greenhouse gases from refineries and manufacturing of solid fuels (Mt CO₂-eq.).

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	2.1	2.1	2.4	2.2	2.2	2.2	6%	7%
Methane	0.001	0.001	0.001	0.001	0.001	0.001	-8%	-8%
Nitrous oxide	0.001	0.001	0.001	0.001	0.001	0.001	-25%	-24%

Total emissions	2.1	2.1	2.4	2.2	2.2	2.2	6%	7%
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4.3.2 Residential and commercial/institutional

Emissions from households and premises and from combustion in the agricultural, forestry and fishing sectors are projected to continue to decrease, see Table 4.5 and Figure 4.4. This decline is mainly due to a continuing replacement of individual oil-fuelled boilers for heating and hot water purposes in households and premises with district heating, electric heating, heat pumps and biomass. The shift to electric and district heating results in decreased emissions in this sector. However, since the increased production of electricity and heat is mainly based on wind power, biomass and waste, and with district heating being a more efficient way of heating, emissions on the whole still decrease.

Total emissions from combustion in the agricultural, forestry and fishing sectors are projected to decrease during the projection period. Emissions from energy consumption in the agricultural sector are expected to decrease to some extent during the projection period, due to a reduction in the use of diesel fuel for working machinery and a reduction in oil consumption for buildings. Emissions from working machinery in the forestry sector and from fishing are assumed to remain at about the same level during the entire projection period.

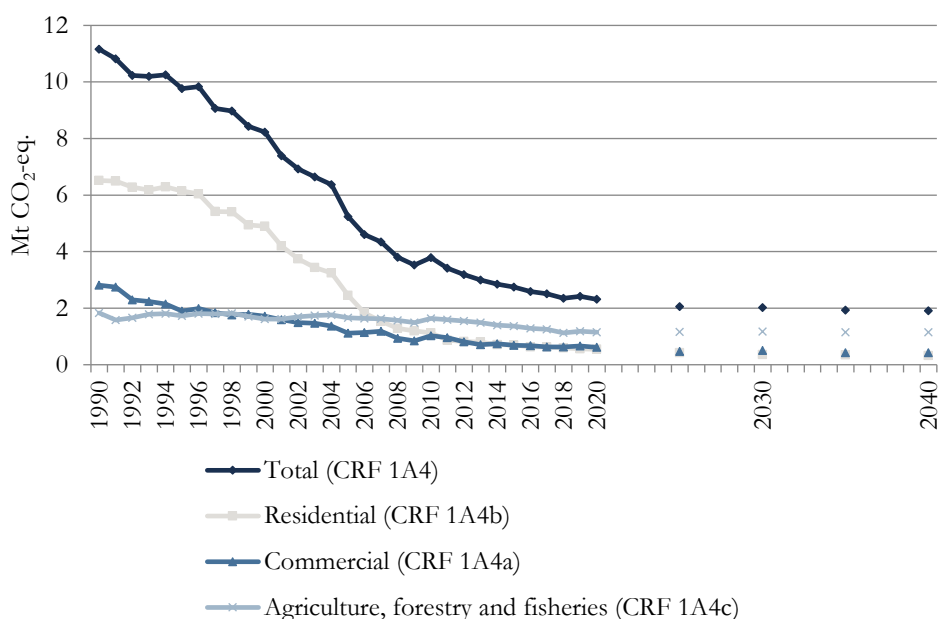


Figure 4.4 Historical and projected emissions of greenhouse gases from combustion in households, premises, agriculture, forestry and fisheries.

Table 4.5 Historical and projected emissions of greenhouse gases from residential and commercial sectors (Mt CO₂-eq.)

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	10.9	2.2	1.9	1.9	1.8	1.8	-83%	-83%
Methane	0.1	0.06	0.05	0.05	0.04	0.04	-57%	-69%
Nitrous oxide	0.2	0.1	0.1	0.1	0.1	0.1	-51%	-57%
Total emissions	11.2	2.3	2.1	2.0	1.9	1.9	-83%	-83%

4.3.3 Industrial combustion

To cover all industry-related emissions, it is necessary to take account of process emissions, emissions from combustion, part of energy industries and fugitive emissions, which according to UNFCCC guidelines are to be reported under separate CRF (Common Reporting Format) categories.

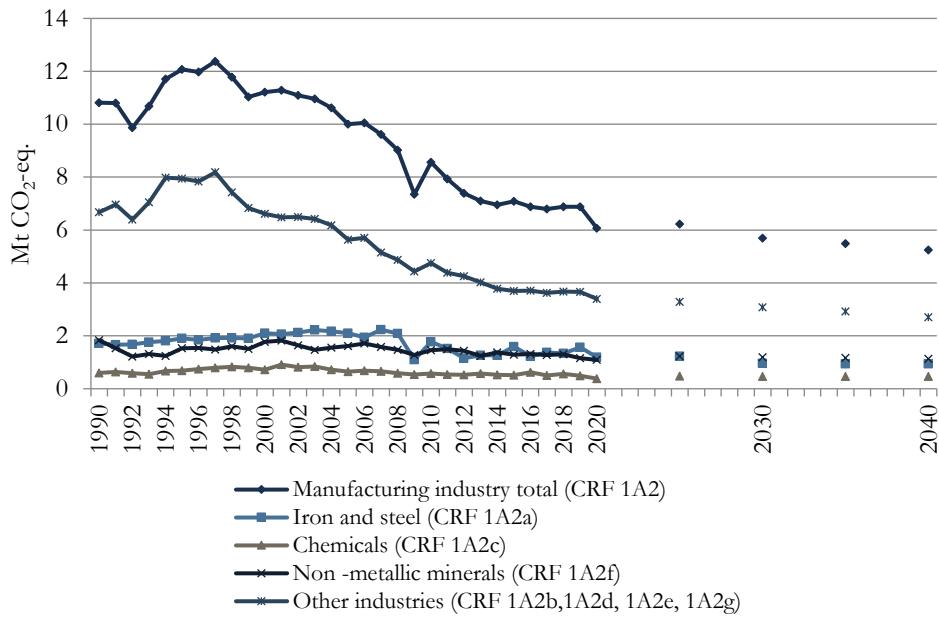


Figure 4.5 Historical and projected emissions of greenhouse gases from combustion in manufacturing industries.

Emissions from combustion in manufacturing industries are projected to decrease to 2040, because the use of biofuel and electricity is expected to increase more than the use of fossil fuels, see Table 4.6 and Figure 4.5. This decrease in emissions is mainly due to a shift in the pulp and paper industry from using fossil fuels to using biofuels. Emissions from the mineral industry are also expected to decrease, while emissions from the chemical industry and the iron and steel industry remain relatively stable in the projection.

Table 4.6 Historical and projected emissions of greenhouse gases from combustion in manufacturing industries (Mt CO₂-eq.).

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	10.7	5.9	6.0	5.5	5.3	5.1	-48%	-52%
Methane	0.02	0.02	0.03	0.03	0.03	0.03	13%	16%
Nitrous oxide	0.1	0.1	0.1	0.1	0.2	0.2	8%	10%
Total emissions	10.8	6.1	6.2	5.7	5.5	5.2	-47%	-52%

4.3.4 Fugitive emissions

The majority of fugitive emissions originate from refineries. Emissions are assumed to remain at the same level during the projections period, see Table 4.7.

Table 4.7 Historical and projected emissions of greenhouse gases from fugitive emissions (Mt CO₂-eq.).

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	0.3	0.4	0.9	1.0	1.0	1.0	165%	170%
Methane	0.1	0.04	0.06	0.06	0.06	0.06	-25%	-25%
Nitrous oxide	0.001	0.001	0.001	0.001	0.001	0.001	4%	4%
Total emissions	0.4	0.5	0.9	1.0	1.0	1.0	128%	133%

4.3.5 Industrial processes and product use

The industrial processes and product use sector contributes with greenhouse gas emissions from the materials used in industrial processes and the use of solvents and other products, including the use of fluorinated greenhouse gases.

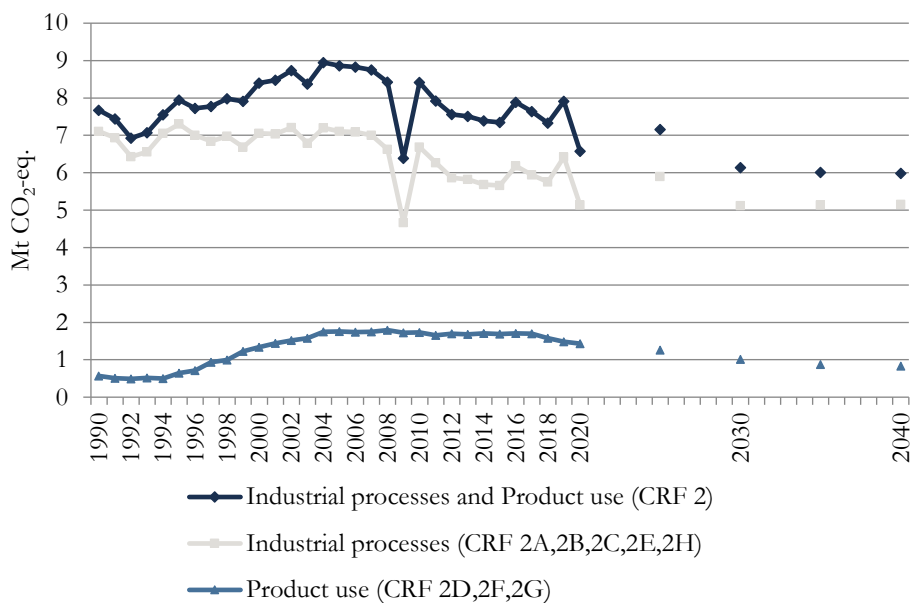


Figure 4.6 Historical and projected emissions of greenhouse gases from industrial processes and product use.

Greenhouse gas emissions from industrial processes and product use are projected to decrease slightly to 2040, see Table 4.8 and Figure 4.6. This decrease is due to a decrease in emissions of fluorinated greenhouse gases but also a decrease in emissions from carbon dioxide are expected after 2030..

Carbon dioxide emissions are expected to decrease to 2040. The decrease is mainly due to a decrease in emissions from the metal industry until 2040 and especially after 2030, due to a shift to fossil-free technology in a part of the iron and steel industry. The emissions of carbon dioxide from the mineral

industry are expected to slightly increase until 2040 compared with 1990 due to a projected continuing increase in constructing new buildings. The emissions of greenhouse gases from chemical industry are assumed to remain around the same level as in 2019. The emissions from fuel combustion in industry are reported in the energy.

Emissions of fluorinated greenhouse gases are expected to decrease to 2040 due to a ban on their use that resulted from EU regulations.

Table 4.8 Historical and projected emissions of greenhouse gases from industrial processes and product use sector (Mt CO₂-eq.).

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	6.0	5.3	6.2	5.4	5.4	5.4	-10%	-10%
Methane	0.03	0.01	0.01	0.01	0.01	0.01	-65%	-66%
Nitrous oxide	1.0	0.2	0.2	0.2	0.2	0.2	-78%	-79%
Fluorinated greenhouse gases	0.7	1.0	0.8	0.5	0.4	0.4	-21%	-48%
Total emissions	7.7	6.6	7.2	6.1	6.0	6.0	-20%	-22%

4.3.6 Transport

Emissions from domestic transport, especially from road transport, are projected to decrease to 2040 for several reasons, see Table 4.9, Table 4.10 and Figure 4.7. The decrease in emissions is mainly due to large reductions from cars. One reason for this decrease is an ongoing improvement of energy efficiency due to EU CO₂ requirements that limits the emissions from new cars, heavy duty and light-duty lorries. Another reason for the decrease is a greater use of biofuels. It is in particular the obligatory low-blend of biofuels in petrol and diesel by which suppliers must reduce carbon dioxide emissions.

Emissions from domestic aviation have decreased in recent years, mostly due to higher efficiency. In the projection, travel is assumed to increase from today's level over the entire projection period, resulting in increasing emissions. Emissions from domestic navigation have varied between 0.5 and 0.7 Mt CO₂-eq. Emissions are assumed to be around 0.7 million tonnes until 2040. Emissions from railways are low during the projection period.

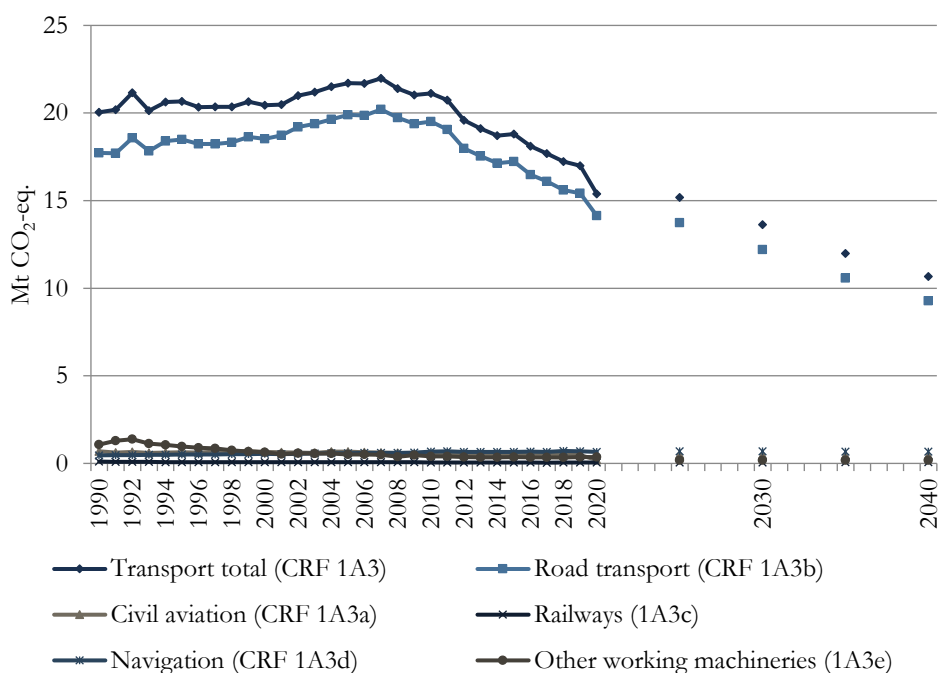


Figure 4.7 Historical and projected emissions of greenhouse gases from the domestic transport sector.

Table 4.9 Historical and projected emissions of greenhouse gases from different domestic transport modes (Mt CO₂-eq.).

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Road transportation	17.7	14.1	13.7	12.2	10.6	9.3	-31%	-48%
Civil aviation	0.7	0.2	0.5	0.5	0.5	0.5	-28%	-34%
Navigation	0.5	0.7	0.7	0.7	0.7	0.7	50%	44%
Railways	0.1	0.04	0.06	0.06	0.06	0.07	-43%	-36%
Other*	1.1	0.4	0.4	0.4	0.4	0.4	-67%	-67%

*includes other mobile machinery not used in industry, agriculture, forestry, fisheries or residential/commercial

Table 4.10 Historical and projected emissions of greenhouse gases from domestic transport (Mt CO₂-eq.).

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	19.7	15.2	14.9	13.4	11.7	10.4	-31%	-46%
Methane	0.2	0.05	0.04	0.04	0.04	0.04	-78%	-79%
Nitrous oxide	0.2	0.2	0.2	0.2	0.2	0.2	24%	15%
Total emissions	20.0	15.4	15.2	13.6	12.0	10.7	-31%	-46%

4.3.7 Waste

Methane emissions from landfill are projected to decrease by 96 % to 2040 compared to 1990, see Table 4.11 and Figure 4.8. This decrease is mainly due to a ban, from 2002, on depositing combustible materials in landfills and a ban, from 2005, on depositing organic materials in landfill. Furthermore, a tax on depositing waste in landfill was introduced in 2000.

Emissions of carbon dioxide from waste incineration and nitrous oxide from wastewater treatment are low and are expected to remain stable during the entire projection period. However, emissions of nitrous oxide and methane from biological treatment of solid waste are expected to increase slightly during the period, due to increased production of biogas.

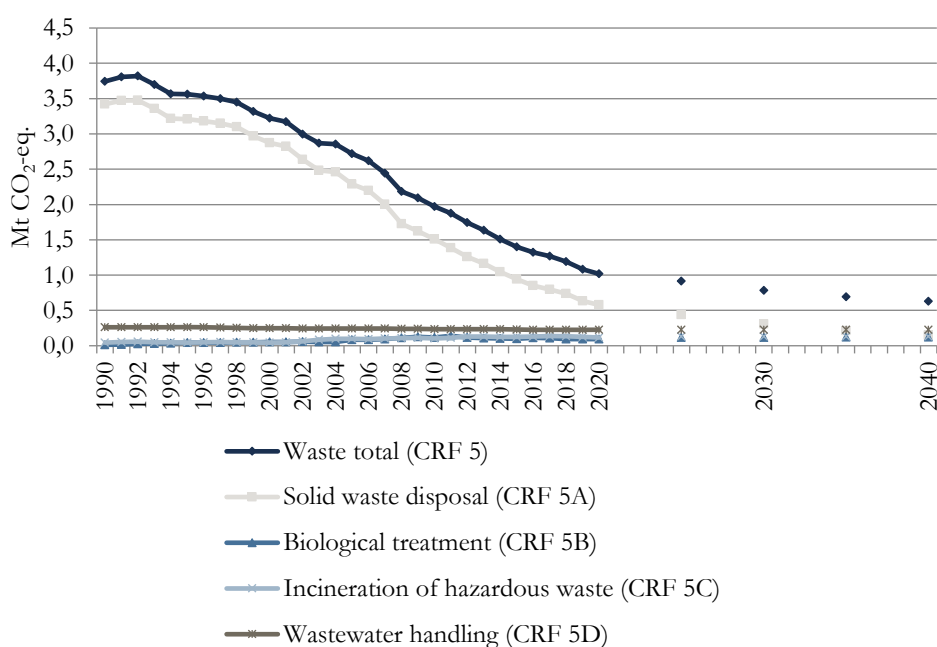


Figure 4.8 Historical and projected emissions of greenhouse gases from the waste sector.

Table 4.11 Historical and projected emissions of greenhouse gases from the waste sector (Mt CO₂-eq.)

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	0.04	0.1	0.1	0.1	0.1	0.1	189%	189%
Methane	3.5	0.7	0.6	0.4	0.3	0.3	-88%	-92%
Nitrous oxide	0.2	0.2	0.2	0.2	0.2	0.2	0%	0%
Total	3.7	1.0	0.9	0.8	0.7	0.6	-79%	-83%

4.3.8 Agriculture

Greenhouse gas emissions from agriculture have decreased since 1990, mainly due to improved production efficiency and fewer cattle. This in turn has led to lower methane emissions from the digestion process in ruminant animals and reduced emissions of methane and nitrous oxide from manure. Emissions of nitrous oxide from agricultural land have also declined as a result of reduced cereal acreage, reduced use of fertilizers, reduced nitrogen leaching and a transition from solid manure to slurry management.

Emissions from agriculture are estimated to decrease as a result of a continuously declining cattle population, see Table 4.12, Table 4.13 and Figure 4.9. The reduced numbers of dairy cows until 2040 are primarily a result of increased productivity, product pricing mechanisms and continuous adaptation to EU agricultural policy regulations.

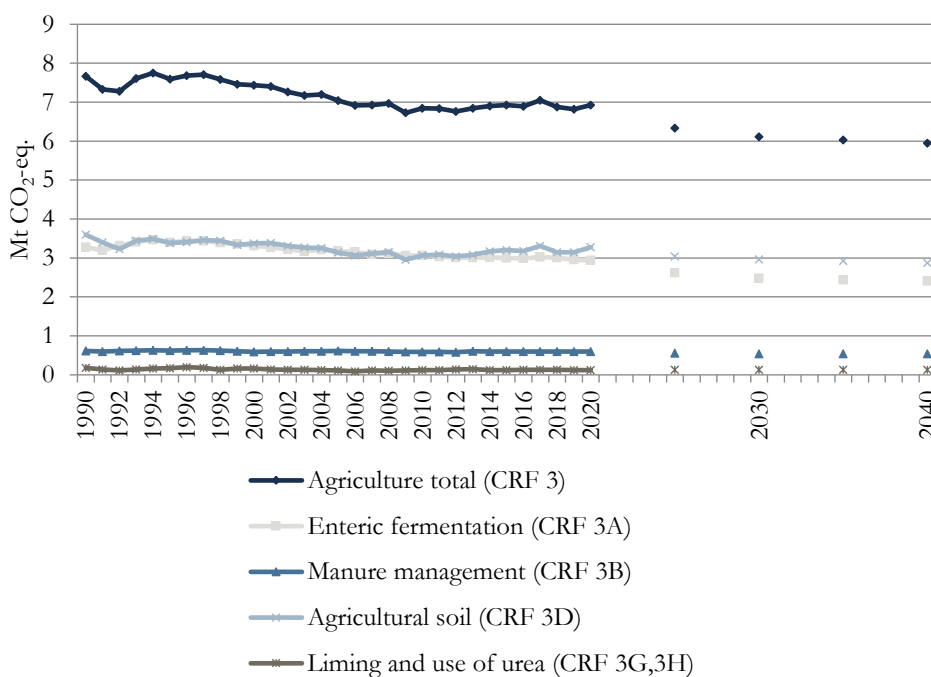


Figure 4.9 Historical and projected emissions of greenhouse gases from agriculture.

Table 4.12 Historical and projected emissions of greenhouse gases from agriculture per gas (Mt CO₂-eq.)

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Methane	3.5	3.2	2.9	2.7	2.7	2.6	-23%	-25%
Nitrous oxide	4.0	3.6	3.3	3.3	3.2	3.2	-18%	-20%
Carbon dioxide	0.2	0.1	0.1	0.1	0.1	0.1	-29%	-29%

Total emissions	7.7	6.9	6.3	6.1	6.0	5.9	-20%	-22%
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Table 4.13 Historical and projected emissions of greenhouse gases from agriculture (Mt CO₂-eq.)

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Enteric fermentation	3.3	2.9	2.6	2.5	2.4	2.4	-24%	-27%
Manure management	0.6	0.6	0.6	0.5	0.5	0.5	-12%	-12%
Agricultural land	3.6	3.3	3.0	3.0	2.9	2.9	-18%	-20%
Liming/Use of urea	0.2	0.1	0.1	0.1	0.1	0.1	-29%	-29%
Total emissions	7.7	6.9	6.3	6.1	6.0	5.9	-20%	-22%

4.3.9 Land Use, Land Use Change and Forestry (LULUCF)

The LULUCF sector contributed to the total greenhouse gas budget with an annual net removal of greenhouse gases in Sweden during the period 1990–2020. Net removals for LULUCF are expected to increase to 2040, see Table 4.14, Table 4.15 and Figure 4.10. This trend is mainly due to a increase in removals from forest land. The projections for removals of carbon dioxide from forest land is based on the assumption that the current harvest intensity (2015-2019) persist over time and a climate effect which gives a positive effect on the annual gross increment.

The projections are based on a number of assumptions which are characterised by uncertainties. A sensitivity analysis has been performed for the LULUCF projection, simulating forest land using the same settings but without the climate effect which gives a positive effect on the annual gross increment. The net removals for the LULUCF-sector are instead projected to decrease to 2040. See also section 4.6.

Net emissions from cropland have varied during the period 1990–2020. The emissions are projected to decrease slightly based on a projected slight decrease in area and the average net emissions per area for the latest ten years. Net emissions from settlements are caused by felling due to urbanisation and the establishment of power lines and forest roads. These emissions are projected to be at the same level for the entire projection period as the average for the last ten years. The carbon stock changes in

grassland and wetlands were small during the period 1990–2020 and are projected to stay low during the projection period.

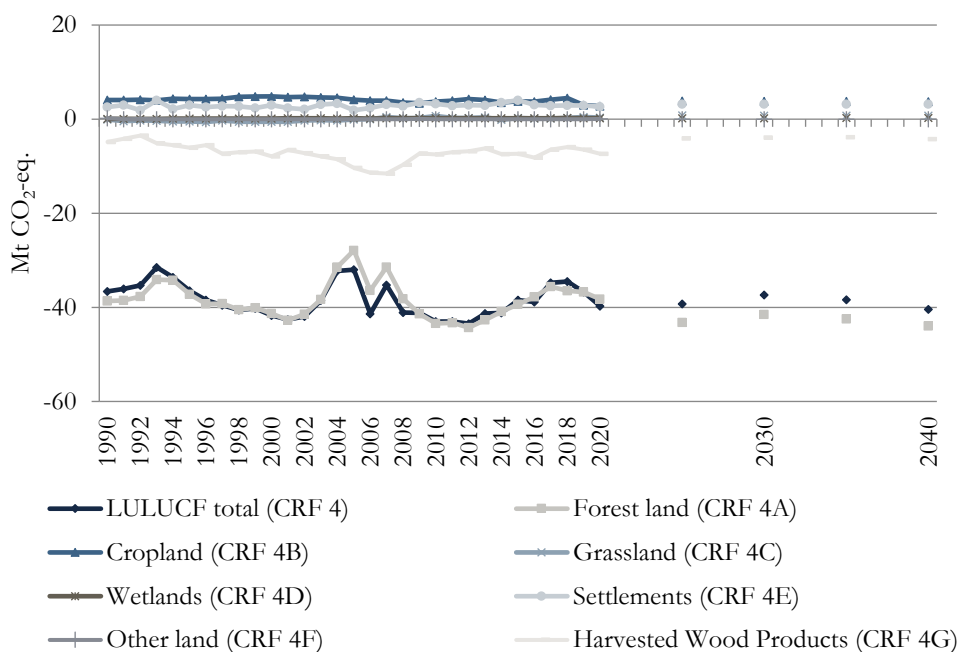


Figure 4.10 Historical and projected emissions (+) and removals (-) from the LULUCF sector and its subcategories in Mt CO₂-equivalents per year.

Table 4.14 Historical and projected emissions (+) and removals (-) of greenhouse gases from LULUCF (Mt CO₂-eq.)

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Forest land	-38.7	-37.8	-43.2	-41.5	-42.4	-44.0	7%	14%
Cropland	4.1	2.8	3.9	3.8	3.8	3.7	-7%	-10%
Grassland	0.1	0.3	0.8	0.8	0.8	0.7	413%	397%
Wetlands	0.1	0.2	0.2	0.2	0.2	0.3	181%	216%
Settlements	2.6	2.6	3.2	3.2	3.2	3.2	23%	23%
Other land	0.2	-0.02	-0.005	-0.005	-0.005	-0.005	-102%	-102%
HWP	-4.8	-7.4	-4.1	-3.9	-3.8	-4.3	-20%	-11%
Total net removals	-36.6	-39.8	-39.3	-37.4	-38.4	-40.4	2%	10%

Table 4.15 Historical and projected emissions (+) and removals (-) of greenhouse gases from LULUCF per gas (Mt CO₂-eq.)

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	-38.3	-41.5	-37.4	-40.9	-38.9	-41.9	2%	10%
Methane	0.5	0.4	0.4	0.4	0.4	0.4	-9%	-11%

Nitrous oxide	1.2	1.3	1.1	1.1	1.1	1.1	-5%	-6%
Total net removals	-36.6	-39.8	-39.3	-37.4	-38.4	-40.4	2%	10%

4.3.10 International transport

Emissions from bunkers for international transport are projected to increase to 2040, mainly due to increased emissions from international aviation, see Table 4.16 and Figure 4.11. This increase is explained by an expected increase in private consumption during the projection period, resulting in increased number of passengers..

The increased use of fuel for international navigation is due to an increase in passenger traffic, growth in exports of goods and increased refuelling in Sweden. The projection is based on the assumption that transport volumes will increase as transportation becomes more efficient. This leads to projected emissions from international navigation at about the same level during the projection period. The number of international bunkers counted in Sweden also depends largely on where international ships and airplanes choose to refuel.

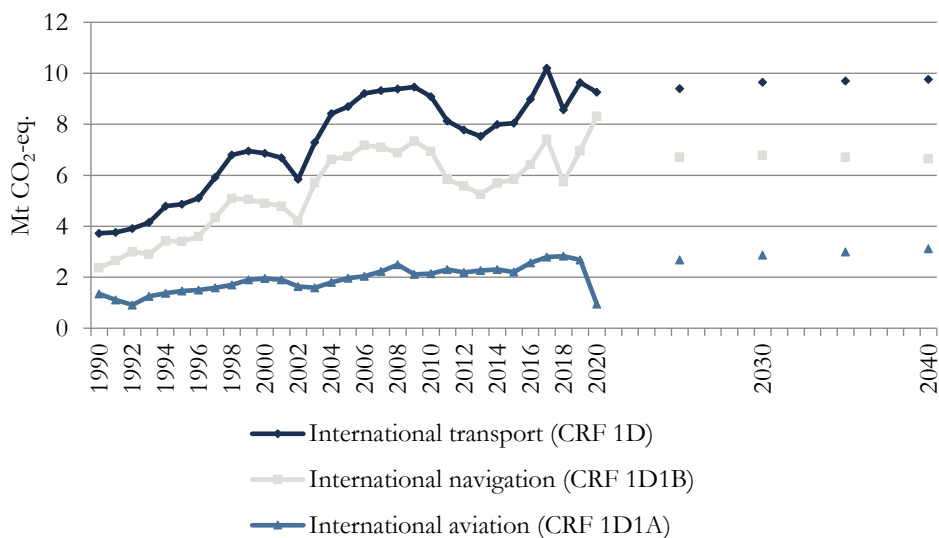


Figure 4.11 Historical and projected emissions of greenhouse gases from international bunkers.

Table 4.16 Historical and projected emissions of greenhouse gases from international bunkers (Mt CO₂-eq.)

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Navigation	2.4	8.3	6.7	6.8	6.7	6.6	186%	180%
Aviation	1.4	0.9	2.7	2.9	3.0	3.1	111%	130%

Total emissions	3.7	9.3	9.4	9.6	9.7	9.8	159%	162%
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4.4 Sensitivity analysis

Sensitivity calculations were produced by varying some parameters in the energy sector (incl. transport) and some in the transport sector. Aggregated for all sectors, the sensitivity calculations show that the emission level in 2040 may be 40 to 46 % lower than 1990 levels, depending on the sensitivity projection, see Table 4.17. However, this does not include uncertainty in the calculations, which may expand the percentage span between the projections.

Table 4.17 Historical and projected total emissions of greenhouse gases for different projections in the sensitive analysis excl. LULUCF (Mt CO₂-eq.)

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Projections WEM	71.4	46.3	47.0	43.2	41.0	39.4	-39%	-45%
Energy sector including transport								
Projection “Lower fossil fuel prices”			48.1	43.9	42.8	42.5	-38%	-40%
Projection “Lower GDP”			46.9	42.9	40.4	38.6	-40%	-46%
Transport sector								
Projections “Lower mileage”			46.9	42.9	40.6	38.9	-40%	-45%

Two sensitivity projections were calculated for the energy sector including transport: one projection with 30 % lower fossil fuel prices and one with 30 % lower economic growth than in the reference projections. Lower fossil fuel prices also result in higher economic growth than in the reference projections. All other assumptions are identical to the assumptions in the reference projection.

Results of the sensitivity projections show that the projection with lower fossil fuel prices results in higher emissions in 2040 compared to the reference projection, as expected. A lower fossil fuel price decreases the incentive to replace fossil fuels and increase energy efficiency in industry, giving higher emissions in the transport sector.

The projection with lower economic growth than in the reference projection results in lower emissions in the energy and transport sectors compared to

the reference projection. The main reason for the decreased emissions is a lower energy demand, due to lower production in the industrial sector. Lower economic growth leads to a lower demand for the transportation of both goods and people.

For the road transportation sector, a projection with lower mileage were performed separately. All other assumptions are identical to the ones in the reference projections. In the projection, mileage is assumed to be 10 % lower in 2040 compared to the reference projection. Results show that the projections with lower mileage result in reductions in emissions.

4.4.1 Sensitivity calculations for the LULUCF sector

The projections for the LULUCF-sector is based on a number of assumptions which are characterised by uncertainties. The result should be interpreted with that in mind. A sensitivity projection has been calculated for the LULUCF sector. In the reference projections a positive climate effect which gives a positive effect on the annual gross increment by 21 % 2070-2100 compared to 1970-2000 was included for forest management and HWP. In the sensitivity projections no positive climate effect is included. All other assumptions are identical to the ones in the reference projection.

The calculations of the sensitivity projections show that the projection with no climate effect results in a decrease in net removals until 2040 instead of an increase as in the reference projection. The emissions are projected to be around 30 million tonnes in 2040 which is about 11 million tonnes lower compared to the reference projection with climate effect.

Table 4.18 Historical and projected emissions and removals of greenhouse gases for different projections in the sensitive analysis for the LULUCF sector (Mt CO₂-eq.).

	1990	2020	2025	2030	2035	2040	1990-2030	1990-2040
Total LULUCF with climate effect	-36.6	-39.8	-39.3	-37.4	-38.4	-40.4	2%	11%
Total LULUCF without climate effect	-36.6	-39.8	-35.4	-30.3	-30.7	-29.1	-17%	-20%

4.5 Comparison with Fourth Biennial Report

The projections presented in 2020 in Sweden’s Fourth Biennial Report (BR4) showed reductions in total greenhouse gas emissions of 35 % between 1990 and 2030. The projection set out here, in the Fifth Biennial Report (BR5), uses partly different assumptions and assessments based on trends over the last few years, see Table 4.18. The new projections show a decrease in total greenhouse gas emissions of 39 % between 1990 and 2030. A comparison of percentage changes in emissions overall and by sector is shown in Figure 4.12.

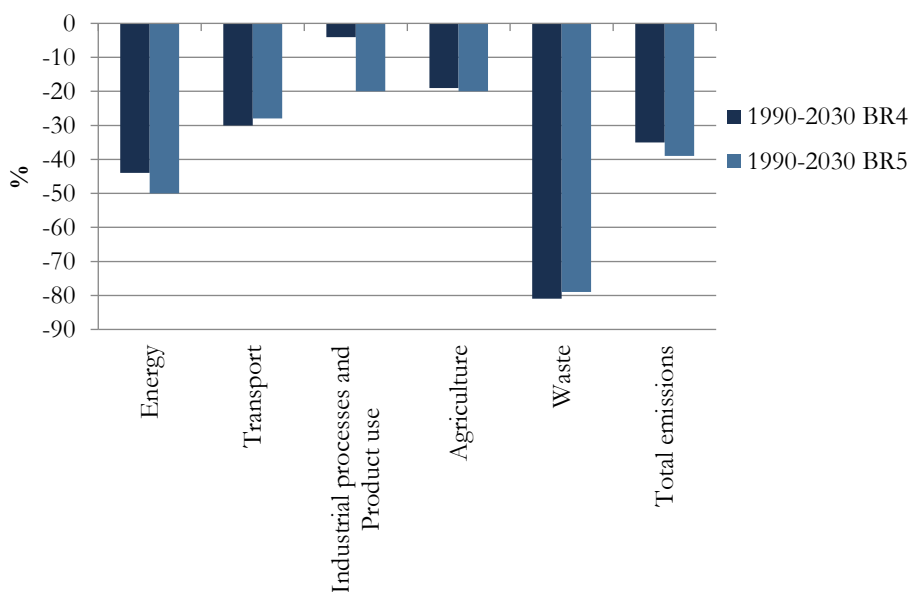


Figure 4.12 Percentage changes in emissions between 1990 and 2030 respectively as projected in BR4 and BR5, overall and by sector.

The projections presented here indicate a larger reduction of emissions by 2030 for some sectors compared with those in BR4. The difference is mainly due to differing assumptions, for instance regarding fossil fuel prices, and assumptions based on the trend over the last few years.

Table 4.19 Key assumptions in the Fourth Biennial Report and in the Fifth Biennial report.

	BR4	BR5
	2015-2035	2015-2035
GDP (annual change %)	2.05	1.72
	2030 <i>(2015 prices)</i>	2030 <i>(2016 prices)</i>
Price of crude oil (USD/barrel)	121	89

Price of coal (USD/tonne)	124	86
Price of natural gas (USD/MBtu)	12	6
Emissions trading (Euro/tonne CO ₂)	34.7	30
Electricity price (SEK/kWh)	0.44	0.33
Electricity certificates (new renewable electricity compared with 2012)	28.4 TWh by 2020	28.4 TWh by 2020

4.6 Progress towards targets under the EU Climate and Energy Package

Under the UNFCCC, the EU and its Member States committed to achieving a joint quantified economy-wide greenhouse gas emission reduction target of 20 per cent below the 1990 level by 2020 (“the Cancun pledge”). (See chapter 2). The EU has substantially overachieved its reduction target under the Convention, which means that also its Member States and the UK have fulfilled their emission reduction obligations. As stated in the 2022 EU GHG inventory submission to the UNFCCC, total GHG emissions, excluding LULUCF and including international aviation, decreased by 34 % in the EU-27 + UK compared to the base year 1990 or 1.94 billion tons of CO₂-eq.

4.6.1 Sweden’s commitment according to the Effort Sharing Decision

The EU has jointly committed to its UNFCCC target and implemented it internally through EU legislation in the 2020 EU Climate and Energy Package. In this package, the EU introduced a clear approach to achieving the 20 % reduction in total GHG emissions from 1990 levels, by dividing the effort between the sectors covered by the EU Emissions Trading System (EU ETS) and the sectors under the Effort Sharing Decision (ESD). Binding national targets were set for Member States under the Effort Sharing Decision.

Emissions from installations included in the EU Emissions Trading System (EU ETS) are to fall by 21 % between 2005 and 2020 for the EU as a whole. Emissions not covered by the trading system are to be reduced from EU as a whole with 10 % to 2020 compared to 2005, in line with the Effort Sharing Decision (ESD) (EU Decision 406/2009/EC). For Sweden, this decision means that emissions in the ESD-sector must decrease by 17 % between 2005 and 2020, in line with a target emissions trajectory. This means that the

ESD emissions must decrease linearly from 41.7 Mt in 2013 to 36.1 Mt in 2020⁶⁶.

Furthermore, Sweden can use credits from international project activities to meet the target. The annual use is restricted to 3 % of 2005 emissions⁶⁷, which equals 10.9 million tonnes for the entire period 2013–2020. In addition, 1 % of 2005 emissions can be used in international projects fulfilling certain requirements. This corresponds to 3.6 million additional tonnes for the entire period 2013–2020. The maximum possible annual use of international credits thus amounts to a maximum of 1.8 million tonnes. A member state may transfer up to 5 % of their allocated Annual Emissions Allocations (AEA) for a given year to other member states. Furthermore, 5 % of the AEA's can be carried over from the following year, and if there is a surplus of allowances it can be banked to following years or transferred to other member states.

For the years 2013-2020, Sweden's ESD-emissions have been lower than the ESD-targets, see Figure 4.13. The surplus amount of AEAs was over 5 million tonnes per year compared to the Swedish ESD target, see Table 4.20. The surplus for 2013-2019 was deleted. The government has proposed to the Swedish Parliament that also the surplus for 2020 should be deleted. Compliance for 2020 is planned to be performed in 2023.

The target for Sweden is set to 36.1 Mt CO₂-eq. in 2020 (EU Decision C(2013)1708). ESD emissions were 29.4 million tonnes in 2020. The overachievement in 2020, compared to the Swedish target, is estimated to be over 6 million tonnes, without the use of international credits. Note that these figures are preliminary and compliance are planned to be performed in 2023 after review.

⁶⁶ In 2017 the target for 2020 was adjusted from 37.2 to 36.1 million, because the historical emissions are lower due to methodological changes. Commission Decision 2017/1471 amending decision 2013/162/EU to revise Member States' annual emissions allocations for the period from 2017 to 2020.

⁶⁷ According to National Inventory Report submission 2012

Table 4.20 Sweden's historical and projected emissions of greenhouse gases (based on National Inventory Report submission 2022). Emission data presented as total emissions, ETS emissions, CO₂-emissions from domestic aviation and emissions covered by the Effort Sharing Decision (ESD) in relation to ESD target (scope 2013-2020, excl. aviation) in Mt CO₂-eq.

	2013	2014	2015	2016	2017	2018	2019	2020	2030	2040
Total emissions	55.8	53.9	54.1	53.7	53.1	52.2	50.8	46.3	43.2	39.4
ETS emissions	20.1	19.3	19.2	19.7	19.6	19.9	18.8	16.5	16.6	16.5
Domestic aviation	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	0.5	0.4
ESD emissions^{68 69}	35.2	34.1	34.4	33.4	32.9	31.8	31.6	29.6	26.1	22.5
ESD target⁷⁰	41.7	41.0	40.4	39.8	37.8	37.2	36.7	36.1		

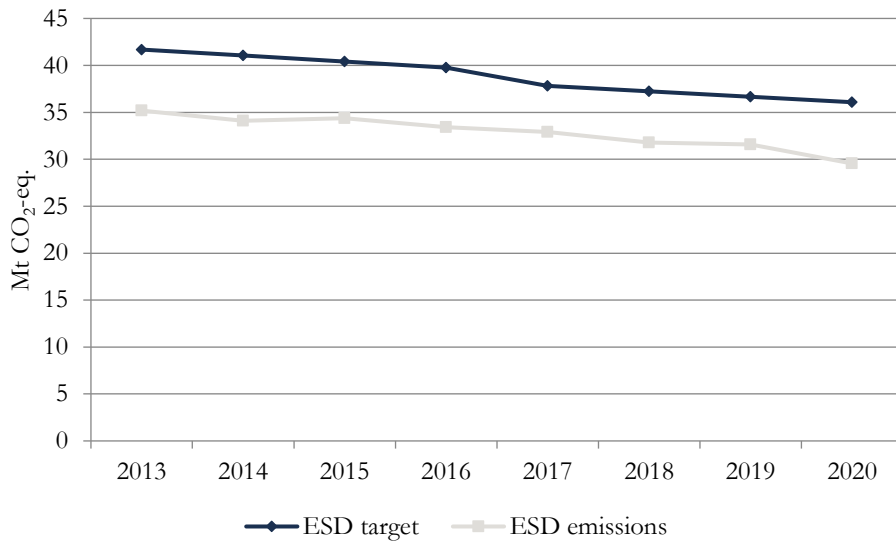


Figure 4.13 The ESD target 2013-2020, the Swedish ESD emissions 2013-2017 and the projected Swedish ESD emissions 2020.

4.7 Target fulfilment in relation to national targets

According to the 2009 climate policy resolution of the Swedish Parliament, the Swedish target for emissions that are not included in the EU ETS, must

⁶⁸ ESD emissions include emissions that are covered by the Effort Sharing Decision and are calculated as total emissions excl. LULUCF minus CO₂ emissions from domestic aviation minus emissions from EU ETS.

⁶⁹ Historical emissions are presented according to National Inventory Report submission 2022. The ESD emissions for compliance are based on relevant submission and the ESD-emissions in 2013 according to submission 2016 were 35.3 Mt CO₂-eq. which means a surplus of 6.4 million AEAs deleted. Emissions in 2014 were 34.5 Mt CO₂-eq. (sub 2016) a surplus of 6.5 million AEAs was deleted. Emissions in 2015 were 33.9 Mt CO₂-eq. (sub2017), a surplus of 6.5 million AEAs deleted. Emissions in 2016 were 32.6 Mt CO₂-eq. (sub2018), a surplus of 7.2 million AEAs was deleted. Emissions in 2017 were 32.5 Mt CO₂-eq. (sub2019), a surplus of 5.3 million AEAs was deleted. Emissions in 2018 were 31.4 Mt CO₂-eq. (sub2020), a surplus of 5.8 million AEAs was deleted. Emissions in 2019 were 31.7 Mt CO₂-eq. (sub2021), a surplus of 5.0 million AEAs is planned to be deleted.

⁷⁰ According to the revised targets in EU decision C(2013) 1708 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC.

be reduced by 40 %, or around 20 Mt CO₂-eq., between 1990 and 2020⁷¹, of which one third can be reduced through emission reductions in other countries.

In 2020, the national target will preliminarily be 28.7 Mt CO₂-eq.. Projections indicate that emissions will decrease to around 29.6 Mt CO₂-eq. and there will be a gap to target of approximately 0.8 Mt CO₂-eq. in 2020. Note that numbers are preliminary until 2022–2023, when a definitive calculation can be done, based on reviewed inventory data. If a gap to the target still remains, it can be closed by emission reductions in other countries.

In June 2017, the Parliament in Sweden adopted a climate policy framework including targets for 2045. By 2045, Sweden is to have no net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions. Emissions outside the EU ETS should be at least 63 % lower by 2030 than emissions in 1990, and at least 75 % lower by 2040. To achieve these targets, no more than 8 and 2 percentage points, respectively, of the emissions reductions may be realised through supplementary measures such as increase in carbon sinks, verified emissions reductions through investments in other countries and carbon capture and storage of biogenic carbon dioxide. A reduction of 63 % means that the target is preliminary set to 17 Mt CO₂-eq. in 2030. The emissions outside EU ETS are projected to decrease to 26 Mt CO₂-eq. by 2030, which indicate a gap of around 9 Mt CO₂-eq. In addition, emissions from domestic transport are to be reduced by at least 70 % by 2030, compared to 2010. Emissions from domestic transport are projected to decrease by 35 % between 2010 and 2030.

⁷¹ This was equivalent to a decrease of 33 % between 2005 and 2020 when the target was adopted in 2009 (EU ETS scope 2008–12). In the third period of EU ETS, 2013–2020, the scope of the EU ETS was extended to include additional sectors. The target was consequently adjusted corresponding to emissions in the transferred sectors.

4.8 References

Commission decision (EU) (2017/1471) of 10 August 2017 amending Decision 2013/162/EU to revise Member States' annual emission allocations for the period from 2017 to 2020

Commission Decision (2013/162/EU) of 26 March 2013 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC of the European Parliament and of the Council (notified under document C(2013) 1708)

Commission Implementing decision (2013/634/EU) of 31 October 2013 on the adjustments to Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC of the European Parliament and of the Council

EU Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

EU Decision C(2013) 1708 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC.

EU regulation No 525/2013 of the European Parliament and of the Council Decision on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC

EU Regulation No 2018/1999 of the European Parliament and of the Council Decision on the Governance of the Energy Union and Climate

Govt. Bill 2020/21:1 *Budgetpropositionen för 2021*. Ministry of Finance

Ministry of the Environment and Energy. 2021. *Report for Sweden on climate policies and measures and on projections*. In accordance with article 18 under Regulation (EU) No 2018/1999 of the European Parliament and of the Council Decision on the Governance of the Energy Union and Climate Action.

National Inventory Report Sweden, Submission 2021.

National Inventory Report Sweden, Submission 2022.



5. Provision of financial, technological and capacity-building support to developing country Parties

5.1 Introduction

Climate change is the defining issue of our time and a top priority for the Swedish government. Sweden has a long history of support for work on climate change issues in developing countries, in an array of sectors and on a long-term basis but has raised its ambitions further since the adoption of the Paris Agreement. Sweden has consistently called for coherent and co-ordinated implementation of the Paris Agreement, Agenda 2030 and the Addis Ababa Action Agenda for development finance – on both global and national levels. Effective financing of climate action is facilitated by mainstreaming climate action in national budget and planning processes, thereby paving the way for successful national resource mobilisation. A large number of Swedish actors, such as ministries, government agencies, state-owned companies, non-governmental organisations, universities and the private sector are engaged in climate actions such as providing grants and innovative finance, technology transfer, research and various forms of capacity building.

The continuous progress in the development of methodologies to track climate finance, as well as the efforts within the EU to harmonise methodologies, make it difficult to directly compare the numbers in this report with previous reports. Any differences between climate reporting to EU and the UNFCCC might be due to quality assurances or new information being available. The underlying methodology is the same for both EU and UNFCCC reports.

5.2 Governing policies and principles

5.2.1 Policy framework for Swedish development cooperation and humanitarian aid

In December 2016, the Government adopted a policy framework outlining the direction of Swedish development cooperation and humanitarian aid. The purpose of the policy framework is to have a knowledge-based, broadly supported framework that is aligned with the internationally adopted 2030 Agenda for Sustainable Development. At the same time, the Swedish policy framework also goes beyond the 2030 Agenda in a number of aspects, such as gender equality, democracy and human rights.

Environment and climate change are one of the key areas of the policy, one of three top priorities of the government, and in addition, an environment and climate change perspective shall be integrated in all Swedish development cooperation. The policy highlights that Sweden will support low and middle-income countries' accession to, and implementation of, commitments under the climate convention, and the implementation of their Nationally Determined Contributions under the Paris Agreement.

5.2.2 Key principles

The principles contained in the Paris Declaration of 2005, the Accra Agenda of 2008 and the Busan Partnership of 2011, and the outcome document from the second high-level meeting of the Global Partnership for Effective Development Cooperation in Nairobi (2016) are pivotal to international development cooperation and climate finance. National ownership is also key to securing long-term sustainability of climate change-related initiatives. External actors should seek to improve coordination and alignment to the national systems and processes of developing countries so as to ensure transparency and mutual accountability.

Within the multilateral funds Sweden has been a champion for direct access, where national authorities are able to directly access financing and manage all aspects of the projects/programs. In our bilateral work the countries' and organisations' own needs, priorities and strategies are weighed into the strategies, and a fundamental entry point for all of Sida's contributions. Sweden consider the countries' NDC:s and NAP:s and development plans areas central tools for Sida for understanding needs, priorities and where the funding gap is the largest in our partner countries in terms of financial and capacity building support.

5.2.3 New and additional measures

According to the UN Framework Convention on Climate Change, "The developed country Parties [...] shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations". 'New and additional resources' is a complex term, used in many multilateral contexts. There is currently no international agreement on how it should be defined. Sweden is one of few OECD DAC members to have met, and even far exceeded, the UN international development aid goal of 0.7 % of gross national income (GNI).

There is broad Parliamentary support, to continue delivering 1 % of Sweden’s GNI to Official Development Assistance (ODA). Against this background, all climate finance provided by Sweden during 2017-2020 should be viewed as new and additional. Figures for total Swedish ODA 2017-2020 are shown in Table 5.1, together with the share of climate finance compared to total ODA. Figure 5.1 shows climate finance based on type of support. Sweden’s overall climate financing having increased more than threefold since 2014.

Table 5.1 Total Swedish official development assistance, 2019–2020⁷²

	2019	2020
ODA (SEK million)	50 710	52 110
ODA (USD million)	5 362	5 658
ODA (% of GNI) ⁷³	1,00	1,00
Climate finance (SEK million)	8 031	7 316
Climate finance (USD million)	849	794
Climate finance (% of ODA)	15,8	14

⁷² Total ODA corresponds to total ODA in the budget bill. In Sweden’s previous Biennial report under the UNFCCC, total ODA corresponded to the amount reported to the OECD DAC. However, considering that Sweden, in 2020, reported a debt note to the Green Climate fund á 8 billion SEK, which is included in the OECD DAC 2020 outcome, whereas actual payments are allocated over several years, the budget bill ODA level makes for a more relevant comparison. Climate finance corresponds to estimated climate finance based on policy markers and core support to organizations reported to the OECD DAC. Imputed climate finance for core support is based on data from the OECD DAC: https://webfs.oecd.org/climate/Imputed_multilateral_shares_climate.xlsx. Exchange rates are according to <https://data.oecd.org/conversion/exchange-rates.htm>. Any differences between climate reporting to EU and the UNFCCC might be due to quality assurances or new information being available. The underlying methodology is the same for both EU and UNFCCC reports. Climate finance in 2019 also includes 74 (million SEK) other official flows (OOF). For 2020 climate finance also includes 42 million SEK OOF.

⁷³ BNI according to ENS 2010

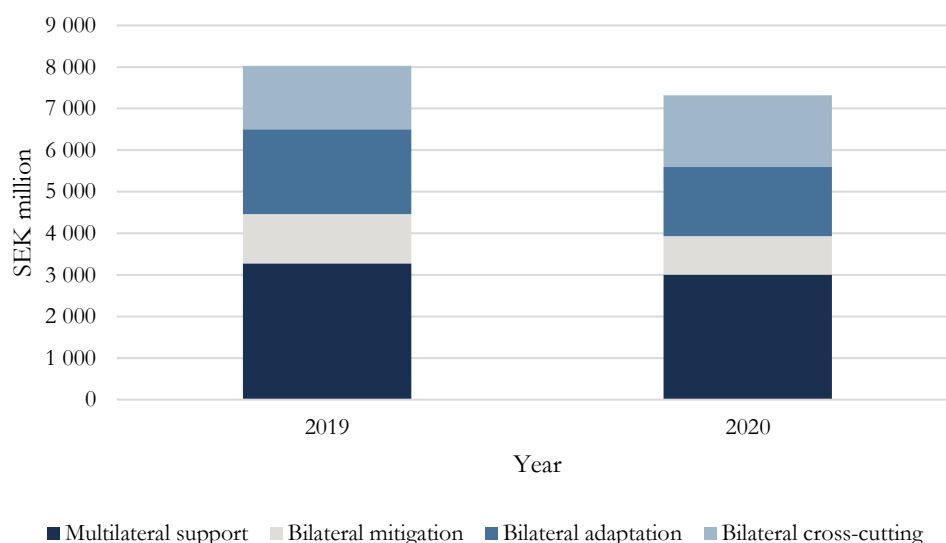


Figure 5.1 Total Swedish climate finance, 2019-2020. Multilateral support in this report refer to climate share of core contribution to multilateral organizations with reference to OECD DAC imputed climate shares (available here: https://webfs.oecd.org/climate/Imputed_multilateral_shares_climate.xlsx). During Sweden's in-country review 2023, Sida has updated the climate finance reporting for 2020 following feedback from OECD/DAC on Sweden's official development finance reporting.

5.3 Multilateral financial support

In 2020 total climate finance channeled through multilateral organizations whereas climate specific support were 3004 MSEK. Sweden is one of the largest per capita donors in the world to the financial mechanism under the UN Framework Convention on Climate Change – the Green Climate Fund (GCF) and the Global Environment Facility (GEF). In addition, Sweden provided substantial climate finance through a number of other multilateral climate change funds, such as the Adaptation Fund, the Least Developed Countries Fund, the Climate Investment Funds (CIF) as well as the Global Centre for Adaptation. Sweden was also instrumental in a renewed replenishment of the Nordic Development Fund (NDF) in 2020 with first instalments due in 2022. Multilateral core support to climate finance refers to the estimated amount of multilateral core support that is considered climate specific, using the OECD DAC imputed multilateral (climate) shares.⁷⁴

Sweden was also instrumental in a renewed replenishment the replenishment of the Nordic Development fund (NDF) in 2020 and made new commitments to the Climate Investment Funds' (CIFs) Industry Transitioning Program, as well as the Global Center for Adaptation.

⁷⁴ Imputed climate finance for core support is based on data from the OECD DAC: https://webfs.oecd.org/climate/Imputed_multilateral_shares_climate.xlsx.

Multilateral climate finance (presented in CTF Table 7 and 7a) is mainly managed by the Ministry for Foreign Affairs, including core support to Multilateral Development Banks (MDB) and UN organisations. Sweden considers core funding key for flexibility, rapid response, long-term planning and in line with the principles of aid effectiveness, and has thus chosen to present some of this support in Table 7a (note that it does not necessarily provide an exhaustive list of all of Sweden's multilateral contributions; for example imputed climate shares are unavailable for some organizations that Sweden provides with core support which may have climate activities to some degree).

The Ministry of Climate and Enterprise administered support to a number of strategic initiatives linked to the UNFCCC negotiations, such as the UNFCCC Trust Fund Fund for Supplementary Activities and Trust Fund for Participation, the New Climate Economy, the International Institute for Environment and Development, the International Institute for Sustainable Development's work with the Global Subsidies Initiative, and the OECD's Research Collaborative on Tracking Climate Finance. The Swedish Energy Agency, the Swedish Environmental Protection Agency and the Swedish Meteorological and Hydrological Institute were also involved in important climate initiatives, programs and mechanisms, such as the Climate and Clean Air Coalition, and the Sustainable Development Initiative.

Sweden has been a champion of gender integration in the multilateral climate funds, including the promotion of separate gender policies and action plans that support gender-responsive actions. During the reporting period, for example the GCF adopted an updated gender policy in 2019. Integration of gender issues continues to improve, thus also contributing to raising the efficiency and long-term sustainability of the projects and programs funded by multilateral climate funds.

5.4 Bilateral financial support

In this chapter three sections will follow: multi-bilateral, bilateral support from Sida and bilateral support from the Swedish Energy Agency. In Sweden, climate finance data is provided by three government agencies (Ministry for Foreign Affairs, Sida and Swedish Energy Agency). The vast majority of the bilateral support is provided by Sida.

In 2020, total bilateral finance support was 4313 MSEK (924 MSEK for bilateral mitigation, 1667 MSEK for bilateral adaptation and 1721 MSEK for

Cross-cutting). In 2019, total bilateral climate finance support was 4757 MSEK (1190 MSEK for bilateral mitigation, 2041 MSEK for bilateral adaptation and 1526 MSEK for Cross-cutting. For an overview, please see table 5.3 below.

Table 5.2 Total bilateral climate finance 2019-2020.

Total bilateral finance 2019		
Type of support	Climate finance (MSEK)	Climate finance (MUSD)
Mitigation	1190	126
Adaptation	2041	216
Cross-cutting	1526	161
Total	4756	503
Total bilateral finance 2020		
Type of support	Climate finance (MSEK)	Climate finance (MUSD)
Mitigation	924	100
Adaptation	1667	181
Cross-cutting	1721	187
Total	4313	468

5.4.1 Multi-bilateral support

An overview of Sweden’s earmarked multilateral support (multi-bi) in 2020, with respect to type of support, is presented in Figure 5.2 (corresponding outcome in 2019 is not readily available).

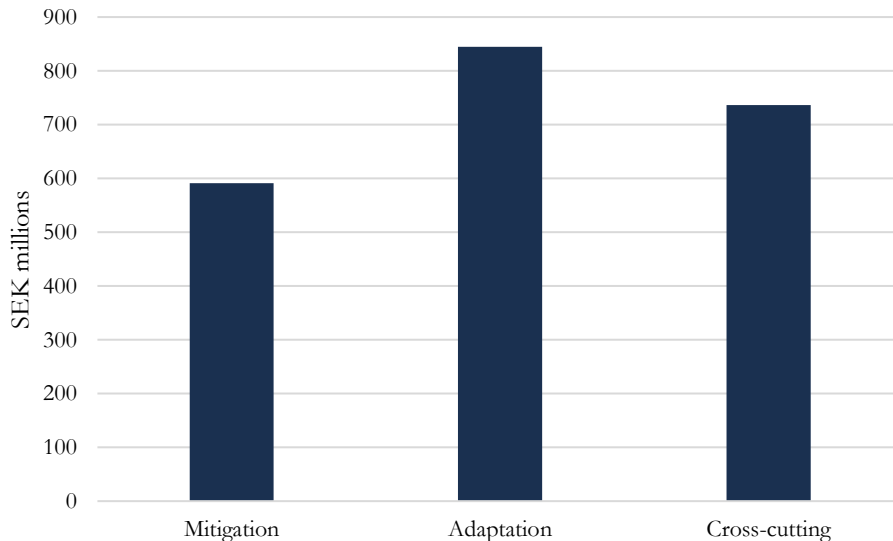


Figure 5.2 Swedish multi-bilateral climate finance 2020 by type of support.

More information for each year can be found in CTF table 7a.

5.4.2 Methodology for tracking climate-related bilateral ODA

The Swedish bilateral support provided through Sida includes support to bilateral, regional and global institutions and organisations (including so-called ‘multi-bi’ support) and is reported in CTF Table 7: summary financial information, 7b: details at component level, 8: examples of technology development contributions, and 9: examples of capacity building contributions.

Online publishing

Detailed information about Sida’s operations is continuously published online according to the internationally agreed International Aid Transparency Initiative (IATI) standard at www.openaid.se.

Tracking, coefficients and range of countries

Sida uses the OECD-DAC Rio markers for climate change mitigation and climate change adaptation to track climate finance. The components are marked using a scale of 0–2, where 2 represents ‘principal objective’, 1 ‘significant objective’ and 0 ‘not targeted’. In climate finance reporting, Sweden includes the full amount of finance to components that have climate change as a principal (main) objective, but only 40% of the finance provided to components with climate change as a significant objective, i.e. climate change is integrated in components that have other main objectives (see Table 5.4). In CTF Table 7 and 7b, the disbursed amounts presented are already weighted with the coefficients.

These standard coefficients are relatively simple to apply, while they help avoid over-reporting of finance that does not have climate change as the main objective. This approach is in accordance with the reporting of several donors, including the European Commission. To acknowledge the synergies between mitigation and adaptation, and ensure that there is no double counting, the type of climate change action is determined as mitigation, adaptation or cross-cutting according to Table 5.4.

Table 5.3 Matrix of how the type of contribution is determined based on the two Rio Markers, climate change mitigation (CCM) and climate change adaptation (CCA), and the application of coefficients

Rio Marker	CCM 2	CCM 1	CCM 0
CCA 2	Cross-cutting; 100% of finance	CCA; 100% of finance	CCA; 100% of finance
CCA 1	CCM; 100% of finance	Cross-cutting; 40% of finance	CCA; 40% of finance
CCA 0	CCM; 100% of finance	CCM; 40% of finance	Not climate finance

Gender equality integration

The OECD-DAC gender policy marker is used to track gender equality integration in climate finance. The climate contributions that are marked with the gender policy marker 1 or 2 are considered gender integrated. Level of gender integration in Sweden’s bilateral climate finance in 2019 and in 2020 is presented in Table 5.5.

Equality between women and men is a prerequisite for sustainability and for achieving the goals of UNFCCC and the Paris Agreement. Sida is committed to integrating the gender equality perspective throughout its operations, including the support for climate action. Between 2019 and 2020, the level of gender integration fell to 79% due to quality assurance of data. Sida’s voluntary reporting of gender integration in the Biennial Report is done to track the progress, stimulate further integration and encourage other actors to do the same. See table 5.5 below for information of level of gender integration in Sidas bilateral climate finance.

Mobilisation of finance

In addition to climate finance in the form of grants, Sida provides guarantees to support actors to mobilise climate finance from private and public sources; see the section “Mobilised finance”.

5.4.3 Bilateral financial support through Sida

The majority of Swedish climate finance to low- and middle-income countries is channelled as bilateral ODA through Sida. Sida provides climate change support at several levels, including support to local and national

institutions, bilateral support to multilateral organisations⁷⁵ and support to other regional and global organisations.

The support is provided to partner organisations both with climate change as a main objective ('principal objective' according to DAC terminology), and as a secondary objective ('significant objective' according to DAC terminology), i.e. integrated in contributions that have other main objectives. This is done in cooperation with a variety of actors, including government institutions, multilateral organisations, research institutions, non-governmental organisations, the private sector and Swedish authorities.

Table 5.4 Climate finance provided by Sida during 2019-2020 and level of gender integration in Sweden's bilateral climate finance (only ODA). Note that this table only include climate finance data from Sida, and not from MFA or Swedish Energy Agency.

Climate finance provided by Sida and level of gender integration in 2019			
Type of support	Climate finance (MSEK)	Climate finance (MUSD)	Of which gender integrated (%)
Mitigation	1 091	115	78%
Adaptation	2 041	216	85%
Cross-cutting	1 521	161	89%
Total	4 653	492	85%
Climate finance provided by Sida and level of gender integration in 2020			
Type of support	Climate finance (MSEK)	Climate finance (MUSD)	Of which gender integrated (%)
Mitigation	863	94	67%
Adaptation	1569	170	83%
Cross-cutting	1521	146	81%
Total	3781	411	79%

The support is provided to partner organisations both with climate change as a main objective ('principal objective' according to DAC terminology), and as a secondary objective ('significant objective' according to DAC terminology), i.e. integrated in contributions that have other main objectives. This is done in cooperation with a variety of actors, including government institutions, multilateral organisations, research institutions, non-governmental organisations, the private sector and Swedish authorities. Between 2019 and 2020, the climate finance provided by Sida to non-Annex I Parties decreased with approximately 872 MSEK. The decrease is a result of quality assurance of data as well as effects of the Covid-19 pandemic, including delays and reallocation of funds.

⁷⁵ "Multi-bi" according to OECD DAC definitions.

Sida has made efforts to focus on supporting countries in climate change adaptation since the Climate Change Initiative of the Swedish Government 2009–2013. Since then, Sida has continued to strengthen the focus on adaptation and increasingly meet the growing demand from country partners and organisations in this field. Sweden has also continued providing significant support to the Adaptation Fund and adaptation windows in other multilateral funds. Globally, the majority of international climate finance continues to be directed to climate change mitigation (70 % in 2018) and only a relatively small proportion to climate change adaptation (21 % in 2018).⁷⁶ While adaptation is underfunded, the needs continue to grow, as do demands for support from

Sida’s work is conducted within the framework of bilateral, regional and global development cooperation strategies decided by the Swedish Government. Sida provides resources that enable development initiatives

BOX 5.1

Sida has provided funding to DemoEnvironment, a challenge fund with the purpose of increasing technology transfers to a selection of developing countries in order to improve living conditions and health of people in poverty, enhance the ability to adapt in the cooperation countries, and decrease negative impact on the environment and climate. In 2020, it was concluded that a majority of the projects carried out with support from the DemoEnvironment challenge fund have successfully implemented new technologies, which in turn can be established in the recipient countries in the future. DemoEnvironment has for example i) supported the implementation of technology enabling the production of roof tiles made from sand and recycled plastic in Kenya, while creating employment opportunities for local women; ii) enabled technology transfer for sustainable forestry in Mozambique; and iii) financed technology for the production of briquettes from faecal waste in Kenya, which has created employment opportunities and improved sanitation practices.

focusing on the poorest and most vulnerable people. Broad-based local and national ownership is key to sustainable development and sustainable results from climate finance. The countries’ and organisations’ own needs, priorities and strategies are weighed into the bilateral strategies, and constitute a fundamental entry point in all of Sida’s operations.

⁷⁶ [OECD-DAC](#). November 2020

BOX 5.2

Sida supports the Inclusive Green Economy (IGE) programme, contributing to a transformational shift towards an inclusive green economy in Ethiopia, Kenya, Rwanda, Tanzania and Uganda. The programme builds on the participating countries' own current work on inclusive green economy and focuses on enhancing governmental capacities to successfully combine environmentally friendly and economically successful policies. Activities include sharpening present policy and practice instruments, such as taxes, fees, pollution charges, green investments and subsidies. Participants include senior civil servants in government, high-level policy and decision-makers but also academics and civil society representatives. After the end of the programme, participants will be accredited IGE fellows, with a regional network to share best-practices and the possibility of training colleagues in successful implementation of IGE practices. The initiative is considered to have both climate change adaptation and mitigation as significant objectives, hence approximately 3.6 MSEK (that is 40% of the total disbursement in 2020) is identified as climate finance.

BOX 5.3

Sida provides funding to ICIMOD, an intergovernmental organisation with eight member countries in the Hindu Kush Himalayan region. The overall objective of ICIMOD's work is that men, women, and children in the region enjoy improved well-being in a healthy mountain environment. The programme aims to contribute to reduced poverty, reduced physical and social vulnerability and improvement of ecosystem services. Activities and results include development and dissemination of flood early warning systems; climate change adapted value chains; measurement, monitoring and management of air pollution; strengthening of women's capacity and leadership roles in agriculture and local decision making bodies; strengthening the regional cooperation through technical exchanges and management of transboundary natural resources; and increasing the global awareness of the importance of mountain areas for resilient living conditions and ecosystems. ICIMOD coordinated the HKH assessment, which was published in 2020 and yielded great interest. With more than 2 000 media mentions, 580k downloads, 715 native tweets and 82 citations, the publication has the widest reach of any ICIMOD publication in the institution's history. In 2020, ICIMOD was accredited by the Adaptation Fund, the only accredited regional organisation in Asia.

BOX 5.4

Sida supports the Rwandan national climate and environment fund (FONERWA). The Fund has the objective to mobilise domestic and international climate finance, and secure sustainable financing to support projects that contribute to environmental sustainability, resilience to climate change and green growth. The Fund is open to line ministries and districts, civil society organisations, private entities and research institutions. The support is expected to i) provide access to sustainable and equitable finance that enables public and private entities to address climate and environment priorities; ii) improve skills of national stakeholders and CSOs in the design of project proposals; iii) result in bankable projects approved for funding by the FONERWA board; and iv) enable implementation of projects and dissemination of lessons learned. These outcomes will be achieved through activities such as training of national CSOs by international NGOs in developing proposals and increased participation of national CSOs in addressing climate change and environmental challenges. The support from Sida specifically provides technical assistance to environmental CSOs, capacity building of FONERWA and tools for improved gender integration. The projects supported by FONERWA are often pilots, in which new innovative methods are applied, such as climate-smart production of vegetables or clean cooking. In a newly completed project, electric motorcycle taxis were introduced and recommendations were provided to the Rwandan government for continued development of electric transport.

Table 5.5 A summary of the top five countries receiving Sida climate finance during 2019–2020. Most of the countries are among Sweden's major bilateral development cooperation partners. Note that this table only include climate finance data from Sida, and not from MFA or Swedish Energy Agency.

2019	Country	Disbursed (MSEK)	Disbursed (MUSD) ⁷⁷
1.	Mozambique	255	27
2.	Burkina Faso	239	25
3.	Somalia	167	18
4.	Mali	140	15
5.	Kenya	132	14
2020	Country	Disbursed (MSEK)	Disbursed (MUSD) ⁷⁸
1.	Mozambique	181	20
2.	Somalia	171	19
3.	Burkina Faso	136	15
4.	Kenya	130	14
5.	Bangladesh	87	9

Table 5.6 A summary of the top five countries receiving Sida climate finance during 2019–2020. Most of the countries are among Sweden's major bilateral development cooperation partners. Note that this table only include climate finance data from Sida, and not from MFA or Swedish Energy Agency.

Organisation	Climate output 2019 (MSEK)	Climate output 2019 (MUSD) ⁷⁹
IBRD/International Bank for Reconstruction and Development/The World Bank	622	66
UNDP/United Nations Development Programme	487	52

⁷⁷ For 2019, 1 USD = 9.4559 SEK

⁷⁸ For 2020, 1 USD = 9.2097 SEK

⁷⁹ For 2019, 1 USD = 9.4559 SEK

FAO/Food and Agriculture Organization	241	25
EBRD/European Bank for Reconstruction and Development	102	11
UNICEF/United Nations Children's Fund	91	10
Grand total	1543	163
Organisation	Climate output 2020 (MSEK)	Climate output 2020 (MUSD)⁸⁰
IBRD/International Bank for Reconstruction and Development/The World Bank	686	74
UNDP/United Nations Development Programme	407	44
FAO/Food and Agriculture Organization	198	21
UNICEF/United Nations Children's Fund	81	9
SEFA/Sustainable Energy Fund for Africa	75	8
Grand total	1447	157

Adaptation finance

Since the Climate Initiative by the Swedish government in 2009, Sida has made efforts to focus on supporting the countries' measures for climate adaptation and meeting the increasing demand and needs from a poverty perspective. The biggest part of Sida's climate aid is directed to climate adaptation, given that many of Sida's partner countries contribute marginally to global emissions, while the partner countries are extremely exposed and vulnerable to the effects of climate change. Since 2018, Sida is required to fulfil the requirements of the Climate Adaptation Regulation which instructs public authorities to give consideration to a changing climate and adapt their activities accordingly. Sida is required to initiate, support and evaluate its climate adaptation work within its area of responsibility and within the framework of its mandate. One of the specific requirements of the regulation is for authorities to investigate the impact of climate change on operations through a climate and vulnerability analysis. In order to comply with the regulation, climate adaptation must be taken into account in Sida's operative and normative work. The purpose of this analysis is also to support Sida's in-depth climate adaptation work and deliver more sustainable development in the long-term.

5.4.4 The Swedish program for International Climate Initiatives

The Swedish Program for International Climate Initiatives is split into two areas: the Kyoto Protocol's flexible mechanisms, and the development of new market mechanisms under the Paris Agreement. The core mission of

⁸⁰ For 2020, 1 USD = 9.2097 SEK

the program is to support the development of international climate cooperation, to achieve cost-effective greenhouse gas reductions and to contribute to sustainable development in developing countries.

Support through the project-based flexible mechanisms under the Kyoto Protocol

Through the program, Sweden has supported over 90 bilateral projects through the Clean Development Mechanism (CDM) and Joint Implementation (JI) as well as participation in 11 multilateral carbon funds⁸¹. By the end of 2020, bilateral projects and multilateral funds had achieved emission reductions equivalent to 31 Mt CO₂-eq at total cost of SEK 1,8 billion. The program has a total commitment of approximately SEK 1,9 billion⁸² and is expected to generate emission reductions equivalent to a total of 35 Mt CO₂-eq. Priority project types include renewable energy, energy efficiency and waste management. Priority has been given to projects set in Sub-Saharan Africa (32 % of emission reduction units), India (17 % of emission reduction units) and China (17 % of emission reduction units). Other regions with projects are South East Asia (12 % of emission reduction units) and South America (9 % of emission reduction units).⁸³ The program is expected to close in 2025 with final payments in 2022.

The year of 2020 marked the final year of the second commitment period of the Kyoto Protocol. A number of projects and multilateral funds are nevertheless expected to keep delivering emission units post 2020. By the end of 2020, 14 bilateral projects and four multilateral funds were expected to deliver emission reduction units post 2020.

During 2019-2020, a total of SEK 254 million was paid out to bilateral projects and multilateral carbon funds, and 8,4 million certified emission reduction units were delivered.

All emission reductions delivered up until June 1st 2023 have been cancelled. Cancellation of units received in 2019 was conducted in 2021⁸⁴ while the cancellation of emission reductions received in 2020 was conducted in

⁸¹ Future Carbon Fund (FCF), Asia Pacific Carbon Fund (APCF), Transformative Carbon Asset Facility (TCAF), Carbon Initiative for Development (Ci-Dev), Carbon Partnership Facility (CPF), Pilot Auction Facility for Methane and Climate Change Mitigation (PAF), Umbrella Carbon Facility Tranche 2 (UCF T2), Prototype Carbon Fund (PCF), Multilateral Carbon Credit Fund (MCCF), Testing Ground Facility (TGF) and Partnership for Market Readiness (PMR).

⁸² Calculated with currency rates from October 2021.

⁸³ Including delivered emission reductions as well as projected deliveries until the end of the program.

⁸⁴ Reference M2021/00442

2023.⁸⁵ Cancelled units have been permanently withdrawn from the market and have not been used to fulfil Sweden's commitments under the Kyoto Protocol. However, out of the cancelled emission reductions for 2020, 641 388 emission reductions have been cancelled for use towards fulfilment of the Swedish national target for 2020.⁸⁶ The rest of the cancelled credits has been reported climate finance. Since the main objective of the program is climate change mitigation, the support provided is regarded as 100 percent climate finance according to the Rio markers (climate change mitigation is principal objective).

The cancelled international emission reduction units have been reported as climate finance the year of the financial flow from the Swedish government to the project owner. Figures for 2019 and 2020 are included in Annex A, CTF table 7 and 7b.

Contribution to the development of new market mechanisms under the Paris Agreement

Since 2018, the Swedish Energy Agency (SEA) has received funding aimed at supporting the development of new international forms of cooperation under the Paris Agreement, namely Article 6. The aim is to contribute to increased climate ambition and to provide results-based climate finance or, alongside other supplementary measures, contribute to the fulfilment of Sweden's national climate targets. In 2019-2020, efforts have been directed toward developing concrete, bilateral collaborations under Article 6.

In late 2019, the SEA launched a global call for proposals on international climate collaborations within the Article 6 framework. Over 60 proposals were received, out of which six activities were selected in 2020 for further development of detailed mitigation activity design documents, focusing on compliance with the Article 6 framework. These project documents formed a foundation for future decisions on financing and implementation.

In parallel to the progress of these Article 6 activities, there are ongoing dialogues with the respective host countries to find agreement on the conditions and rules for the collaboration. In 2019, the SEA entered into an agreement with the Global Green Growth Institute (GGGI) for a tailor-made Article 6-program. The objective of the agreement is to develop ideas

⁸⁵ Reference KN2023/03293

⁸⁶ Emission reductions were used to fulfil the national target to reduce emissions not covered by the EU Emission Trading System (EU ETS) by 40 percent compared to emission levels in 1990. Emission reductions were thus not used to meet Sweden's commitments under the Kyoto Protocol as an EU member state

for feasible Article 6-activities and build the competence and institutional infrastructure necessary for host countries to trade with emission outcomes. In 2020, the program with GGGI resulted in four proposals for mitigation activities in three different countries, as well as blueprints for host country agreements and institutional infrastructure.

The work is also focused on methodological development with a special focus on monitoring, reporting and verification (MRV) and sustainable development. Representing Sweden in the negotiations of the rulebook for Article 6, the SEA is actively working for robust rules on sustainable development and environmental integrity. The SEA also participates in several capacity building initiatives aimed at supporting countries in entering collaborations under Article 6, such as the Article 6 Support Facility hosted by the Asian Development Bank and the Climate Market Club hosted by the World Bank.

5.5 Financial flows leveraged by bilateral climate finance

5.5.1 Mobilisation of capital through Sida

Since 2009 Sweden has an Ordinance for Financing of Development Loans and Guarantees for Development Cooperation. This provides opportunities to expand and leverage available resources for development by linking public measures with market finance. Guarantees stimulate mobilisation of both private and public capital, including partner countries' domestic capital. Sida helps lenders deal with risks by insuring eligible projects against losses relating to the different market risks. A common set-up is that Sida covers part of the loss if the borrower fails to repay the loan to the bank. Sida's guarantees are based on a set of simple key principles and conditions: additionality, risk-sharing, risk reflecting premium to be charged and that it should be non-distortionary. In 2020, Sida had guarantees to climate-relevant initiatives with a total guarantee volume of approximately 5 billion SEK, mobilising about 14.7 billion SEK.⁸⁷ Note that part of the mobilised capital is provided by Development Finance Institutions (DFIs) that are partly or fully owned by public entities.

⁸⁷ Owing to the lack of methodologies for tracking mobilised climate finance, none of the figures presented in table 5.9 are included in the CTF tables.

Table 5.7 Guarantees provided by Sida in 2020 for climate-relevant investments⁸⁸

	Agreement period	Guaranteed amount (MSEK)	Guaranteed amount (MUSD)	Mobilised amount (MSEK)	Mobilised amount (MUSD)	Main source of mobilised capital
54020146 - Portfolio Guarantee - Asian Development Bank	2016-10-03 - 2026-12-31	2000	217	4235	460	Public
54020185 - Guarantee of IFC's loan portfolio	2017-11-13 - 2042-11-13	535	58	3842	417	Public
10421 - NEFCO guarantee energy efficiency Ukraine education	2017-11-01 - 2032-12-31	270	29	1500	163	Public
54020115 - Pakistan - Guar Windpower	2013-10-14 - 2024-11-18	480	52	1071	116	Public
54020111 - Deutsche Bank Consortium II: Guarantee 2012-2018	2012-08-01 - 2020-01-31	14	2	835	91	Private
54020134 - Conflict-Affected and Fragile Economies Facility (CAFEEF/MIGA)- Guarantee	2013-06-01 - 2034-06-30	200	22	684	74	Public
54020155 - NEFCO Portfolio guarantee	2015-01-01 - 2029-12-31	300	33	600	65	Public
13406 - SunFunder Guarantee	2019-12-23 - 2029-02-15	363	39	540	59	Private
10121 - Portfolio Guarantee Georgia	2018-12-18 - 2025-12-31	220	24	440	48	Private
10154 - Private Agriculture Sector Support (PASS)	2017-09-26 - 2024-09-26	190	21	264	29	Public and Private
54020158 - Global Guarantee Facility Household Technologies	2014-12-01 - 2029-09-28	160	17	210	23	Private
12866 - Lendahand crowdfunding guarantee	2018-12-18 - 2023-12-18	60	6	120	13	Private
11016 - TRINE, 2018-2022, Crowdfunding Renewable Energy	2018-03-12 - 2023-03-11	60	7	100	11	Private
51180131 - Renewable Energy Guarantee - Uganda	2019-08-30 - 2026-08-30	68	7	91	1	Private
54020124 - Agri Guarantee USAID_Zanaco	2012-10-01 - 2020-01-31	26	3	46	5	Private
54020084 - Guarantee BiH Sberbank (formerly Volksbank) in cooperation with USAID	2010-09-01 - 2020-09-30	25	3	42	5	Private
54020179 - Zambia, bioenergy Madison Finance LPG guarantee	2015-09-01 - 2022-09-30	26	3	33	4	Private
54020125 - Loan Portfolio Guarantee for Sustainable Energy Moldova	2014-04-01 - 2029-04-30	9	1	15	2	Private
Total**⁸⁹		5 006	543	14 668	1 593	

⁸⁸ Note that this is a complete list of all the climate relevant guarantees that are currently ongoing. The amounts included in the table refer to the total amount of the guarantee (not the yearly amount), i.e. the guarantees included in this list run over several years. All climate relevant guarantees that are currently active are included for transparency reasons.

⁸⁹ *The digit number in front of each guarantee is a project code that can be used to find information on the specific projects on the openaid.se webpage.

**The values for each guarantee have been rounded off. The totals refer to the sums of more specific values of the guarantees.

Sida implements the methodology for calculating mobilized private capital outlined in the DAC directives: In the case of guarantees, the mobilized amount is attributed to guarantors pro-rata, i.e. according to the amounts guaranteed by each guarantor. The reporting is made on commitment basis. Sida reports subsidies separately, as ODA grants. While the relevance of guarantees and any other reported instruments is made based on the Rio markers for climate change adaptation and climate change mitigation, the amounts guaranteed and mobilized are not (contrary to the reporting of ODA flows) weighted according to the levels of the markers.

Sida continuously works to enhance mobilisation of additional climate finance and is currently leading a project with the objective to increase access and implementation of innovative partnership- and financing methods and tools, as well as increasing the knowledge and engagement around innovative financing amongst a broad network of actors. The project supports the Global Innovation Lab for Climate Finance – an incubator which works with identifying and strengthening innovative financing instruments that mobilise capital within climate finance, including sectors such as sustainable cities, renewable energy and sustainable food systems.

In addition to guarantees, Sida also mobilises climate finance through other instruments such as Public Private Development Partnerships (PPDPs) and challenge funds in which funding from Sida enables mobilisation of private capital.

5.5.2 Mobilisation of private capital through Swedfund

Swedfund International Ltd is Sweden's development finance institution. It is a limited liability company entirely owned by the Swedish state. The Ministry of Enterprise and Innovation assumes responsibility for administration of the Swedish state's ownership of Swedfund, whereas the Ministry of Foreign Affairs is responsible for the company's development policy mission and financial contributions. Swedfund's mission is to contribute to the goal of Sweden's development policy and Sweden's Policy for Global Development. Swedfund's mission is to contribute to poverty reduction by sustainable investments in developing countries - investments that are financially, environmentally and climate related, and socially sustainable. Since 1979, Swedfund has invested in companies and funds located in Africa, Asia, Latin America, Eastern Europe and the Middle East.

At the end of 2020 Swedfund had 65 investments in businesses, financial institutions and funds in 17 countries, of which 54 percent of investments were located in Africa.

Environmental, climate and social aspects are of paramount importance in all Swedfund's investments, as established in the owner's instruction for Swedfund and demonstrated in Swedfund's business model and comprehensive Policy for Sustainable Development. In order to measure performance, the ownership instruction includes mission goals linked to certain targets, within which the Swedish government's strong focus on climate is clearly expressed. By 2045, Swedfund shall have a climate-neutral portfolio, and green-house gas emissions from the portfolio per invested Swedish krona shall decrease with 2020 as the base year.

Swedfund is always a minority investor, thereby ensuring that an investment made by Swedfund is catalytic and leads to financial commitments from both industrial and financial partners. In line with OECD/DAC criteria for additionality, Swedfund's additionality as an investor is viewed not only in financial terms, but also in terms of knowledge transfer, e.g. with respect to climate and environmental impact, social impact and other sustainability criteria such as good governance and anti-corruption.

In recent years, Swedfund has increased its investments substantially in the energy and climate sector. In accordance with the owner's instruction, Swedfund only invests in renewable energy. For example, in 2019, Swedfund invested in JCM Power. JCM Power is an independent power producer dedicated to accelerating social, economic and environmental sustainability in growth markets through the development, construction and operation of renewable energy infrastructure.

In 2020, Swedfund invested 12 million USD in the Solar Energy Transformation Fund, which is managed by SunFunder. SunFunder is a leading provider of loans, with the aim of financing the off-grid solar sector in sub-Saharan Africa, where over half of the population has no access to electricity. Swedfund's investment will contribute to increased access to electricity, as well as the increased generation of renewable energy.

In 2018, Swedfund analysed how climate and environmental risks impact on Swedfund's investments and how, in turn, these risks can impact on Swedfund's financial position. To conduct the analysis, Swedfund developed

a method to take account of the climate risks and the requirements concerning mitigation that Swedfund imposes on portfolio holdings. In 2020, Swedfund analysed how well the portfolio is aligned with the Paris Agreement. The results shows an alignment of 90 % of Swedfund's portfolio with the Paris Agreement. In order to increase alignment, Swedfund provides training to the portfolio companies to give them the tools needed to advance the climate agenda.

In addition to financial commitments, Swedfund has continued to contribute to renewable energy in developing countries by, for example, cooperating with the wider European development community within the realm of ElectriFI, a facility set up to develop early-stage electrification projects using renewable resources.

In 2019 and 2020, Swedfund made the investments and helped mobilise the amounts of capital listed below. The table includes climate investments contracted in 2019 and 2020 (The World Bank definition of mobilized capital is used).

Table 5.8 Swedfund - New investments 2019 and 2020 (Contracted)

Portfolio company	Swedfund's investment	Mobilized capital	Source of capital	Sector
GEF South Asia Growth Fund II	14.26 MUSD	1,60 MUSD	Equity (Fund)	Energy & Climate
JCM Power Corporation	9,47 MUSD	4,79 MUSD	Equity (Direct)	Energy & Climate
Greenteco SES (Chigirin Solar Projekt)	10,64 MUSD	6,92 MUSD	Debt	Energy & Climate
SunFunder	10,43 MUSD	1,92 MUSD	Debt	Energy & Climate
Co-operative Bank of Kenya	12.98 MUSD	2,02 MUSD	Debt	Financial Inclusion
Interact Climate Change Facility	15,96 MUSD	n.a	Debt	Various

5.6 Capacity building

5.6.1 Capacity building through official development assistance (ODA)

Capacity and institutional development is central for development, and is a fundamental entry point in all of Sweden's development cooperation. The majority of the climate finance support that Sweden provides through Sida therefore has capacity building integrated into the core of its operations.

Capacity building takes place at the organisational level, individual level, level of institutional frameworks, and often a combination of the three. In order to identify and address the specific capacity building needs of partner countries or organisations, their nationally determined contributions and national adaptation plans, as well as key development plans, are important sources of information.

Examples of Sweden's support to building climate change capacity are provided in CTF table 9 and the boxes below. The examples represent different types of capacity building support that Sida provides. These include initiatives where building climate change capacity is the main objective, other contributions where climate is part of contributions aiming to develop negotiating skills in international fora, and contributions where climate change is integrated in operations building capacity in areas such as agriculture, forestry or water and sanitation. It may include support directly to low-income country government institutions or support via multilateral institutions, as in the case of the initiative together with the World Food Programme in Kenya, focusing on strengthening the capacity of national and county institutions in managing food insecurity in arid and semi-arid lands.

It includes support to regionally active organisations, such as the Regional Community Forestry Training Center for Asia and the Pacific (RECOFTC); to civil society-based organisations, for example through the Pan African Climate Justice Alliance (PACJA), which works with the participation of African CSOs in the climate governance discourse and strengthening their ability to follow up on national commitments, compliance and implementation of the Paris Agreement, including NDCs; and in cooperation with Swedish authorities, such as the preparatory support to the Swedish Environmental Protection Agency ahead of the collaboration with UNICEF on air quality and children/youth's health in the Western Balkans.

BOX 5.5

Sida provides support to the global project Poverty-Environment Action for Sustainable Development Goals (PEA), a joint initiative between the UNDP and UNEP. The initiative aims at mainstreaming environmental sustainability and climate objectives for poverty eradication into development planning, budgeting and monitoring systems, public and private finance, and investment - in order to accelerate delivery of the 2030 Agenda and the SDGs. This is achieved through capacity building and technical assistance to national and sub-national governments to mainstream and align finance and investment with poverty, environment and

climate change objectives, in the face of the changing forms and conditions of poverty found in the world today.

In Mozambique, training-of-trainer sessions on implementation of environmental and climate change elements of the reformed Sub-system for Planning and Budgeting (SPO) were conducted. A total of 52 technical and planning staff at the central level were trained and received information on the new law package on decentralization, the new sub-system, the module on planning and budgeting, and integration of NDCs and the SDGs.

In Rwanda, an environmental and climate change assessment was conducted, informing 16 sector plans and 30 district single action plans. This information was crucial in supporting the national planning and budget consultations for fiscal year 2020/21 in all sectors at the Ministry of Finance and Economic Planning. PEA also supported revision of the budget checklist for all budget agencies to include gender, environmental and natural resource indicators to enhance monitoring. Additionally, PEA Rwanda, in close collaboration with the Rwanda Environment Management Authority and the Ministry of Infrastructure, conducted a strategic environmental assessment for urbanization policy. The assessment was aimed at providing sustainable and inclusive guidance on implementation of the recently enacted PEA-supported National Land Use and Development Master Plan. Particular attention was given to conservation; integrated water resource management; agriculture; and population, urbanization, settlement and housing, especially with regard to projected long-term environmental impacts.

In order to finance pledges set out in its NDC, the Indonesian government formed the Green Sukuk initiative, consisting of bonds to finance climate change mitigation and adaptation. PEA continues to provide technical assistance in support of the Green Sukuk initiatives to deliver transparent and accountable use of the proceeds of Green Sukuk issuances. Green Sukuk has contributed to a projected reduction of 8.9 million tonnes of greenhouse gas emissions, construction of more than 690 kilometres of railway track, an increase of 7.3 million kilowatt-hours of electricity and improved solid waste management for more than 5 million households. PEA supported this work through the identification of green projects for issuances, covering resilience to climate change, and the sustainable transport and waste management sectors. PEA also finalized and disseminated a study on Indonesia's retail Green Sukuk, which highlights the impact of the world's first retail Green Sukuk instrument in allowing a broader and more diverse domestic investor base and advancing financial inclusion, as well as cultivating public awareness (particularly among younger potential investors) on green and sustainable investing in the country.

BOX 5.6

The Global Facility for Disaster Reduction and Recovery (GFDRR) is a global partnership that helps developing countries better understand and reduce their vulnerability to natural hazards and climate change. GFDRR is a grant-funding mechanism, managed by the World Bank and engaging over 400 local, national, regional, and international partners. GFDRR provides knowledge, funding, and technical assistance in order to build capacity and to help vulnerable nations improve resilience and reduce risk. In 2020, more than 130 countries were supported for

improved government institutional capacity in disaster and climate risk-informed policy design and analysis. The contribution is considered to have climate change adaptation as principal objective, hence Sida's total disbursement in 2020 of approximately 25 MSEK is identified as climate finance.

BOX 5.7

Global Programme on Strengthened institutions for a sustainable climate, a 4-year International Training (ITP) programme (2019-2022) that aspires to enhance institutional capacity in developing countries in Africa on climate mitigation and adaptation, including sustainable urbanisation. The Swedish Environmental Protection Agency implements the capacity development program "Strengthening Institutions for Sustainable Climate and Cities" together with 6 other Swedish authorities in several countries in Africa. In Uganda and in Rwanda, they are working together with Statistics Sweden to build the capacity of the Ministry of Environment in its reporting of NDCs. In Kenya, SMHI supports local environmental planning committee understanding of climate change and planning of climate adaptation activities. The Programme aims to tackle challenges posed by climate change, sustainable urbanisation, growing emissions and explore viable adaptation potentials.

Sida's work for the implementation of Agenda 2030 and to deliver on the Paris agreement has a strong focus on capacity development, strengthened institutions and innovative solutions with broader partnerships. Sida starts from a systems approach where each actor has an important role and the interaction between the actors (e.g. authorities, academia, private sector, civil society organizations) enables development in the desired direction such as e.g. reduced environmental impact, energy efficiency or strengthened resilience to the effects of climate change. Capacity development is a foundation of almost all development cooperation. Stronger capacity improves the possibilities of working through countries' own systems and lays the foundation for lasting results that go beyond development cooperation. International Training Programs (ITP) is a method where participating organizations at central, regional and/or local level and other relevant partners use new capacities and new contacts to jointly formulate change projects for their respective countries, as well as create professional networks for the exchange of experience. The strengthening of formal structures and institutions through individual and organizational capacity development has positive effects on recipient countries' capacity to implement the Paris Agreement such as technology transfer including support to endogenous capacities and technologies and contributes to better planning, implementation and monitoring of climate adaptation and emission reduction measures. Several of the ITP programmes includes aspects of technology transfer in the sense that capacity building contributes to countries readiness to e.g. make use of available technology or undertake procurement of technics that are suitable and prioritised by themselves.

In summary, Sweden provides extensive support to climate change capacity building, with different approaches and in cooperation with different types of actors. This diversity is needed to respond to different partner countries' or organisations' specific needs and contexts.

5.6.2 Capacity building through other official flows (OOF)

Many of today's environmental challenges are transboundary and cannot be solved only within the borders of Sweden. The major emerging national economies of Brazil, Russia, India, Indonesia, China and South Africa (BRIICS) have extensive manufacturing industries that provide products to both the domestic and global market. These populous countries have a major impact on global resource use and environmental performance and are, therefore, key players in global environmental and climate cooperation. Developing relationships with strategic countries is positive for tackling environmental challenges, but also in terms of industry, export trade, foreign policy and security policy.

The Swedish Environmental Protection Agency (Swedish EPA) is recipient of a fund from the Swedish Ministry for Environment totalling ca SEK 34 M per year allocated to support countries that have strategic importance to the global environment and climate. The partnerships with the project countries are based on mutual interest to reach environmental objectives. Four Swedish government agencies are involved to carry out this bilateral cooperation: the Swedish EPA, the Swedish Agency for Marine and Water Management, the Swedish Chemicals Agency and the Swedish Meteorological and Hydrological Institute (SMHI). The EPA is for example supporting South Africa to develop a national strategy for hazardous waste from households. The EPA works with Brazilian authorities and institutions to implement initiatives on food waste prevention and municipal waste planning (c.f Box 5.7).

During 2020 the EPA engaged in dialogue with the Climate Center under the Chinese Ministry of the Environment on emissions pricing and emissions trading, to create incentives for industrial change in China. The EPA also supported Russia to further develop and deepen the work on waste management, climate and air policies and integrated environmental permits based on best available technology (BAT). To increase the competence of environmental officials at the state level in India, the Swedish EPA collaborates with the environmental organization Center for Science and Environment (CSE) and has helped arranging trainings regarding waste management. Within the Arctic Council the EPA has contributed to knowledge building on climate change and its effects. Furthermore, the EPA has been active in the revision of the climate plan for the Barents region.

BOX 5.8

For instance, the Swedish EPA has contributed in the planning and execution of a training program in municipal waste planning for officials from 15 Brazilian municipalities. These municipalities have also learned to pass on their knowledge and so far, another 50 Brazilian municipalities have taken part in the training.

BOX 5.9

The Swedish EPA has started a project with the Palestinian Environment Quality Authority (EQA) with a focus on capacity development in the areas of climate and cross-border transport of hazardous waste. During the year, EPA helped to develop checklists in accordance with Basel Convention on Legal and Illegal Transboundary Movements and safe storage of hazardous waste. EPA also contributed with exchange of experience on the Climate Convention with a focus on MRV (Measuring, Reporting and Verification) in order to help develop a Palestinian MRV system.

5.7 Technology development and technology transfer**5.7.1 Technology development through official development assistance (ODA)**

A large proportion of Sweden's development cooperation includes climate-friendly technology development or technology transfer. The projects stem from countries' and organisations' own needs, priorities and strategies and are designed through a collaboration between Sida and the implementing partner. Transfer of technology is often combined in an integrated way with capacity building to ensure long-term sustainability. Examples are presented in CTF table 10 and in the boxes below. The examples represent different types of contributions, including mitigation and adaptation technologies, and are from a range of actors and contexts in Africa, Asia and Europe and global partnerships, soft as well as hard technologies, and within a number of different sectors, including energy, agriculture and disaster risk reduction. Note that these are examples only and not an exhaustive list.

BOX 5.10

As part of Power Africa, the Beyond the Grid Fund Zambia aims to allow for clean energy access and accelerate private-sector growth in energy generation and distribution. The contribution includes support and advise to contracted companies, and advisory support to the Zambian government in managing a coordination platform for off-grid energy, the “Off-Grid Task Force”. Since 2017, the Beyond the Grid Fund has brought clean, affordable off-grid energy access to over 800,000 Zambians, and in 2020 the fund expanded to four new countries, with an expanded partnership managed by Nordic Environment Finance Corporation. Beyond the Grid Fund has also won the prestigious Ashden Award for Innovative Finance, and the 2019 UN Climate Action Award.

BOX 5.11

The Beog-Puuto Family Farming project aims at restoring eroded abandoned farmland, increasing productivity in family farms and strengthening resilience of 50,000 vulnerable households in dry areas in northern and eastern Burkina Faso. The impact is expected to be increased productivity in family farms through a positive systems change, stronger resilience of vulnerable households to climate change, higher income, improved situation for women and strengthened incentives to young men to refuse militant extremism. The project aims to i) recover eroded farmland and increase productivity; and to ii) sustainably improve the soil status and increase productivity in family farms through a broad application of traditional water and soil conservation techniques. Groups of farmers are trained in running the agro-ecology pilot farms as well as farmer schools on their own.

5.7.2 Technology development through other official flows (OOF)

Technology transfer is a component in most of Sweden’s climate related cooperation with focus on mitigation and adaptation. Climate technology, both for adaptation and mitigation, is an essential part of climate action and economic development. For this reason, it is not possible to report on climate finance which is only directed to technology transfer. However, this section will highlight some examples of cooperative action on technology transfer.

Support to the technology mechanism under the UNFCCC and Paris Agreement

According to article 10 in the Paris Agreement, parties share a long-term vision on the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions. According to article 10, parties shall strengthen cooperative action on technology development and transfer under the Paris

Agreement, and the Technology Mechanism established under the UNFCCC shall also serve as a mechanism under the Paris Agreement. Sweden supports climate technology cooperation through to the UNFCCC's technology mechanism, the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN).

The CTCN promotes the accelerated transfer of environmentally sound technologies for low carbon and climate resilient development at the request of developing countries. CTCN provides technology solutions, capacity building and advice on policy, legal and regulatory frameworks tailored to the needs of individual countries.⁹⁰ CTCN reports annually to COP and CMA on the progress.

Sweden has supported the CTCN with SEK 2 million in total for 2019 and 2020. The Swedish Energy Agency is Sweden's focal point (National Designated Entity) to the technology mechanism together with focal points from 160 other countries. Sweden also contributes to the CTCN through active participation in the CTCN Advisory board. During 2020-2021 the representative from Sweden served as co-chair for CTCN Advisory Board together with a representative from China. In 2021-2022, the Swedish representative will serve as chair of the board together with a representative from Kenya.

Enhanced cooperative action on technology transfer

The Swedish Energy Agency (SEA) offers technology transfer through various programs, such as accelerator programs that support Swedish small and medium-sized enterprises (SMEs) with innovative energy solutions to reach out to other countries. In two of these accelerators the SEA introduces and demonstrates innovative technology in India and Indonesia in cooperation with local stakeholders. Other programs have a sectoral focus, such as promoting sustainable heating and cooling in China. A key component in these programs is to encourage private sector activities that support the countries to access sustainable technologies, contributing to an accelerated green transition in the energy sector. The main objective in the long run with all the SEA's programs is a sustainable energy future, in line with the 1.5-degree target. The programs are financed by the R&D budget of the SEA.

⁹⁰ Joint annual report of the Technology Executive Committee and the Climate Technology Centre and Network for 2020: <https://unfccc.int/documents/267476>

A few examples of technology development and transfer are presented below. Note that these are examples only and not an exhaustive list. Though Sweden's support to some of the following initiatives spans over a number of years, the examples below focus on technology transfer in 2019-2020.

Technology development and transfer cooperation with India

The SEA has been active in India since 2009, engaging in a Swedish-Indian cooperation in the field of energy. Its overall objective is to build long-term relationships based on trade, research cooperation and knowledge development. Since 2013, the SEA has developed the program India-Sweden Innovations Accelerator (ISIA). The program supports business-oriented innovation development and dissemination by promoting networking and knowledge sharing between Swedish and Indian actors active in innovative technologies for sustainable energy systems.

Since the start, the ISIA program has facilitated the introduction of more than 50 Swedish SMEs to the Indian market. Around half of them are still active in different collaboration projects, from pilots to commercial partnerships. In 2019-2020, five new Swedish innovations were introduced to the Indian market through the ISIA. Due to the pandemic, the program had to revise its methods and time frames, leading to fewer Swedish companies being introduced than under normal conditions. Despite the constraints, new partnerships have been developed and stakeholders from both countries have shared knowledge and deepened their collaborations.

In November 2020, a new program was launched to promote research and innovations; *India-Sweden Collaborative Industrial Research & Development Programme 2020*. The program is a collaboration between the Swedish Energy Agency and the Indian Department of Science and Technology. The program focuses on the development of smart grid technologies, recognizing the importance of efficient electricity distribution as demand for electricity grows. Jointly, the Swedish and Indian authorities will support industry led projects to develop smart grid solutions.

Technology transfer cooperation with Indonesia

Since 2017, there is a Memorandum of Understanding (MoU) on energy cooperation between the governments of Sweden and Indonesia. The Swedish Energy Agency (SEA) is the implementing party in Sweden. However, already in 2015, the SEA set up a continuous program for transferring technology to Indonesia: the so-called Business Accelerator

Program Indonesia (BAPI). The program provides support to Swedish SMEs to enter the Indonesian market through the means of matchmaking with Indonesian stakeholders and market knowledge support. In 2019-2020, nine Swedish companies took part in the BAPI program, offering technologies within energy efficiency, renewable energy and smart grid solutions.

The BAPI program is performed by Business Sweden Jakarta in cooperation with different Indonesian stakeholders.⁹¹ Due to the pandemic, travel to Indonesia was not possible in 2020. Nevertheless, virtual delegations took place, and the companies in the program have still been able to sign Non-Disclosure Agreements and explore leads for pilot installations and other joint ventures.

Waste management and waste-to-energy is another field of cooperation between Sweden and Indonesia. Since 2020, Sweden and the Province of West Java are exploring the possibility for technology transfer on energy recovery from waste. Waste management including energy recovery from waste is also prioritized within the Joint Working Group under the MoU on energy cooperation.

Technology transfer cooperation with China

A Memorandum of Understanding (MoU) was signed by the energy ministers on Swedish-Chinese cooperation in the energy area in 2017. One outcome of this MoU is a focused effort on the promotion of sustainable heating and cooling techniques in China, launched in 2019. In 2019, Business Sweden was assigned by the Swedish Energy Agency to perform promotion activities in the Chinese district energy market in close collaboration with the Embassy of Sweden in Beijing and the export-oriented industry organization SweHeat & Cooling. Several activities promoting Swedish district energy solutions were performed in 2019-2020, including roadshows to different cities. Some of the activities were also in cooperation with the China District Heating Association. The overall aim is to mitigate emissions of greenhouse gases from the heating and cooling sectors through the uptake of Swedish innovative technologies.

⁹¹ The Indonesian Energy Efficiency Society (MASKEEI), the Indonesian Renewables Energy Society (METI) and the Indonesian Employers Association (APINDO), among others.

Global Innovation Accelerator

Since 2017, the Swedish Energy Agency has been running Cleantech Hubs – Energy Innovations by Sweden, a program that facilitates the introduction of Swedish innovations to markets across Europe, Asia and America. The program was built up around three footholds in China, USA and United Kingdom, but was not restricted to these countries.

However, at the end of the program in 2021, results did not meet the expectations of the program. The needs and starting points of participating companies were found to have varied widely, and combined with a pandemic, the setup could not fully deal with the combined challenges. A revised approach is under development and is expected to start before the end of 2021. By applying increased flexibility towards the participating companies regardless of geographical focus in the upcoming project, the ambition is to facilitate easier access not only to mature markets but also less developed ones.

Multilateral cooperation for technology development and transfer

Sweden participates in several multilateral initiatives that support, finance, and facilitate technology development and transfer, especially within the energy sector. A few examples are presented below, highlighting Swedish contributions to the initiatives in 2019-2020.

Clean Energy Ministerial

The Clean Energy Ministerial (CEM) is a high-level global forum that brings together a community of the world's leading countries, companies and international experts with the mission to accelerate the transition to a global clean energy economy. Together, CEM members account for 90% of the world's clean power production and 80% of global clean energy investment. CEM members (28 member countries spread globally plus EU) collaborate to establish policies and programs that enhance clean energy supply and expand clean energy access.

Sweden has been a member of CEM since it started in 2011 as a 5-year collaboration. The second phase of CEM, CEM 2.0 during 2016-2021, is currently being concluded. Sweden is committed to continue within the next 5-year phase of CEM, i.e. CEM 3.0 (2021-2026). This involves active participation in different Initiatives and Campaigns. By the end of 2020, Sweden participated actively in 8 out of 22 Campaigns and Initiatives.

In 2019 and 2020, the Swedish government contributed SEK 1 million of funding to the CEM secretariat. During these years, Sweden did not join any new campaigns within CEM, with a view to focus on existing commitments. However, planning was conducted for a new CEM-initiative to be launched in 2021: the Flexibility Hub. The initiative will be co-led by Sweden and will focus on the role of power system flexibility as demand for renewable energy grows.

Mission Innovation

Launched at the Paris Climate Conference in 2015, Mission Innovation (MI) is a global initiative of 24 governments responsible for over 90% of global public investment in clean energy innovation. Together with the European Commission, on behalf of the European Union, these members have committed to greater action to make clean energy affordable, attractive, and accessible to all this decade. This is to be achieved by engaging with the private sector, fostering international collaboration and celebrating innovators. Specifically, Mission Innovation encourages private sector activities to boost investment and demand for clean energy technologies, supporting developing as well as developed countries to plan their green energy transitions.

During the first phase of MI in 2015-2020, Sweden participated in roughly 10 Innovation Challenges and cross-sectoral initiatives. Innovation Challenges (ICs) are global calls to action aimed at accelerating research, development and demonstration (RD&D) in technology areas that could provide significant benefits in reducing greenhouse gas emissions and increasing energy security.

In 2019-2020, Sweden was vice-chair of the MI steering committee. During the first half of 2019, Sweden also supported MI with a part-time member of staff at the MI secretariat.

Sweden intends to continue its active role in the second phase of MI, MI 2.0, which is being launched in 2021. Sweden is committed to further contributing to the MI secretariat and the Innovation Platform with special focus on the UNFCCC initiative on innovation for Climate Action and on the Net-Zero Compatibility Innovation (NCI) initiative. The NCI is designed to enhance private sector engagement and investment in energy innovation by providing a framework for assessing avoided emissions. The NCI supports investors and funders to identify those system solutions and

technologies that have significant ability or potential to contribute to avoided emissions of greenhouse gases. In 2019-2020, 175 solutions were calculated through NCI:s Avoided Emissions Framework with the potential of avoiding 4,9 Gigatons of emissions if rolled out globally by 2030. So far, NCI has identified innovations in Chile and India amounting to 150 and 200 Megatons respectively of avoided emissions.

International Renewable Energy Agency

With 164 Member Countries, the International Renewable Energy Agency (IRENA) plays a leading role in the energy transformation as a center of excellence for knowledge and innovation, a global voice for renewables, a network hub and a source of advice and support for countries. Counteracting climate change is in the forefront of IRENA's objectives.

Sweden has been a member since IRENA's founding in 2009. The annual membership fee is approximately SEK 1.7 million. Beyond membership fees, Sweden provided a voluntary contribution of SEK 2 million in 2019, aimed for a pilot study on innovations for a 100% renewable electricity system as well as workshops with other member countries with similar ambitions, such as Costa Rica and Uruguay.

6. Other reporting matters

See section 3.1.2 for more information on Sweden's Monitoring under the new national climate policy framework.

6.1 Additional monitoring

In addition to the institutional set up under the national climate framework, monitoring takes place at both the EU and the national level. Under the EU's monitoring mechanism (Regulation (EU) No 525/2013), Sweden reports every two years on policies and measures, implemented and planned, to achieve the climate target for 2020. At a national level, regular evaluations have been performed of the country's climate policy. The first was a 'checkpoint' review that started in 2004 (leading to a climate policy decision in 2006), and the second was initiated in 2007 (resulting in the 2009 climate policy decision). To analyse progress towards the objectives, as well as the state of knowledge, a further checkpoint review was undertaken in 2015.

The Swedish domestic institutional arrangement for self-assessment is using the national system for the GHG inventory and policies and measures and projections, as described in section 1.3 and 1.4 above.

Annex A Projections methodology and calculations assumptions

Methodology

Different projection methods are used for different sectors. The methods that have been used to draw up the projections in this report are described in this section.

Energy sector

Projections for greenhouse gases for the energy sector are based on projections for the whole energy system. Projections for carbon dioxide emissions from the energy sector are drawn up by multiplying the total consumption of each fuel by the corresponding emissions factors. The energy projections, together with expert assessments of future emissions factors, have provided the basis for the projections of methane and nitrous oxide from incinerators.

Different models are used for each sub-sector in drawing up projections of trends in the energy system. The Times-Nordic model is used to make projections for electricity and heating production. Demand in the sub-sectors, taxes and other policy instruments, fuel prices and economic and technical development are used as input data for Times-Nordic. Times-Nordic is a dynamic optimization model. Most of the methods and models used to project development in the energy sector are based on a bottom-up perspective. Model results for different sub-sectors are coordinated so that weighted projections for the whole energy system are finally obtained. The process is described in Figure A.1. Expert assessments are an important element in all stages of the process.

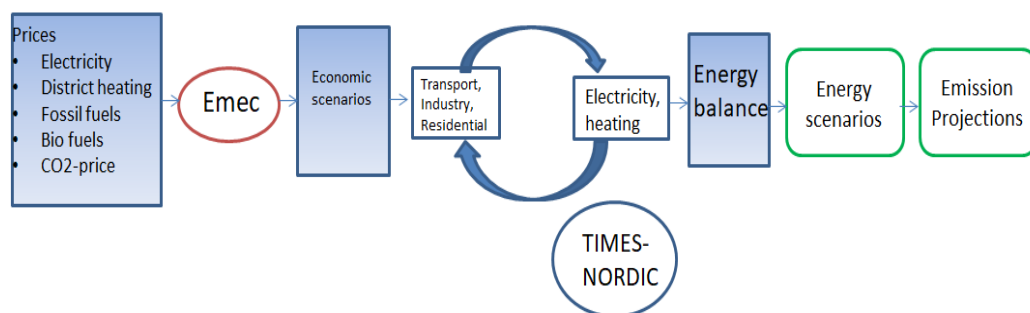


Figure A.1 Projection process for emissions from the energy sector.

A starting point in the projection work on the development of the energy system in the short and long-term is assumptions on economic trends, both in Sweden and internationally. The economic variables included in the work on energy projections mainly consist of estimates of the trend in gross domestic product, private and public consumption, disposable income and trends in value-added for industry and commerce. For industry, estimates of economic development at the level of individual branches of industries are included.

Projections on economic development are drawn up using a general equilibrium model, EMEC, by the National Institute of Economic Research. Input data for projections on economic development are harmonized with projections on the development of the energy system by the National Institute of Economic Research and the Swedish Energy Agency. The economic growth generated by the EMEC model is governed firstly by access to production factors such as labor and capital and secondly by technical development, which are given exogenically in the model. The advantage in using this type of model is that it encompasses the whole economy. The model is therefore able to capture repercussions between sectors, for example a change of tax or the introduction of emission caps. The total economic impact is therefore captured in a more complete way than in partial models.

Another important basis for projections on trends in the energy system is the fossil fuel prices received from the EU. A model is used to convert international fossil-fuel prices for crude oil and coal to domestic user prices, paid by the final consumer, as crude oil has to be refined into finished motor fuels and fuels for heating before it can be used on the Swedish market.

Electricity and district-heating production

The projections on fuel use for electricity and district-heating production are based on the Times-Nordic model. The demand for electricity and district heating is exogenic data for the model which, through its optimisation algorithm, works out the most cost-effective fuel mix for the whole energy system, i.e. including energy use in the user sectors. Times-Nordic represents all Nordic countries (excluding Iceland) and permits electricity trade between neighboring countries. Not just the Swedish energy system, but the Nordic energy system, is therefore optimised.

Residential and commercial/institutional sectors

The projections of energy use in the residential and commercial/institutional sectors are drawn up by combining the model results from Times-Nordic and assessments by experts. Times-Nordic also models the competition for different heating systems in buildings. Different variables such as electricity and fuel prices, population development, potential for different heating systems, investment costs of heating systems, levels of efficiency and energy efficiency improvement are assumed.

6.1.1 Industry sector

The projections on energy use in the industry sector come from an Excel-based model with the energy use in industries linked to economic relations (value added and production value) and energy prices. The energy use is primarily based on assumptions of economic development and energy prices. This result is harmonised through contacts with energy-intensive companies and industry organisations. Account is also taken of the results of the Times-Nordic energy system model.

6.1.2 Transport sector

The projections on carbon dioxide emissions from the transport sector are calculated on the basis of projections of energy use in the transport sector. The calculation of emissions of other greenhouse gases is based on the change in transport activity, number of vehicles in different vehicle types (e.g. fitted with catalytic converter) and emissions factors. The transport sector has been divided into four sub-sectors: road traffic, air traffic, rail traffic and shipping.

The projections for road transport are based on assessments on transport demand and on the development of the vehicle fleet. The demand for transport with passenger cars is expected to be mainly influenced by demography, fuel prices and income in households, while the demand for freight transport is based on assumptions on economic development and trading overseas. The development of the vehicle fleet is based on the assumptions on the allocations of fuels and annual efficiency, which are a result of existing instruments and historical trends. The projections for aviation, navigation and railways are based on assumptions on transport demand and future efficiency.

6.1.3 Industrial processes

Carbon dioxide emissions from industrial processes have been calculated using an Excel-based trend analysis of historical emissions. In addition to official statistics, data and other information from industry organisations and companies have been used to obtain more detailed knowledge on the industries and emissions concerned.

6.1.4 Waste sector

Emissions from landfills in the waste sector are calculated using a model developed by the IPCC that has been partially modified to better represent conditions in Sweden. Results from the model calculations are also compared with results from field measurements. The method is based on figures on quantities of landfilled waste from 1952, the organic content of waste, the gas potentials of different types of waste and emissions factors.

6.1.5 Agricultural sector

Projections of activity data for the agricultural sector are based on results from an economic equilibrium model; the Swedish Agricultural Sector model (SASM), which is based on assumptions on production and future agriculture policy. The projected activity data is used to calculate future emissions in the same way as is done for current emissions within the climate reporting process. Activity data includes figures related to numbers of livestock, manure production, stable period, methods for manure management and annual balances of nitrogen flows to and from agricultural land.

6.1.6 Land Use, Land-Use Change and Forestry sector

The projections for net removals in *Forest land* in the Land Use, Land-Use Change and Forestry sector are mainly estimated using the Heureka Regwise modelling tool. The model simulates the future development of the forests based on assumptions on how they are managed and harvested. The calculations encompass biomass in living trees and dead wood on forest soil in productive forests. In the projection, net removal in these pools are calculated as the difference between the stocks at different times. The emissions/removals in the soil organic carbon pool and the dead organic matter pool are based on the trend in these pools as reported in the latest submission.

For *Cropland* and *Grassland*, the average net annual emissions/removals per hectare for each carbon pool for the latest ten reported years are used together with the projected area of these land use categories. The projected emissions/removals for each reported carbon pool for *Wetlands* and *Settlements* are assumed to be constant and estimated as the mean over the latest ten years as reported in the latest submission. The net removals for HWP are estimated based on the projected harvest from the Heureka-Regwise-model and the assumption that available biomass is distributed to the different product groups in the same way as in current distribution, i.e. as an average of the five latest years in the latest submission.

6.2 Assumptions underlying the calculations

6.2.1 Calculation assumptions for energy sector

General assumptions on which estimates for the energy sector are based:

- Within the EU emissions trading scheme, a price of 30 euros was assumed per tonne of carbon dioxide 2030 and 53 euros per tonne 2040 (in 2016 price).
- Based on the decision in force regarding the Swedish-Norwegian electricity certificate system, it was assumed that the system is operational during the whole projection period and will lead to an increase of 28.4 TWh of new renewable electric power production in 2020 compared to 2012's level. This production goal is considered consistent after year 2020 and the system operational until 2040.
- In general, current taxes and other instruments (in place first of July 2020) are assumed to remain unchanged until 2040.
- National Institute of Economic Research estimates of economic development (%/year):

	Reference	
	2015-2035	2035-2040
GDP	1.72	1.76
Private consumption	1.87	2.22
Export	2.58	2.59
Import	2.60	2.70

- The trends in fossil fuel prices are given by the European Commission (2016 prices)

	Base year		Reference	
	2018	2020	2030	2040
Crude oil (USD/barrel)	68	42	89	103
Coal (USD/tonnes)	93	53	86	98
Natural gas (USD/Mbtu)	6	4	6	8

Assumptions on which estimates for energy industries are based:

- 2 of Sweden's 8 reactors have shut down until 2020. This leads to a decrease of the nuclear capacity in Sweden. The remaining nuclear power plants are assumed to have an economic working life of 60 years, which means no decommission during the projection period.
- Projections of the Swedish sector price for electricity for the years 2030 and 2040. (Annual average, 2016 price level in SEK/kWh)

	2018	2030	2040
Electricity price	0.46	0.33	0.50

- Electricity production from hydropower (incl. small-scale hydropower) and nuclear power production has been assumed to be, in TWh:

	2018	2030	2040
Hydropower	62	67	68
Nuclear power production	66	52	52

- For the refinery sector, the emissions are assumed to increase during the projection period, in accordance with the expansion plans of this sector. Counteracting measures for higher efficiency of 5 % in 2040 compared to 2019 are assumed.
- A shift to fossil-free technology is assumed for a part of the manufacturing of solid fuels

Assumptions on which estimates for residential, commercial/institutional and combustion in agricultural, forestry and fishing sectors are based:

- The projections on energy use in households, premises and combustion in the agricultural, forestry and fishing sectors are based on assumptions on future temperature conditions, population trend, stock of housing and commercial premises, energy prices, investment costs, technological development and economic development.

- Future temperature conditions are based on IPCC scenario RCP 4.5.⁹²
- Population growth (Statistics Sweden)

	2018	2030	2040
Population	10 230 185	11 094 873	11 529 973

- The number of new apartments in single-dwelling houses and multi-dwelling houses in the projection is assumed to increase by 295 000 from 2019 to 2025 and by 526 000 from 2025 to 2050.
- Heated area of new single dwelling houses and new apartment buildings is assumed to be 150 m² and 65 m² respectively.
- The projections for energy use from working machinery in agricultural sector are based on the projections in the agriculture sector. For working machinery in forestry the projections are based on projections of different processes in forest management.

Calculation assumptions for industry

Assumptions on which estimates for industrial combustion are based:

- The projection for manufacturing industries is based on assumptions on the economic development for the respective industry, the extent of energy efficiency efforts and assumptions on future fuel and energy prices.
- Annual growth in value-added between 2015-2035 and 2035-2040 (National Institute of Economic Research):

Industry	Annual growth (%) 2015-2035	Annual growth (%) 2035-2040
Pulp and paper industry	2.05	1.33
Chemical industry	1.80	2.05
Iron and steel industry	0.29	0.16
Manufacture of non-metallic mineral products	1.20	1.21
Non-ferrous metalworks	1.07	0.83
Engineering industry	1.33	1.55

⁹² RCP : Reference Concentration Pathway

Assumptions on which estimates for industrial processes and product use are based:

- The projection is based on historical trends as well as economic projections for each industry.
- The assumption on projected value added is the same as those for manufacturing industries.

Assumptions on which estimates for transport are based:

- The transport projections are based on several assumptions regarding number of inhabitants, disposable income of households, GDP, fuel price, exports and imports. Of importance are also assumptions regarding technical development, energy efficiency, mileage and introduction of renewable fuels.
- Traffic volume for cars in the projections is based on the historical relationships between traffic volume trends, GDP and cost of driving.
- Traffic volumes for light-duty lorries and heavy-duty lorries in the projection are based on the respective relationships between the traffic volume trends and GDP.
- The tax exemption for pure and high-blended biofuels is enforced from 2018-2020, after 2020 no decision on its future has been made meaning the competitiveness for high-blended biofuels and pure biofuels is worsened, meaning less of these fuels (E85, ED95, FAME100 and HVO100) is used.
- EU emission regulations set for cars, heavy-duty vehicles and light duty vehicles respectively.
- Fuel prices, SEK/litre, including tax and excluding VAT, 2018-year fixed prices

Fuel prices, SEK/litre, including tax and excluding VAT, 2018-year fixed prices	2018	2040
Petrol, with low-blend ethanol	12.3	17.7
Diesel, with low blend biodiesel	12.3	19.4

- Since July 1st 2018 there is no exemption from carbon and energy tax on bio-diesel and bio-petrol that is blended with components from non-renewable sources, no matter the level of renewable content. The same tax levels as of today are assumed during the whole period. The low blending of HVO and ethanol is assumed to increase aligned with the emission reduction obligation until 2020. After 2020 the level of low-blending of HVO in diesel is assumed to be unchanged and the volume of low-blended HVO is thus solely dependent on the

diesel usage and the same assumption is made for low-blending of ethanol in petrol. Renewable fuel (except biogas) that is sold without being blended with non-renewable fuel is fully exempted from tax in 2020, where after the exemption is removed.

Calculation assumptions for the waste sector

Assumptions on which estimates the waste sector are based:

- The projections are based on the existing policies and measures for reduced landfilling of organic waste, such as the prohibition of landfilling and landfill tax, and have been calculated partly on the basis of estimates of future quantities of landfilled waste, the emergence of alternative treatment capacity and future efficiency in gas recovery at landfills.
- The projections of emissions from biological treatment of solid waste are based on assumed continued increasing production.

Calculation assumptions for the agriculture sector

Assumptions on which estimates the agriculture sector are based:

- The projections are based on assumptions on prices, productivity and available areas and buildings.
- The prices are based on average prices for 2013-2017 in Sweden and price projections from OECD/FAO⁹³, extrapolated to 2040.
- Assumed growth in productivity per year:

	Change per year
Harvest	+0.5%
Milk yield	+1%
Swine per sow	+1,5%
Supplies	-0.5%
Labour	-1.5%

- Assumed availability of buildings: 35 % of current buildings are assumed to be in use in 2030 with only maintenance needed, 13% are disposed and 52 % can be used if renovations are made.
- The common agricultural policy (CAP) in 2019 is assumed to continue until 2040.

⁹³ OECD/FAO. 2018. OECD-FAO Agricultural outlook 2018-2027. OECD Publishing.

Calculation assumptions for the LULUCF sector

Assumptions on which estimates the LULUCF sector are based:

Forest land

- The reported projection is based on a projection assuming that current harvest intensity (2015-2019) persist over time. The harvest level was estimated to 84% of the growth available for harvest on productive forest land.
- Other settings are based on the projection in an analysis of the forest development (SKA-15) in terms of management, climate effect and nature conservation.⁹⁴
- The reported projection is based on a projection in which felling is assumed to not be higher than what is considered as sustainable in the long term.
- The structure of the standing stock at the start of the model simulation is based on the Swedish National Forest Inventory (NFI) which also forms the base for the annual reporting under the UNFCCC and the Kyoto protocol.
- In the projection current forest management practices are assumed, including environmental measures in forestry and environmental policy aimed at preserving biological diversity. This means that a total of 848 000 ha is set aside for nature conservation through legal protection and 1 332 000 ha is voluntary set aside by forest owners. Further 1 468 000 ha is left as retention patches within the forest used for timber production. The total forest land area used for timber production is 21 349 000 ha. The total simulated area consisted of productive forest land of 23 497 000 ha (including legally or voluntary set-aside areas and forest land used for timber production) and low-production forest land of 4 474 000 ha.
- In the projection a climate effect is included, based on the RCP 4.5 scenario (IPCC 2013) which gives a positive effect on the annual gross increment by 21 % 2070-2100 compared to 1970-2000.

Cropland, Grassland, Wetlands

- The projections for each carbon pool are based on the mean net annual carbon stock change for the period 2010-2019 as reported in the National Inventory Report, submission 2021.

⁹⁴ Claesson, S., Duvemo, K., Lundström, A., & Wikberg, P.E. 2015. Skogliga konsekvensanalyser 2015 – SKA 15. Skogsstyrelsen. Rapport 10/2015.

- The mean annual carbon stock change per area is multiplied with the projected area. The projection assumes that the area continues to decrease at the same rate as the last 30 years period.

Settlements

- The projected emissions/removals for each reported carbon pool are assumed to be constant and estimated as a mean for the period 2010-2019 as reported in the National Inventory Report, submission 2021.

Harvested Wood Products (HWP)

- The net removals for HWP is estimated based on the projected harvest and the assumption that the available biomass is distributed on the different product groups equally as today.

