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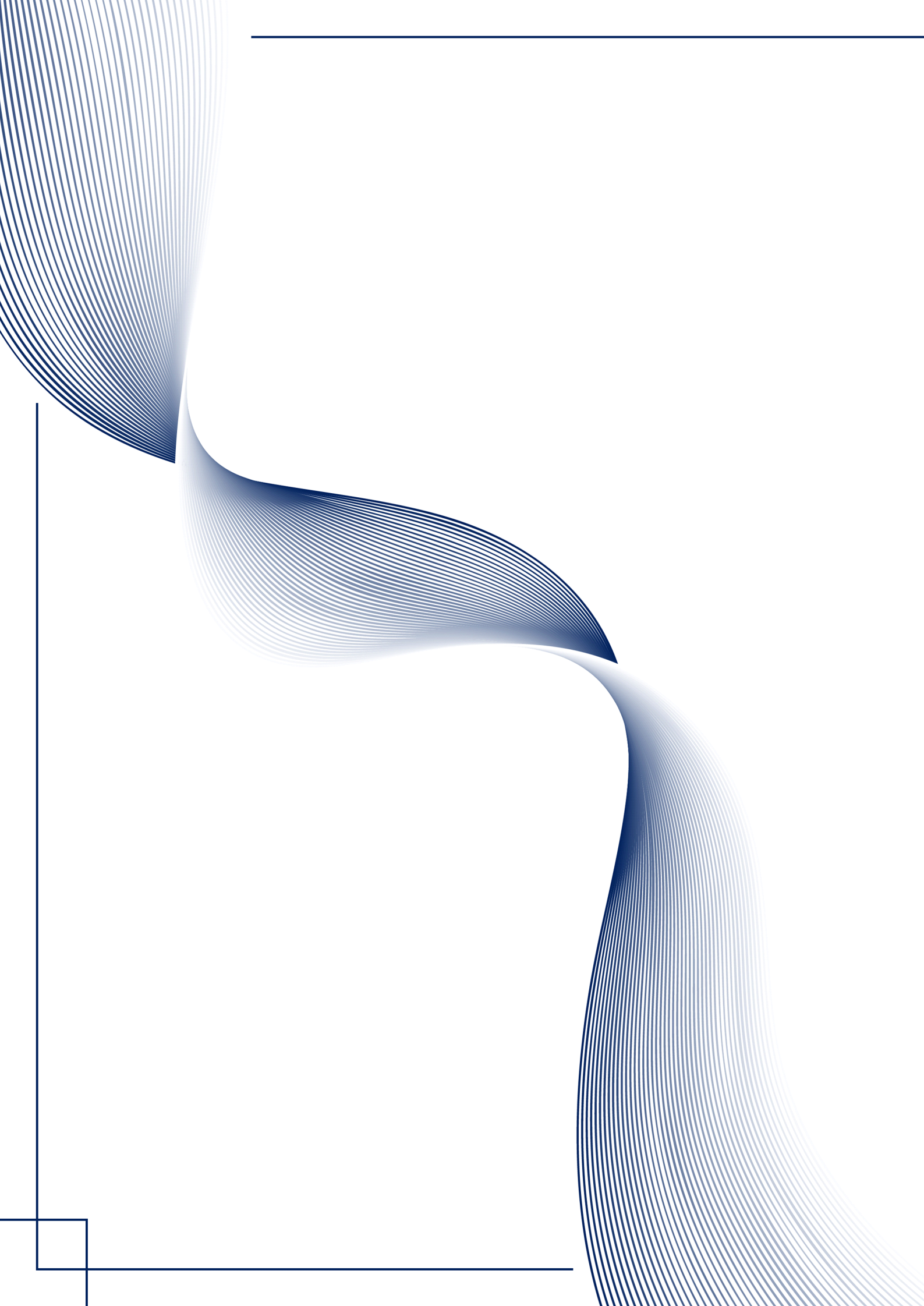
The Republic of Korea's First Biennial Transparency Report and Fifth National Communication

under the United Nations Framework Convention on Climate Change and the Paris Agreement

The Government of
the Republic of Korea



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- The Biennial Transparency Report (BTR) is prepared and submitted biennially to the United Nations Framework Convention on Climate Change (UNFCCC) based on the deliberation and resolution of the Presidential Commission on Carbon Neutrality and Green Growth, in accordance with Article 13 of the Paris Agreement, Decision 1/CP.24, Decision 18/CMA.1 and its annex, and Article 77 of the *Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis* (September 2021).

- The National Communication (NC), submitted together with the BTR as an annex, is reported quadrennially in accordance with Article 12 of UNFCCC, Decision 17/CP.8, and Decision 1/CP.16.

- This report has been prepared under the supervision of the Ministry of Environment of the Republic of Korea (ROK), with the Greenhouse Gas Inventory and Research Center (GIR) serving as the secretariat, in collaboration with relevant ministries.

- The structure of the First BTR is as follows: ⅰ) Greenhouse Gas (GHG) Inventory, ⅱ) Tracking progress in implementing and achieving the Nationally Determined Contribution (NDC), ⅲ) Climate change impacts and adaptation, ⅳ) Support provided to the global community, and ⅴ) Annexes, which include the Fifth National Communication (NC), the National Inventory Report (NIR), and the Common Tabular Formats (CTFs) to track progress in implementing and achieving the NDC.

- While this report contains the latest information up to 2024, the national GHG inventory, reduced and projected GHG emissions estimates through mitigation policies and measures (PaMs), and support provided to global community are reported up to 2022, based on finalized official statistics.

- Chapter Ⅰ presents the national GHG inventory that includes the latest emissions data from 1990 to 2022 following deliberation and confirmation by the National GHG Inventory Management Committee in December 2024.

- While the emissions and removals estimates in Chapter Ⅰ of this report were calculated using methodologies recommended in the 2006 IPCC Guidelines and GWPs from the IPCC Fifth Assessment Report (AR5), information necessary to track progress of the NDC in Chapter Ⅱ used the 1996 IPCC Guidelines and GWPs from the IPCC Second Assessment Report (SAR), resulting in the difference in methodological approaches.

- Chapter Ⅱ is prepared with the objective of tracking the implementation progress of the enhanced update of the 2030 NDC target (total emissions) submitted to UNFCCC in December 2021.

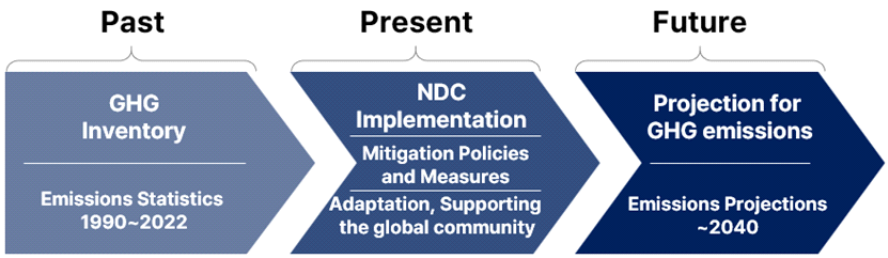
- Chapter Ⅲ outlines updates on the ROK's Adaptation Communication (AdCom) published in April 2023, and Chapter Ⅳ includes information on support provided to the global community under Article 13, Paragraphs 8 and 9 of the Paris Agreement.

- To avoid reiteration with the BTR, the Fifth NC, submitted as an annex to the BTR, only includes specific sections on Research and Systematic Observation (RSO) and Education, Training, and Public Awareness.

Executive Summary

Overview

The First Biennial Transparency Report (BTR) of the Republic of Korea (ROK) is prepared in accordance with rules and guidelines adopted by the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, highlighting greenhouse gas (GHG) emissions and mitigation efforts of the ROK from past, present and the future. This report provides detailed information on GHG emissions and trends from 1990 to 2022 as well as current mitigation policies and measures (PaMs) to achieve the Nationally Determined Contributions (NDC) target. It also reports on GHG emission projections up to 2040, climate change adaptation actions, and the provision of financial and technological assistance including capacity building in developing country partners around the world, demonstrating the Republic of Korea's commitments under UNFCCC and the Paris Agreement.



National Greenhouse Gas Inventory

The ROK has opted to submit its latest National Inventory Report (NIR[1)]) as a stand-alone report in line with the Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement (Annex Part E, paragraph 12, Decision 18/CMA.1). Chapter Ⅰ of this report provides a summary thereof.

GHG emissions and removals estimates presented in the NIR are organized and calculated using methodologies consistent with the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories.

Additionally, the 100-year global warming potential (GWP) values from the IPCC Fifth Assessment Report (AR5) were used to estimate emissions in accordance with the Paris Agreement (Annex 2.D Paragraph 37, Decision 18/CMA.1). The ROK has expanded the scope of GHG reported from six gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) to seven gases, which includes nitrogen trifluoride (NF_3).

1) In accordance with Paragraph 38 of the MPGs, the National Inventory Report (NIR) consists of the Common Reporting Tables (CRTs) and the National Inventory Document (NID).

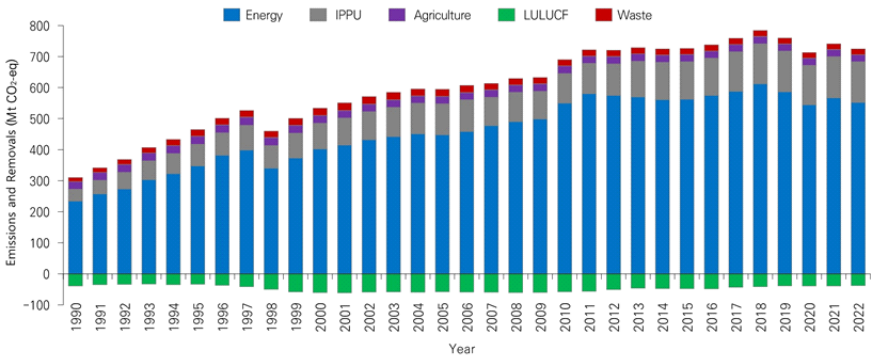
Executive Summary

The latest National GHG Inventory of the ROK covering the period of 1990-2022[2)] showed that total GHG emissions (excluding LULUCF) in 2022 were 724.3 $MtCO_2$-eq, representing an increase of 133.2% (413.7 $MtCO_2$-eq) compared to 1990 levels of 310.6 $MtCO_2$-eq. It also marks a decrease of 2.3% (16.7 $MtCO_2$-eq) compared to 2021 levels of 741.0 $MtCO_2$-eq, and a decrease of 7.6% (59.6 $MtCO_2$-eq) from the peak emissions recorded in 2018. Net GHG emissions (including LULUCF) in 2022 were 686.5 $MtCO_2$-eq, reflecting an increase of 152.7% (414.8 $MtCO_2$-eq) compared to 1990 levels of 271.6 $MtCO_2$-eq, a decrease of 2.2% (15.5 $MtCO_2$-eq) compared to 2021 levels of 702.0 $MtCO_2$-eq, and a decrease of 7.5% (55.8 $MtCO_2$-eq) compared to 2018 levels of 742.3 $MtCO_2$-eq.

While the emissions showed an increasing trend in the 1990s due to the country's economic growth, the rate of increase gradually slows down since the 2000s, and emissions began to decline after reaching its peak in 2018. The financial crisis in 1998 led to a decrease of 12.5% in emissions compared to the previous year, followed by an increasing trend with an average annual rate of 2.6% from 1999 to 2008. In 2009, the year-on-year increase was limited to 0.6% due to the 2008 economic recession. Emissions in 2020 decreased by 6.1% compared to the previous year as a result of the outbreak of the COVID-19 pandemic.

2) The latest revisions to the Yearbook of Energy Statistics (December 2024) have been incorporated to improve the accuracy and timeliness of the national GHG inventory. As a result, the submission schedule for the first BTR has been postponed from the originally planned December 2024 to February 2025.

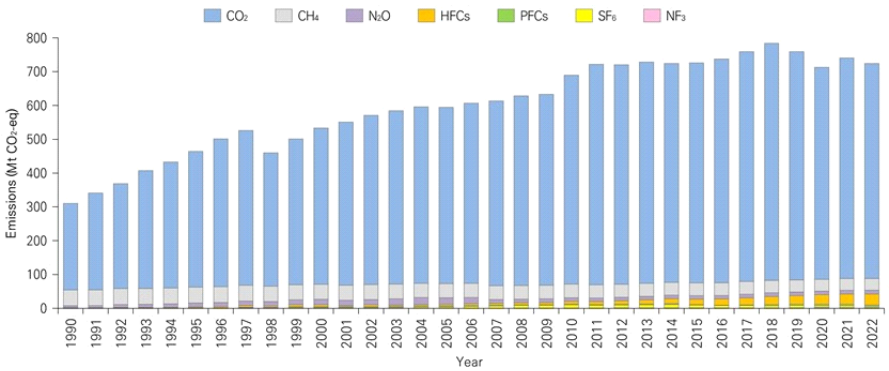
By sector, energy accounts for the largest share at 76.2% of the total emissions in 2022, followed by industrial processes and product use (IPPU) at 18.1%, agriculture at 3.2%, and waste at 2.5%. Notably, due to the manufacturing-centered industrial structure, the energy sector has consistently maintained a share of 74-80% since 1990.



GHG Emissions and Removals by Sector (1990-2022)

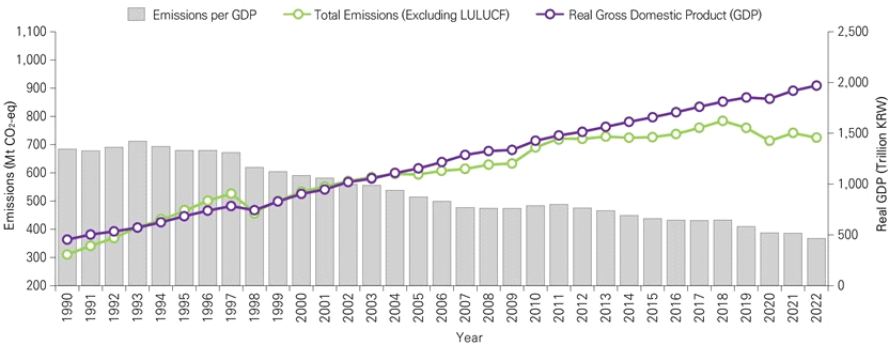
By gas, CO_2 accounted for the largest share at 87.8%, followed by fluorinated gases at 5.9% (HFCs 4.5%, PFCs 0.56%, SF_6 0.55%, NF_3 0.2%), CH_4 of 4.9%, and N_2O at 1.5%. While most gases, including CO_2, have continued to increase, CH_4 emissions has continuously decreased since 1990 due to reduced the amount of waste disposed and a decrease in rice cultivation areas. Fluorinated gas showed an upward trend compared to 1990 due to increased use of refrigeration and air-conditioning system, and the production of semiconductors.

Executive Summary



GHG Emissions by Gas (1990-2022)

Total GHG emissions per unit of GDP in 2022 were 367.9 tCO_2-eq/KRW billion, showing a decrease of 46.2% compared to 1990 levels (683.9 tCO_2-eq/KRW billion) and a decrease of 4.7% compared to 2021 levels (386.2 tCO_2-eq/KRW billion). Since emissions peaked in 2018, a decoupling trend has been observed, with GDP continuing to grow while emissions decrease.



Total GHG Emissions per Real Gross Domestic Product (1990-2022)

Tracking Progress in Implementing and Achieving NDC

The ROK has established an institutional foundation for achieving carbon neutrality by legislating its 2050 carbon neutrality vision and specifying the 2030 NDC target therein. In 2021, the ROK submitted an enhanced NDC to UNFCCC, demonstrating its firm commitment to a 40% reduction in total emissions compared to 2018 levels by 2030.

Progress towards the 2030 NDC target shows that the reduction rate is at approximately 8.4% based on total emissions in 2022 compared to 2018 levels. As shown in the table below, a continuous declining trend is observed with a decrease of 2.81% in emissions in 2022 compared to 2021, marking the second consecutive year of decline.

Information on Tracking Progress in Implementing and Achieving NDC (CTF Ⅱ.4)

	Unit	Reference Point[1] (2018)	NDC Implementation Period		Target Level[2]	Target Year	NDC Progress Status
			2021	2022			
Annual Total GHG Emissions	$MtCO_2$-eq	732.9	690.8	671.2	40%	2030	As of 2022, approx. 8.4% reduction compared to 2018
ITMOs Utilization	As international mitigation projects are at the initial stage, the ROK plans to report on NDC utilization of ITMOs and double counting prevention in its subsequent BTRs.						

1) Updated figures due to recalculation (727.6 → 732.9)
2) The ROK plans to use voluntary cooperation under Article 6 of the Paris Agreement as a complementary measure to its domestic mitigation efforts including LULUCF to achieve its target

Executive Summary

While the emissions and removals estimates in Chapter Ⅰ of this report were calculated using methodologies recommended in the 2006 IPCC Guidelines and GWPs from the IPCC Fifth Assessment Report (AR5), information necessary to track progress of the NDC submitted used the 1996 IPCC Guidelines and GWPs from the IPCC Second Assessment Report (SAR), resulting in the difference in methodological approaches.

The ROK plans to apply the 2006 IPCC Guidelines for its 2035 NDC and subsequent BTRs, ensuring consistency between national GHG inventory and the 2035 NDC implementation.

The ROK's mitigation PaMs have served as an institutional foundation that led to the implementation of the *Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis* (Carbon Neutrality Act) (September 2021). The Act introduced key mechanisms such as the Climate Response Fund and the Greenhouse Gas Reduction Cognitive Budget which were incorporated into the *First National Framework Plan for Carbon Neutrality and Green Growth* (April 2023), establishing the framework for implementing the ROK's 2030 NDC. In particular, the Korea Emissions Trading System (K-ETS), which has been in operation since 2015 as one of the most impactful climate mitigation measures that encourages voluntary reduction activities and investments by businesses, covers approximately 73.5% of national GHG emissions.

Major mitigation PaMs described in the report encompass the following: power generation, industry, building, transportation, agriculture, livestock farming and fisheries, waste, and carbon sinks. Examples of national-level policy actions include the phase-out of old coal power plants, the introduction of renewable energy facilities, and the expansion of landfill methane capture. For some measures, reduced emissions for 2021-2022 and projected estimates for 2030 are also presented.

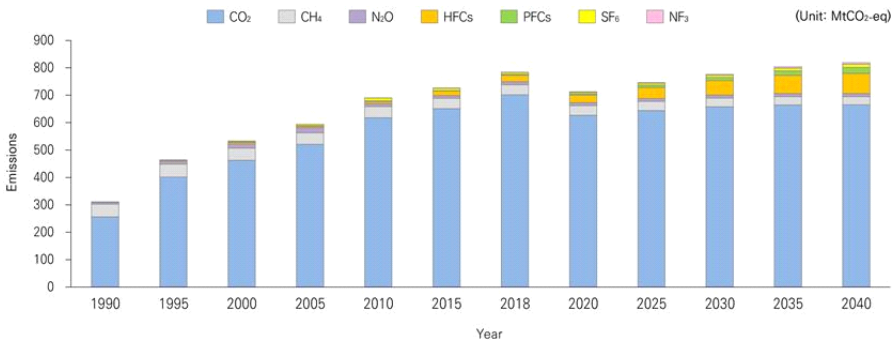
Not only at the national level, but also at the local level, 17 metropolitan and provincial governments have started submitting their first *Master Plan for Carbon Neutrality and Green Growth* starting from 2024, integrating climate actions into local operations and decision making.

This report outlines a long-term GHG emissions projection up to 2040 in accordance with Paragraph 92 of the MPGs. The projection is based on the "with measures scenario" (WM scenario) that includes policies announced and implemented up to 2021.

The emissions projection is based on GHG emissions data up to 2021 that are calculated in accordance with the 2006 IPCC Guidelines, as outlined in the 2024 National Greenhouse Gas Inventory (1990-2022), categorized into seven GHGs.[3)] Emissions by gas are specified in CO_2 equivalent values using GWPs from the IPCC AR5. However, the projection does not include indirect GHGs or international bunker fuel emissions from international aviation and maritime transport.

3) The emission projection is based on data from 2021, the latest available at the time of analysis. However, following the latest revision of the Yearbook of Energy Statistics (December 2024), the emission projection has been updated to reflect the changes.

Under the WM scenario, total emissions in 2040 are projected to reach 818.7 $MtCO_2$-eq, reflecting an increase of 4.4% compared to 2018 levels, with an average annual rate of 0.2% from 2018 to 2040.



GHG Emissions by Gas: Trends and Projection

The emissions projection above does not include PaMs introduced after 2021. Future updates to the emission projection based on the latest available year are expected to show a decrease compared to the current projection with new PaMs introduced in the following years.

Climate Change Impacts and Adaptation

The ROK has mandated its national-level climate change response through the Carbon Neutrality Act 2021, and has been developing the *National Climate Change Adaptation Plan* every five years since 2010. The *Enhanced 3rd National Climate Change Adaptation Plan* (June 2023) which complements the previous *3rd National Climate Change Adaptation Plan* features a comprehensive monitoring and evaluation system, consisting of annual progress assessments as well as mid-term and final evaluations conducted in the third and fifth years.

Adaptation plans are established and implemented every five years not only at the national level but also by 17 metropolitan and provincial governments, 226 municipal governments, and 62 public institutions responsible for critical infrastructure such as transportation and electricity. The government works together with various adaptation stakeholders, including the private sector and the public, providing support for climate change adaptation measures targeting vulnerable populations such as the elderly and low-income households.

The ROK has completed scientific assessments to evaluate the current and future impacts of climate change and further develop effective adaptation strategies. Climate change impact and vulnerability assessments are carried out through the Model Of InTegrated Impact and Vulnerability Evaluation of climate change (MOTIVE) across sectors, including health, water, agriculture, forestry, ecosystem, ocean, and fisheries. Additionally, the Vulnerability assESsment tool To build climate change Adaptation Plan (VESTAP) provides expertise as a basis for scientific decision-making by identifying priority areas vulnerable to climate change.

Supporting the Global Community

The ROK has been committed to enhancing global climate change efforts to address the climate crisis and support developing country partners by sharing its knowledge and experience.

Bilateral financial support through Official Development Assistance (ODA) amounted to approximately USD 1,439 million in 2021 and USD 2,156 million in 2022, with climate change adaptation accounting for 79.5% and 61.8% of the total, respectively. To effectively reflect developing countries' climate change needs and priorities, the ROK has established Country Partnership Strategies (CPS) to provide tailored support for each country.

Multilateral funds for climate change response, including the Green Climate Fund (GCF) and the Global Environment Facility (GEF), have also been increased. By 2023, the ROK has contributed USD 100 million to the GCF initial resource mobilization and USD 200 million to its first replenishment. Starting in 2024, the ROK has pledged an additional USD 300 million for the second replenishment. Support for the GEF amounted to KRW 2,230 million in 2022, and increased to KRW 2,420 million in 2023. Moreover, additional KRW 3,600 million to the Adaptation Fund and USD 7 million to the Loss and Damage Fund have been planned for 2023-2025.

The ROK is also committed to enhancing international cooperation by working with international partners of which examples include funding for need-based climate finance projects under UNFCCC, support for the preparation of the IPCC Sixth Assessment Report (AR6), operation of the Climate Technology Centre and Network Partnership & Liaison Office (CTCN PALO), and management of the World Meteorological Organization (WMO) Regional Training Centre Trust Fund.

Activities for systematic technology development and transfer are carried out under the *Act on Promotion of Technology Development for Coping with Climate Change 2021* with the Ministry of Science and ICT as the National Designated Entity (NDE). Through CTCN Technical Assistance (TA) projects, a total of 18 pro-bono TA projects were implemented during 2021-2022, primarily supporting climate technology cooperation tailored to the needs of developing countries in the areas of energy, water and sanitation.

The ROK has been strengthening support to assist developing countries in achieving their climate goals, which includes providing technical expertise, enhancing capacity for forest and GHG management, and supporting the establishment of environmental improvement master plans. Since 2017, in cooperation with UNFCCC, the ROK has been organizing the UNFCCC-GIR-CASTT (Climate Action and Support Transparency Training) Programme on GHGs to support developing countries in implementing the Enhanced Transparency Framework (ETF) and strengthening their GHG reporting capacity.

I

National Greenhouse Gas Inventory

1. Current Status and Institutional Arrangements

1.1 Background Information on Climate Change and Greenhouse Gas Inventory

1.1.1 Background Information on Climate Change

The average annual temperature in the Republic of Korea (ROK) has increased by approximately 1.6°C over the last 30 years (1991-2020) compared to the historical 30-year period from 1912 to 1940. Six of the ten warmest years on record between 1912 and 2020 have taken place in the last decade (2011-2020). In addition, extreme weather events have been escalating, as evidenced by the intensified precipitation in the past decade.[1)] By the end of the 21st century (2081-2100), the average annual temperature is projected to increase by 2.3°C to 6.3°C compared to the period from 2000 to 2019.[2)] Furthermore, climate change continues to influence extreme weather events worldwide, and simultaneous and recurring climate hazards are expected to increase risks and impacts on health, ecosystems, infrastructure, and food security.[3)]

Since the ROK's ratification of the United Nations Framework Convention on Climate Change (UNFCCC) in 1993, the government has been actively participating in joint efforts to address climate change. Following the adoption of the Paris Agreement, a new global agreement for combating climate change in the post-Kyoto Protocol era, the ROK submitted its intended nationally determined contribution (INDC) to the UNFCCC in June 2015. In 2020, the national vision to achieve carbon neutrality by 2050 was declared, and in the following year, an enhanced update of its first nationally determined contribution (NDC) for 2030 with more ambitious greenhouse gas (GHG) reduction target was submitted. Both the 2050 carbon neutrality vision and the 2030 NDCs were codified in the *Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis* (Carbon Neutrality Act) and its Enforcement Decree, which were enacted in September 2021 and March 2022, respectively.

1) Source: Analysis report on climate change in Korea over 109 years (1912-2020) (Korea Meteorological Administration & National Institute of Meteorological Sciences, 2021)
2) Source: Comprehensive climate change projection report for South Korea: Climate change projections* under four SSP scenarios (National Institute of Meteorological Sciences, 2022)
* National Institute of Meteorological Sciences (2022) developed detailed climate change scenarios for ROK based on the latest greenhouse gas pathways from the IPCC Sixth Assessment Report (AR6) under the Shared Socioeconomic Pathways (SSP). These scenarios include SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5, and the National Institute of Meteorological Sciences (2022) presents the projected annual average temperature increases for the years 2081-2100 for each scenario.
3) Source: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2023)

To achieve carbon neutrality and the 2030 NDC target, the ROK has established the *First National Framework Plan for Carbon Neutrality and Green Growth* (April 2023)[4] - a legally mandated plan spanning 20 years with quinquennial updates. The plan outlines both mid- to long-term national and sectoral reduction targets on an annual basis. Sectoral policies and measures (PaMs) to reduce GHG emissions - both implemented and planned - include enhancing the Korean Emission Trading System (K-ETS), expanding zero-carbon electricity generation, strengthening building energy efficiency standards, and increasing new carbon sinks, such as urban forests. Additionally, each metropolitan city and provincial government has developed a Master Plan for Carbon Neutrality and Green Growth to implement climate change response policies tailored to their regions.

1.1.2 Background Information on GHG Inventory

As the existing Measurement, Reporting and Verification (MRV)[5] system for national GHG inventories transitions to the Enhanced Transparency Framework (ETF) under the Paris Agreement, all Parties shall submit a National Inventory Document (NID) and the Common Reporting Tables (CRTs), to the UNFCCC either as a stand-alone report or as part of a Biennial Transparency Report (BTR), due by the end of 2024.[6]

Chapter Ⅰ, 'National Greenhouse Gas Inventory', contains information on the emissions and removals of the seven GHGs - carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3) - taking place within national territory and offshore areas over which the ROK has jurisdiction, in accordance with paragraphs 40 and 50 of the modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement (MPGs).

Anthropogenic emissions and removals, in accordance with paragraphs 17 and 20 of the MPGs, are estimated using the methodologies described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines)[7] and, where appropriate, the

4) Source: First National Framework Plan for Carbon Neutrality and Green Growth (The ROK Government, 2023)
5) The ROK, as a Non-Annex I country under the UNFCCC, has communicated its National Communications (NC) and Biennial Update Reports (BUR) to the UNFCCC in accordance with the principle of Common But Differentiated Responsibilities (CBDR).
※ NC1 (February 1998), NC2 (December 2003), NC3 (March 2012), NC4 (November 2019)
BUR1 (December 2014), BUR2 (November 2017), BUR3 (November 2019), BUR4 (December 2021)
6) Source: Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement (Decision 18/CMA.1) (UNFCCC, 2018)

2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2019 Refinement)[8] is applied to certain emission sources (see Chapter Ⅰ, Section 1.3). For metrics, this inventory uses the 100-year time horizon global warming potential (GWP) values from the IPCC Fifth Assessment Report,[9] as specified in paragraph 37 of the MPGs (see Chapter Ⅰ, Section 1.5).

The national GHG inventory is categorized into the Energy, Industrial Processes and Product Use (IPPU), Agriculture, Land Use, Land-Use Change and Forestry (LULUCF), and Waste sectors. In accordance with paragraph 50 of the MPGs, the 2006 IPCC Guidelines integrate Agriculture and LULUCF into one category of Agriculture, Forestry and Other Land Use (AFOLU). The reporting period covers 33 years, from 1990 to 2022.

7) Source: 2006 IPCC guidelines for national Greenhouse Gas inventories. (Eggleston, H. S., Buendia, L., Miwa, K., Ngara, T., & Tanabe, K., 2006)
8) Source: 2019 Refinement to the 2006 IPCC guidelines for national Greenhouse Gas inventories. (IPCC, 2019)
9) Source: IPCC Fifth Assessment Report (IPCC, 2014)

1.2 Institutional Framework

1.2.1 Institutional Arrangements

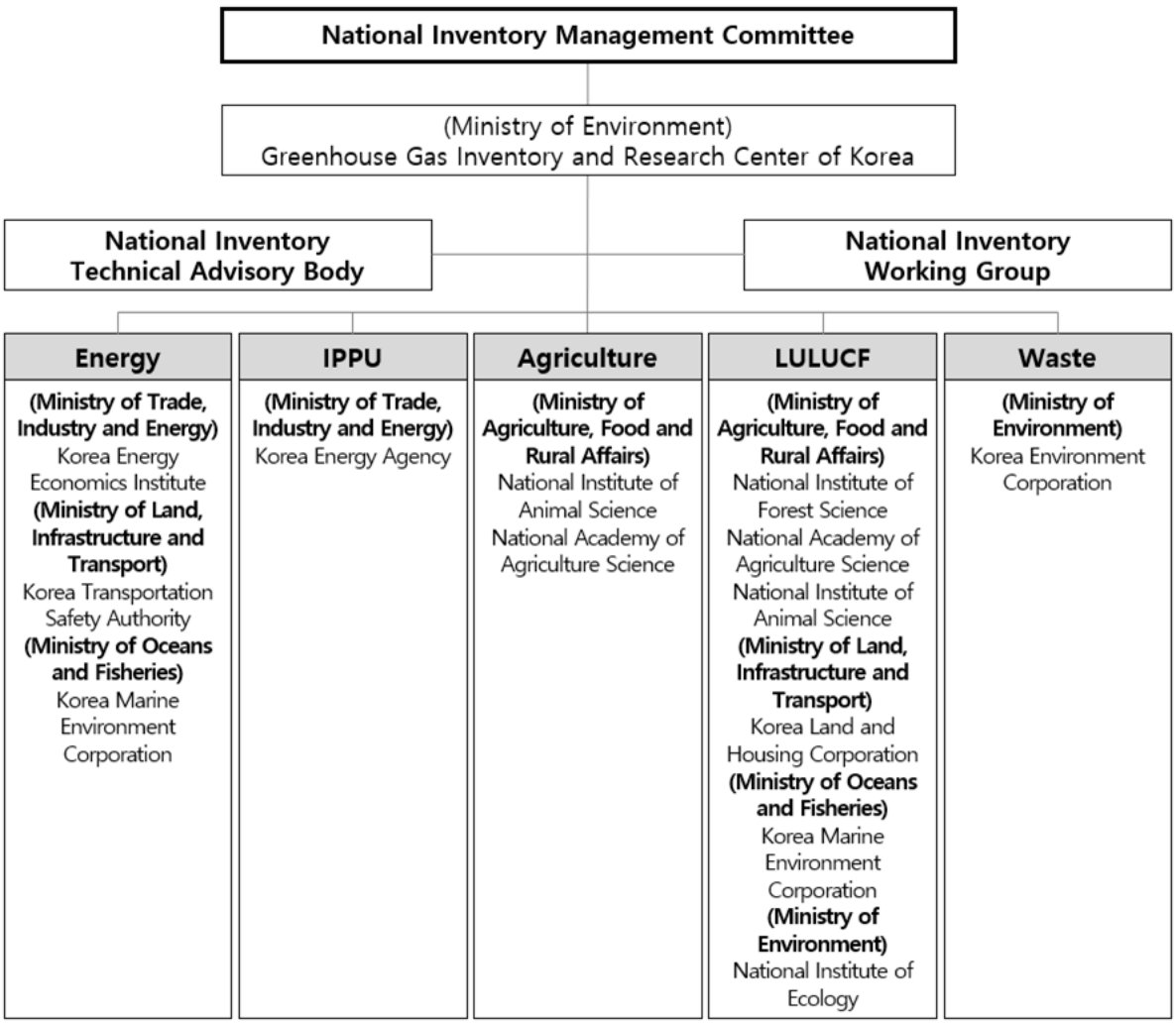
The Greenhouse Gas Inventory and Research Center of Korea (GIR) was established in 2010 under the Ministry of Environment to verify national GHG inventories and to develop and operate an integrated GHG data management system. The responsibilities of the GIR include developing a master plan for national inventories and MRV guidelines, verifying national inventories and country-specific emission/removal factors (CS EF/RFs), preparing NID and CRTs, operating and managing the national inventory reporting system, and promoting international cooperation. The GIR is also responsible for establishing and coordinating the National Inventory Management Committee (Management Committee), the National Inventory Working Group (Working Group), and the National Inventory Technical Advisory Body (Technical Advisory Body).

The Technical Advisory Body, composed of national GHG inventory experts recommended by government ministries, provides technical advice on inventories and CS EF/RFs.

The Working Group is an goverment-wide coordination body responsible for the establishment and revision of MRV guidelines, as well as the development and verification of CS EF/RFs. It is chaired by the GIR president, and its members include division-director-level officials from the Office for Government Policy Coordination, Ministry of Agriculture, Food and Rural Affairs, Ministry of Trade, Industry and Energy, Ministry of Environment, Ministry of Land, Infrastructure and Transport, Ministry of Oceans and Fisheries, Rural Development Administration, Korea Forest Service, and Statistics Korea.

The Management Committee is the final deliberation and decision-making body for establishing and revising MRV guidelines as well as developing and verifying CS EF/RFs. It is chaired by the Vice Minister of Environment and its members include director-general-level officials from the Office for Government Policy Coordination, Ministry of Agriculture, Food and Rural Affairs, Ministry of Trade, Industry and Energy, Ministry of Environment, Ministry of Land, Infrastructure and Transport, Ministry of Oceans and Fisheries, and Statistics Korea, in addition to experts with extensive knowledge and experience in sector-specific GHG inventories, emission/removal factors, and statistics. The GIR serves as the secretariat for the Management Committee.

The management of sector-specific GHG inventories is handled by the respective competent authorities. The competent authorities appoint designated agencies to develop CS EF/RFs, and to estimate sector-specific GHG emissions and removals. The competent authorities review the national GHG inventory prepared by the designated agencies and forward it to the GIR for verification.



[Figure Ⅰ-1] National GHG Inventory Preparation Framework

<Table Ⅰ-1> Overview of National Inventory Arrangements by Sector and Category

Sector and category		Competent Authority	Designated Agency
Energy	Fuel Combustion (Energy industries and manufacturing industries and construction) and Fugitive Emissions	Ministry of Trade, Industry and Energy	Korea Energy Economics Institute
	Transportation (Aviation, Road, Rail) and Building	Ministry of Land, Infrastructure and Transport	Korea Transportation Safety Authority
	Transportation (Maritime) and Fisheries	Ministry of Oceans and Fisheries	Korea Marine Environment Corporation
IPPU		Ministry of Trade, Industry and Energy	Korea Energy Agency
Agriculture	Livestock	Ministry of Agriculture, Food, and Rural Affairs	National Institute of Animal Science
	Cultivation		National Academy of Agricultural Science
LULUCF	Forest Land, Harvested Wood Products		National Institute of Forest Science
	Cropland		National Academy of Agricultural Science
	Grassland		National Institute of Animal Science
	Wetlands-Inland	Ministry of Environment	National Institute of Ecology
	Wetlands-Coastal	Ministry of Oceans and Fisheries	Korea Marine Environment Corporation
	Settlements, Other Land	Ministry of Land, Infrastructure and Transport	Korea Land and Housing Corporation
Waste		Ministry of Environment	Korea Environment Corporation

1.2.2 Inventory Preparation Process

1) Preparation

The GIR and relevant ministries jointly develop a five-year rolling plan - the *Master Plan for National Greenhouse Gas Inventory* (Master Plan)[10] - to ensure the consistency and improvement of national inventories according to the international guidelines. The Master Plan provides guidance for continuous improvements aimed at enhancing the quality of the national inventories. These improvements include the advancement of estimation methodologies, the development, verification, and management of CS EF/RFs, securing and management of activity data, and the establishment and operation of IT systems.

The GIR prepares annual amendments to the MRV guidelines, incorporating requirements from the Master Plan and improvements identified during the previous year's inventory verification process. These amendments are finalized following review by the Working Group and deliberation by the Management Committee. The GIR then forwards the revised guidelines to the competent authorities by December of the preceding year, ahead of the inventory submission.

The competent authorities develop an annual work plan for estimating GHG emissions and removals within their respective sectors, based on the methodologies outlined in the MRV guidelines distributed by the GIR. Other responsibilities include reviewing the activity data and tracking any changes in data provision. The competent authorities also designate sector-specific agencies with relevant expertise to delegate the roles of developing CS EF/RFs and of estimating emissions/removals.

2) Measurement, Reporting, and Verification

The designated agencies collect the necessary data for estimating sectoral emissions by sources and removals by sinks in cooperation with data-providing institutions, and estimate national emissions in accordance with the MRV guidelines. The competent authorities perform quality assurance (QA) and quality control (QC) procedures on the overall inventory process, including activity data, emission/removal factors, and methodologies. Finally, the competent authorities prepare and submit the emissions/removals estimates and inventory reports for the respective sectors to the GIR, along with supporting documentation, by

10) Source: *First Master Plan for National Greenhouse Gas Inventory* (Joint Ministries, 2015) and *Second Master Plan for National Greenhouse Gas Inventory* (Joint Ministries, 2020)

March of the year preceding the official national inventory submission.

The GIR compiles sectoral GHG inventory submitted by the competent authorities, verifies activity data, emission/removal factors and methodologies, and checks for any calculation errors. If errors or areas for improvement are identified during the verification process, the GIR accordingly requests corrections and supplementation from the respective competent authorities. After the final confirmation of the revised inventory resubmitted by the competent authorities, the GIR produces the final draft of the data tables and report for the national GHG inventory, covering all sectors.

3) Finalization, Publication and Improvement

The final draft of national GHG inventory prepared by the GIR is officially announced after consultations in the Working Group and deliberation by the Management Committee. The finalized national inventory is publicly disclosed online through the websites of the GIR and Statistics Korea. The published national inventory is then used in the NC, BTR, and NID submitted to the UNFCCC.

Areas for improvement identified during the inventory preparation process are incorporated either into the MRV guidelines for the following year or into the subsequent Master Plan, depending on whether the improvements can be made in the short or long term. This process ensures the continuous improvement in the quality of national inventories.

<Table Ⅰ-2> Annual Schedule for National GHG Inventory Preparation

Procedure	Entity	Main Activities	Year t-1	Year t			
				Jan	Mar	Oct	Dec
Preparation							
Development of MRV Guidelines	GIR	• Drafting and distributing MRV guidelines	■				
Establishment of an annual work plan	CA	• Reviewing the data necessary for GHG estimation	■				
Estimation and Reporting							
GHG estimation and reporting by sector	CA DA	• Estimating emissions and removals by sector • Conducting internal QA/QC processes and reporting to the GIR		■	■		
Verification							
Aggregation and verification	GIR	• Compiling sectoral inventories and preparing aggregated inventory tables • Reviewing the aggregated inventory tables and inventory reports • Requesting corrections and improvements to sector-specific inventories				■	
	CA	• Correcting and resubmitting sector-specific inventories				■	
Deliberation and Confirmation							
Review	WG	• Reviewing the draft of national emissions/removals • Developing the national inventory improvement plan					■
Finalization	MC	• Reviewing and finalizing the national inventory					■
Publication							
Domestic	GIR	• Public release of official statistics					■
International	ME MOFA	• Preparing for submission to the UNFCCC • Submission to the UNFCCC					■

Note: The reporting period extends from 1990 to two years prior to the submission year, in accordance with the MRV Guidelines for the National GHG Inventory

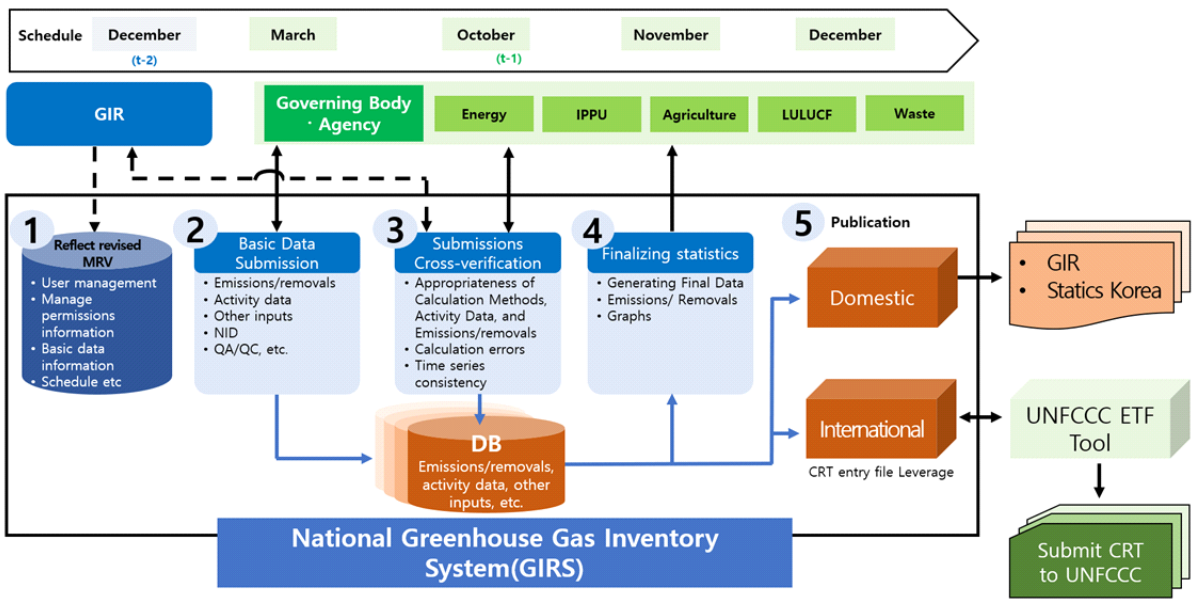
※ ME: Ministry of Environment, MOFA: Ministry of Foreign Affairs, GIR : Greenhouse Gas Inventory and Research Center of Korea, CA: Competent Authorities, DA: Designated Agencies, WG: Working Group, MC: Management Committee

1.2.3 Archiving of Information

The GHG Inventory Reporting System (GIRS) manages all data used for emissions estimation, ensuring the continuity of data collection and archiving for the national GHG inventory. It manages users, submission schedules, emissions/removals sources and basic data (activity data, emissions/removals, and methodologies) and records the history of data submissions and verification conducted by GIR.

The GIR updates the basic data (in Excel format) in accordance with the annually revied MRV guidelines and distributes them through GIRS. The designated agencies register basic data as well as NID and QA/QC reports through the GIRS. After verification by competent authorities, the data is then submitted to GIR via the GIRS.

Once final approval is obtained through the Working Group and Management Committee, GIRS generates domestic publication (GIR, Statistics Korea) and CRT entry files for the UNFCCC that can be input into the ETF Reporting Tool, the Paris Agreement's ETF reporting platform.[11)]



[Figure Ⅰ-2] Information Management System for National GHG Inventory

11) The function for ETF Reporting Tool input data generation is currently under trial operation.

1.3 Methodologies and Data Sources

1.3.1 Methodology

The national GHG inventory in this report applied methodologies consistent with Article 20 of the 2006 IPCC Guidelines in accordance with the MPGs. The 2013 Supplement (Wetlands) and the 2019 Refinement were also used to supplement methodologies for sub-sectors where detailed activity data and updated emission and removal factors are available. The 2013 Supplement (Wetlands) were used for methodologies for CO_2 emissions and removal from coastal wetlands and CO_2 emission factor for tidal marshes. Similarly, the 2019 Refinement was used for emission factors for fugitive CO_2 and CH_4 from underground mines including abandoned ones in the Energy sector, methodology for N_2O emissions from manure management in the Agriculture sector, and methodologies for CO_2 emissions and carbon stock in harvested wood products (HWP) in the LULUCF sector.

1.3.2 Data Sources

The sources of activity data used in national GHG inventory include national statistics, published by statistics agencies[12] designated under the *Statistics Act* (1962.01), internal data from Statistics Korea, data provided by relevant associations, and performance reports from compliance entities under the GHG Target Management System (TMS) and K-ETS. When using national statistics as activity data, such as the designated agencies' own surveys, Clean Development Mechanism (CDM) reports, and electronic disclosure project reports, internal QA/QC procedures are strengthened to enhance and secure data accuracy of the national inventories by verifying the original sources of the data (see Chapter Ⅰ, Section 1.4 for QA/QC and Verification).

12) The ROK designates statistics agencies through a specific procedure based on Article 15 of the *Statistics Act* (1962.01), to promote the production, dissemination, and use of statistics. These agencies are tasked with compiling numerical information used for government policy development and evaluation, as well as for research and analysis of economic and social phenomena.

<Table Ⅰ-3> Summary of Data Sources

Sector	Data and Statistics	Statistics Agency
Energy	Yearbook of Energy Statistics	Korea Energy Economics Institute
	Oil Supply Statistics	Korea National Oil Corporation
	Energy Census	Ministry of Trade, Industry and Energy
	Reports under Emissions Trading System (K-ETS) and Target Management System (TMS)	Ministry of Environment
	Aviation fuel consumption	Korea Transportation Safety Authority
	Number of takeoffs and landings per aircraft type	Korea Transportation Safety Authority
	Urea water sales	Ministry of Environment Transportation Environment Division
	Lubricants Industry Resources	Korea Lubricating Oil Industries Association
	Ship LNG supply	LNG suppliers
	Number of mines closed by year	Korea Mine Rehabilitation and Mineral Resources Corporation
IPPU	Volume of glass production, shipments, inventory, imports, exports	Korea Energy Agency
	Import and export statistics	Korea Customs Service
	Reports under Target Management System (TMS) and Emissions Trading System (K-ETS)	Ministry of Environment
	Company-specific survey on activity data in mineral and chemical sectors	Korea Energy Agency
	Clinker production	Korea Cement Association
	Lime production	Korea Limestone Industry Cooperation
	Bottle glass production	Korea Glass Industry Cooperative
	Limestone, dolomite consumption	Korea Iron & Steel Association
	Aluminium production	Korea Nonferrous Metal Association
	Volume of lubricants and grease production, imports and exports	Korea Lubricating Oil Industries Association
	Gas consumption	Korea Semiconductor Industry Association
	Gas consumption	Korea Display Industry Association
	Reports on manufacturing and import volume of pharmaceuticals	Ministry of Food and Drug Safety
	Petrochemical Statistics	Korea Chemical Industry Association
	CDM monitoring reports	UNFCCC
	Yearbook of Energy Statistics	Korea Energy Economics Institute

Sector	Data and Statistics	Statistics Agency
Agriculture	Livestock Statistics	Statistics Korea
	Statistical Yearbook of Agriculture, Food and Rural Affairs	Ministry of Agriculture, Food and Rural Affairs/Statistics Korea
	Annual Agriculture, Forestry and Fisheries Survey	Statistics Korea
	Agricultural Area Statistics	Statistics Korea
	Census of Agriculture, Forestry and Fisheries	Statistics Korea
	Crop Production Survey	Statistics Korea
	Agricultural and livestock production cost survey	Statistics Korea
	Fertilizer Use Statistics Yearbook	NONGHYUP Agribusiness Group
	Fertilizer Yearbook	Korea Fertilizer Industry Association
LULUCF	Statistical Yearbook of Forestry	Korea Forest Service
	Basic Forest Statistics	Korea Forest Service
	Market Survey of Timber Products	Korea Forest Service
	Agricultural Area Statistics	Statistics Korea
	Research on Development of Fruit Farming (1992)	Rural Development Administration
	Soil Classification and Explanation of ROK (2011)	Rural Development Administration
	Cadastral Statistics	Ministry of Land, Infrastructure and Transport
	Number of ice cover days	Korea Meteorological Administration
	National Blue Carbon Inventory System (K-BIS)	Ministry of Oceans and Fisheries
Waste	National Waste Generation and Treatment Report	Ministry of Environment
	National Waste Management Survey	Ministry of Environment
	Sewer Statistics	Ministry of Environment
	Generation and treatment of industrial wastewater	Ministry of Environment
	Sudokwon Landfill Statistics Yearbook	Sudokwon Landfill Site Management Corporation

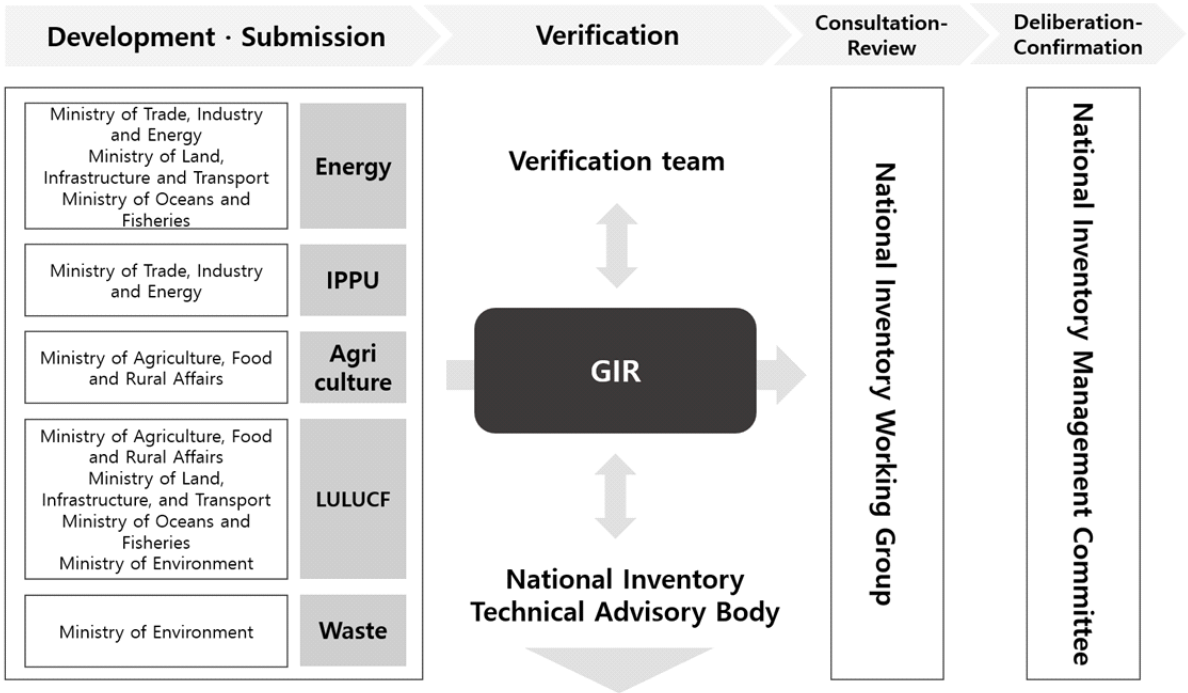
※ National Statistics in shaded cells ( )

1.3.3 Country-Specific Emission/Removal Factors (CS EF/RFs)

To improve accuracy and robustness of national GHG inventories, the government establishes the Master Plan, which includes a national plan for developing CS EF/RFs. The GIR also establishes the Guidelines for Developing and Verifying National Greenhouse Gas emission/removal factors (CS EF/RFs Guidelines) to systematically develop, verify, and manage the ROK's CS EF/RFs.

In accordance with the CS EF/RFs Guidelines, the competent authorities develop factors that reflect the characteristics of emission by sources and removal by sinks, considering domestic circumstances. The calculation methods used for CS EF/RFs development include methodologies presented by the IPCC, methodologies in line with the MRV guidelines for K-ETS and TMS, and academically recognized methodologies (such as those published in SCI (E)-indexed journals).

The CS EF/RFs developed by the designated agencies are verified by the GIR, and then finalized and published after consultation and review by the Working Group and deliberation by the Management Committee. The finalized national emission/removal factors are ultimately incorporated into revisions of the MRV guidelines and used as the basic data for national inventories.



[Figure Ⅰ-3] Process for the Development of National GHG Emission and Removal factors

1.4 Quality Assurance and Quality Control (QA/QC)

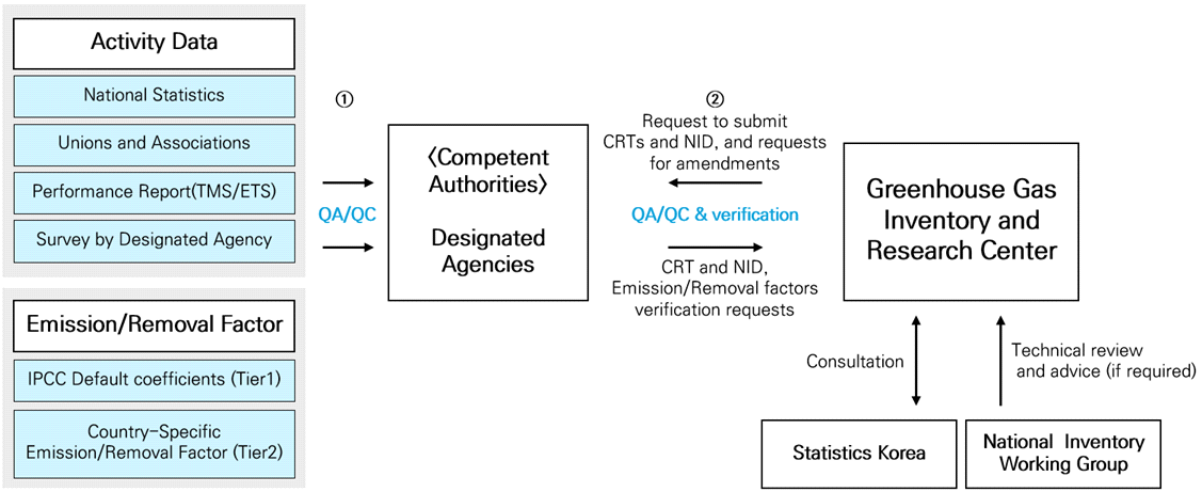
1.4.1 Procedure of QA/QC

To ensure and enhance the transparency, accuracy, consistency, completeness, and comparability of the national GHG inventory, the ROK implements QA/QC procedures in accordance with the 2006 IPCC Guidelines.

The competent authorities, designated agencies and external experts conduct QA/QC activities as per general and sector-specific procedures.

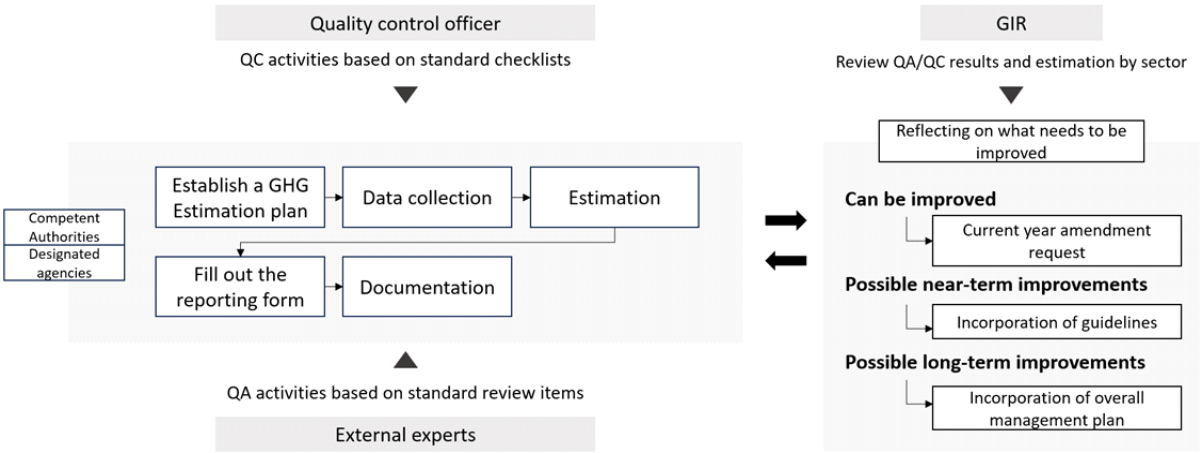
The general QC procedures involve technical elements that must be examined to ensure the accuracy of emission estimates such as activity data, emission and removal factors and methodologies. Sector-specific QC criteria include elements specifically needed for estimation of emissions from each sub-sector.

The general QA procedures include elements that need to be reviewed in general during the planning, estimation and reporting processes of sectoral emissions. External experts who did not participate in estimation of emissions and removals conducted general QA activities to verify the appropriateness of activity data, compliance of emission and removal factors as well as methodologies with relevant guidelines, and the time series consistency of activity data and emission and removal estimates.



[Figure Ⅰ-4] Framework for QA/QC in National GHG Inventory

The competent authorities and designated agencies subsequently report the results of their independently performed QA/QC activities to the GIR. The GIR reviews the QA/QC reports and the sectoral emissions and removals submitted, verifying the accuracy of the emissions estimates to improve the quality of the national inventory. Furthermore, among the areas of improvement identified during QA/QC procedures and verification, those that can be addressed immediately are implemented in the current year, while those that can be improved in the short-term are reflected in the following year's MRV guidelines, and those requiring long-term improvement are incorporated into the five-year rolling Master Plan. This process ensures continuous improvement in the quality of the national GHG inventory.



[Figure Ⅰ-5] QA/QC Procedure

To ensure the accuracy of the national inventory, all activity data, emission/removal factors, and emission/removal estimates must undergo the QA/QC and verification procedures mentioned above. In particular, for national statistics under the *Statistics Act* (1962.01) and CS EF/RFs, more detailed QA/QC and verification procedures are implemented to further enhance the accuracy of the inventory. The detailed information is as follows.

1.4.2 QA/QC of National Statistics

A significant portion of the activity data used for estimating the national GHG inventory is from national statistics. National statistics refer to data that has been approved by, or has undergone consultation with, the Commissioner of Statistics Korea Pursuant to Articles 18 or 20 of the *Statistics Act* (1962.01). Statistics agencies are required to consult with the Commissioner and obtain approval when creating new statistics or when making modifications to or discontinuing existing statistics.[13)]

Statistics Korea systematically manages the quality of national statistics through three types of evaluations and consultations. First, the regular assessments which are conducted on key statistics identified in the *five-year National Statistical Quality Management Plan*. A team of experts is assembled to perform basic assessments based on statistical information reports submitted by statistics agencies, along with in-depth and specialized evaluations (e.g., data collection systems, questionnaire design, sampling design) to assess the quality of the statistics. Second, the ad hoc assessment which are conducted following the regular evaluation process for statistics where quality issues have been identified, with additional detailed assessments addressing specific statistical concerns. Third, the self-assessment which promote internal quality improvement by encouraging statistics agencies to evaluate their own statistics through responses to questionnaires and checks of quality-related matters. In addition, consultation and technical assistance for quality improvement are provided upon request from statistics agencies, especially when agencies face challenges in improving quality independently due to limited statistical expertise or budget constraints.

<Table Ⅰ-4> Quality Management System for Official Statistics

	Regular assessment	Ad hoc assessment	Self-assessment	Consulting
Mandate	Article 9, *Statistics Act*	Article 10, *Statistics Act*	Article 11, *Statistics Act*	Article 13, *Statistics Act*
Scope	Major Statistics[1)]	Statistics subject to improvement[2)]	National Statistics[3)]	Statistics upon request
Interval	5 years	As needed	1 year	As needed
Entity	Statistics Korea	Statistics Korea	Statistics agencies	Statistics Korea

Note: 1) Statistics extensively utilized for the formulation and evaluation of government policies or for the production of other statistical data
2) Statistics for which quality issues have been identified through continuous monitoring (e.g., external critiques by the media) or planned monitoring (e.g., self-diagnosed statistics with low evaluation scores)
3) Excluding subject to regular or ad hoc assessment, statistics of local governments, and unpublished statistics in the relevant year

13) Source: Fundamental Principles of Official Statistics (UN, 2014)

1.4.3 QA/QC and Verification for Country-specific Emission/Removal Factors (CS-EF/RFs)

The competent authorities develop CS-EF/RFs for their respective sectors and submit them to the GIR after conducting a self-assessment using a standard verification procedure based on a checklist of indicators. The GIR then forms a verification team, comprising both internal and external experts, along with a technical advisory body primarily composed of external experts, to assess the appropriateness, representativeness, and accuracy of the measurement and analysis methods used in the emission/removal factor development submitted by the competent authorities. Afterward, the verified emission/removal factors are finalized and announced after consultation and review by the Working Group and subsequent deliberation by the Management Committee.

The GIR considers six major verification criteria and fourteen verification elements during the development and verification process of emission/removal factors. The methodology and representativeness of the factors are verified by confirming whether appropriate methodologies outlined by the IPCC were used in their development, and whether sample target groups were selected appropriately, considering factors such as emission/removal ratios and production ratios. The accuracy of measurement and analysis is confirmed by verifying whether the selected methodologies account for emission/removal characteristics, and whether extreme values or missing values in raw data were appropriately addressed. The validation of factors through QA/QC procedures, as well as uncertainty assessments, is also a critical element reviewed during the factor development and verification process. Following these verifications, the factors are discussed in the Working Group with input from relevant ministries, and are then deliberated and finalized by the Management Committee. The finalized CS-EF/RFs are ultimately incorporated into the revision of MRV guidelines, serving as fundamental data for national GHG inventory.

<Table Ⅰ-5> Verification Criteria for National GHG Emission/Removal Factors

Criteria	Elements
Methodology	① Consistency with national and international (IPCC) emission/removal estimation guidelines
	② Appropriateness of methodology for developing emission/removal factors
	③ Consideration of emission/removal characteristics
Representativeness	④ Appropriateness of sample target group
	⑤ Adequacy of sample size
Accuracy	⑥ Appropriateness of measurement/analysis type and methodology
	⑦ Reliability of measurement/analysis entities
	⑧ Reliability of measurement/analysis tools
Data Management	⑨ Appropriateness of data management
	⑩ Consistency of time ranges between factor development data
QA / QC	⑪ Adequacy of QA/QC activities
	⑫ Factor equivalence evaluation
Uncertainty assessment	⑬ Appropriateness of uncertainty estimation methods
	⑭ Uncertainty assessment

Source: Guidelines for Development, Verification, and Management of Greenhouse Gas Emission and Removal Factors (Greenhouse Gas Inventory and Research Center, 2020)

1.5 Metrics

The contribution of each GHG to global warming varies depending on factors such as how long it stays in the atmosphere and how much heat it absorbs. To compare and evaluate the emissions of different GHGs, the international community uses the carbon dioxide equivalent (CO_2-eq). The CO_2-eq is calculated using the GWP of each greenhouse gas. The GWP values are applied based on the IPCC assessment reports. The first BTR uses the 100-year GWP values presented in the IPCC Fifth Assessment Report, in accordance with paragraph 37 of the MPGs.

<Table Ⅰ-6> Global Warming Potential

Gas	Chemical formula	GWP100
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	N_2O	265
Hydrofluorocarbons		
HFC-23	CHF_3	12,400
HFC-32	CH_2F_2	677
HFC-41	CH_3F	116
HFC-125	CHF_2CF_3	3,170
HFC-134	CHF_2CHF_2	1,120
HFC-134a	CH_2FCF_3	1,300
HFC-143	CH_2FCHF_2	328
HFC-143a	CH_3CF_3	4,800
HFC-152	CH_2FCH_2F	16
HFC-152a	CH_3CHF_2	138
HFC-161	CH_3CH_2F	4
HFC-227ea	CF_3CHFCF_3	3,350
HFC-236cb	$CH_2FCF_2CF_3$	1,210

Gas	Chemical formula	GWP100
HFC-236ea	CHF_2CHFCF_3	1,330
HFC-236fa	$CF_3CH_2CF_3$	8,060
HFC-245ca	$CH_2FCF_2CHF_2$	716
HFC-245fa	$CHF_2CH_2CF_3$	858
HFC-365mfc	$CH_3CF_2CH_2CF_3$	804
HFC-43-10mee	$CF_3CHFCHFCF_2CF_3$	1,650
Perfluorinated compounds (PFCs)		
PFC-14	CF_4	6,630
PFC-116	C_2F_6	11,100
PFC-218	C_3F_8	8,900
PFC-318	$c\text{-}C_4F_8$	9,540
PFC-31-10	C_4F_{10}	9,200
PFC-41-12	C_5F_{12}	8,550
PFC-51-14	C_6F_{14}	7,910
PCF-91-18	$C_{10}F_{18}$	7,190
Trifluoromethyl sulfur pentafluoride	SF_5CF_3	17,400
Perfluorocyclopropane	$c\text{-}C_3F_6$	9,200
Sulfur hexafluoride	SF_6	23,500
Nitrogen trifluoride	NF_3	16,100

2. Trends in National GHG Inventory

2.1 Trends in National GHG Emissions and Removals

2.1.1 Introduction

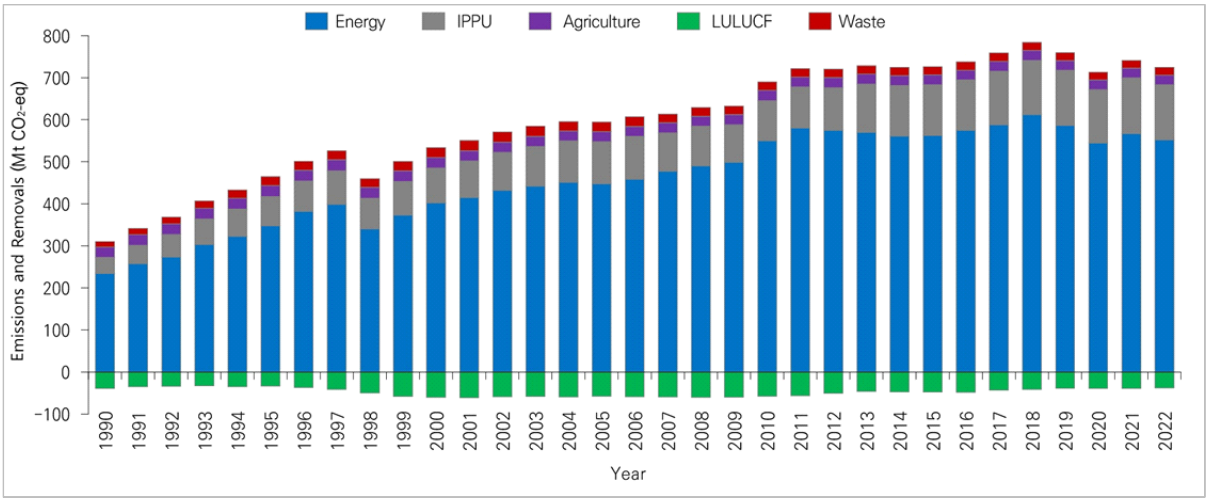
The ROK's total GHG emissions in 2022 (excluding LULUCF)[14] were 724.3 $MtCO_2$-eq, indicating a 133.2% (413.7 $MtCO_2$-eq) increase from 310.6 $MtCO_2$-eq in 1990, but a 2.3% (16.7 $MtCO_2$-eq) decrease from 741.0 $MtCO_2$-eq in 2021, and a 7.6% (59.6 $MtCO_2$-eq) decrease from the emission peak in 2018.

The net GHG emissions in 2022 (including LULUCF)[15] were 686.5 $MtCO_2$-eq, showing a 152.7% (414.8 $MtCO_2$-eq) increase from 271.6 $MtCO_2$-eq in 1990, but a 2.2% (15.5 $MtCO_2$-eq) decrease from 702.0 $MtCO_2$-eq in 2021, and a 7.5% (55.8 $MtCO_2$-eq) decrease from 742.3 $MtCO_2$-eq in 2018.

National total emissions generally followed an increasing trend during the 1990s due to economic growth. However, the rate of increase gradually slowed after the 2000s, and emissions began to decline after reaching their peak in 2018. There were temporary sharp decreases in emissions due to the 1998 financial crisis, the 2008 economic recession, and the COVID-19 pandemic in 2020. In 1998, GHG emissions decreased by 12.5% compared to the previous year due to the financial crisis, followed by an increasing trend with an average annual growth rate of 2.6% from 1999 to 2008. However, in 2009, the year-on-year increase was limited to 0.6% due to the economic recession. In 2020, emissions decreased by 6.1% compared to the previous year as a result of the COVID-19 pandemic.

By sector, energy was accounted for the largest share of total emissions in 2022 at 76.2%, followed by IPPU at 18.1%, agriculture at 3.2%, and waste at 2.5%. Notably, due to the manufacturing-centered industrial structure, the energy sector has consistently maintained a share of 74-80% since 1990.

14) Total emissions are the sum of emissions from the energy, IPPU, agriculture, and waste sectors, excluding the LULUCF sector. For the analysis of the country's total emissions share, and growth rate in this report, total emissions excluding the LULUCF sector are used.
15) Net emissions are the sum of emissions from all sectors (energy, IPPU, agriculture, waste, and LULUCF), including both emission sources and carbon sinks in the LULUCF sector.



[Figure Ⅰ-6] GHG Emissions and Removals by Sector (1990-2022)

<Table Ⅰ-7> GHG Emissions and Change Rate by Sector

(Unit: $MtCO_2$-eq)

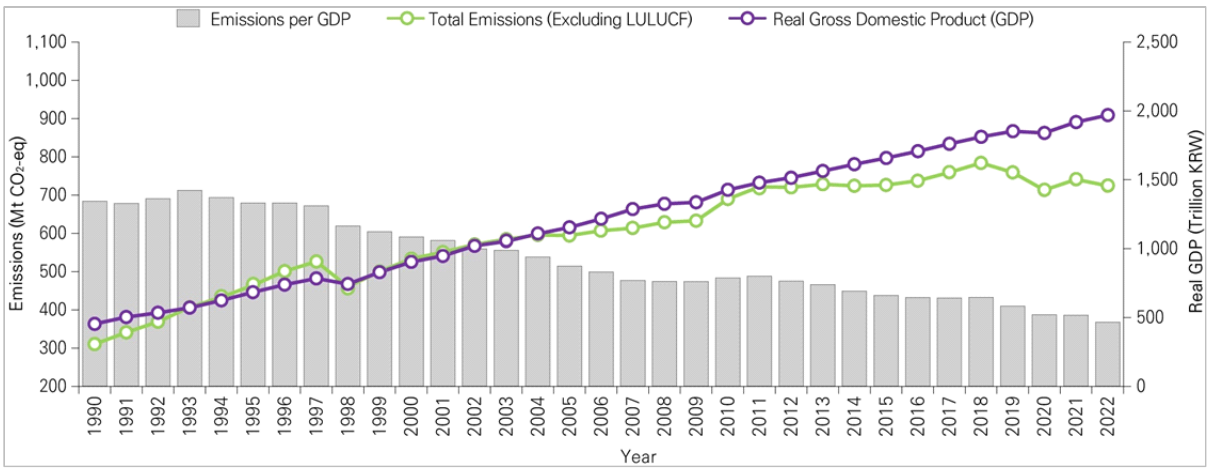
Sector		1990	2000	2010	2018	2020	2021	2022	Change Rate (%)	
									Compared to 1990	Compared to previous year
Energy	Emission	234.5	402.2	550.3	612.1	544.6	566.8	551.9	135.4	-2.6
	Share (%)	75.5	75.4	79.8	78.1	76.4	76.5	76.2		
IPPU	Emission	37.8	83.1	95.0	128.9	126.8	132.8	131.3	247.3	-1.1
	Share (%)	12.2	15.6	13.8	16.4	17.8	17.9	18.1		
Agriculture	Emission	24.9	24.7	24.7	23.5	23.1	23.1	23.0	-7.7	-0.5
	Share (%)	8.0	4.6	3.6	3.0	3.2	3.1	3.2		
LULUCF	Emission	-39.0	-60.4	-57.4	-41.6	-38.8	-39.0	-37.8	-*	-*
Waste	Emission	13.4	23.4	19.7	19.4	18.5	18.3	18.2	35.3	-0.8
	Share (%)	4.3	4.4	2.9	2.5	2.6	2.5	2.5		
Total Emissions (excluding LULUCF)	Emission	310.6	533.5	689.8	783.9	713.0	741.0	724.3	133.2	-2.3
	Share (%)	100	100	100	100	100	100	100		
Net Emissions (including LULUCF)	Emission	271.6	473.1	632.4	742.3	674.1	702.0	686.5	152.7	-2.2

* For the LULUCF sector, the change rate is not presented.

2.1.2 Total GHG Emissions per Unit of Real Gross Domestic Product (GDP)

The GHG emissions intensity (emissions per unit of GDP) in 2022 was 367.9 tCO_2-eq/billion won, showing a 46.2% decrease from 683.9 tCO_2-eq/billion won in 1990, and a 4.7% decrease from 386.2 tCO_2-eq/billion won in 2021.

The ROK's GHG emissions intensity has shown a gradual declining trend, and after reaching peak emissions in 2018, a decoupling[16] phenomenon was observed, where GDP increased while emissions decreased. In the 1990s, both GDP growth rate and total GHG emissions growth rate showed similar increases of 5-10%. Beginning in the 2000s, weak decoupling started to manifest as the emissions growth rate (2000-2009 annual average growth rate of 1.9%) became lower than the GDP growth rate (2000-2009 annual average growth rate of 4.4%). After 2010, as the average annual economic growth rate settled into the 2-3% range (2010-2017), the average annual growth rate of total emissions slowed to 1.4%. Absolute decoupling was achieved after 2018, when the total emissions growth rate became negative (-3.1%). However, phenomena of simultaneous sharp increases in both GDP and emissions were observed temporarily during recovery periods following the 1998 financial crisis (1998-1999), the 2008 economic recession (2010-2011), and the COVID-19 pandemic (2020-2021).



[Figure Ⅰ-7] Total GHG Emissions per Real Gross Domestic Product (1990-2022)

<Table Ⅰ-8> Total GHG Emissions per Real Gross Domestic Product

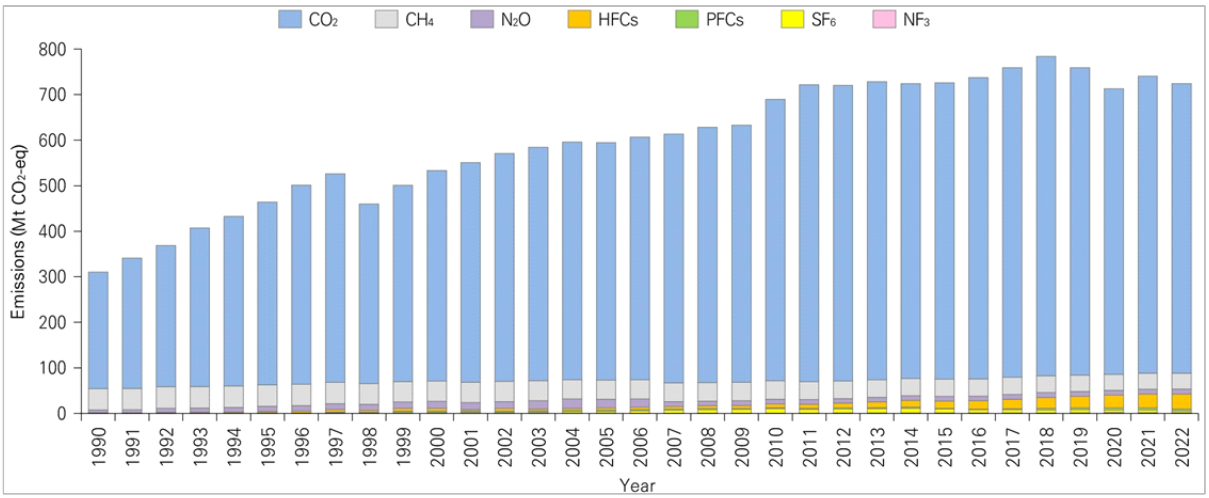
	1990	2000	2010	2018	2020	2021	2022
Total Emissions ($MtCO_2$-eq)	310.6	533.5	689.8	783.9	713.0	741.0	724.3
GDP* (Trillion KRW)	454	904	1,427	1,812	1,840	1,919	1,969
Total Emission per GDP (tCO_2-eq/1 Billion KRW)	683.9	590.4	483.5	432.6	387.6	386.2	367.9

* Source: National Accounts, GDP and GNI by Economic Activity (Real, 2015 Basis) (Bank of Korea, 2023)

16) GHG decoupling refers to the phenomenon where the paths of GHG emissions and economic growth become separated.

2.2 Trends in GHG Emissions and Removals

Among the GHGs, CO_2 accounts for the largest share at 87.8% of total emissions in 2022, followed by fluorinated gases at 5.9% (HFCs 4.5%, PFCs 0.56%, SF_6 0.55%, NF_3 0.2%), CH_4 at 4.9%, and N_2O at 1.5%.



[Figure Ⅰ-8] GHG Emissions by Gas (1990-2022)

<Table Ⅰ-9> GHG Emissions and Change Rate by Gas

(Unit: $MtCO_2$-eq)

GHG		1990	2000	2010	2018	2020	2021	2022	Growth Rate (%)	
									Compared to 1990	Compared to previous year
CO_2	Emission	256.2	462.6	618.0	701.1	626.7	652.5	635.8	148.2	-2.6
	Share (%)	82.5	86.7	89.6	89.4	87.9	88.1	87.8		
CH_4	Emission	46.8	44.6	40.6	37.2	35.6	35.3	35.2	-24.9	-0.5
	Share (%)	15.1	8.4	5.9	4.7	5.0	4.8	4.9		
N_2O	Emission	6.3	14.9	10.6	10.9	10.7	10.8	10.7	68.9	-0.9
	Share (%)	2.0	2.8	1.5	1.4	1.5	1.5	1.5		
HFCs	Emission	1.0	6.0	7.6	23.6	27.9	30.3	32.9	3,062.5	8.8
	Share (%)	0.3	1.1	1.1	3.0	3.9	4.1	4.5		
PFCs	Emission	IE,NE,NO	2.5	2.5	3.9	4.5	4.7	4.1	116.6[1)]	-14.4
	Share (%)	-	0.5	0.4	0.5	0.6	0.6	0.6		
SF_6	Emission	0.2	2.8	10.0	6.3	5.4	5.5	4.0	2,243.3	-28.4
	Share (%)	0.1	0.5	1.4	0.8	0.8	0.7	0.5		
NF_3	Emission	IE,NO	IE,NO	0.4	1.0	2.1	1.8	1.7	359.7[2)]	-7.7
	Share (%)	-	-	0.1	0.1	0.3	0.2	0.2		
Total Emission (excluding LULUCF)		310.6	534.0	689.8	783.9	713.0	741.0	724.3	133.2	-2.3
p%		100	100	100	100	100	100	100		

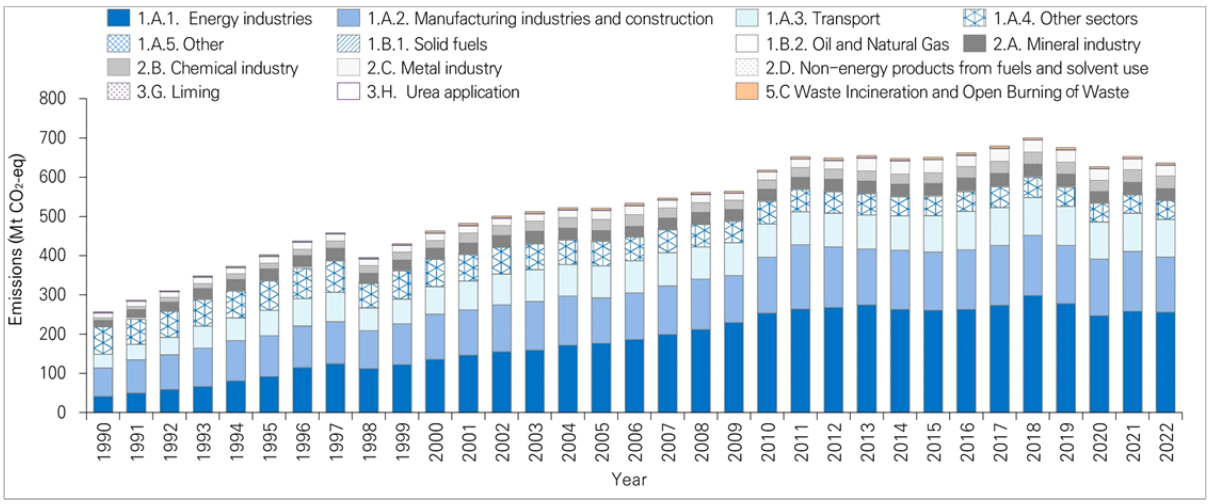
Note: 1) The growth rate for PFCs is calculated based on the year 1997, when the first inventory was estimated.
2) The growth rate for NF_3 is calculated based on the year 2008, when the first inventory was estimated.

While GHG including CO_2 show an overall increasing trend, CH_4 emissions have consistently decreased since 1990 due to reduced coal production in the energy sector and decreased rice cultivation area in the agriculture sector. Meanwhile, fluorinated gases show high growth rates in 2022 compared to 1990, primarily due to increased use of HFCs as refrigerants in refrigeration and air conditioning equipment, and increased use of PFCs, SF_6, and NF_3 in semiconductor and display manufacturing processes.

2.2.1 Carbon Dioxide (CO_2)

Total CO_2 emissions in 2022 (excluding LULUCF) were 635.8 $MtCO_2$-eq, accounting for 87.8% of total national GHG emissions (excluding LULUCF). This represents a 148.2% increase compared to 256.2 $MtCO_2$-eq in 1990, and a 2.6% decrease compared to 652.5 $MtCO_2$-eq in 2021.

The 2022 CO_2 emission (excluding LULUCF) was highest in the energy sector at 85.5%, followed by IPPU sector at 13.9%, waste sector at 0.7%, and agriculture sector at 0.01%.



[Figure Ⅰ-9] CO_2 Emissions and Removal by Sector (1990-2022)

<Table Ⅰ-10> CO_2 Emissions and Removals by Sector

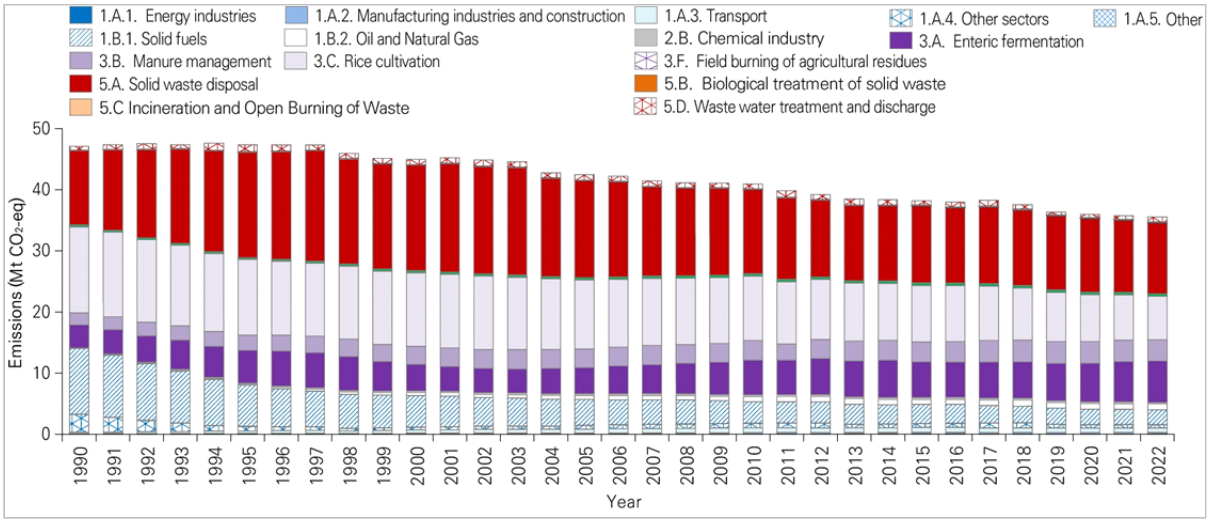
(Unit: $MtCO_2$-eq)

Sector		1990	2000	2010	2018	2020	2021	2022
1. Energy	1.A.1. Energy industries	41.9	135.8	253.7	298.5	247.0	258.7	256.2
	1.A.2. Manufacturing industries and construction	71.9	115.0	142.2	152.8	144.2	152.2	140.3
	1.A.3. Transport	35.6	70.1	84.5	96.4	94.4	97.1	96.1
	1.A.4. Other sectors	69.3	69.7	57.9	52.0	47.5	47.2	47.7
	1.A.5. Other	0.2	2.4	3.0	3.1	2.9	2.9	3.0
	1.B.1. Solid fuels	0.19	0.05	0.02	0.01	0.01	0.01	0.01
	1.B.2. Oil and Natural Gas	<0.001	<0.001	0.027	0.016	0.010	0.004	0.002
2. IPPU	2.A. Mineral industry	16.4	26.1	28.3	30.5	28.0	29.0	28.4
	2.B. Chemical industry	6.3	20.1	23.6	30.6	28.4	32.1	31.3
	2.C. Metal industry	13.1	18.5	20.3	31.6	29.1	28.0	27.8
	2.D. Non-energy products from fuels and solvent use	0.36	0.51	0.55	0.60	0.55	0.57	0.61
3. Agriculture	3.G. Liming	0.003	0.003	0.003	0.003	0.003	0.002	0.002
	3.H. Urea application	0.43	0.28	0.12	0.12	0.11	0.11	0.09
5. Waste	5.C. Incineration and open burning of waste	0.5	4.2	3.8	4.8	4.5	4.5	4.3
Total CO_2 emissions (excluding LULUCF)		256.2	462.6	618.0	701.1	626.7	652.5	635.8

2.2.2 Methane (CH_4)

Total CH_4 emissions in 2022 (excluding LULUCF) were 35.2 $MtCO_2$-eq accounting for 4.9% of total national GHG emissions (excluding LULUCF). This demonstrates a 24.9% decrease compared to 46.8 $MtCO_2$-eq in 1990, and a 0.5% decrease compared to the previous year (35.3 $MtCO_2$-eq). CH_4 emissions have shown a continuous decreasing trend due to reduced rice cultivation area and decreased the amount of waste disposed.

CH_4 emissions in 2022 (excluding LULUCF) was highest in the agriculture sector at 49.4%, followed by the waste sector at 35.7%, energy sector at 14.1%, and IPPU sector at 0.7%.



[Figure Ⅰ-10] CH_4 Emissions by Sector (1990-2022)

<Table Ⅰ-11> CH_4 Emissions by Sector

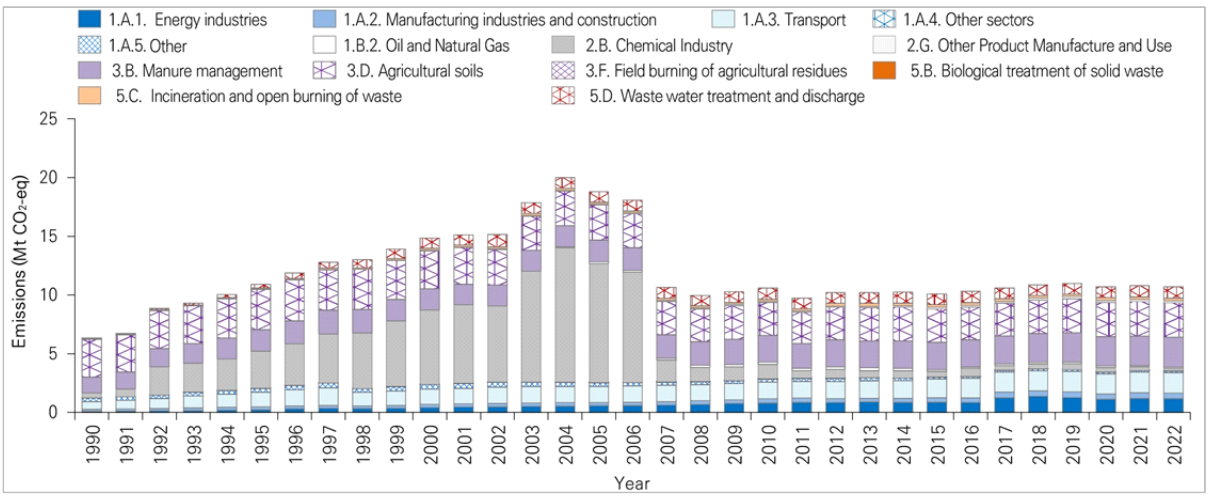
(Unit: $MtCO_2$-eq)

Sector		1990	2000	2010	2018	2020	2021	2022
1. Energy	1.A.1. Energy industries	0.03	0.06	0.10	0.07	0.07	0.08	0.09
	1.A.2. Manufacturing industries and construction	0.08	0.15	0.20	0.23	0.22	0.24	0.23
	1.A.3. Transport	0.20	0.51	0.76	0.72	0.67	0.68	0.68
	1.A.4. Other sectors	2.98	0.43	0.73	0.84	0.60	0.59	0.57
	1.A.5. Other	<0.001	0.009	0.011	0.012	0.011	0.011	0.011
	1.B.1. Solid fuels	10.7	5.2	3.5	2.7	2.6	2.5	2.4
	1.B.2. Oil and Natural Gas	0.1	0.5	0.8	1.0	0.9	0.9	1.0
2. IPPU	2.B. Chemical Industry	0.05	0.28	0.31	0.35	0.29	0.32	0.25
3. Agriculture	3.A. Enteric fermentation	3.8	4.3	5.6	6.0	6.3	6.6	6.7
	3.B. Manure management	2.0	2.9	3.2	3.5	3.5	3.5	3.5
	3.C. Rice cultivation	14.1	12.0	10.6	8.5	7.7	7.4	7.1
	3.F. Field burning of agricultural residues	0.04	0.05	0.04	0.03	0.03	0.03	0.02
5. Waste	5.A. Solid waste disposal	12.1	17.3	13.8	12.3	12.0	11.8	11.6
	5.B. Biological treatment of solid waste	NE	0.005	0.02	0.11	0.13	0.13	0.11
	5.C. Incineration and open burning of waste	<0.001	0.002	0.002	0.002	0.002	0.002	0.002
	5.D. Waste water treatment and discharge	0.7	0.9	0.9	0.8	0.6	0.6	0.9
Total CH_4 emissions (excluding LULUCF)		46.8	44.6	40.6	37.2	35.6	35.3	35.2

2.2.3 Nitrous Oxide (N_2O)

Total N_2O emissions in 2022 (excluding LULUCF) were 10.7 $MtCO_2$-eq, accounting for 1.5% of total national GHG emissions (excluding LULUCF). This represents a 68.9% increase compared to 6.3 $MtCO_2$-eq in 1990, and a 0.9% decrease from 10.8 $MtCO_2$-eq in 2021. Emissions decreased significantly following the implementation of N_2O abatement by destruction in adipic acid and nitric acid production plants in the latter half of 2006.

Total N_2O emissions in 2022 (excluding LULUCF) was highest in the agriculture sector at 51.3%, followed by the energy sector at 33.1%, waste sector at 12.7%, and IPPU sector at 2.8%.



[Figure Ⅰ-11] N_2O Emissions by Sector (1990-2022)

<Table Ⅰ-12> N_2O Emissions by Sector

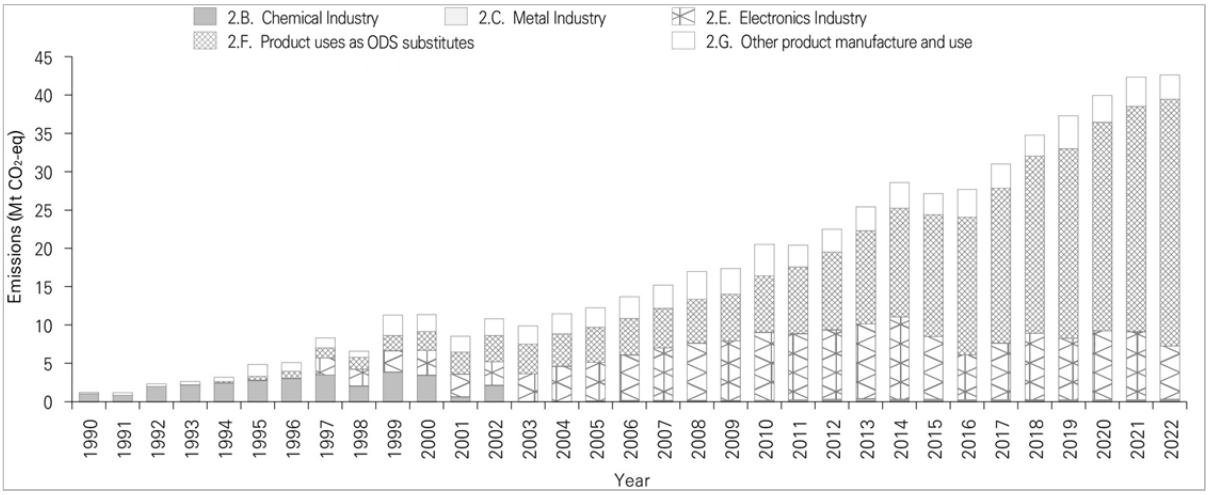
(Unit: $MtCO_2$-eq)

Sector		1990	2000	2010	2018	2020	2021	2022
1. Energy	1.A.1. Energy industries	0.1	0.4	0.8	1.4	1.1	1.2	1.2
	1.A.2. Manufacturing industries and construction	0.2	0.3	0.3	0.5	0.5	0.5	0.5
	1.A.3. Transport	0.6	1.3	1.4	1.7	1.7	1.7	1.7
	1.A.4. Other sectors	0.3	0.4	0.3	0.2	0.2	0.2	0.2
	1.A.5. Other	<0.001	0.005	0.006	0.007	0.006	0.006	0.006
	1.B.2. Oil and Natural Gas	NA,NO	NA,NO	<0.001	<0.001	<0.001	<0.001	<0.001
2. IPPU	2.B. Chemical Industry	0.4	6.3	1.2	0.4	0.4	0.3	0.2
	2.G. Other Product Manufacture and Use	NE,NO	NE,NO	0.20	0.13	0.13	0.10	0.10
3. Agriculture	3.B. Manure management	1.3	1.8	2.3	2.4	2.5	2.5	2.6
	3.D. Agricultural soils	3.2	3.3	2.8	2.8	2.9	3.0	2.9
	3.F. Field burning of agricultural residues	0.011	0.012	0.010	0.008	0.008	0.007	0.005
5. Waste	5.B. Biological treatment of solid waste	NE,NO	0.03	0.07	0.17	0.16	0.17	0.17
	5.C. Incineration and open burning of waste	0.03	0.16	0.19	0.22	0.23	0.22	0.22
	5.D. Waste water treatment and discharge	0.05	0.88	0.96	0.91	0.93	0.97	0.97
Total N_2O emissions (excluding LULUCF)		6.3	14.9	10.6	10.9	10.7	10.8	10.7

2.2.4 Fluorinated Gas (HFCs, PFCs, SF_6, and NF_3)

Fluorinated gas (HFCs, PFCs, SF_6, and NF_3) are emitted entirely from IPPU sector. Total GHG emissions in 2022 (excluding LULUCF) were 42.6 $MtCO_2$-eq, accounting for 5.9% of total national GHG emissions (excluding LULUCF). This indicates a 3,420.7% increase compared to 1.2 $MtCO_2$-eq in 1990, and a 0.6% increase from 42.4 $MtCO_2$-eq in 2021. Fluorinated gas showed an upward trend due to increased use of refrigeration and air conditioning equipment, and the production of semiconductors.

The share of fluorinated gas in the total emissions from the IPPU sector continuously increased from 3.2% in 1990 to 32.5% in 2022. Accordingly, the share of CO_2 of IPPU sector, which decreased from 95.6% in 1990 to 67.1% in 2022.



[Figure Ⅰ-12] Fluorinated Gas Emissions by Sector (1990-2022)

<Table Ⅰ-13> Fluorinated Gas Emissions by Sector

(Unit: $MtCO_2$-eq)

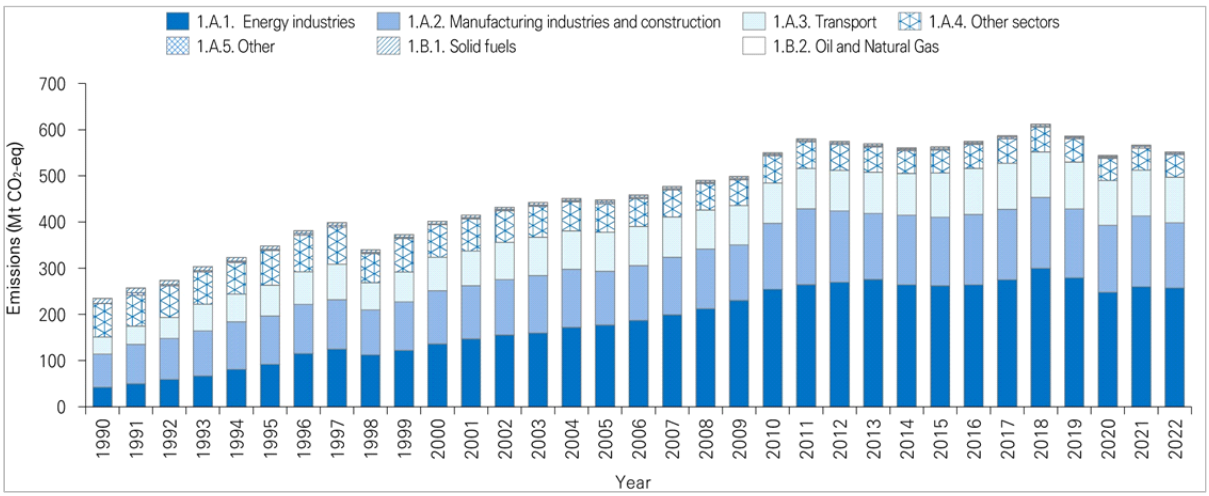
Sector		1990	2000	2010	2018	2020	2021	2022
2.IPPU	2.B. Chemical Industry	1.0	3.4	0.03	0.09	0.09	0.10	0.09
	2.C. Metal Industry	<0.001	0.02	0.10	0.15	0.17	0.15	0.20
	2.E. Electronics Industry	IE,NO	3.3	8.9	8.7	9.0	8.9	7.0
	2.F. Product uses as ODS substitutes	IE,NO	2.5	7.4	23.1	27.2	29.4	32.2
	2.G. Other Product Manufacture and Use	0.2	2.2	4.1	2.7	3.5	3.8	3.2
Total Fluorinated Gas Emissions		1.2	11.3	20.5	34.8	40.0	42.4	42.6

2.3 Trends in Emissions and Removals by Sector

2.3.1 Energy Sector

Total GHG emissions from the energy sector in 2022 were 551.9 $MtCO_2$-eq, accounting for 76.2% of total national emissions. This demonstrates a 135.4% increase compared to 1990 (234.5 $MtCO_2$-eq), but a 2.6% decrease compared to the previous year (566.8 $MtCO_2$-eq).

Emissions in the energy sector steadily increased from 1990 to 1997, but then sharply decreased in 1998 due to the economic crisis. Afterward, emissions rebounded until 2011 as the economy recovered. From then, emissions showed a slight decline until 2014, before switching to an upward trend and reaching the peak in 2018. It recovered slightly from the effects of COVID-19 pandemic in 2021, and has subsequently resumed its declining trend.



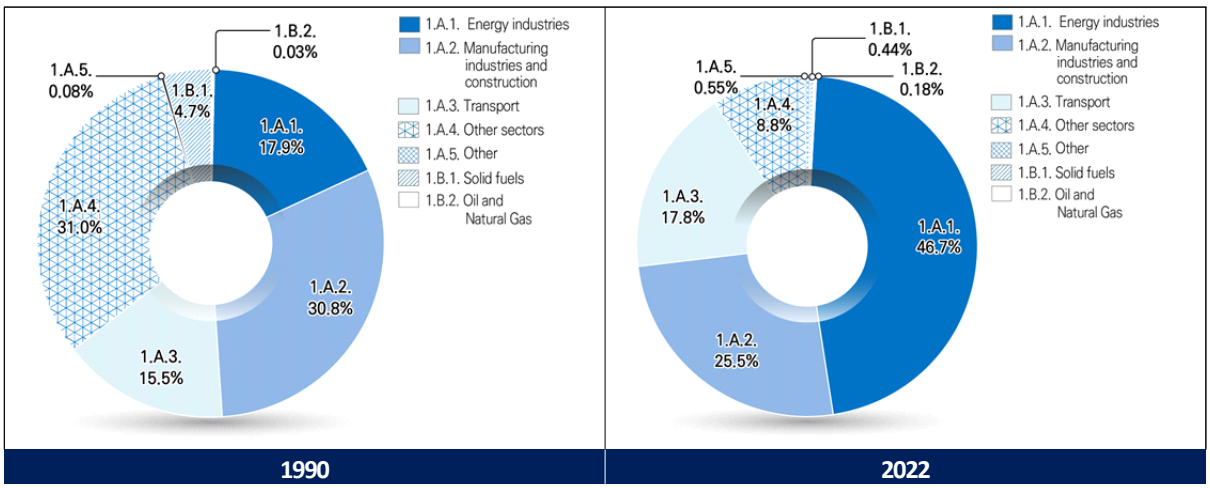
[Figure Ⅰ-13] GHG Emissions from the Energy Sector (1990-2022)

<Table Ⅰ-14> GHG Emissions from the Energy Sector

(Unit: $MtCO_2$-eq)

Category	1990	2000	2010	2018	2020	2021	2022	Growth Rate (%)	
								Compared to 1990	Compared to previous year
1.A. Fuel Combustion	223.5	396.5	545.9	608.4	541.1	563.4	548.5	145.4	-2.6
1.A.1. Energy Industries	42.0	136.3	254.6	300.0	248.2	260.0	257.5	512.7	-1.0
1.A.2. Manufacturing Industries and Construction	72.2	115.4	142.8	153.5	144.9	152.9	141.0	95.4	-7.8
1.A.3. Transport	36.5	71.9	86.7	98.8	96.8	99.5	98.5	170.2	-1.0
1.A.4. Other Sectors	72.6	70.5	58.9	53.0	48.3	48.0	48.4	-33.3	0.9
1.A.5. Other	0.2	2.4	3.0	3.1	2.9	2.9	3.0	1,561.0	3.3
1.B. Fugitive Emissions from Fuels	11.0	5.7	4.4	3.7	3.5	3.4	3.4	-69.1	-0.5
1.B.1. Solid Fuels	10.9	5.2	3.6	2.7	2.6	2.5	2.4	-77.8	-2.3
1.B.2. Oil and Natural Gas	0.1	0.5	0.9	1.0	0.9	0.9	1.0	1,456.3	4.1
Total Emissions	234.5	402.2	550.3	612.1	544.6	566.8	551.9	135.4	-2.6

In Energy sector, emissions are divided into Fuel Combustion and Fugitive Emissions from Fuels. As of 2022, Fuel Combustion is accounted for most of energy sector at 99.4% (548.5 $MtCO_2$-eq) and the proportion of Fugitive Emissions from Fuels was relatively small at 0.6% (3.4 $MtCO_2$-eq). Within the sub-sector, the share of category was: Energy Industries (46.7%), Manufacturing Industries and Construction (25.5%), Transport (17.8%), Other Sectors (8.8%), Other (0.6%), Solid Fuels (0.4%), and Oil and Natural Gas (0.2%) of the energy sector emissions.

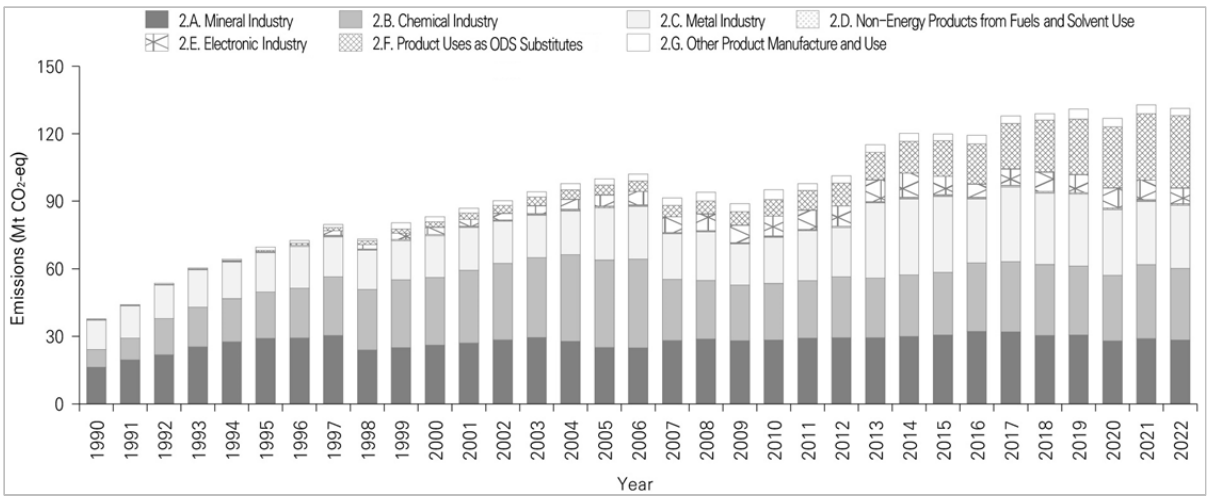


[Figure Ⅰ-14] Proportion by Categories in the Energy Sector

2.3.2 IPPU Sector

The total GHG emissions from the IPPU sector in 2022 were 131.3 $MtCO_2$-eq, accounting for 18.1% of total national emissions. In 2022, the total GHG emissions from the IPPU sector increased by 247.3% compared to 1990, but decreased by 1.1% compared to the previous year.

As of 2022, most of the sub-sectors showed decrease of emissions compared to the previous year, except for the product uses as substitutes for Ozone Depleting Substances (ODS) and non-energy products and solvent use. The emissions from the electronic industry sub-sector decreased by 21.6% (1.9 $MtCO_2$-eq) compared to the previous year due to improvement on GHG reduction efficiency of GHG emissions control technologies. Meanwhile, the emissions from the chemical industry sub-sector decreased by 3.0% (1.0 $MtCO_2$-eq) due to a reduction of raw material input for the Naphtha Cracking Center (NCC) process.



[Figure Ⅰ-15] GHG Emissions from the IPPU sector (1990-2022)

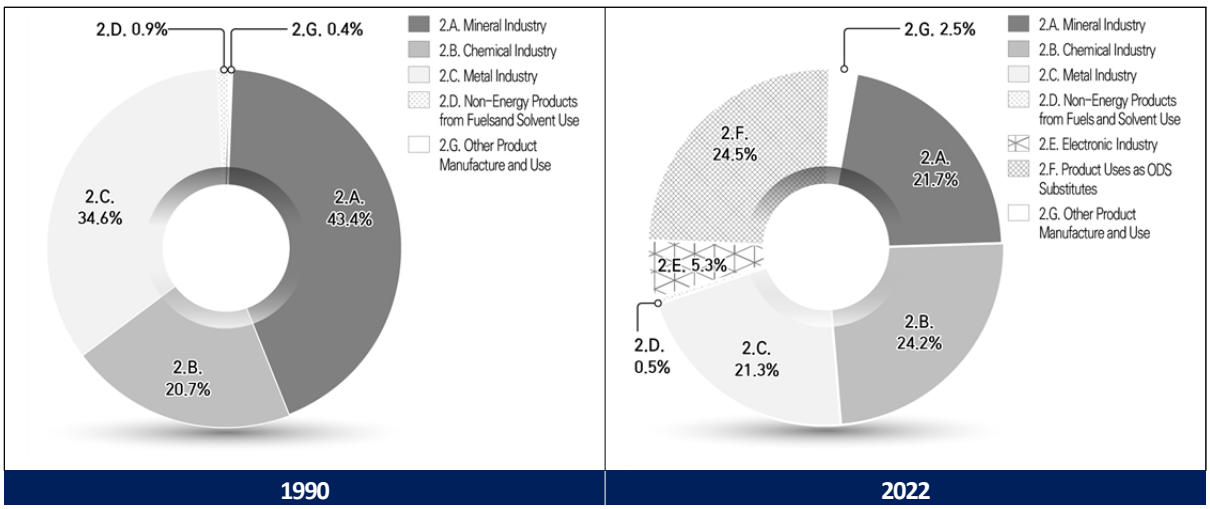
<Table Ⅰ-15> GHG Emissions from the IPPU Sector

(Unit: $MtCO_2$-eq)

Sector	1990	2000	2010	2018	2020	2021	2022	Growth Rate (%)	
								Compared to 1990	Compared to previous year
2.A. Mineral Industry	16.4	26.1	28.3	30.5	28.0	29.0	28.4	73.4	-2.0
2.B. Chemical Industry	8.9	33.5	25.1	31.4	29.1	32.8	31.8	306.9	-3.0
2.C. Metal Industry	13.1	18.5	20.5	31.7	29.3	28.2	28.0	114.1	-0.8
2.D. Non-Energy Products from Fuels and Solvent Use	0.36	0.51	0.55	0.60	0.55	0.57	0.61	72.0	7.0
2.E. Electronic Industry	IE,NA,NO	3.3	8.9	8.7	9.0	8.9	7.0	212.5*	-21.6
2.F. Product Uses as ODS Substitutes	IE,NO	2.5	7.4	23.1	27.2	29.4	32.2	2,053,154.8*	9.5
2.G. Other Product Manufacture and Use	0.2	2.2	4.3	2.9	3.7	3.9	3.3	1,835.1	-16.9
Total Emissions	37.8	83.1	95.0	128.9	126.8	132.8	131.3	247.3	-1.1

* The growth rate for the electronics industry and the product uses as ODS substitutes sub-sector were calculated based on the year 1997 and 1992 respectively, when the first inventory were estimated.

Within the IPPU sector in 2022, the share of emissions by sub-sector was as follows: Product Uses as ODS Substitutes had the largest share at 24.5%, followed by Chemical Industry at 24.2%, Mineral Industry at 21.7%, Metal Industry at 21.3%, Electronic Industry at 5.3%, Other Product Manufacture and Use at 2.5%, and Non-Energy Products from Fuels and Solvent Use at 0.5%.

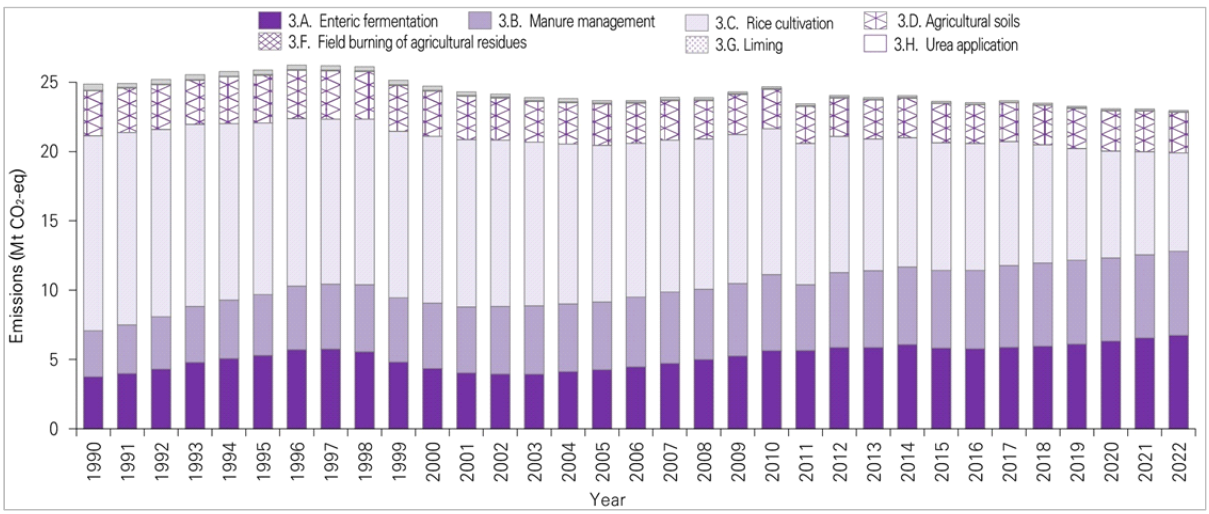


[Figure Ⅰ-16] Proportion by Categories in the IPPU Sector

The activity data sources for the IPPU sector can be broadly categorized into two periods, i.e., before and after the implementation of the TMS (2010) and the K-ETS (2015)[17]. For entities[18] initially designated under the TMS in 2010, emissions data verified by a third party have been reported since 2007. Before 2007, emissions were estimated using data from industry associations, national statistics, and other sources such as CDM reports and direct surveys conducted by the designated agencies. The significance of this lies in replacing parts of association and direct survey data with facility-level data verified by third parties to compile the national GHG inventory.

2.3.3 Agriculture Sector

In 2022, total GHG emissions from the Agriculture sector amounted to approximately 23.0 $MtCO_2$-eq, accounting for about 3.2% of national total emissions. Agricultural emissions in 2022 decreased by 7.7% compared to 1990 levels and by 0.5% compared to the previous year.



[Figure Ⅰ-17] GHG Emissions from the Agriculture Sector (1990-2022)

17) *Act on the Allocation and Trading of Greenhouse Gas Emissions Allowances* (May 2012)

18) The facilities initially designated under the TMS in 2010 have been reporting their emissions since 2007 based on the most recent three years of emissions for the implementation year. Among the facilities subject to the Target Management System, high-emission facilities were incorporated into the K-ETS from 2015 onward, while the remaining facilities continue to report their emissions under the Target Management System.

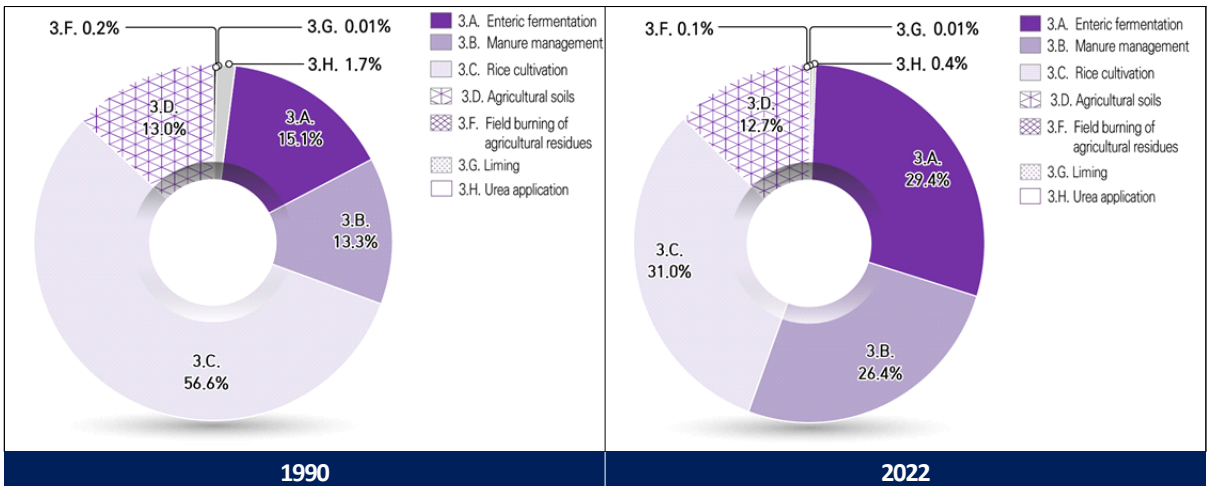
<Table Ⅰ-16> GHG Emissions from the Agriculture Sector

(Unit: $MtCO_2$-eq)

Sector	1990	2000	2010	2018	2020	2021	2022	Growth Rate (%)	
								Compared to 1990	Compared to previous year
3.A. Enteric Fermentation	3.8	4.3	5.6	6.0	6.3	6.6	6.7	79.7	2.8
3.B. Manure Management	3.3	4.7	5.5	6.0	6.0	6.0	6.1	82.9	0.8
3.C. Rice Cultivation	14.1	12.0	10.6	8.5	7.7	7.4	7.1	-49.5	-4.1
3.D. Agricultural Soils	3.2	3.3	2.8	2.8	2.9	3.0	2.9	-9.7	-1.0
3.F. Field Burning of Agricultural Residues	0.06	0.06	0.05	0.04	0.04	0.03	0.03	-53.2	-22.4
3.G. Liming	0.003	0.003	0.003	0.003	0.003	0.002	0.002	-2.4	0.7
3.H. Urea Application	0.4	0.3	0.12	0.12	0.11	0.11	0.09	-78.8	-16.7
Total Emissions	24.9	24.7	24.7	23.5	23.1	23.1	23.0	-7.7	-0.5

Emissions from the rice cultivation sub-sector in 2022 decreased by 4.1% (0.3 $MtCO_2$-eq) compared to the previous year. This was due to the reduction of the rice cultivation area, a decrease of the proportion of continuously flooded area in water regime and a decrease of organic amendment application. Emissions from enteric fermentation sector increased by 0.2 $MtCO_2$-eq (2.8%) compared to the previous year due to an increase of the population of non-dairy cattle.

The share of emissions within the Agriculture sector in 2022 was as follows: Rice Cultivation (31.0%), Enteric Fermentation (29.4%), Manure Management (26.4%), Agricultural Soils (12.7%), Urea Application (0.4%), Field Burning of Agricultural Residues (0.1%), and Liming (0.01%).

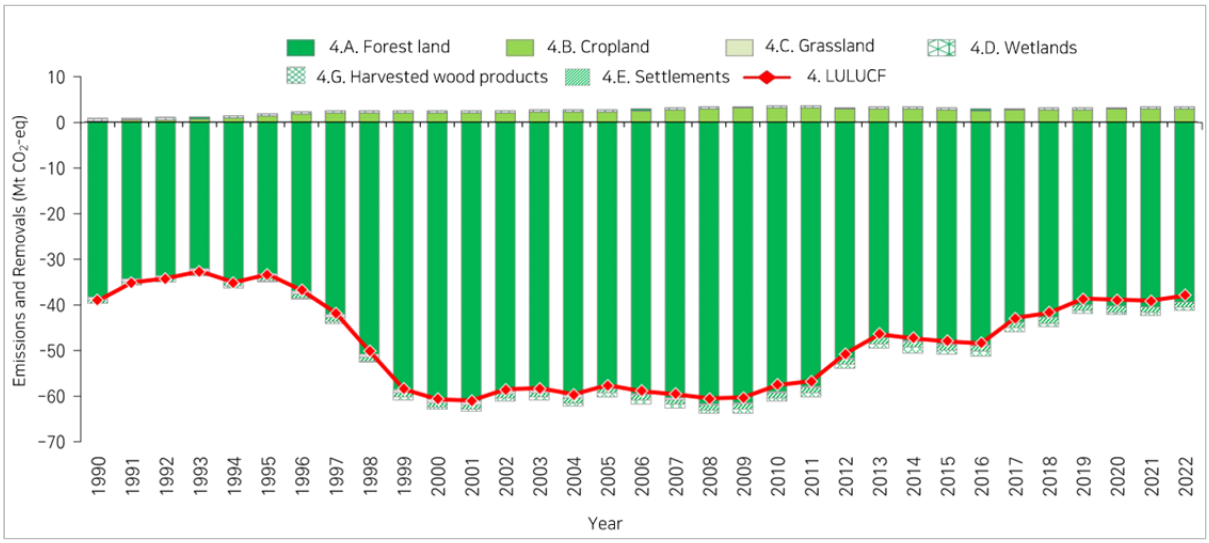


[Figure Ⅰ-18] Proportion by Categories in the Agriculture Sector

2.3.4 LULUCF Sector

In 2022, total net GHG removals from the LULUCF sector amounted to 37.8 $MtCO_2$-eq. The 2022 LULUCF sector net removals decreased by 1.1 $MtCO_2$-eq compared to 1990 and by 1.2 $MtCO_2$-eq compared to the previous year.

For the LULUCF sector in 2022, net removals were mostly from Forest Land (39.3 $MtCO_2$-eq, followed by the Settlements (1.2 $MtCO_2$-eq) and HWP (0.5 $MtCO_2$-eq). Meanwhile, the net emissions in the LULUCF sector were from the Cropland (2.9 $MtCO_2$-eq), followed by the Wetlands (0.38 $MtCO_2$-eq), and the Grassland (0.001 $MtCO_2$-eq).



[Figure Ⅰ-19] GHG Emissions and Removals from the LULUCF sector (1990-2022)

<Table Ⅰ-17> GHG Emissions and Removals from the LULUCF Sector

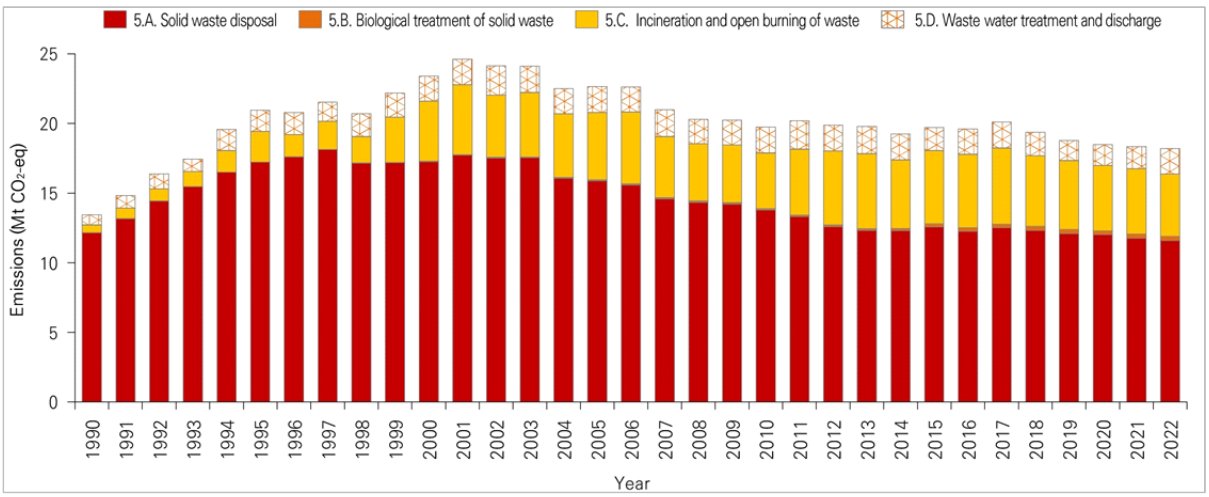
(Unit: $MtCO_2$-eq)

Sector	1990	2000	2010	2018	2020	2021	2022	Net Change	
								Compared to 1990	Compared to previous year
4.A. Forest Land	-38.2	-60.5	-58.8	-42.6	-40.2	-40.4	-39.3	-1.1	1.1
4.B. Cropland	0.1	1.9	3.0	2.6	2.7	2.9	2.9	2.8	-0.02
4.C. Grassland	-0.7	-0.7	-0.21	-0.04	-0.02	-0.01	0.001	0.7	0.008
4.D. Wetlands	0.34	0.39	0.37	0.39	0.41	0.40	0.38	0.03	-0.03
4.E. Settlements	-0.7	-0.9	-1.1	-1.21	-1.22	-1.22	-1.22	-0.5	0.005
4.G. Harvested Wood Products	0.2	-0.5	-0.6	-0.7	-0.5	-0.7	-0.5	-0.7	0.1
Total Net Emissions	-39.0	-60.4	-57.4	-41.6	-38.8	-39.0	-37.8	1.1	1.2

The majority of the net removals is attributed to Forest Land. During and after the Korean War (1950-1953), significant forest degradation occurred. When forest-related statistics began to be compiled in 1953, the average timber stock was only 5.6 m^3/ha. However, over time, continuous and successful efforts, including erosion control, afforestation, and forest protection projects led by both the government and private entities, resulted in an increase in the average timber stock to 172 m^3/ha by 2022, leading to the green forests today. Due to continuous reforestation and forest management, forest sector removals began increasing after 1995, reaching the peak of 61.5 $MtCO_2$-eq in 2008, followed by a declining trend. The decrease in removals by forest land in 2022 compared to the previous year is attributed to reduced annual net growth due to aging forests and decreased forest area. Forest area in 2022 was 6,291 kha, approximately 190 kha less than in 1990 (6,476 kha).

2.3.5 Waste Sector

In 2022, GHG emissions from the waste sector amounted to 18.2 $MtCO_2$-eq, accounting for 2.5% of total national emissions. This represents a 35.3% increase compared to 1990 and a 0.8% decrease compared to the previous year. From 1990 to 2001, emissions from the waste sector have generally shown an upward trend, but after reaching a peak in 2001, emissions have been decreasing. The emission trend in the waste sector followed the same pattern of the Solid Waste Disposal sub-sector, which accounts for the largest share of waste sector emissions. For the other sub-sectors except Solid Waste Disposal, emissions have shown a continuous upward trend in the 1990s and remained steady since the mid-2000s.



[Figure Ⅰ-20] GHG Emissions from the Waste Sector (1990-2022)

<Table Ⅰ-18> GHG Emissions from the Waste Sector

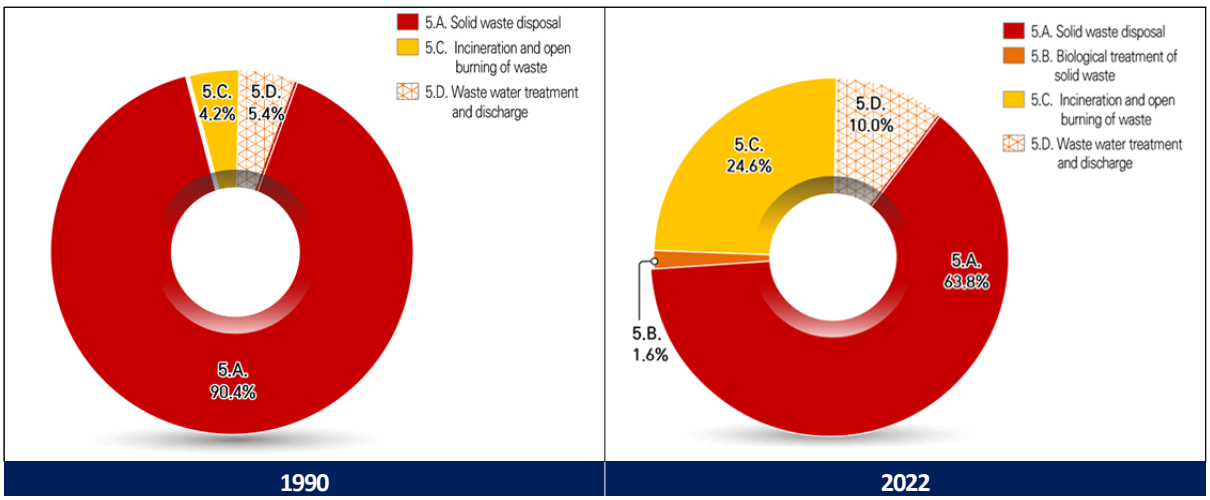
(Unit: $MtCO_2$-eq)

Sector	1990	2000	2010	2018	2020	2021	2022	Growth Rate (%)	
								Compared to 1990	Compared to previous year
5.A. Solid Waste Disposal	12.1	17.3	13.8	12.3	12.0	11.8	11.6	-4.5	-1.4
5.B. Biological Treatment of Solid Waste	NE,NO	0.03	0.09	0.28	0.28	0.30	0.29	6,593.4%*	-3.8
5.C. Incineration and Open Burning of Waste	0.6	4.3	4.0	5.1	4.7	4.7	4.5	699.4	-4.5
5.D. Waste Water Treatment and Discharge	0.7	1.8	1.9	1.7	1.5	1.6	1.8	149.9	15.2
Total Emissions	13.4	23.4	19.7	19.4	18.5	18.3	18.2	35.3	-0.8

* The growth rate for the Biological Treatment of Solid Waste sector was calculated based on the first year data which was collected in 1994.

As of 2022, emission share by sub-sector in the waste sector was as follows: Solid Waste Disposal (63.8%), Incineration and Open Burning of Waste (24.6%), Waste Water Treatment and Discharge (10.0%) and Biological Treatment of Solid Waste (1.6%)

The largest portion of emissions in the waste sector comes from Solid Waste Disposal sub-sector, which reached the peak in 1997 with 18.1 $MtCO_2$-eq and has gradually decreased since then. Notably, after the introduction of the direct landfilling prohibition of food waste in 2005, food waste has been separately recycled, leading to a continuous decrease in emissions of the sub-sector. While emissions from the Incineration and Open Burning of Waste sub-sector increased dramatically from 1990 to 2001, as a result of the increased waste incineration due to population growth and rapid economic development.



[Figure Ⅰ-21] Proportion by Categories in the Waste Sector

When examining the changes in emission proportion by sub-sector in the waste sector, the share of Solid Waste Disposal decreased from 90.4% in 2022 to 63.8% in 1990, while the proportion of Incineration and Open Burning of Waste increased from 4.2% to 24.6%. Although the emissions and share of the latter have risen, energy recovery from incineration facilities of municipal waste have also increased, which contributed to slowing the growth of emissions. Energy recovery from incineration facilities began in 1998, and more than 80% of incinerated municipal waste was used for energy recovery since 2005.

II

Tracking Progress in Implementing and Achieving NDC

1. National Circumstances and Institutional Arrangements

1.1 National Circumstances

1.1.1 Government Structure

Since the enactment of its Constitution, the Republic of Korea (ROK) has maintained a system of separation of powers, with the executive authority vested in the executive branch led by the President, the legislative authority in the National Assembly, and the judicial authority in the courts composed of judges.

The executive branch is headed by the President and consists of the Prime Minister and members of the State Council. The President serves a single five-year term and is elected by direct popular vote. The Prime Minister is appointed by the President with the consent of the National Assembly, while State Council members are appointed by the President upon the recommendation of the Prime Minister. Key government policies are deliberated in the State Council. As of 2024, the executive branch comprises of 22 ministries and 20 agencies. Major ministries include the Ministry of Economy and Finance, the Ministry of Education, the Ministry of Science and ICT, the Ministry of Foreign Affairs, the Ministry of Unification, the Ministry of Justice, the Ministry of National Defense, the Ministry of the Interior and Safety, and the Ministry of Environment. Each minister serves as a State Council member.

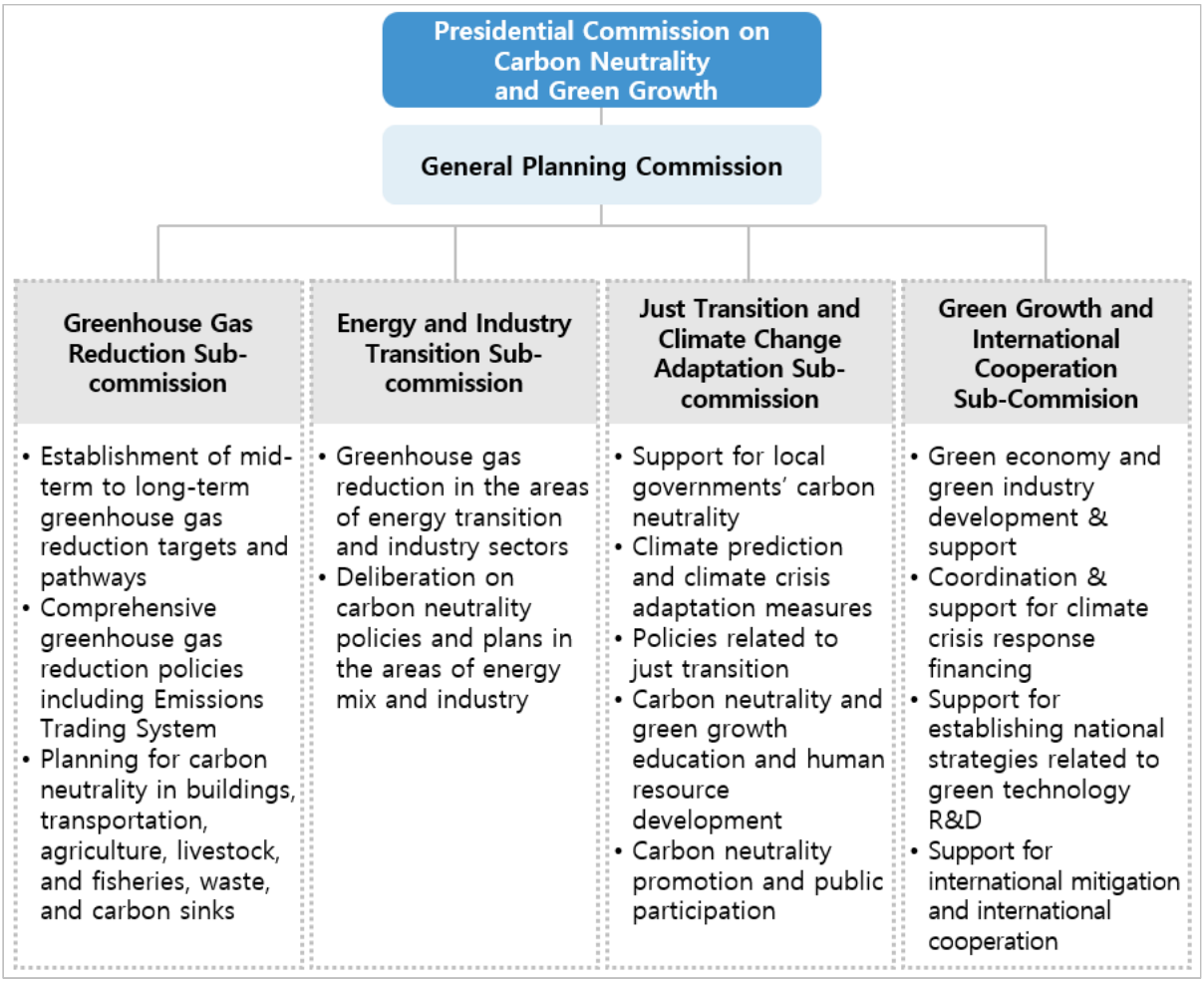
[Figure Ⅱ-1] Government Organization Chart

Source: Government Organization Chart (Government Organization Management System)

The Presidential Commission on Carbon Neutrality and Green Growth (Carbon Neutrality and Green Growth Commission) is a public-private joint governance that deliberates and decides on major policies and plans for the transition to a carbon-neutral society and the promotion of green growth. Carbon Neutrality and Green Growth Commission was established under Article 15 of the *Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis* (Carbon Neutrality Act) (September 2021) and performs the following functions in accordance with the Act:

ⅰ) Establishing the basic direction for the transition to a carbon-neutral society and the promotion of green growth
ⅱ) Setting and monitoring the implementation status of the national vision, mid- to long-term emission reduction targets, and national framework plans
ⅲ) Establishing, revising, and monitoring national climate change adaptation plans
ⅳ) Promoting public understanding, promotion, communication, and international cooperation related to carbon neutrality

Carbon Neutrality and Green Growth Commission comprises of the following four Sub-commissions; Greenhouse Gas (GHG) Reduction, Energy and Industry Transition, Just Transition and Climate Change Adaptation, and Green Growth and International Cooperation. The chairperson is the Prime Minister and co-chaired by private sector, with the commission members consisting of 21 ex officio government members and 32 private sector members appointed by the President.



[Figure Ⅱ-2] Organization Chart of the Presidential Commission on Carbon Neutrality and Green Growth

Source: Organization & Composition (Presidential Commission on Carbon Neutrality and Green Growth website)

Next, the legislative branch, the National Assembly, is composed of members elected by the sovereign people. They enact laws that form the basis of national operations, review and confirm budgets, and decide on major policies on behalf of the people.

In August 2021, the National Assembly passed the Carbon Neutrality Act through a plenary session resolution. This establishes the ROK as the 14th country in the world to legislate the 2050 carbon neutrality vision and implementation system, specifying carbon neutrality by 2050 as a national vision and systematizing the establishment and implementation monitoring procedures of national strategies, mid- to long-term GHG reduction targets, and basic plans to achieve it.

In December 2022, in accordance with the *National Assembly Act*, the Special Committee on Climate Crisis was established to monitor the government's climate crisis countermeasures

and discuss related institutional and policy improvements and support measures. This committee initially operated as an ad hoc committee for about a year, but as the climate crisis intensifies, there is a growing need to make it as a standing committee. The National Assembly is discussing the establishment of a permanent Special Committee on Climate Crisis and the potential granting of deliberative authority over legislation and budget matters to enable prompt and accurate responses to the climate crisis.

Finally, the judiciary has the Supreme Court as the highest court and consists of various levels of courts, including high courts, patent courts, district courts, family courts, and administrative courts. Courts have jurisdiction over civil, criminal, and administrative cases. They also deal with climate change-related cases, such as government licensing and support issues that may affect climate change, corporate responsibility for climate change due to fossil fuel use, and green-washing.

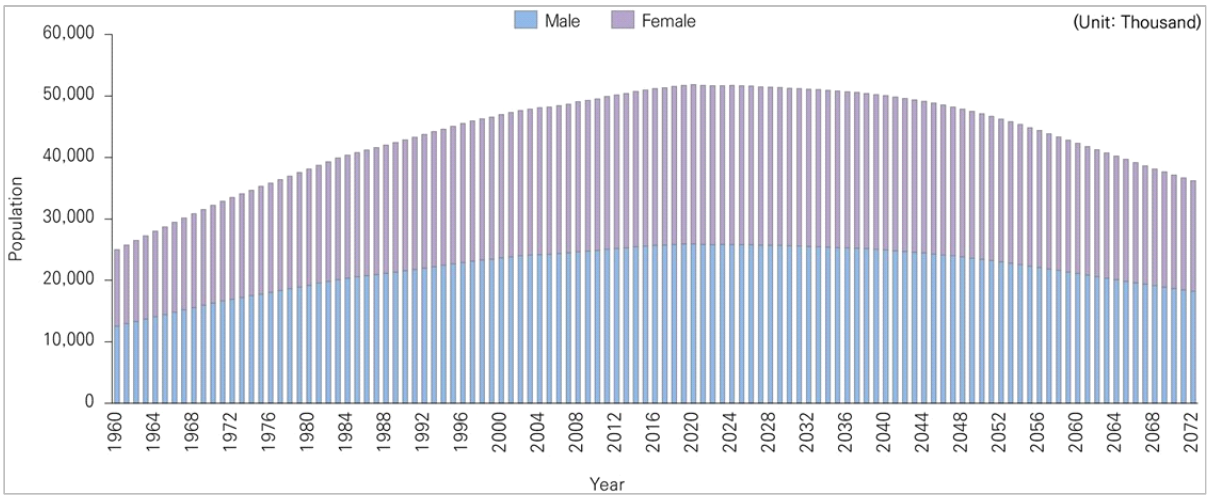
The Constitutional Court assesses whether the government is appropriately implementing efforts to reduce GHG emissions for the protection of citizens' fundamental rights under the Constitution. In March 2020, 19 youth members of Youth 4 Climate Action filed a constitutional petition asserting that the government's insufficient GHG reduction target setting violated citizens' fundamental rights. This was followed by four similar constitutional petitions, leading to the Constitutional Court's final decision in August 2024. The Constitutional Court ruled that certain provisions of the Carbon Neutrality Act were incompatible with the Constitution as they failed to establish specific reduction targets for the period from 2031 to 2049. In response to this decision, the government plans to amend the relevant provisions by 2026.

1.1.2 Population Profile

As of 2022, the total population of the ROK stood at 51.7 million, accounting for about 0.6% of the world's population. In terms of population size, it ranks 29th in the world, and its population density is about 514.6 people per square kilometer, ranking 27th among 237 countries.[19)] As of 2022, the population aged 65 and older was about 9 million, accounting for 17.5% of the total population. By 2025, this figure is expected to increase to 20.6%, transitioning the ROK into a super-aged society.

19) Source: World Population Prospects 2022 (UN, 2022)

The ROK's population growth rate was at an annual average of 3% in the 1960s, but the growth rate slowed down as population control policies were implemented until the 1980s. In 2021, the average annual rate of growth compared to 2020 was recorded at -0.1%, and the total population declined for the first time on record. The population is expected to continue decreasing to approximately 51.7 million in 2025 and 51.3 million in 2030.



[Figure Ⅱ-3] Total Population (1960-2072)

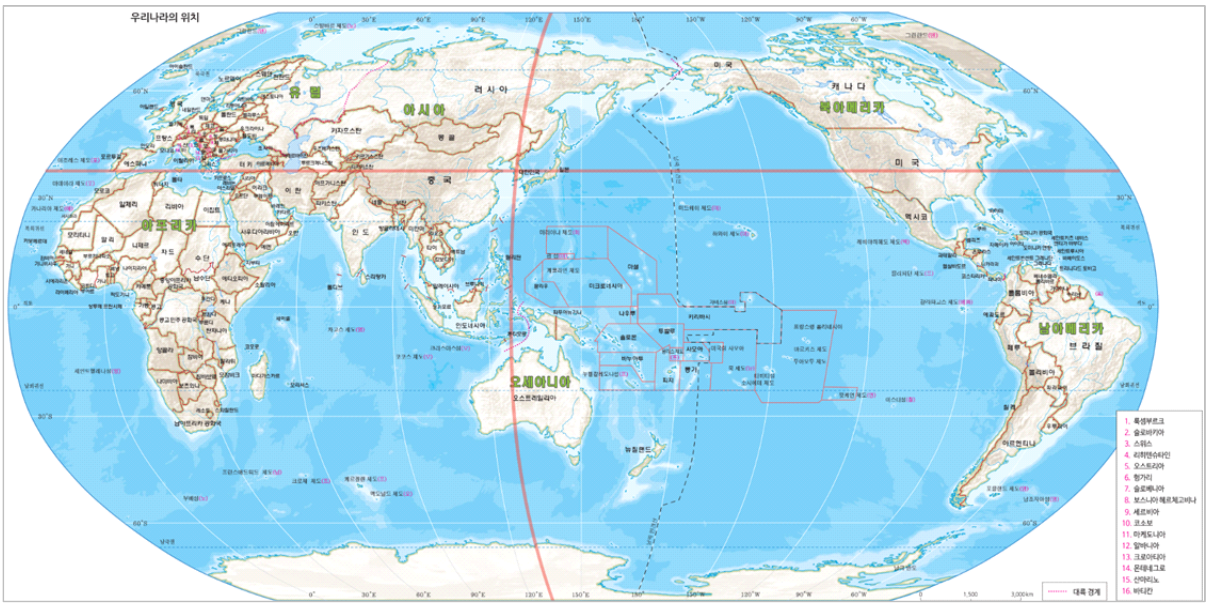
Source: Population Projections 2022-2072 (Statistics Korea, 2023)

Looking at population changes by major regions, Seoul reached its peak of 10.5 million in 1990 and decreased to 9.4 million in 2022. Similarly, Busan and Daegu also showed declining trends. These population declines are analyzed to be mainly due to low birth rates and population outflow due to movement to other regions. On the other hand, Gyeonggi Province, Sejong Special Self-Governing City, and Incheon Metropolitan City have showed steadily increasing population over the past 10 years (2013-2022), which is the result of population inflow from surrounding areas.

In terms of population distribution by major regions, as of 2022, Gyeonggi Province has the largest population nationwide with 13.690 million, accounting for 26.5% of the total national population. Seoul Metropolitan City ranks second with 9.4 million, representing 18.2% of the total population. The capital region, which includes Gyeonggi Province, Seoul Metropolitan City, and Incheon Metropolitan City (3 million, ranked fifth), has a population of 26.1 million, accounting for 50.48% of the total population. However, this region occupies only 11.8% of the national territory, highlighting severe population concentration.

1.1.3 Geographical Profile

Under the Constitution, the territory of the ROK consists of the Korean Peninsula and its adjacent islands. The total area of the Korean Peninsula is 223,663 km^2, ranking 85th among 253 countries worldwide. The Korean Peninsula is located in the eastern part of the Asian continent, between 124 and 132 degrees east longitude and between 33 and 44 degrees north latitude. The Korean Peninsula borders with the People's Republic of China and the Russian Federation to the north, and faces Japan across the Korea Strait to the east, connecting the vast Eurasian continent with the Pacific Ocean.



[Figure Ⅱ-4] The ROK in the World

Source: National Atlas of Korea (National Geographic Information Institute, 2020)

The Korean Peninsula has favorable geographical accessibility as it is adjacent to both the continent and the ocean. It is advantageous in terms of transportation and logistics due to its close proximity to major Asian cities. It is well linked to major cities around the world through air and sea routes. With rail and road networks, it would also have increased accessibility to the Eurasian continent.

Geographically, the Korean Peninsula has a distinctive difference in terms of altitude between the east and west. High mountains are distributed in the east and north regions, centered on the Taebaek Mountains, Nangnim Mountains, and Hamgyeong Mountains, while the west region is relatively low and flat. Due to these topographical characteristics, agricultural areas are mainly located in the western region, while forest areas are mainly located in the northeastern region.

The altitude of the Korean Peninsula ranges from 0m to 2,744m, with highlands over 1,600m accounting for only 5% of the total area, while lowlands under 300m account for 52%. The average altitude is 448m, which is lower than the East Asian average of 910m. However, the average slope is 5.7°, and it is steeper than the East Asian average of 3.9°.

[Figure Ⅱ-5] Topography of Korea

Source: Map of Korea (National Geographic Information Institute), Available at: https://www.ngii.go.kr/world/mapdownload05_en.html

1.1.4 Climate Profile

The ROK is located in the mid-latitude temperate zone with four distinct seasons. In spring and autumn, migratory high-pressure systems bring clear and dry weather. Summer is characterized by hot and humid conditions due to the North Pacific high-pressure system, while winter is characterized by cold and dry weather under the influence of the continental high-pressure system.

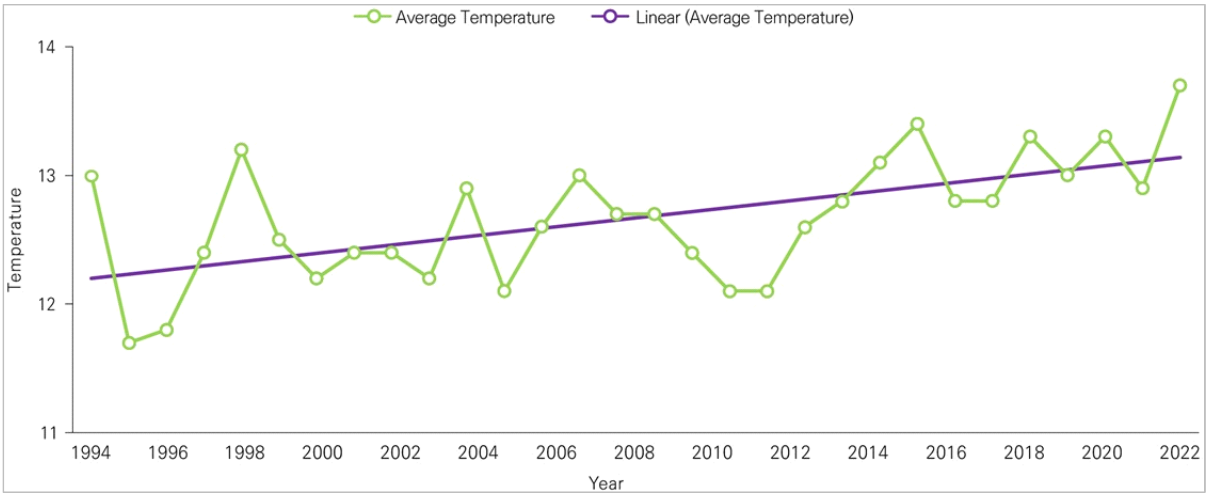
Over the past 30 years (1994-2023), the annual mean temperature of the ROK was 12.7°C, with August recording the highest monthly average at 25.4°C and January the lowest at -1.0°C. Regionally, August temperatures ranged from 19.7°C in Daegwallyeong to 26.7°C in Daegu Metropolitan City, while January temperatures varied from -6.9°C in Daegwallyeong to 3.6°C in Busan Metropolitan City.

The annual average precipitation is 1,331.7 mm, with summer precipitation accounting for 54.6% (727.3 mm) of the annual total. The monsoon season begins in mid-to-late June in Jeju Island then gradually extends to the southern region and the central region of the Korean Peninsula. The monsoon period lasts the longest in Jeju Island for 32.4 days, followed by 31.5 days in the southern region and 31.4 days in the central region.

<Table Ⅱ-1> Monthly Mean Temperature and Precipitation over the Past Three Decades

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Temperature (℃)	-1.0	1.4	6.4	12.3	17.5	21.5	24.8	25.4	20.6	14.4	7.8	1.0
Minimum Temperature (℃)	-5.8	-3.8	0.7	6.2	11.7	17.0	21.4	21.8	16.4	9.2	2.7	-3.7
Maximum Temperature (℃)	4.4	7.2	12.5	18.7	23.6	26.8	29.1	30.0	26.0	20.8	13.7	6.4
Precipitation (mm)	25.9	32.3	58.0	88.4	103.1	151.6	297.8	283.0	157.1	64.9	49.7	27.6

Source: Climate Statistics Analysis (Korea Meteorological Administration Open Data Portal)



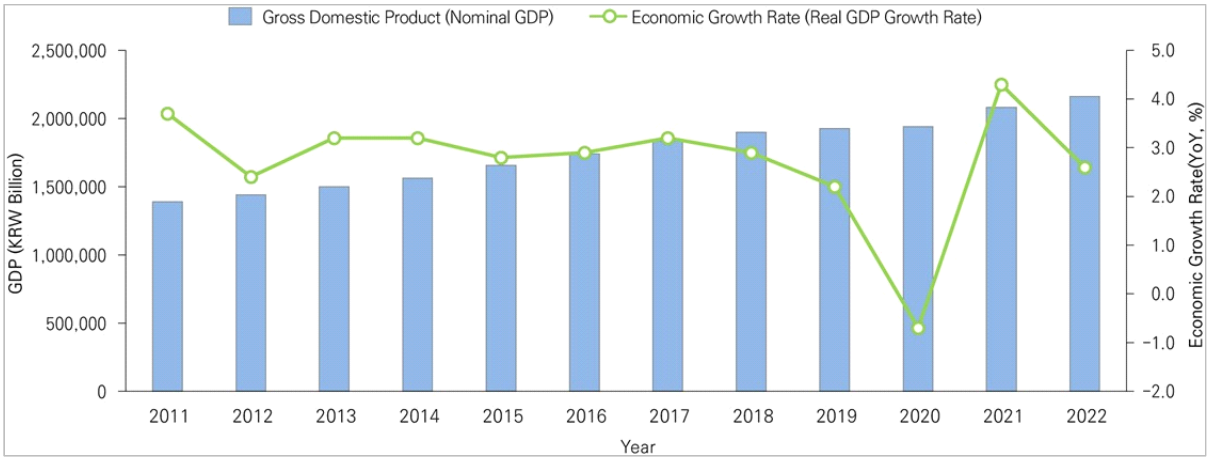
[Figure Ⅱ-6] Average Yearly Temperature of the ROK (1994-2023)

Source: Climate Statistics Analysis (Korea Meteorological Administration Open Data Portal)

Wind patterns show clear seasonal variations, with strong northwesterly winds in winter and southwesterly winds in summer. Coastal regions experience significant sea and land breezes. On average, 25.1 typhoons form annually over the Northwest Pacific, of which 3.4 typhoons directly or indirectly affect the Korean Peninsula each year. The annual average relative humidity maintains at 69-75%, peaking at 78-79% in July and August and dropping to 59-60% in March and April.

1.1.5 Economic Profile

The nominal GDP of the ROK in 2021 was calculated at KRW 2,080 trillion, with the real GDP growth rate reaching 4.3%. This represents a significant recovery from the -0.7% contraction experienced in 2020 during the first year of the COVID-19 pandemic. In 2022, while the nominal GDP increased to KRW 2,162 trillion, the economic growth rate moderated to 2.6%. Notably, while the first quarter of 2022 showed a growth rate of 3.1% year-on-year, it declined to 1.4% in the fourth quarter, indicating an economic slowdown in the latter half of the year.



[Figure Ⅱ-7] Gross Domestic Product and Economic Growth Rate of the ROK

Source: National Accounts, Key Indicators (Annual Indicators, Base Year of 2015) (Bank of Korea)

The Korean economy is characterized by high dependence on manufacturing and exports. Despite fluctuations over the past decade, these sectors continue to maintain significant importance in the national economy. The manufacturing sector maintained a consistent 28.0% share of GDP in both 2021 and 2022, while export dependency recorded at 33.2% and 38.0% respectively in these years.

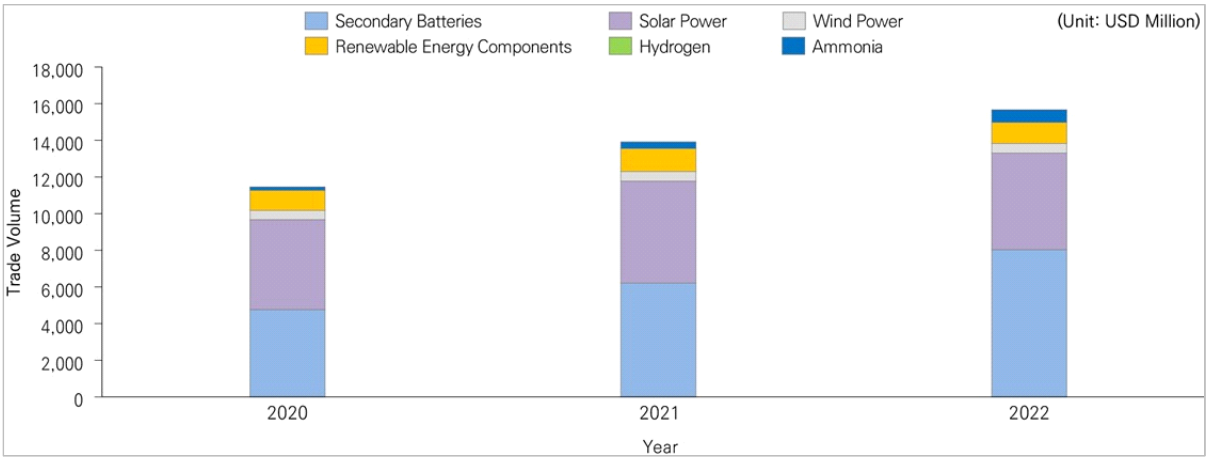
<Table Ⅱ-2> Export Dependency and Manufacturing Share of GDP

(Unit:%)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Manufacturing Industry Share[1)]	30.3	29.5	29.0	28.8	29.5	29.1	27.5	27.1	28.0	28.0
Export Dependency Ratio[2)]	39.0	36.8	34.2	31.4	33.5	33.2	31.0	29.4	33.2	38.0

1) National Accounts, Key Indicators (Annual Indicators, Base Year of 2015) (Bank of Korea)
2) Trade Dependency Ratio (Ratio of Exports and Imports to GDP) (National Statistics Portal)

Industries related to carbon neutrality have shown notable growth, particularly in secondary batteries and solar power sectors. The trade volume of the secondary battery industry increased from USD 4,756 million in 2020 to USD 8,035 million in 2022, indicating an approximate 1.7-fold increase. Furthermore, the solar power industry continued its growth trajectory, recording a trade volume of USD 5,274 million in 2022.



[Figure Ⅱ-8] Trade Volume of the ROK's Carbon-Neutral Industries

Source: Trade Statistics (Korea International Trade Association)

The carbon neutrality-related finance sector has demonstrated a substantial growth since 2021. The government has established institutional frameworks through the Green Bond Guidelines in December 2020 and the K-Taxonomy Guidelines in December 2022. Consequently, green bond issuance increased significantly from KRW 960 billion in 2020 to KRW 12.459 trillion in 2021, followed by KRW 5.861 trillion in 2022.

Furthermore, the number of companies publishing sustainability reports among listed companies on the Korea Exchange has increased from 78 in 2021 to 129 in 2022, representing year-on-year increases of 105% and 65% respectively. The government has continued to strengthen institutional support through the release of the K-ESG Guidelines in December 2021 and the Supply Chain Response K-ESG Guidelines in December 2022, providing frameworks to support corporate ESG goal achievement and related information disclosure.

1.2 Sectoral Information

1.2.1 Power Generation

The power generation sector is an area that produces secondary energy such as electricity and heat using primary and secondary energy sources. The ROK's electricity consumption temporarily decreased during 2019-2020 due to seasonal temperature variations, economic conditions, and COVID-19. However, excluding this period, it has steadily increased over the past decade (2013-2022). Since 2013, electricity consumption has grown at an annual average rate of 1.6%, reaching 547.9 TWh in 2022, which marks a 15.4% (73.1 TWh) increase compared to 2013 level.

Electricity consumption for industrial use accounted for the largest share at 52.5% (287.9 TWh) of total consumption in 2022, followed by commercial use at 33.1% (181.4 TWh) and residential use at 14.3% (78.6 TWh). These proportions have remained relatively stable. In terms of consumption growth rates, residential use showed the highest increase at 22.8% (14.6 TWh) compared to 2013, while commercial and industrial uses increased by 17.8% (27.4 TWh) and 12.1% (31.1 TWh) respectively. The average annual growth rates (2013-2022) were 2.3% for residential, 1.8% for commercial, and 1.3% for industrial use. Recent increases in electricity consumption can be attributed primarily to the expanded adoption of eco-friendly vehicles such as electric vehicles as well as the proliferation of new data centers driven by Artificial Intelligence (AI) technology advancements.

<Table Ⅱ-3> Trends in Electricity Consumption by Use

(Unit: TWh)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total	474.8	477.6	483.6	497.1	507.8	526.2	520.6	509.3	533.5	547.9
Residential	64.0	62.7	63.8	66.2	66.5	70.7	70.5	74.1	77.6	78.6
Commercial	154.0	150.3	154.2	160.9	164.6	174.6	172.8	168.1	173.2	181.4
Industrial	256.8	264.6	265.6	270.0	276.7	280.9	277.3	267.1	282.7	287.9

Source: 2022 Korea Electric Power Statistics (No.92) (Korea Electric Power Corporation, 2023)

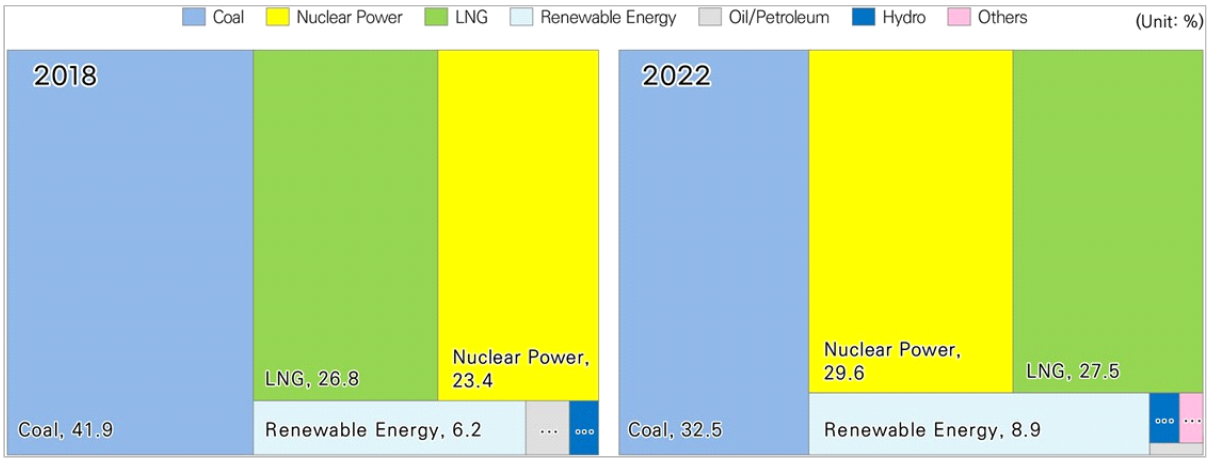
The country's energy mix (based on power generation) consists of coal, nuclear, Liquefied Natural Gas (LNG), and new and renewable energy. To achieve carbon neutrality targets, the composition is gradually shifting toward reducing the share of coal, while progressively expanding the proportion of carbon-free power sources. Coal power generation and its share have been steadily decreasing since 2018, with the share dropping from 41.9% in 2018 to 32.5% in 2022, marking four consecutive years of decline. Conversely, the share of zero-carbon power sources has been notably increasing. The share of new and renewable energy generation has increased from 6.2% in 2018 to 8.9% in 2022, while nuclear power generation expanded from 23.4% in 2018 to 29.6% in 2022.

<Table Ⅱ-4> Trends in Power Generation by Energy Source

Energy Source		2018	2019	2020	2021	2022
Total	Generation (TWh)	570.6	563.0	552.2	576.8	594.4
	Share (%)	100.0	100.0	100.0	100.0	100.0
Coal	Generation (TWh)	239.0	227.4	196.3	198.0	193.2
	Share (%)	41.9	40.4	35.6	34.3	32.5
Nuclear	Generation (TWh)	133.5	145.9	160.2	158.0	176.1
	Share (%)	23.4	25.9	29.0	27.4	29.6
LNG	Generation (TWh)	152.9	144.4	145.9	168.4	163.6
	Share (%)	26.8	25.6	26.4	29.2	27.5
New & Renewable	Generation (TWh)	35.6	36.4	36.5	43.1	53.2
	Share (%)	6.2	6.5	6.6	7.5	8.9
Oil/Petroleum	Generation (TWh)	5.7	3.3	2.3	2.4	2.0
	Share (%)	1.0	0.6	0.4	0.4	0.3
Pumped Storage	Generation (TWh)	3.9	3.5	3.3	3.7	3.7
	Share (%)	0.7	0.6	0.6	0.6	0.6
Other	Generation (TWh)	0.0	2.2	7.7	3.3	2.7
	Share (%)	0.0	0.4	1.4	0.6	0.5

Source: 2022 Korea Electric Power Statistics (No.92) (Korea Electric Power Corporation, 2023)

The most notable change in the energy mix between 2018 and 2022 was the expansion of nuclear power generation. As a result, LNG, which had the second-largest share after coal power in 2018, has become the third-largest source after coal and nuclear power in 2022. The share of new and renewable energy in power generation has also steadily increased as capacity expanded through the deployment of facilities. These changes in the energy mix represent one of the processes to strengthen energy security and to achieve carbon neutrality. In particular, the phase-out of aged coal power plants, substitution with LNG, and expansion of carbon-free power sources such as nuclear, and new and renewable energy are serving as key drivers for implementing the Nationally Determined Contribution (NDC).

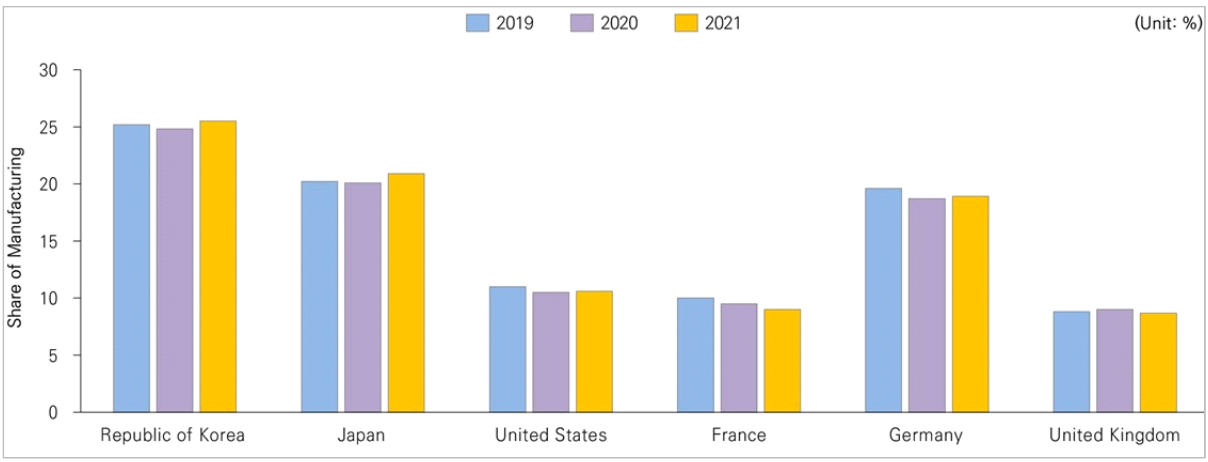


[Figure Ⅱ-9] Comparison of the Energy Mix in 2018 and 2022

Source: 2022 Korea Electric Power Statistics (No.92) (Korea Electric Power Corporation, 2023)

1.2.2 Industry

The industry sector encompasses areas that produce goods or services through processes that change the chemical or physical structure of raw materials and fuels, and through energy use. Since the 1970s, the ROK has rapidly restructured its industrial structure from primary industry-centered to secondary and tertiary industry-centered, maintaining a higher proportion of manufacturing compared to developed countries. Manufacturing accounted for 28.0% of GDP in 2021 and 2022, playing a crucial role in the national economy.



[Figure Ⅱ-10] Share of Manufacturing Sector in GDP among Major Countries

Source: Manufacturing, value added (% of GDP) (World Bank)

Manufacturing production in the ROK temporarily decreased in 2019-2020 due to the impact of COVID-19, but has recovered from 2021 and recorded KRW 2,073.78 trillion in 2022, representing an increase of 31.6% (KRW 497.78 trillion) compared to 2018 level. This upward trend is primarily attributed to the expansion of production capacity in major industries responding to domestic and international demand, based on strong technological competitiveness in sectors such as semiconductors, automobiles, and petrochemicals.

By major sector in 2022, the highest share was accounted by electronic components, computers, video, audio and communication equipment manufacturing, including the semiconductor industry, at 16.2% (KRW 336.32 trillion). This was attributed to the increased exports of system semiconductors driven by rising global semiconductor demand. Automobile and trailer manufacturing was second highest at 12.1% (KRW 250.15 trillion), followed by chemical substances and chemical products manufacturing (10.5%), primary metal manufacturing (9.8%), and coke, briquette and petroleum refining products manufacturing (9.7%). The top five sectors accounted for 57.5% of total manufacturing production in 2021 and 58.4% in 2022.

<Table Ⅱ-5> Trends in Production Value by Major Industries

Industry		2018	2019	2020	2021	2022
Total	Value (KRW billion)	1,575,999	1,552,706	1,502,500	1,781,283	2,073,778
	Share (%)	100.0	100.0	100.0	100.0	100.0
Electronic components, computer, visual, sound, and communication equipment	Value (KRW billion)	277,829	260,743	262,540	315,513	336,323
	Share (%)	17.6	16.8	17.5	17.7	16.2
Motor vehicles and trailers	Value (KRW billion)	189,653	196,714	195,677	213,746	250,154
	Share (%)	12.0	12.7	13.0	12.0	12.1
Chemicals and chemical products (except pharmaceuticals)	Value (KRW billion)	163,826	153,925	145,350	189,319	218,750
	Share (%)	10.4	9.9	9.7	10.6	10.5
Basic metals	Value (KRW billion)	144,510	141,185	133,010	183,071	204,019
	Share (%)	9.2	9.1	8.9	10.3	9.8
Coke, briquettes and refined petroleum products	Value (KRW billion)	132,906	125,812	81,506	123,344	201,054
	Share (%)	8.4	8.1	5.4	6.9	9.7
Other machinery and equipment	Value (KRW billion)	123,319	119,087	117,841	135,757	150,320
	Share (%)	7.8	7.7	7.8	7.6	7.2
Electrical equipment	Value (KRW billion)	84,113	88,790	98,671	115,055	149,629
	Share (%)	5.3	5.7	6.6	6.5	7.2
Fabricated metal products (except machinery and furniture)	Value (KRW billion)	74,909	75,479	71,193	79,272	89,058
	Share (%)	4.8	4.9	4.7	4.5	4.3
Rubber and plastic products	Value (KRW billion)	69,626	69,272	68,201	74,044	80,404
	Share (%)	4.4	4.5	4.5	4.2	3.9
Other transport equipment	Value (KRW billion)	45,125	47,968	46,537	42,813	47,891
	Share (%)	2.9	3.1	3.1	2.4	2.3
Non-metallic mineral products	Value (KRW billion)	35,648	34,097	33,085	36,202	39,295
	Share (%)	2.3	2.2	2.2	2.0	1.9
Other manufacturing	Value (KRW billion)	234,535	239,634	248,888	273,150	306,881
	Share (%)	14.9	15.4	16.6	15.3	14.8

Source: Mining and Manufacturing Survey (Statistics Korea)

Manufacturing energy consumption also temporarily decreased in 2019-2020 due to COVID-19, but reached up to 133,654 ktoe in 2022. Total manufacturing consumption recovered to pre-COVID-19 levels as energy consumption increased in the petrochemical and refining industries.

By major sector in 2022, Chemical substances and chemical products manufacturing accounted for 30.5% (40,744.1 ktoe) of total consumption. Following the trend from 2021, this increase was attributed to the expansion of petrochemical facilities, which led to a rise in petroleum consumption for raw materials. Coke, briquette and petroleum refining products manufacturing was second at 25.2% (33,672.8 ktoe), followed by Primary metal manufacturing (23.5%), Non-metallic mineral products manufacturing (4.6%), and Electronic components, computers, video, audio and communication equipment manufacturing (4.4%). The top five sectors accounted for 89.0% and 88.2% of total manufacturing energy consumption in 2021 and 2022 respectively.

<Table Ⅱ-6> Trends in Energy Consumption by Major Industries

Industry		2018	2019	2020	2021	2022
Total	Energy Consumption (ktoe)	133,327.9	130,661.8	128,263.5	133,573.9	133,654.0
	Share (%)	100.0	100.0	100.0	100.0	100.0
Chemicals and chemical products (except pharmaceuticals)	Energy Consumption (ktoe)	33,472.0	33,738.7	34,800.4	42,982.5	40,744.1
	Share (%)	25.1	25.8	27.1	32.2	30.5
Coke, briquettes and refined petroleum products	Energy Consumption (ktoe)	37,075.7	36,325.1	32,661.2	30,290.0	33,672.8
	Share (%)	27.8	27.8	25.5	22.7	25.2
Basic metals	Energy Consumption (ktoe)	33,815.0	33,537.9	33,667.5	34,003.5	31,395.9
	Share (%)	25.4	25.7	26.2	25.5	23.5
Non-metallic mineral products	Energy Consumption (ktoe)	6,284.1	6,337.8	5,897.8	6,003.7	6,152.2
	Share (%)	4.7	4.9	4.6	4.5	4.6
Electronic components, computer, visual, sound, and communication equipment	Energy Consumption (ktoe)	5,054.9	5,600.3	5,541.5	5,556.2	5,933.4
	Share (%)	3.8	4.3	4.3	4.2	4.4
Food products	Energy Consumption (ktoe)	2,439.5	2,065.8	2,296.3	2,157.6	2,242.4
	Share (%)	1.8	1.6	1.8	1.6	1.7
Motor vehicles and trailers	Energy Consumption (ktoe)	2,143.8	1,979.1	1,850.2	1,808.5	2,031.8
	Share (%)	1.6	1.5	1.4	1.4	1.5
fabricated metal products (except machinery and furniture)	Energy Consumption (ktoe)	2,299.2	1,787.9	2,570.5	1,731.2	1,953.7
	Share (%)	1.7	1.4	2.0	1.3	1.5
Pulp, Paper and Paper Products	Energy Consumption (ktoe)	2,168.2	2,013.3	1,945.2	1,917.5	1,862.0
	Share (%)	1.6	1.5	1.5	1.4	1.4
Rubber and plastic products	Energy Consumption (ktoe)	2,197.1	1,811.5	1,415.9	1,670.9	1,818.8
	Share (%)	1.6	1.4	1.1	1.3	1.4
Other machinery and equipment	Energy Consumption (ktoe)	1,360.7	1,096.1	1,293.4	1,133.7	1,376.0
	Share (%)	1.0	0.8	1.0	0.8	1.0
Other manufacturing	Energy Consumption (ktoe)	4,534.2	3,867.9	3,851.3	3,829.4	3,937.1
	Share (%)	3.4	3.0	3.0	2.9	2.9

Source: Sector-specific Energy Consumption Data (National GHG Emission Total Information System)

1.2.3 Building

The buildings sector refers to areas where daily life or economic activities take place in structures with roofs, pillars, and walls. Total building energy consumption decreased slightly in 2019-2020 due to reduced energy use in non-residential buildings during COVID-19, but has shown an increasing trend again from 2021. Total consumption in 2022 reached 36,362 ktoe, a 5.6% increase (1,920 ktoe) compared to 2018, influenced by increased floor area from new construction. In 2022, apartment buildings accounted for the largest share (42.6%) of building energy use, followed by detached houses and neighborhood living facilities. Residential buildings accounted for 58.0% of total consumption in 2022.[20)]

Building energy consumption per unit area showed similar trends due to COVID-19 but has decreased by 4.8% compared to 2018, reaching 122 kWh/m^2 in 2022. This was mainly attributed to an 8.0% decrease (244 days) in heating and cooling degree-days compared to 2018, as energy consumption generally correlates with heating and cooling degree-days.[21)] Total energy consumption increased by only 5.6% despite a 10.9% increase in floor area compared to 2018, which also contributed to the decrease in energy consumption per unit area.

<Table Ⅱ-7> Trends in Building Energy Consumption

	2018	2019	2020	2021	2022
Total Floor Area (100,000m^2)	31,263	32,187	32,619	33,632	34,672
Total Energy Consumption (ktoe)	34,442	33,572	33,187	34,344	36,362
Energy Consumption per Unit Area (kWh/m^2)	128	121	118	119	122
Heating and Cooling Degree-Days	3,050	2,704	2,628	2,663	2,806

Source: Building Energy in 2022, 4.8% decrease in energy consumption per unit area compared to base year 2018 (Press Release, Ministry of Land, Infrastructure and Transport, May 31, 2023)

Aged buildings, generally defined as those over 30 years since their approval for use, tend to show increased energy consumption as they age. Over the past decade (2013-2022), the number and floor area of aged buildings have steadily increased, accounting for 41.0% (3,017,299 buildings) of total buildings and 21.4% (884,101 thousand m^2) of total floor area in 2022. In particular, buildings established through large-scale housing construction projects in the 1980s are significantly contributing to increased energy consumption as they age. As

20) Source: 'Building Energy in 2022, 4.8% decrease in energy consumption per unit area compared to base year 2018' (Press Release, Ministry of Land, Infrastructure and Transport, May 31, 2023)

21) Heating and cooling degree days refer to the sum of the monthly differences between the daily average temperature and the base temperature (18°C for heating, 24°C for cooling)

the number and total floor area of aged buildings rapidly increase, their share of total building energy consumption is progressively expanding.

<Table Ⅱ-8> Trends in Aged Buildings

Age		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total	Number of Buildings	6,851,802	6,911,288	6,986,913	7,054,733	7,126,526	7,191,912	7,243,472	7,275,266	7,314,264	7,354,340
	Total Floor Area (Thousand m^2)	3,376,649	3,451,352	3,534,068	3,573,626	3,641,933	3,754,128	3,860,871	3,961,888	4,056,243	4,131,341
30 years or more, less than 35 years	Number of Buildings	435,088	497,313	498,813	499,448	483,941	497,285	480,131	535,672	586,505	647,083
	Total Floor Area (Thousand m^2)	147,504	159,730	169,251	181,743	199,497	216,153	241,574	287,339	359,144	418,480
35 years or more	Number of Buildings	1,922,960	1,978,819	2,013,087	2,043,769	2,117,329	2,169,438	2,258,369	2,284,186	2,310,334	2,370,216
	Total Floor Area (Thousand m^2)	223,523	245,425	263,732	280,620	306,034	336,638	365,725	392,956	420,332	465,621

Source: Annual Building Statistics (Ministry of Land, Infrastructure and Transport)

1.2.4 Transportation

The transportation sector encompasses various modes of transport, including road, railroad, maritime, and air, carrying passengers and freight. Domestic passenger transport volume sharply declined in 2020 due to the impact of COVID-19. However, excluding this anomaly, the transport volume has steadily increased over the past decade (2013-2022) at an average annual growth rate of 1.6%.

In 2021, the modal share of domestic passenger transport by mode was highest for road transport at 88.4%. Subways accounted for 8.1%, railroads for 3.4%, and aviation and

maritime transport each accounted for 0.1%. In 2013, the road transportation share was 87.5%, but it has declined to 84.3% by 2019 due to policies promoting public transportation, which reduced the use of private cars. During the same period, the shares of rail and subway transport rose to 4.6% and 10.9%, respectively. However, with the outbreak of COVID-19 in 2020, private car usage increased, leading to a rebound in the road transport share, while rail and subway shares declined. In the maritime transport sector, the government's *Coastal Passenger Ship Safety Management Plan* (September 2014) has resulted in record-high performance in 2017. Meanwhile, the share of aviation transport showed an overall upward trend due to the expansion of low-cost carrier services and increasing travel demand. However, both maritime and aviation transport experienced temporary declines in 2020 due to the impact of COVID-19, followed by signs of recovery starting in 2021.

<Table Ⅱ-9> Trends in Modal Share of Passenger Transport

Modal		2013	2014	2015	2016	2017	2018	2019	2020	2021
Total	Passengers (Thousands)	30,067,308	30,507,071	31,029,472	33,158,711	33,336,713	33,595,785	33,972,470	29,197,761	34,144,138
	Share (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Road	Passengers (Thousands)	26,327,678	26,678,513	27,193,794	28,090,714	28,192,366	28,409,618	28,649,339	25,361,540	30,168,830
	Share (%)	87.5	87.4	87.6	84.7	84.6	84.6	84.3	86.9	88.4
Subway	Passengers (Thousands)	2,476,394	2,526,167	2,522,900	3,572,127	3,604,712	3,618,352	3,705,150	2,677,582	2,759,948
	Share (%)	8.2	8.3	8.1	10.8	10.8	10.8	10.9	9.2	8.1
Rail	Passengers (Thousands)	1,224,820	1,263,472	1,269,417	1,449,534	1,490,319	1,521,590	1,570,415	1,122,872	1,170,749
	Share (%)	4.1	4.1	4.1	4.4	4.5	4.5	4.6	3.8	3.4
Aviation	Passengers (Thousands)	22,353	24,648	27,980	30,913	32,406	31,600	32,981	25,164	33,147
	Share (%)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Maritime	Passengers (Thousands)	16,063	14,271	15,381	15,423	16,910	14,625	14,585	10,603	11,464
	Share (%)	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0

Source: 2022 National Transportation Statistics (Domestic Edition), (Ministry of Land, Infrastructure and Transport, 2023)

Domestic freight transport volume had been steadily increasing since 2013, reaching its peak in 2018, but subsequently declined due to the impact of COVID-19. In 2021, as road freight transport volume recovered, the overall freight transport volume also returned to an upward trend. In 2021, road transport accounted for the highest share of freight transport by mode, followed by maritime, rail, and aviation transport. However, rail and aviation transport have shown a declining trend in modal share compared to road transport.

<Table Ⅱ-10> Trends in Modal Share of Freight Transport

Modal		2013	2014	2015	2016	2017	2018	2019	2020	2021
Total	Freight (kt)	1,704,342	1,668,282	1,927,284	1,975,640	2,028,558	2,047,201	1,983,572	1,926,889	1,990,292
	Share (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Road	Freight (kt)	1,546,407	1,512,700	1,761,291	1,799,565	1,854,011	1,895,686	1,847,241	1,788,917	1,848,182
	Share (%)	90.7	90.6	91.3	91.1	91.4	92.6	93.1	92.8	92.9
Maritime	Freight (kt)	117,860	117,920	128,611	143,227	142,587	120,327	107,408	111,513	115,125
	Share (%)	6.9	7.1	6.7	7.2	7.0	5.9	5.4	5.8	5.8
Rail	Freight (kt)	39,822	37,379	37,094	32,555	31,670	30,915	28,664	26,277	26,780
	Share (%)	2.3	2.2	1.9	1.6	1.6	1.5	1.4	1.4	1.3
Aviation	Freight (kt)	253	283	288	293	290	273	259	182	205
	Share (%)	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0

Source: 2022 National Transportation Statistics (Domestic Edition), (Ministry of Land, Infrastructure and Transport, 2023)

The cumulative registered number of motor vehicles, a representative mode of transportation, has steadily increased by 2-3% annually since 2013, reaching 25.5 million by the end of 2022. This growth was primarily driven by an increase in the number of vehicles per household and the rise of single-person households. By vehicle type, passenger cars accounted for the largest share, followed by vans, trucks, and special-purpose vehicles.

In 2022, the cumulative number of registered vehicles by fuel type showed that gasoline and diesel vehicles were the most prevalent, followed by LPG, hybrid, electric, and hydrogen vehicles. Compared to 2013, the number of gasoline and diesel vehicles increased

by 28.4% and 31.9%, respectively. Meanwhile, LPG vehicles saw a decline. In contrast, eco-friendly vehicles experienced a significant surge during the same period, particularly electric and hybrid vehicles. The number of hydrogen vehicles have also steadily increased since 2015, surpassing 10,000 units in 2020, and continued their growth in 2022. The rapid increase in eco-friendly vehicle registrations can be attributed to government policies promoting and supporting such vehicles, as well as the growing market demand.

<Table Ⅱ-11> Trends in Registered Vehicles

(Unit: 10,000 vehicle)

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total		1,940.1	2,011.8	2,099.0	2,180.3	2,252.8	2,320.3	2,367.7	2,436.6	2,491.1	2,550.3
Internal Combustion Engine	Total	1,918.7	1,986.3	2,068.8	2,143.0	2,205.1	2,259.4	2,292.3	2,338.2	2,357.7	2,373.2
	Gasoline	940.0	958.7	980.9	1,009.2	1,037.0	1,062.9	1,096.1	1,141.0	1,176.0	1,206.9
	Diesel	739.6	793.9	862.2	917.0	957.6	993.0	995.8	999.2	987.2	975.8
	LPG	239.2	233.7	225.7	216.7	210.5	203.5	200.5	197.9	194.6	190.5
Eco-friendly	Total	10.5	14.0	18.0	24.4	33.9	46.2	60.1	82.0	115.9	159.0
	Hybrid	10.4	13.8	17.5	23.3	31.4	40.5	50.6	67.4	90.8	117.1
	Electric	0.1	0.3	0.6	1.1	2.5	5.6	9.0	13.5	23.1	39.0
	Hydrogen	-	-	0.0	0.0	0.0	0.1	0.5	1.1	1.9	3.0
Other Fuels		10.8	11.5	12.1	12.9	13.8	14.7	15.3	16.4	17.5	18.1

Source: Vehicle Registration Status Report (Ministry of Land, Infrastructure and Transport)

1.2.5 Agriculture, Livestock farming and Fisheries

The agriculture, livestock farming and fisheries sector encompasses the production of food through crop cultivation, livestock breeding, and the harvesting, aquaculture, and processing of marine resources. The ROK has experienced a steady decrease in grain consumption due to increasing trends in dining out, westernization of dietary habits, and preference for convenience foods. Meanwhile, meat consumption has continued to rise.[22)23)] Seafood consumption has also shown an upward trend due to rising national income and growing health consciousness.

22) Source: "Forecast of Declining Rice Consumption, Need to Implement Policies Reflecting Consumption Changes" (Press release, Korea Rural Economic Institute, June 13, 2019)
23) Source: Meat Consumption Status (Korea Meat Trade Association)

In the household sector, the annual per capita grain consumption in 2022 was 64.7kg, indicating a 14.1% (10.6kg) decrease compared to 2013, with an average annual decline of 1.7% since 2013. Rice consumption, which accounts for the majority (87.7%) of total grain consumption, has been decreasing at an annual rate of 1.9% since 2013.[24)]

The total amount of chemical fertilizers used for crop cultivation in 2022 was 410 kt, showing a 10.7% (49 kt) decrease compared to 2013. The amount used per unit area was 255kg/ha, indicating a 2.7% (7kg/ha) decrease from 2013. The total amount of chemical fertilizer use has continuously decreased due to reduced cultivation area, following the declining rice consumption, while the amount used per unit area has maintained levels similar to previous years.[25)]

Livestock manure production in 2022 reached 139,353 tonnes/day, showing a 3.1% (4,227 tonnes/day) increase compared to 2013. By livestock type in 2022, cattle accounted for 59,174 tonnes/day (42.5%), pigs for 55,344 tonnes/day (39.7%), and other livestock (poultry, horses, sheep, goats, deer, etc.) for 24,835 tonnes/day (17.8%). The amount of livestock manure has been continuously increasing due to growing livestock numbers in response to increased meat consumption. Of the livestock manure produced in 2022, 79.5% was self-managed independently, with the majority being recycled into compost or liquid fertilizer.

24) Source: Grain Consumption Survey (Statistics Korea)
25) Source: Pesticide and Chemical Fertilizer Consumption (K·indicator)

<Table Ⅱ-12> Trends in Livestock Manure Production and Management

			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Number of Livestock Farms (Households)			212,794	213,599	194,823	192,982	201,745	197,026	198,229	194,665	178,197	178,069
Livestock Population (Thousands)			235,144	240,176	236,801	252,197	258,492	261,477	291,996	247,111	246,541	233,255
Livestock Manure Production (tonnes/day)	Total		135,126	136,627	134,562	138,205	137,701	144,313	153,220	139,753	142,027	139,353
	Swine		53,322	55,227	54,268	56,291	56,229	58,614	60,883	56,270	56,439	55,344
	Cattle		40,696	40,004	39,072	39,854	39,393	42,121	45,284	44,921	46,676	47,911
	Dairy Cattle		17,230	17,075	17,101	16,292	15,562	16,772	17,324	12,411	12,765	11,263
	Other Livestock		23,878	24,321	24,120	25,769	26,517	26,805	29,730	26,152	26,148	24,835
Livestock Manure Management (tonnes/day)	Self-Management	Total	104,315	103,922	102,488	114,035	110,810	115,779	122,319	113,520	114,239	110,744
		Composting	89,608	88,559	88,620	101,122	99,579	105,653	107,768	98,659	100,198	87,934
		Liquid Fertilizer	7,256	8,010	7,203	5,560	4,725	3,678	5,287	6,800	6,709	11,018
		Wastewater Treatment	5,623	5,595	4,771	5,725	5,032	6,060	9,129	7,966	7,274	11,758
		Untreated	1,829	1,758	1,896	1,627	1,475	388	135	94	57	33
	Outsourced Management*	Total	30,811	32,705	32,073	24,170	26,891	28,534	30,901	26,233	27,788	28,609
		Composting	-	-	-	-	-	-	9,107	6,074	5,666	6,144
		Liquid Fertilizer	-	-	-	-	-	-	10,882	10,263	11,676	11,526
		Wastewater Treatment	-	-	-	-	-	-	10,473	9,461	9,931	10,134
		Untreated	-	-	-	-	-	-	440	436	515	805

* Detailed breakdown of outsourced management methods was not surveyed prior to 2018.
Source: Livestock manure Treatment Statistics (Ministry of Environment)

The production of compound feed in 2022 reached 21,413 kt, showing a 13% (2,477 kt) increase compared to 2013, attributed to the increased demand from growing livestock numbers. By livestock type, feed for pigs and poultry accounted for the largest proportion, while feed for beef cattle showed a slight decrease. The production of dairy cattle feed decreased due to declining dairy cattle numbers, reducing its share in total compound feed production.[26)]

In the fisheries sector, the number of registered fishing vessels peaked at 95,890 vessels in 2000, but has steadily decreased to 64,385 vessels in 2022. This reduction results from the coastal fishing and offshore vessel reduction program aimed at protecting marine resources. As of 2022, registered coastal and offshore fishing vessel account for 60.7% of total vessels, showing a 43.1% decrease compared to 2000. Meanwhile, the number of aged vessels over 21 years old were 23,103 as of 2022, accounting for 35.9% of total vessels, with this proportion continuing to increase due to restrictions on new fishing permits under the vessel reduction program.[27)]

<Table Ⅱ-13> Trends in Registered and Aged Fishing Vessels

(Unit: vessel)

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total	Registered	71,287	68,417	67,226	66,970	66,736	65,906	65,835	65,744	65,531	64,385
	Aged	11,193	10,734	11,698	13,102	14,247	15,511	17,771	19,841	21,905	23,103
Distant Water	Registered	315	368	348	258	213	208	211	199	192	194
	Aged	286	337	319	230	185	182	184	173	162	168
Offshore	Registered	2,780	2,714	2,643	2,640	2,730	2,720	2,677	2,613	2,492	2,372
	Aged	682	729	765	891	952	1,002	998	957	942	891
Coastal	Registered	44,713	43,116	42,692	41,166	39,607	38,399	37,785	37,271	37,062	36,694
	Aged	5,116	5,393	6,598	7,216	7,979	8,671	9,798	10,944	12,247	13,426
Aqua-culture	Registered	16,772	16,992	16,976	17,716	18,095	18,913	19,347	18,707	18,915	19,148
	Aged	3,011	2,991	3,102	3,143	3,352	3,888	4,552	4,946	5,513	6,021
Inland	Registered	2,908	3,150	3,101	3,091	3,012	3,009	3,067	3,081	3,001	2,943
	Aged	301	407	538	684	721	826	928	1,119	1,177	1,152
Other	Registered	3,799	2,077	1,466	2,099	3,079	2,657	2,748	3,873	3,869	3,034
	Aged	1,797	877	376	938	1,058	942	1,311	1,702	1,864	1,445

Source: Registered Fishing Vessel Statistics (Ministry of Oceans and Fisheries)

26) Source: Compound Feed Production and Raw Material Usage Statistics (Ministry of Agriculture, Food and Rural Affairs)
27) Source: "Total number of fishing vessels in 2022 reaches 64,385. Influenced by the fishing vessel reduction program for fisheries resource management" (Press release, Ministry of Oceans and Fisheries, June 29, 2023)

1.2.6 Waste

The waste sector encompasses the treatment of waste generated from daily life and economic activities, through methods such as landfilling, incineration, and recycling. The ROK's waste generation had been steadily increasing due to industrial production and construction activities before showing a slight decrease in 2022. Since 2013, waste generation has increased at an average annual rate of 3.0%, reaching 186.45 million tonnes in 2022, indicating a 29.9% increase compared to 2013.

<Table Ⅱ-14> Trends in Waste Generation by Type

(Unit: 10,000 tonnes/year)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total	14,348	14,660	15,265	15,663	15,678	16,283	18,149	19,546	19,738	18,645
Municipal Waste	1,778	1,822	1,871	1,962	1,952	2,045	2,115	2,254	2,269	2,304
Industrial Waste	5,418	5,591	5,669	5,918	6,018	6,122	7,396	8,087	8,490	8,106
Construction Waste	6,699	6,766	7,236	7,280	7,164	7,554	8,070	8,644	8,381	7,618
Designated Waste	453	481	489	503	544	562	568	561	598	617

Source: National Waste Generation and Treatment Status (Resource Circulation Information System)

In 2022, industrial waste, consisting of slag, dust, and sludge, accounted for the largest proportion at 43.5% of total waste generation. This was followed by construction waste at 40.9%, municipal waste at 12.4%, and designated waste[28] at 3.3%. The proportions of industrial and construction waste fluctuate according to industrial activity and construction market conditions. The average annual growth rates from 2013 to 2022 were 2.9% for municipal waste, 4.6% for industrial waste, 1.4% for construction waste, and 3.5% for designated waste. Notably, in 2020, municipal waste generation increased by 6.5% compared to 2019, primarily due to increased waste paper and plastic waste generation resulting from the expansion of non-face-to-face consumption (online shopping, food delivery, etc.) during the COVID-19 pandemic.

Waste treatment, which includes collection, transportation, storage, recycling, and disposal of generated waste, has fluctuated in accordance with waste generation volumes. While waste

28) Designated waste refers to industrial waste, such as waste oil, waste acid, or medical waste, that can harm the surrounding environment or pose risks to human health.

treatment previously relied primarily on landfilling, the introduction of the volume-based waste fee system and separate collection of recyclables has significantly expanded the proportion of recycling. As of 2022, recycling accounts for 86.8% of total waste treatment, maintaining at over 80% consistently since 2013. The remaining treatment methods comprise of incineration at 5.2%, landfilling at 5.1%, and other treatment methods at 2.9%,[29] with non-recycling treatment methods showing a declining trend. From 2013 to 2022, the average annual growth rate for recycling was 3.4%, while landfilling decreased by 4.2%, and incineration remained relatively stable with a 0.7% change.

<Table Ⅱ-15> Trends in Waste Treatment by Method

(Unit: 10,000 tonnes/year)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total	14,348	14,660	15,265	15,663	15,678	16,283	18,149	19,546	19,738	18,645
Recycling	11,932	12,294	12,878	13,279	13,383	14,025	15,708	17,076	17,161	16,188
Landfill	1,386	1383	1380	1385	1297	1265	1114	1002	1046	944
Incineration	914	895	952	965	960	964	948	1015	979	977
Other	116	88	55	34	38	29	379	453	552	536

Source: National Waste Generation and Treatment Status (Resource Circulation Information System)

1.2.7 Carbon sinks

The carbon sinks sector encompasses the role of terrestrial and coastal ecosystem vegetation and soil in absorbing and storing atmospheric carbon. As of 2020, the ROK has a total forest area of 6,298 kha, accounting for 62.7% of the total land area, ranking fourth highest among OECD countries after Finland (73.7%), Sweden (68.7%), and Japan (68.4%). Forest area has decreased by 0.58% (36 kha) compared to 2015 due to deforestation to other uses such as road construction and housing development.

Compared to 2011, coniferous forest area decreased by 9.5% (245 kha), while deciduous forest area increased by 16.7% (287 kha). Mixed forest area also decreased by 10.2% (189 kha) compared to 2011.

29) Since 2019, the calculation method for "Others" has been revised to include intermediate disposal methods (e.g., mechanical, chemical, biological treatments) excluding incineration, as well as marine emissions.

<Table Ⅱ-16> Trends in Forest Area by Type

(Unit: kha)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total	6,348	6,340	6,339	6,342	6,335	6,326	6,318	6,306	6,299	6,298
Coniferous	2,569	2,562	2,557	2,552	2,339	2,333	2,329	2,321	2,314	2,324
Broadleaved	1,719	1,719	1,718	1,721	2,029	2,025	2,021	2,018	2,012	2,006
Mixed	1,855	1,844	1,838	1,830	1,706	1,703	1,699	1,693	1,688	1,666
Bamboo	7	7	7	7	22	22	22	20	20	20
Non-stocked	197	207	219	233	239	243	247	254	265	282

Source: 2020 Forest Basic Statistics (Korea Forest Service)

Forest age class distribution as of 2020 shows that age classes 4-5 (31-50 years) account for 76% of total forest area. Meanwhile age class 6 and above currently accounts for only 6%, and it is projected to increase to 35% by 2030 and 80% by 2050 if the current forest age structure is maintained. This concentration in specific age classes results from the large-scale national forestation efforts conducted in the 1970-1980s.

As of 2023, coastal wetland area was 2,443.3 km^2, accounting for approximately 2.4% of the national land area. Coastal wetland area has decreased by 1.6% (38.7 km^2) compared to 2018 due to reclamation for port areas, residential areas, and industrial sites.[30] Tidal flat ecological surveys conducted from 2015 to 2022 identified 42 halophyte communities in the second cycle (2017-2018), 45 in the third cycle (2019-2020), and 38 in the fourth cycle (2021-2022). The community area was 1,501,404 m^2 in the first cycle (2015-2016), 1,790,954 m^2 in the second cycle, 3,955,715 m^2 in the third cycle, and 2,324,343 m^2 in the fourth cycle. The decrease in community area during the fourth cycle is attributed to factors such as abnormal weather conditions including high temperature, drought, and high salinity during germination periods, as well as tidal flat sedimentation patterns affecting the characteristics of halophyte vegetation.[31]

<Table Ⅱ-17> Number and Total Area of Halophyte Plant Communities

	Average	First Cycle (2015-2016)	Second Cycle (2017-2018)	Third Cycle (2019-2020)	Fourth Cycle (2021-2022)
Number of Communities (Unit)	41.6	-	42	45	38
Total Community Area (m^2)	2,393,104	1,501,404	1,790,954	3,955,715	2,324,343

Source: National Comprehensive Investigation into Marine Ecosystems 2022 (Ministry of Oceans and Fisheries, 2022)

30) Source: Status of Coastal Wetland Area (Ministry of Oceans and Fisheries)
31) Source: National Comprehensive Investigation into Marine Ecosystems 2022 (Ministry of Oceans and Fisheries, 2022)

1.3 Institutional Arrangement to track progress in implementing and achieving the NDC

1.3.1 Governance for Tracking NDC Progress

The ROK has operated the Presidential Committee on Green Growth since 2009, based on the *Framework Act on Low Carbon, Green Growth* (January 2010), which established fundamental directions for low-carbon green growth policies and implemented the *National Green Growth Strategy* (July 2009), *Basic Plan for Coping with Climate Change*, *Basic Plans for Energy*, and *Basic Plans for Sustainable Development*. In May 2021, the government integrated the National Council on Climate and Air Quality and the Presidential Committee on Green Growth to establish the 2050 Carbon Neutrality Commission (Carbon Neutrality Commission), a public-private governance body under the direct authority of the President, as the implementation system for 2050 carbon neutrality.

Following its establishment, Carbon Neutrality Commission developed the *2050 Carbon Neutrality Scenarios* (October 2021) and the *Enhanced Update of its First Nationally Determined Contribution* (October 2021), establishing milestones for achieving 2050 carbon neutrality target. These documents present a blueprint for the ROK's economic and social transformation over 30 years.

In March 2022, with the implementation of the Carbon Neutrality Act, the Carbon Neutrality Commission was renamed to the Carbon Neutrality and Green Growth Commission with expanded functions and roles. The commission has since reestablished its legal status as a governance body that incorporates opinions from all sectors of society and performs a pivotal role in achieving carbon neutrality.

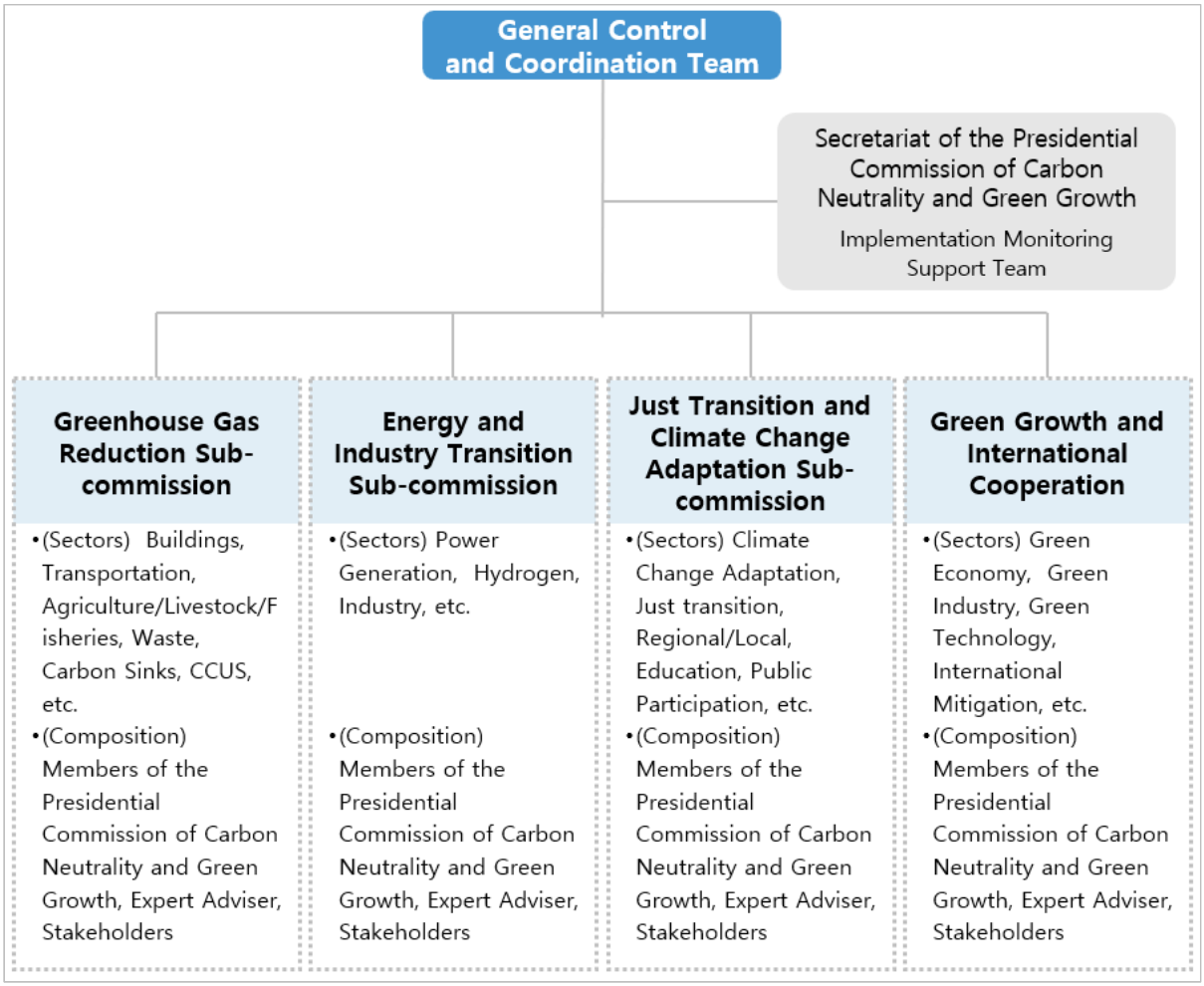
Carbon Neutrality and Green Growth Commission serves as the key institution for tracking the ROK's implementation of the NDC by: ⅰ) establishing basic directions for transitioning to a carbon-neutral society and promoting green growth; ⅱ) setting and monitoring national vision, mid- to long-term reduction targets, and national basic plans; ⅲ) establishing, modifying, and monitoring national climate change adaptation plans; ⅳ) promoting public understanding, communication, and international cooperation related to carbon neutrality.

In June 2023, the commission deliberated and approved the *Plan for Implementation Review of 2023 Carbon Neutrality and Green Growth* and also established the Monitoring Group for

Carbon Neutrality and Green Growth Implementation. This monitoring group includes commission members, expert members, youth and future generations, as well as civil society organizations, ensuring reliability and transparency in the transition to a carbon-neutral society by reflecting diverse stakeholder opinions. The monitoring group comprises of four sectoral inspection teams and a general coordination team. The sectoral teams conduct efficient assessments through the participation of the Carbon Neutrality and Green Growth Commission-appointed members, experts, and stakeholders. After reviewing the 2022 GHG reduction achievements and the implementation of the *First National Framework Plan for Carbon Neutrality and Green Growth* (Carbon Neutrality Framework Plan) (April 2023), the inspection body presented policy recommendations and areas for improvement, and identified and highlighted the best practices.[32] These assessment results are expected to serve as crucial reference material for establishing the NDC implementation roadmap.[33]

32) Source: Launch of an Inspection Team for the Implementation Management of Carbon Neutrality and Green Growth (Press Release by the Presidential Commission on Carbon Neutrality and Green Growth, July 26, 2023)

33) Source: 2022 Carbon Neutrality and Green Growth Implementation Inspection Results (Presidential Commission on Carbon Neutrality and Green Growth, 2023)



[Figure Ⅱ-11] Carbon Neutrality and Green Growth Implementation Inspection Team

Source: Launch of an Inspection Team for the Implementation Management of Carbon Neutrality and Green Growth (Press Release by the Presidential Commission on Carbon Neutrality and Green Growth, July 26, 2023)

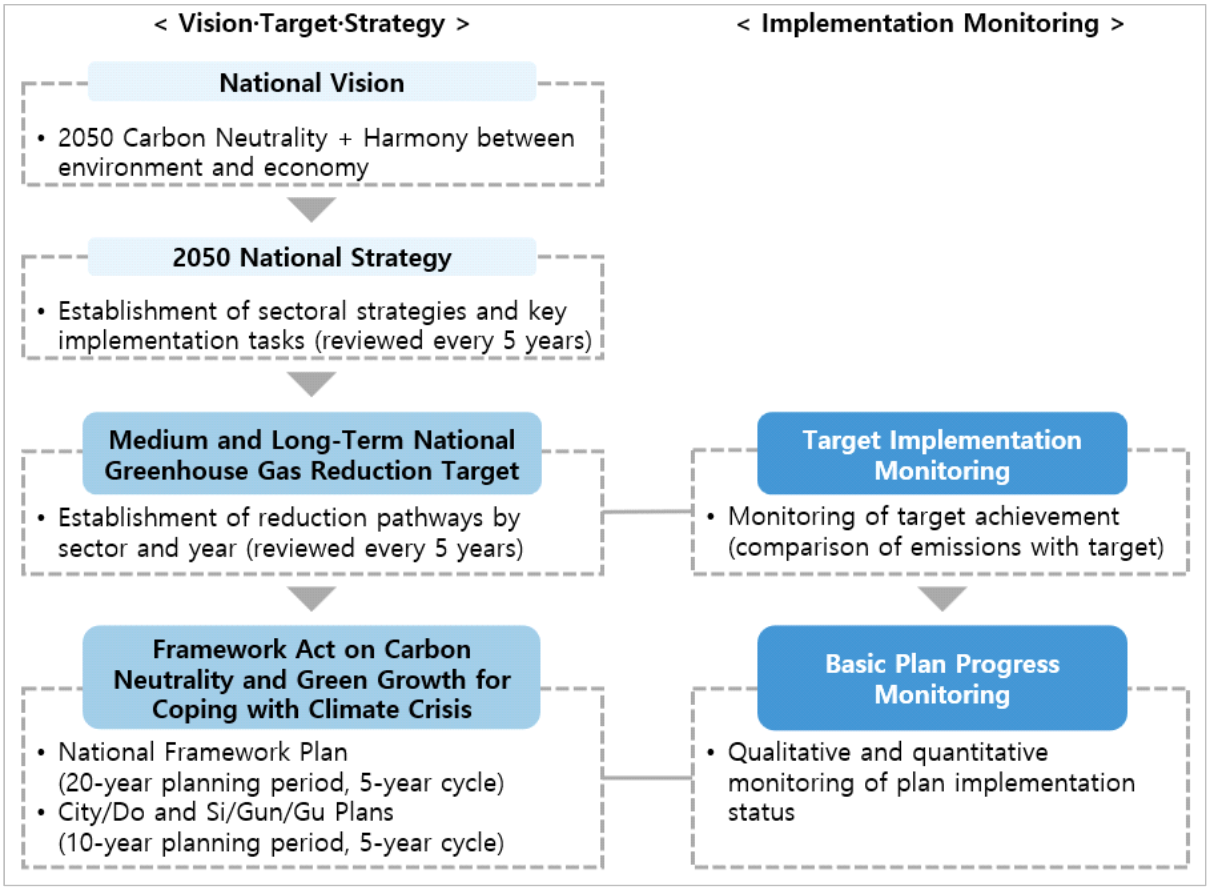
1.3.2 Legal, Institutional, Administrative, and Procedural Arrangements

Since 1999, the ROK has established a foundation for its climate change response policies. This began with the development of three iterations of the *Comprehensive Strategies for Responding to the UNFCCC* through the Technical Working Group Meeting on the Climate Change Convention, which operated from 1999 to 2007. Subsequently, the *Basic Plan for Climate Change Response* was introduced in September 2008. In 2014, the ROK voluntarily set a national GHG reduction target to reduce emissions by 30% compared to the Business-As-Usual (BAU) scenario by 2020,[34] thereby establishing a foundation for the policy framework on climate change response.

34) The BAU scenario projects future GHG emissions assuming no additional mitigation efforts are implemented and current trends continue.

The ROK then submitted its Intended Nationally Determined Contribution (INDC) in 2015, setting a target to reduce GHG emissions by 37% compared to the BAU scenario by 2030, and developed a detailed roadmap for achieving this target in 2016. Additionally, based on the *Plan to Strengthen Climate Change Response Systems for Effective Implementation of the Paris Agreement*, which was jointly prepared by relevant ministries under the leadership of the Office for Government Policy Coordination, the climate response framework was restructured. This involved shifting responsibility for climate action oversight from the Ministry of Environment to a system led jointly by the Prime Minister and the Deputy Prime Minister for Economic Affairs. Building on this pan-government response framework, the ROK developed the *First Basic Plan for Coping with Climate Change* in December 2016, a 20-year plan addressing climate change projections along with the mitigation and adaptation responses. This was followed by the *Second Basic Plan for Coping with Climate Change* in October 2019, which was further expanding and formalizing the national climate response system.

In line with the international community's full-scale discussions on carbon neutrality in 2020, the Carbon Neutrality Act was enacted in 2021 to replace the existing Green Growth Act. The Act includes the following key provisions. First, the establishment of the vision of achieving carbon neutrality by 2050, ensuring harmony between environmental protection and economic growth. It formalizes national strategies and mid- to long-term GHG reduction targets, including a specific goal to reduce GHG emissions by more than 35% by 2030 compared to 2018 levels. Furthermore, both the national government and local governments are also mandated to set reduction targets and plans. A system to monitor progress and assess the achievement of these goals is also in place. Second, the creation of the highest level of public-private governance to deliberate and decide on policies, targets, and implementation monitoring related to the climate crisis through the Carbon Neutrality and Green Growth Commission. Third, the mandate for measures such as Climate Change Impact Assessments, Greenhouse Gas Reduction Cognitive Budget, Internationally Transferred Mitigation Outcomes. Fourth, the foundation laid for implementing comprehensive climate crisis responses, including adaptation to climate change, just transition, and green growth. Fifth, the provision for the creation of Climate Response Fund to secure financial resources for industrial restructuring and climate crisis response initiatives.



[Figure Ⅱ-12] Framework for Carbon Neutrality Implementation

Source: Legislation of Carbon Neutrality Vision and Greenhouse Gas Reduction Commitment, Moving Towards a 2050 Carbon Neutral Society (Office for Government Policy Coordination Press Release, March 22, 2022)

2. ROK's Nationally Determined Contribution

2.1 NDC Target

2.1.1 History of Establishment and Updates

With the adoption of the Paris Agreement in 2015, a new climate regime was launched with participation from both developed and developing countries. Under its goal to hold the increase in global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit it to 1.5°C, all parties are required to submit their NDCs to the UNFCCC every five years from 2020.

The ROK has established its Intended Nationally Determined Contribution (INDC) in June 2015 and announced to the international community its target to reduce GHG emissions by 37% compared to the BAU levels by 2030. In 2016, the government published the *Roadmap for the 2030 NDC* (December 2016), presenting systematic implementation measures for the achievement of the NDC. Subsequently, as energy transition and fine dust reduction measures were strengthened, the reduction strategy required modification. In 2018, the government reaffirmed its commitment through the *Revised roadmap for the 2030 NDC* (July 2018), which expanded domestic reduction shares (sectoral reduction amounts) within the existing reduction target, reaffirming the ROK's strong commitment to GHG reduction.[35)]

Recognizing the limitations of the BAU approach, the discussions to transition to an absolute reduction target method was initiated to enhance implementation monitoring effectiveness and international credibility. Consequently, in December 2020, the ROK submitted the update of its First NDC to the UNFCCC, targeting a 24.4% reduction from 2017 levels (26.3% from 2018 levels), alongside the *2050 Long-term Low Greenhouse Gas Emission Development Strategy* (LEDS) (December 2020). This aligned with Article 4.4 of the Paris Agreement, which states that developed country Parties should undertake absolute emission reduction targets, while developing country Parties should continue enhancing their mitigation efforts and are encouraged to move over time towards economy-wide emission reduction targets.

35) The overall reduction target remains the same, but the proportion of domestic and overseas reductions has been adjusted from 25.7% domestic and 11.3% overseas to 32.5% domestic and 4.5% overseas.

Following the ROK's declaration of carbon neutrality, a Technical Advisory Body was established to align the preparation of the 2050 Carbon Neutrality Scenarios with the updated NDC. Efforts were made to review and enhance the NDC targets, taking into account the objectives of the Carbon Neutrality Act, international trends, and domestic conditions. As a result, for the first time since the initial establishment of the INDC in 2015, the ROK has significantly revised its reduction targets, finalizing its Enhanced Update of the First NDC in October 2021, to achieve a 40% reduction in GHG emissions by 2030 compared to 2018 levels. This enhanced commitment was announced to the international community during the 26th UN Climate Change Conference of the Parties (COP26) and was officially submitted to the UNFCCC in December of the same year.

<Table Ⅱ-18> NDC Formulation and Updating Process

	2030 National GHG Reduction Target (June 2015)	National Roadmap for GHG Reductions by 2030 (December 2016)	Revised National Roadmap for GHG Reductions by 2030 (July 2018)	Updated 2030 Nationally Determined Contribution (NDC) (December 2020)	Enhanced 2030 Nationally Determined Contribution (NDC) (October 2021)
Sector	-	8 sectors and 30 industries	8 sectors		7 sectors
Reduction Target	37% reduction compared to 2030 BAU* (* 850.6 $MtCO_2$-eq)			24.4% reduction compared to 2017 total emissions* (* 709.1 $MtCO_2$-eq)	40% reduction compared to 2018 total emissions* (* 727.6 $MtCO_2$-eq)

2.1.2 NDC Description

The Enhanced NDC targets a reduction of 40% (291 $MtCO_2$-eq) from 2018 total emissions (727.6 $MtCO_2$-eq), aiming to reduce net emissions to 436.6 $MtCO_2$-eq by 2030. The reduction target is set as an absolute value, calculated by subtracting 2030 net emissions (including LULUCF) from 2018 total emissions (excluding LULUCF). The average annual reduction rate of 4.17%/year presents the ROK's more ambitious target compared to major developed countries such as the EU (1.98%/year), USA (2.81%/year), and Japan (3.56%/year).

The NDC implementation period is from 2021 to 2030, with the target year being 2030 (single year target). The target covers seven sectors – i.e., power generation, industry, building, transportation, agriculture/livestock farming/fisheries, waste, and carbon sinks (LULUCF) - and six GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6).

Following the NDC submission in 2021, the Carbon Neutrality Framework Plan was established under the Carbon Neutrality Act, defining and organizing key sectoral policy measures to achieve the NDC. Additionally, the ROK is expanding public-private cooperation projects and investments while establishing a foundation for international mitigation projects to utilize Internationally Transferred Mitigation Outcomes (ITMOs) under Article 6 of the Paris Agreement as a complementary measures for achieving its NDC.

<Table Ⅱ-19> Key Elements of the Enhanced 2030 NDC (October 2021)

	Information
Target(s) and description	The ROK's updated NDC target is to reduce 40% from the total national GHG emissions in 2018, which is 727.6 $MtCO_2$-eq, by 2030. It plans to use voluntary cooperation under Article 6 of the Paris Agreement as a complementary measure to its domestic mitigation efforts, including LULUCF, to achieve its target.
Target year(s) or period(s)	[Target year] 2030, Single-year target
Reference point(s), base year(s), and their respective value(s)	[Base year] 2018 [National total GHG emissions (excluding LULUCF) in 2018] 727.6 $MtCO_2$-eq
Time frame(s) and/or periods for implementation	From January 1, 2021, to December 31, 2030
Scope and coverage	[Sectors] Power Generation, Industry, Building, Transportation, Agriculture/Livestock Farming/Fisheries, Waste, Carbon Sinks (LULUCF) [Gases] CO_2, CH_4, N_2O, HFCs, PFCs, SF_6
Intention to use cooperative approaches	The ROK plans to utilize voluntary cooperation under Article 6 of the Paris Agreement as a complementary measure to support the achievement of its NDC.
Any updates of previously reported information	The ROK enhanced its reduction target from 26.3% to 40% compared to 2018 total emissions (excluding LULUCF).
Methodologies	The following methodologies are applied to ensure transparency, accuracy, completeness, comparability, consistency principles, and environmental integrity while preventing double counting when calculating emissions and removals. [Methodologies] - Calculated based on Decision 24/CP.19 and the 1996 IPCC Guidelines - Partial application of IPCC GPG 2000, IPCC GPG-LULUCF 2003, and 2006 IPCC Guidelines [Common Metrics] IPCC Second Assessment Report (SAR) Global Warming Potentials (GWPs)

2.2 Information Necessary to Track Progress in Implementing and Achieving the NDC

2.2.1 Indicator

The key indicator selected in the First Biennial Transparency Report (BTR) to evaluate the progress in implementing and achieving the NDC is annual total GHG emissions (excluding LULUCF). This indicator is calculated as the sum of GHG emissions from energy, industrial processes, agriculture, and other sectors, excluding the Land Use, Land-Use Change and Forestry (LULUCF) sector.

2.2.2 Methodology

In accordance with Article 4, paragraphs 13 and 14 of the Paris Agreement, the Intergovernmental Panel on Climate Change Guidelines for National GHG Inventories (IPCC Guidelines) were applied as the NDC estimation methodology to ensure environmental integrity, transparency, accuracy, completeness, comparability, consistency in estimating emissions and removals, and to prevent double counting.

The methodologies for calculating emissions and removals were primarily based on Decision 24/CP.19 and the 1996 IPCC Guidelines with Global Warming Potentials (GWPs) from the IPCC Second Assessment Report applied as common metrics. Some estimation methodologies applied the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (GPG 2000), the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF 2003), and the 2006 IPCC Guidelines. The sectors using the GPG 2000 are ⅰ) Energy: Civil aviation, ⅱ) Agriculture: Enteric fermentation and manure management, and ⅲ) Waste: Waste disposal in landfills, wastewater treatment, and waste incineration. The sectors applying the GPG-LULUCF 2003 include agricultural land and grassland in the LULUCF category. Meanwhile, the detailed categories using the 2006 IPCC Guidelines are: ⅰ) Energy: Fugitive emissions from natural gas systems, ⅱ) Industrial Processes: Nitric acid production, semiconductor and liquid crystal display manufacturing, and heavy electrical equipment, ⅲ) Agriculture: Rice cultivation and agricultural soils, ⅳ) LULUCF: Forest land and wetlands, and ⅴ) Waste: Other subcategories.

Variables are applied differently according to calculation tiers, primarily using Tier 1, with Tier 2 methods applied in specific sectors. The sectors using the Tier 2 method are ⅰ) CO_2 from fuel combustion, (ⅱ) CH_4 and N_2O from public electricity and heat production, ⅲ)

PFCs, HFCs, SF_6, and CO_2 from semiconductor and liquid crystal display manufacturing, Agriculture Sector, ⅳ) CH_4 from rice cultivation, ⅴ) N_2O from agricultural soils, ⅵ) CO_2 from forest land (LULUCF), ⅶ) CH_4 from waste disposal in landfills, and ⅷ) CH_4 from wastewater treatment, ⅸ) N_2O from waste incineration.

The government systematically and continuously manages emission sources to include all possible sources in NDC estimation and maintain consistency thereafter. A Technical Advisory Body comprising sectoral experts conducts reviews by sector - power generation, industry, buildings, etc. - to ensure expertise and rationality in NDC estimation. Once established, the NDC is finalized through deliberation and resolution by the Carbon Neutrality and Green Growth Commission.

There are differences between the methodologies used for estimating the NDC and the National GHG Inventory reported in the First BTR. According to Decision 18/CMA.1, national GHG inventories shall use the 2006 IPCC Guidelines and the GWPs from the IPCC Fifth Assessment Report (AR5) for estimating emissions and removals. For the first time, the ROK included inventory information applying the 2006 IPCC Guidelines and AR5 GWPs in Chapter Ⅰ of its first BTR. However, the Enhanced NDC submitted in 2021 was estimated using the 1996 IPCC Guidelines, leading to a difference from the inventory information presented in Chapter 1 of the BTR and the NDC. Furthermore, information on Policies and Measures (PaMs) in this report was also calculated using the 1996 IPCC Guidelines.

Meanwhile, ITMOs under Article 6 of the Paris Agreement are being pursued through bilateral agreements with countries such as Vietnam and Uzbekistan. However, no reduction outcomes have been generated yet. Therefore, reporting on the use of ITMOs for NDCs and measures to prevent double counting will be included in subsequent BTRs.

2.2.3 Tracking Progress in Implementing and Achieving NDC

While the ROK's enhanced NDC submitted to the UN in 2021 has reported a total emissions of 727.6 $MtCO_2$-eq for the base year 2018, this figure was recalculated to 732.9 $MtCO_2$-eq based on the latest statistics from December 2024. This report applies the updated figure of 732.9 $MtCO_2$-eq as the reference point.[36)]

Based on annual total GHG emissions, progress shows emissions of 690.8 $MtCO_2$-eq in 2021 and 671.2 $MtCO_2$-eq in 2022. The reduction level, based on total emissions for 2022, represents approximately 8.4% (61.7 $MtCO_2$-eq) compared to 2018, showing a 2.84% decrease from the previous year and marking two consecutive years of decline. As international mitigation projects are in their initial stages, information regarding ITMOs for NDC and measures to prevent double counting will be reported in subsequent BTRs.

<Table Ⅱ-20> Information on Tracking Progress in Implementing and Achieving NDC (CTF Ⅱ.4)

	Unit	Reference Point[1] (2018)	NDC Implementation Period		Target Level[2]	Target Year	NDC Progress Status
			2021	2022			
Indicators and Related Information for Tracking Progress in Implementing and Achieving NDC							
Annual Total GHG Emissions	$MtCO_2$-eq	732.9	690.8	671.2	40%	2030	As of 2022, approx. 8.4% reduction compared to 2018
ITMOs Utilization	As international mitigation projects are at the initial stage, the ROK plans to report on NDC utilization of ITMOs and double counting prevention in its subsequent BTRs.						
NDC Achievement	As the ROK's NDC sets a single-year target for 2030, achievement status cannot be verified in the first BTR						

1) Updated figures due to recalculation (727.6 → 732.9)
2) The ROK plans to use voluntary cooperation under Article 6 of the Paris Agreement as a complementary measure to its domestic mitigation efforts including LULUCF to achieve its target.

36) Refer the comparison of criteria for estimating GHG emissions between 1996 IPCC Guidelines and 2006 IPCC Guidelines contained in NID.

3. Mitigation Policies and Measures

3.1 Overview

Various mitigation PaMs have been implemented based on several key strategies and plans, including the *Comprehensive Strategies for Responding to the UNFCCC*, the *Comprehensive Basic Plan for Climate Change Response* (September 2008), the *Basic Plan on New and Renewable Energy*, the *Master Plan for Rationalization of Energy Use*, and the *National Climate Change Adaptation Plan*. The *Framework Act on Low Carbon, Green Growth* (January 2010) was subsequently enacted, followed by the adoption of the *First Basic Plan for Coping with Climate Change* (December 2016). This plan comprehensively outlined mitigation and adaptation measures, financial support, and implementation monitoring in alignment with the Paris Agreement.

The *First Basic Plan for Coping with Climate Change* (December 2016) covers the period from 2017 to 2036 and consists of seven tasks: ⅰ) transitioning to low-carbon energy policy, ⅱ) cost-effective GHG mitigation through market mechanisms, ⅲ) fostering climate response new industries and expanding investment in new technologies, ⅳ) advancing towards a climate-resilient society, ⅴ) enhancing carbon removal and circulation, ⅵ) strengthening international cooperation, and ⅶ) enhancing public participation base. Through these measures, it aims to efficiently respond to climate change and implement a low-carbon society.

The *Second Basic Plan for Coping with Climate Change* (October 2019) was formulated with the vision of implementing a sustainable low-carbon green society. It presents sectoral mitigation PaMs by dividing GHG mitigation measures into sectors such as power generation, industry, buildings, transport, waste, public sector, agriculture and livestock farming, and carbon sinks. The main mitigation measures include: ⅰ) (Power generation) Improvement of energy mix, energy demand management, ⅱ) (Industry) Efficiency improvement, refrigerant replacement, fuel/raw material conversion, waste heat utilization, ⅲ) (Building) Enhanced insulation, facility improvement, Building Energy Management System (BEMS) expansion, ⅳ) (Transportation) Expansion of eco-friendly vehicles, fuel efficiency improvement, eco-friendly ships, biodiesel expansion, ⅴ) (Waste) Expanded recycling, methane gas recovery, ⅵ) (Public sector) Light Emitting Diode (LED) lighting replacement, expanded renewable energy use, ⅶ) (Agriculture/Livestock Farming) bio energy utilization, paddy water management, and ⅷ) (Carbon Sinks) Carbon Capture, Utilization, and Storage (CCUS).

The implementation of mitigation PaMs has been strengthened through institutional foundations, such as the Climate Response Fund and the Greenhouse Gas Reduction Cognitive Budget, with the enforcement of the Carbon Neutrality Act in April 2022. These measures have been integrated into the Carbon Neutrality Framework Plan and continue to serve as key PaMs for implementing the ROK's 2030 NDC. The following sections introduce major policies by sector.

3.2 Sectoral Mitigation Policies and Measures

3.2.1 Cross-Sector

Since the declaration of 2050 Carbon Neutrality in October 2020, which aims to achieve carbon neutrality by 2050, various PaMs for mitigation have been implemented.

PaMs are being implemented across multiple sectors including power generation, industry, building, transportation, agriculture, livestock farming and fisheries, waste, and carbon sinks to achieve NDC target. In addition to sector-specific mitigation policies, cross-sectoral policies such as the Korean Emission Trading System (K-ETS) and GHG Target Management System (TMS) are in operation. The K-ETS applies to entities with average annual GHG emissions of 125 $ktCO_2$-eq or more over the last three years, or those with at least one place of business emitting 25 $ktCO_2$-eq or more. While the K-ETS is designed to operate in five-year phases, the first phase (2015-2017) and the second phase (2018-2020) were set as three-year periods to closely monitor industrial impacts and allow for timely system improvements during the initial implementation stage. From the third phase onwards, it operates on a five-year periods.

The scope of the K-ETS has been expanded since its inception. The first phase (2015-2017) covered 26 sectors and 591 companies, while the second phase (2018-2020) included 65 sectors and 636 companies. The third phase (2021-2025) encompasses 69 sectors and 713 companies with the addition of sectors such as railroads and shipping, covering approximately 73.5% of national GHG emissions.

The K-ETS has also expanded both allocation auction and Benchmark (BM) allocation to directly and indirectly incentivize corporate to mitigate GHG. During the first phase, all allowances were freely allocated to facilitate the stabilization of the system. However, starting from the second phase, 3% of allowances for business entities eligible for allocation of emission permits (business entities eligible for allocation) were auctioned. The number was increased to 10% in the third phase. BM allocation, which gives the advantages for companies with higher efficiency within the same sector, was applied to 3 sectors in the first phase, 7 sectors in the second phase, and 12 sectors in the third phase to encourage efficiency improvements.

The enhancement of the emissions trading market has incentivized corporate mitigation activities and investments. Market liquidity has been enhanced by expanding third-party market participation, including market makers and securities firms. Additionally, auction revenues have been used to reduce corporate mitigation costs and achieve mitigation outcomes. Since 2022, the Climate Response Fund has been operating, funded by revenues from allowance auctions. This fund supports K-ETS participants with costs for carbon mitigation technologies and facility installations. In 2023, support was expanded to include both small and medium-sized enterprises (SMEs) and large companies subject to allowance auction, leading to enhanced mitigation effects.

The K-ETS is being improved to function as a more efficient mechanism for driving GHG mitigation. Opinions have been widely gathered from various stakeholders including business entities eligible for allocation, academia, and civil society to identify areas for improvement. The *K-ETS Improvement Plan* (November 2022) was established focusing on short-term improvements. The *K-ETS Market Enhancement Plan* (September 2023) was then announced to strengthen market functions. Mid- to long-term system improvements were reflected in the development of the *Fourth Master Plan for Emission Trading System* (December 2024).

The TMS targets companies with substantial GHG emissions not covered by the K-ETS, aiming to reduce emissions. Designated entities (controlled emitters) under this system are categorized by entity or place of business. Entities with average annual emissions of 50 $ktCO_2$-eq or more over the last three years, or a place of business emitting 15 $ktCO_2$-eq or more are designated as controlled emitter. As of 2022, 355 controlled emitters are subject to the TMS, with its coverage expanding annually.

<Table Ⅱ-21> Designation Criteria for Controlled Emitter

	Until 2011		From 2012		From 2014		From March 2022	
	Entity level	Place level	Entity level	Place level	Entity level	Place level	Entity level	Place level
GHG Emissions ($ktCO_2$-eq)	125	25	87.5	20	50	15	50	15
Energy Consumption* (TJ)	500	100	350	90	200	80	-	-

* Following the enactment of the Carbon Neutrality Act, energy consumption was removed from the designation criteria for controlled emitter from March 2022

■ Emission Trading System ■

1. Overview

- The Emissions Trading System (ETS) is a market-based GHG mitigation mechanism that allocates annual emission allowances to facilities that meet the designated criteria for GHG emissions, allowing emissions only within the allocated limits.
- To implement the ETS, the ROK established a legal foundation by enacting the *Act on the Allocation and Trading of Greenhouse Gas Emission Permits* (May 2012) and its *Enforcement Decree* (November 2012).
- The ETS was launched in 2015 with the adoption of the *Master Plans for Emissions Trading System* (January 2014), which set the total emission allowances linked to NDC target, the *National Greenhouse Gas Emission Permit Allocation Plan for the First Planning Period* (September 2014), and related Guidelines.

Master Plans for Emissions Trading System

	First Planning Period (2015-2017)	Second Planning Period (2018-2020)	Third Planning Period (2021-2025)
Main Objective	• Accumulating experience and ensuring the stability of the ETS	• Achieving substantial GHG mitigation	• Implementing effective mitigation measures
System Operation	• Improving system flexibility, with an expanded scope of eligible offsets • Developing infrastructure for accurate Measurement, Reporting, and Verification (MRV)	• Expanding the scope of the trading system and enhancing GHG mitigation targets • Strengthening standards for emissions reporting and verification	• Enhancing cap-setting in line with the roadmap • Expanding market functions by strengthening the market maker system and introducing exchange-traded derivatives
Allocation Method	• 100% free allocation • Applying lessons learned from the TMS	• Introducing auction-based allocation • Advancing allocation methodologies, including BM allocation	• Refining criteria for free allocation sectors and increasing the proportion of auctioned allowances • Expanding BM allocation

2. Designation Criteria for ETS Facilities

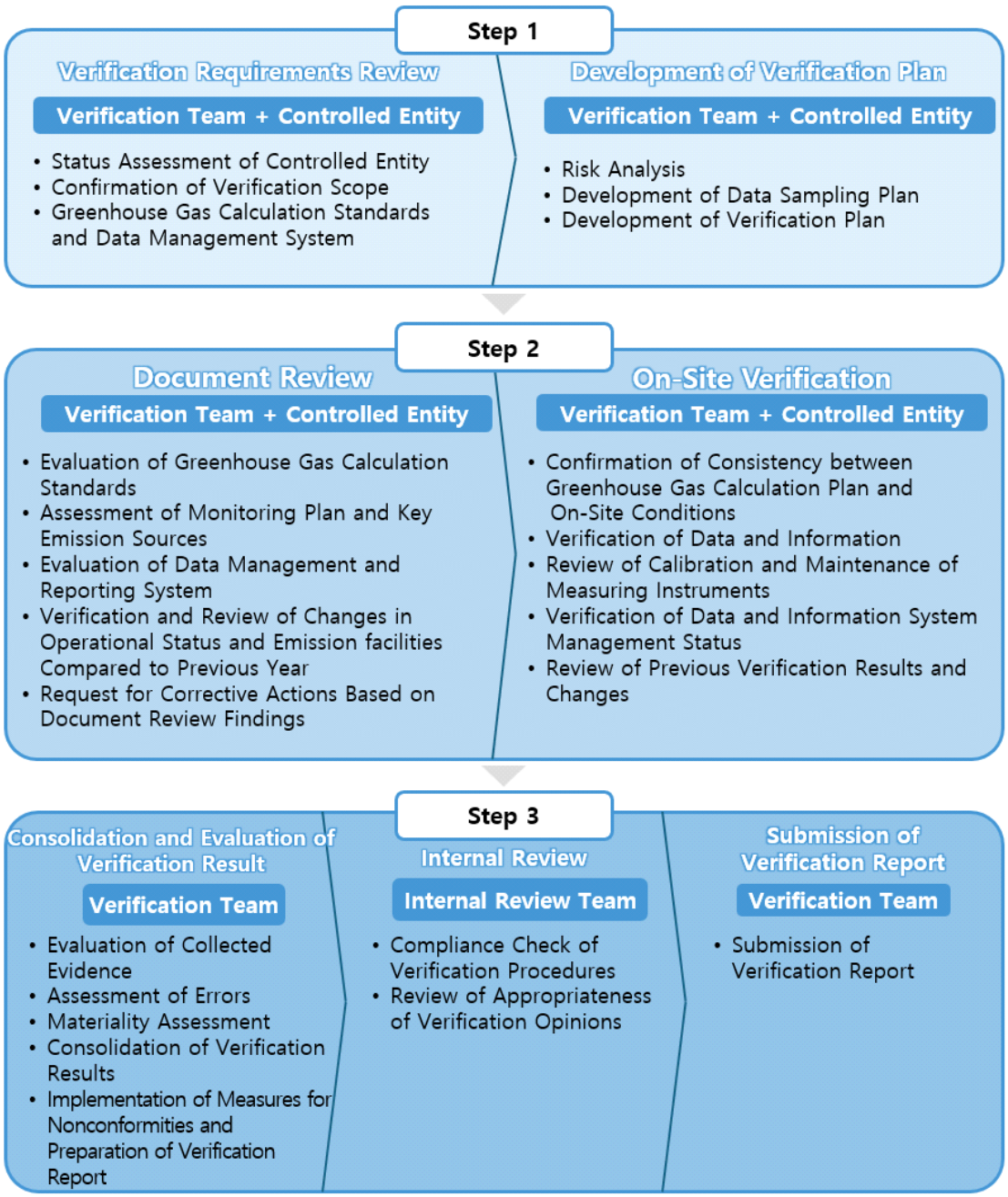
- A business entity is designated as a business entities eligible for allocation if its average annual total GHG emissions over the last three years are at least 125 $ktCO_2$-eq, or if it operates at least one place of business with the emissions of 25 $ktCO_2$-eq or more.

Emissions Trading System Entities by Planning Period

Planning Period	Year	Certified Emissions ($MtCO_2$-eq)	Year-on-Year Change Rate (%)	Number of Entities
First period	2015	542.7	-	522
	2016	554.3	2.2	560
	2017	571.9	3.2	591
Second period	2018	601.5	5.2	586
	2019	587.9	-2.3	610
	2020	554.4	-5.7	636
Third period	2021	591.0	6.6	687
	2022	572.0	-3.2	713

3. Emission Measurement Standards and Verification Methods

- The measurement and verification of emissions follow the Guidelines for Reporting and Certification of GHG Emissions Trading System (August 2024) and the Verification Guidelines for Management of GHG Emissions Trading System (August 2024).
- Business entities eligible for allocation must calculate their emissions in compliance with the minimum required Tier level, based on the scale of emission facilities and detailed emission activity types.
- Emission verification is conducted through third-party verification of statements submitted by regulated entities, using verification bodies designated or announced by the Ministry of Environment.



Verification Procedures for GHG Emissions

3.2.2 Power Generation

GHG mitigation in the power generation sector is being pursued through transition to clean energy systems, establishment of renewable energy supply infrastructure, and innovation in power supply and demand systems. According to the *10th Basic Plan for Electricity Supply and Demand* (January 2023) which outlines power supply strategies and generation facility plans from 2022 to 2036, the transition to clean energy systems will be accelerated through the phasing down aging coal power plants and continued operation of nuclear power plants. Renewable energy will be actively expanded through facility expansion and the Renewable Portfolio Standard (RPS). Furthermore, GHG emissions will be gradually reduced through the establishment of future power grid systems such as High Voltage Direct Current (HVDC) and distributed energy supply.

<Table Ⅱ-22> Power Generation Capacity and Generation by Energy Source

	2020	2021	2022	2030
Total Capacity (GW)	129.2	134.0	138.2	198.0
- Coal	36.9	37.3	38.1	31.7
- Nuclear	23.3	23.3	24.7	28.9
- LNG	41.2	41.2	41.2	58.6
- New and Renewable	20.5	24.9	28.1	72.7
- Others	7.4	7.4	6.1	6.1
Total Power Generation (TWh)	552.2	576.8	594.4	621.8
- Coal	196.3	198.0	193.2	122.5
- Nuclear	160.2	158.0	176.1	201.7
- LNG	145.9	168.4	163.6	142.4
- New and Renewable	36.5	43.1	53.2	134.1
- Others	13.2	9.4	8.4	21.1

Source: *10th Basic Plan for Electricity Supply and Demand* (Ministry of Trade, Industry and Energy, 2023), 2022 Korea Electric Power Statistics (No. 92) (Korea Electric Power Corporation, 2023)

1) Acceleration of Transition to Clean Energy Systems

(a) Phasing Down Aging Coal Power Plants

Efforts are underway to reduce GHG emissions while maintaining total power generation through the improvements in the energy mix. A key measure is the phasing down of aging coal power plants and their transition to lower-emission facilities, such as Liquefied Natural Gas (LNG) power plants of equivalent capacity. In 2020 and 2021, aging coal power plants with a total capacity of 1,000 MW and 1,620 MW, respectively, were closed. From 2025, starting with Taean Units 1 and 2 (1,000 MW), aging coal power plants totaling 9,520 MW will be gradually phased down by 2030. These coal power facilities will be replaced with LNG power facilities of equivalent capacity.

<Table Ⅱ-23> Phasing Down Aging Coal Power Plants

(Unit: MW)

	2020	2021	2025	2026	2027	2028	2029	2030
Coal (Phasing down)	1,000	1,620	1,000	2,620	1,500	1,500	1,900	1,000
LNG (Replacement)	-	-	1,000	2,620	1,500	1,500	1,900	1,000

Source: *10th Basic Plan for Electricity Supply and Demand* (Ministry of Trade, Industry and Energy, 2023), 2022 Korea Electric Power Statistics (No. 92) (Korea Electric Power Corporation, 2023)

(b) Continued Operation of Nuclear Power Plants

The energy mix is being improved by focusing on clean energy through the expansion of nuclear power generation, a carbon-free power source. Major procedures, including the development of continued operation plans and licensing reviews, are underway for 10 nuclear power plants reaching the end of their design life by 2030. Applications for continued operation have been submitted for 10 nuclear power units including Kori Units 2, 3, and 4, and Hanbit Units 1 and 2, approaching the end of their operating licenses. Upon approval, nuclear power facilities totaling 8,450 MW are expected to continue operation. The share of nuclear power generation is projected to reach 32.4% by 2030.

<Table Ⅱ-24> Nuclear Power Plants Subject to Continued Operation

Nuclear Power Plants		Capacity (MW)	Power Generation (MWh)	Operating License Expiration (Year)	Continued Operation Application Time (Year)	Continued Operation Extension Period (Year)
Kori	Unit 2	650	3,821,423	2023	2022	10
	Unit 3	950	8,890,860	2024	2022	10
	Unit 4	950	9,136,497	2025	2022	10
Hanbit	Unit 1	950	6,191,305	2025	2023	10
	Unit 2	950	5,576,302	2026	2023	10
Hanul	Unit 1	950	7,499,716	2027	2023	10
	Unit 2	950	8,806,282	2028	2023	10
Wolsong	Unit 2	700	2,157,103	2026	2024	10
	Unit 3	700	4,887,729	2027	2024	10
	Unit 4	700	5,310,886	2029	2024	10

Source: Korea Hydro & Nuclear Power Co., Ltd.

2) Establishment of Renewable Energy Supply Infrastructure

(a) Support for Renewable Energy Facility Deployment

Institutional frameworks are being established through the development of the *10th Basic Plan for Electricity Supply and Demand* (January 2023) and the *Strategies for Expanding Supply and Strengthening Supply Chain for Renewable Energy* (March 2024). Key programs include financial support in the form of long-term, low-interest loans for renewable energy generation facilities and end-use infrastructure, and deployment supports subsidizing installation costs for renewable energy facilities in housing, buildings, and regions. Renewable energy facilities (solar and wind power) with a total capacities of 412 MW and 475 MW have received financial support programs in 2021 and 2022, respectively.

<Table Ⅱ-25> Performance of Financial Support for New and Renewable Energy

(Unit: MW)

	2021	2022
Total	412	475
Solar Power Capacity Supported	373	402
Wind Power Capacity Supported	39	73

Source: 2024 Greenhouse Gas Reduction Cognitive Budget Management Plan (Government of the Republic of Korea, 2023)

(b) Renewable Energy Portfolio Standard (RPS)

To increase renewable energy generation, the RPS operates under the *Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy* (December 2004). The system requires power generators, and operating power facilities with a capacity of at least 500 MW (excluding renewable energy facilities), to supply a certain percentage of total generation from renewable energy. Accordingly, obligated suppliers are required to secure Renewable Energy Certification (REC) equivalent to their mandatory supply ratio. REC can be self-procured by constructing renewable energy power plants or purchased from the REC trading market. Meanwhile, renewable energy suppliers can receive incentives by acquiring REC for their renewable energy generation and trading them in the REC trading market.

Annual mandatory supply targets were 7% in 2020, 9% in 2021, and 12.5% in 2022, with compliance rates of 100% and 98.1% in 2021 and 2022 respectively, nearly fulfilling the mandatory supply requirements. The mandatory supply target will be gradually increased to 25% by 2030 to expand renewable energy deployment. The RPS will be improved to promote cost-effective expansion of renewable energy.

<Table Ⅱ-26> RPS Mandatory Supply Ratio, Volume, and Implementation Rate

	2020	2021	2022	2023	2025	after 2030
Mandatory Supply Ratio (%)	7.0	9.0	12.5	13.0	14.0	25.0
Mandatory Supply Volume (thousand REC)	35,590	47,447	78,623	-	-	-
Implementation Rate (%)	99.9	100.0	98.1	-	-	-

Source: Enforcement Decree of the *Act on the Promotion of the Development, Use, and Diffusion of New and Renewable Energy*, Annex 3, 2024 KEA Energy Handbook (Korea Energy Agency, 2024)

(c) Support for Renewable Energy Usage Certification System (K-RE100)

Institutional foundations are being strengthened to support for voluntarily implementation of the Renewable Electricity 100% (RE100) in the private entity. The system has been improved to allow general consumers to purchase REC, which were previously limited to RPS obligated suppliers. Various policy instruments such as Green Premium and Power Purchase Agreement (PPA) are also being developed.

Under the Green Premium system, consumers can purchase electricity from renewable sources by paying an additional premium to Korea Electric Power Corporation (KEPCO) on

top of regular electricity charges. PPAs are categorized into direct PPAs, where power purchase contracts are directly made between renewable energy suppliers and consumers, and third-party PPAs, where contracts are concluded through KEPCO as an intermediary.

As a result of establishing institutional frameworks and active private entity participation, the number of enterprises participating in the K-RE100 rapidly increased from 83 in 2021 to 149 in 2022. Their renewable energy consumption also surged from 1.5 TWh in 2021 to 6.3 TWh in 2022. Moving forward, relevant measures and trading markets will be continuously improved to enable companies to procure electricity from renewable sources more easily through support measures such as consulting, PPA grid usage fee, and establishment of corporate renewable energy funds.

<Table Ⅱ-27> Renewable Energy Use Certification System

	2021	2022
Number of Participating Companies	83	149
Renewable Energy Usage* (TWh)	1.5	6.3

* Renewable energy usage is based on the volume of renewable energy use certificates issued
Source: 2021-2022 White paper on Trade, Industry and Energy (Energy Section) (Ministry of Trade, Industry and Energy, 2023)

Renewable energy deployment is rapidly expanding through the policies including support for renewable energy facility deployment, RPS, K-RE100. Cumulative renewable energy deployment reached 24.9 GW in 2021 (solar PV 18.5 GW, wind 1.7 GW, other renewables 4.5 GW) and increased to 28.1 GW in 2022. The share of renewable energy generation has also risen from 7.5% (43,096 GWh) in 2021 to 8.9% (53,182 GWh) in 2022.

<Table Ⅱ-28> New and Renewable Energy Facility Distribution

(Unit: GW)

	2020	2021	2022	2030
Total	20.5	24.9	28.1	72.7
Solar Power	14.6	18.5	21.2	46.5
Wind Power	1.6	1.7	1.9	19.3
Hydropower	1.8	1.8	1.8	2.0
Marine	0.3	0.3	0.3	0.3
Biomass	1.3	1.4	1.8	1.8
Fuel Cell	0.6	0.7	0.9	2.5
IGCC	0.3	0.3	0.3	0.3

Source: Electric Power Statistics (Korea Electric Power Corporation), *10th Basic Plan for Electricity Supply and Demand* (Ministry of Trade, Industry and Energy, 2023)

3) Innovation in Power Supply and Demand System

(a) Establishment of Future Power Grid System

Efforts are underway to reduce GHG emissions through the establishment of future power grid systems. The systems are designed to ensure the stable integration of renewable energy into the power grid while accommodating the increased power demand from data centers. As the grid integration of renewable energy increases due to intermittency and regional concentration of renewable sources, the need for power grid reinforcement grows. However, power grid systems establishment has been facing challenges due to local residents' opposition to the installation of transmission and distribution network.

Policies are being implemented to proactively address issues surrounding future power grid establishment. First, to increase local acceptance of transmission and distribution networks, the proportion of community support within compensation packages for areas surrounding transmission facilities has been expanded to over 50%. Additionally, to address the mismatch between energy supply and demand regions due to regional concentration of renewable energy, efforts to foster communication through the operation of win-win councils with local residents or by promoting resident committees are being underway. The 500 kV East Coast-Seoul Metropolitan Area HVDC project is a representative case that has proceeded after reaching consensus through dialogue with local residents.

(b) Promotion of Distributed Energy System

To address power grid load issues arising from imbalances between power supply and demand regions, policies to promote distributed energy are being implemented by producing electricity near consumption sites. The *Special Act on Activation of Distributed Energy* (June 2023) has been enacted to support its foundation and expansion. Key provisions include: ⅰ) mandatory distributed energy facility installation,[37] requiring use of a certain proportion of energy consumption from distributed energy, ⅱ) power grid impact assessment for large-scale power consumption facilities (≥10 MW) to distribute power demand concentrated in grid-saturated areas (Seoul metropolitan area) and enhance power supply stability and predictability, ⅲ) specialized zone for distributed energy allowing direct supply of locally produced electricity to users, and ⅳ) incentives including cost subsidies, loans, and fund investments to promote distributed energy development and deployment.

3.2.3 Industry

Mitigation activities in the industrial sector can be categorized into four areas: advancing technologies and fostering corporate investments for carbon neutrality, creating a basis for improving enterprise energy efficiency, and establishing carbon neutrality governance between government and industry. First, the *Carbon Neutral Industry and Energy R&D Strategy* (November 2021) was established to promote technology development in sectors where GHG mitigation is essential for achieving carbon neutrality, such as steel, petrochemicals, cement, and semiconductors/displays. Additionally, support is being provided for corporate carbon neutrality investments through assistance in establishing Energy Management Systems and Voluntary Energy Efficiency Target System. Furthermore, institutional frameworks for improving energy efficiency, such as mandatory energy audit, are being established to encourage corporate GHG mitigation. Lastly, carbon neutrality governance is being built between government and industry through the Committee on Promoting Carbon Neutral Industrial Transformation.

37) In accordance with Article 10 of the Enforcement Decree of the *Special Act on Activation of Distributed Energy* (June 2024), this refers to projects involving the construction or major renovation of buildings expected to use more than 200,000 MWh of energy annually, or development projects such as housing site development or urban development with a project area of 1 million m^2 or more.

<Table Ⅱ-29> Major Mitigation Policies in the Industrial Sector

Policy	Description
Establishment of the Committee on Promoting Carbon Neutral Industrial Transformation (March 2021)	・(**Organizer)** Co-chaired by the Minister of Trade, Industry and Energy and the Chairman of the Korea Chamber of Commerce and Industry ・(**Role)** Facilitating public-private consensus on vision and strategy for GHG mitigation in the industrial sector
Carbon Neutral Industry and Energy R&D Strategy (November 2021)	・(**Investment Expansion)** Significantly increasing the carbon neutrality R&D budget, with a strong focus on 17 key areas, to ensure concentrated investment in carbon neutrality research. ・(**System Transition)** Transitioning to a carbon neutral R&D system through active support of ⅰ) performance-oriented, large-scale integrated R&D, ⅱ) field-based demonstration R&D, and ⅲ) international collaborative R&D built on solidarity and cooperation ・(**Infrastructure Expansion)** Strengthening private-sector engagement in carbon neutrality R&D through the establishment of an innovation fund and the development of technology valuation models.

1) Securing Core Technologies for Carbon Neutrality

(a) Research and Development of Technologies for Achieving Carbon Neutrality

The ROK has announced the *Strategy for Technology Innovation for carbon neutrality* (March 2021) and the *Carbon Neutral Industry and Energy R&D Strategy* (November 2021) as technology development roadmaps for carbon neutrality. Accordingly, priority areas and technologies for achieving carbon neutrality have been selected, and support throughout the entire cycle is being strengthened to promote public and private technology development and investment. For GHG mitigation, the focus is particularly on developing innovative technologies that enable low-carbon transition in carbon-intensive and hard-to-abate industries. Currently, the Carbon Neutrality Core Technology Development Project is being carried out as a Research and Development (R&D) targeting four industries: steel, petrochemicals, cement, and semiconductors/displays.

In the steel industry, 85% of GHG emissions occur in the blast furnace-basic oxygen furnace process (BF-BOF). Accordingly, efforts are underway to develop hydrogen based ironmaking technology to reduce GHG emissions. A total of KRW 26.9 billion support fund has been provided from 2023 to 2025 for the development of basic technologies for hydrogen based ironmaking process design, and plans are being implemented to support subsequent technology development and demonstration.

In the petrochemical industries, more than 50% of GHG emissions occur in the core naphtha cracking process. Currently, the industry aims to secure innovative technologies for substituting fuels and raw materials, with plans to provide KRW 52.4 billion for naphtha cracking process innovation and KRW 133.4 billion for developing technologies to convert methane from petrochemical by-product gases.

In the cement industry, large amounts of CO_2 are emitted during the clinker manufacturing process using limestone. Accordingly, KRW 138.9 billion will be provided for developing technologies to increase the content of cement admixtures in raw materials and expand the application of blended cement, and KRW 143.7 billion for developing technologies to reduce bituminous coal and increase the use of waste synthetic resins in fuel. In the semiconductor and display industry, large amounts of fluorinated gas are emitted during the manufacturing process. To reduce GHGs, it is essential to develop technologies to replace high-GWP etching, deposition, and cleaning process gases with low-GWP substances. For this purpose, KRW 257.1 billion will be provided to develop low-GWP alternative process gases and process optimization technologies.

(b) Support for Technology Investment in the Private Entity

Support for promoting technology investment in the private entity is being strengthened. In 2022, the carbon neutrality field was newly introduced in the scope of new growth and original technologies under the *Act on Eligible Tax Credit* (December 1998), incorporating 49 new mitigation-related technologies including CCUS, hydrogen, and renewable energy. Through this, enterprises investing in R&D classified as mitigation technologies or related facilities can receive tax credits of 20-30% and 3-12% of the investment amount, respectively. Additionally, the Loan Program for Carbon Neutrality Leading Project is being implemented to support enterprises that face difficulties investing in mitigation measures due to financial constraints. Loans or interest subsidies are being provided for private facility investments and R&D investments for carbon neutrality, and in 2022, the subsidies totaling KRW 91.2 billion were provided to 30 projects.

2) Alleviating Corporate Investment Burdens for Carbon Neutrality

(a) Building Infrastructure for Energy Management System (EnMS)

Support is being provided for building infrastructure for Energy Management System (EnMS), including energy consulting and monitoring system, to enhance corporate energy efficiency. Notably, consulting for EnMS has been provided through the Support Program for Establishment of EnMS Infrastructure implemented since 2011. In 2022, the support program for Factory Energy Management System, which had been ongoing for Smart Green Industrial Complexes nationwide, was integrated. As a result, EnMS infrastructure has been established in 272 business sites as of 2022. The plan is to establish infrastructures at approximately 40 new business sites annually, targeting a cumulative total of 608 business sites by 2030.

<Table Ⅱ-30> Number of Business Sites with Energy Management System Infrastructures

	2020	2021	2022	2030
Number of Business Sites with Energy Management System Infrastructures (Cumulative, sites)	184	227	272	608

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

(b) Voluntary Energy Efficiency Target System

Since 2020, a pilot project for the voluntary energy efficiency target system has been implemented for energy-intensive business sites with annual energy consumption of 2,000 toe or more. After the Korea Energy Agency (KEA) and places of business jointly establish energy intensity improvement targets, incentives are provided when places of business achieve their targets. In 2021, 63 places of business participated, with an average energy intensity improvement rate of 3.54%. In 2022, 91 places of business participated, with an average energy intensity improvement rate of 2.06%. In 2022, the Korea Energy Efficiency Partnership (KEEP 30) was established with the top 30 companies in energy consumption, under which the participating companies plan to set and implement energy intensity improvement targets for a five-year period from 2023 to 2027. In this process, incentives such as technology development, tax benefits, and infrastructure establishment packages will be specifically provided based on the improvement rate of energy intensity for each company.

<Table Ⅱ-31> Voluntary Energy Efficiency Target System

	2020	2021	2022
Number of Participating Sites	44	63	91
Unit Improvement Rate (%)	1.78	3.54	2.06

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

(c) Support for Energy-Saving Facility Investments

Financial and tax support systems for energy saving facility investments are being operated to assist companies experiencing difficulties in investing in energy-saving facilities. The support system is broadly categorized into two types, i.e., Energy Service Company (ESCO)[38] investment projects where ESCOs invest on behalf of companies with funding difficulties, and energy-saving facility installation projects where energy users make direct investment and the government provides low-interest loans and interest subsidies for such investments. Accordingly, investment support of approximately KRW 244.5 billion in 2021 and KRW 254.0 billion in 2022, resulted in a total of 228 ktoe and 209 ktoe energy savings, respectively.

<Table Ⅱ-32> Investment Support Projects for Energy-Saving Facilities

		2020	2021	2022
Total	Savings Amount (ktoe)	228	228	209
	Support Amount (hundred million KRW)	2,829	2,445	2,540
ESCO Investment Project	Savings Amount (ktoe)	67	96	85
	Support Amount (hundred million KRW)	413	410	370
Savings Facility Installation Project	Savings Amount (ktoe)	161	132	124
	Support Amount (hundred million KRW)	2,416	2,035	2,170

Source: 2023 KEA Energy Handbook (Korea Energy Agency, 2023)

38) An ESCO refers to companies registered with the Minister of Trade, Industry and Energy with equipment, assets, and technical personnel in accordance with Article 25 of the *Energy Use Rationalization Act* (December 1979) and Article 30 of its Enforcement Decree

(d) Support for Carbon-Neutral Leading Plants

The Support for Carbon-Neutral Leading Plant project is being implemented to establish carbon neutrality model by applying optimal technologies that can dramatically mitigate GHG emissions, targeting SMEs in carbon-intensive and hard-to-abate industries such as steel, petrochemicals, and cement. This project support types are categorized into the following: energy efficiency improvement; fuel and raw material conversion; and circular economy, providing partial subsidies for investment amounts. First, the energy efficiency improvement category includes facilities such as load-adjustable inverters for air compressors and EnMS necessary for process operation. The fuel and raw material conversion category includes replacing B/C oil boilers with LNG facilities and, new and renewable energy facilities. Lastly, the circular economy category includes recycling facilities that reduce waste, waste heat, and waste gas within places of business. Accordingly, in 2022, funding was provided to five companies in the petrochemical, cement, machinery, paper, and non-ferrous metals industries for process improvements. Upon completion of this project, mitigation effects of approximately 30 $ktCO_2$-eq annually are to be expected.

3) Enhancing Energy Efficiency

(a) Consultation for Energy Use Plan

This program mandates for prior consultation on companies' energy supply and demand, and for efficiency improvement plans before implementing large-scale projects such as land development, energy development, and social infrastructure facilities. Through this, energy use plan consultation has been made mandatory, which aims to improve corporate energy efficiency, and to promote the installation of renewable energy facilities. While the system initially targeted public facilities when introduced, it has now included private projects and facilities.

<Table Ⅱ-33> Energy Use Plan Consultation

	2020	2021	2022
Number of Consultations	100	98	84

Source: 2023 KEA Energy Handbook (Korea Energy Agency, 2023)

(b) Energy Supporters to Small and Medium-sized Enterprises

Energy Supporters, a group of energy experts, provide on-site visits, technical guidance, and consulting to support energy-saving activities for SMEs lacking energy management expertise. This program targets SMEs with an annual energy consumption of less than 2,000 toe. Efforts are also underway to alleviate the financial burden of upgrading aging facilities by linking with subsidy programs. As a result of deploying Energy Supporters to 120 and 110 SMEs in 2021 and 2022 respectively, energy savings (reduction rates) of 4 ktoe (10.8%) and 2 ktoe (5.3%) were recorded.

<Table Ⅱ-34> Energy Supporter for Small and Medium-sized Enterprises

	2020	2021	2022
Number of Target Companies for Energy Supporter (sites)	200	120	110
Energy Savings Amount (ktoe)	9	4	2
Savings Rate (%)	14.3	10.8	5.3

Source: 2023 KEA Energy Handbook (Korea Energy Agency, 2023)

(c) Mandatory Energy Audits

Excessive energy-consuming business entities with annual energy consumption of 2 ktoe or more are subject to energy audit. They must undergo energy audit regularly to identify energy usage patterns and loss factors for improving energy efficiency. Energy audit companies can identify energy usage patterns of energy-intensive businesses and suggest energy-saving measures to encourage investments for energy efficiency improvement and GHG mitigation. Through energy audits of 755 places of business in 2021 and 666 places in 2022, GHG mitigation potentials amounting to 1,429 $ktCO_2$-eq and 1,540 $ktCO_2$-eq, respectively, were identified.

<Table Ⅱ-35> Mandatory Energy Audit Projects

	2020	2021	2022
Number of Business Sites	710	755	666
GHG mitigation Potential ($ktCO_2$-eq)	1,034	1,429	1,540

Source: 2023 KEA Energy Handbook (Korea Energy Agency, 2023)

4) Government-Industry Partnership for Carbon Neutrality

The government and industry have established carbon neutrality governance to minimize the industry burden, while simultaneously encouraging voluntary GHG mitigation. To support decarbonization of industry, the government and the industry jointly launched the Committee on Promoting Carbon Neutral Industrial Transformation in 2021. Based on this, Industry-Specific, Technology Innovation, and Standardization Councils are being operated, focusing on carbon-intensive industries.[39] These councils aim to encourage voluntary GHG mitigation by industry. Through the establishment of this carbon neutrality governance, voluntary practices of GHG mitigation in the private entity are being promoted, while discussions on laws and institutional arrangements that hinder carbon neutrality achievement are being continued in same entity.

3.2.4 Building

In accordance with the *Second Master Plans for Green buildings* (December 2019) and the *Land, Infrastructure and Transport Carbon Neutral Roadmap* (December 2021), the ROK is encouraging GHG mitigation by certifying new buildings as Zero Energy Buildings (ZEB). Additionally, support is being provided for green remodeling, which improves energy efficiency by renovating existing buildings. Finally, to improve building energy efficiency, the efficiency of gas-using equipment is being enhanced, and Advanced Metering Infrastructure (AMI) is being distributed. Furthermore, various institutional measures are being prepared to facilitate the spread of new and renewable energy in the building sector.

<Table Ⅱ-36> Major Mitigation Policies in the Building Sector

Policy	Description
Second Master Plans for Green buildings (December 2019)	・Strengthening Energy Performance of New Buildings (Accelerating ZEB Adoption, Advancing Energy Performance Standards) ・Promoting Green Transformation of Existing Buildings (Fostering Green Remodeling of Aging Buildings, Enhancing Energy-Efficient Operation and Management)
Land, Infrastructure and Transport Carbon Neutral Roadmap (December 2021)	・(**Key Task)** ZEB for New Buildings, Green Remodeling of Existing Buildings ・(**ZEB for New Buildings)** Expanding Mandatory Implementation, Enhancing Existing Incentives ・(**Green Remodeling of Existing Buildings)** Broadening Public Facility Support Systems and Regulations, Increasing Private Entity Support

39) Refers to oil refining, shipbuilding, machinery, steel, cement, automotive, bio, petrochemicals, non-ferrous metals, electrical and electronics, paper and textile, and semiconductor and display industries.

1) Measures for New Buildings

(a) Promotion of Zero Energy Building (ZEB)

The government grants certification grade 1-5 to Zero Energy Buildings (ZEB) based on the energy independence rates under the ZEB certification system. A ZEB refers to a building that minimizes energy consumption by reducing the energy load and utilizing new and renewable energy. ZEB certification has been mandatory for public buildings since 2020. Through the revision of the *Green Buildings Construction Support Act* (February 2012) from 2023, the mandatory certification targets have been expanded to include public buildings with a total floor area of 500 m^2 or more (previously 1,000 m^2 or more) and public apartment buildings with 30 or more households. From 2025, for public buildings with a total floor area of 1,000 m^2 or more across 17 building types, including office facilities, the mandatory certification grade will be raised from grade 5 to grade 4. For private buildings, research and legal revisions to improve minimum performance requirements will be pursued in 2025.

In 2021, ZEB achieved a total floor area 5,937.8 thousand m^2 and GHG mitigation of 100.9 $ktCO_2$-eq, while in 2022, the achieved numbers are 6,708.1 thousand m^2 and 114.0 $ktCO_2$-eq, respectively. Considering ZEB construction and GHG mitigation over the last three years, the target for 2030 is set at 20,830 thousand m^2 and 354.1 $ktCO_2$-eq.

<Table Ⅱ-37> Floor Area of Zero-Energy Buildings

	2020	2021	2022	2030
Total Floor Area (Cumulative, Thousand m^2)	2,652.4	5,937.8	6,708.1	20,830
GHG mitigation ($ktCO_2$-eq)	45.1	100.9	114.0	354.1

(b) Promotion of Building Energy Management Systems (BEMS)

Since 2017, to encourage GHG mitigation in energy consumption, Building Energy Management Systems (BEMS) have been a mandatory for newly constructed or separately expanded public buildings with a total floor area of 10,000 m^2 or more. This requirement promotes efficient energy management in new buildings. In 2021 and 2022, BEMS were installed in 73 and 65 new buildings, respectively.

BEMS or electronic remote metering devices are mandatory for ZEB certification. To promote the ZEB certification system, certification agency meetings and policy briefings were conducted in 2023. Plans are in place to integrate the ZEB certification system with the Building Energy Efficiency Rating Certification System. Additionally, mandatory certification of ZEB for public buildings will be implemented in several phases.

<Table Ⅱ-38> Number of Building Energy Management System Installations

(Unit: installation)

	2020	2021	2022
Public Building	39	72	63
Private Building	1	1	2

Source: 2023 KEA Energy Handbook (Korea Energy Agency, 2023)

2) Green Remodeling for Existing Buildings

Green remodeling is a project to convert existing buildings into green buildings to minimize environmental impact and provide comfortable living environments. In accordance with Article 27 of the *Green Buildings Construction Support Act*, support is provided for insulation, window replacement, and new and renewable energy facility construction to improve energy performance and efficiency of existing buildings.

Interest support for green remodeling is being provided to promote green remodeling of private buildings. In 2021, the scale of interest support and target buildings were expanded, and support procedures were simplified to encourage active private entity participation in green remodeling. Additionally, the method for calculating energy performance improvement rate has been changed, from using a separate program to a simplified evaluation table, also in efforts to encourage active participation from the private entity.

To drive GHG mitigation in the public entity, green remodeling is being implemented for public buildings (senior citizen centers, health centers, daycare centers, etc.). Support is prioritized according to priority after evaluating urgency and effectiveness among buildings applied for by public institutions and local governments. The scope of support is being expanded to include high energy-consuming and large-scale buildings. Project sites are selected based on a scoring system that quantifies energy-saving elements, such as insulation, windows, high-efficiency equipment, new and renewable energy, and institutional

commitment to project implementation. Among these, buildings expected to have high energy-saving effects and promotional value are selected as signature projects to encourage expansion of green remodeling projects. Sites selected as signature projects receive up to double the support compared to general support targets, to drive regional expansion of the project and to enable the introduction of innovative technologies.

In 2021, green remodeling projects in private and public buildings covered a total floor area of 1,951.6 thousand m^2, resulting in 36.5 $ktCO_2$-eq. In 2022, this decreased to 1,289.4 thousand m^2 and 22.2 $ktCO_2$-eq, respectively.

<Table Ⅱ-39> Green Remodeling: Floor Area and GHG Reductions

	2020	2021	2022
Total Floor Area (Thousand m^2)	1,949.2	1,951.6	1,289.4
GHG mitigation ($ktCO_2$-eq)	36.4	36.5	22.2

3) Improving Energy Efficiency in Buildings

(a) Improving the Efficiency of Household Appliances

City gas is the energy source with the highest proportion among fossil fuels consumed in the building sector. Therefore, improving the efficiency of water heating and cooking equipment that primarily use city gas can reduce GHG emissions by decreasing fossil fuel use in the building sector. To this end, energy-efficient equipment is widely adopted in large buildings, with grade 1 and 2 registered models of gas water heaters accounting for approximately 56.1% of the market, and with energy efficiency continuously being improved through setting energy efficiency targets and evaluating energy consumption. In the private entities, the increasing use of household induction cooking appliances is contributing to improved energy efficiency and reduced fossil fuel consumption.

(b) Development of Energy Efficiency Indicators by Building Type

An energy efficiency evaluation system was introduced for public buildings in 2022, and plans are in place to expand the evaluation to commercial buildings of 3,000 m^2 or more from 2024. In accordance with the *Second Master Plans for Green Buildings* (December 2019), operation efficiency indicators by building use are being developed to enable comparative evaluation of energy use levels in existing buildings for establishing an efficient energy

operation and management system. In 2022, accommodation facility types were classified, and factors affecting energy consumption such as total floor area, number of facility users, and room occupancy rates were analyzed. Additionally, based on data from pilot projects for medical, educational, office, and retail facilities, existing indicators were supplemented and operational efficiency reports were prepared. In 2023, methods for analyzing building operational efficiency were developed by classifying cultural facility types and analyzing energy impact factors, while model verification is currently in progress. Furthermore, based on pilot project data for medical, educational, office, retail, and cultural facilities, existing indicators were supplemented. Methods to improve building operational efficiency and verification models are also currently under development.

(c) Advanced Metering Infrastructure (AMI)

AMI is a core infrastructure for managing real-time energy consumption through wired and wireless communications. It consists of bidirectional communication-based digital meters, electricity consumption monitoring devices, and power control devices. Using wired and wireless communications, AMI enables both demand response for consumers and demand prediction and load management for suppliers by relaying real-time energy consumption and electricity pricing information. AMI distribution has steadily increased, with 10,200 thousand units in 2020, 10,720 thousand units in 2021, and 12,400 thousand units in 2022. The target is to distribute 22,500 thousand units by 2030.

<Table Ⅱ-40> Number of AMI Installations

	2020	2021	2022	2030
Distribution of AMI (Cumulative, thousand)	10,200	10,720	12,400	22,500

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

(d) Deploying New and Renewable Energy in Buildings

GHG mitigation can be expected in the building sector by utilizing various new and renewable energy sources such as Building Integrated PhotoVoltaic (BIPV), solar thermal, geothermal heat pumps, and building fuel cells. In response, the ROK has formulated the *Strategies for Activating the Building-Integrated PhotoVoltaic Industry Ecosystem* (October 2022) to expand the deployment of solar photovoltaic technology for buildings. To promote new and renewable energy, the government provides annual subsidies for self-consumption new and

renewable energy facilities through the Support Program for New and Renewable Energy Distribution. Furthermore, the R&D Project for Establishment of BIPV Demonstration Center is being implemented to develop and standardize BIPV technology through practical demonstrations.

3.2.5 Transportation

In the transportation sector, mitigation policies are categorized into eco-friendly vehicles, public transportation, demand management for internal combustion engine vehicles, and eco-friendly railroad, aviation, and maritime policies. Recently, the *Fourth Master Plans for Development of Environment-Friendly Motor Vehicles* (February 2021) was established, to include support for subsidies and tax benefits for eco-friendly vehicles and related infrastructure construction, focusing on establishing a foundation for eco-friendly vehicles. Additionally, demand management for internal combustion engine vehicles is being pursued through reducing private travel distance or improving efficiency in logistics. Along with this, GHG and fuel efficiency standards for passenger vehicles are being strengthened, and support is being provided for early scrapping of old diesel vehicles to accelerate the transition to low-carbon internal combustion engines. Beyond the road sector, policies for sector-specific low-carbonization are being pursued in the maritime sectors through the establishment of the *First National Plan for the Development and Popularization of Green Ship* (December 2020).

<Table Ⅱ-41> Major Mitigation Policies in the Transportation Sector

Policy	Description
Fourth Master Plans for Development of Environment-Friendly Motor Vehicles (February 2021)	・Achieving 51% of new vehicle sales as eco-friendly vehicle by 2025 and 83% by 2030, while reducing GHG emissions by 5.9 $MtCO_2$-eq by 2025 and 17.3 $MtCO_2$-eq by 2030
First National Plan for the Development and Popularization of Green Ship (December 2020)	・Assessing the current status and outlining detailed implementation strategies to promote the adoption of eco-friendly ships ・Facilitating the early transition in the public sector and expanding adoption in the private sector ・Encouraging the transition to eco-friendly ships through tailored financial support for private shipping companies

1) Promotion of Eco-friendly Vehicle Distribution

(a) Support for Eco-friendly Vehicle Purchases

Electric and hydrogen vehicles use electricity and hydrogen fuel cells as power sources respectively, contributing to GHG mitigation through lower fossil fuel usage compared to internal combustion engine vehicles. To promote the transition from internal combustion engine vehicles to eco-friendly vehicles, purchase subsidies and tax reductions for electric and hydrogen vehicles are being implemented. The goal is to distribute a cumulative of 4.5 million of these vehicles by 2030. Additionally, when private entities purchase eco-friendly vehicles, both national and local governments provide subsidies. In particular, to increase mitigation effects by raising the distribution rate of vehicles with excellent electricity efficiency, electric vehicle subsidy guidelines were revised in 2021 to expand subsidy payments. Along with this, individual consumption tax and acquisition tax reductions for eco-friendly vehicle purchases are being implemented to encourage active private entity purchase of eco-friendly vehicles.

(b) Zero-Emission Vehicle Charging Infrastructure

Charging infrastructure is being established nationwide to promote eco-friendly vehicle distribution. Electric Vehicle Charging Infrastructure Information System has been established to improve public accessibility to charging infrastructure and electric vehicle charger installation support projects have been implemented since 2011. As of 2022, there are 194,081 electric vehicle charging stations installed. The government also holds briefing sessions on national funding support for electric vehicle charging operators to share the latest information. To promote the distribution of hydrogen vehicles, support is being provided for the construction of hydrogen charging stations, focusing on transportation and logistics hubs. As of 2022, a total of 229 hydrogen charging stations have been constructed, and plans are in place to expand the station infrastructure by streamlining permitting procedures and promoting best practices for installation.

(c) Mandatory Purchase and Lease of Low-Emission Vehicles by Public Institutions

In accordance with the *Clean Air Conservation Act* (August 1990) and the *Act on Promotion of Development and Distribution of Environment-Friendly Motor Vehicles* (October 2004), the Mandatory Purchase and Lease of Low-emission Vehicle by Public Institutions system is being implemented. This system is requiring national institutions, local governments, and public institutions to purchase or lease a certain percentage of new vehicles as low-emission vehicles. Under the system, low-emission vehicles are categorized into Type 1 electric and hydrogen vehicles (zero-emission vehicles), Type 2 hybrid vehicles, and Type 3 LPG and gasoline vehicles that meet low-emission standards. In 2022, the system applied to a total of 766 institutions, including 50 national institutions, 262 local governments, and 454 public institutions.

The achievement rate for mandatory purchase and lease by public institutions has steadily increased from 69.3% in 2020 to 83.7% in 2021 and 92.0% in 2022. In 2022, low-emission vehicles accounted for 90.2% of the total 8,072 vehicles purchased or leased by public institutions. In particular, electric and hydrogen vehicles have shown a consistent upward trend, with an increase of 881 units compared to the previous year.

<Table Ⅱ-42> Achievement of Mandatory Purchase and Lease of Low-emission Vehicle

	2020	2021	2022	2030
Proportion of institutions achieving mandatory purchase/lease ratio (%)	69.3	83.7	92.0	100

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

Through support for eco-friendly vehicles, the expansion of zero-emission vehicle charging infrastructure, and the mandatory purchase and lease system by public institutions, the distribution of eco-friendly vehicle is steadily increasing. As a result, 108,959 zero-emission vehicles were distributed in 2021 and 174,742 in 2022, reaching a cumulative total of 432,282 zero-emission vehicles by 2022, while resulting in GHG mitigation of 274 $ktCO_2$-eq in 2021 and 413 $ktCO_2$-eq in 2022.

<Table Ⅱ-43> Distribution Status of Zero-Emission Vehicles

(Unit: Vehicle)

		Until 2019	2020	2021	2022	2023	Total (Cumulative)
Total		96,025	52,556	108,959	174,742	167,277	599,559
Electric Vehicles	Subtotal	90,923	46,713	100,427	164,486	162,605	565,154
	Passenger	88,909	31,329	71,517	123,920	115,817	431,492
	Van	840	1,016	1,290	2,074	2,820	8,040
	Truck	1,150	14,320	27,566	38,471	43,940	125,447
	Other	24	48	54	21	28	175
Hydrogen Vehicle	Subtotal	5,102	5,843	8,532	10,256	4,672	34,405
	Passenger	5,085	5,783	8,473	10,104	4,294	33,739
	Van	17	60	54	152	367	650
	Truck	-	-	5	-	11	16

2) Promoting Public Transportation and Managing Demand for Private Internal Combustion Engine Vehicles

(a) Reduction of Private Vehicle Kilometers Traveled (VKT)

Policies are being implemented to reduce private vehicle travel distance through initiatives such as the Carbon Neutral Point System, which provides incentives for reduced vehicle use, and the expansion of public transportation networks, including metropolitan express buses and bus rapid transit (BRT). The goal is to reduce the total travel distance of private passenger vehicles by 4.5% by 2030. The average daily travel distance of private passenger vehicles has shown a decrease, reaching 35.6 km in 2021 and 31.1 km in 2022.

<Table Ⅱ-44> Travel Distance of Non-Business Passenger Vehicles

	2020	2021	2022
Non-business passenger vehicles (Km/day·vehicle)	32.8	35.6	31.1

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

(b) Intelligent Transport System (ITS) Infrastructure

The Intelligent Transport System (ITS) is a transportation system that integrates cutting-edge Information and Communications Technology (ICT) to mitigate traffic congestion, enhance user safety and convenience, and automate and optimize the operation and management of

transportation networks. Representative applications of ITS include bus arrival information systems at bus stops, optimal route guidance via navigation systems, and adaptive traffic signal systems reflecting intersection characteristics. The deployment of ITS is also closely linked to carbon neutrality. By improving fuel efficiency in vehicles, ITS contributes to reducing fossil fuel consumption and mitigating GHG emissions. Additionally, ITS enhances energy efficiency in the transportation sector by providing demand-responsive mobility services. Accordingly, the government plans to expand ITS infrastructure nationwide by 2025 to alleviate traffic congestion, prevent secondary accidents, and establish the foundations for autonomous and cooperative driving. The total length of roads equipped with ITS nationwide has steadily increased, from 18,036 km in 2020 to 22,236 km in 2021 and 26,919 km in 2022, accounting for 27% of the total paved road length as of 2022.

<Table Ⅱ-45> Expansion of Intelligent Transportation System (ITS) in Roads

	2020	2021	2022
ITS-Equipped Roads (km)	18,036	22,236	26,919

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

(c) Modal-Shift for Freight Transportation

To mitigate GHG emissions, freight transportation is being shifted from roads, which produce relatively high emissions, to railroads and coastal shipping, which are more environmentally friendly. The Support Program for Freight Modal-Shift to Railroads and Coastal Shipping provides subsidies to cargo owners who transition from road transport to lower-emission alternatives. In 2021, the railroad modal shift subsidy system was restructured to encourage greater participation by cargo owners. As a result of these policies, freight volume shifted from roads to railroads totaled 2.59 million tonnes in 2021 and 2.21 million tonnes in 2022, while freight volume shifted from roads to shipping totaled 2.73 million tonnes in 2021 and 2.84 million tonnes in 2022.

<Table Ⅱ-46> Volume of Freight Transported by Road Modal Shift

(Unit: million tonnes)

	2020	2021	2022
Freight Volume Shifted from Road to Rail	1.66	2.59	2.21
Freight Volume Shifted from Road to Shipping	2.62	2.73	2.84

3) Reducing Emissions from Internal Combustion Engines

(a) Vehicle GHG Emission and Fuel Efficiency Standards

GHG and fuel efficiency standards are separately established for passenger cars, small vans and trucks, and medium-heavy vans and trucks. Vehicles with 15 or fewer seats and a gross vehicle weight under 3.5 tonnes, including passenger cars, small vans, and trucks, must comply with either the average energy consumption efficiency standard or the GHG emission allowance standard. Fuel efficiency requirements are determined by considering electric and hydrogen vehicle sales incentives and eco-innovation performance. In contrast, medium-heavy vans and trucks are not currently subject to direct regulation under energy consumption efficiency standards or GHG emission allowance standards. However, a voluntary GHG mitigation system has been implemented, targeting GHG reductions of 2% in 2023, 4.5% in 2024, and 7.5% in 2025 compared to 2021-2022 levels. Moving forward, plans are in place to gradually mandate GHG emission and fuel efficiency standards for medium-heavy vans and trucks.

<Table Ⅱ-47> Average Fuel Economy and GHG Emissions of Vehicles

		2021		2022	
		Results (Including incentives)	Target (Reflecting curb weight)	Results (Including incentives)	Target (Reflecting curb weight)
Average Fuel Economy (km/L)	Passenger	17.67 (20.77)	24.8 (21.21)	17.35 (20.47)	24.8 (21.06)
	Small Vans/Trucks	12.55 (13.68)	15.6 (15.39)	12.41 (13.60)	15.6 (15.04)
GHG Emissions (g/km)	Passenger	135.9 (106.1)	97 (107.6)	130.6 (97.4)	97 (108.1)
	Small Vans/Trucks	177.4 (130.9)	166 (167.9)	170.5 (116.9)	166 (164.7)

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

(b) Early Scrapping and Operation Restrictions of Old Diesel Vehicles

To fundamentally phase out old diesel vehicles, which are major sources of GHG emissions in the transportation sector, early scrapping incentives and operational restrictions are key policy measures. Support for early scrapping of old diesel vehicles has been in place since

2005. Until 2022, support was provided only for the early scrapping of Grade 5 diesel vehicles, but starting in 2023, the scope has been expanded to progressively include Grade 4 diesel vehicles, forklifts, and excavators.

Additionally, restrictions on the operation of old vehicles are enforced under the *Special Act on the Improvement of Air Quality in Air Control Zones* (April 2019) and the *Special Act on the Reduction and Management of Fine Dust* (August 2018). Since 2018, the Seoul Metropolitan Area has enforced a permanent operational restrictions for Grade 5 diesel vehicles that have not undergone low-emission modifications. During the seasonal management program period (December to March of the following year), when high concentrations of fine dust frequently occur, operation restrictions for all Grade 5 vehicles are expanded beyond the Seoul Metropolitan Area to include Busan, Daegu, Gwangju, Daejeon, Ulsan, and Sejong Special Self-Governing City.

(c) Increasing Mandatory Biodiesel Blend Ratio

Petroleum refiners and importers are required to blend a certain percentage of new and renewable energy fuel into transportation fuel annually. The mandatory ratio refers to the percentage of new and renewable energy fuel that must be mixed into transportation fuel. The ratio was raised through amendments to the *Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy* and its enforcement decree (July 2021). Accordingly, the biodiesel blend ratio has been incrementally raised by 0.5% and is expected to expand to 5.0% by 2030. This led to GHG mitigation of 1,942 $ktCO_2$-eq in 2021 and 1,880 $ktCO_2$-eq in 2022.

<Table Ⅱ-48> Biodiesel Blending

	2021	2022	2030
Biodiesel blend ratio (%)	3.27	3.54	5.0
GHG mitigation amount ($ktCO_2$-eq)	1,942	1,880	-

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

4) Eco-friendly Railroad, Aviation, and Maritime Transportation

(a) Railroad Network Extension

GHG mitigation is being pursued by increasing the utilization of railroad, a low-carbon mode of transportation, through the extension of the railroad network and the development of hydrogen fuel cell-based railroad vehicles. Currently, under the *Fourth Construction Plans for National Railroad Networks* (June 2021), early commencement of new high-speed and conventional railroad construction is underway for expansion of major arterial networks including railroads and roads. The goal is to construct a total railroad network of 5,341 km by 2030. In 2021, 4,307 km of railroad network was constructed, and in 2022, 4,313.4 km was constructed.

<Table Ⅱ-49> Length of Railroad Network

	2020	2021	2022	2030
Railroad network extension (km)	4,281.1	4,307	4,313.4	5,341

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

(b) Improvement of Aircraft Operation Efficiency

GHG mitigation from aircraft operations is being pursued by improving the operational efficiency of aircraft from domestic airlines in the ROK. Currently, aircraft operational efficiency is being improved through aircraft engine cleaning, weight and operation management. Additionally, when introducing new aircraft, airlines are encouraged to prioritize the introduction of the latest aircraft with superior fuel efficiency to promote GHG mitigation in the aviation sector. Through these efforts, aircraft efficiency in 2021 and 2022 has improved by 0.87% and 0.84% compared to the previous year, respectively.

(c) Eco-friendly Ships and Alternative Maritime Power (AMP) Deployment

GHG mitigation in the maritime sector is being promoted through the expansion of eco-friendly ships and Alternative Maritime Power (AMP) supply. Currently, vessels using alternative energy sources such as LNG-powered bulk carriers and battery-electric car ferries qualify for the eco-friendly ship certification system. It also certifies vessels that apply marine pollution reduction or energy efficiency technologies. This system contributes to expanding the supply of eco-friendly coastal vessels in the private sector.

Furthermore, GHG mitigation is being promoted through improving fuel efficiency by supplying AMP to vessels. AMP is a device that supplies shore power to vessels while they are docked at ports. With the goal of installing AMP at 248 berths across 13 ports by 2030, pilot projects began at 8 berths in Busan, Incheon, and Gwangyang ports from August 2018. By 2023, AMP has been installed at 25 berths across 10 ports including Busan Port.

<Table Ⅱ-50> Eco-friendly Ship Certification and AMP Distribution

	2020	2021	2022
Number of certified vessels*	-	6	10
AMP distribution (units)	11	21	22

* Excluding international navigation vessels

3.2.6 Agriculture, Livestock Farming, and Fisheries

GHG mitigation in the sector can be largely divided into reductions in cultivation, livestock farming, and fisheries sectors. According to the *2050 Net-zero Strategy in The Agri-Food Sector* (December 2021) and the *2030 Strategic Plan to Reduce Greenhouse Gas Emissions and Achieve Green Growth in the Livestock Industry* (January 2024), GHG mitigation is being pursued through the spread of GHG mitigation farming methods, such as mid-season drainage in rice cultivation and appropriate fertilization and low-carbon livestock technologies, including low-nitrogen feed supply and energy conversion of livestock manure. Additionally, according to the *2050 Carbon Neutrality Roadmap for the Marine and Fisheries Sector* (December 2021) and the *Fourth Comprehensive Plan for Climate Change Response in the Marine and Fisheries Sector* (September 2022), GHG emissions in the fisheries sector will be reduced through the conversion of existing fishing vessels to eco-friendly models and the introduction of energy-efficient fishing facilities.

<Table Ⅱ-51> Major Mitigation Policies in the Agriculture, Livestock Farming, and Fisheries Sector

Policy	Description
2050 Net-zero Strategy in Agri-Food Sector (December 2021)	· Optimizing the Agricultural Input Structure · Reducing GHG emissions through paddy water management and low-methane feed · Improving energy efficiency in greenhouse horticulture
2030 Strategic Plan to Reduce Greenhouse Gas Emissions and Achieve Green Growth in the Livestock Farming Sector (January 2024)	· Expanding GHG mitigation processes in composting and liquid fertilizer production facilities · Generating energy from livestock manure and producing biochar · Increasing the distribution of low-methane feed and low-nitrogen feed
2050 Carbon Neutrality Roadmap for the Marine and Fisheries Sector (December 2021)	· Replacing aging fishing vessels or their engines · Deploying energy-efficient equipment in fishery processing industry
Fourth Comprehensive Plan for Climate Change Response in the Marine and Fisheries Sector (September 2022)	· Expanding energy-saving facilities in the fisheries sector · Supporting the replacement of aging fishing vessels

1) Agriculture Sector

(a) Water Management Technology

Mid-season drainage is being implemented to reduce methane emissions that occur when organic matter decomposes anaerobically in flooded rice paddies. This paddy water management technique keeps paddy fields dry by halting water supply for more than two weeks, starting one month after dibbling of rice seedling and opening drainage channels. The mid-season drainage technology is being disseminated to farmers through pilot projects for promoting paddy water management technology and training programs. As a result, the proportion of mid-season drainage area has continuously increased from 41.0% in 2020 to 41.7% in 2021 and 45.5% in 2022, while GHG emissions from rice cultivation have steadily decreased from 5.6 $MtCO_2$-eq in 2020 to 5.2 $MtCO_2$-eq in 2022.

<Table Ⅱ-52> Mid-season Drainage in Rice Paddies

	2020	2021	2022
Proportion of mid-season drainage area (%)	41.0	41.7	45.5
GHG emissions from rice cultivation ($MtCO_2$-eq)	5.6	5.4	5.2

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

(b) Fertilizer Prescription Based on Soil-Testing

Fertilizer prescription,[40] which specify appropriate fertilizer amounts for each cultivation area based on scientific analysis of agricultural land, is being used to reduce GHG emissions in the agricultural sector. By collecting soil samples from agricultural areas and prescribing fertilizer applications based on regional soil characteristics, excessive use of nitrogen fertilizer can be prevented in unsuitable areas, thereby reducing N_2O emissions from agricultural land. Fertilizer prescriptions were issued for 677 thousand cases in 2021 and 739 thousand cases in 2022.

<Table Ⅱ-53> Number of issued Fertilizer Prescriptions

	2020	2021	2022
Number of fertilizer prescriptions issued (thousand cases)	611	677	739

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

(c) Biochar

GHG mitigation in the agricultural sector is being pursued through the distribution of biochar,[41] which strengthens the carbon sequestration capacity of soil. In 2022, plans were established for the production and utilization of livestock manure biochar. In 2023, the N_2O reduction effect of biochar was assessed through analysis of agricultural land where biochar had been applied. Additionally, research was conducted on biochar usage standards and application models. By 2027, the biochar usage standards will be established, with plans to publish crop-specific manuals, develop business models, and diversify treatment methods, including biochar production using livestock manure.

(d) Energy-Saving and Renewable Energy Facilities in the Agriculture Sector

In agricultural sector, the energy efficiency of agricultural facilities is being enhanced through the expansion of energy-saving facilities such as multi-layered thermal curtains and automatic thermal screens to prevent heat loss from greenhouses. The cumulative area of energy-saving facilities reached 14,665 ha in 2021 and 15,300 ha in 2022.

40) Information calculating the amount of liquid fertilizer to be applied per hectare considering the fertilizer (nitrogen, phosphoric acid, potassium) demand of crops, fertilizer content in agricultural land, and fertilizer content in livestock manure liquid fertilizer

41) A portmanteau of biomass and charcoal, which is a porous carbonized material produced by pyrolyzing (carbonizing) biomass at over 350 degrees Celsius under oxygen-limited conditions

Furthermore, agricultural infrastructure such as reservoirs, pumping and drainage stations, and idle land[42] are being used for renewable energy development, particularly solar power, to generate clean electricity. Renewable energy facilities are being installed at approximately 10 agricultural infrastructure each year, with cumulative installations reaching 105 sites in 2021 and 114 sites in 2022.

2) Livestock Farming Sector

(a) Low-Methane and Low-Nitrogen Feed

Since 2021, government and private initiatives have been developing feed additives, such as synthetic compounds and microbial agents, to reduce methane emissions from ruminant livestock digestion. In October 2023, the *Standards and Specifications for Feed* (December 2014) was revised to include definitions and evaluation methods for low-methane feed, paving the way for the supply of low-methane feed. Policies are also being implemented to reduce GHG emissions from livestock production. These include lowering crude protein content standards in pig feed by 1-3 percentage points and establishing new upper limits for crude protein in poultry and cattle feed. These measures aim to reduce surplus nitrogen in animal waste, thereby decreasing N_2O emissions during manure treatment processes. By 2030, these measures aim to reduce GHG emissions by 308 $ktCO_2$-eq through low-methane feed and 443 $ktCO_2$-eq through low-nitrogen feed.

(b) Energy Recovery in Livestock Manure Treatment Facilities

Livestock manure contributes significantly to GHG emissions in the livestock farming sector. To address this, energy recovery facilities are being established to convert manure from traditional composting and liquid fertilizer processes into valuable resources such as biogas and biochar, thereby reducing emissions. In 2022, institutional reforms expanded eligibility for participation in the facilities that convert livestock manure into energy, while also extending project periods to enhance local acceptance. Additionally, plans are in place to expand the use of mechanical agitation[43] and forced ventilation[44] in composting facilities, as these technologies have been shown to reduce GHG emissions by approximately 39% during the fermentation process. Through such energy recovery and purification treatment of livestock manure, approximately 792 $ktCO_2$-eq of GHGs were reduced in 2022, with plans to reduce 2,058 $ktCO_2$-eq by 2030.

42) Idle land refers to parcels of land that are currently vacant and unused
43) Mechanical agitation refers to the process of stirring or mixing materials using mechanical devices or equipment
44) Forced ventilation refers to a method of forcibly injecting air into compost piles or fermenting materials using mechanical devices such as fans or blowers during the composting process.

3) Fishery Sector

(a) Replacement of Aging Fishing Vessels

Support is being provided for the replacement of aging engines or the construction of new vessels for coastal and offshore fishing vessels. This increases the energy efficiency of fishing vessels, reducing fossil fuel consumption and thereby lowering GHG emissions from fishing activities. Currently, when coastal and offshore fishing vessels replace aging engines, 60% of the replacement cost is covered by national and local government funds. When aging fishing vessels are replaced with newly constructed vessels, an interest subsidy is provided. As a result, GHG emissions were reduced by 1,483 tCO_2-eq in 2021 and 1,376 tCO_2-eq in 2022.

<Table Ⅱ-54> Replacement of Aging Fishing Vessels and Engines

	2020	2021	2022
Vessel replacement (cumulative, vessels)	21	32	34
Engine replacement (vessels)	350	311	300
GHG mitigation amount (tCO_2-eq)	1,605	1,483	1,376

(b) Energy-Saving Facilities and Equipment in Aquaculture Farms

GHG mitigation is being pursued by distributing energy-saving facilities such as heat pumps[45] and inverters[46] to fish farms with high energy consumption. Marine aquaculture farms and fishery processing facilities require heating and cooling to maintain constant temperatures (aquaculture farms) or heat for drying (fishery processing facilities). When installing equipment with good heating efficiency such as heat pumps and inverters in these facilities, energy efficiency can be improved and GHG emissions can be reduced. Heat pumps and inverters are being deployed to the aquaculture farm, while heat pumps are also being installed in the fishery processing facilities. Additionally, heat pumps were deployed to a cumulative total of 17 and 24 fishery processing facilities in 2021 and 2022 respectively. The heat pump distribution project is ongoing with the goal of supporting a cumulative total of 50 facilities by 2050.

45) Heat pump refers to a device that absorb heat from low-temperature sources such as seawater or aquaculture discharge water to produce hot water
46) Inverter refers to a power conversion device that regulates and controls the speed and frequency of electric motors, improving energy efficiency

3.2.7 Waste

Waste sector focuses on reducing waste at the source, ensuring a stable supply of recyclables as resources, and promoting high-value recycling.

Following the *First Master Plans for Resources Circulation*, policies to reduce disposable products are implemented to minimize waste at source, while establishing collection systems for recyclables and promoting high-value recycling, including electric vehicle batteries. Additionally, under the *Act on Promotion of Production and Use of Biogas from Organic Waste Resources* (Biogas Act) (December 2022), plans are in place to expand biogas utilization by imposing mandatory production requirements on both public and private businesses generating and handling organic waste from 2025, while providing support for facility installation.

<Table Ⅱ-55> Major Mitigation Policies in the Waste Sector

Policy	Description
First Master Plans for Resources Circulation (September 2018)	・Establishing a resource circulation system ・Prioritizing waste reduction and promoting high-quality material recycling ・Optimizing regional waste treatment through governance
Korean (K)-Circular Economy Implementation Plan (December 2021)	・Reducing net GHG emissions in waste reduction and resource circulation sector to achieve the 2050 national carbon neutrality goal ・Transiting to a circular economy society by establishing a circulation system
Comprehensive Plastic-free Measures (October 2022)	・Expanding the use of recycled plastics and developing alternative materials and services ・Advancing the recycling industry and enhancing competitiveness
Act on Promotion of Production and Use of Biogas from Organic Waste Resources (December 2022)	・Mandating biogas production by local governments ・Mandating biogas production from major organic waste generators and handlers ・Supporting mandated biogas producers and promoting biogas utilization

1) Reduction of Waste at Production, Distribution, Consumption and Disposal Stages

(a) Imposition of Waste Incineration and Landfill Charges

The government imposes waste disposal charges on facilities that incinerate or landfill recyclable waste while offering exemptions for recycling, creating incentives for recycling. From 2018 to 2023, a total of KRW 912.4 billion was collected as waste disposal charges. These revenues fund circular economy infrastructure and projects, creating a sustainable cycle that reduces waste generation.

(b) Expansion of Landfill Methane Capture

Waste sector reduces GHG emissions by expanding methane capture at large-scale landfills. Capture facilities in landfills collect methane from biological decomposition processes and convert it to electricity, reducing fossil fuel consumption. As of 2022, there are 13 facilities of landfill methane capture. These facilities collected 93 kt of methane in 2021 and 91 kt in 2022, resulting in GHG mitigation of 1,953 ktCO_2-eq and 1,911 ktCO_2-eq, respectively.

<Table Ⅱ-56> Methane Gas Collection Facilities and Performance in Public Landfills

	2020	2021	2022
Number of Methane Capture Facility (Cumulative)	13	13	13
Amount of GHG Mitigation (ktCO_2-eq)	1,869	1,953	1,911

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

2) Stable Supply of Waste Resources as Recycling Raw Materials

(a) Extended Producer Responsibility (EPR) System

To strengthen producer recycling responsibility, the Extended Producer Responsibility (EPR) system replaced the Deposit-Refund System in 2003. While the Deposit-Refund System required manufacturers to pay deposits during production that were returned upon recycling, the EPR system directly assigns manufacturers and importers the responsibility to collect and recycle waste from their packaging and products. As of 2023, EPR target items include a total of 28 types (4 types of packaging materials, 24 types of products) under the *Act on the Promotion of Saving and Recycling of Resources* (December 1992). In 2022, 1,949 kt of waste was reduced, resulting in GHG mitigation of 1,086 ktCO_2-eq.

<Table Ⅱ-57> Recycling Rates for EPR Targets and Waste Reduction Performance

	2020	2021	2022
Recycling Rates (%)	71.9	73.8	72.9
Amount of Waste Reduction (kt)	1,820	1,859	1,949
Amount of GHG Mitigation ($ktCO_2$-eq)	1,016	1,036	1,086

(b) Installation of Community Recycling Centers

Since 2015, the government has been promoting the installation of permanent collection facilities (community recycling centers) in rural areas to improve recycling rates, through enhanced recyclable resource separation. From 2015 to 2023, a total of 2,136 community recycling centers were installed, reducing waste incineration and landfill volumes. This has led to waste reductions of 7.79 kt in 2021 and 10.59 kt in 2022, resulting in GHG mitigation of 4.34 $ktCO_2$-eq in 2021 and 5.90 $ktCO_2$-eq in 2022.

<Table Ⅱ-58> Number of Neighborhood Recycling Center Installed

	2020	2021	2022	2030
Number of Community Recycling Center (Cumulative)	1,003	1,248	1,697	4,713
Amount of Waste Reduction (kt)	6.26	7.79	10.59	29.41
Amount of GHG Mitigation ($ktCO_2$-eq)	3.49	4.34	5.90	16.39

(c) Modernization of Public Sorting Facilities

Local governments are promoting projects to enhance recycling sorting and support the transition to a circular economy by funding the expansion of public sorting facilities and their modernization with automated technology. As a result, residual material generation at these facilities decreased from 35.1% in 2022 to 34.4% in 2023. During 2021-2022, these projects secured a capacity of 877 tonnes/day and reduced GHG emissions by 151 $ktCO_2$-eq.

<Table Ⅱ-59> Recycled Waste at Public Sorting Facilities

	2021	2022
Amount of Recycling (kt)	82.8	180.3
Amount of GHG Mitigation ($ktCO_2$-eq)	47	103

3) High Value Recycling

(a) Public Procurement of Recycled Products

Expanding the use of recycled materials contributes to a circular economy and carbon neutrality by reducing plastic consumption and promoting recycling. The government fosters stable demand by promoting products made from recycled materials and encouraging the use of recyclable resources. Under a green procurement mandate, public institutions are required to purchase recycled products, driving the demand for green products. As a result, public institutions have purchased approximately KRW 4 trillion in green products in 2022.

(b) Recycling of High-Value Waste

The government promotes the circular economy and GHG mitigation by encouraging recycling of high-value waste, particularly electric vehicle batteries and construction waste. By fostering a circular economy ecosystem, the government is advancing new industries in battery recycling and establishing a domestic supply chain for battery minerals. Institutional improvements include extending battery storage periods and classifying remanufactured or reused batteries as resources. The government is also developing recycling clusters for used electric vehicle batteries. These policies reduced waste by 82.4 tonnes in 2022 through battery recycling, with GHG mitigation of 125.22 tCO_2-eq. By 2030, these figures are expected to reach 1,795.1 tonnes and 2,810.21 tCO_2-eq respectively.

The selective demolition system, introduced in April 2019, prevents recyclable aggregates from being mixed with non-recyclable waste. This system requires the removal of combustible materials during the demolition that generate large amounts of construction waste. The approach promotes converting construction waste into high-quality recycled aggregates.

<Table Ⅱ-60> GHG Reductions from Electric Vehicle Battery Recycling

	2022	2030
Sale Performance (Unit)	183 (reuse 129, recycling 54)	3,989 (reuse 2,274, recycling 1,715)
Amount of Waste Reduction (tonne)	82.4	1,795.1
Amount of GHG Mitigation (tCO_2-eq)	125.22	2,810.21

(c) Organic Waste Biogas Facilities

Organic waste biogas facilities that convert organic waste from food, livestock manure, and sewage sludge into biogas are being installed to reduce GHG emissions. These facilities prevent methane generation from organic waste while producing alternative fuel such as biogas. As of 2022, 110 biogas facilities were in operation, with plans to increase this number to 140 by 2030. Under the Biogas Act, a dedicated biogas center will be established by 2024 to manage the production target system and provide ongoing support for the sector. These facilities are expected to produce 96,291 Nm^3/year of biogas, which could reduce GHG emissions by 114.9 $ktCO_2$-eq when substituting city gas.

<Table Ⅱ-61> Installation of Biogas Facilities for Organic Waste Resources

	2022	2030
Installation of Biogas Facilities (Cumulative, sites)	110	140

3.2.8 Carbon Sinks, Carbon Capture, and Hydrogen

The sector of carbon sinks, carbon capture, and hydrogen can be largely categorized into expanding forest and marine carbon sinks, CCUS, and fostering the hydrogen economy.

To expand carbon sequestration, the government is enhancing forest sinks through afforestation and management, while developing blue carbon through coastal wetland restoration. These efforts follow the *Third Comprehensive Plans for Improvement of Carbon Sinks* (June 2023) and the *Blue Carbon Strategy* (May 2023).

The government is establishing institutional support systems for CCUS research and development. This includes building effective implementation frameworks, securing technological competitiveness, and achieving cost efficiency. These efforts align with the *Technology Innovation Roadmap for Carbon Dioxide Capture and Utilization* (June 2021), *CCUS Sector Carbon Neutrality Technology Innovation Strategic Roadmap* (November 2022), and *Carbon Dioxide Capture and Utilization Technology Advancement Strategy* (December 2023).

To foster the hydrogen economy, the government plans to shift from gray hydrogen to a clean hydrogen ecosystem. This initiative focuses on creating large-scale hydrogen demand and developing necessary infrastructure, as outlined in the *First Hydrogen Economy Transition Basic Plan* (November 2021) and *Plan for Creating a Clean Hydrogen Ecosystem* (November 2022).

<Table Ⅱ-62> Major Mitigation Policies in the Carbon Sinks, Capture, and Hydrogen Sector

Policy	Description
Third Comprehensive Plans for Carbon Sinks (June 2023)	· Enhancing forest carbon sequestration through sustainable forest management cycles · Developing new forest carbon sinks while preserving and restoring existing ones
Blue Carbon Strategy (May 2023)	· Enhancing marine carbon sequestration through coastal vegetation restoration and proactive blue carbon conservation · Building long-term foundations through blue carbon certification systems and regional research infrastructure
Carbon Dioxide Capture and Utilization Technology Advancement Strategy (December 2023)	· Developing customized CCU technology strategies based on current domestic technology levels and market demand · Customizing deployment strategies of CCU technology by analyzing key issues and barriers for each technology type
Plan for Creating a Clean Hydrogen Ecosystem (June 2021)	· Expanding hydrogen demand through hydrogen commercial vehicle deployment and fuel conversion at thermal power plants · Ensuring stable hydrogen supply by developing clean hydrogen supply chains and expanding distribution infrastructure

1) Enhancing Carbon Sequestration through Sustainable Forest Management

(a) Improving Carbon Sequestration through Reforestation and Forest Management

Following large-scale national reforestation efforts in the 1970s-1980s to restore degraded forests, the government has implemented various reforestation projects based on management objectives and site conditions. These include commercial forest development, large-scale tree planting, and post-fire restoration. Reforestation covered 20,532 ha in 2021 and 19,114 ha in 2022, resulting in GHG removal of 117.4 $ktCO_2$-eq and 228.0 $ktCO_2$-eq respectively. Carbon sequestration capacity is further enhanced through forest management projects that improve growth environments and increase forest health and timber value. These management practices are categorized into plantation management, young forest management, and mature forest management based on tree growth stages.

<Table Ⅱ-63> Progress of Reforestation

	2021	2022
Reforestation Area* (cumulative ha)	20,532	39,646
Amount of GHG Removal ($ktCO_2$-eq)	117.4	228.0

* Reforestation area excludes natural seeding and sprout regeneration areas

Source: 2022 Greenhouse Gas Reduction Implementation Status (Greenhouse Gas Inventory and Research Center, 2023)

(b) High-Value Timber Utilization

Timber use in buildings and facilities is encouraged to leverage wood's carbon storage capacity. Projects are creating wooden urban architecture, streets, and living environments through timber-friendly city initiatives to expand private sector demand. To promote timber utilization in the private sector, restrictions on wooden structure height and scale in the *Building Act* (January 1962) that limited wooden construction were lifted in 2020. Additionally, the labeling for timber carbon storage has been operating since 2013, through which the government diversifies incentives and develops infrastructure to support timber use. These measures resulted in timber utilization of 2,189 thousand m^3 in 2021 and 2,077 thousand m^3 in 2022, removing 2,106 $ktCO_2$-eq and 1,744 $ktCO_2$-eq of GHG respectively.

2) Systematic Restoration and Management of Forest and Marine Carbon Sinks

(a) Urban Forests for Coping with Climate Crisis

The government is creating diverse urban forests in city and residential areas. These include village forests to improve local living environments, landscape forests to preserve scenic views, and school forests to enhance educational settings. Local governments receive support by selecting best practices and establishing support centers for urban forests. Plans are in place to develop an additional 17 kha of urban forests by 2050, further expanding carbon sinks in urban areas.

(b) Expansion of New Carbon Sinks

Carbon sinks are expanding through new green and ecological spaces. Green spaces are now mandatory in housing site development plans and urban redevelopment plans, while abandoned urban parks are being transformed into carbon sinks. The government is also restoring damaged green belt areas and creating GHG-absorbing ecological zones in waterfront areas such as dam flood plains and rivers.

(c) Carbon Sinks through Inland Wetlands Conservation

Wetlands store carbon in plants and soil, making wetland expansion an effective GHG removal strategy. Projects are underway to expand protected wetland areas, purchase private lands within these zones, and restore damaged areas for ecosystem conservation and systematic management.

Since 1999, wetlands with high ecological value have been designated as protected areas to expand carbon sinks, with storage capacity enhanced through annual restoration projects. According to the *4th Master Plans for Wetland Conservation* (December 2022), Goseong Madong Lake and Suncheon Waryong Mountain wetlands were newly designated as protected areas in 2022, while existing sites like Gimhae Hwapo Stream and Gwangju Jangrok Wetland were expanded. Additionally, damaged portions of four protected areas, including Ungok Wetland, were restored across a total area of 221,303 m^2, contributing to a total protected wetland area of 13.5 kha as of 2022.

Plans are in place to designate additional protected wetland areas annually and implement restoration projects within these zones, with the goal of increasing the total protected area to 16 kha by 2030.

(d) Prevention of Forest Disasters

Policies to enhance forest carbon sequestration focus on preventing disasters and restoring damaged areas. The project to develop ICT platforms is expanded, monitoring forest fire in real-time based on AI. Drones are deployed to eliminate firefighting blind spots. Ecological restoration efforts target key ecology areas such as the Baekdu Mountain Range and DMZ to restore forests damaged by disasters. These initiatives resulted in the restoration of 87 ha and 165 ha of forests in 2021 and 2022 respectively, removing 0.6 $ktCO_2$-eq and 1.7 $ktCO_2$-eq of GHG.

(e) Restoration and Protection of Coastal Wetlands and Management of Marine Protected Areas

Marine carbon sinks are expanding through coastal wetland restoration and protection, alongside marine protected area management. Tidal flat restoration projects have been implemented since 2010 to enhance blue carbon absorption, complemented by salt marsh vegetation initiatives launched in 2022. Areas with significant coastal wetland and marine ecosystem value are being designated as protected zones to strengthen ocean carbon sequestration. Recent designations include Hwaseong Maehyangri Tidal Flat and Pohang's Homi Peninsula in 2021 (2 sites, 14.33 km^2), Goheung's Yeoja Bay Tidal Flat and Uljin's Nagok-ri Coastal Waters in 2022 (2 sites, 63.23 km^2), and Sacheon Gwangpo Bay and Jeju Ojo-ri Tidal Flats in 2023 (2 sites, 3.7 km^2).

(f) Marine Forest Creation

Marine forests, where seaweed and seagrass grow densely, remove GHG by converting CO_2 into organic matter and storing it in ocean ecosystems. The marine forest project aims to establish 387.5 km^2 of new marine forests between 2018 and 2030. As of 2023, a total area of 164.7 km^2 have been developed. The project has evolved from government-led efforts to a collaborative approach involving local governments in 2023 and private companies from 2024.

3) Technology Development and Infrastructure Construction for Carbon Capture, Utilization, and Storage (CCUS)

(a) Establishment of Institutional Framework for Carbon Capture, Utilization, and Storage (CCUS)

CCUS technology captures CO_2 from emission sources or the atmosphere and either converts it into usable materials or stores it underground. The government is implementing a mid- to long-term roadmap for CCUS development based on the *National CCS Comprehensive Implementation Plan* (July 2010). The enactment of the *Act on the Capture, Transportation, Storage and Utilization of Carbon Dioxide* (February 2024) provided the legal basis for CCUS, with subordinate regulations and detailed standards being developed to promote its widespread adoption.

(b) Development of Technology and Infrastructure for Carbon Capture and Storage (CCS)

CCS technology reduces GHG emissions by capturing CO_2 from industrial sources or the atmosphere. This process involves separating CO_2 from exhaust gases in carbon-intensive industries like coal or LNG power generation, steel, cement, and petrochemicals, then storing it in supercritical form[47] in geological formations such as depleted oil and gas fields, saline aquifers, and unmineable coal seams.

Following the *CCUS Sector Carbon Neutrality Technology Innovation Strategic Roadmap* (November 2022) and the *Carbon Dioxide Capture and Utilization Technology Advancement Strategy* (December 2023), the government is conducting R&D for CO_2 capture, transportation, and storage technologies. Simultaneously, potential storage sites like the East

47) Supercritical form refers to the condition of a substance when it exceeds both its critical temperature and critical pressure. In this state, the distinction between liquid and gas disappears, and the substance exhibits characteristics of both states simultaneously.

Sea gas field are being evaluated through exploratory drilling. International partnerships with Australia, Malaysia, Indonesia, and other countries are being developed to secure overseas storage capacity through collaboration with private companies.

(c) Development of Technology and Infrastructure for Carbon Capture and Utilization (CCU)

CCU technology reduces GHG emissions by capturing CO_2 from emission sources or the atmosphere, and converting it into valuable products. This process transforms captured CO_2 into substances like CO, formic acid, and biodegradable polymers through chemical and biological conversion methods.

Since 2023, corporate pilot projects have been advancing core original technology development, aiming for commercialization after 2030. A notable achievement is the CO_2 dry reforming plant[48] commissioned in June 2023. The government is also developing the CCU Mega Project, which will create large-scale industrial clusters connecting CO_2-intensive companies (upstream) with businesses demanding CCU products (downstream). This project seeks to establish CCU business models and integrate CCU technology into existing industrial processes.

4) Creation of Clean Hydrogen Ecosystem

(a) Development of Technology and Infrastructure for Hydrogen

Development of technology and infrastructure for hydrogen is progressing, particularly in water electrolysis using renewable energy. Pilot projects are underway to construct and operate 30MW water electrolysis facilities by 2030. As of 2022, the facilities had reached a total capacity of 2MW capacity with 55% efficiency.

To establish an institutional framework for clean hydrogen, the government amended the *Hydrogen Economy Promotion and Hydrogen Safety Management Act* (February 2020) in 2022. This amendment provides legal basis for defining the scope of clean hydrogen eligible for administrative and financial support, as well as clean hydrogen certification. A clean hydrogen ecosystem will be developed through technology advancement and administrative and financial incentives.

48) CO_2 dry reforming plant refers to an industrial facility that produces syngas (a mixture of hydrogen and CO) using CO_2 and CH_4

(b) Establishment of Stable Hydrogen Supply Base

The government is establishing a stable hydrogen supply infrastructure. The First Hydrogen Economy Transition Basic Plan (November 2021) set a hydrogen demand and supply target of 27.9 million tonnes by 2050 as a key milestone. Following the Plan for Creating a Clean Hydrogen Ecosystem (November 2022), the government initiated pilot testing and commercialization of hydrogen production in conjunction with nuclear power.

These policies support construction of four hydrogen production facilities based on water electrolysis in Buan (North Jeolla), Pyeongchang and Donghae (Gangwon), and Boryeong (South Chungcheong), each producing approximately 330 tonnes annually. Additionally, a hydrogen production facility based on carbon capture will be built in Cheongju (North Chungcheong), with an annual capacity of 990 tonnes.

(c) Expansion of Hydrogen Demand and Utilization

Sustained demand for clean hydrogen is essential for a hydrogen ecosystem. The government has set a target of 300 thousand hydrogen vehicles by 2030 while pursuing research on hydrogen and ammonia co-firing power generation. In the steel industry, R&D on hydrogen based ironmaking is underway, with plans for million-tonne scale pilot project by 2030. The petrochemical industry is developing technologies to replace conventional fuels with hydrogen in facilities such as Naphtha Cracking Centers (NCC).

3.3 Other Mitigation Policies and Measures

3.3.1 Mitigation Policies and Measures in Local Government

Local governments' climate change and green growth policies began with voluntary participation from 2018. In May 2021, at the Partnering for Green Growth and the Global Goals 2030 (P4G) Summit held in Seoul Metropolitan City, all 243 local governments declared 2050 carbon neutrality, which became an opportunity for regional action for carbon neutrality are. Regional carbon neutrality support centers were established to support regional carbon neutrality and green growth, with the Carbon Neutrality Act of 2022 making basic plans mandatory for local governments.

On May 9, 2024, 17 metropolitan and provincial governments submitted their *First Master Plan for Carbon Neutrality and Green Growth*, which serves as their regional carbon neutrality strategy. Each local government developed policies reflecting local conditions and resident opinions, establishing regional action guidelines through the 2050 Local Carbon Neutrality and Green Growth Commission. The governments demonstrated strong commitment by setting GHG mitigation targets of over 40% by 2030 compared to 2018 levels, in alignment with NDC. The plans will be implemented as rolling plans, updated every five years from 2024 to 2033, focusing on practical implementation at the local level.

Carbon neutrality requires society-wide changes, with local governments playing a crucial role. The governments implement mitigation PaMs through residential and commercial building management, land use, transportation policy, and waste management. As of 2018, metropolitan governments' GHG emissions amounted to 728.1 $MtCO_2$-eq (based on 2006 IPCC Guidelines). Of these emissions, local governments can directly manage 316.6 $MtCO_2$-eq, representing 43% of the total. Emissions are concentrated primarily in buildings and transportation, followed by waste, agriculture, livestock farming and fisheries sectors.

Each region will continue to develop and implement mitigation PaMs tailored to their specific characteristics. Key projects by local governments are as follows.

<Table Ⅱ-64> Major Cases of Local Government Mitigation PaMs

<table>
<tr><th>Region</th><th>Sector</th><th>Case</th></tr>
<tr><td>Seoul</td><td rowspan="2">Building</td><td>○ Building Energy Reporting and Rating System
· (Description) Reporting energy consumption, disclosing ratings, and displaying ratings based on building type*. High-performing buildings receive low-carbon certification, while underperforming buildings are given priority support for energy audits and building energy efficiency improvements
* Public: Total floor area 1,000 m^2 or more / Private: Total floor area 3,000 m^2 or more
· (Status) Establishment of building energy evaluation and audit system (2023) ⇒ Energy rating evaluation and public disclosure for public buildings (2024) ⇒ Energy rating evaluation and public disclosure for private buildings (from 2024 onward)
· (Expected Outcome) This initiative aims to significantly reduce emissions from the building sector, which accounts for 67% of Seoul Metropolitan City's total GHG emissions</td></tr>
<tr><td>Gwangju</td><td>○ Low-Carbon Apartment Complex Incentive Program
· (Description) GHG reduction performance of apartment complexes with 100 or more households is evaluated*, and incentives are provided based on the results
* Criteria: (Quantitative) Reduction performance in electricity, water, gas, food waste consumption (Qualitative) Campaign and promotion activities, resident participation efforts for creating green residential environments
· (Status) Outstanding complexes have been selected annually, with incentives provided since 2010
<table>
<tr><th></th><th>Participating Complexes (locations)</th><th>Outstanding Complexes (locations)</th><th>Incentive Support (KRW million)</th><th>Energy Savings (electricity conversion, toe)</th><th>GHG Mitigation (tCO_2-eq)</th></tr>
<tr><td>Total</td><td>636</td><td>384</td><td>1,868</td><td>14,030</td><td>28,147</td></tr>
</table>
· (Major Achievement) About 28,147 tCO_2-eq reduced from 2010 to 2023, the same impact as planting 427,331 pine trees</td></tr>
<tr><td>Daejeon</td><td>Transportation</td><td>○ Establishment of Advanced Traffic Management System
· (Description) The advanced traffic management system is being optimized by analyzing data collected from detection devices (e.g., smart signal control systems and section detectors) installed on roads and vehicles
· (Status) Introduction of ITS and selection as advanced transportation model city (2002) ⇒ Implementation of ITS Phase 2 project (2012) ⇒ Advancement of ITS (-2023) ⇒ Establishment of an Advanced traffic management system (2024)
· (Expected Outcome) Achieving low-carbon transportation in the sector by optimizing traffic flow, managing traffic demand, and creating an efficient mobility environment</td></tr>
</table>

Region	Sector	Case
Ulsan	Waste	○ **Steam Supply from Waste Heat Recovery in Incineration Plants** · (**Description)** Waste heat generated during the municipal waste incineration process is recovered and used to produce steam, which is then supplied as industrial energy to businesses. This system helps improve energy efficiency, lower fuel costs, and reduce GHG emissions by utilizing heat that would otherwise be wasted · (**Status)** Operation of Seongam incineration plant municipal waste incineration facilities Units 1 and 2 (2000) ⇒ Start of waste heat steam production and supply to businesses (2008) ⇒ Operation of incineration facility Unit 3 (2012) ⇒ Reconstruction of incineration facilities Units 1 and 2 (2016-present) · (**Major Achievements)** Supplying 406,407 tons of steam energy from waste heat has led to lower GHG emissions and significant cost reductions for businesses - (**Mitigation)** As of the end of 2023, GHG emissions reduced by 64,619 tCO-eq, equivalent to planting 452,333 pine trees - (**Cost)** Generated KRW 14.3 billion in non-tax revenue and saved KRW 6.1 billion in business energy costs
South Jeolla	Agriculture, Livestock Farming, and Fisheries	○ **Achieving Low-Carbon Livestock Farming through Technology** · **(Description)** Transition to a low-carbon livestock industry, technologies and management techniques are being introduced to enhance feeding efficiency and reduce emissions from cattle farming. Farmers are supported in adopting optimized feeding strategies that improve productivity while minimizing environmental impact. Additionally, the low-carbon livestock certification system encourages the adoption of sustainable practices in the livestock farming sector · (**Status)** Newly established according to the *First South Jeolla Province Master Plan for Carbon Neutrality and Green Growth* in 2023 · (**Expected Effect)** By reducing feed costs, this initiative is expected to improve livestock farm profitability while also cutting carbon emissions from cattle farming

<table>
<tr><th>Region</th><th>Sector</th><th>Case</th></tr>
<tr><td>Daegu</td><td>Carbon Sinks</td><td>○ Green Forest Low-Carbon NET Initiative (Forest Daegu Project)
(Description) A 25 ha Daegu Green Healing Belt has been established along the Geumho River and surrounding forests. Additionally, a 189 ha climate-responsive forest is being managed, and a 45 ha Second Arboretum has been constructed. Urban greening projects, including rooftop gardens covering 20,000m^2 annually, are also underway

(Status)
- (Forest Management) Annual maintenance of 1,000-2,000 ha of forest through projects such as fine dust reduction forests, young tree care, and afforestation site maintenance.
- (Tree Planting) As part of the Green Daegu Project, 10.93 million trees were planted from 1996 to 2006, making Daegu the first local city to achieve the milestone of planting 10 million trees.
- (Gardens/Arboretum) Plans are in place to establish the Geumho River National Garden (from 2025 onward) and expand forest welfare infrastructure, including the construction of the Second Arboretum (45 ha) by 2025.

(Major Achievement) From 2019 to 2023, approximately 15,698.5* tCO-eq of GHG emissions were reduced.
* Tree Planting: 15,576 tCO_2-eq / Rooftop Greening: 122.5 tCO_2-eq</td></tr>
<tr><td>Gyeonggi</td><td>Other Sectors</td><td>○ Achieving RE100 in Public Institutions
(Description) Efforts are underway to expand renewable energy adoption in Gyeonggi Province and its affiliated public institutions through the installation of solar power facilities and community-driven solar power plants.
- (Goal) Increase the renewable energy share to 100% for all public institutions by 2026 (currently 4.1% as of 2023) and expand renewable energy by 84 MW

(Status) Expansion of solar power generation in public institutions and public property
- (Public Institutions) Installation of 18.8 MW of solar power facilities at 68 sites is in progress.
<table>
<tr><th></th><th>Total</th><th>Site Discovery</th><th>Consulting</th><th>Permission</th><th>Construction Progress</th><th>Construction Complete</th></tr>
<tr><td>Target Sites (location)</td><td>68</td><td>42</td><td>7</td><td>7</td><td>11</td><td>1</td></tr>
<tr><td>Generation Capacity (kW)</td><td>18,776</td><td>10,549</td><td>2,518</td><td>2,334</td><td>2,597</td><td>778</td></tr>
</table>
- (Public Property) Installation of 12.7 MW of community-driven solar power plants at 44 locations is in progress.
<table>
<tr><th></th><th>Total</th><th>Consulting</th><th>Use Approval</th><th>Paid Permission</th><th>Construction Progress</th><th>Construction Complete</th></tr>
<tr><td>Public property (location)</td><td>44</td><td>20</td><td>15</td><td>4</td><td>1</td><td>4</td></tr>
<tr><td>Generation Capacity (kW)</td><td>12,718</td><td>5,194</td><td>4,276</td><td>1,680</td><td>300</td><td>1,268</td></tr>
</table>
(Expected Outcome) Expanding energy transition by increasing renewable energy adoption and improving inefficient energy consumption patterns, contributing to Gyeonggi Province’s carbon neutrality and driving the expansion of RE100 in the private sector.</td></tr>
</table>

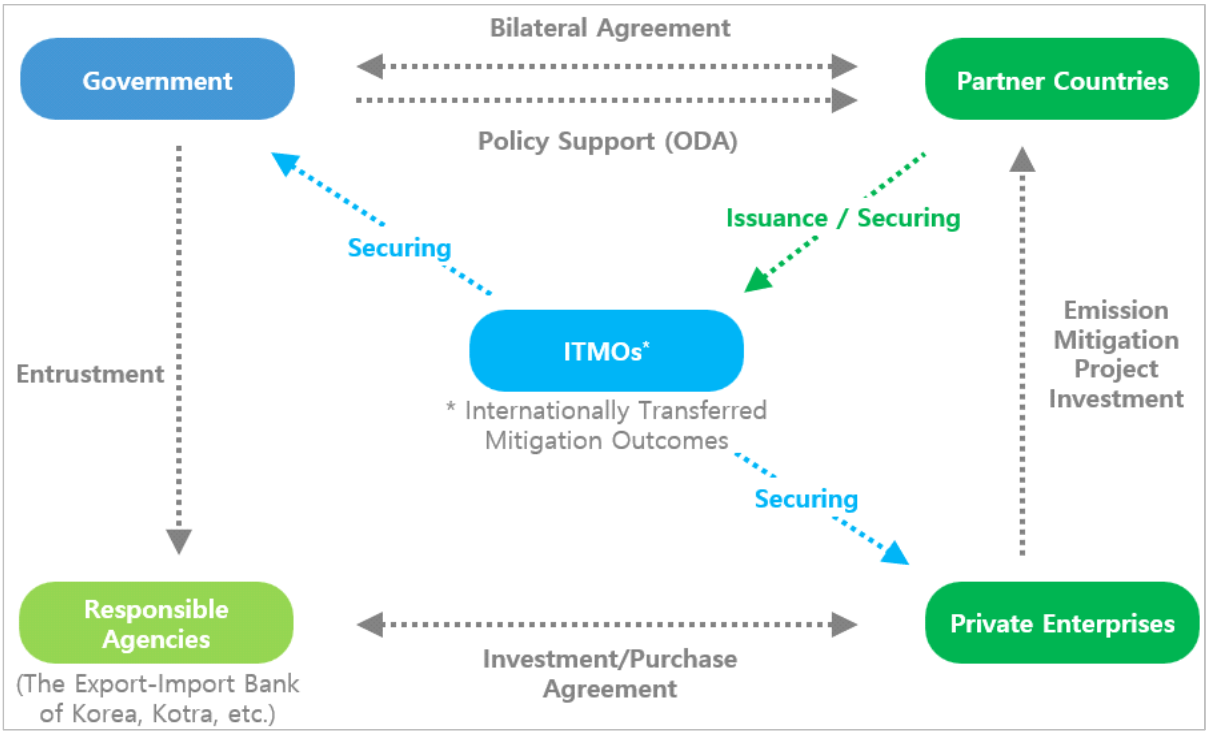
3.3.2 International Mitigation Project

Articles 6.2 and 6.4 of the Paris Agreement stipulate market mechanisms for cost-effective GHG mitigation. Article 6.2, which enables voluntary cooperation between countries to reduce emissions, is drawing attention as a key tool for addressing climate change.

The ROK is utilizing international mitigation project as a supplementary means to achieve its NDC. Under the Carbon Neutrality Act, the Carbon Neutrality and Green Growth Commission oversees these projects, while sectoral ministries implement them in their respective sectors. These ministries include the Ministry of Land, Infrastructure and Transport, the Ministry of Agriculture, Food and Rural Affairs, the Ministry of Trade, Industry and Energy, the Ministry of Environment, and the Ministry of Oceans and Fisheries. The Ministry of Environment, in particular, manages the international mitigation registry and approves ITMOs.

Many countries, including the ROK, are actively pursuing international mitigation projects under Articles 6.2 and 6.4 of the Paris Agreement. Countries are establishing bilateral agreements for project approval, issuance and transfer of mitigation outcomes with partner governments. To strengthen comprehensive cooperation in addressing climate change, the ROK has formed bilateral agreements with nine other countries as of December 2024, including Vietnam, Mongolia, Gabon, Uzbekistan, UAE, Morocco, Peru, Laos, and Kyrgyzstan. Additionally, the ROK is establishing inter-agency agreements to expedite these projects based on partner countries' circumstances.

Through these projects, the ROK plans to promote GHG mitigation that will contribute to achieving its NDC. Additionally, by distributing mitigation facilities and stimulating private investment in green sectors, it aims to support sustainable development in developing countries. By pursuing these initiatives, the ROK will establish a mutually beneficial cooperation framework and assume a leading role in international climate change response efforts. Major examples of international mitigation projects being pursued by various ministries are as follows.



[Figure Ⅱ-13] Procedure of International Mitigation Project Implementation

<Table Ⅱ-65> Major Cases of International Mitigation Project by Relevant Ministries

Ministry	Case
Ministry of Land, Infrastructure and Transport	○ **MOU for Cooperation on GHG Mitigation and Climate Change Response in Land and Transport Sector** · On September 19, 2023, a Memorandum of Understanding (MOU) was signed with the Global Green Growth Institute (GGGI) for "cooperation on carbon mitigation and climate change response in the land and transport sector". Under this agreement, both parties plan to pursue cooperation for generating ITMOs, including identifying potential partner countries for cooperation in the land and transportation sector. · The Ministry has been conducting bilateral meetings for international mitigation project cooperation by inviting relevant high-level officials through the annual Global Infrastructure Cooperation Conference (GICC) (2023-2024). At GICC 2024, it co-hosted the "Land and Transport Carbon Neutrality Cooperation Seminar: First Steps toward a Sustainable Future" with GGGI. ○ **Establishment of Domestic Foundation for Promoting International Mitigation Projects in Land and Transport Sector** · To enhance understanding among relevant domestic industries and institutions, the Ministry is developing and publishing the 2024 Implementation Guidelines for International Mitigation Projects for Business Operators, providing free consulting for companies and institutions interested in international mitigation projects, and operating basic and advanced training programs to establish a domestic foundation for promoting international mitigation projects. · Furthermore, in 2024, the Ministry plans to identify international mitigation items through supporting feasibility studies for international mitigation projects in the land and transport sector pursued by private companies. From 2025, it plans to secure GHG mitigation results by fully implementing pilot installation support projects with partner countries.

Ministry	Case
Korea Forest Service	○ **Establishment of the Legislative Framework for International Mitigation REDD+ Programs in Forest Sector** ・ To contribute to achieving NDC and responding to climate change through Reducing emissions from deforestation and forest degradation plus in developing countries (REDD+) activities as encouraged in accordance with paragraph 2, Article 5 of the Paris Agreement, the *Act on Support for Reducing Greenhouse Gas Emissions and Enhancing Carbon Accumulation Through Forest in Developing Countries* (REDD+ Act) which is supporting GHG mitigation and enhancement of carbon stocks from forests in developing countries was enacted (August 2023) and implemented (February 2024). ・ Korea Forest Service plans to establish a bilateral cooperation system for national and/or sub-national REDD+ under Article 6.2 and REDD+ activities under Article 6.4 based on the UNFCCC Warsaw REDD+ Framework and utilize ITMOs from REDD+ for achieving 2030 NDC. To systematically implement this, operational standards for REDD+ and a master plan will be formulated.
Ministry of Environment	○ **Landfill Gas Capture and Combustion in Ulaanbaatar, Mongolia** ・ In May 2022, a bilateral meeting was held with Mongolia's Ministry of Environment and Tourism, resulting in the signing of an Implementation Arrangement on Cooperative Approaches under Article 6 of the Paris Agreement (International GHG Mitigation Implementation Arrangement) (May 2022) and MOU on Environmental Cooperation. ・ Based on the International GHG Mitigation Implementation Arrangement, a project to capture and combust methane gas generated from the Narangiin landfill in Ulaanbaatar, Mongolia, is being implemented. The project is expected to reduce approximately 540 $ktCO_2$-eq of GHGs over the 10-year project period. ○ **MOU with Kazakhstan for Mitigation Projects** ・ In June 2024, a MOU for GHG Mitigation Projects was signed with Kazakhstan's Ministry of Ecology and Natural Resources, establishing a legal foundation for implementing international mitigation projects between governments under the Paris Agreement. ・ A Korean business consortium (ROEN Consulting consortium) is reviewing the feasibility of a project to capture methane gas from the Almaty landfill, Kazakhstan's largest city, for power generation. If implemented, this project is expected to reduce total GHG emissions by 6.17 $MtCO_2$-eq over 15 years and improve the local environment.
Ministry of Oceans and Fisheries	○ **MOU on Collaboration on the Cooperative Approaches for NDC Implementation** ・ In November 2022, a MOU was signed with the GGGI for cooperation on NDC implementation support and international mitigation projects under the Paris Agreement. ・ Under this agreement, both parties plan to identify potential partner countries for cooperation in the marine sector, including blue carbon, and implement international mitigation projects for strengthening partner countries' MRV capacity and generating ITMOs based on Articles 6 and 13 of the Paris Agreement. ・ Furthermore, from 2024, the Ministry plans to identify international mitigation items through supporting feasibility studies for marine sector international mitigation projects pursued by private companies, such as mangrove restoration and coastal solar power facility distribution. From 2025, it plans to secure GHG mitigation results by fully implementing pilot installation support projects with partner countries.

3.3.3 International Transportation

The ROK participates in international community efforts to reduce GHG emissions from international transport, such as aviation and shipping, and has established domestic implementation measures and specific plans.

The ROK has also enacted the *Act on Management of International Aviation Carbon Emissions* (February 2024) to manage emissions from international flights according to standards in the Convention on International Civil Aviation and its Annex XVI, fostering sustainable aviation industry growth. Supporting the International Civil Aviation Organization's (ICAO) 2050 carbon neutrality framework, the *Strategies for SAF Diffusion* (August 2024) to reduce aviation carbon emissions through Sustainable Aviation Fuel (SAF) was established. Commercial operations began in August 2024 with nine of Korea's 11 airlines, including Korean Air, using domestic SAF in short-distance international flights. A mandatory SAF system will be implemented from 2027, requiring domestic refineries to comply with specific mixing ratios and mandating SAF use for all international departures.

The ROK continues to lead efforts in international shipping decarbonization and eco-friendly transition. At COP27, the ROK and the United States jointly announced the Collaboration on Green Shipping Corridors to achieve zero-carbon emissions using carbon-free fuels and technologies. Following this announcement, both countries have identified specific routes between major ports through joint research and are currently developing roadmaps. The *Strategy for International Shipping Decarbonization* (February 2023) was established to proactively address GHG regulations in the global maritime transport sector. This strategy aims to convert all international vessels to eco-friendly ships by 2050, starting with dual-fuel vessels capable of using eco-friendly fuels by 2030, followed by zero-carbon vessels powered by ammonia and hydrogen as technology advances.

Futhermore, the ROK submitted *Toward Green Shipping by 2050* (July 2023) to the International Maritime Organization (IMO), consolidating various decarbonization policies in maritime and port sector including Strategy for *Strategy for Decarbonization of International Shipping* (February 2023), *2050 Carbon Neutrality Roadmap for the Marine and Fisheries Sector* (December 2021), and *Carbon Neutral Port Roadmap*. This submission demonstrated the ROK's commitment to achieving green shipping on a global scale.

4. Projection of GHG Emissions and Removals

4.1 Introduction

This chapter presents GHG emissions projection up to 2040. This projection represents a With Measures scenario (WM scenario), which reflects the effects of climate and energy PaMs implemented up to 2021. Policies proposed or planned before 2021 but not implemented, unconfirmed bills, and PaMs without demonstrated reduction effects due to lack of budget allocation are not included in the scenario analysis. However, large-scale projects confirmed to be operated in the near future, regardless of their reduction effects, are included in the projection.

The GHG emissions data up to 2021 presented is based on the 2024 National Greenhouse Gas Inventory (1990-2022), which was prepared according to the 2006 IPCC Guidelines.[49)]

Projection result is presented by gas type. The gases are categorized into seven gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). Emissions are presented as carbon dioxide equivalent (CO_2-eq) values using the GWP conversion factors from the IPCC Fifth Assessment Report (AR5), which are consistent with the GWP values used in Chapter Ⅰ of the BTR for the National GHG Inventory. Projection related to international transportation and indirect GHGs is excluded from this analysis.

49) The emission projection is based on data from 2021, the latest available at the time of analysis. However, following the latest revision of the Yearbook of Energy Statistics (December 2024), the emission projection has been updated to reflect the changes.

4.2 Total GHG Emissions Projection

Total GHG emissions projection does not include reduction effects from mitigation PaMs introduced after 2021. Reduction effects from PaMs adopted before 2021 are assumed to be already reflected in historical energy use and GHG emissions. Projection is based on the WM scenario, which analyzes the relationship between total GHG emissions and macroeconomic variables such as population changes, economic growth, and energy prices. The WM scenario assumes that the level of mitigation PaMs reflected in emissions up to 2021 will continue into the future.

According to the WM scenario, total GHG emissions (excluding net GHG removals from the LULUCF sector) in 2040 are expected to be 818.7 $MtCO_2$-eq, increasing at an annual average rate of 2.0% since 1990. However, while GHG emissions increased at an annual average rate of 3.4% from 1990 to 2018 (the base year for the 2030 NDC), the annual average increase rate is projected to decline significantly to 0.2% from 2018 to 2040.

The GHG removals from the LULUCF sector in 2040 are projected to be 13.6 $MtCO_2$-eq, continuing a consistent decline since 2000. Net GHG emissions, including the LULUCF sector, are projected to reach 805.1 $MtCO_2$-eq in 2040.

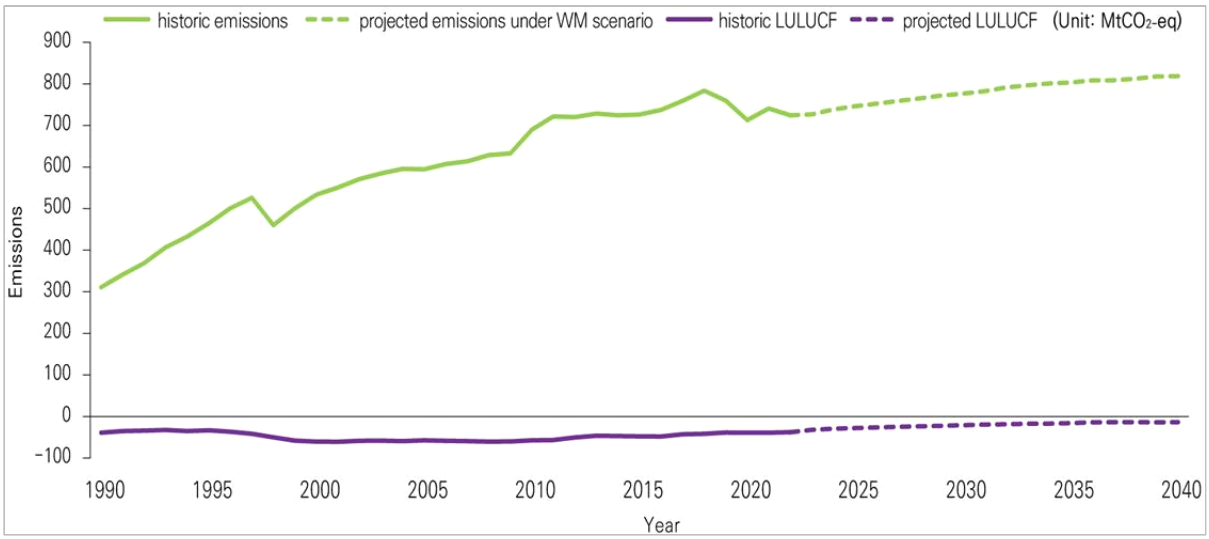
It should be noted that this projection result does not take into account PaMs for GHG reduction targets introduced after 2021. When emissions projection is updated based on the most recent year, reflecting new PaMs, emissions are expected to decrease compared to this projection. However, given that the ROK's economy is significantly influenced by global factors such as export supply chains and energy prices, these changes may have substantial effects on the ROK's economic development and corresponding GHG emissions levels. Therefore, like all predictions, it is necessary to consider that emissions projection also involves considerable uncertainty.

<Table Ⅱ-66> GHG Emissions and Projection: WM Scenario

(Unit: $MtCO_2$-eq)

	1990	1995	2000	2005	2010	2015	2018	2020	2025	2030	2035	2040
Total Emissions	310.6	464.5	533.5	594.4	689.8	726.1	783.9	713.0	746.2	776.4	803.4	818.7
LULUCF	-39.0	-33.3	-60.4	-57.5	-57.4	-47.8	-41.6	-38.8	-27.8	-21.0	-16.1	-13.6
Net Emissions	271.6	431.2	473.1	536.9	632.4	678.3	742.3	674.1	718.5	755.3	787.3	805.1

Note: For 2018, Korea's 2030 NDC base year, the reference value used for target setting was based on the inventory prepared in 2022 according to the 1996 inventory guidelines, thus differing from the 2018 value above



[Figure Ⅱ-14] GHG Emissions and Projection: WM Scenario

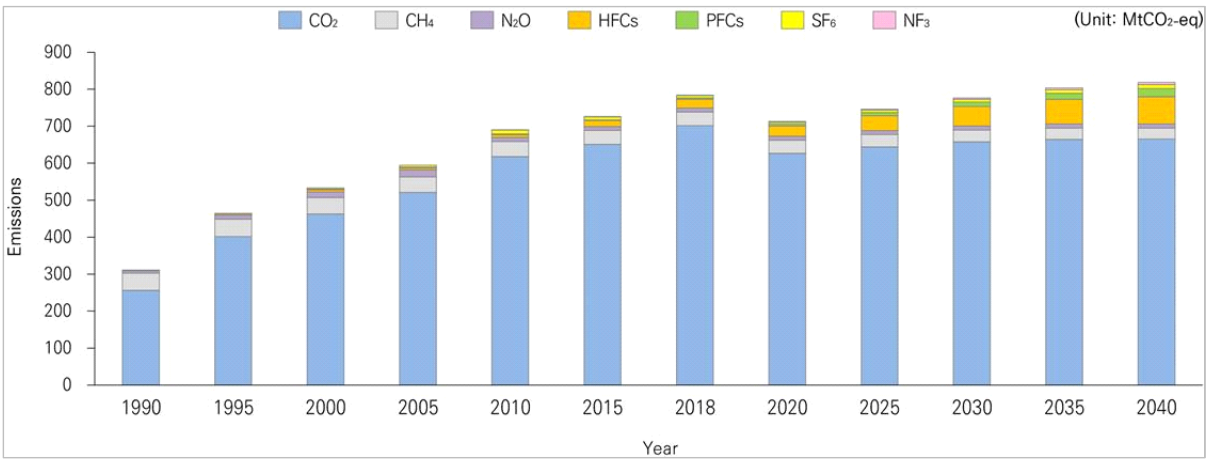
4.3 Projection by Gas

Historical emissions by gas and projected GHG emission trends are shown in Table II-67.

<Table Ⅱ-67> GHG Emissions by Gas: Trends and Projection

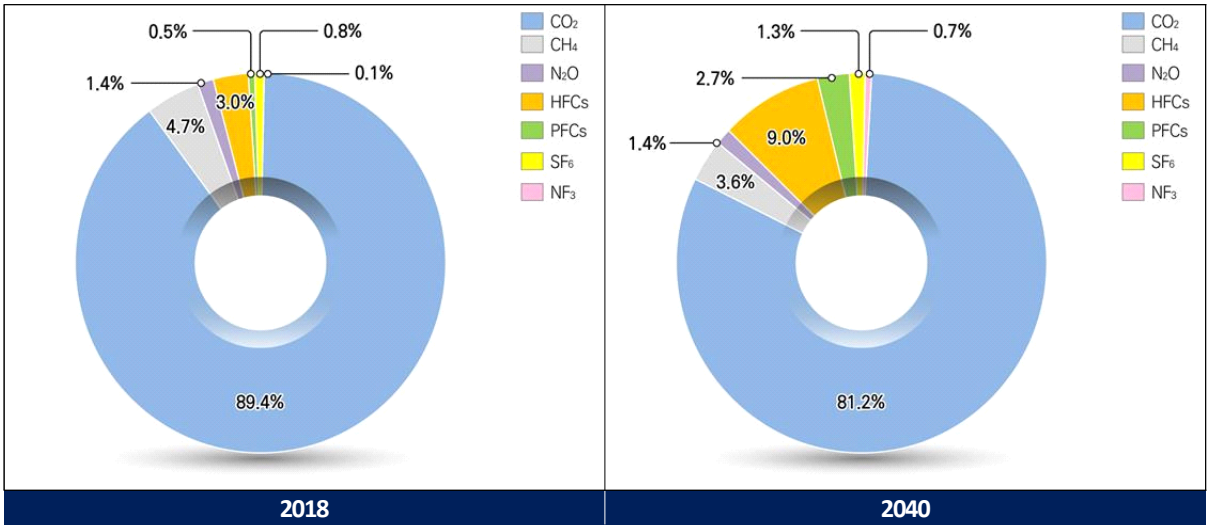
(Unit: $MtCO_2$-eq)

		1990	1995	2000	2005	2010	2015	2018	2020	2025	2030	2035	2040
CO_2		256.2	401.7	462.6	521.3	618.0	651.1	701.1	626.7	643.9	657.9	664.3	665.1
CH_4		46.8	47.1	44.6	42.1	40.6	37.8	37.2	35.6	33.4	31.8	30.9	29.9
N_2O		6.3	10.9	14.9	18.8	10.6	10.1	10.9	10.7	10.8	11.0	11.2	11.3
HFCs		1.0	3.3	6.0	4.8	7.6	16.1	23.6	27.9	40.7	52.1	65.8	73.6
PFCs		-	-	2.5	3.2	2.5	1.8	3.9	4.5	8.8	12.3	16.6	22.0
SF_6		0.2	1.5	2.8	4.3	10.0	8.4	6.3	5.4	6.0	7.6	9.6	10.9
NF_3		-	-	-	-	0.4	0.8	1.0	2.1	2.8	3.7	4.9	6.1
Total Emissions		310.6	464.5	533.5	594.4	689.8	726.1	783.9	713.0	746.2	776.4	803.4	818.7
LULUCF	CO_2	-39.4	-33.6	-60.9	-57.8	-57.7	-48.2	-42.0	-39.3	-28.2	-21.5	-16.5	-14.1
	CH_4	0.3	0.3	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	N_2O	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	-39.0	-33.3	-60.4	-57.5	-57.4	-47.8	-41.6	-38.8	-27.8	-21.0	-16.1	-13.6
Net Emissions		271.6	431.2	473.1	536.9	632.4	678.3	742.3	674.1	718.5	755.3	787.3	805.1



[Figure Ⅱ-15] GHG Emissions by Gas: Trends and Projection

Figure II-16 shows the emission ratio by gas in 2018 and projected ratio in 2040. Under the WM scenario, the order of gases by proportion is expected to change from CO_2 > CH_4 > HFCs > N_2O > SF_6 > PFCs > NF_3 in 2018 to CO_2 > HFCs > CH_4 > PFCs > N_2O > SF_6 > NF_3 in 2040.



[Figure Ⅱ-16] Emissions Ratio by Gas in 2018 and Projected Emissions Ratio in 2040

4.3.1 Carbon Dioxide (CO_2)

Based on total emissions, CO_2 emissions are projected to reach 665.1 $MtCO_2$-eq in 2040, a 5.1% decrease compared to 2018, the NDC base year. CO_2 emissions accounted for 89.4% of the ROK's total emissions in 2018 and are projected to gradually decrease to 81.2% by 2040.

CO_2 emissions from all sectors increased at an average of 3.7% anually from 1990 to 2018. However, they are projected to decrease by an average of 0.2% annually until 2040 due to short-term factors such as the pandemic and global economic recession, and long-term improvements in carbon intensity resulting from decreased coal and oil/petroleum usage and increased use of gas and renewable energy.

4.3.2 Methane (CH_4)

CH_4 emissions are projected to decrease by 19.6% to 29.9 $MtCO_2$-eq in 2040 compared to 2018 based on total emissions. CH_4 emissions accounted for 4.7% of the ROK's total emissions in 2018 and are projected to gradually decrease to 3.6% by 2040.

The decrease in CH_4 is expected to be primarily due to the continuous reduction in rice cultivation area in the agricultural sector, the ban on food waste landfill disposal, and increased recycling rates in the waste landfill sector.

4.3.3 Nitrous Oxide (N_2O)

N_2O emissions are projected to increase by 3.7% to 11.3 $MtCO_2$-eq in 2040 compared to 2018 based on total emissions, showing slight change. N_2O emissions accounted for 1.4% of total emissions in 2018 and are projected to remain at the same level of 1.4% in 2040.

4.3.4 Fluorinated Gas (HFCs, PFCs, SF_6, NF_3)

Emissions of fluorinated gases (HFCs, PFCs, SF_6, NF_3) reflect trends in the electronics industry, improvements in activity data for Ozone Depleting Substances (ODS) alternatives, and methodology enhancements in calculating actual emissions from production, use, and disposal. Accordingly, fluorinated gases accounted for 4.4% of total emissions in 2018 and are projected to increase to 13.7% by 2040.

Among fluorinated gases, emissions of HFCs, which constitute the majority of ODS alternative use, show an increasing trend. Since the ROK is classified as Group I of Article 5 under the Kigali Amendment to the Montreal Protocol on Substances That Deplete the Ozone Layer (Kigali Amendment) and freezes HFCs production and consumption starting in 2024, this effect is not reflected in the WM scenario. An increasing trend is projected, reflecting a partial transition to HFCs in light of the scheduled phase-out of HCFC production and consumption by 2030 under the Montreal Protocol on Substances That Deplete the Ozone Layer. However, emissions are expected to gradually decrease through additional reduction efforts such as compliance with the Kigali Amendment, replacement with low-GWP refrigerants, expanded use of recycled refrigerants, and increased recovery during use and disposal phases.

4.4 Methodology

The GHG emissions data presented in this report is based on the 2024 National Greenhouse Gas Inventory (1990-2022), prepared according to the IPCC 2006 GL. To develop the WM scenario for the ROK's first BTR submission, technical working groups comprising experts from relevant government agencies for each sector were formed to conduct emissions projection. Sector-specific technical working groups reviewed various econometric models and other projection methodologies, selected the most appropriate methods, and conducted emission projection. The results were finalized after consulting with industry, external experts, relevant ministries, the Carbon Neutrality and Green Growth Commission, and other stakeholders to gather diverse opinions.

The projection of major activity data for GHG emissions utilizes econometric models that best explain the relationship with socioeconomic macroeconomic variables and preconditions.

The projection results of key macroeconomic variables used in emissions projection are shown in Table II-68. The projection utilizes results from relevant institutions responsible for key variables such as the ROK's population, economic growth, oil prices, and industrial structure.

For key assumptions, population projection uses the medium population projection scenario among various scenarios projected by Statistics Korea. Economic growth assumptions utilize long-term economic projection by the Korea Development Institute (KDI) based on actual figures from the Bank of Korea's Economic Statistics System. Oil prices assumptions utilize projection from the Korea Energy Economics Institute (KEEI) based on data from the International Energy Agency's (IEA) World Energy Outlook.

<Table Ⅱ-68> Key Variables and Assumptions

Variable	Unit	2018	2020	2025	2030	2035	2040
Population	Million	51.6	51.8	51.7	51.3	50.8	50.1
GDP	KRW Trillion	1,812.0	1,839.5	2,077	2,231	2,351	2,447
Oil Price	USD/bbl	69.0	43.6	92.1	89.4	89.0	88.6

4.5 Uncertainty (Sensitivity Analysis)

The ROK has included baseline emissions projection under the WM scenario for the first time in its First BTR, submitted to the international community under the Paris Agreement. The development of a With Additional Measures (WAM) scenario, which reflects the effects of additional reduction measures, and sensitivity analyses on uncertainties in future values of key variables such as demographics, economic growth, and fuel prices, will be developed in detail and included in subsequent BTRs.

III

Climate Change Impacts and Adaptation

1. National Circumstances, Institutional Arrangements and Legal Frameworks

1.1 National Circumstances

1.1.1 Current Climate Trends

The Republic of Korea (ROK) has experienced temperature increases at a faster rate than the global average. During the 109-year period from 1912 to 2020, the ROK's annual mean temperature rose by 0.20°C per decade. When comparing the recent 30-year period (1991-2020) with the earlier period (1912-1940), the mean temperature increased by 1.60°C. This increase significantly exceeds the global average temperature rise of 1.09°C observed between the pre-industrial era (1850-1900) and the recent decade (2011-2020).

Between 1912 and 2020, the ROK has experienced an increase in annual mean precipitation despite a decrease in the number of rainy days. Precipitation increased by 17.71 mm per decade, while rainy days decreased by 2.73 days per decade. Additionally, there has been a significant increase in the frequency of extreme rainfall events.

Indicators of extreme heat, particularly heatwave days and tropical nights, have increased significantly in recent years. Compared to the 1991-2020 period, the recent decade (2011-2020) saw an increase of 2.8 days in heatwave frequency and 4.6 more tropical nights. In contrast, cold weather indicators have shown a consistent decline over the 109-year period since 1912. Cold days decreased by 1.91 days per decade, while frost days declined by 0.61 days per decade.

Sea surface temperatures around the ROK have risen dramatically, with the annual mean increasing by 1.44°C between 1968 and 2023. This increase is more than twice the global average rise of 0.70°C over the same period. Satellite observations in 2023 recorded an annual mean sea surface temperature of 19.8°C, the highest since the monitoring began in 1990.

The mean sea level along the ROK's coast has risen by approximately 3.06 mm per year from 1989 to 2023, with a cumulative increase of 10.7 cm over this 35-year period. The rate of increase has accelerated in recent years, reaching an average of 3.88 mm annually during the 2014-2023 period.

1.1.2 Projected Climate Trends

Climate change impacts in the ROK are projected to intensify throughout the century. Based on the Intergovernmental Panel on Climate Change (IPCC)'s Shared Socioeconomic Pathways (SSP) scenarios, the ROK's annual mean temperature is expected to rise by 2.3°C to 6.3°C above current levels by the end of the 21st century (2081-2100), with the variation depending on future greenhouse gas (GHG) emissions.

Annual precipitation levels are also expected to change significantly. By the end of the 21st century, all SSP scenarios project an increase in the annual precipitation of 4% to 16% compared to current levels. However, this increased precipitation is expected to be concentrated in fewer days, with projections showing a decrease of 10 to 14 annual precipitation days.

Extreme heat events are projected to become more frequent. By the end of the 21st century, all scenarios indicate an increase of 15.4 to 70.7 heatwave days and 19.1 to 65.2 tropical nights annually. The high-emission scenario (SSP5-8.5), which assumes continued fossil fuel-driven economic growth, projects a particularly sharp increase in both metrics after mid-century (2041-2060). Under this scenario, the frequency of both heatwave days and tropical nights could double between mid-century and the 2081-2100 period.

Sea surface temperatures in ROK waters are projected to rise continuously, with the high-emission scenario (SSP5-8.5) projecting an increase of up to 4°C by 2100. Sea level rise in these waters is expected to vary by emission scenario, with annual rates ranging from 5.44 to 9.51 mm. This could result in a total rise of 46.8 to 81.8 cm by 2100.

1.2 Institutional Arrangements and Legal Framework

1.2.1 Legal Basis and Policies

The ROK has established a comprehensive legal framework to address climate change adaptation. This began with the *Framework Act on Low Carbon, Green Growth* (January 2010), and was strengthened by the *Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis* (Carbon Neutrality Act) (September 2021). The current legislation mandates nationwide climate change adaptation through monitoring and forecasting of climate change impacts, development and implementation of the National Climate Change Adaptation Plan, and regular progress assessments of adaptation measures. The Carbon Neutrality Act extends adaptation planning responsibilities beyond the sub-national governments and public institutions, while also providing legal grounds for establishing specialized adaptation institutions.

In 2020, the ROK established the '2050 Carbon Neutral Vision', setting the goal of achieving carbon neutrality by 2050. Subsequently, in 2023, the *First National Framework Plan for Carbon Neutrality and Green Growth* (April 2023) has been developed and policies to address climate change has been implemented. Regarding climate change adaptation, the ROK has been developing and implementing the *National Climate Change Adaptation Plan* (NCCAP) in five-year cycles since 2010. Currently, the *Enhanced 3rd National Climate Change Adaptation Plan* (Enhanced 3rd NCCAP) (June 2023), which is a revised and supplemented version of the 3rd NCCAP (December 2020), is being implemented.

The National Human Rights Commission of Korea officially recognized in 2022 that protecting citizens' human rights under climate change is a fundamental government responsibility. Based on this recognition, the Commission recommended strengthening laws and systems to address climate change through a human rights perspective. Following these recommendations, the ROK has enhanced its climate change adaptation policies to ensure comprehensive protection for all citizens, with particular attention to vulnerable populations.

1.2.2 Governance

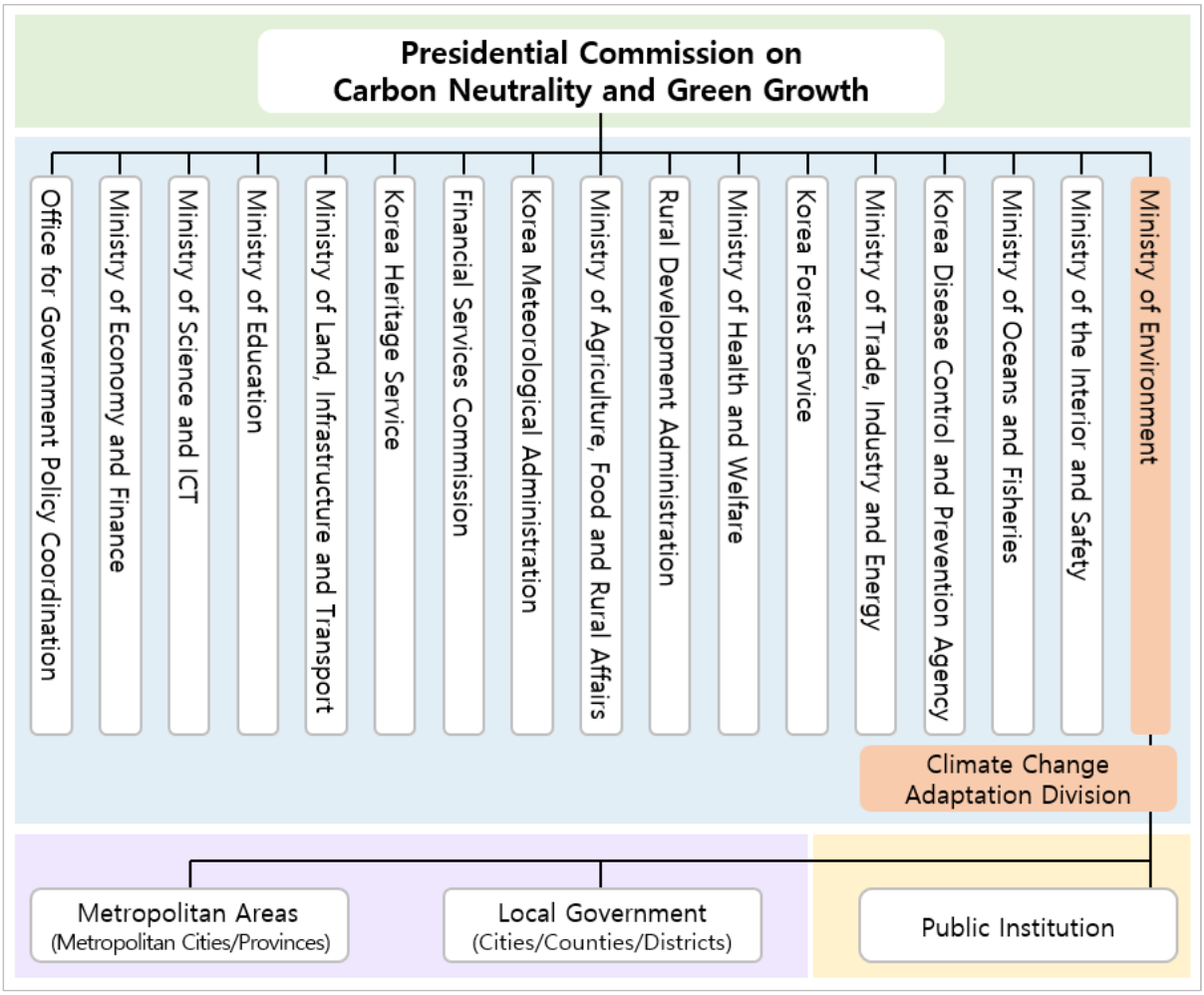
The ROK has established a multi-level governance framework for climate change adaptation. At the central level, 15 ministries coordinate to develop and implement the NCCAP. This governance structure extends vertically from the central government through metropolitan and municipal governments to public institutions. The framework also promotes active engagement with diverse stakeholders, including the private sector and civil society, while providing targeted support for climate-vulnerable populations.

The Ministry of Environment leads the ROK's climate change adaptation efforts at the central government level, coordinating the five-year NCCAP development process and conducting both annual assessments and comprehensive evaluations. Under the Enhanced 3rd NCCAP, 15 ministries are actively involved in implementation. Each participating ministry develops its own action plans and regularly reports on the implementation progress.

Sub-national governments, including 17 metropolitan and provincial governments and 226 municipal governments, must develop and implement *Sub-National Climate Change Adaptation Plans* (SNCCAPs) on a five-year cycle. Similarly, 62 public institutions managing critical infrastructure in sectors such as transportation and electricity are required to establish and implement their own five-year adaptation plans.

The Presidential Commission on Carbon Neutrality and Green Growth (Carbon Neutrality and Green Growth Commission) oversees key policies and implementation measures for achieving carbon neutrality and promoting green growth, including climate change adaptation initiatives.

The ROK actively engages with industry and the general public as key stakeholders in climate change adaptation efforts. The government has also developed specialized support programs targeting climate-vulnerable populations, particularly the elderly and low-income households.



[Figure Ⅲ-1] Organizational Framework for Climate Change Adaptation in the ROK

The Ministry of Environment has established specialized institutions to support climate change adaptation research, policy development, and implementation. The Korea Adaptation Center for Climate Change (KACCC) was established within the Korea Environment Institute (KEI) in 2009. The KACCC leads multiple adaptation initiatives, including research, plan development and implementation, international cooperation, assessment tool development, and public education. Additionally, the National Adaptation Center for Climate Change (NACCC) was established in 2021 as part of the National Institute of Environmental Research (NIER) to enhance the scientific foundation for climate change adaptation.

2. Impacts, Risks and Vulnerabilities

2.1 Scientific Assessment

The ROK conducts comprehensive scientific assessments to evaluate both current and projected climate change impacts, supporting the development of effective adaptation strategies.

The ROK also regularly publishes the Korea Climate Change Assessment Report, which synthesizes domestic and international climate change research findings to inform policy decisions.

The Ministry of Environment conducts national climate change risk assessments every five years to inform the development of the NCCAP. For the Enhanced 3rd NCCAP (June 2023), the ministry completed a new risk assessment in 2023, which reviewed existing risks and identified emerging threats. These findings were integrated into the Enhanced 3rd NCCAP.

In collaboration with other ministries, the Ministry of Environment has developed the Model Of InTegrated Impact and Vulnerability Evaluation of Climate Change (MOTIVE) to assess climate change impacts and vulnerabilities. Initially, MOTIVE covered seven sectors: water management, forestry, health, agriculture, fisheries, oceans, and ecosystems. However, since 2022, MOTIVE has been upgraded to enhance its capacity to support adaptation-related decision-making across six sectors: water management, forestry, health, agriculture, industry, and ecosystems.

Also, the Ministry of Environment has developed the Vulnerability Assessment Tool to Build Climate Change Adaptation Plan (VESTAP), a web-based platform provided to sub-national governments, public institutions, and other key stakeholders. VESTAP assists in sub-national adaptation planning by identifying climate-vulnerable areas, reducing policy uncertainties, and providing scientific evidence for decision-making. The tool conducts vulnerability assessments across six sectors - water management, health, agriculture and fisheries, land and coastal areas, industry and energy, and ecosystems. These assessments, based on climate exposure, sensitivity, and adaptive capacity indicators, are available at both municipal (si, gun, gu) and sub-municipal (eup, myeon, dong) levels.

2.2 Climate Change Impacts

The ROK systematically evaluates climate change impacts through its regularly published Korea Climate Change Assessment Report. The following sections present key sectoral impacts of climate change and recent extreme weather events in the country.[50)]

2.2.1 Water Resources

The impact of climate change on water resources in the ROK is evidenced by increased summer precipitation and more frequent heavy rainfall events. Heavy rainfall is categorized by daily precipitation thresholds of 30 mm, 50 mm, 80 mm, and 100 mm. Analysis shows that summer precipitation increased by 11.6 mm per decade during the 106-year period from 1912 to 2017. In eight of its major cities, the frequency of heavy rainfall days increased by 3.1% to 15% during the 30-year period from 1981 to 2010. More recently, the heavy rainfall from June to September 2023 resulted in 50 fatalities, 3 missing persons, and property damage of approximately KRW 807.1 billion.

2.2.2 Forest

Climate change impacts on forests are manifested through rising temperatures and more frequent extreme weather events occurrences, including droughts, monsoons, heatwaves, and strong winds. These changes affect forest growth, species distribution, and disaster patterns. In particular, climate change has reduced the growth rates of key coniferous species, including Big-Cone pine trees and Korean red pine trees. In subalpine regions, coniferous forests that provide critical habitats for endangered species such as the Korean fir have decreased by 25% between 1990 and 2010.

Forest fire risk has also increased due to spring dry weather, severe droughts in southern regions, and strong winds. In 2023, forest fires occurred 5% more frequently and affected 25% larger areas in total, compared to the 10-year average (2014-2023).

50) The information on climate change impacts is sourced from the Korea Climate Change Assessment Report 2020, which provides trends and projections of climate change impacts in the ROK. This report is based on a comprehensive analysis of approximately 1,900 domestic and international research papers and reports published between 2014 and 2020, conducted by 120 experts. Additionally, some information originates from climate change impact assessment reports issued by various ministries.

2.2.3 Public Health

Climate change affects public health through increased risks of heat-related mortality and illnesses, as well as dangers from extreme weather events including typhoons, heatwaves, and heavy snow. Studies show that a 1°C temperature increase raises mortality risk by 5%, with this risk escalating to 8% during heatwave periods. Heat-related health impacts were particularly evident in 2023, when 2,818 cases of heat-related illnesses were reported during the summer heatwave monitoring period, representing an 80.2% increase from the previous year.

2.2.4 Marine and Fisheries

The marine environment around the Korean Peninsula is experiencing accelerated changes, with sea surface temperatures rising and ocean acidification progressing more rapidly than global averages. Waters surrounding the peninsula have warmed by approximately 1.44°C over the 56-year period from 1968 to 2023, about twice the global average increase of 0.70°C.

Rising sea surface temperatures over the past 40 years have significantly affected marine ecosystems. Catches of subtropical pelagic fish species, such as Spanish mackerel and yellowtail, have increased as their habitats shift northward. In September 2023, sea surface temperatures around the peninsula reached a record high of 19.8°C since the monitoring began. This extreme temperature led to mass mortality events in aquaculture facilities, affecting species including flatfish, abalone, and sea squirts, resulting in losses estimated at KRW 43.8 billion.

2.2.5 Ecosystems

Climate change has altered ecosystem dynamics, particularly affecting the distribution of disease vectors such as mosquitoes and ticks across the country. The impact is evidenced by a 55.7% increase in tick-borne diseases in 2022 compared to 2019, and raising concerns about the potential emergence of endemic severe malaria.

2.2.6 Agriculture

Climate change impacts on agriculture include shifts in cultivation zones northward,

increased prevalence of overwintering pests and invasive species, and growing numbers of herbicide-resistant weeds. The effects are particularly evident in high-altitude crops, where rising temperatures have significantly impacted traditional farming areas. Since the 2000s, cultivation areas for high-altitude Nappa cabbage and radish have steadily declined, reaching approximately half their original size.

2.2.7 Industry, Energy, and Human Settlements

Climate change impacts in this sector are particularly evident in summer energy consumption patterns, with heatwaves and tropical nights driving increased electricity use in buildings during July and August. Rural areas face heightened vulnerability due to their distinct characteristics compared to urban areas: lower population density and income levels, less developed infrastructure, higher proportions of elderly residents. These factors contribute to various challenges, including poor heating and cooling efficiency in homes, inadequate water and sewage systems, aging housing stock, and limited public transportation access.

2.3 Risk Assessment

The ROK conducts national climate risk assessments to identify climate change risks and develop targeted adaptation responses. In preparing the Enhanced 3rd NCCAP, a comprehensive review of existing risks was conducted through expert consultation with 36 specialists, resulting in the identification of 72 risks across seven sectors. The key risks for each sector are presented below.

2.3.1 Water Management

The assessment identifies three major risks in water management. First, extreme rainfall poses challenges to infrastructure maintenance, potentially compromising the structural integrity of dams, reservoirs, and rivers when precipitation exceeds design parameters. Second, severe droughts create water scarcity issues affecting residential, industrial, and agricultural water supplies, with elevated temperatures further impacting water resource productivity. Third, climate change brings environmental risks, including increased mobility of waterborne pollutants during heavy rainfall, ecosystem degradation through riverbed desiccation, and reduced environmental flows during drought periods.

2.3.2 Forest

The assessment reveals three primary risks to forest ecosystems. Among them, wildfires pose a significant threats, particularly due to the high concentration of coniferous trees in ROK forests and seasonal wind patterns along the eastern coast. Meanwhile, landslide risks are heightened during monsoon seasons with intense rainfall. Forest health and biodiversity face increasing pressure from climate change, as elevated temperatures and drought conditions also accelerate pest damage, inhibit tree growth, and increase tree mortality.

2.3.3 Public Health

The assessment identifies several key health risks associated with climate change. Temperature-related illnesses, including both heat- and cold-induced conditions, represent a significant health concern. Vector-borne diseases transmitted by insects and animals pose increasing threats, intensified by rising temperatures and greater international mobility. The assessment also highlights emerging risks, including the potential outbreak of new infectious diseases and psychological impacts from climate-related disasters.

2.3.4 Housing, Urban, and Infrastructure

The assessment also identifies risks in the built environment. Extreme weather events, particularly heavy rainfall and typhoons, increase flooding risks in urban residential areas, with vulnerable populations facing the greatest impact. Additionally, land transportation infrastructure, including railways and roads, shows increasing vulnerability to extreme weather damage.

2.3.5 Port and Coastal Areas

The assessment identifies climate risks affecting ports and coastal regions. Sea level rise threatens coastal areas with increased flooding and inundation, damage to the infrastructure, and erosion of beaches and tidal flats. Ports face additional challenges from extreme weather events, which can damage facilities and disrupt operations.

2.3.6 Agriculture and Fisheries

The assessment identifies climate risks affecting agricultural production and food security. Climate change threatens agricultural productivity through multiple pathways: water scarcity from droughts and heatwaves, geographical shifts in suitable cultivation areas, and reduced crop yields due to rising temperatures.

2.3.7 Ecosystems

The assessment identifies climate-driven risks to biodiversity and habitats. Rising temperatures and changing precipitation patterns are affecting ecosystems through three main pathways: declining native species populations, expanding invasive species distributions, and emerging wildlife diseases.

3. Adaptation Strategies, Policies, Plans, Goals and Actions

3.1 National Level

The ROK implements its climate change adaptation policies through five-year National Climate Change Adaptation Plans. The current Enhanced 3rd NCCAP (June 2023) covers the period 2023-2025 and builds upon the previous 3rd NCCAP (December 2020). This enhanced version incorporates recent IPCC climate projections and strengthens responses to extreme weather events, while providing more detailed implementation plans. The Ministry of Environment leads the coordination among fifteen participating ministries and oversees implementation monitoring and evaluation.

3.1.1 Enhanced 3rd National Climate Change Adaptation Plan

The Enhanced 3rd NCCAP (June 2023) establishes its vision of a ‘Safe and Climate-resilient Republic of Korea’ in response to increasing climate challenges. Covering the period of 2023-2025, the plan establishes three core objectives supported by four strategic directions to enhance the nation's adaptive capacity and resilience.

Vision	**A Safe and Climate-Resilient Republic of Korea**	
Goals	• Support for adaptation measures based on scientific predictions • Minimizing public damage through climate disaster prevention • Enhancement of capacities through the collective efforts of all adaptation stakeholders	
4 Major Policies	1 Enhancement of Scientific Climate Monitoring, Prediction and Adaptation Foundation	- Strengthen climate crisis monitoring systems and projections - Promote the production of climate change adaptation information and technology development
	2 Realization of a Safe Society Resilient to Climate Disasters and Risks	- Enhance water management system to prepare for floods and drought - Prevent forest disasters such as wildfires and landslides - Strengthen preventive measures for health impacts caused by extreme weather events like heatwaves and cold waves
	3 Building Social Infrastructure Adapting to Climate Crisis	- Strengthen disaster resilience of housing, urban areas, and infrastructure in response to the climate crisis - Develop climate-adaptive ports and marine spaces - Create a sustainable agricultural and fisheries environment - Maintain ecosystem stability
	4 Promoting Climate Change Adaptation Implementation with All Stakeholders	- Strengthen national protection for vulnerable groups facing the climate crisis - Improve disaster response capabilities - Establish adaptation governance with public participation

[Figure Ⅲ-2] Framework of the Enhanced 3rd National Climate Change Adaptation Plan

The first strategic direction aims to enhance climate forecasting capabilities and improve public access to adaptation information. This strategy integrates socioeconomic factors, including population growth and economic development, into climate projections. It also establishes a comprehensive digital platform that consolidates adaptation data from various ministries and presents it through visualized climate risk maps for public use.

The second strategic direction focuses on strengthening infrastructure resilience and disaster response capabilities against future climate risks. This strategy encompasses two key initiatives: upgrading critical infrastructure, such as dams and drainage systems, to withstand projected climate impacts; and enhancing early warning systems for climate-related disasters, including floods, heatwaves, cold spells, and forest fires.

The third strategic direction aims to strengthen the resilience of both built and natural environments. This strategy prioritizes four key areas: improving disaster-resistant housing, upgrading urban and transportation infrastructure, developing climate-adaptive agricultural practices, and expanding biodiversity monitoring for ecosystem preservation.

The fourth strategic direction focuses on strengthening institutional frameworks and multi-stakeholder collaboration. This strategy emphasizes two key areas: enhancing partnerships among national and local governments, industry, and the financial sector; and providing targeted support for climate-vulnerable populations. These efforts aim to build societal resilience through improved cooperation between government agencies, businesses, and civil society.

<Table Ⅲ-1> Tasks of the Enhanced 3rd National Climate Change Adaptation Plan

Policy Objectives	Implementation Tasks
Strengthening Climate Change Monitoring and Forecasting Systems	Diversifying and Strengthening Comprehensive Climate Change Monitoring and Collaboration Systems
	Developing Advanced Climate Projection Technologies and Preparing for Future Scenarios
	Advancing Early Warning Systems for Climate Risks and Supporting Decision-Making
Promoting Climate Change Adaptation Information and Technological Development	Establishing a Comprehensive Adaptation Information Platform with User-Friendly Information
	Enhancing Visualization of Climate Change Adaptation Information and Evaluation Methods
	Promoting Adaptation Technology Development Across Monitoring, Forecasting, and Response Phases
Enhancing Water Resource Management for Flood and Drought Preparedness	Securing Critical Response Time for Extreme Floods and Improving Related Infrastructure
	Enhancing Drought Response Capabilities and Advancing Water Resource Management
	Building a Healthy and Stable Water Environment Amid Climate Change
Preventing Forest Disasters, Including Wildfires and Landslides	Establishing a Proactive Response System for Increasing and Intensifying Wildfires
	Strengthening Damage Mitigation and Recovery in Landslide-Prone Areas
	Protecting Forest Ecosystems from Climate Change Impacts
Strengthening Public Health Measures for Extreme Temperature Events (Heatwaves and Cold Waves)	Monitoring Extreme Temperatures and Minimizing Related Damages
	Advancing Research, Surveillance, and Response Capacity for Climate-Related Diseases
	Strengthening Protective Frameworks for Vulnerable populations Facing Increased Health Risks

Policy Objectives	Implementation Tasks
Enhancing Disaster Resilience of Housing, Urban Areas, and Infrastructure	Improving Disaster-Prone Housing and Enhancing Building Resilience
	Strengthening Management of Social Infrastructure to Respond to Extreme Climate Events
	Developing Climate Change Adaptation-Focused Urban Planning at the Sub-National Level
Developing Climate-Resilient Ports and Marine Spaces	Enhancing Information Dissemination to Prevent Coastal Disasters
	Reinforcing Port Infrastructure and Improving Design Standards to Address Coastal Disasters
	Developing Korea-Specific Coastal Disaster Response Technologies and Building Expertise
Fostering Sustainable Agricultural and Fisheries Practices	Enhancing Agricultural and Fisheries Production Information for Climate Disaster Preparedness
	Strengthening Climate Change Adaptation Capacity in Production Infrastructure
	Developing Climate-Resilient Technologies and Varieties and Upgrading Smart Infrastructure
	Enhancing Food Security and Reforming Response Systems for Climate Change
Maintaining Ecosystem Stability and Biodiversity	Strengthening Monitoring and Information Dissemination to Protect Ecosystems from Climate Change
	Enhancing Response to Ecological Disasters, Such as Mass Species Proliferation
	Protecting Vulnerable Species and Promoting Biodiversity and Ecosystem Stability
Strengthening National Protection for Climate Vulnerable Populations	Identifying Climate Vulnerable Populations and Developing Targeted Adaptation Measures
	Improving Health Management and Reducing Energy Burden for Climate Vulnerable Populations
	Enhancing Living Conditions and Assessing Support Needs for Vulnerable Residential Areas
Enhancing Response Capabilities for Climate-Related Disasters	Establishing a Rapid and Accurate Disaster Information Dissemination System
	Strengthening Measures and Support for Field Response and Recovery
	Promoting a Culture of Safety Through Inclusive Collaboration
Implementing Inclusive Adaptation Governance with Public Participation	Enhancing Institutional and Cooperative Foundations for an Adaptive Society, and Developing Decision-Support Systems
	Strengthening and Consolidating Adaptation Capacity for All Stakeholders
	Enhancing Public Outreach, Education, and International Cooperation in Alignment with Public Needs

3.1.2 Performance Indicators of the Plan

The Enhanced 3rd NCCAP (June 2023) incorporates monitoring and evaluation frameworks from its planning phase through established performance metrics. The Plan includes two sets of indicators, i.e., 18 policy indicators to assess implementation progress, and 15 public-oriented indicators to measure adaptation outcomes.

<Table Ⅲ-2> Performance Indicators for the Enhanced 3rd National Climate Change Adaptation Plan

Policy Objectives	Indicator Names	
	Policy Indicators	Public-Oriented Indicators
Strengthening Climate Change Monitoring and Forecasting Systems	Climate Change Situation Map	-
	Establishment of GHG Ground Observation Network	-
Promoting Climate Change Adaptation Information and Technological Development	Development of a Standard Classification System for Adaptation Information	-
Enhancing Water Resource Management for Flood and Drought Preparedness	Expansion of Flood Forecasting Locations (units)	Expansion of Small-Scale Rain Radar Systems (units)
	National Drought Vulnerability Map Service	Designation of Priority Areas for Sewerage Management (units)
	-	Users of National Drought Information Service (persons/year)
	-	Provision of Drought Meteorological Forecasts
Preventing Forest Disasters, Including Wildfires and Landslides	Advanced Wildfire Prediction System	Advanced Landslide Early Warning System
	Precision of Landslide Hazard Map	Establishment of Mountain Meteorological Observation Network (units)
Strengthening Public Health Measures for Extreme Temperature Events (Heatwaves and Cold Waves)	Development of Methodology for Estimating Climate-Related Disease Burden	-
Enhancing Disaster Resilience of Housing, Urban Areas, and Infrastructure	Support for Relocation of Households in Non-Standard Residences to Public and Private Rental Housing (households)	-
	Green Remodeling of Public Rental Housing Units (units)	-
Developing Climate-Resilient Ports and Marine Spaces	Reinforcement of External Port and Fishing Port Facilities (units)	-

Policy Objectives	Indicator Names	
	Policy Indicators	Public-Oriented Indicators
Fostering Sustainable Agricultural and Fisheries Practices	Expansion of Crop Disaster Insurance Coverage	Development of Climate-Resilient Crop Varieties (varieties)
	Expansion of Real-Time Sea Temperature Observation Network (units)	Provision of Farm-Specific Early Warning System Information (sub-national governments)
Maintaining Ecosystem Stability and Biodiversity	Designation of National Protected Areas (km^2)	Database of Species Experiencing and Likely to Experience Mass Proliferation Events
	Urban Ecological Corridor Restoration Projects (projects)	Eco-Friendly Pest Control Guidelines
Strengthening National Protection for Climate Vulnerable Populations	Standard Model for Adaptation Infrastructure (units)	Survey and Guidelines for Climate Vulnerable Populations
	-	Support for Adaptation Infrastructure Development (sub-national governments)
Enhancing Response Capabilities for Climate-Related Disasters	Publication of Korea Climate Change Assessment Report	Selection Plan for Climate Risk Priority Management Areas
Implementing Inclusive Adaptation Governance with Public Participation	Operation of Adaptation Research Institution Consultation Network	Operation of Adaptation Academy (cumulative/persons)
	-	Operation of Regional Expert and Resident Support Groups for Sub-National Government Adaptation Plans (sub-national governments)

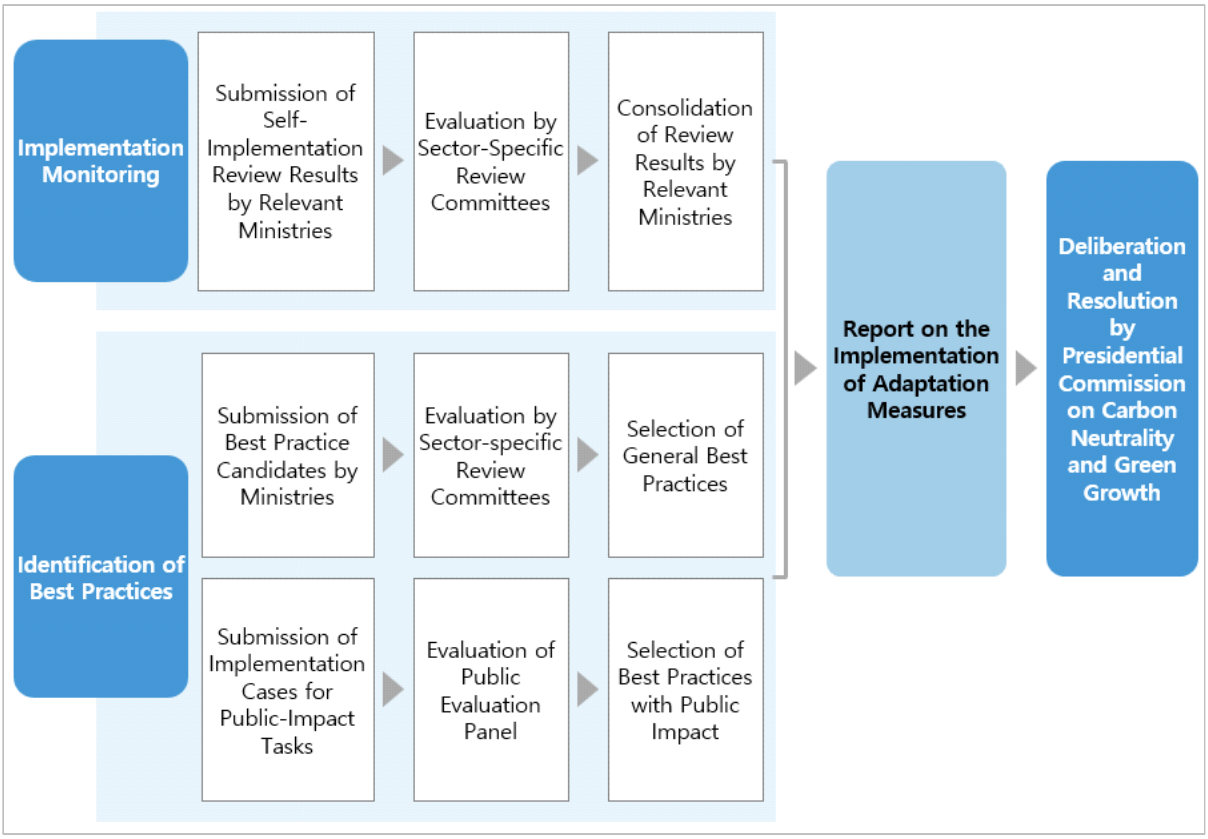
3.1.3 Monitoring and Evaluation of the Plan

The NCCAP employs a multi-tiered evaluation system consisting of annual assessments, along with interim and comprehensive evaluations in the third and fifth years, respectively.

The annual assessment process follows two parallel tracks: ministerial self-assessment and best practice evaluation. Ministries submit yearly reports to the Ministry of Environment, documenting their implementation results and selected best practices, including public-focused outcomes. The Ministry of Environment, together with the Expert Review Panel, analyzes these submissions to prepare a comprehensive progress report for the Carbon Neutrality and Green Growth Commission's review. The evaluation results are then distributed to all ministries to inform their action plans for the following year.

The annual progress assessment evaluates ministerial implementation through their yearly reports. The Ministry of Environment consolidates these reports and works with the Expert Review Panel to analyze overall progress.

The best practice assessment consists of two distinct categories. The first category examines ministry-recommended practices, where the Expert Review Panel evaluates and selects exemplary cases from ministry submissions. The second category focuses on public-oriented practices, where the Public Review Panel selects outstanding practices from projects that demonstrate significant impact on citizens' daily lives.



[Figure Ⅲ-3] Progress Monitoring System for the National Climate Change Adaptation Plan

3.2 Sub-National Level

3.2.1 Sub-National Climate Change Adaptation Plans

Under the Carbon Neutrality Act, all sub-national governments must develop and implement SNCCAPs on a five-year cycle. These plans are designed to address region-specific climate change impacts.

Metropolitan governments (17 metropolitan and provincial governments) initiated climate change adaptation planning with the *First Regional Climate Change Adaptation Plan* (First RCCAP) and are currently implementing the *Third Regional Climate Change Adaptation Plan* (Third RCCAP).

Local governments (226 cities, counties, and districts) began their adaptation planning in 2013 with the *First Local Climate Change Adaptation Plan* (First LCCAP). Following the mandate established in 2015, these governments now develop five-year plans tailored to their local conditions. The *Third Local Climate Change Adaptation Plan* (Third LCCAP) development process began in 2024.

3.2.2 Monitoring and Evaluation of the Plans

The RCCAP maintains a systematic evaluation process. Metropolitan and provincial governments submit annual self-assessment reports on their implementation results to the Ministry of Environment. The Ministry then consolidates these reports into a comprehensive progress report for review by the Carbon Neutrality and Green Growth Commission. The evaluation outcomes are then distributed to both metropolitan and local governments to inform their implementation plans for the following year.

The progress assessment evaluates implementation preparedness, achievement levels, improvement needs, and government initiatives. The preparedness evaluation reviews how effectively organizations have addressed previously identified weaknesses, managed regional advisory groups of experts and citizens, and strengthened local adaptation capacity. The implementation evaluation uses both quantitative and qualitative indicators to assess organizational performance and examining goal achievement and budget execution for process evaluation, while considering the identification and application of best practices for outcome assessment.

Since 2023, metropolitan governments have established regional advisory groups of experts and citizens to strengthen public engagement in adaptation policies and to identify region-specific practices. These groups operate across six sectors: ⅰ) water management, ⅱ) forestry and ecosystems, ⅲ) health, ⅳ) agriculture and fisheries, ⅴ) land and coastal areas, and ⅵ) industry and energy. Each group integrates distinct perspectives from regional experts and residents.

4. Progress on the Implementation of Adaptation

4.1 Best Practices of Climate Change Adaptation in the ROK

4.1.1 National Adaptation Plan Best Practices

Through its annual assessment of the NCCAP, the ROK documents successful adaptation initiatives. Expert Review Panels have evaluated the ministry self-assessment reports and have identified several notable achievements between 2021 and 2023.

1) Based on Internal Review by Ministries

In 2023, the Ministry of Land, Infrastructure, and Transport launched a project to improve flood resilience in vulnerable housing structures. This initiative focuses on protecting semi-basement dwellings and underground parking facilities from intensifying summer rainfall events caused by climate change. The project includes installing flood prevention systems such as barriers, drainage pumps, and backflow prevention devices. As of November 2023, 4,440 housing units in flood-prone areas have received these installations, with regular maintenance checks planned to ensure ongoing system effectiveness.

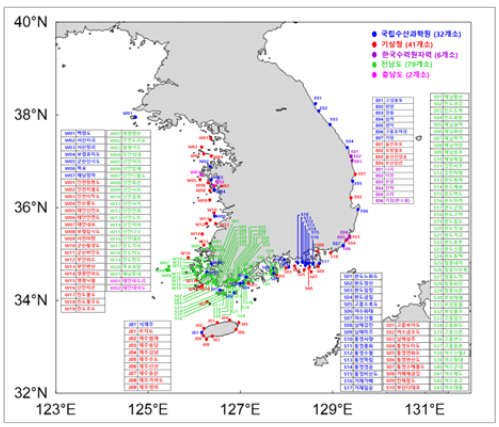
[Figure Ⅲ-4] Renovation for Climate Vulnerable Housing

[Figure Ⅲ-5] Flood Prevention Facilities in Pohang

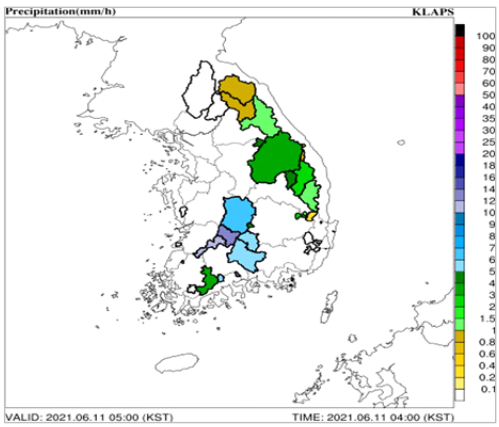
The Ministry of Oceans and Fisheries has enhanced port resilience through climate-adaptive design standards and infrastructure improvements. In 2021, the Ministry increased the design wave recurrence interval from 50 to 100 years to better protect ports and hinterlands from rising sea levels. A nationwide safety and flood vulnerability assessment of outer port facilities was conducted in 2023 using these enhanced standards. Based on the assessment results, the Ministry initiated a comprehensive reinforcement program through

2032, which includes strengthening breakwaters at 43 locations across 30 ports and installing protective walls at 22 locations across 16 flood-prone ports.

In 2022, the Ministry of Oceans and Fisheries established an Internet of Things (IoT)-based marine monitoring system for fisheries resources and aquaculture species. This system provides real-time marine observation data to reduce climate-related damage to aquaculture. The ministry deployed advanced equipment and a real-time observation network to monitor sea temperatures and track ecological changes in fisheries resources. By providing timely information to fishermen, the system helps secure adequate response time to high sea temperatures, thereby reducing potential damage. The ministry also developed an aerial surveillance system for harmful organisms and implemented an algorithm to predict red tide concentrations.



[Figure Ⅲ-6] Real-time Water Temperature Monitoring Network



[Figure Ⅲ-7] Dam Basin Precipitation Forecast Map

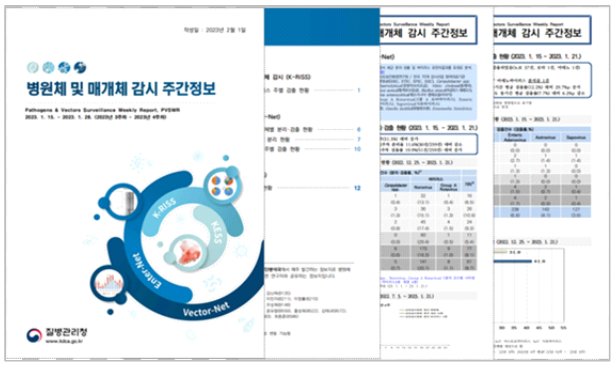
In 2021, the Korea Meteorological Administration enhanced its flood forecasting system through improved inter-agency collaboration. This initiative strengthened coordination among the Ministry of Environment, the River Flood Control Office (RFCO), and the Korea Water Resources Corporation (K-water). The system provides customized weather forecasting data and shares meteorological information to support flood forecasting and dam operation decisions. The administration also established an inter-agency coordination system with specialized training programs, while improving data collection by reducing observation intervals and installing new monitoring equipment.

2) Public Selection

The following cases highlight best practices selected by the Public Review Panel from ongoing ministry initiatives that focus on public impact.

In 2023, the National Institute of Biological Resources (NIBR) expanded citizen participation in climate change biodiversity monitoring. The initiative created partnerships among the general public, para-taxonomists, and experts to support biodiversity conservation and management policies. In collaboration with local research teams of citizens and citizen scientists, the project monitored over 100 national climate change bioindicator species, collecting 73,491 verified observations via a nature observation app. This data helps track climate change impacts on bioindicator species and predict changes in their future distribution.

[Figure Ⅲ-8] Climate Change Adaptation Monitoring



[Figure Ⅲ-9] Climate Change Infectious Disease Information

In 2023, the Korea Disease Control and Prevention Agency (KDCA) enhanced its surveillance of climate-related infectious diseases. Through collaboration with over 70 hospitals and provincial Public Health and Environment Research Institutes (PHERI), the KDCA monitored and analyzed climate-related public health threats. The agency provided weekly public updates on its website, including analysis of waterborne and foodborne pathogens and disease outbreak trends.

In 2023, the Rural Development Administration (RDA) conducted research to assess extreme weather damage to major crops and develop protective measures. The project quantified crop damage from climate-related events such as heavy rainfall, drought, and extreme temperatures. The RDA developed damage reduction technologies for various crops, including horticultural specialty crops, Nappa cabbages, fruits, and ginseng, while successfully breeding 337 climate-resilient crop varieties.

[Figure Ⅲ-10] Development of Climate-Adaptive Apple Varieties

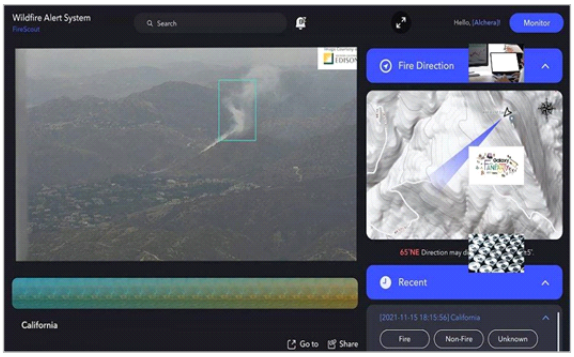
[Figure Ⅲ-11] Public-Friendly Drought Information

In 2021, the Ministry of Environment improved public access to drought information and awareness through several initiatives. The ministry provided customized drought information and established a virtual reality-based drought education center. It also launched a National Drought Information Portal to enhance public access to drought-related resources. To raise awareness towards drought issues, the ministry has developed educational programs targeting children and elementary school teachers.

3) Other Best Practices

Beyond the practices highlighted above, ministries continue to implement various adaptation initiatives. A notable trend is the increasing use of advanced Information and Communication Technologies (ICT), particularly artificial intelligence (AI), in climate change adaptation efforts.

In 2023, the Korea Forest Service enhanced its forest fire management system through advanced ICT applications. The initiative strengthens response capabilities to large-scale forest fires that are becoming more frequent due to climate change. The Korea Forest Service developed an AI-based Intelligent Forest Fire Prevention Platform that uses deep learning for automatic detection and continuous monitoring of forest fires. The system integrates forest fire surveillance cameras with Closed Circuit Television (CCTV) networks from forest and related agencies. The Korea Forest Service also operates specialized drone teams for firefighting and surveillance in challenging conditions, such as nighttime operations and rugged terrain.



[Figure Ⅲ-12] ICT Platform for Forest Fire Prevention

[Figure Ⅲ-13] Mobile Rest Areas for Outdoor Workers

Adaptation support for climate-vulnerable populations has also been strengthened.

The Ministry of Environment provides ongoing support to climate-vulnerable populations, including by installing cooling systems in local children's centers and homes of elderly residents living alone to reduce heatwave risks. In 2023, the ministry conducted a comprehensive analysis of climate exposure, socioeconomic factors, and housing conditions to identify priority vulnerable groups. The ministry has also surveyed vulnerable populations to assess damage patterns, vulnerabilities, and adaptation needs, aiming to enhance targeted support measures.

The Ministry of Trade, Industry, and Energy has improved energy efficiency in homes of climate-vulnerable populations. Between 2021 and 2023, the ministry supported 98,149 low-income households and social welfare facilities through housing improvements, including insulation work, window installations, flooring renovations, and high-efficiency heating and cooling system upgrades. These improvements enhance climate change adaptation capacity while also reducing GHG emissions.

Meanwhile, the Korea Forest Service has initiated community-based ecological restoration of fire-damaged forests. Following a large-scale forest fire in 2022 that devastated approximately 4,800 ha of protected areas in Uljin-gun, including forest genetic resource reserves, the Korea Forest Service established a collaborative framework. This framework brings together local residents, experts, and NGOs to develop restoration plans and includes a Donors' Forest Campaign to facilitate community participation. In 2023, the Korea Forest Service restored 220 ha of forest using ecological techniques, including native plants collected and propagated from surrounding areas, natural materials, and sprouts from damaged trees.

4.1.2 Sub-National Adaptation Plans Best Practices

The following are best practices among adaptation projects implemented at the sub-national level from 2021 to 2023. These projects were tailored to address the major risks and specific conditions of each region.

Gyeonggi Province has implemented nature-based solutions through eco-friendly inland fisheries to address declining fishery resources and ecosystem changes caused by climate change. In 2023, the province released 2 million juvenile fish of five native species and 5.9 million seedlings of seven marine species. The province improved smelt reproduction by switching from egg attachment to direct juvenile fish release, addressing the species' low hatching rate. The province also achieved stable mass production of species such as manila clams and ark shells through the high-density seawater spray system.

[Figure Ⅲ-14] Native Fish Stocking

[Figure Ⅲ-15] Climate-Resilient Rice Varieties

South Chungcheong Province has conducted research on climate-adaptive rice varieties. The province achieved a breakthrough in developing extra-early maturing varieties with improved taste by introducing medium-glutinous characteristics, the first of such achievement in the ROK. These shorter growing periods help reduce methane emissions during cultivation. The province has also developed high-yielding varieties with blast resistance through selective breeding to address the increasing risks of extreme weather events and diseases as impacted by the climate change.

Daegu Metropolitan City, one of the ROK's hottest cities, implemented comprehensive heat mitigation measures in 2022. The city established the *Mid- to Long-term Comprehensive Plan for Addressing Heatwaves and Urban Heat Island Effect* and developed an integrated disaster management platform called the ‘Ansim Hai so (Stay Safe)’ app. The city also installed cooling facilities such as fog systems at bus stops and climate-controlled shelters, while promoting citizen engagement through initiatives like regular parasol use.

[Figure Ⅲ-16] Cooling Fog Installed in Parks

[Figure Ⅲ-17] Automatic Drip Irrigation System

In 2021, North Chungcheong Province launched a pilot project to stabilize open-field pepper production under extreme weather conditions. The initiative developed cultivation techniques to address weather challenges, such as drought and frost, and implementing them across 25 farms covering a total area of 5.74 ha. The project introduced rain shelters and automatic drip irrigation systems with soil tension sensors, while providing technical support to farmers. These improvements have led to a 20% increase in pepper production and a 19% rise in farm income.

In 2021, Gyeyang District of Incheon Metropolitan City enhanced its heat protection services for vulnerable residents. The district supported 26 facilities serving vulnerable populations with cooling subsidies and installed shade structures at 28 cooling centers. The initiative also provided 36 thousand health education sessions for vulnerable populations, complemented by mobile healthcare and free shuttle services.

[Figure Ⅲ-18] Visiting Healthcare for Vulnerable Populations

[Figure Ⅲ-19] 'Companion Partners' for Vulnerable Residents in Semi-basement Housing

Beyond existing adaptation projects in SNCCAPs, local governments have initiated new programs to address emerging risks from extreme weather events.

In 2023, the Seoul Metropolitan Government created a community support network for vulnerable residents in flood-prone housing. The initiative focuses on residents with severe disabilities living in semi-basement or flood-prone areas who may face evacuation challenges during heavy rainfall. The program matches these at-risk residents with nearby community members and public officials who serve as their emergency partners. These partners monitored 954 vulnerable households, including those with disabilities and elderly residents, providing evacuation assistance and emergency updates.

4.1.3 Best Practices from Public Institutions

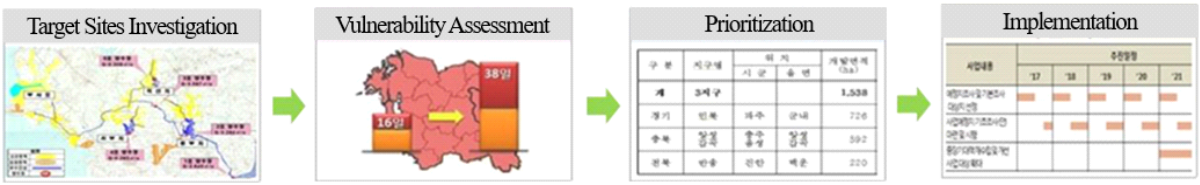
Public institutions managing critical infrastructure, such as transportation, began developing their *Institutional Climate Change Adaptation Plans* in 2022 as required by law, with implementation starting in 2023. The following sections present adaptation initiatives from these institutions.

Since 2023, the K-water has developed and operated a Digital Twin and AI-based Urban Flood Forecasting Platform under the Ministry of Environment's flood prevention initiative. Piloted in the Dorimcheon Stream area, this platform combines virtual modeling using high-precision spatial data with real-time monitoring through IoT sensors and CCTV. The system provides real-time flood risk information to local residents during flood events. K-water is also collaborating with NAVER, a domestic internet service company, to explore international applications of this technology as part of Saudi Arabia's Digital Transformation Project.

[Figure Ⅲ-20] Urban Flooding Forecast Platform

The Korea Rural Community Corporation (KRC) has revised its design guidelines to strengthen the climate resilience of agricultural infrastructure. The new guidelines require climate change impact and vulnerability assessments in master planning for agricultural facilities. Design specifications for critical facilities like dams and irrigation systems can be

adjusted based on their vulnerability levels and strategic importance. The guidelines also mandate the use of standardized climate scenarios with future meteorological data to determine water supply needs and design capacities for agricultural dams, drainage systems, and irrigation facilities. These changes aim to enhance infrastructure resilience while improving agricultural productivity.



[Figure Ⅲ-21] Climate Change Vulnerability Assessment

4.2 Partnerships and Cooperation Cases

4.2.1 Domestic Level

The ROK is actively promoting domestic cooperation to strengthen climate change adaptation efforts. The following are notable examples of domestic collaboration:

The Ministry of Environment organized a Local Government Climate Change Adaptation Declaration Ceremony during Korea Global Adaptation Week 2023 (KGAW 2023), which was part of the 2023 United Nations Framework Convention on Climate Change (UNFCCC) Adaptation Week. The ceremony secured commitments from 96% of sub-national governments, demonstrating strong regional support for adaptation action. Through this declaration, local government leaders committed to various priorities including adaptation policies, implementation systems, protecting vulnerable populations, promoting local economic development and job creation, and fostering public participation in adaptation efforts.

[Figure Ⅲ-22] 2023 Climate Change Adaptation Declaration Ceremony for Local Governments

[Figure Ⅲ-23] Climate Change Adaptation Research Network

[Figure Ⅲ-24] Forum on the IPCC Sixth Assessment Report

The Ministry of Environment has established the Climate Change Adaptation Research Network in 2022 to support science-based decision-making. The network brings together 10 research institutions specializing in diverse fields such as marine science, fisheries, water management, ecosystems, meteorology, agriculture, forestry, and public health. These institutions collaborate to strengthen climate change adaptation research.

The Korea Meteorological Administration has enhanced its IPCC engagement through the Korean IPCC Response Council (K-IPCC). Recognizing IPCC reports as crucial scientific evidence for climate change, K-IPCC supported the Sixth Assessment Report and began preparations for the Seventh Assessment Report in 2023. The council, led by the Korea Meteorological Administration and involving 14 relevant ministries, operates through five bodies, i.e., four

specialized councils - Physical Science Basis (Working Group Ⅰ), Climate Change Impacts, Adaptation, and Vulnerability (Working Group Ⅱ), Climate Change Mitigation (Working Group Ⅲ), and the Task Force on National Greenhouse Gas Inventories (TFI) - and a General Coordination Committee for cross-group integration. The council also translates IPCC reports into Korean and organizes public forums to raise awareness of climate change issues.

4.2.2 International Level

The ROK actively participates in global climate initiatives and shares its adaptation knowledge and experience. The following sections highlight key international partnerships and cooperation in climate change adaptation.

The Ministry of Environment co-hosted Korea Global Adaptation Week 2023 (KGAW 2023) with the UNFCCC Secretariat and other international organizations, under the theme of 'A New Era for Adaptation: Scaling Up and Transformation in Adaptation'. The event brought together 1,223 participants from 70 countries for wide-ranging adaptation discussions. As the first Global Adaptation Week co-hosted with the United Nations Environment Programme (UNEP), it featured 24 events and 86 sessions, significantly expanding its scope. Held in preparation for the COP28, the event made substantial contributions to global adaptation dialogue.

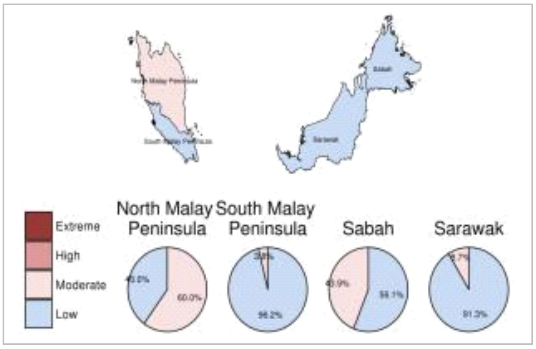
[Figure Ⅲ-25] Korea Global Adaptation Week 2023

[Figure Ⅲ-26] Biodiversity Field Books for Cambodia, Laos, and Vietnam

The Ministry of Environment supports biodiversity conservation and sustainable resource management in climate-vulnerable developing countries through international research collaboration. The ministry conducts joint research with 10 partner countries across Southeast Asia, Africa, and Latin America, including the publication and distribution of biodiversity field guides for protected areas. This initiative has produced various guides: mushroom and plant guides for Cambodia, Laos, and Myanmar in 2021; fish, moth,

butterfly, and medicinal plant guides for Cambodia, Laos, and Vietnam in 2022; and a flora guide for Micronesia in 2023 to mark the Korea-Pacific Islands Summit.

The Korea Meteorological Administration has developed climate prediction technologies for the Asia-Pacific Economic Cooperation (APEC) region to strengthen climate resilience. In 2023, the Korea Meteorological Administration extended its wildfire prediction service from Indonesia to Malaysia and established a dynamic climate information system to enhance user-oriented services.

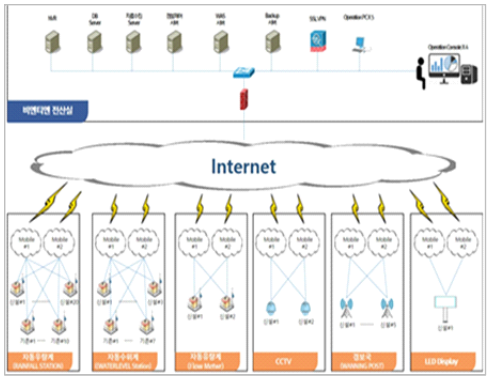


[Figure Ⅲ-27] Forest Fire Prediction System for Malaysia

[Figure Ⅲ-28] 2022 UNFCCC-CASTT Adaptation Academy

The Ministry of Environment operates the UNFCCC Climate Action and Support Transparency Training (UNFCCC-CASTT) Adaptation Academy with the UNFCCC Secretariat and international organizations. This initiative helps developing countries meet adaptation reporting requirements under the Paris Agreement. The academy has trained 30 participants from 15 Asia-Pacific countries since 2021, expanded globally in 2022 to train 23 participants from 23 countries, and provided online training to 129 participants from 48 countries in 2023. These efforts support other countries in preparing their Biennial Transparency Reports (BTR), which become mandatory from 2024.

The ROK has expanded its adaptation support through Official Development Assistance (ODA) projects. In the past three years, the Ministry of Environment has conducted 10 international cooperation projects in 9 countries, with the majority focused on water resource management to address increasing flood and drought risks. Major initiatives include a Flood Forecasting and Warning System in Laos, a Smart Water Management System in Cambodia, Carbon-neutral Water Infrastructure for Indonesia's new capital Nusantara, and Smart Irrigation Systems in Uzbekistan and Kyrgyzstan for drought preparedness.



[Figure Ⅲ-29] Flood Forecasting and Warning System in Laos

[Figure Ⅲ-30] Carbon-Neutral Water Supply Infrastructure Development Project in Nusantara

IV

Supporting the Global Community

The Republic of Korea (ROK), as an "Other Party" providing support under the Paris Agreement,[51] recognizes that the Agreement simultaneously pursues climate action and support for developing countries. While implementing greenhouse gas (GHG) emissions reduction and climate change adaptation targets, the ROK also makes voluntary efforts to` assist developing countries in addressing climate change.

In September 2021, the ROK enacted the *Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis* (Carbon Neutrality Act), which legislates the 2050 carbon neutrality target and its implementation framework. This act demonstrates national commitment to support climate action in developing countries through international cooperation.[52] The *First National Framework Plan for Carbon Neutrality and Green Growth* (Carbon Neutrality Framework Plan), established in April 2023, incorporates enhanced cooperation to facilitate green transitions in developing countries as a key policy initiative. Under these legal and planning frameworks, various ministries provide financial, technological, and capacity-building support to developing countries, either through specialized climate programs or by integrating climate considerations into broader support initiatives.

The ROK actively supports developing countries through government and private sector collaboration. Through the Partnering for Green Growth and the Global Goals 2030 (P4G) platform, a global public-private partnership launched in 2018, the government has contributed over USD 4 million to date. Building on this financial foundation, international cooperation projects utilize resources and technologies from private enterprises, public companies, and institutions to support technology development and transfer, and capacity-building.

However, tracking information on private sector support efforts presents challenges. Particularly, since information from companies conducting voluntary support activities requires confidentiality, it is limiting the ability to report on private resources mobilized through public interventions. Therefore, this First Biennial Transparency Report (BTR) focuses on government-led activities where quantitative information is relatively easier to track, while providing qualitative descriptions of experiences and best practices related to efforts to encourage private sector engagement.

51) Paragraph 118 of the Annex to Decision 18/CMA.1

52) Article 3 (Basic Principles) Paragraph 8, Article 4 (Responsibilities of State and Local Governments) Paragraph 8, and Article 75 (Promotion of International Cooperation) Paragraph 2 emphasize international cooperation to support developing countries' in responding to the climate crisis as a member of the international community.

1. Financial Support

The international community has adopted “Take Urgent Action to Combat Climate Change and Its Impacts” as Goal 13 of the Sustainable Development Goals (SDGs), emphasizing the importance of developing countries achieving their Nationally Determined Contributions (NDCs).

In this regard, the ROK has significantly enhanced its financial support for climate change response in developing countries. In May 2021, the ROK hosted the Second P4G Summit in Seoul and, as chair (2021-2023), declared its commitment to support green recovery in developing countries through expanded Official Development Assistance (ODA). The ROK has also pledged a new contribution of USD 4 million to P4G, which supports climate action in developing countries through public-private partnership projects. In November 2022, the ‘Busan Initiative’, was announced, focusing on enhancing cooperation with developing countries in five key areas: climate change, the digital divide, health crisis, food security, and future workforce development.

Furthermore, in alignment with global carbon neutrality efforts, international dialogue on climate change response has intensified through multilateral cooperation. As part of these efforts, the ROK has led the establishment of specialized international environmental organizations, including the Global Green Growth Institute (GGGI) and the Asian Forest Cooperation Organization (AFoCO), while also hosting the Green Climate Fund (GCF) headquarters in Incheon Metropolitan City.

1.1 National Circumstances and Institutional Arrangements

1.1.1 Institutional Arrangements and Implementation Strategy

1) Institutional Arrangements

The ROK's ODA framework operates as a three-tier system established under the *Framework Act on International Development Cooperation* (January 2010). This system consists of a coordinating organization, supervising ministries, and implementing agencies.

The Committee for International Development Cooperation, chaired by the Prime Minister, serves as the primary coordinating body for all ODA activities, with operational support from the Working Committee for International Development Cooperation and the Expert Committee for Evaluation.

The Ministry of Economy and Finance and the Ministry of Foreign Affairs serve as supervising ministries for bilateral concessional loans and grants respectively, developing and overseeing annual implementation plans for each sector. The Ministry of Economy and Finance manages concessional loans through the Economic Development Cooperation Fund (EDCF), which supports large-scale projects in transportation, health, water resources, and energy sectors. As of December 2022, the EDCF was implementing 503 projects across 58 countries, with cumulative approvals of KRW 27.7 trillion. Menawhile, the Ministry of Foreign Affairs executes grant aid through the Korea International Cooperation Agency (KOICA) and coordinates grant programs through the Grant Related Consultative Council and the Strategic Meeting for Grant Development Cooperation.

For multilateral cooperation, the Ministry of Economy and Finance oversees engagement with Multilateral Development Banks (MDBs), while the Ministry of Foreign Affairs manages cooperation with the United Nations (UN) and other international organizations.

2) Implementation Strategy

The *3rd Mid-term Strategy for International Development Cooperation* envisions "Realizing Global Values and Mutual Benefits through Cooperation and Solidarity". To achieve this vision, it outlines four strategic objectives: ⅰ) Inclusive ODA, ⅱ) Mutually Beneficial ODA, ⅲ) Innovative ODA, and ⅳ) Collaborative ODA.

Notably, "Leading Green Transition" has been introduced as a key implementation task under 'Mutually Beneficial ODA', establishing specific measures to support climate change response in developing countries. In July 2021, the *Green ODA Strategy* was formulated, aiming to increase the proportion of green sectors in bilateral ODA, including projects with Rio and environmental markers, to exceed the OECD average by 2025. Thereby, it is strengthening the support for green transition and carbon neutrality in developing countries.

Furthermore, through the *Strategic Plan for Official Development Assistance under the Yoon Administration* and the Carbon Neutrality Framework Plan, the ROK continues to strengthen its global climate change response system through ODA. The ROK is enhancing international cooperation in carbon neutrality and green growth by increasing contributions to international organizations specializing in green sectors, thereby promoting stronger international collaboration in achieving climate-related goals.

<Table Ⅳ-1> Key Policies Related to the ROK's Green ODA

Policy	Description
Mid-term Strategy for International Development Cooperation (From 2011, 5-year intervals)	・Establishes the overarching national ODA vision and objectives for the mid- to long-term (3rd Mid-term Strategy developed in January 2021) ・Promotes increasing Green ODA allocations to support developing countries' transition to green economies, implementing country-specific Green ODA programs, establishing bilateral climate cooperation agreements, and providing R&D support
Annual Comprehensive Implementation Plan for International Development Cooperation (From 2011, Annually)	・Defines annual implementation tasks by ministry (based on confirmed budgets) to realize the *Comprehensive Basic Plan for International Development Cooperation* ・Includes strategic ODA priorities such as prioritizing green sector projects and fulfilling GCF contribution commitments (USD 300 million)
Green ODA Strategy (July 2021)	・Outlines the vision and implementation approach for addressing environmental challenges through Green ODA ・Establishes specific initiatives to strengthen support for developing countries' green transition, lead global cooperation efforts, and build mutually beneficial partnerships with developing countries
Strategic Plan for Official Development Assistance under the Yoon Administration (June 2022)	・Defines ODA priorities and objectives during the Yoon administration ・Outlines approaches for addressing climate change through ODA to advance SDGs and global values
First National Framework Plan for Carbon Neutrality and Green Growth (April 2023)	・Establishes international cooperation priorities and initiatives in carbon neutrality and green growth ・Develops specific measures for ‘Expanding Green ODA to promote green transition in developing countries’ and ‘Strengthening cooperation with the international community for global ODA expansion’ through cross-ministerial Green ODA coordination

1.1.2 Enhancing Support Effectiveness

1) Country-Driven Approach

The ROK has established a tailored support framework to effectively reflect the needs and priorities of developing countries. Since 2010, the ROK has operated a priority partner country system, selecting target countries based on comprehensive assessment of their development level, support needs, and cooperation effectiveness. For each priority partner country, the ROK develops a Country Partnership Strategies (CPS) that identifies key cooperation areas and support approaches aligned with each partner country's development needs, providing customized assistance that meets partner countries' requirements.

Priority areas are selected through comprehensive analysis of mid- to long-term national development strategies and sectoral plans, in consultation with partner country governments to identify cooperation needs. The CPS development and revision process involves thorough assessment of partner countries' progress toward SDGs and their mid-term national strategies. Priority areas are regularly updated to address changing development priorities, with key cooperation sectors including climate change, water management, health and sanitation, transportation, regional development, education, public administration, and energy.

<Table Ⅳ-2> Climate Change and Environmental Mainstreaming in Country Partnership Strategies

Partner Country	Sector	Key Contents
Nepal	Energy	Scaling up development finance through diversification of funding methods, including MDB co-financing and private sector mobilization in energy and water resources
Indonesia	Environmental Protection	Broadening support beyond forest conservation to include climate change adaptation and disaster risk management
Mongolia	Climate Change	Strengthening comprehensive environmental management capacity, with emphasis on addressing air pollution from residential solid fuel use

Source: *Green ODA Strategy* (Joint Ministries, 2021)

2) Climate Risk Management and Performance Monitoring

The ROK has established systematic assessment and performance monitoring frameworks that incorporate climate risk considerations across all ODA projects to enhance project quality. At the government-wide level, the 2022 International Development Cooperation Evaluation Plan introduced an ODA Project Performance Indicator Model that defines objectives and indicators for the climate change sector. These indicators include GHG emissions reduction, hydrogen production capacity, and adoption of climate-related laws and regulations. The model also outlines expected outcomes such as improved access to low-carbon energy, increased climate-resilient crop production, and participation in capacity-building programs.

Implementing agencies are strengthening performance monitoring through project-specific objectives and indicators. The Export-Import Bank of Korea has introduced a Climate Change Impact Response Framework that includes pre-implementation climate risk analyses, mitigation measures, and post-project evaluations. This framework is applied according to the EDCF Climate Change Impact Response Guideline and EDCF Performance Management Framework Guideline, ensuring systematic climate risk management in concessional loan projects. Meanwhile, KOICA implements the Carbon Neutral ODA Program Performance Framework, aligning with its *Climate Action Mid-term Strategy* and *Low-Carbon Transition ODA Program Implementation Plan*.

1.2 Support Detail

1.2.1 Bilateral Channel

The ROK uses the Rio markers of the OECD Development Assistance Committee (DAC) to calculate climate-related financial support. The Rio markers were established in 1998 as a methodology to track resources allocated to projects supporting the objectives of the Rio Conventions in biodiversity, climate change, and desertification prevention, and to evaluate their achievements. The system includes four policy markers: ⅰ) GHG mitigation, ⅱ) climate change adaptation (added in 2010), ⅲ) biodiversity, and ⅳ) desertification prevention. For the first BTR, support scale was measured based on all bilateral projects marked with both mitigation and adaptation markers.

The ROK has significantly increased financial resources for supporting climate action and carbon neutrality in developing countries, highlighting its strategic importance. Bilateral support reached approximately USD 1,439 million in 2021 and USD 2,156 million in 2022. In terms of climate-related financial support trends, the focus is particularly on climate change adaptation. The proportion of support directed to the adaptation sector was approximately 79.5% in 2021 and 61.8% in 2022.

<Table Ⅳ-3> Amount of Financial Support through Bilateral Channel by Type

	2021		2022	
	Amount Provided (USD million)	Proportion (%)	Amount Provided (USD million)	Proportion (%)
Total	1,438.5	100.0	2,156.4	100.0
Mitigation	152.9	10.6	532.0	24.7
Adaptation	1,143.2	79.5	1,332.2	61.8
Cross-Cutting	142.4	9.9	292.1	13.5

Source: OECD DAC Statistics (status: committed)

1.2.2 Multilateral Channel

The ROK is strengthening policy coordination mechanisms to facilitate global green transition as an effective response to climate change as a shared global challenge. Drawing on its experience and technical expertise in green growth, the ROK serves as a 'green ladder' bridging climate gaps within the international community. It demonstrates its commitment to global climate action through significantly increased contributions to multilateral cooperation funds focused on climate change response.

1) Climate Funds

(a) Contribution to Climate Funds

The ROK actively participates in international climate initiatives and has hosted the GCF headquarters in Incheon since December 2013. The ROK contributed USD 100 million to GCF's initial resource mobilization and USD 200 million to its first replenishment by 2023, with an additional USD 300 million pledged for the second replenishment starting in 2024. Korean GCF-accredited entities, the Korea Development Bank (KDB) and KOICA, have developed several cooperation projects. In 2022, the GCF Board approved Korea's first nationally proposed project - the Indonesia Industrial Energy Efficiency Enhancement Project - which provides loans through local financial institutions to help Indonesian SMEs improve energy efficiency in aging industrial facilities. In 2024, the GCF also approved the Cambodia Climate Financing Facility, which supports transforming the Agricultural and Rural Development Bank of Cambodia into a national climate bank.

The ROK contributes to the Global Environment Facility (GEF), which serves as the Financial Mechanism for major Multilateral Environmental Agreements (MEAs) including the United Nations Framework Convention on Climate Change (UNFCCC), Convention on Biological Diversity (CBD), UN Convention to Combat Desertification (UNCCD), Stockholm Convention on Persistent Organic Pollutants, and the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention). Contributions of KRW 2,230 million in 2022 and KRW 2,420 million in 2023 were made. These funds support initiatives in developing countries across five areas: biodiversity, climate change, water resources, land degradation, and chemicals and waste.

Furthermore, the ROK actively engages with various funds that support climate change adaptation and address loss and damage in developing countries. At the 27th Conference of the Parties (COP) in November 2022, the ROK pledged an additional KRW 3,600 million to the Adaptation Fund for 2023-2025. Following the formal establishment of the Loss and Damage Fund at COP28 in Dubai in 2023, a commitment of USD 7 million was made to this new mechanism.

(b) Mobilizing Voluntary Funds

Established in 2012, the Korea Green Growth Trust Fund (KGGTF) is the World Bank's only trust fund dedicated to green growth. Through this fund, the ROK shares its experience and technical expertise in sustainable development. By 2022, the ROK had contributed USD 123.37 million to help transfer its green technology-based infrastructure development knowledge to developing countries. It focuses on areas where it has particular expertise, including renewable energy, smart cities, intelligent transportation systems (ITS), eco-industrial parks, waste management, water resource management, and next-generation power grids.

In March 2022, the GGGI Trust Fund was established, committing KRW 6,000 million annually through 2026 to support climate response projects and capacity-building in developing countries. By 2022, the Ministry of Economy and Finance had approved 17 initiatives (USD 3.26 million) for climate project preparation, including feasibility studies, investment mobilization, and advisory services; 4 initiatives (USD 580 thousand) for preparing submissions to climate funds including the GCF; and 1 initiative (USD 200 thousand) focused on capacity-building and knowledge sharing.

2) International Organizations and Networks

(a) United Nations Framework Convention on Climate Change (UNFCCC)

The Ministry of Economy and Finance has committed a contribution of KRW 3,000 million for the period of 2022-2024 to support the UNFCCC Secretariat's Need-Based Climate Finance Project. This initiative assesses project needs based on regional climate conditions, develops strategic approaches including prioritization mechanisms, and identifies potential capacity-building projects to strengthen climate response capabilities in developing countries. The initiative also provides financial mobilization strategies through training sessions, workshops, and investment forums to facilitate project implementation.

(b) Intergovernmental Panel on Climate Change (IPCC)

The Korea Meteorological Administration has contributed KRW 2,400 million from 2019 to 2023 as host country for the sixth IPCC Chair, supporting the Technical Support Unit in preparing the IPCC Sixth Assessment Report (AR6) Synthesis Report. The AR6 Synthesis Report served as a key input to the First Global Stocktake (GST), completed in December 2023, and has become a foundational document for global climate change policies and strategies.

(c) Climate Technology Center & Network (CTCN)

The Ministry of Science and ICT has contributed KRW 1,000 million for the period of 2017-2020 to support CTCN Technical Assistance (TA) projects. Recognizing the importance of technological innovation and collaborative Research, Development, and Demonstration (RD&D) highlighted in the Paris Agreement, the Ministry proposed establishing the CTCN Partnership & Liaison Office (CTCN PALO) in Korea in 2021 to strengthen TA projects for developing countries. Since its launch in July 2022, the Ministry has implemented three TA projects using these resources and committed an additional KRW 2,000 million annually until 2025 to ensure CTCN PALO's sustainable operation.

(d) World Meteorological Organization (WMO)

The Korea Meteorological Administration has contributed approximately KRW 4,000 million for the period of 2021-2022 to support the World Meteorological Organization (WMO), the UN specialized agency for meteorology and climate. These funds supported key initiatives including the Early Warning for All (EW4ALL) and the Global GHG Watch (G3W). Since 2022, the Korea Meteorological Administration has also contributed to the WMO Regional Training Centre Trust Fund to help bridge climate response capability gaps between developed and developing countries through capacity-building programs in Asia, Africa, and the Southwest Pacific.

(e) International Maritime Organization (IMO)

The Ministry of Oceans and Fisheries has run a capacity-building program on maritime GHG reduction policies for Least Developed Countries (LDCs) and Small Island Developing States (SIDS) since 2022, following a memorandum of understanding with the International Maritime Organization (IMO). This program receives funding through the ROK-established Voyage Together Trust Fund. Participants work with experts on IMO's GHG reduction policies and develop skills to create national action plans and secure necessary financing.

(f) Asian Forest Cooperation Organization (AFoCO)

The ROK proposed for the AFoCO at the 2009 Korea-ASEAN Special Summit to promote sustainable forest management and climate action in the forest sector. Since the establishment of its Seoul Secretariat in 2018, the Korea Forest Service has provided an annual contribution of KRW 4,250 million. This funding helps strengthen Asia's forest sector contributions to carbon neutrality through knowledge-sharing and capacity-building programs. AFoCO has developed a *Climate Action Plan* that aims to restore 10 million hectares of forest over the decade to address climate challenges through forest-based solutions.

(g) Partnering for Green Growth and the Global Goals 2030 (P4G)

P4G was launched in 2018 under Denmark's leadership to advance climate action and SDG achievement through public-private partnerships. The ROK has been an active member since its inception, hosting the Second P4G Summit in 2021 and continuously making ongoing voluntary contributions. The ROK plans to support the 2025 P4G Vietnam Summit and help Korean eco-friendly startups expand internationally through the partnerships.

<Table Ⅳ-4> Major Cases of Support through Multilateral Channel by Institutions

	Major Case
P4G	▪ **First Phase of P4G Partnership (2018-2022)** During 2018-2022, P4G supported 75 projects in 8 ODA recipient countries with USD 29 million in funding. These projects attracted additional investments of USD 98.8 million and reduced GHG emissions by an estimated 10.9 $MtCO_2$-eq.
GCF	▪ **Indonesia Industrial Energy Efficiency Enhancement Project (USD 247.7 million, approved in 2022)** This project transforms Indonesia's energy market by providing loan guarantees through local financial institutions and delivering knowledge sharing and capacity building for Energy Service Companies (ESCOs). The project is expected to reduce GHG emissions by 3.1 $MtCO_2$-eq.
GGGI	▪ **Turkmenistan Methane Gas Flaring Project (USD 300 thousand, approved in 2023)** This project supports the implementation of Turkmenistan's national methane reduction roadmap by directly mitigating methane emissions from refinery operations.
CTCN	▪ **Establishment and Operation Support for CTCN PALO (KRW 2,000 million per year)** The project focuses on: ⅰ) strengthening cooperation between CTCN and GCF, ⅱ) delivering innovative climate technology and collaborative RD&D services, ⅲ) improving TA implementation, and ⅳ) building capacity of Asia-Pacific regional developing country NDEs while expanding member institution networks.
WMO	▪ **Capacity-Building for Climate Service and Climate Action in Developing Countries (2020-2023)** This initiative delivers comprehensive capacity-building by developing online training modules for improved climate service delivery and conducting regional workshops for experts from developing countries in Asia, North and Central America, and the Caribbean.
IMO	▪ **Maritime GHG Emissions Reduction Policy Capacity-Building Program** Funded by the Voyage Together Trust Fund, this program strengthens the capacity of Least Developed Countries (LDCs) and Small Island Developing States (SIDS) to develop and implement national action plans, focusing on policy development and funding strategies for maritime emission reduction.

1.2.3 Best Practices by Sector

In addressing climate challenges in developing countries through ODA projects, the ROK delivers tailored support that considers each country's unique characteristics, climate vulnerabilities, and national green growth strategies.

1) Mitigation Sector

A notable GHG reduction project funded through grants is the Establishment of PAK-KOREA Testing Laboratory for PV Modules and Allied (2019-2023). Pakistan faces electricity quality challenges and low electrification rates, with over 30,000 households lacking electricity access, of which about 80% located in rural areas. The Pakistani government has designated energy as a priority development sector. Given the region's abundant sunshine and solar radiation, there is significant solar power potential, making renewable energy a priority for rural electrification. KOICA established a solar cell module certification laboratory to improve solar product quality in Pakistan through advanced certification standards. This project supports solar industry development while improving income levels and living conditions in Pakistan's rural regions.

The ROK also provided concessional loans to support energy policy improvements in developing countries. The Export-Import Bank of Korea partnered with the Asian Development Bank (ADB) on the Indonesia Energy Sector Reform Program Loan III for Sustainable and Inclusive Growth. Through this program, Indonesia identified three priority areas needing energy sector improvements and implemented 16 policy measures across these areas. These reforms helped create a sustainable and efficient energy market framework that encourages private sector participation. Key achievements include: ⅰ) Recalculating previously low electricity tariffs to reflect actual generation costs, while providing targeted subsidies to vulnerable groups; ⅱ) Streamlining licensing procedures between central and local governments and offering fiscal and financial incentives to attract private investment in renewable energy; and ⅲ) Improving policies to include financial support mechanisms for clean energy promotion and stronger GHG emission standards.

As part of its multilateral cooperation efforts, the ROK also implemented the Accelerating Clean Energy Access to Reduce Inequality project (Korea-Indonesia-Timor-Leste Solar Energy Access Project) from 2020-2022. Indonesia established a national energy strategy targeting

23% renewable energy by 2025, with budget allocations to improve energy access and equity. Through this triangular cooperation among KOICA, Indonesia, and Timor-Leste, the project addressed climate change and reduced energy disparities by installing village-level solar power systems, solar water pumps, and high-efficiency solar lamps, while providing maintenance training. This initiative expanded clean energy use in rural communities, supporting emissions reduction efforts.

2) Adaptation Sector

A key grant-funded initiative is the Establishment of an Integrated Platform for Typhoon Monitoring and Forecasting for Weather and Climate Disaster Prevention Based on Information and Communication Technology (ICT), launched in Vietnam in 2023. This project strengthens Vietnam's disaster risk reduction capabilities and climate resilience by creating an integrated platform for natural disaster monitoring and forecasting. The system uses ICT, including big data analytics, to collect and analyze meteorological and climate information, helping protect Vietnamese citizens' lives and property.

The ROK has also achieved significant results in water infrastructure projects for disaster response, including dams and water/sewage systems funded through concessional loans. The Indonesia Karian Water Supply Project stands out as an exemplary large-scale infrastructure project using Public-Private Partnership (PPP). This project includes construction of the Karian Dam, funded by EDCF since 2010, and water conveyance facilities, supported by the Economic Development Promotion Facility (EDPF) since 2022. The water treatment facilities are scheduled for development through PPP. The project demonstrates successful implementation through blended finance approaches.

2. Technology Development and Transfer

The ROK recognizes technology development and transfer as essential for both mitigation and adaptation actions, and works to meet its international cooperation commitments under Article 10 of the Paris Agreement. The ROK maintains that strengthening the Technology Mechanism, which supports Parties' technology cooperation under the UNFCCC and Paris Agreement, will drive cooperation among Parties and advance global climate action. Despite its classification as an 'Other Party' under the Paris Agreement, the ROK makes voluntary contributions to strengthen the Technology Mechanism.

2.1 National Circumstances and Institutional Arrangements

The ROK has designated the Ministry of Science and ICT as its National Designated Entity (NDE) for technology development and transfer under the UNFCCC. The Ministry supports the development and implementation of policies and strategies to enhance international cooperation in climate technology. Legal and policy frameworks has been established for domestic climate technology development and innovation, while creating comprehensive strategies for global climate technology cooperation to facilitate projects with developing countries.

The *Global Technology Cooperation Strategy for Climate Change Response* (September 2015) was established, showing the commitment to active participation in the Technology Mechanism. The ROK further developed detailed strategies through the *Mid- to Long-Term Plan for Climate Technology Cooperation* (April 2018), comprising of: ⅰ) Support for innovation technology-based R&D, ⅱ) Systematization of global climate technology cooperation projects, ⅲ) Establishment of foundations for climate technology cooperation, ⅳ) Enhancement of participation in the Technology Mechanism, and ⅴ) Government-wide cooperation.

After its 2050 Carbon Neutrality declaration in 2020, the ROK began developing government-wide technology innovation strategies. The ROK established the *Carbon Neutral Technology Innovation Promotion Strategy* (March 2021), outlining specific technology innovation measures. This strategy identified 10 Key Carbon Neutral Technologies, selected based on their alignment with domestic Green policy and the *Long-term Low Greenhouse Gas Emission Development Strategy* (LEDS) (December 2020), their potential for GHG

emissions reduction, and their contribution to industrial low-carbon technology advancement. The strategy created sector-specific innovation roadmaps while presenting measures to strengthen research capabilities and infrastructure, including international cooperation and human resource development. Notably, the strategy includes plans to promote international demonstration and commercialization of new carbon neutrality technologies through CTCN.

Following the enactment of the Carbon Neutrality Act, which established the 2050 Carbon Neutrality goal in law, the ROK developed the *Strategy for Technology Innovation for Carbon Neutrality* (October 2022), outlining government-wide direction for carbon neutrality technology development. Under this strategy, the ROK identified 100 Core Technologies across 17 key areas essential for achieving carbon neutrality. The ROK is building a technology innovation ecosystem based on these technologies to ensure continuous development of innovative carbon reduction solutions through large-scale R&D projects. The strategy includes plans to assess developing countries' technology needs through CTCN and strengthens technology cooperation using both domestic and international resources. The Carbon Neutrality Framework Plan also incorporates technological innovation measures for carbon neutrality and specifically establishes enhanced cooperation with CTCN as a key objective.

The *Act on Promotion of Technology Development for Coping with Climate Change* (April 2021) provides a legal framework for systematically expanding technology development and transfer, strengthening both domestic technology development and international collaboration. Based on this law, the *First Master Plan for Development of Technology for Coping with Climate Change* (December 2022) establishes the R&D direction for technologies essential for GHG reduction and climate change adaptation, specifying methods to contribute internationally through cooperation with CTCN. Importantly, the plan includes initiatives to support climate technology localization projects customized to developing countries' needs, enabling targeted climate technology cooperation that addresses their specific requirements.

<Table Ⅳ-5> Global Climate Technology Cooperation and R&D: Main Laws and Policies

Date of Establishment	Laws and Policies	
September 2015	*Global Technology Cooperation Strategy for Climate Change Response*	
July 2016	*Climate Technology Roadmap*	
April 2018	*Mid- to Long-Term Plan for Climate Technology Cooperation*	
March 2021	*Carbon Neutral Technology Innovation Promotion Strategy*	
October 2022	*Strategy for Technology Innovation for Carbon Neutrality*	*Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis* (September 2021)
April 2023	*First National Framework Plan for Carbon Neutrality and Green Growth*	
December 2022	*First Master Plan for Development of Technology for Coping with Climate Change*	*Act on Promotion of Technology Development for Coping with Climate Change* (April 2021)
September 2023	*Implementation Plan for the 1st Master Plan for Development of Technology for Coping with Climate Change*	

2.2 Support Detail

The ROK conducts various climate technology cooperation activities based on its international cooperation policies and strategies. It actively participates in CTCN TA projects to build capacity in developing countries, strengthening international cooperation to address climate change.

Since 2016, the ROK has collaborated with CTCN to identify developing countries' technology needs and implemented 'Pro-bono TA' projects using domestic resources. This initiative is one of the official support channels proposed by the ROK to expand TA support for developing countries, especially when CTCN faces budget constraints in responding to numerous requests. When developing countries submit TA requests through CTCN, the ROK connects them with domestic private entities that have relevant technologies and expertise. Through this approach, the ROK has created multiple pathways to expand its TA contributions under CTCN.

<Table Ⅳ-6> Overview of Climate Technology Center and Network Technical Assistance

Sector	Sub-sector	Number of Cases
Total		18
Mitigation	Energy	12
	Agriculture	1
	Forestry	1
Adaptation	Water and Sanitation	2
Cross-cutting	Cross-Sectoral	2

During 2021-2022, the ROK has implemented 18 CTCN Pro-bono TA projects, with 9 ongoing in 2022. Most projects were in the mitigation sector, with the largest number focused on energy, followed by water and sanitation adaptation projects and cross-cutting initiatives. The public entities showed the strongest participation, with an additional 5 climate technology cooperation projects supported through PPP. The projects primarily focused on developing sectoral roadmaps and strategies, piloting technologies in local conditions, and assessing the feasibility of technology options.[53)]

53) Supported technology assistance types are classified according to the TA project types under CTCN

<Table Ⅳ-7> Status of Climate Technology Center and Network Technical Assistance

Sector	Country	Period	Project Name	Subsector	TA Type	Status	Entity
Mitigation	Sri Lanka	2019-2021	Development of Kurunegala as a climate smart city	Energy	Technology identification and prioritization	Completed	Private
	Togo	2019-2021	Development of solar energy technology in Togo's rural areas	Energy	Feasibility of technology options	Completed	Public
	Bhutan	2019-2021	Establishment of master plan for improving urban solid waste management system in Thimphu City	Energy	Recommendations for law, policy and regulations	Completed	PPP
	Honduras	2021	Green Energy Island Project in Guanja, Bay Islands, Honduras	Energy	Piloting and deployment of technology in local conditions	Completed	PPP
	Indonesia	2019-2022	Establishment of low-carbon integrated waste management appropriate technology hub center	Energy	Piloting and deployment of technology in local conditions	Completed	Public
	Vietnam	2022-2023	Technical support project for eco-friendly composting and biogas power generation using livestock manure in agriculture	Agriculture	Technology identification and prioritization	In progress	Private
	Laos	2022-2023	Technical Capacity Enhancement for Planning an Urban Public Transport System in Vientiane, Lao PDR	Energy	Sectoral roadmaps and strategies	In progress	PPP
	Uzbekistan	2022-2023	Feasibility study on biogas potential using human waste	Energy	Feasibility of technology options	In progress	PPP
	Thailand	2022-2024	Development of national hydrogen strategy and action plan for accelerating Thailand's net-zero target	Energy	Sectoral roadmaps and strategies	In progress	Public
	Samoa	2022-2024	Development of framework and methodology for measuring carbon sinks from the forest sector using Earth observation in Samoa	Forestry	Recommendations for law, policy and regulations	In progress	Public
	Bangladesh	2022-2023	Development of Framework for Real-Time Transport Information Systems for Public Transport in Greater Dhaka	Energy	Feasibility of technology options	In progress	Public
	Cambodia	2020-2023	Establishment of a Sustainable e-Mobility Ecosystem for Carbon Emissions Reduction in Cambodia	Energy	Sectoral roadmaps and strategies	In progress	Public

Sector	Country	Period	Project Name	Subsector	TA Type	Status	Entity
	Sri Lanka	2020-2023	Research on rural energy business model discovery and funding linkage plan	Energy	Private sector engagement and market creation	In progress	Public
	Serbia	2021-2023	Establishment of smart monitoring system based on IoT for district heating and establishment of renewable energy network plan in Belgrade city, Serbia	Energy	Piloting and deployment of technology in local conditions	In progress	PPP
Adaptation	Cambodia	2020-2021	Application of the gravity-driven membrane (GDM) technology for supplying sustainable drinking water to rural communities	Water and Sanitation	Piloting and deployment of technology in local conditions	Completed	Public
	Mozambique	2021-2022	Development of an action plan for rainwater harvesting system and financing proposals for Mozambique	Water and Sanitation	Financing facilitation	Completed	Private
Cross-Cutting	Tanzania	2020-2021	Technical support for dissemination of sustainable household solar water pump	Cross-Sectoral	Feasibility of technology options	Completed	Private
	Zambia	2022	Development of a framework and roadmap for a National Innovation System to foster low-carbon and climate resilient economic development in Zambia	Cross-Sectoral	Sectoral roadmaps and strategies	Completed	Public

Beyond CTCN TA projects, the ROK regularly hosts workshops and conferences to share climate technology knowledge and build capacity. Since 2016, the ROK has organized 13 meetings for Korean CTCN members to strengthen their ability to support developing countries. In July 2022, the Ministry of Science and ICT and CTCN jointly held a Korean network member conference to coincide with the opening of CTCN PALO. The ROK also hosted both the 26th Technology Executive Committee (TEC) meeting and the 21st CTCN Board meeting in Incheon, demonstrating its active support for the Technology Mechanism.

2.3 Best Practice of Support

In 2019, the ROK implemented a CTCN Pro-bono TA project entitled “Introduction of Low-Carbon Transportation Technology in Cambodia”. The Cambodian government requested CTCN assistance to help meet its NDC target by addressing high emissions in the transportation sector. The Ministry of Science and ICT, CTCN, and the Cambodian government agreed to implement this project through the Pro-bono TA track, selecting ‘Envelops’, a private company, to develop a policy implementation plan for introducing low-carbon transportation technology in Cambodia.

After completing the CTCN Pro-bono TA project, the Ministry of Science and ICT and the Cambodian government discussed about expanding the initiative through the GCF Readiness and Preparatory Programme. The National Institute of Green Technology (NIGT) used the financial proposal developed during the CTCN project to plan and apply for a GCF capacity-building project, which subsequently gain approval.

The main goal of this expanded project was to create a climate technology roadmap for Cambodia's e-mobility industry ecosystem. This roadmap included strategies to overcome e-mobility adoption barriers, with supportive policies and long-term implementation plans for ecosystem development.

This project demonstrates effective linkage between the Technology Mechanism and Financial Mechanism. It represents a successful case where CTCN Pro-bono TA project outcomes were expanded and applied to the GCF Preparatory and Readiness Programme, creating a practical connection between these two mechanisms from a TA perspective.

3. Capacity-Building

As mandated by the Carbon Neutrality Act, the ROK actively promotes international cooperation to address the climate crisis by providing policy, technological and financial support to developing countries. These efforts include sharing climate change-related development experiences, strengthening capabilities in forest and GHG management, and supporting environmental improvement master plans across mitigation, adaptation, and transparency areas.

3.1 Sharing of Experience and Knowledge

The ROK brings a unique perspective as a country that has successfully transitioned from aid recipient to donor nation. Through its Knowledge Sharing Program (KSP), the ROK shares targeted development insights adapted to each partner country's context. The program supports policy analysis, knowledge exchange, and capacity strengthening based on partner countries' specific needs to create meaningful impact. During 2021-2022, 21 of the 89 KSP projects were focused on climate-related knowledge in environment, water resources, and energy sectors.

In the mitigation sector, the ROK collaborated with the Rwandan government on a project entitled “Enhancing Institutional Capacities for Facilitating the Use of Internationally Transferred Mitigation Outcomes (ITMOs) through Electric Mobility in Rwanda” from 2022 to 2023. Rwanda sought to achieve green transformation in its transportation sector, which accounts for 13% of the country's total GHG emissions. The project provided policy recommendations and capacity-strengthening training for expanding electric bus adoption, identified institutional requirements for ITMOs recognition, and developed specific e-mobility implementation initiatives.

In the adaptation sector, the ROK worked with the Dominican Republic from 2022 to 2023 on improving drinking water and wastewater management systems. This project addressed the Dominican Republic’s urgent need for better water treatment infrastructure. The ROK provided expertise on automated treatment systems, renewable energy integration, and energy-saving technologies. The project included training programs for local operators and identified key institutional and technical factors for sustainable infrastructure. The ROK leveraged the partnerships with the Korea Water Partnership (KWP), Korea Environment Institute (KEI), and Korea Environment Corporation (K-eco) to share practical knowledge and develop implementation plans that aligned with international financing opportunities.

3.2 Support for Transparency

Since 2011, the Greenhouse Gas Inventory and Research Center of Korea (GIR) has been running an annual international training program called the UNFCCC-GIR-CASTT Programme on GHG. This 3-4 week program strengthens developing countries' capacity to manage GHG emissions.

GIR formalized its collaboration with the UNFCCC Secretariat in 2017 through an MOU, jointly managing program promotion, participant selection, lectures, and practical training. Participants include government officials, representatives from GHG inventory institutions, and experts from international organizations. They receive technical training on GHG measurement and reduction while sharing their experiences and challenges in developing national inventories. The curriculum covers: i) National reporting and review obligations, ii) Methodologies for Measurement, Reporting, and Verification (MRV), iii) Application of IPCC Guidelines for National GHG Inventories, iv) Preparation of National GHG Inventory Report (NIR), and v) GHG emissions projections.

Between 2011 and 2023, 442 participants completed this training program, of which many have been applying their new knowledge to improve GHG inventory management in their home countries. As a result, demand for the program has grown steadily. At COP28, the UNFCCC Secretariat recognized the GIR training program as an exemplary capacity-building initiative for developing countries. The program received praise for its effectiveness, and developing countries were encouraged to maintain their participation.

<Table Ⅳ-8> Status of Participated Countries of UNFCCC-GIR-CASTT Program on GHGs

Phase	Period	Participating Countries	Participants	Phase	Period	Participating Countries	Participants
First	June 27, 2011 - July 22	21	44	Eighth	June 25, 2018 - July 19	30	30
Second	July 2, 2012 - July 25	22	42	Ninth	July 22, 2019 - August 14	32	32
Third	July 8, 2013 - July 30	28	38	10th	August 20, 2020 - November 10	32	34
Fourth	July 3, 2014 - July 25	29	34	11th	August 2, 2021 - October 8	31	41
Fifth	June 29, 2015 - July 21	27	37	12th	July 25, 2022 - August 12	21	25
Sixth	July 4, 2016 - July 21	24	31	13th	July 10, 2023 - July 28	26	26
Seventh	June 26, 2017 - July 20	28	28	Total			442

3.3 Best Practices by Sector

3.3.1 Energy

With its technological strengths in the energy sector, the ROK has become a preferred cooperation partner for many developing countries. From 2019 to 2022, the ROK implemented the Smart Multi-Micro Grid R&D Capacity Building Project in Morocco to support the country's goal of achieving 52% renewable energy by 2030. This project aimed to establish a research environment for multi-micro grid technology, strengthen research capabilities, and improve rural power supply. The ROK provided essential equipment, technical training, and infrastructure support were provided to help Morocco develop independent research capacity.

The Ministry of Environment supported the Master Plan for Improving Waste Management for the Cairo Governorate, Egypt, from 2021 to 2022. This initiative introduced policies for waste recycling and energy conversion, to move beyond simple landfilling practices. A follow-up project starting in 2024 was planned to include waste resource facility construction and technology transfer to strengthen local technical capabilities. The Export-Import Bank of Korea has therefore conducted feasibility studies for the Waste Fuel Facility Distribution Project throughout Egypt.

3.3.2 Agriculture

The ROK, with its successful experience in post-war recovery and agricultural development, has become an effective partner in addressing climate-related food security challenges in developing countries. Since 2021, KOICA has implemented the Climate Resilience Enhancement Project in Central and Eastern Rural Areas of Guatemala in cooperation with the GCF. This project builds capacity for low-income farmers in Guatemala's climate-vulnerable regions, helping them adopt climate-adaptive farming methods to increase coffee and cocoa production. It also provides infrastructure support and develops market channels, improving resident income and food security.

The Rural Development Administration operates the Food & Agriculture Cooperation Initiative across Asia, Africa, and Latin America. Since 2018, this program has conducted research on climate-resilient rice and vegetable varieties. Participating countries have obtained drought- and flood-resistant rice varieties and developed climate-adapted crops such as peppers and tomatoes. Through the Korea-Latin America Food & Agricultural Cooperative Initiative,

countries have improved soil fertility and crop productivity while reducing GHG emissions by implementing eco-friendly composting methods.

The Korea Partnership for Innovation of Agriculture (KOPIA) has supported countries where agriculture is a major part of the economy. In Uganda, KOPIA helped mitigate drought impacts by introducing rainwater harvesting systems and tree reservoirs. In Ecuador, KOPIA developed a no-till potato cultivation technique that enables high-yield farming on steep slopes while eliminating carbon emissions. This technique was recognized as one of the top five solutions in the 2022 Solution Bank contest hosted by the FAO's Platform of Latin America and the Caribbean for Climate Action on Agriculture (PLACA).

3.3.3 Forestry

Drawing on its successful reforestation history, the ROK has implemented forest cooperation projects to strengthen developing countries' capacity for climate change mitigation and adaptation.

From 2019 to 2022, the ROK conducted the Restoration of Burnt Peatland and Enhancing Resilience to Climate Change Project in Jambi, Indonesia, achieving reforestation of 200 hectares area and re-wetting of 1,000 ha area. This project focused on peatlands severely damaged by forest fires in 2015 and 2017, which had released significant GHG emissions. The restoration prevented further peatland degradation and desertification, contributing to carbon emission reduction. The project engaged with local communities through awareness programs and technical training for sustainable peatland management. It also improved livelihoods by providing training in agroforestry, aquaculture, and product processing, creating jobs for vulnerable groups, including women, in 10 surrounding villages. These activities increased household incomes and improved the quality of life for local residents.

Since 2012, the Korea Forest Service has operated a capacity-building program on Reducing Emissions from Deforestation and Forest Degradation in developing countries (REDD+). This program enhances developing countries' capacity for forest management using ICT, improves forest disaster management, and strengthens MRV systems. In 2022, the program trained 9 participants from 5 countries, including the Dominican Republic, Ecuador, and Paraguay. In 2023, it expanded to include 17 participants from 7 additional countries: Cambodia, Laos, Myanmar, Vietnam, East Timor, Bhutan, and Indonesia. Through 19 training sessions to date,

the program has trained over 250 participants, contributing to global efforts to combat deforestation and forest degradation.

3.3.4 Water Management

The ROK has actively supported developing countries in adapting to increasing natural disasters occurrence through comprehensive interventions. These include policy consultations, water resource management platforms, and critical infrastructure, such as dams and water supply systems. Since 2007, the Master Plan Development Support Project has identified environmental management needs and established foundational plans for cooperation across various sectors. Furthermore, starting from 2020, the ROK has expanded its climate change adaptation support in Asian countries, including Laos and the Philippines, to address the growing risks of floods and droughts intensified by climate change.

A significant initiative is the Laos Water Resource Management Capacity Building Program, jointly implemented by KOICA, Korea Meteorological Administration, and the Ministry of Environment. As Laos faced increasing natural disaster risks including typhoons, heavy rainfall, and droughts, improved water resource management became urgent. Since 2020, KOICA has developed water resource management systems in the Nam Ngum River basin, including river monitoring and dam operation systems. From 2020 to 2023, Korea Meteorological Administration established an integrated typhoon monitoring and prediction platform to enhance Laos' disaster preparedness. The Ministry of Environment supported the Master Plan for Establishing a National Flood Forecasting and Warning System in Laos (2020-2021), strengthening the Laotian government's flood response capabilities. In 2022, as a follow-up project, the Ministry launched the Establishment of Climate Change Adaptive Flood Forecasting and Warning System in Xe Banghieng River Basin, helping to prevent property damage and save lives during floods. This initiative significantly improved conditions for local residents, who previously relied on weather forecasts from neighboring Thailand. Following the implementation, residents reported greater accuracy in local weather and flood forecasts, increasing their confidence in Laos' own forecasting systems.[54)]

54) Source: ‘Evaluation of Climate Change Response ODA Projects’ Research Report (Korea Institute for International Economic Policy and Korea Environment Institute, 2023)

Annex I

Fifth National Communication

Ⅰ. Research and Systematic Observation

1. Research and Technology Development

1.1 Institutional Framework

The Republic of Korea (ROK) is focusing on research and development (R&D) of technologies essential for addressing the global climate crisis. To this end, the ROK has established a robust institutional framework to support both public and private research efforts, particularly in areas where private investment is limited. Through national R&D projects, the ROK actively promotes technological innovation not only as a response to the climate crisis, but also as a core driver of new economic growth. Comprehensive support is provided for basic, applied, and demonstration research, with systematic monitoring of research activities and outcomes.

1.1.1 Legal and Institutional Foundation

The *Act on Promotion of Technology Development for Coping with Climate Change* (April 2021) provides a legal foundation for the systematic development of technologies aimed at greenhouse gas (GHG) mitigation and climate change adaptation. This law enables coordinated national support for climate technology development. Additionally, the Carbon Neutral Technology Special Committee, established under the Presidential Advisory Council on Science and Technology, plays a pivotal role in overseeing and aligning government-wide policies on carbon neutrality R&D. This ensures the integration of policy objectives and efficient progress in technology development.

In October 2022, the ROK announced the *Strategy for Technology Innovation for carbon neutrality*, which outlines the R&D directions necessary to achieve the 2030 Nationally Determined Contribution (NDC) and carbon neutrality by 2050. This strategy prioritizes private sector-led mission-driven innovation, increased R&D investment, and the creation of an enabling environment for pioneering technologies. The strategy identifies ROK's 100 Core Technologies for Carbon Neutrality across 17 key areas, including power generation, industry, transportation, building, waste, and carbon sinks, which are essential for implementing the national carbon neutrality objectives.

<Table Annex Ⅰ-1> 100 Core Technologies for Carbon Neutrality

Sector		Core Technology
Solar Power		Ultra-high Efficiency Solar Cells
		Multi-purpose Solar Power Systems
		Solar Panel Recycling
Wind Power		Ultra-large Wind Turbines
		Floating Structure Systems for Offshore Wind Farm
		Operation and Management of Offshore Wind Power
		Vertical-axis Floating Wind Power Generation
		Offshore Wind Installation and Construction
Hydrogen supply	Production	Alkaline Water Electrolysis
		PEM Water Electrolysis
		Next-generation Water Electrolysis
	Storage and Transportation	Gaseous Hydrogen Storage and Transportation
		Liquid Hydrogen Storage and Transportation
		Hydrogen-dedicated Pipeline Network
	Overseas Import	Large-scale Overseas Ammonia and Hydrogen Storage and Transportation
		Next-generation Overseas Hydrogen Storage and Transportation
		Liquid Hydrogen Transport Vessels
		Liquid Hydrogen Receiving Terminal
Zero-carbon New Power Sources		Hydrogen Co-firing Gas Turbine Power Generation
		Hydrogen-only Gas Turbine Power Generation
		Ammonia Co-firing in Coal Boilers
		Ultra-high Efficiency Fuel Cell Combined Cycle
		High-efficiency Fuel Cell Combined Heat and Power System
Power Storage		Short-term Energy Storage Systems
		Long-term Energy Storage Systems
		Second-life Battery Energy Storage Systems
Power Grid		Intelligent Power Transmission and Distribution Systems
		Real-time Power Trading Platform
		Integrated Operation of Distributed Power Sources and Flexible Resources
Energy Integration Systems		Industrial High-temperature and Ultra-low Temperature Heat Pumps
		Complex Energy Systems
		Thermal Energy Storage Systems
Nuclear Power		Small Modular Reactor (SMR)
		Advanced Nuclear Systems
		Nuclear Waste Management
Steel		Blast Furnace Fuel and Raw Material Substitution
		Basic Oxygen Furnace Raw Material Substitution
		Carbon-reduced Electric Arc Furnace
		Korean Hydrogen-Based Ironmaking
		Zero-carbon Fuel Conversion for Steel Industry Secondary Processes
		Steel By-product Resource Recovery
Petro chemical	Fuel Substitution	Electric Heating NCC Systems
		Zero-carbon Fuel NCC Process
		By-product Gas High Value-added Conversion
	Raw Material Substitution	Bio-naphtha and Olefin
		Bio-based Polyethylene Furanoate (Bio-PEF)
		Bio-polyol
	Resource Circulation	Automatic Sorting of Waste Plastics
		Waste Plastic Solvent Extraction
		Waste Plastic Depolymerization

Sector		Core Technology
Petro chemical	Resource Circulation	Thermal Pyrolysis of Waste Plastics
		Waste Plastic Gasification
	New Process	Conversion of Fuel Oil and Its By-products to Basic Chemical Raw Materials
		Low-energy Reaction Process
		Low-energy Separation Materials and Processes
		Smart Plant Conversion
Cement		Non-carbonate Raw Material Substitution
		Increased Mixed Material Content
		New Mixed Material Production
		Recycled Resource Fuel Substitution
		Utilization of Low-carbon New Heat Sources
CCUS	Capture	Wet CO_2 Capture
		Dry CO_2 Capture
		Membrane Separation Capture
		Next-generation Capture
	Storage	Storage Site Exploration, Evaluation and Selection
		Storage Facility and Equipment Design and Construction
		CO_2 Injection and Operation of Storage Sites
		CO_2 Storage Monitoring
	Utilization	Chemical Conversion
		Mineral Carbonation
		Biological Conversion
General Industry		Industrial Process Hydrogen and Ammonia Utilization
		Process Gas Substitution (Semiconductor and Display)
		Process Gas Treatment (Semiconductor and Display)
		Eco-friendly Refrigerants
		Motor and Power Converter Efficiency Enhancement
		Green Data Centers
		Carbon Emission Reduction Monitoring
Eco-friendly Vehicles		Advanced Secondary Battery Cells
		Advanced Secondary Battery Systems
		Enhanced Drive Motor Performance
		Advanced Power Conversion Devices
		High-speed Wired Charging
		High-capacity Wireless Charging
		Advanced Fuel Cell Systems
		Vehicle Hydrogen Storage Systems
		Hydrogen Refueling Stations
Ship Carbon Neutrality		Carbon Neutral Internal Combustion Engine
		Ship Fuel Cell and Battery Systems
		Ship Electric Propulsion Systems
		Fuel Post-treatment and Energy Efficiency Improvement
Building Zero Energy		High-performance Multi-functional Envelope
		Building Equipment Electrification and High Efficiency
		Building Renewable Energy and Energy Integration Systems
		Building Energy Management, Control and Data Utilization
Environment		Biodegradable Bio-plastics
		Renewable Plastics
		Metal Resource Recovery
		Land-Based Carbon Sequestration Enhancement by Space Type

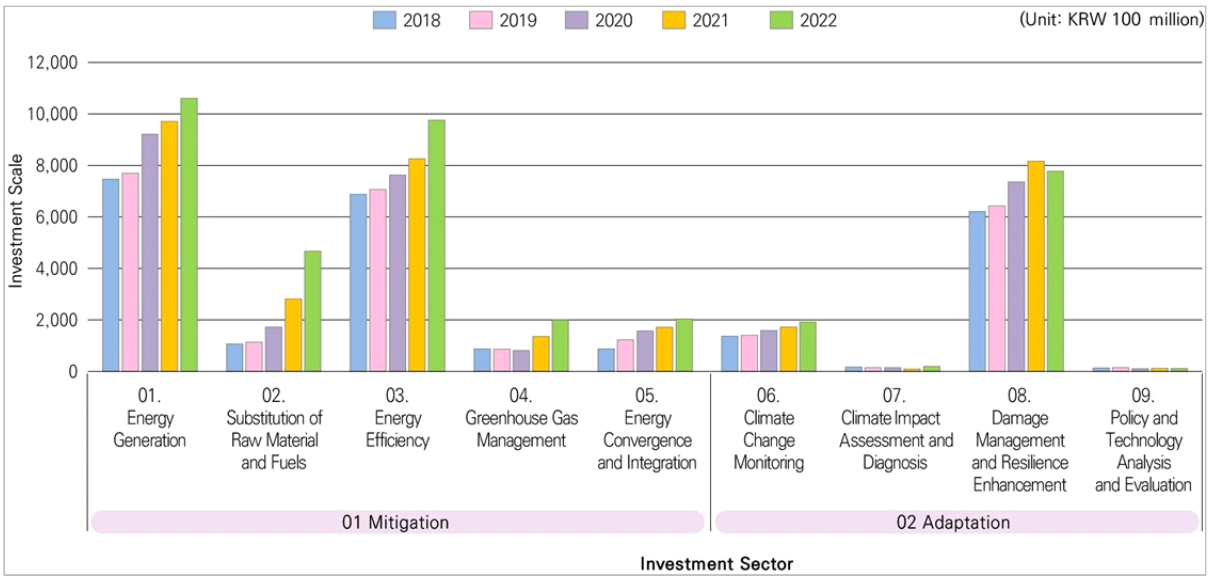
1.1.2 Status of R&D Investment

In line with these policy trends, the total investment in national climate technology R&D projects in 2022 amounted to KRW 3,907.3 billion, accounting for approximately 12.9% of the total national R&D. Of this climate technology R&D investment, KRW 2,907.2 billion (74.4%) was allocated to GHG reduction, while KRW 1 trillion (25.6%) was dedicated to adaptation. In the mitigation sector, energy production received the highest investment at KRW 1,061.1 billion, followed by energy efficiency at KRW 976.1 billion, and fuel and feedstock substitution at KRW 466.6 billion. In the climate change adaptation sector, damage control and resilience enhancement received the highest investment at KRW 777.9 billion, followed by climate change monitoring at KRW 191.3 billion, and climate impact assessment and diagnosis at KRW 19.6 billion.

<Table Annex Ⅰ-2> Scale of Climate Technology R&D Investment in 2022

Category	2022 Climate Technology R&D Investment Status by Sectors			National Total R&D
	Mitigation	Adaptation	Total	
Investment Amount (KRW)	2.9072 trillion	1 trillion	3.9073 trillion	28.6801 trillion
Percentage (%)	74.4	25.6	100	-

Source: Analysis of National R&D Investment in Climate Technology (2018-2022) (National Institute of Green Technology, 2022)



[Figure Annex Ⅰ-1] Scale of Climate Technology R&D Investment

Source: Analysis of National R&D Investment in Climate Technology (2018-2022) (National Institute of Green Technology, 2022)

1.2 Major R&D Cases by Sector

1.2.1 Mitigation Sector

1) Power Generation

(a) Solar, Wind, and Wave Power Generation

The ROK is focusing on advancing technologies to expand deployment in the new and renewable energy sector. In the solar power sector, the ROK has developed high-efficiency, large-area perovskite and silicon tandem solar cell manufacturing technology with the goal of achieving ultra-high efficiency. Technologies suitable for commercialization, such as urban solar cells and mobile device solar cells, are also being developed to promote growth of the renewable energy industry and increase deployment.

Specifically, wind power research focuses on ultra-large turbines and offshore systems to improve economic feasibility. The ROK has developed an 8 MW domestic offshore wind system and aims to create a 10 MW large-scale system. Long-term goals include advancing vertical-axis floating wind generation technology, commercializing substructure designs, and improving offshore wind farm operations. The ROK has also been enhancing fuel cell technology to meet growing energy storage needs by developing both short- and long-term storage solutions, improving battery recycling processes, and advancing solid oxide fuel cell efficiency.

<Table Annex Ⅰ-3> Research and Development Progress in Solar and Fuel Cells

	R&D Progress
Solar Cell	World's highest module efficiency certification for organic solar cells using non-halogen solvents
	Development of high-efficiency, large-area perovskite and silicon tandem solar cell manufacturing technology for commercialization
Fuel Cell	Development of high-performance oxygen electrode materials for tube-type materials
	Development of optimal design technology for bipolar recirculation system of high-performance double-stack proton exchange membrane fuel cells

Research on commercializing eco-friendly marine energy such as wave power and marine green hydrogen also continues to advance. A wave power demonstration plant integrated with breakwaters has been constructed on Jeju Island's coast, successfully generating electricity during pilot operations. This technology has been transferred to the private sector. Current development

focuses on enhancing multi-module wave power generation performance in connection with breakwaters under construction. Additionally, researchers are conducting onshore testing to validate a fixed offshore green hydrogen production system connected to marine renewable energy. Work is also underway to develop offshore green hydrogen production technology that uses wave power-generated electricity to electrolyze desalinated seawater.

(b) Hydrogen Supply

The ROK actively supports full-cycle hydrogen industry technologies, from production through storage, transportation, and utilization. The country has secured water electrolysis technology for hydrogen production, while working to improve economic feasibility through large-capacity systems and efficiency enhancements in storage and transportation. There are also plans to expand support for new hydrogen market development. The Ministry of Science and ICT has developed eco-friendly, high-efficiency hydrogen energy technologies through the Hydrogen Energy Innovation Technology Development Project (2019-2023). The ministry has also been promoting the Future Hydrogen Original Technology Development Project since 2021, focusing on future-oriented technologies.

Hydrogen production and storage research has yielded significant results. Water electrolysis investments have led to durable electrodes and separation membranes in alkaline systems, as well as high-performance oxygen electrodes in polymer electrolyte membrane systems. Future research includes hydrogen production through solar, thermochemical, and biochemical methods, with technology transfers ongoing from 2021 to 2024. Research also focuses on developing porous adsorption materials and optimal structures for hydrogen storage, along with large-capacity storage and extraction technologies using ammonia. The ROK has successfully developed high-efficiency storage and release original technologies using liquid organic hydrogen carriers.

(c) Nuclear Energy

The ROK actively advances R&D to build a sustainable nuclear energy ecosystem. Key focus areas include core technologies for innovative Small Modular Reactors (i-SMR), nuclear plant decommissioning, and radioactive waste management. Current projects include developing standard designs for i-SMR and cost-effective manufacturing technologies. Safety research aims to minimize operational failures and accidents, ensuring long-term plant safety, while developing accident prevention technologies for extreme environments.

The ROK has successfully demonstrated cutting and decontamination technologies for safely dismantling decommissioned nuclear plants, with supporting infrastructure under construction. For radioactive waste management, safety technologies for high-level waste are under development, and a Comprehensive Safety Verification Report is being prepared to ensure safe nuclear waste handling.

(d) Energy Utilization and Management

The ROK is developing technologies to ensure stable energy systems and efficient utilization. Research focuses on power grid technologies that better integrate renewable energy and promote distributed generation. Large-scale power conversion devices and High-Voltage Direct Current (HVDC) transmission technologies are being developed and applied to stabilize metropolitan power grids. The ROK has also developed fire safety assessment technologies for large-capacity energy storage systems, establishing the world's largest secondary battery verification center.

In the industrial, building, and transportation sectors, the ROK is driving a transition toward high-efficiency, low-energy structures through technology development. Achievements include low-loss power converters, high-efficiency motors, smart farm energy-saving systems, and ultra-fast chargers. Future plans focus on improving energy efficiency in energy-intensive industries and expanding the low-carbon industrial ecosystem by implementing demand management technologies to reduce peak power consumption.

2) Industry

The ROK is pursuing research to improve energy efficiency and substitute fuels and raw materials in carbon-intensive industries like steel, petrochemicals, and cement. Steel industry research focuses on developing hydrogen-based ironmaking technology. The petrochemical sector is working on energy-efficient process innovations, while the cement industry is developing technologies for raw material substitution and process emission reduction.

The ROK is also advancing Carbon Capture and Utilization (CCU) technologies. Building on established original technologies, researchers aim to achieve early commercialization through medium and large-scale demonstration projects while developing next-generation technologies. The Carbon Resource Platform Chemical Manufacturing Technology Development Project is creating production technologies that use CO_2 from GHG emissions,

by-product gases, and organic waste. Researchers are also developing innovative raw material production methods by capturing CO_2 from coal-fired power plant emissions and large-scale processes to capture CO_2 generated during hydrogen production.

The ROK actively supports technology development to enhance climate response capabilities in small and medium-sized enterprises (SMEs). The Ministry of SMEs and Startups has built a foundation for low-carbon practices by developing carbon-neutral technologies applicable across carbon-intensive industry processes and promoting their adoption through process expansion initiatives. Since 2022, the ministry has selected 16 projects based on SME technological needs, with plans to connect completed technologies to commercialization support programs. Through the *Strategic Technology Roadmap*, the ROK facilitates partnerships between research institutions with eco-friendly and low-carbon expertise and the SMEs. The ROK is also developing and supporting GHG emission calculation and verification methods tailored to small and medium-scale processes.

<Table Annex Ⅰ-4> Research and Development Progress in CCU Technology

Sector	Field	R&D Progress
By-product Gas and CO_2 Simultaneous Utilization	Simultaneous Conversion of By-product Gas and CO_2	Developing technologies to produce syngas, olefins, and other products by simultaneously converting by-product gas and CO_2 Demonstrating integrated separation, conversion, and purification processes at pilot scale
	Separation of Carbon Resources from By-product Gas	Developing membrane separation-adsorption hybrid processes to recover high-value chemical gases (CO, CO_2, hydrogen) from by-product gas Scaling up membrane and adsorbent technologies and validating hybrid process performance
Renewable Energy-linked CO_2 Conversion	Hydrocarbon Production through Hydrogenation	Producing liquid hydrocarbons such as naphtha from captured CO_2 or CO_2-rich by-product gas using hydrogen generated from renewable energy sources Testing core Power-to-Liquid processes in demonstration facilities
	CO_2 Conversion Using Renewable Energy	Developing electrochemical conversion technologies to produce olefins directly from captured CO_2 using renewable energy Implementing integrated electrochemical CO_2 conversion processes in test facilities
Organic Waste/CO_2 Simultaneous Utilization	Simultaneous Conversion of CO_2 and Biomass By-products	Developing technologies to produce polymer platform compounds by simultaneously converting CO_2 and biomass by-products Verifying integrated processes for green polymer production through field testing
	Development of Integrated Biogas Conversion Process	Developing integrated processes that connect biogas production, purification, and conversion to bio-naphtha and lubricating oil Validating integrated systems for bio-naphtha and lubricating oil production in operational environments

3) Building

The ROK is advancing building energy statistics and management technologies to reduce energy consumption. Researchers are measuring and analyzing nationwide building energy use by source, identifying key factors that influence consumption patterns. They are creating a data foundation by linking building information with energy analysis. The country is also developing ICT-based building energy diagnosis and management systems, along with methods to rapidly assess energy performance in aging buildings. Future research is planned to analyze green remodeling effects to develop strategies for improving building energy efficiency and reducing carbon emissions.

4) Transportation

The ROK is developing various technologies to reduce GHG emissions in aviation and marine transportation. In aviation, the Korea Augmentation Satellite System (KASS), established in 2014 and became effective since 2022, provides highly precise location information that meets International Civil Aviation Organization (ICAO) standards. KASS significantly reduces CO_2 emissions during aircraft approach operations, with each approach achieving an average reduction of approximately 31.6 kg of CO_2.

In shipping, eco-friendly vessel technology projects are contributing to decarbonization efforts. Since 2022, the ROK has been developing waste heat recovery power generation systems and ammonia fuel technologies for vessels. The government is establishing shore-based test facilities for electric propulsion systems and eco-friendly fuel supply chains. An electric propulsion vessel powered by mobile batteries that can be recharged at ports has been built and is undergoing operational testing. Emission reduction technologies for small and medium-sized vessels are being developed, including performance assessments of dry GHG reduction devices and feasibility studies for their application in smaller vessels.

5) Waste

The ROK is developing advanced waste management technologies and promoting resource recycling for environmental protection. In 2019, the Ministry of Environment launched research on converting livestock waste to energy, demonstrating how anaerobic digestion can recover energy from livestock waste in wastewater. Researchers are also developing methods to recover valuable resources like nitrogen and phosphorus. Field tests are

evaluating technologies that capture methane from livestock operations. Furthermore, the government plans to introduce GHG reduction certification for the livestock sector and landfills to support commercialization of swine waste treatment systems and landfill microbial technologies.

The ROK is working to maximize resource recycling through various initiatives. These include developing thermal decomposition processes for waste plastics, waste conversion systems, and technologies to produce hydrogen from mixed plastic waste. Researchers are creating proper treatment methods for emerging waste streams such as solar panels and electric vehicle batteries. For waste batteries specifically, the lifecycle approaches from design to disposal that improve circularity and recover valuable materials are currently under development. Research is also underway on technologies that convert organic waste and industrial waste gases into energy using thermochemical and biological methods.

The ROK is enhancing marine waste reduction technologies. In 2021, the Ministry of Oceans and Fisheries created the *First Master Plan for the Management of Marine Garbage and Contaminated Marine Sediment*, and launched R&D initiatives for lifecycle management of marine waste from prevention through collection and treatment. Researchers are developing amphibious vehicles to collect marine plastics from difficult-to-access coastal areas. The ROK is also creating data-driven technologies to estimate waste generation and predict movement patterns. Small thermal decomposition systems designed for islands and fishing villages are under development. Meanwhile, scientists are researching microplastic inflow patterns and source characteristics, analyzing environmental behavior and ecological risks to build scientific data for addressing marine microplastics. The ROK is also developing ceramic-based eco-friendly buoys to prevent microplastic pollution from styrofoam alternatives.

6) Carbon Sinks

The ROK is actively researching carbon sink management and development, with the Korea Forest Service is conducting R&D to maximize forest carbon sink effectiveness. In 2022, the ministry launched the Foundation for Carbon Neutrality Implementation and Demonstration Technology in the Forest Sector to identify and develop promising tree species that enhance carbon absorption and storage capacity. Researchers are developing sustainable forest management techniques, including forest tending and timber harvesting. Studies are also

evaluating carbon absorption in urban forests and mangroves, and measuring forest soil carbon storage according to international standards.

Since 2022, the Ministry of Environment has been evaluating carbon absorption and emission in inland wetlands and developing technologies to enhance absorption through wetland restoration. In 2023, the ministry began a research to improve carbon absorption measurement methods across different ecosystem types, aiming to align with Intergovernmental Panel on Climate Change (IPCC) recommendations. This research will provide scientific evidence for maintaining biodiversity while enhancing carbon absorption capacity.

The Ministry of Oceans and Fisheries is also developing technologies to protect and expand marine carbon sinks. The ministry is working to enhance blue carbon storage through nature-based solutions (NbS), researching international certification for new blue carbon sources, and developing methods to create carbon-absorbing coastal wetlands. Current certification research focuses on non-vegetated tidal flats, seaweed, and continental shelf sediments, which show excellent carbon absorption and storage potential. The ministry also plans to expand alternative carbon sinks such as artificial reefs.

1.2.2 Adaptation Sector

1) Vulnerability Assessment

To implement science-based adaptation policies, the ROK has enhanced disaster management since 2014 through the Vulnerability assessment tool To build climate change Adaptation Plan (VESTAP). This tool measures vulnerability by administrative district across seven key sectors: health, land/coastal areas, agriculture and livestock farming, forests/ecosystems, marine/fisheries, water, and industry/energy. Research to improve VESTAP's technical capabilities has been ongoing since 2022. The ROK is also conducting research to diversify adaptation policies, including climate and atmospheric projections, future socioeconomic scenario development, adaptation effectiveness analysis, and nature-based solutions (NbS) for disaster response.

2) Climate Change Prediction

To minimize flood damage, the ROK is advancing AI-powered scientific flood management technologies. Research on an AI-based flood forecasting system began in 2020. Following its launch in 2024, forecasting points have increased from 75 to 223 locations, significantly improving response accuracy and speed.

The Korea Forest Service has been enhancing monitoring and prediction technologies for climate-related forest disasters like wildfires and landslides. Since 2023, the ministry has used an ICT platform with AI and sensors for wildfire monitoring and prediction. The ministry also plans to provide real-time risk assessments by improving wildfire spread prediction systems and creating a forest flow observation network.

The Ministry of Oceans and Fisheries is addressing sea level rise through the Land-Ice/Ocean Network Exploration with Semiautonomous Systems (LIONESS), a consortium of 21 institutions from 10 countries, including the United States, New Zealand, and Italy. Research on cryosphere changes in East Antarctica's Terra Nova Bay and West Antarctica's Thwaites Glacier has improved sea level prediction models and identified mechanisms to slow ice shelf collapse, contributing to more accurate global sea level predictions. Since 2023, the ministry has also been researching ways to help the fisheries industry adapt to climate change. This work includes developing a high-resolution marine climate model with projections to 2100, analyzing fisheries sector vulnerabilities, and creating long-term response strategies based on these predictions.

Since 2021, the Ministry of Science and ICT has been researching global carbon dynamics to improve fundamental understanding of climate change. This initiative conducts basic research on CO_2 behavior and associated phenomena in ocean, land, and atmosphere. By monitoring carbon budget changes within the Korean Peninsula, the research aims to strengthen national climate change response capabilities and establish a foundation for better climate prediction.

3) Climate Change Scenarios

(a) National Climate Change Scenarios

From 2019 to 2021, the Korea Meteorological Administration had participated in the IPCC international project, producing global climate change scenarios as well as regional scenarios for East Asia. Using its independently developed model, the ministry submitted climate change prediction data for the IPCC Sixth Assessment Report, contributing to international multi-ensemble scenarios. In 2021, the ministry collaborated with academic institutions to produce four additional scenarios for the East Asian region. The projections from these scenarios were incorporated into the Revised Edition of the Korean Peninsula Climate Change Projections Report 2020.

In 2022, the Korea Meteorological Administration produced high-resolution 'South Korea Detailed Scenarios' with 1 km horizontal resolution to support Sub-National Climate Change Adaptation Plans (SNCCAPs) and carbon neutrality policy development. These scenarios were created using statistical downscaling techniques based on four Shared Socioeconomic Pathways (SSP). Beyond temperature and precipitation, the scenarios include variables such as wind speed, humidity, and solar radiation to enhance policy applications. The ministry published the Revised Edition of South Korea Detailed Climate Change Projections Report based on these scenarios and made both the data and projection reports publicly available through its Climate Information Portal.

In 2023, the administration then produced climate change predictions based on national scenarios for 17 metropolitan cities and provinces, over 260 municipalities, and more than 3,500 local districts. This information was published through the Climate Information Portal and climate change situation maps. Between 2022 and 2024, the ministry analyzed and provided various climate impact data, including application indices for agriculture, forestry, health, disaster prevention, water resources, and animal ecology. The data also covered extreme climate event frequency and intensity, projections of high fine dust and ozone concentrations, extreme precipitation forecasts by watershed, and summer heat stress predictions. In 2024, new projection data on climate extreme indices was developed to address complex extreme climate phenomena.

(b) Marine Sector Scenarios

In 2022, the Korea Meteorological Administration provided four types of global ocean climate change scenarios, covering sea surface height, sea surface temperature, sea ice area, and surface salinity. In 2023, the ministry began developing high-resolution ocean climate change scenarios with 8 km horizontal resolution to produce temperature and salinity projections. For 2024, the Administration has planned to provide wave and storm surge scenarios and marine heatwave impact information to address marine climate change.

The Ministry of Oceans and Fisheries produced ocean climate change scenarios in 2023 with 3-5 km horizontal resolution for waters around the Korean Peninsula, covering sea surface height, water temperature, salinity, and ocean currents. From 2022 to 2026, research projects are developing scenarios for about 10 parameters, including temperature, salinity, and nutrients, for Korean Peninsula waters (5 km resolution) and the North Pacific (13 km resolution) to improve ocean climate change response capabilities.

The Korea Hydrographic and Oceanographic Agency provides annual sea level rise rates by analyzing data from tide gauge stations with over 30 years of records to assess long-term trends. The agency also produces projections of sea level, water temperature, and ocean circulation for the Northwest Pacific through 2100 using SSP scenarios, sharing this information through the Ocean Data in Grid System on its website.

Since 2017, the National Institute of Fisheries Science has provided abnormal water temperature predictions for Korean coastal waters through its Abnormal Water Temperature Prediction System, including high and low temperature events and East Sea cold water masses. This system helps mitigate marine fisheries disasters caused by climate change. The Institute has analyzed climate change impacts on fisheries through publications, including the Assessment Report on Fisheries Impacts in a Changing Climate (2019) and the Annual Report for Climate Change Trends in Fisheries (2022 and 2023). Since 2022, the Institute has also provided predictions on hypoxic water mass variations in coastal waters.

2. Systematic Observation

2.1 Institutional Framework

2.1.1 Legal and Institutional Foundation

The ROK is enhancing its climate change monitoring and prediction systems to safeguard ecosystems, climate stability, and public well-being. A comprehensive, three-dimensional observation network integrating ground, marine, aviation, polar, and satellite systems has been developed to effectively monitor climate phenomena. Concurrently, efforts are underway to diversify the utilization of information generated by this integrated monitoring system. Through these strategic initiatives, the ROK aims to mitigate climate-related risks, protect citizens from potential climate disasters, and minimize potential damage to critical sectors such as agriculture, forestry, and fisheries.

The *Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis*, enacted in September 2021, mandates scientific monitoring and prediction of climate change. As a subsequent measure, the *Act on Monitoring and Prediction of Climate and Climate Change* was legislated in October 2023. Based on this legislation, the ROK is developing a comprehensive *Framework Plan for Monitoring and Prediction of Climate and Climate Change*. Furthermore, key governmental agencies, including the Korea Meteorological Administration, Ministry of Environment, Ministry of Oceans and Fisheries, Ministry of Agriculture, Food and Rural Affairs, and Korea Forest Service, are establishing mid- to long-term strategic plans to systematically generate and disseminate climate observation and prediction information.

2.1.2 Implementation Status by Ministry

The Korea Meteorological Administration is systematically advancing its climate crisis monitoring and analysis system through successive *Master Plans for Meteorological Services*. The *Third Master Plan for Meteorological Services* (December 2016) established a strategic approach to supporting climate change response policies and expanding international cooperation. Building upon this foundation, the *Fourth Master Plan for Meteorological Services* (December 2022) continues to prioritize the enhancement of climate and climate change information as a core objective.

The Ministry of Environment has been reinforcing GHG monitoring systems at both national and sub-national levels in alignment with the *First National Framework Plan for Carbon Neutrality and Green Growth* (Carbon Neutrality Framework Plan) (April 2023). To enhance the precision and temporal relevance of the GHG inventory, the ROK is progressively developing comprehensive ground- and satellite-based real-time GHG monitoring and analysis systems.

The Ministry of Oceans and Fisheries developed the *2050 Carbon Neutrality Roadmap for the Marine and Fisheries Sector* (December 2021) and subsequently formulated the *Fourth Comprehensive Plan for Climate Change Response in the Marine and Fisheries Sector* (September 2022) to guide policy implementation. Through this plan, the ROK is pursuing improvements to the marine climate change observation system, strengthening domestic and international cooperation governance, and enhancing polar and oceanic ecosystem research.

The Ministry of Agriculture, Food and Rural Affairs has developed *Climate Change Adaptation Plan for the Agriculture Sector* and *Enhanced Climate Change Adaptation Plan*. These strategies encompass systematic impact assessments and vulnerability analyses targeting agricultural systems, rural communities, water resources, and production infrastructure. The ROK is simultaneously expanding private sector access to critical climate change information.

The Korea Forest Service established the *2050 Carbon Neutral Strategy for the Forestry Sector* (December 2021) and developed the *Third Comprehensive Plan for Improvement of Carbon Sinks* (June 2023) to guide major policy implementation over a five-year period. Building on these strategic frameworks, the ROK is reinforcing climate change observation infrastructure and advancing R&D in forest meteorological and ecosystem monitoring, as well as forest disaster prediction and response mechanisms.

2.2 Observation Systems

2.2.1 Atmosphere

The ROK began background atmospheric observations at the Sobaeksan Meteorological Observatory in 1987 to monitor changes in substances that contribute to climate change. After joining the World Meteorological Organization (WMO) Global Atmosphere Watch (GAW) Programme in 1989, the ROK aligned its observations with international climate monitoring standards. As of 2024, climate change monitoring stations operate in Anmyeondo, Gosan-Ri (Jeju Island), Pohang City, and Ulleungdo-Dokdo. Seven universities and research institutions have also been designated as commissioned observation stations to measure various climate change elements. The four main monitoring stations measure 37 substances across six key areas: GHG, reactive gases, aerosols, stratospheric ozone/ultraviolet radiation, atmospheric radiation, and total atmospheric deposition, following the WMO recommendations. Observation data are published annually in the Global Atmosphere Watch Report and shared with international organizations, governments, and researchers through the WMO GAW World Data Center for climate policy development and research. The GHG background levels observed at these stations are included in the WMO global average and serve as the country's national standard.

Climate monitoring data utilization has expanded considerably. Since 2021, the Climate Information Portal has displayed real-time observational data, beginning with CO_2 measurements. By 2023, it has expanded to 12 data types, and now 20 data types have been available in time-series format, providing timely information on climate-influencing substances.

Surface meteorological observations are conducted through 98 automated synoptic observing stations, 539 disaster prevention stations, and 36 yellow dust observation stations. Upper-air observations operate at 7 rawinsonde stations and 13 wind profiler stations. The ROK also maintains 10 operational weather radar stations and 3 small weather radar stations, with airport weather radar networks at major airports to support flight safety. High-quality meteorological information is generated using domestically developed technologies for radar data quality control, precipitation estimation, and nowcasting. The ROK exchanges radar data with 43 observation stations in neighboring countries, including Japan, China, and Russia, to monitor and forecast meteorological conditions across East Asia.

Efforts to identify the causes of increasing GHG concentrations continue.[55] Since 2020, the ROK has built a three-dimensional monitoring network using ground stations, aircraft, vessels, remote sensing equipment, high-rise towers, and satellites. In 2021, the ROK launched INVERSE-KOREA, Asia's first WMO-approved GHG source tracking system, which combines observations with atmospheric transport models to generate top-down GHG emission and absorption data. The source tracking model was completed in 2023, with system construction beginning in 2024 to quantify national-scale GHG processes and support climate policy.

High-resolution GHG observation data for major emission sources and sink regions are produced through ground and satellite networks. As of 2024, 10 national GHG observation stations are operating, with 96 additional stations planned by 2042. The expanded network will monitor aerosols and reactive gases alongside GHGs. This data will be publicly available through Air Korea and the Comprehensive Platform for National Climate Crisis Adaptation Information for various applications.

2.2.2 Ocean

The ROK has established and operates the National Ocean Observing Network to systematically manage maritime territories and collect comprehensive oceanographic data. As of 2024, this network includes 139 monitoring stations: 56 tide stations, 36 marine observation buoys, 44 ocean current monitoring sites, and 3 ocean research stations. Coastal tide stations track long-term changes in sea levels, water temperature, salinity, and marine weather conditions. Marine buoys monitor ocean currents and maritime weather patterns in both coastal and offshore waters. Radio wave technologies enable surface current measurements in coastal areas, while specialized research stations conduct in-depth oceanographic investigations in open seas. The Ieodo Ocean Research Station plays a crucial role in disaster prevention, positioned strategically along major typhoon routes. Observation data from the National Ocean Observing Network is transmitted in real time through the Ocean Data Grid platform. This comprehensive dataset supports multiple critical sectors, including climate research, maritime navigation, fisheries management, marine recreation, and emergency maritime operations. Long-term tide records provide essential insights for understanding climate change impacts, particularly sea level variations. The ROK continues to enhance both the observation network's scope and the quality of collected data.

55) The Anmyeondo Climate Change Monitoring Station, which holds the ROK's longest continuous GHG observation records, measured an average CO_2 concentration of 369.2 ppm in 1999, which increased to 400.3 ppm in 2012 and reached 427.6 ppm in 2023, demonstrating a consistent upward trend.

Oceanic meteorological observation is also being strengthened. As of 2023, the ROK operates 258 observation facilities across eight different types, including marine meteorological buoys, wave buoys, coastal observation stations, and maritime meteorological equipment. The ROK has participated in the International Argo Program since 2001, deploying ocean observation instruments around the Korean Peninsula and the Northwest Pacific to collect temperature and salinity data. The collected data is shared with the Global Data Assembly Center (GDAC), with the Korea Meteorological Administration serving as a recognized Regional Data Assembly Center (RDAC). Since 2005, the West Sea Comprehensive Ocean Observation (First Marine Observatory) has been operating on Bukgeoryelbi Island, the westernmost uninhabited island, to detect dangerous weather phenomena such as heavy rain, heavy snow, and typhoons approaching the Korean Peninsula in advance. Since 2022, the Base Station of Oceanic-Meteorological Observation (Second Marine Observatory) has been operating on Deokjeok Island for the metropolitan area, and starting in 2024, the Third Comprehensive Ocean Observation would be installed on Anma Island to proactively monitor dangerous weather in the Honam region.

The ROK monitors 11 marine physical, chemical, and biological parameters at 207 coastal observation points in the East, West, South Seas, and East China Sea. This data, published through the National Institute of Fisheries Science website and annual oceanographic reports, enables long-term climate change impact assessments on marine ecosystems. Since 2023, these findings have been integrated into the Annual Report for Climate Change Trends in Fisheries, supporting continuous marine fisheries climate change adaptation research.

The ROK is conducting active polar research using multiple research stations and vessels. The Antarctic King Sejong Station and Jang Bogo Station, along with the icebreaking research vessel Araon and Arctic Dasan Station, produce core climate data and monitor critical atmospheric components. The King Sejong Station tracks global atmospheric substances, including CH_4, N_2O, SF_6, halogen compounds, NF_3, and CO_2. The Jang Bogo Station focuses on total ozone, organic aerosols, and continuous CO_2 and N_2O monitoring. Meanwhile, the Araon research vessel investigates key climate elements in Arctic and Antarctic polar regions. Current research plans include gathering additional observational data on atmospheric, oceanic, and biogeochemical elements. Arctic observation bases in permafrost regions across six Arctic Council countries are conducting ongoing climate environmental change research, analyzing atmospheric, land, and coastal data.

2.2.3 Agriculture

The ROK conducts agricultural meteorological observations at 10 subsidiary stations nationwide, following World Meteorological Organization (WMO) technical regulations. Since the late 1990s, local rural development institutions have progressively installed automatic weather monitoring equipment to support agricultural technology dissemination. By December 2023, the network has expanded to 212 observation points.

These stations collect comprehensive data across 11 key parameters, including temperature, humidity, precipitation, wind characteristics, soil moisture, solar radiation, and sunshine duration. Measurements are recorded at minute-by-minute intervals, providing high-resolution environmental data.

The collected observations are processed into detailed agricultural meteorological information, serving critical stakeholders including farmers, policymakers, and researchers. This data supports essential agricultural management activities such as pest and disease forecasting, fertilizer application strategies, and crop condition predictions. The agricultural meteorological information service was meticulously designed to address the distinct needs of four primary user groups: farmers, agricultural meteorology professionals, agricultural control agencies, and academic researchers.

2.2.4 Forest

The ROK has established a mountain meteorological observation network to prevent forest disasters and enhance forest management systems. Initiated in 2012, the network currently comprises of 479 stations across mountainous regions nationwide, with plans to expand to 620 stations by 2032. These stations monitor critical meteorological parameters including temperature, humidity, wind characteristics, atmospheric pressure, ground temperature, and precipitation at minute-by-minute intervals. Some stations also collect forest-specific data such as fuel moisture, soil moisture, and solar radiation.

The collected mountain meteorological data is widely utilized across multiple platforms. The Mountain Meteorological Information System and Public Data Portal provide real-time weather information and 3-day forecasts for 162 locations, including the country's top 100 mountains and forest recreation areas. Additional public-friendly content includes predictions for flowering and autumn foliage timing, hiking comfort indices, rainfall and landslide risk

information during summer, and forest fire danger indices during spring and autumn prevention periods.

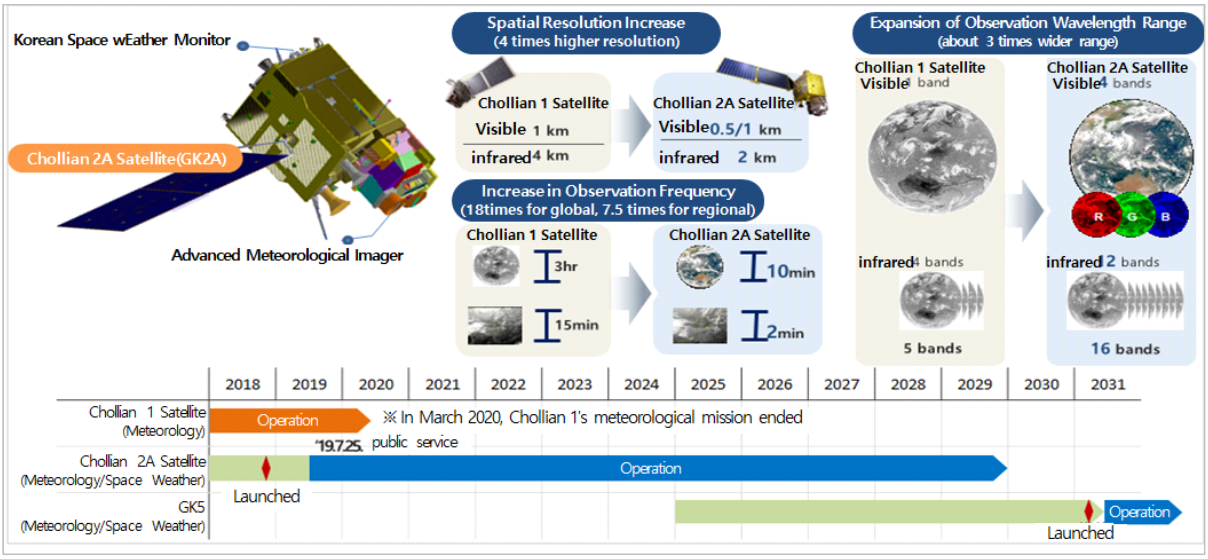
The ROK continues to advance forest disaster prediction through innovative big data and AI technologies. Mountain meteorological data is integrated into various critical services, including the Korea Meteorological Administration's cloud disaster prevention system, the Ministry of the Interior and Safety's life safety map, the Ministry of National Defense's DMZ mountain meteorological network, and Open-API-based information services.

2.2.5 Satellite

The ROK's satellite observation system began with Chollian Satellite 1, which operated from 2010 to 2020. Chollian Satellite 2A, launched in 2018, has since become a critical platform for collecting and distributing weather and climate-related satellite data to domestic and international users. Currently, the system processes data from over 30 global satellites, playing a pivotal role in climate monitoring.

Chollian Satellite 2A features advanced instruments, including the Advanced Meteorological Imager (AMI) and the Korean Space Weather Monitor (KSEM). Compared to its predecessor, the satellite demonstrates significant technological improvements: spatial resolution increased fourfold, observation frequency eighteenfold, and observation wavelength bands threefold. These enhancements enable more precise monitoring of hazardous weather phenomena.

The satellite generates 52 meteorological products categorized into four primary groups: scene analysis/surface, cloud/precipitation, radiation/aerosol, and atmosphere/aviation. Its applications span along four critical domains: very short-term forecasting, typhoon and ocean monitoring, data convergence, and climate and environmental assessment. To ensure the continuity, the ROK plans to develop Chollian Satellite 5 between 2025 and 2031.



[Figure Annex Ⅰ-2] Chollian 2A Satellite Observation System

Source: Satellite Meteorological Observation (Korea Meteorological Administration website)

Complementing Chollian Satellite 2A, Chollian Satellite 2B carries the Geostationary Environment Monitoring Spectrometer (GEMS) and Geostationary Ocean Color Imager-II (GOCI-II). As the world's first geostationary environmental satellite, GEMS monitors air pollutants and short-lived climate forcers across approximately 20 countries, stretching from Japan to India and from Mongolia to Indonesia, including the Korean Peninsula. This real-time data collection supports both domestic and international air quality forecasting and public health initiatives.

The GOCI-II satellite generates 26 types of high-resolution marine satellite information, covering critical parameters such as tide variations, salinity concentrations, marine pollution, ocean currents, fishing ground dynamics, coastal water quality, sea fog, and sea ice in waters surrounding the Korean Peninsula. This comprehensive monitoring supports marine environmental research and enables rapid disaster response.

2.3 Observation Research

2.3.1 Satellite Development and Utilization

1) Development of Ultra-small GHG Observation Satellite

Starting in 2023, the ROK has planned to develop five ultra-small satellites in low Earth orbit (below 600 km) with high spatial resolution (below 100 m) to observe facility-level GHG emissions, and the development was began in 2024. These satellites observe methane using short-wave infrared sensors, with plans to add CO_2 observation capabilities to secure technology for follow-up satellites in both low Earth and geostationary orbits. Data from these satellites will support GHG emission management, mitigation strategies, and climate change adaptation planning.

The ROK is also developing small satellites (100 kg class) for low Earth orbit operation to understand the global spatial-temporal distribution and movement patterns of CO_2. Analysis of user requirements, key technologies by development phase, and satellite development strategies is underway to ensure that these satellites are built with domestically developed technology.

2) Research on Satellite Development and Utilization

The ROK has developed a satellite for forest and agricultural observation from 2020 to 2024, with the launch scheduled for 2025. This satellite will collect wide-area Earth observation images for joint use by the Korea Forest Service and Rural Development Administration. To date, algorithms have been developed for applications including forest disaster response, resource assessment, and ecosystem monitoring.

The satellite will reduce response times by detecting forest fires and landslides in near real-time and will provide essential data for sustainable forest management, such as forest area, species, biomass, and carbon content. It will also improve public services through early detection of forest anomalies and monitoring of ecosystem health.

3) Environmental Satellite Utilization Research

Research is underway to maximize the use of the world's first geostationary environmental satellite. Since GHGs and air pollutants are often co-emitted, the Ministry of Environment

plans to convert satellite-observed NO2 data into emission information such as CO_2 concentrations for greater utility. Since 2023, the Ministry has also been using international satellite data to develop national GHG inventory (CO_2, CH_4) techniques and high-resolution spatial visualization technologies. This work aims to improve national GHG inventory accuracy and support carbon neutrality implementation assessment by national and local governments.

4) Marine Satellite Research

The Korea Hydrographic and Oceanographic Agency has established satellite information validation and calibration stations to improve marine satellite product accuracy. Since 2022, the Agency has continuously conducted research to enhance marine satellite algorithms, and by 2024, it has been implementing a quality verification system covering five validation stations and 12 basic products.

Through research on multi-satellite data applications, the Agency has developed 11 new products, including sea surface temperature maps, Sargassum horneri detection systems, and ocean current visualizations. To further expand marine satellite information use, the Agency is collaborating with the U.S. National Oceanic and Atmospheric Administration (NOAA) on validation projects and ocean condition data fusion.

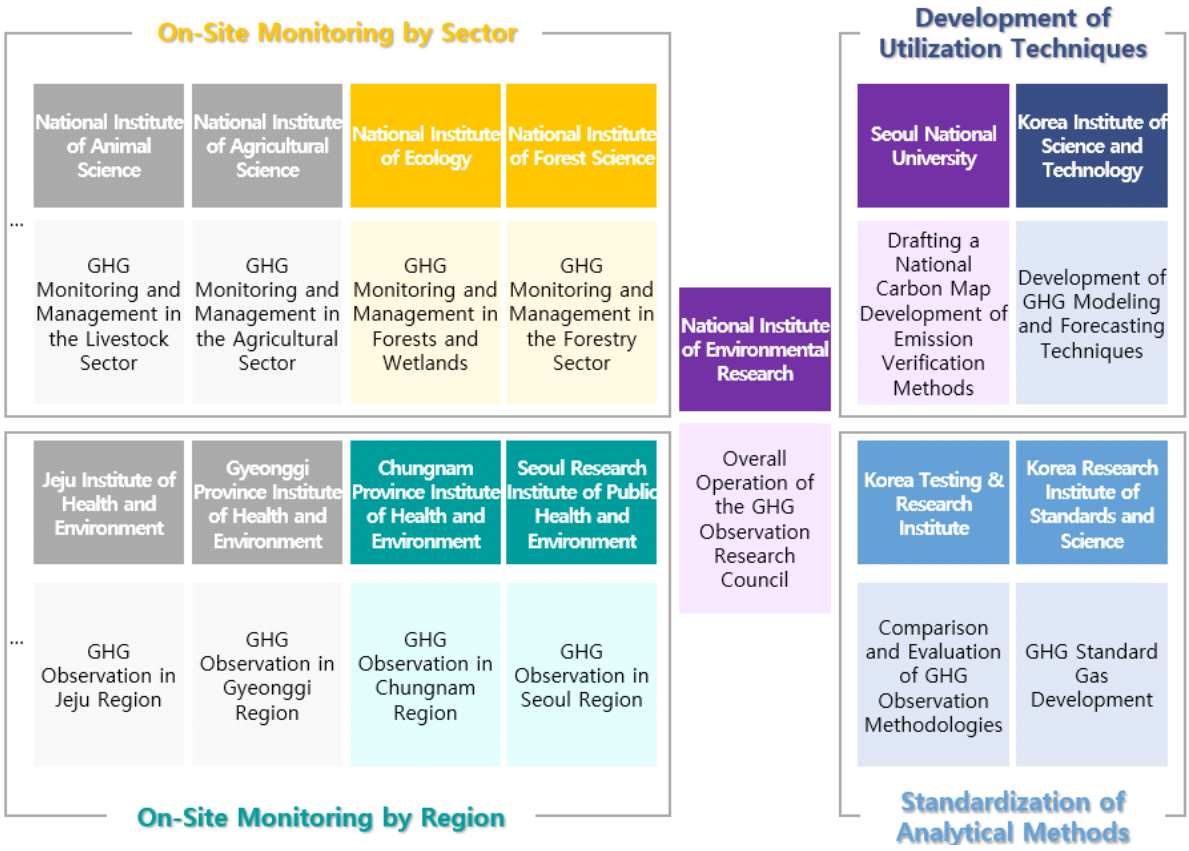
2.3.2 International Joint Research

1) Strengthening GHG Monitoring Capacity

The ROK plays a key role in strengthening global GHG monitoring capabilities. In 2012, the WMO officially designated the Korea Meteorological Administration as the “World Calibration Center for SF_6”. It published standardized sulfur hexafluoride observation techniques as a WMO report (WMO GAW No.239) and has conducted annual training programs for global GHG observation personnel to improve their understanding of GHG monitoring and to support accurate observation practices. The administration also performs suitability assessments at WMO GAW network observation stations, evaluating equipment performance, analysis technique optimization, operator proficiency, and observation environments. Through these activities, the World Calibration Center for SF_6 transfers GHG data quality improvement technologies worldwide.

2) GHG Emissions Analysis Consortium

The ROK is strengthening academic cooperation in GHG observation through various initiatives. Following the 2019 IPCC National Greenhouse Gas Inventory Guidelines revision, the National Institute of Environmental Research has been conducting an ongoing research to verify national and local GHG inventories and regional emissions. Since 2021, the Institute has been operating a GHG observation research consortium with nine participating institutions, including the Korea Research Institute of Standards and Science and multiple observing organizations. This consortium facilitates domestic sharing of regional and sectoral GHG observation infrastructure and research resources while promoting joint research and technical cooperation to improve data quality and expand applications. In 2024, the ROK launched an international collaborative campaign, “An International Collaborative Study of Air Quality in Asia (Asia-AQ)”, in partnership with NASA, using ground-based, airborne, and satellite observations to investigate air pollution and GHG emission sources.



[Figure Annex Ⅰ-3] GHG Observation Research Consortium

3) Pandora Asia Network

Following the launch of the world's first geostationary environmental satellite in February 2020, the ROK has worked to improve air quality across Asia by establishing the Pandora Asia Network (PAN) with the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP) and the Korea International Cooperation Agency (KOICA). This network combines satellite data with ground-based remote observation networks to provide real-time information on air pollution and short-lived climate forcers. Since 2022, the ROK has been conducting annual workshops to train policy makers and ground station operators from beneficiary countries on environmental satellites and Pandora equipment. By 2024, ground-based remote observation stations will be installed at 20 locations across seven countries: Thailand, Vietnam, Indonesia, Mongolia, Cambodia, the Philippines, and Laos. This network will serve as a foundation for expanded cooperation projects aimed at improving air quality throughout Asia.

Ⅱ. Education, Training and Public Awareness

1. Education and Training

The ROK enacted the *Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis* (Carbon Neutrality Act) in September 2021 to promote citizens' GHG emissions reduction through energy and resource conservation and increased use of green products. The Act also mandates nationwide sustainability campaigns that promote education, training, and public engagement through partnerships with local governments, businesses, and civil organizations.

The ROK established the *First National Framework Plan for Carbon Neutrality and Green Growth* (Carbon Neutrality Framework Plan) (April 2023) to promote collective understanding and cooperation in achieving carbon neutrality. The Plan focuses on fostering climate action by promoting: i) carbon neutrality education and training expansion for citizens, ii) human resources development to meet emerging needs from industrial transformation, and iii) collaborative campaigns enhancement among the public, businesses, and civil society.

To support the transition to a carbon-neutral society, the ROK provides comprehensive environmental education and training programs. These programs aim to develop environmentally conscious citizens and promote active public engagement in environmental issues. The initiatives include environmental education in schools from kindergarten through high school, public environmental training programs, and specialized training for carbon neutrality professionals.

1.1 Environmental Education

1.1.1 School Environmental Education

1) Legal and Institutional Framework

The ROK has strengthened its legal framework for environmental education in response to growing emphasis on human-environment coexistence, ecological sustainability, and climate change response. This framework includes the *Framework Act on Education* (December 1997, revised in 2021), the *Act on the Promotion and Support for Environmental Education* (March 2008, revised in 2022), and the Carbon Neutrality Act. Notably, the *Act on the Promotion and Support for Environmental Education* mandates environmental education in elementary and middle schools from 2023. This requirement ensures students' right to environmental learning, enabling them to develop essential literacy and competencies for climate change response and carbon neutrality from an early age.

Additionally, various initiatives promote environmental education from early childhood education institutions through universities. Metropolitan and provincial education offices have enacted the *School Environmental Education Promotion Ordinance* to establish policies and strengthen institutional support for environmental education in schools.

2) Educational Practices and Developments

The ROK provides age-appropriate environmental education programs for young children to build early awareness of climate issues. Three national early childhood environmental education centers offer experiential learning programs through play-based activities for children aged 3 to 5. The Korea Meteorological Administration supports children's understanding of climate science through its information portal, providing educational materials such as storybooks and animations.

Environmental, climate, and carbon neutrality contents have been integrated into the national curriculum for elementary schools through high schools, particularly within the achievement standards for major subjects like social studies and science. The new curriculum, effective from 2025, will strengthen climate change education through dedicated environmental subjects that emphasize the significance of climate issues and carbon neutrality.

Practice-based educational activities connecting schools, communities, and homes are promoted through creative experiential programs within the national curriculum. Through goverment-wide cooperation, 774 schools nationwide have been designated as carbon neutrality-focused and pilot schools, helping to develop and disseminate exemplary environmental education models. In 2024, the introduction of zero-emission hydrogen buses has provided additional environmental education opportunities nationwide.

Universities offer environmental education, including climate change response, as general education courses to enhance students' environmental literacy. Selected universities operate green leadership programs to develop environmental talent and promote sustainable campus culture. Environmental education for pre-service teachers has been strengthened through dedicated courses at teacher training colleges. The National Environmental Education Center continues to develop and distribute climate change and carbon neutrality educational materials tailored to all educational levels, improving access for both teachers and students.

1.1.2 Social Environmental Education

Beyond formal education, various environmental initiatives promote public awareness and action on climate issues.

Environmental education has been increasingly emphasized for civil servants, teachers, and public institution employees, with particular focus on carbon neutrality and green growth. Corporate environmental training programs have also been enhanced with industry-specific and role-based approaches. The 2021 Environmental Education Survey showed that climate change and carbon neutrality were the most prominent topics in social environmental education. The Ministry of Environment and the Korea Adaptation Center for Climate Change launched the Climate Change Adaptation Academy in 2023 to provide public education on climate impacts and adaptation, improving public understanding of adaptation policies.

To enhance environmental education quality, the Ministry of Environment manages the Environmental Education Specialist certification program for professionals who plan and implement environmental education. Since 2022, climate change courses have been added to the specialist training curriculum to develop experts who understand climate issues and can promote carbon neutrality practices. the Korea Meteorological Administration has trained climate science instructors to deliver educational programs at multicultural family support centers and senior welfare centers.

1.2 Training

The ROK has been developing professionals to lead the transition to a low-carbon green industry, providing expertise in both technical aspects and broader policy, economic, and social contexts. This development is guided by the *Fifth Environmental Technology, Environmental Industry, and Environmental Technology Human Resources Development Plan* (February 2023) and the Carbon Neutrality Framework Plan. Universities and specialized training programs are cultivating professionals for leadership roles in low-carbon and green sectors.

1.2.1 Human Resource Development in the Graduate School

As of 2023, the ROK operates 15 specialized graduate schools in key fields including climate change, carbon neutrality, and waste-to-energy, to develop experts for a sustainable future. The Pilot Project for Climate Technology Human Resource Development was also implemented, following its establishment under the *Act on Promotion of Technology Development for Coping with Climate Change* (April 2021). This project, launched in 2022, enhances global capabilities of domestic graduate students. The program invited officials from four Southeast Asian countries (Indonesia, Malaysia, Philippines, and Vietnam) to evaluate climate technology needs and development status. It facilitated climate technology dissemination and joint research through seminars, and organized field visits to universities, research institutes, plant sites, workshops, and technology exhibitions focusing on renewable energy-linked low-carbon desalination technology in Qatar and the UAE.

1.2.2 Professional Training

The ROK has established practical training programs to support professionals and workers in the carbon neutrality transition through 16 specialized development courses. In 2023, new training programs focused on corporate ESG were introduced. These programs were enhanced in 2024 with advanced courses covering priority areas such as climate disclosure, supply chain due diligence, and life cycle carbon emission calculation. The Korea Environment Corporation offers theoretical and practical training on climate change and GHG emissions estimation for job seekers, combining education with employment support to develop GHG management experts.

The energy sector also prioritizes professional development. The Ministry of Trade, Industry and Energy provides specialized education programs aligned with emerging energy trends,

focusing on new energy industries and convergence education to support carbon neutrality goals. The ministry has developed various courses to enhance understanding of energy policy trends and related knowledge, preparing specialists to lead the energy paradigm shift.

The ROK also provides ongoing education to support workers affected by industrial transitions and to develop talent for the environmental sector. The Ministry of Employment and Labor proactively supports workforce development and job transitions in response to low-carbon industrial transformation. The ministry develops training roadmaps based on transition assessments and job analyses for SMEs, and since 2022, it has been establishing industrial transition training centers providing targeted programs for SME's employees. Additionally, Korea Polytechnic University, a public vocational training institution, has created departments in emerging environmental and low-carbon fields, such as low-power semiconductor design and electric vehicles, combining theoretical education with project-based training to develop professionals at various levels.

2. Public Awareness and Participation

2.1 Public Awareness

The ROK promotes public engagement in climate action by providing transparent information about its climate change response and adaptation policies, encouraging citizens' participation in climate-related activities in their daily lives.

2.1.1 Climate Information Portal

The Climate Information Portal (climate.go.kr) provides comprehensive scientific information on climate change through an integrated online platform. It presents climate monitoring data across atmospheric, terrestrial, and oceanic systems, future projections based on national standard climate scenarios, and visual climate scenario maps. The portal also offers impact assessments detailing current and projected effects of global warming across sectors including meteorology, agriculture, forestry, and ecosystems. Since 2000, the portal has undergone continuous updates, building a systematic database essential for climate monitoring and research.

The ROK operates two online platforms to share scientific information for climate change adaptation policy and to support two-way communication and industry-academia-research collaboration, i.e., the Korea Adaptation Center for Climate Change portal (kaccc.kei.re.kr) at the Korea Environment Institute and the National Adaptation Center for Climate Change website (nier.go.kr/naccc) at the National Institute of Environmental Research. These platforms provide adaptation policy trends, research and educational materials, national and local government adaptation plans, and resources to support adaptation planning for industries and public institutions. Users can also access climate change impact and vulnerability assessment tools through these websites.

2.1.2 Transitioning to Carbon-Neutral Lifestyle

In 2021, the ROK published the Carbon Neutrality Life Practice Guide to promote carbon-neutral practices by providing methods for reducing GHG emissions in daily life. This guide presents 81 practical measures across five areas - energy, consumption, transportation, resources circulation, and carbon sinks - for households, schools, and businesses. The guide was developed collaboratively, incorporating inputs from youth groups, civil organizations, local governments, educational offices, and relevant ministries.

The ROK operates two online portals to facilitate government-citizen communication on carbon neutrality, i.e., the 2050 Carbon Neutrality Policy Portal(www.gihoo.or.kr/netzero) and Practice Portal(www.gihoo.or.kr/main). The Policy Portal provides climate change policy updates and GHG emissions data, while the Practice Portal offers guidance on daily carbon-neutral practices and promotes public engagement campaigns.

2.2 Public Participation

2.2.1 Public Campaigns on Climate Action

The ROK promotes citizen engagement in carbon neutrality through various information programs and daily-life campaigns that encourage independent climate action.

The ROK has implemented incentive programs for carbon reduction activities in daily life. Participants can receive up to KRW 100,000 annually for reducing electricity, water, and city gas consumption in homes or commercial facilities, or for decreasing vehicle mileage. The Carbon Neutrality Point System, introduced in 2022, provides up to KRW 70,000 annually for ten eco-friendly activities including using tumblers, returning disposable cups, using refill stations, and purchasing green products.

The ROK has been observing Climate Change Week annually since 2009, running for one to two weeks around Earth Day (April 22). During this period, various climate-friendly lifestyle events, including lights-off campaigns, are held nationwide to promote the importance of carbon neutrality and green growth while encouraging active public participation. The Rural Development Administration conducts various activities during this period, including carbon neutrality practice campaigns in the agricultural sector.

The government operates the ‘Plenty of Resources’ platform to promote resources circulation by connecting institutions with reusable office furniture and equipment. Since 2022, 13 companies have supplied 3,244 items through this platform, with 2,845 items being reused by 55 institutions. The government encourages corporate participation by measuring performance outcomes and sharing success stories. The government also runs the ‘Bye Bye Plastic’ campaign to reduce plastic use, engaging public institutions, businesses, and citizens.

Since 2021, public engagement has expanded with a focus on youth initiatives such as the Carbon Neutral Supporters program. These supporters develop climate action and carbon

neutrality campaigns while creating online content about government policies and practical carbon reduction methods to promote carbon-neutral lifestyles.

The Korea Meteorological Administration works to enhance public understanding of climate science through its 'Dalcom Climate' brand. This initiative includes contests and busking events to promote public engagement with climate science.

The ROK also encourages public transportation use through a cost-support program. The Thrifty Transportation Card project, launched in 2020, provides mileage rewards based on public transit usage, with enhanced benefits for youth and low-income groups. The program has increased average monthly public transportation use by seven trips. The initiative received special recognition from the International Association of Public Transport (UITP) in 2021 for promoting sustainable transportation.

2.2.2 Community Activities

The ROK seeks diverse societal inputs in developing carbon neutrality and green growth policies. The Presidential Commission on Carbon Neutrality and Green Growth conducts stakeholder consultations and public hearings with representatives from major emitting industries and academia. The Commission also incorporates perspectives from youth groups, civil society, industry, and labor through inclusive discussions. Regular public forums are held to share information on climate finance, climate technology, regional carbon neutrality progress, and international trends.

Furthermore, the ROK operates a Public Assessment Group for Climate Change Adaptation Policy under the *3rd National Climate Change Adaptation Plan* (December 2020). The group comprises of 50 citizens who receive training on climate change adaptation policies and measures, and participate in evaluating 49 policy tasks. This initiative improves public understanding while enhancing transparency and accountability in policy decisions.

As carbon neutrality becomes a national strategy for climate action, voluntary participation is growing across industries, education institutions, religious groups, and civil society. In the industry sector, 36 companies have voluntarily committed to RE100, actively increasing their renewable energy use. Major GHG-emitting sectors, including steel, petrochemical, and automobile industries, have established a Hydrogen Economy Council to demonstrate their commitment to emissions reduction.

Religious communities have also actively embraced carbon neutrality initiatives. Following the Christian community's carbon neutrality declaration in May 2021, the Catholic Diocese of Suwon announced its 2040 carbon neutrality plan, while Buddhist Climate Action called for carbon neutrality achievement by 2040. This societal commitment to climate action is further demonstrated by metropolitan and provincial education offices issuing a Joint Declaration on the Environment in 2021.

Annex II

National Inventory Report

Refer to the Common Reporting Tables (CRTs) and the National Inventory Document (NID) expected to be listed on the United Nations Framework Convention on Climate Change (UNFCCC) website.

Annex III

Common Tabular Formats to Track Progress in Implementing and Achieving NDC

< Enhanced 2030 Nationally Determined Contribution (NDC) (October 2021) >

	Information
Target and description, including target type(s), as applicable	The ROK's updated NDC target is to reduce 40% from the total national GHG emissions in 2018, which is 727.6 $MtCO_2$-eq, by 2030. It plans to use voluntary cooperation under Article 6 of the Paris Agreement as a complementary measure to its domestic mitigation efforts, including LULUCF, to achieve its target.
Target year(s) or period(s), and whether they are single-year or multi-year target(s), as applicable	[Target year] 2030, Single-year target
Reference point(s), level(s), baseline(s), base year(s) or starting point(s), and their respective value(s), as applicable	[Base year] 2018 [National total GHG emissions (excluding LULUCF) in 2018] 727.6 $MtCO_2$-eq
Time frame and/or periods for implementation, as applicable	From January 1, 2021, to December 31, 2030
Scope and coverage, including, as relevant, sectors, categories, activities, sources and sinks, pools and gases, as applicable	[Sectors] Power generation, Industry, Building, Transportation, Agriculture/Livestock Farming/Fisheries, Waste, Carbon Sinks (LULUCF) [Gases] CO_2, CH_4, N_2O, HFCs, PFCs, SF_6
Intention to use cooperative approaches that involve the use of ITMOs under Article 6 towards NDCs under Article 4 of the Paris Agreement, as applicable	The ROK plans to utilize voluntary cooperation under Article 6 of the Paris Agreement as a complementary measure to support the achievement of its NDC.
Any updates or clarifications of previously reported information, as applicable	The ROK enhanced its reduction target from 26.3% to 40% compared to 2018 total emissions (excluding LULUCF).

1. Structured summary: Description of selected indicators

Indicator selected to track progress	Description
Annual national total GHG emissions (excluding LULUCF)	Economy-wide absolute GHG emission reduction target
Information for the reference point, level, baseline, base year or starting point, as appropriate	[Base year] 2018 [National total GHG emissions (excluding LULUCF) in 2018] 732.9 $MtCO_2$-eq
Updates in accordance with any recalculation of the GHG inventory, as appropriate	Based on the latest inventory calculated in December 2024, the 2018 emissions were recalculated from 727.6 $MtCO_2$-eq to 732.9 $MtCO_2$-eq.
Relation to NDC	The indicator can be used for tracking progress in implementing and achieving the NDC target.

2. Structured summary: Definitions needed to understand NDC

Definition needed to understand each indicator	
Annual national total GHG emissions (excluding LULUCF)	Total annual emissions by sector including energy, IPPU, agriculture, and waste, excluding LULUCF sector
Any sector or category defined differently than in the national inventory report:	
Sectors	Power Generation, Industry, Building, Transportation, Agriculture/Livestock Farming/Fisheries, Waste, Carbon Sinks (LULUCF)
Definition needed to understand mitigation co-benefits of adaptation actions and/or economic diversification plans:	
Mitigation Co-benefits	NA

3. Structured summary: Methodologies and accounting approaches - consistency with Article 4, paragraphs 13 and 14, of the Paris Agreement and with decision 4/CMA.1

Reporting Requirement	Description or reference to the relevant section of the BTR
For the first NDC under Article 4	
Accounting approach, including how it is consistent with Article 4, paragraphs 13~14, of the Paris Agreement (para. 71 of the MPGs)	The following methodologies are applied to ensure transparency, accuracy, completeness, comparability, consistency, and environmental integrity while preventing double counting when calculating GHG emissions and removals. [Methodologies] - Calculated based on Decision 24/CP.19 and the 1996 IPCC Guidelines - Partial application of IPCC GPG 2000, IPCC GPG-LULUCF 2003, and 2006 IPCC Guidelines [Common Metrics] IPCC Second Assessment Report (SAR) Global Warming Potentials (GWPs)
For the second and subsequent NDC under Article 4, and optionally for the first NDC under Article 4	
Information on the accounting approach used is consistent with paragraphs 13-17 and annex II of decision 4/CMA.1 (para. 72 of the MPGs)	NA
Explain how the accounting for anthropogenic emissions and removals is in accordance with methodologies and common metrics assessed by the IPCC and in accordance with decision 18/CMA.1 (para. 1 (a) of annex II to decision 4/CMA.1)	NA

Reporting Requirement	Description or reference to the relevant section of the BTR
Explain how consistency has been maintained between any GHG data and estimation methodologies used for accounting and the Party's GHG inventory, pursuant to Article 13, paragraph 7 (a), of the Paris Agreement, if applicable (para. 2 (b) of annex II to decision 4/CMA.1)	NA
Explain how overestimation or underestimation has been avoided for any projected emissions and removals used for accounting (para. 2 (c) of annex II to decision 4/CMA.1)	NA
For each NDC under Article 4	
Accounting for anthropogenic emissions and removals in accordance with methodologies and common metric assessed by the IPCC and adopted by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement	
Each methodology and/or accounting approach used to assess the implementation and achievement of the target (s), as applicable (para. 74 (a) of the MPGs)	Assessment of reduction target implementation and achievement through comparison between total emissions (excluding LULUCF) in the base year 2018 and net emissions (including LULUCF) in the target year 2030
Each methodology and/or accounting approach used for the construction of any baseline, to the extent possible (para. 74 (b) of the MPGs)	NA
If the methodology or accounting approach used for the indicator (s) in table 1 differ from those used to assess the implementation and achievement the target, describe each methodology or accounting approach used to generate the information generated for each indicator in table 4 (para. 74 (c) of the MPGs)	NA

Reporting Requirement	Description or reference to the relevant section of the BTR
Any conditions and assumptions relevant to the achievement of the NDC under Article 4, as applicable and available (para. 75 (i) of the MPGs)	NA
Key parameters, assumptions, definitions, data sources and models used, as applicable and available (para. 75 (a) of the MPGs)	NA
IPCC Guidelines used, as applicable and available (para. 75 (b) of the MPGs)	Application of 1996 IPCC Guidelines with partial utilization of IPCC GPG 2000, IPCC GPG-LULUCF 2003, and 2006 IPCC Guidelines
Report the metrics used, as applicable and available (para. 75 (c) of the MPGs)	IPCC Second Assessment Report (SAR) Global Warming Potentials (GWPs)
For Parties whose NDC cannot be accounted for using methodologies covered by IPCC guidelines, provide information on their own methodology used, including for NDCs, pursuant to Article 4, paragraph 6, of the Paris Agreement, if applicable (para. 1 (b) of annex II to decision 4/CMA.1)	NA
Provide information on methodologies used to track progress arising from the implementation of policies and measures, as appropriate (para. 1 (d) of annex II to decision 4/CMA.1)	NA
Where applicable to its NDC, any sector-, category- or activity-specific assumptions, methodologies and approaches consistent with IPCC guidance, taking into account any relevant decision under the Convention, as applicable (para. 75 (d) of the MPGs)	Application of 1996 IPCC Guidelines with partial utilization of IPCC GPG 2000, IPCC GPG-LULUCF 2003, and 2006 IPCC Guidelines Preparing to apply 2006 IPCC Guidelines, 2013 KP Supplement, and 2013 Wetlands Supplement

Reporting Requirement	Description or reference to the relevant section of the BTR
For Parties that address emissions and subsequent removals from natural disturbances on managed lands, provide detailed information on the approach used and how it is consistent with relevant IPCC guidance, as appropriate, or indicate the relevant section of the national GHG inventory report containing that information (para. 1 (e) of annex II to decision 4/CMA.1, para. 75 (d) (i) of the MPGs)	Planning to calculate and report emissions and subsequent removals from natural disturbances on managed lands in accordance with the 2013 KP Supplement
For Parties that account for emissions and removals from harvested wood products, provide detailed information on which IPCC approach has been used to estimate emissions and removals (para. 1 (f) of annex II to decision 4/CMA.1, para. 75 (d) (ii) of the MPGs)	Planning to calculate and report emissions and removals from harvested wood products using the 2006 IPCC Guidelines and 2013 KP Supplement
For Parties that address the effects of age-class structure in forests, provide detailed information on the approach used and how this is consistent with relevant IPCC guidance, as appropriate (para. 1 (g) of annex II to decision 4/CMA.1, para. 75 (d) (iii) of the MPGs)	Continuously managing forests to secure stable removals by improving the age-class structure of forests concentrated in specific age groups
How the Party has drawn on existing methods and guidance established under the Convention and its related legal instruments, as appropriate, if applicable (para. 1 (c) of annex II to decision 4/CMA.1)	Preparing to apply 2006 IPCC Guidelines, 2013 KP Supplement, and 2013 Wetlands Supplement

Reporting Requirement	Description or reference to the relevant section of the BTR
Any methodologies used to account for mitigation co-benefits of adaptation actions and/or economic diversification plans (para. 75 (e) of the MPGs)	NA
Describe how double counting of net GHG emission reductions has been avoided, including in accordance with guidance developed related to Article 6 if relevant (para. 76 (d) of the MPGs)	As international mitigation projects are in their initial stages, plans for ITMOs use in NDC and measures to prevent double counting will be reported from subsequent BTRs.
Any other methodologies related to the NDC under Article 4 (para. 75 (h) of the MPGs)	NA
Ensuring methodological consistency, including on baselines, between the communication and implementation of NDCs (para. 12 (b) of the decision 4/CMA.1)	
Explain how consistency has been maintained in scope and coverage, definitions, data sources, metrics, assumptions and methodological approaches including on baselines, between the communication and implementation of NDCs (para. 2 (a) of annex II to decision 4/CMA.1)	No changes in the sectors, definitions, data sources, metrics, assumptions, or calculation methodologies since the submission of the 2030 NDC (2021)

Reporting Requirement	Description or reference to the relevant section of the BTR
Explain how consistency has been maintained between any GHG data and estimation methodologies used for accounting and the Party's GHG inventory, pursuant to Article 13, paragraph 7 (a), of the Paris Agreement, if applicable (para. 2 (b) of annex II to decision 4/CMA.1) and explain methodological inconsistencies with the Party's most recent national inventory report, if applicable (para. 76 (c) of the MPGs)	The 2030 NDC (2021) utilizes the 1996 IPCC Guidelines and Global Warming Potentials (GWPs) from the IPCC SAR. However, the latest NIR in Chapter Ⅰ applies the 2006 IPCC Guidelines and Global Warming Potentials (GWPs) from the IPCC AR5 for the six GHGs* and nitrogen trifluoride (NF_3). Consequently, there are differences in targeted GHG, calculation methodologies, and common metrics between them. * Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)
For Parties that apply technical changes to update reference points, reference levels or projections, the changes should reflect either of the following (para. 2 (d) of annex II to decision 4/CMA.1)	
Technical Changes Related to the NIR	The NIR calculation methodology in Chapter Ⅰ differs from the NDC reference point methodology (1996 IPCC Guidelines) as it applies the 2006 IPCC Guidelines and IPCC Fifth Assessment Report (AR5) Global Warming Potentials (GWPs) for the six GHGs* and nitrogen trifluoride (NF_3). * Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)
Technical changes related to improvements in accuracy that maintain methodological consistency (para. 2 (d) (ii) of annex II to decision 4/CMA.1)	NA
Explain how any methodological changes and technical updates made during the implementation of their NDC were transparently reported (para. 2 (e) of annex II to decision 4/CMA.1)	NA
Striving to include all categories of anthropogenic emissions or removals in the NDC and, once a source, sink or activity is included, continuing to include it (para. 3 of annex II to decision 4/CMA.1)	

Reporting Requirement	Description or reference to the relevant section of the BTR
Explain how all categories of anthropogenic emissions and removals corresponding to their NDC were accounted for (para. 3 (a) of annex II to decision 4/CMA.1)	[Calculation Methodology] - Calculated through 1996 IPCC Guidelines - Partial application of IPCC GPG 2000, IPCC GPG-LULUCF 2003, and the 2006 IPCC Guidelines [Common Metrics] IPCC Second Assessment Report (SAR) Global Warming Potentials (GWPs) [Measurement Tiers] - Primarily uses Tier 1 for inventory calculations - Applies Tier 2 for specific sectors > Energy sector: (1) CO_2 from fuel combustion, (2) CH_4 and N_2O from public electricity and heat generation > IPPU sector: (3) PFCs, HFCs, SF_6 from semiconductor and LCD manufacturing > Agriculture sector: (4) CH_4 from rice cultivation, (5) N_2O from agricultural soils > LULUCF sector: (6) CO_2 from forestland > Waste sector: (7) CH_4 from landfill, (8) CH_4 from wastewater treatment, (9) N_2O from waste incineration
Explain how Party is striving to include all categories of anthropogenic emissions and removals in its NDC, and, once a source, sink or activity is included, continue to include it (para. 3 (b) of annex II to decision 4/CMA.1)	NA
Provide an explanation of why any categories of anthropogenic emissions or removals are excluded (para. 4 of annex II to decision 4/CMA.1)	NA
Each Party that participates in cooperative approaches that involve the use of ITMOs towards an NDC under Article 4, or authorizes the use of mitigation outcomes for international mitigation purposes other than achievement of its NDC	
Provide information on any methodologies associated with any cooperative approaches that involve the use of ITMOs towards an NDC under Article 4 (para. 75 (f) of the MPGs)	As international mitigation projects are currently in their initial stages, plans for ITMOs use in NDC and measures to prevent double counting will be reported in subsequent BTRs.

Reporting Requirement	Description or reference to the relevant section of the BTR
Provide information on how each cooperative approach promotes sustainable development, consistent with decisions adopted by the CMA on Article 6 (para. 77 (d) (iv) of the MPGs)	Same as above
Provide information on how each cooperative approach ensures transparency, including in governance, consistent with decisions adopted by the CMA on Article 6 (para. 77 (d) (iv) of the MPGs)	Same as above
Provide information on how each cooperative approach applies robust accounting to ensure, inter alia, the avoidance of double counting, consistent with decisions adopted by the CMA on Article 6 (para. 77 (d) (iv) of the MPGs)	Same as above
Any other information consistent with decisions adopted by the CMA on reporting under Article 6 (para. 77 (d) (iii) of the MPGs)	Same as above

4. Structured summary: Tracking progress made in implementing and achieving the NDC under Article 4 of the Paris Agreement

	Unit	Reference Point[1] (2018)	NDC Implementation Period		Target Level[2]	Target Year	NDC Progress
			2021	2022			
Indicators and Related Information for Tracking Progress in NDC Implementation and Achievement							
Annual national total GHG emissions (excluding LULUCF)	$MtCO_2$-eq	732.9	690.8	671.2	40%	2030	As of 2022, approx. 8.4% reduction compared to 2018
Where applicable, total GHG emissions and removals consistent with the coverage of the NDC (para. 77 (b) of the MPGs)	$MtCO_2$-eq	732.9	690.8	671.2	-	-	-
Contribution from the LULUCF sector for each year of the target period or target year, if not included in the inventory time series of total net GHG emissions and removals, as applicable (para. 77 (c) of the MPGs)	-	-	-	-	-	-	-
Each Party that participates in cooperative approaches that involve the use of ITMOs towards an NDC under Article 4 of the Paris Agreement, or authorizes the use of mitigation outcomes for international mitigation purposes other than achievement of the NDC, shall provide (para. 77 (d) of the MPGs)	As international mitigation projects are at the initial stage, the ROK plans to report on NDC utilization of ITMOs and double counting prevention in its subsequent BTRs.						
If applicable, an indicative multi-year emissions trajectory, trajectories or budget for its NDC implementation period (para. 7 (a) (i), annex to decision 2/CMA.3)	-	-	-	-	-	-	-

	Unit	Reference Point[1] (2018)	NDC Implementation Period		Target Level[2]	Target Year	NDC Progress
			2021	2022			
If applicable, multi-year emissions trajectory, trajectories or budget for its NDC implementation period that is consistent with the NDC (para. 7 (b), annex to decision 2/CMA.3)	-	-	-	-	-	-	-
Annual anthropogenic emissions by sources and removals by sinks covered by its NDC or, where applicable, from the emission or sink categories as identified by the host Party pursuant to paragraph 10 of annex to decision 2/CMA.3 (para. 23 (a), annex to decision 2/CMA.3) (as part of para. 77 (d) (i) of the MPGs)	-	-	-	-	-	-	-
Annual anthropogenic emissions by sources and removals by sinks covered by its NDC or, where applicable, from the portion of its NDC in accordance with paragraph 10, annex to decision 2/CMA.3 (para. 23 (b), annex to decision 2/CMA.3)	-	-	-	-	-	-	-
If applicable, annual level of the relevant non-GHG indicator that is being used by the Party to track progress towards the implementation and achievement of its NDC and was selected pursuant to paragraph 65, annex to decision 18/CMA.1 (para. 23 (i), annex, decision 2/CMA.3)	-	-	-	-	-	-	-
Annual quantity of ITMOs first transferred (para. 23 (c), annex to decision 2/CMA.3) (para. 77 (d) (ii) of the MPGs)	-	-	-	-	-	-	-

	Unit	Reference Point[1] (2018)	NDC Implementation Period		Target Level[2]	Target Year	NDC Progress
			2021	2022			
Annual quantity of mitigation outcomes authorized for use for other international mitigation purposes and entities authorized to use such mitigation outcomes, as appropriate (para. 23 (d), annex to decision 2/CMA.3) (para. 77 (d) (ii) of the MPGs)	-	-	-	-	-	-	-
Annual quantity of ITMOs used towards achievement of the NDC (para. 23 (e), annex to decision 2/CMA.3) (para. 77 (d) (ii) of the MPGs)	-	-	-	-	-	-	-
Net annual quantity of ITMOs resulting from paras. 23 (c)-(e), annex to decision 2/CMA.3 (para. 23 (f), annex to decision 2/CMA.3)	-	-	-	-	-	-	-
If applicable, the cumulative amount of ITMOs, divided by the number of elapsed years in the NDC implementation period (para. 7 (a) (ii), annex to decision 2/CMA.3)	-	-	-	-	-	-	-
Total quantitative corresponding adjustments used to calculate the emissions balance referred to in para. 23 (k) (i), annex to decision 2/CMA.3, in accordance with the Party's method for applying corresponding adjustments consistent with section III.B, annex to decision 2/CMA.3 (Application of corresponding adjustments) (para. 23 (g), annex to decision 2/CMA.3)	-	-	-	-	-	-	-

	Unit	Reference Point[1] (2018)	NDC Implementation Period		Target Level[2]	Target Year	NDC Progress
			2021	2022			
The cumulative information in respect of the annual information in para. 23 (f), annex to decision 2/CMA.3, as applicable (para. 23 (h), annex to decision 2/CMA.3)	-	-	-	-	-	-	-
For metrics in tonnes of CO_2 eq. or non-GHG, an annual emissions balance consistent with chapter III.B (Application of corresponding adjustment), annex, decision 2/CMA.3 (para. 23 (k) (i), annex to decision 2/CMA.3) (as part of para. 77 (d) (ii) of the MPGs)	-	-	-	-	-	-	-
For metrics in non-GHG, for each non-GHG metric determined by participating Parties, annual adjustments resulting in an annual adjusted indicator, consistent with para. 9 of chapter III.B (Corresponding adjustments), annex to decision 2/CMA.3, and future guidance to be adopted by the CMA (para. 23 (k) (ii), annex to decision 2/CMA.3)	-	-	-	-	-	-	-
Any other information consistent with decisions adopted by the CMA on reporting under Article 6 (para. 77 (d) (iii) of the MPGs)	-	-	-	-	-	-	-
NDC Achievement Status	As the ROK's NDC sets a single-year target for 2030, achievement status cannot be verified in the first BTR.						

1) Updated figures due to recalculation (727.6 → 732.9)
2) The ROK plans to use voluntary cooperation under Article 6 of the Paris Agreement as a complementary measure to its domestic mitigation efforts including LULUCF to achieve its target.

5. Mitigation policies and measures, actions and plans, including those with mitigation co-benefits resulting from adaptation actions and economic diversification plans, related to implementing and achieving a nationally determined contribution under Article 4 of the Paris Agreement

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Cross-Sector	Emissions Trading System	Allocating emission allowances to carbon-intensive entities, permitting greenhouse gas (GHG) emissions within the cap, while allowing the trading of surplus or deficit of allowances among entities	Allocating total GHG emission allowances to carbon-intensive entities and promoting GHG mitigation by enabling trading among entities with surplus or deficit of allowances	Economic Instrument	Implement-ed	Energy, IPPU	CO_2 CH_4 N_2O HFCs PFCs SF_6	2015	Ministry of Environment, Ministry of Land, Infrastructure, and Transport, Ministry of Agriculture, Food, and Rural Affairs, Ministry of Economy and Finance, Ministry of Trade, Industry and Energy, Ministry of Oceans and Fisheries	IE	IE	IE

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Cross-Sector	Target Management System	Setting annual GHG reduction targets for facilities with high emissions and imposing penalties for failure to meet these targets	Designating entities that emit GHG above certain thresholds as controlled emitters and setting and managing GHG reduction targets, while exempting them from the emissions trading system	Other	Implement-ed	Energy, IPPU	CO_2 CH_4 N_2O HFCs PFCs SF_6	2010	Ministry of Environment	IE	IE	IE
Power Generation	oPhasing Down Aging Coal Power Plants	Accelerating the phasing-down of aging coal power plants and transitioning to lower-emission facilities such as Liquefied Natural Gas (LNG) power plants	Contributing to GHG mitigation by phasing down aging high-emitting coal power plants and replacing them with lower-emitting LNG facilities	Other	Implement-ed	Energy	CO_2 CH_4 N_2O	2020	Ministry of Trade, Industry and Energy	570	11,458	-
Power Generation	Continued Operation of Nuclear Power Plants	Developing plans and licensing procedures to extend operations of nuclear power plants beyond their design life to expand zero-carbon energy sources	Achieving a low-carbon power mix and reducing GHG emissions by continuing the operation of nuclear power plants beyond their design life	Other	Implement-ed	Energy	CO_2 CH_4 N_2O	2022	Ministry of Trade, Industry and Energy	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Power Generation	Support for Renewable Energy Facilities	Providing long-term, low-interest loans to support the installation of renewable energy facilities	Aiming to reduce GHG emissions in the power generation sector through the expansion of renewable energy generation	Economic Instrument	Implement-ed	Energy	CO_2 CH_4 N_2O	2006	Ministry of Trade, Industry and Energy	-	-	-
Power Generation	Support for Residential Renewable Energy Deployment Based on the Electric Power Industry Fund	Providing financial support for the installation of renewable energy facilities in single-family and multi-family homes	Aiming to reduce GHG emissions in the power generation sector through the expansion of renewable energy generation	Economic Instrument	Implement-ed	Energy	CO_2 CH_4 N_2O	1993	Ministry of Trade, Industry and Energy	-	-	-
Power Generation	Support for Building Renewable Energy Deployment Based on the Electric Power Industry Fund	Providing financial support for the installation of renewable energy facilities in non-residential buildings	Aiming to reduce GHG emissions in the power generation sector through the expansion of renewable energy generation	Economic Instrument	Implement-ed	Energy	CO_2 CH_4 N_2O	1993	Ministry of Trade, Industry and Energy	-	-	-
Power Generation	Support for Integrated Renewable Energy Deployment Based on the Electric Power Industry Fund	Supporting projects that integrate two or more renewable energy sources or community-level initiatives	Aiming to reduce GHG emissions in the power generation sector through the expansion of renewable energy generation	Economic Instrument	Implement-ed	Energy	CO_2 CH_4 N_2O	2013	Ministry of Trade, Industry and Energy	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Power Generation	Renewable Portfolio Standard (RPS)	Securing Renewable Energy Certificates (RECs) through installation of renewable facilities or purchase to meet mandatory renewable energy supply targets for power generators, while allowing renewable energy generators to sell their RECs	Requiring companies with power generation facilities of 500MW or more to generate a certain percentage of their total electricity from renewable sources, contributing to the expansion of renewable energy generation	Economic Instrument	Implement-ed	Energy	CO_2 CH_4 N_2O	2012	Ministry of Trade, Industry and Energy	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Power Generation	Support for Renewable Energy Usage Certification System (K-RE100)	Improves systems to enable general consumers to purchase RECs, allowing private companies to procure renewable electricity by paying additional fees to transmission and distribution system operators, and establishing implementation measures such as power purchase agreements (PPAs) between renewable energy power suppliers and consumers	Supporting adoption of voluntary renewable energy use (RE100) in the private sector to expand renewable energy deployment and reduce GHG emissions	Other	Implement-ed	Energy	CO_2 CH_4 N_2O	2021	Ministry of Trade, Industry and Energy	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Power Generation	Establishment of Future Power Grid System	Formulating and implementing optimized power grid plans to accommodate increasing electricity demand and evolving power mix, while establishing a foundation for smart and flexible grid operations to ensure power supply stability	Building a power grid system incorporating High Voltage Direct Current(HVDC), Energy Storage Systems (ESS), and other advanced technologies to meet growing future electricity demand and support the expansion of renewable energy deployment	Other	Implement-ed	Energy	CO_2 CH_4 N_2O SF_6	-	Ministry of Trade, Industry and Energy	-	-	-
Power Generation	Promotion of Distributed Energy System	Enacting the *Special Act on Activation of Distributed Energy* to mandate distributed energy installation, introducing power grid impact assessment systems, and implementing incentive measures	Enhancing grid stability and efficiency by facilitating power generation near high-demand areas, alleviating grid congestion, and optimizing electricity distribution	Other	Implement-ed	Energy	CO_2 CH_4 N_2O	2023	Ministry of Trade, Industry and Energy	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Industry	Research and Development Technologies for Achieving Carbon Neutrality	Developing core carbon neutrality technologies to reduce carbon emissions in manufacturing processes of four major carbon-intensive industries (steel, petrochemical, cement, semiconductor/display)	Driving essential process and facility innovations in industrial sites to accelerate the transition to a low-carbon industrial structure	Other	Implement-ed	IPPU	CO_2 HFCs PFCs	2023	Ministry of Trade, Industry and Energy	-	-	-
Industry	Support for Technology Investment in the Private Sector	Offering tax credits for research and development (R&D) investments in 49 newly designated mitigation technologies under the *Act on Eligible Tax Credit*, and implementing a loan program for projects that provides financing and interest subsidies to support private investments in carbon-neutral facilities	Developing a support system to foster technology innovation and commercialization, ensuring the successful development of core technologies to achieve carbon neutrality	Economic Instrument	Implement-ed	Energy, Transport, IPPU, Waste	CO_2 CH_4 N_2O HFCs PFCs SF_6	2022	Ministry of Trade, Industry and Energy	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Industry	Building Infrastructure for Energy Management Systems (EnMS)	Supporting businesses through energy efficiency consulting, establishing real-time monitoring systems for energy consumption, and promoting energy-saving activities using EnMS infrastructure	Supporting businesses in establishing EnMS infrastructure to enhance corporate energy efficiency	Economic Instrument	Implement-ed	Energy	CO_2	2014	Ministry of Trade, Industry and Energy	-	-	-
Industry	Voluntary Energy Efficiency Target System	Setting energy intensity improvement targets in collaboration with energy-intensive businesses (annual consumption of 2,000 toe or more) and providing incentives for achieving these targets	Encouraging voluntary energy efficiency improvements among energy-intensive businesses through goal-setting and incentive mechanisms	Other	Implement-ed	Energy	CO_2	2020	Ministry of Trade, Industry and Energy	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Industry	Support for Energy-Saving Facility Investments	Supporting financially constrained companies through Energy Service Company (ESCO) investment programs and providing low-interest loans and interest subsidies for energy efficiency investments	Facilitating business energy efficiency by supporting investments in energy-saving facilities that might otherwise be delayed or abandoned due to financial constraints	Economic Instrument	Implement-ed	Energy	CO_2	1980	Ministry of Trade, Industry and Energy	-	-	-
Industry	Support for Carbon-Neutral Leading Plants	Providing financial support for carbon-neutral leading plants that utilize best available technologies to reduce GHG emissions in carbon-intensive industries	Accelerating GHG mitigation by promoting the adoption of carbon-neutral leading plants utilizing advanced low-carbon technologies in carbon-intensive industries	Economic Instrument	Implement-ed	Energy, IPPU	CO_2	2022	Ministry of Trade, Industry and Energy	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Industry	Consultation for Energy Use Plan	Requiring consultations on energy supply, demand, and energy efficiency improvement plans before initiating large-scale projects through a mandatory regulatory system	Promoting energy efficiency improvements and renewable energy adoption in businesses by mandating consultations on energy use plans	Regulatory	Implement-ed	Energy	CO_2	1991	Ministry of Trade, Industry and Energy	-	-	-
Industry	Energy Supporters to Small and Medium-sized Enterprises	Deploying energy supporters to small and medium-sized enterprises (SMEs) lacking energy management expertise to provide on-site technical assistance for energy efficiency improvements	Supporting SMEs in reducing energy consumption through on-site visits by energy supporters who provide technical guidance and expert consultations	Other	Implement-ed	Energy	CO_2	2010	Ministry of Trade, Industry and Energy	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Industry	Mandatory Energy Audits	Requiring excessive energy-consuming business to conduct mandatory periodic energy audits to assess energy consumption patterns and identify efficiency improvement opportunities	Promoting energy efficiency improvements in businesses by identifying energy-saving opportunities through energy audits	Regulatory	Implement-ed	Energy	CO_2	2007	Ministry of Trade, Industry and Energy	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Industry	Government -Industry Partnership for Carbon Neutrality	Establishing the Committee on Promoting Carbon Neutral Industrial Transformation as a government-industry partnership platform to collaborate on achieving carbon neutrality	Encouraging voluntary GHG mitigation in the private sector and removing regulatory barriers through government-industry partnership	Other	Implement-ed	Energy, Transport, IPPU	CO_2 CH_4 N_2O HFCs PFCs SF_6	2021	Ministry of Trade, Industry and Energy, Office for Government Policy Coordination, Ministry of Land, Infrastructure, and Transport, Ministry of Economy and Finance, Ministry of Agriculture, Food, and Rural Affairs, Ministry of SMEs and Startups, Ministry of Environment	-	-	-
Building	Promotion of Zero Energy Building	Implementing ZEB standards for new buildings to increase renewable energy self-sufficiency and decrease dependency on fossil fuels	Promoting the adoption of zero energy buildings to minimize energy consumption	Regulatory	Implement-ed	Energy, Other (Building)	CO_2 CH_4 N_2O	2017	Ministry of Land, Infrastructure, and Transport, Ministry of Trade, Industry and Energy	101	114	354

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Building	Promotion of Building Energy Management Systems (BEMS)	Mandating the installation of BEMS in new building to optimize energy use and improve efficiency	Enhancing energy efficiency in new buildings through the implementation of BEMS	Regulatory	Implement-ed	Energy, Other (Building)	CO_2 CH_4 N_2O	2017	Ministry of Land, Infrastructure, and Transport, Ministry of Trade, Industry and Energy	-	-	-
Building	Green Remodeling for Existing Buildings	Supporting energy efficiency improvements in aging buildings through remodeling projects with enhanced insulation	Reducing building energy consumption by enhancing energy efficiency in aging buildings	Economic Instrument	Implement-ed	Energy, Other (Building)	CO_2 CH_4 N_2O	2013	Ministry of Land, Infrastructure, and Transport	37	22	-
Building	Improving the Efficiency of Household Appliances	Improving the efficiency of household gas appliances in buildings through energy efficiency target setting and energy consumption assessments for large buildings	Reducing fossil fuel consumption and GHG emissions by improving the efficiency of household gas appliances	Other	Implement-ed	Energy, Other (Building)	CO_2 CH_4 N_2O	2001	Ministry of Trade, Industry and Energy	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Building	Development of Energy Efficiency Indicators by Building Type	Developing energy efficiency indicators and evaluation systems for building	Establishing energy efficiency evaluation system for buildings to promote effective energy management and encourage voluntary GHG mitigation	Other	Implemented	Energy, Other (Building)	CO_2 CH_4 N_2O	2019	Ministry of Trade, Industry and Energy, Ministry of Land, Infrastructure, and Transport, Ministry of Environment	-	-	-
Building	Advanced Metering Infrastructure (AMI)	Deploying AMI that enables real-time monitoring and management of building energy usage through wired and wireless network	Improving building energy efficiency by encouraging energy usage reduction through AMI	Other	Implemented	Energy, Other (Building)	CO_2 CH_4 N_2O	2010	Ministry of Trade, Industry and Energy	-	-	-
Building	Deploying New and Renewable Energy in Buildings	Promoting the deployment of renewable energy technologies in buildings, including building-integrated photovoltaics (BIPV), solar thermal, and geothermal systems, to facilitate transition from fossil fuels	Reducing fossil fuel consumption and GHG emissions through deployment of renewable energy systems in the building sector	Economic Instrument	Implemented	Energy, Other (Building)	CO_2	2022	Ministry of Trade, Industry and Energy, Ministry of Land, Infrastructure, and Transport	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Transportation	Promotion of Eco-friendly Vehicle Distribution	Supporting eco-friendly vehicle adoption through purchase incentives, charging infrastructure development, and mandatory purchase and lease programs for public institutions	Reducing GHG emissions in the road transport sector by promoting the adoption of low-emission vehicles, including electric and hydrogen vehicles	Economic Instrument	Implement-ed	Transport	CO_2 CH_4 N_2O	2011	Ministry of Environment, Ministry of Land, Infrastructure, and Transport, Ministry of Economy and Finance, Ministry of Trade, Industry and Energy	274	413	-
Transportation	Reduction of Private Vehicle Kilometers Traveled (VKT)	Providing incentives to encourage individuals to reduce their private VKT	Reducing fossil fuel consumption and reducing GHG emissions by decreasing private vehicle kilometers traveled	Other	Implement-ed	Transport	CO_2 CH_4 N_2O	2018	Ministry of Land, Infrastructure, and Transport, Ministry of Environment	-	-	-
Transportation	Intelligent Transport System (ITS) Infrastructure	Applying ITS technologies to road infrastructure to enhance user safety and convenience, while automating and optimizing traffic management for improved transportation efficiency	Enhancing vehicle fuel efficiency and reducing fossil fuel consumption through ITS	Other	Implement-ed	Transport	CO_2 CH_4 N_2O	2020	Ministry of Land, Infrastructure, and Transport	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Transportation	Modal Shift for Freight Transportation (Road→Rail)	Promoting modal shift from road transportation to eco-friendly railroad transportation	Reduces GHG emissions by promoting the use of low-emission rail transport	Other	Implement-ed	Transport	CO_2 CH_4 N_2O	2010	Ministry of Land, Infrastructure, and Transport	-	-	-
Transportation	Modal Shift for Freight Transportation (Road→Shipping)	Promoting modal shift from road transportation to eco-friendly maritime transportation	Reduces GHG emissions by promoting the use of low-emission maritime transport	Economic Instrument	Implement-ed	Energy	CO_2 CH_4 N_2O	2010	Ministry of Oceans and Fisheries	454	439	-
Transportation	Vehicle GHG Emission and Fuel Efficiency Standards	Establishing GHG emission and average fuel efficiency standards for passenger, vans and trucks with 15 or fewer seats and gross weight under 3.5 tonnes	Reducing fossil fuel consumption and GHG emissions by strengthening vehicle GHG emission standards and fuel economy regulations	Other	Implement-ed	Transport	CO_2 CH_4 N_2O	2012	Ministry of Environment, Ministry of Land, Infrastructure, and Transport, Ministry of Trade, Industry and Energy	-	-	-
Transportation	Early Scrapping and Operation Restrictions of Old Diesel Vehicles	Implementing vehicle operation restrictions by designating eligible vehicles, enforcement periods, and specific hours to promote energy conservation and reduce traffic congestion	Reducing GHG emissions by restricting the operation of old diesel vehicles with poor fuel efficiency	Other	Implement-ed	Transport	CO_2 CH_4 N_2O	2005	Ministry of Environment, Ministry of Land, Infrastructure, and Transport	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Transportation	Increasing Mandatory Biodiesel Blend Ratio	Mandating petroleum refiners and importers to blend a minimum annual percentage of renewable energy fuels into transportation fuels	Reduces GHG emissions by requiring the blending of biodiesel into transportation fuels	Other	Implement-ed	Transport	CO_2	2018	Ministry of Trade, Industry and Energy, Ministry of Land, Infrastructure and Transport	1,942	1,880	-
Transportation	Railroad Network Extension	Expanding railroad networks to increase rail usage	Reduces GHG emissions by extending railroad networks to encourage use of rail for passenger and freight transportation	Other	Implement-ed	Transport	CO_2 CH_4 N_2O	2018	Ministry of Land, Infrastructure, and Transport	-	-	-
Transportation	Improvement of Aircraft Operation Efficiency	Enhancing aircraft operational efficiency for domestic carriers through engine cleaning, weight reduction, and improved flight management	Reducing fuel consumption and GHG emissions per flight distance through improved aircraft efficiency	Other	Implement-ed	Transport	CO_2	2018	Ministry of Land, Infrastructure, and Transport, Ministry of Trade, Industry and Energy	-	-	-
Transportation	Eco-friendly Ships	Contributing to wider adoption of eco-friendly ships in the private sector by certifying vessels powered by eco-friendly energy sources such as LNG	Reducing GHG emissions by encouraging the transition to eco-friendly ships	Economic Instrument	Implement-ed	Transport	CO_2	2021	Ministry of Oceans and Fisheries	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Transportation	Alternative Maritime Power (AMP) Supply	Providing vessels with Alternative Maritime Power (AMP) instead of onboard power generated by fossil fuels	Reducing GHG emissions by connecting docked vessels to shore-side electricity instead of using fuel-based generation	Other	Implement-ed	Transport	CO_2 CH_4 N_2O	2019	Ministry of Oceans and Fisheries	-	-	-
Agriculture, Livestock Farming, and Fisheries	Water Management Technology	Expanding mid-season drainage in rice cultivation areas by cutting off irrigation for at least two weeks and opening drainage channels to maintain dry paddy fields	Reducing methane emissions during rice cultivation by expanding mid-season drainage	Other	Implement-ed	Agriculture	CH_4	2022	Ministry of Agriculture, Food, and Rural Affairs	-	-	-
Agriculture, Livestock Farming, and Fisheries	Fertilizer Prescription Based on Soil-Testing	Providing appropriate fertilizer amounts for each field based on scientific soil-testing to encourage proper fertilization of agricultural land	Reducing N_2O emissions from agricultural soils by preventing over-fertilization	Other	Implement-ed	Agriculture	N_2O	2023	Ministry of Agriculture, Food, and Rural Affairs	-	-	-
Agriculture, Livestock Farming, and Fisheries	Biochar	Distributing biochar to enhance the carbon sequestration capacity of agricultural soils	Reducing soil N_2O emissions by enhancing its carbon sequestration capacity	Other	Planned	Agriculture	N_2O	2026	Ministry of Agriculture, Food, and Rural Affairs	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Agriculture, Livestock Farming, and Fisheries	Energy-Saving and Renewable Energy Facilities in the Agriculture Sector	Promoting carbon mitigation through the installation of energy-saving facilities and wider deployment of renewable energy such as solar power	Enhancing energy efficiency and reducing GHG emission in the agricultural sector	Other	Implement-ed	Agriculture	CO_2	2023	Ministry of Agriculture, Food, and Rural Affairs	-	-	-
Agriculture, Livestock Farming, and Fisheries	Low-Methane and Low-Nitrogen Feed	Supplying livestock with specialized feed containing methane-reducing additives to decrease emissions by at least 10%, and low-protein feed with reduced crude protein content	Reduces enteric fermentation methane emissions and N_2O from livestock manure treatment by expanding the supply of low-methane and low-nitrogen feed	Regulatory	Planned	Agriculture	CH_4 N_2O	2024	Ministry of Agriculture, Food, and Rural Affairs	-	-	751
Agriculture, Livestock Farming, and Fisheries	Energy Recovery in Livestock Manure Treatment Facilities	Diversifying treatment options for livestock manure beyond composting by adopting energy recovery and water purification systems	Reducing both fossil fuel consumption and N_2O emissions through advanced livestock manure treatment processes	Regulatory	Implement-ed	Agriculture	CH_4 N_2O	2022	Ministry of Agriculture, Food, and Rural Affairs	-	792	2,058

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Agriculture, Livestock Farming, and Fisheries	Replacement of Aging Fishing Vessels	Providing financial support for replacing aging engines in coastal and offshore fishing vessels (30% national treasury, 30% local governments, 40% vessel owners), and offering interest subsidies for construction of new vessels	Reducing GHG emissions from the fishing vessels in the fisheries and aquaculture sector	Economic Instrument	Implement-ed	Transport	CO_2	2021	Ministry of Oceans and Fisheries	1	1	1
Agriculture, Livestock Farming, and Fisheries	Energy-Saving Facilities and Equipment in Aquaculture Farms	Supplying energy-efficient heat pumps and inverters to aquaculture farms and fishery processing facilities to reduce energy consumption	Improving energy efficiency and reducing GHG emissions by installing energy-saving equipment in fisheries facilities	Other	Planned	Energy	CO_2	2020	Ministry of Oceans and Fisheries	-	-	-
Waste	Imposition of Waste Incineration and Landfill Charges	Imposing waste disposal charges on facilities that incinerate or landfill recyclable materials	Promoting waste recycling and reducing greenhouse gas emissions through financial penalties on improper waste disposal	Regulatory	Implement-ed	Waste	CO_2 CH_4 N_2O	2021	Ministry of Environment	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Waste	Improvement of Unsanitary Landfills	Excavating, sorting, and transferring waste from unsanitary landfills	Preventing methane generation from organic waste decomposition by sorting and transferring waste from unsanitary landfills	Other	Implemented	Waste	CH_4	1995	Ministry of Environment	-	-	-
Waste	Expansion of Landfill Methane Capture	Capturing and utilizing methane from landfills through capture facilities to reduce fossil fuel use and GHG emissions	Reducing fossil fuel use and GHG emissions through landfill methane collection	Other	Implemented	Waste	CH_4	2009	Ministry of Environment	1,953	1,911	-
Waste	Extended Producer Responsibility (EPR) System	Assigning manufacturers and importers the responsibility to collect and recycle waste from their packaging and products	Reducing waste and GHG emissions by assigning responsibility for waste recycling to companies at the source	Regulatory	Implemented	Waste	CO_2 CH_4 N_2O	2003	Ministry of Environment	1,036	1,086	-
Waste	Installation of Community Recycling Centers	Providing permanent collection facilities in areas with limited recycling infrastructure to enable easy sorting of recyclable materials	Enhancing recycling and reducing GHG emissions by facilitating the separation of recyclable materials in areas with limited recycling infrastructure	Other	Implemented	Waste	CO_2 CH_4 N_2O	2015	Ministry of Environment	4	6	16

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Waste	Modernization of Public Sorting Facilities	Replacing aging public sorting facilities with newly constructed and modernized sorting ones	Strengthening recycling and reducing GHGs emissions by improving the sorting rate of public recycling facilities	Other	Implement-ed	Waste	CO_2 CH_4 N_2O	2000	Ministry of Environment	47	103	-
Waste	Public Procurement of Recycled Products	Mandating public institutions to purchase recycled products, driving demand for green products	Encouraging recycling and reducing GHG emissions by expanding public procurement of recycled products	Other	Implement-ed	Waste	CO_2 CH_4 N_2O	2005	Ministry of Environment	-	-	-
Waste	Electric Vehicle Battery Recycling	Expanding institutional support for waste battery recycling by increasing storage facilities and classifying remanufactured and reused batteries as recyclable resources.	Promoting a circular economy and reducing GHG emissions by advancing waste battery recycling	Other	Implement-ed	Waste	CO_2 CH_4 N_2O	2022	Ministry of Environment, Ministry of Land, Infrastructure, and Transport, Ministry of Trade, Industry and Energy	-	0.1	2.8

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Waste	Construction Waste Recycling	Enhancing institutional support for construction waste recycling to implement a selective demolition system for separating combustible waste and recyclable materials throughout the demolition process	Promoting a circular economy and reducing GHG emissions by enhancing construction waste recycling	Other	Implement-ed	Waste	CO_2 CH_4 N_2O	2019	Ministry of Environment	-	-	-
Waste	Organic Waste Biogas Facilities	Installing organic waste biogas facilities to produce biogas from resources such as food waste and livestock manure	Preventing methane generation from organic waste resources and reducing GHGs by utilizing methane as alternative fuel through biogas production	Economic Instrument	Implement-ed	Energy, Waste	CO_2 CH_4	2022	Ministry of Environment	-	-	115
Carbon Sinks, Carbon Capture, and Hydrogen	Reforestation	Promoting reforestation projects to enhance forest's carbon sequestration capacity as part of sustainable forest management	Enhancing carbon sequestration capacity through reforestation	Regulatory	Implement-ed	LULUCF	CO_2	2021	Korea Forest Service	117	228	1,202

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Carbon Sinks, Carbon Capture, and Hydrogen	Forest Management	Implementing forest management by categorizing into plantation management, young forest management, and mature forest management based on tree growth stages	Strengthening carbon sequestration capacity of forests and reducing GHGs through forest management	Regulatory	Implement-ed	LULUCF	CO_2	2021	Korea Forest Service	-	-	-
Carbon Sinks, Carbon Capture, and Hydrogen	High Value-Added Timber Utilization	Promoting timber use in building and infrastructure construction to enhance carbon storage capacity.	Enhancing carbon storage capacity and reducing GHG emissions by promoting timber use in construction	Regulatory	Implement-ed	LULUCF	CO_2	2021	Korea Forest Service	2,106	1,744	1,871
Carbon Sinks, Carbon Capture, and Hydrogen	Urban Forests for Coping with Climate Crisis	Creating urban forests as new carbon sinks near urban areas	Providing new carbon sinks and reducing GHG emissions through urban forest development	Regulatory	Implement-ed	LULUCF	CO_2	2021	Korea Forest Service, Ministry of Land, Infrastructure, and Transport, Ministry of Environment, Ministry of Agriculture, Food, and Rural Affairs	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Carbon Sinks, Carbon Capture, and Hydrogen	Expansion of New Carbon Sinks	Expanding new carbon sinks by transforming abandoned urban parks into green spaces and restoring damaged green belt areas	Strengthening carbon absorption capacity and reducing GHG emissions by creating and restoring green spaces	Regulatory	Implement-ed	LULUCF	CO_2	-	Korea Forest Service, Ministry of Environment, Ministry of Land, Infrastructure and Transport, Ministry of Environment, Ministry of Agriculture, Food and Rural Affairs	-	-	-
Carbon Sinks, Carbon Capture, and Hydrogen	Carbon Sinks through Inland Wetlands Conservation	Promoting conservation and management of wetland protected areas by expanding their coverage, purchasing private lands within these zones, and restoring damaged areas	Enhancing the carbon storage capacity of wetlands and reducing GHG emissions by expanding wetland areas and conserving ecosystems	Regulatory	Implement-ed	LULUCF	CO_2	2021	Ministry of Environment	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Carbon Sinks, Carbon Capture, and Hydrogen	Prevention of Forest Disasters	Addressing firefighting blind spots and preventing forest disasters through AI-based ICT platforms and advanced suppression techniques	Enhancing forest carbon sequestration capacity and reducing GHG emissions through forest disaster prevention and restoration of damaged forest areas	Regulatory	Implement-ed	LULUCF	CO_2	2021	Korea Forest Service	1	2	18
Carbon Sinks, Carbon Capture, and Hydrogen	Restoration and Protection of Coastal Wetlands and Management of Marine Protected Areas	Strengthening marine carbon sink capacity by restoring tidal flat vegetation, rehabilitating salt marshes, and designating marine protected areas	Reducing GHG emissions by enhancing carbon sequestration in marine carbon sink	Other	Implement-ed	LULUCF (Coastal Wetlands)	CO_2 CH_4 N_2O	2022	Ministry of Oceans and Fisheries	-	-	-
Carbon Sinks, Carbon Capture, and Hydrogen	Marine Forest Creation	Securing new carbon sinks by developing marine forests	Enhancing carbon storage in marine carbon sinks	Other	Implement-ed	Others	CO_2	2018	Ministry of Oceans and Fisheries	8	9	11

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Carbon Sinks, Carbon Capture, and Hydrogen	Establishment of Institutional Framework for Carbon Capture, Utilization, and Storage (CCUS)	Establishing institutional frameworks, including relevant legislation and plans for CCUS technology development and infrastructure construction	Reducing CO_2 emissions through CCUS	Other	Planned	Others	CO_2	-	Office for Government Policy Coordination, Ministry of Science and ICT, Ministry of Trade, Industry and Energy, Ministry of Oceans and Fisheries	-	-	-
Carbon Sinks, Carbon Capture, and Hydrogen	Development of Technology and Infrastructure for Carbon Capture and Storage (CCS)	Promoting R&D and evaluating suitable sites for carbon storage to advance CCS technology and infrastructure development	Reducing CO_2 emissions through CCS	Other	Planned	Others	CO_2	2026	Ministry of Trade, Industry and Energy, Ministry of Oceans and Fisheries	-	-	-
Carbon Sinks, Carbon Capture, and Hydrogen	Development of Technology and Infrastructure for Carbon Capture and Utilization (CCU)	Promoting R&D and pilot projects for CCU technology and infrastructure development	Reducing CO_2 emissions through CCU	Other	Planned	Others	CO_2	2026	Ministry of Science and ICT	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Carbon Sinks, Carbon Capture, and Hydrogen	Development of Technology and Infrastructure for Hydrogen	Developing hydrogen infrastructure by revising relevant legislation and implementing pilot projects for water electrolysis	Establishing a clean hydrogen ecosystem and reducing GHG emissions through technology development for a hydrogen economy	Other	Implement-ed	Others	CO_2	2022	Ministry of Science and ICT, Ministry of Trade, Industry and Energy, Ministry of Oceans and Fisheries, Ministry of Environment	-	-	-
Carbon Sinks, Carbon Capture, and Hydrogen	Establishment of Stable Hydrogen Supply Base	Promoting a stable hydrogen supply infrastructure through the construction of facilities based on water electrolysis	Stimulating the hydrogen economy and reducing GHG emissions by ensuring a stable hydrogen supply	Other	Implement-ed	Others	CO_2	2022	Ministry of Trade, Industry and Energy, Ministry of Science and ICT, Ministry of Oceans and Fisheries, Ministry of Environment	-	-	-

Sector	Name	Description	Objectives	Type of instrument	Status	Sector(s) affected	Gases affected	Start year of implementation	Implementing entity or entities	Estimates of GHG emission reductions ($ktCO_2$-eq)		
										2021	2022	2030
Carbon Sinks, Carbon Capture, and Hydrogen	Expansion of Hydrogen Demand and Utilization	Reducing GHG emissions through hydrogen and ammonia co-firing power generation and hydrogen based ironmaking	Reducing GHGs by promoting hydrogen vehicles and hydrogen based ironmaking	Other	Implement-ed	Others	CO_2	2022	Ministry of Science and ICT, Ministry of Trade, Industry and Energy, Ministry of Oceans and Fisheries, Ministry of Environment	-	-	-

6. Information on projections of greenhouse gas emissions and removals under a 'with measures' scenario

(Unit: $MtCO_2$-eq)

	Most recent year in the Party's national inventory report	Projections of GHG emissions and removals			
	2022	2025	2030	2035	2040
Sector					
- Energy	-	-	-	-	-
- Transportation	-	-	-	-	-
- IPPU	-	-	-	-	-
- Agriculture	-	-	-	-	-
- LULUCF	-	-	-	-	-
- Waste	-	-	-	-	-
- Others	-	-	-	-	-
Gas					
- CO_2 (Including LULUCF)	597.4	615.7	636.4	647.8	651.0
- CO_2 (Excluding LULUCF)	635.8	643.9	657.9	664.3	665.1
- CH_4 (Including LULUCF)	35.7	33.8	32.2	31.3	30.3
- CH_4 (Excluding LULUCF)	35.2	33.4	31.8	30.9	29.9
- N_2O (Including LULUCF)	10.8	10.8	11.0	11.3	11.3
- N_2O (Excluding LULUCF)	10.7	10.8	11.0	11.2	11.3
- HFCs	32.9	40.7	52.1	65.8	73.6
- PFCs	4.1	8.8	12.3	16.6	22.0
- SF_6	4.0	6.0	7.6	9.6	10.9
- NF_3	1.7	2.8	3.7	4.9	6.1
Total with LULUCF	686.5	718.5	755.3	787.3	805.1
Total without LULUCF	724.3	746.2	776.4	803.4	818.7

7. Projections of key indicators

Key Indicator	Unit, as applicable	Most recent year in the Party's national inventory report	Projections of key indicators			
		2022	2025	2030	2035	2040
Net Emissions (Including LULUCF)	$MtCO_2$-eq	686.5	718.5	755.3	787.3	805.1
Total Emissions (Excluding LULUCF)	$MtCO_2$-eq	724.3	746.2	776.4	803.4	818.7

8. Key underlying assumptions and parameters used for projections

Key underlying assumptions and parameters	Unit, as applicable	Most recent year for which data are available	Projections of key underlying assumptions and parameters			
		2020	2025	2030	2035	2040
Population	Million	51.8	51.7	51.3	50.8	50.1
GDP	Trillion KRW	1,839.5	2,077	2,231	2,351	2,447
Crude Oil Price	$/bbl	43.6	92.1	89.4	89.0	88.6

Acronyms and Abbreviations

	Term	Definition
	1996 IPCC Guidelines	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
	2006 IPCC Guidelines	2006 IPCC Guidelines for National Greenhouse Gas Inventories
A	ADB	Asian Development Bank
	AdCom	Adaptation Communication
	AF	Adaptation Fund
	AFoCO	Asian Forest Cooperation Organization
	AFOLU	Agriculture, Forestry and Other Land Use
	AMI	Advanced Metering Infrastructure
	AMP	Alternative Maritime Power System
	APEC	Asia-Pacific Economic Cooperation
B	BAU	Business As Usual
	BEMS	Building Energy Management System
	BIPV	Building Integrated Photovoltaic
	BM	Benchmark
	BTR	Biennial Transparency Report
	BUR	Biennial Update Report
C	CBD	Convention on Biological Diversity
	CBDR	Common But Differentiated Responsibilities
	CBIT	Capacity-building Initiative for Transparency
	CCS	Carbon Capture and Storage
	CCU	Carbon Capture and Utilization
	CCUS	Carbon Capture, Utilization, and Storage
	CDM	Clean Development Mechanism
	CH_4	Methane
	CI	Carbon Intensity
	CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
	CO	Carbon Monoxide
	CO_2	Carbon Dioxide
	CO_2-eq	Carbon Dioxide Equivalent
	COP	Conference of the Parties
	CPS	Country Partnership Strategies
	CRTs	Common Reporting Tables
	CTCN	Climate Technology Centre & Network
	CTFs	Common Tabular Formats
D	DAC	Development Assistance Committee
	DMZ	Demilitarized Zone
E	EDCF	Economic Development Cooperation Fund

	Term	Definition
	EDPF	Economic Development Promotion Facility
	ETF	Enhanced Transparency Framework
	ETS	Emission Trading System
	ESG	Environmental, Social, and Governance
F	F-gas	Fluorinated Gas
	FAO	Food and Agriculture Organization of the United Nations
G	GAW	Global Atmosphere Watch
	GCF	Green Climate Fund
	GDP	Gross domestic product
	GEF	Global Environment Facility
	GEMS	Geostationary Environment Monitoring Spectrometer
	GGGI	Global Green Growth Institute
	GHG	Greenhouse Gas
	GIRS	GHG Inventory Reporting System
	GWP	Global Warming Potential
H	HCFC	Hydrogenated Chlorofluorocarbon
	HFCs	Hydrofluorocarbons
	HVDC	High Voltage Direct Current
I	ICAO	International Civil Aviation Organization
	ICT	Information and Communication Technology
	IEA	International Energy Agency
	IMO	International Maritime Organization
	INDC	Intended Nationally Determined Contribution
	IOC	Intergovernmental Oceanographic Commission
	IPCC	Intergovernmental Panel on Climate Change
	IPCC GPG 2000	Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories 2000
	IPCC GPG-LULUCF 2003	Good Practice Guidance for Land Use, Land-use Change and Forestry 2003
	IPPU	Industrial Processes and Product Use
	ITMOs	Internationally Transferred Mitigation Outcomes
	ITS	Intelligent Transport System
	i-SMR	innovative Small Modular Reactor
K	KASS	Korea Augmentation Satellite System
	K-BIS	Korea Blue Carbon Information System
	K-IPCC	Korean IPCC Response Council
	KGGTF	Korea Green Growth Trust Fund
	KOSIS	Korean Statistical Information Service
	KP	Kyoto Protocol
	KSP	Knowledge Sharing Program
L	LCA	Life Cycle Assessment
	LDCs	Least Developed Countries
	LEDS	Long-Term Low Greenhouse Gas Emission Development Strategy

	Term	Definition
	LNG	Liquefied Natural Gas
	LPG	Liquefied Petroleum Gas
	LULUCF	Land Use, Land-Use Change and Forestry
M	MDB	Multilateral Development Bank
	MEAs	Multilateral Environmental Agreements
	MOU	Memorandum of Understanding
	MOTIVE	Korean Model Of InTegrated Impact and Vulnerability Evaluation of Climate Change
	MPGs	Modalities, procedures and guidelines for the transparency framework
	MRV	Measurement, Reporting, Verification
N	N_2O	Nitrous Oxide
	NbS	Nature based Solutions
	NC	National Communication
	NDC	Nationally Determined Contribution
	NDE	National Designated Entity
	NID	National Inventory Document
	NIR	National Inventory Report
	NIRS	National Inventory Report System
	NF_3	Nitrogen Trifluoride
	NO_2	Nitrogen Dioxide
	NO_x	Nitrogen Oxides
O	ODA	Official Development Assistance
	ODS	Ozone Depleting Substance
	OECD	Organisation for Economic Co-operation and Development
P	P4G	Partnering for Green Growth and the Global Goals 2030
	PaMs	Policies and Measures
	PFCs	Perfluorocarbons
	PPA	Power Purchase Agreement
	PPP	Public-Private Partnership
Q	QA	Quality Assurance
	QC	Quality Control
R	R&D	Research & Development
	RD&D	Research, Development & Demonstration
	REC	Renewable Energy Certification
	REDD+	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
	RPS	Renewable Portfolio Standard
S	SAF	Sustainable Aviation Fuel
	SDGs	Sustainable Development Goals
	SF_6	Sulfur Hexafluoride
	SIDS	Small Island Developing States
	SO_x	Sulfur Oxides
	SSP	Shared Socioeconomic Pathways

	Term	Definition
	SSP1-2.6	Shared Socioeconomic Pathways 1-2.6
	SSP5-8.5	Shared Socioeconomic Pathways 5-8.5
T	TA	Technical Assistance
	TEC	Technology Executive Committee
	TMS	GHG Target Management System
	TOE	Ton of Oil Equivalent
U	UN	United Nations
	UNCCD	United Nations Convention to Combat Desertification
	UNEP	United Nations Environment Program
	UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
	UNFCCC	United Nations Framework Convention on Climate Change
V	VESTAP	Vulnerability Assessment Tool to Build Climate Change Adaptation Plan
W	WB	World Bank
	WAM Scenario	With Additional Measures Scenario
	WM Scenario	With Measures Scenario
	WMO	World Meteorological Organization
Z	ZEB	Zero Energy Building
	ZEV	Zero-Emission Motor Vehicle

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