2024 National Communication of the Republic of China (Taiwan) under the United Nations Framework Convention on Climate Change

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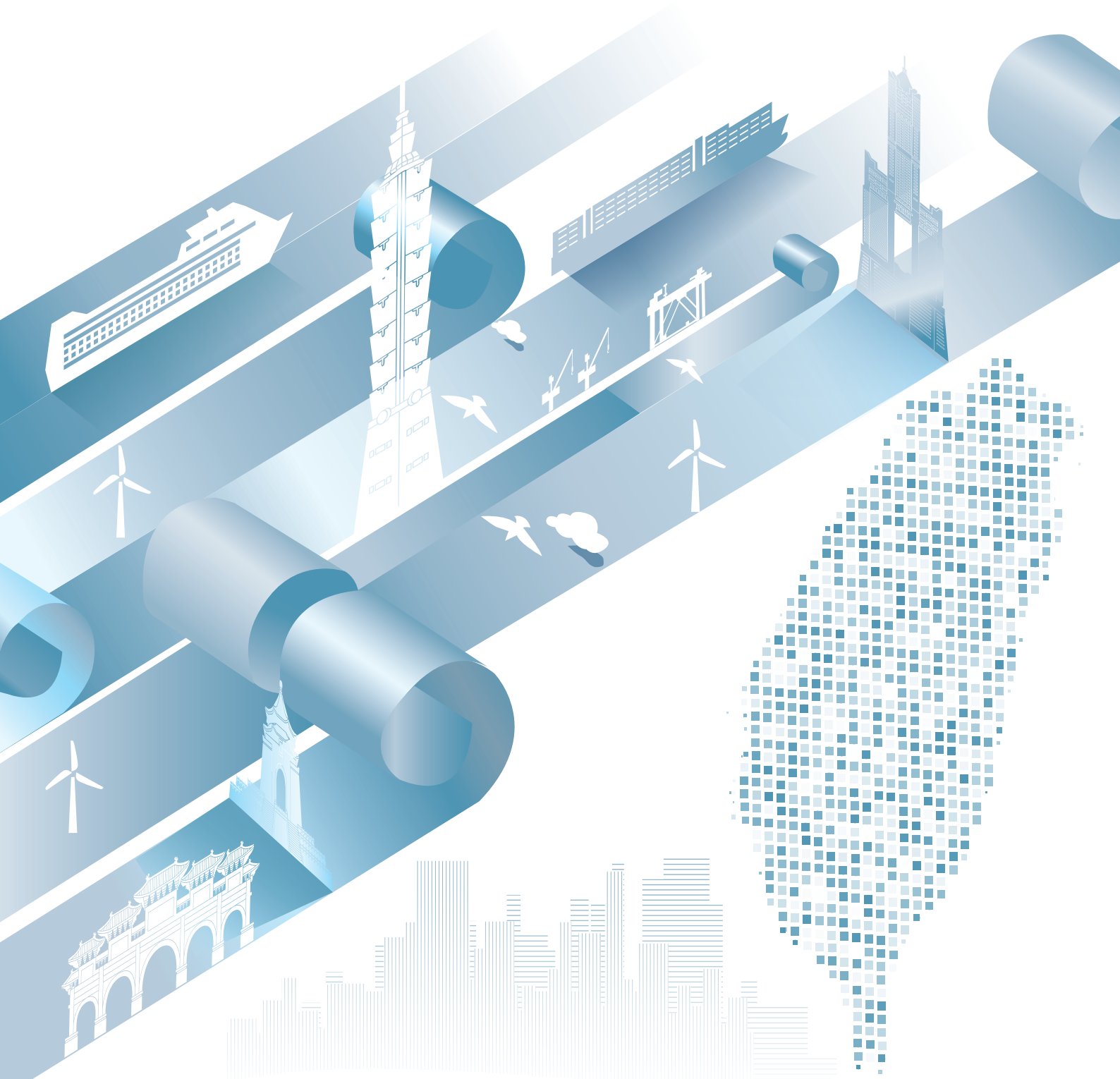

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Executive Summary

In response to global climate change, Taiwan enacted the *Greenhouse Gas Reduction and Management Act* in 2005. As climate challenges intensified, the Ministry of Environment revised the act in 2023 and renamed it the *Climate Change Response Act*. The revisions incorporated the 2050 net-zero emissions target, enhanced emission controls, carbon fee collection, and promotion of a just transition, underscoring Taiwan's commitment to achieving net-zero emissions.

To actively address the challenges of global climate change and promote national climate governance and international cooperation, President Lai Ching-te announced the establishment of the National Climate Change Committee on June 19, 2024. The Committee, comprising representatives from industry, government, academia, and research sectors, serves as a communication platform for formulating national climate governance strategies and driving critical action plans, thereby strengthening resilience to climate change. The Committee convenes quarterly at the Presidential Office and undertakes three core missions: fostering public participation, enhancing policy communication, and improving operational efficiency. Its goal is to build societal consensus and advance the nation's green growth strategy. The committee consists of 28 members, with the President serving as the convener. It addresses seven key themes: net-zero pathways; diversified green energy and carbon reduction technologies; green and digital dual-axis transformation; sustainable green lifestyles; just transition; green sustainable finance; and, resilient and sustainable land-use adaptation.

Taiwan adheres to the requirements of the United Nations Framework Convention on Climate Change (UNFCCC), upholds the principle of periodic disclosure of climate change response achievements by parties to the convention, and has actively implemented related measures. Pursuant to the *Climate Change Response Act* and its enforcement rules, Taiwan compiles a national report every three years. The 2024 Republic of China National Greenhouse Gas Inventory Report comprises nine key chapters: 1) National Circumstances and Basic Environmental Data; 2) Greenhouse Gas Emissions, Absorption Statistics, and Trend Analysis; 3) Taiwan's Policies and Measures for Greenhouse Gas Reduction; 4) Greenhouse Gas Emission Forecasts; 5) Impacts of Climate Change and Adaptation Strategies; 6) Climate Change and Systematic Observation Research; 7) Technology Development, Demand, and Transfer; 8) International Cooperation and Exchange; and 9) Education, Training, and Outreach. The highlights of each chapter are summarized below:

Chapter 1: National Circumstances and Basic Environmental Data

Taiwan is situated at the southeastern edge of the Asian continental shelf along the Pacific Rim. To its east lies the Pacific Ocean, to its west the Taiwan Strait; the Bashi Channel lies to the south, and the Ryukyu Islands are located to the northeast. Taiwan has a spindle-like shape, stretching 394 kilometers from north to south and 144 kilometers from east to west at its widest point, with a total coastline length of 1,150.95 kilometers. Its latitude ranges between approximately 21°N and 26°N. The area under Taiwan's effective jurisdiction includes Taiwan proper and its affiliated islands (the Penghu Archipelago, Kinmen Islands, Matsu Islands, Dongsha Islands, and Nansha Islands), covering a total area of approximately 36,197.3371 square kilometers. In 2023, the annual average temperature on the main island was approximately 24.6°C, with an average annual rainfall of about 1,883.5 millimeters.

Since 2020, Taiwan has experienced natural population decline due to the birth rate falling below the death rate, exacerbated by the impact of the COVID-19 pandemic, resulting in negative population growth. In 2023, population numbers temporarily rebounded due to the return of Taiwanese nationals and a net positive international migration following the pandemic. As of 2023, Taiwan's total population was approximately 23.42 million, with a population density of 647 people per square kilometer. The

population aged 0 to 14 accounted for 11.9%, whereas the population 65 and older constituted 18.3%, reflecting the continuing growth of the elderly population.

In 2023, Taiwan's economic growth rate was 1.12%, impacted by weakened global demand for goods, which affected external trade and investment. However, a rebound in consumption of services and tourism spurred an increase in private consumption. Due to the advancement of emerging technologies such as artificial intelligence (AI) and high-performance computing (HPC), the economic growth rate in 2024 is projected to reach 4.59%. Additionally, in 2024, President Lai Ching-te introduced the National Project of Hope, which focuses on eight key governance objectives, including innovative economy, green growth, and the 2050 net-zero transition, to promote Taiwan's economic transformation and enhance societal well-being.

In terms of energy development, the country faces challenges such as heavy reliance on imported energy and an isolated electricity system. However, with the accelerated global trend toward reducing greenhouse gas emissions, the country is actively promoting an energy transition to increase the proportion of renewable energy, enhance energy efficiency, and reduce dependence on imported fossil fuels. In 2024, Taiwan's power generation structure consisted of 39.3% coal-fired power, 42.4% gas-fired power, and 11.6% renewable energy. Under policy initiatives, solar photovoltaic and wind power generation have shown significant growth.

The nation's transportation sector spans three major areas: land, sea, and air, encompassing four aspects: transportation, tourism, meteorology, and postal services. Land transportation includes road and rail systems. As of the end of 2023, the total road mileage was 21,844 kilometers, and the railway and high-speed rail systems were well-developed, with plans to extend the north–south high-speed rail. In maritime transportation, the country operates seven international commercial ports and four domestic commercial ports, with cargo volume increasing by 45.12% in the first half of 2024. In aviation, eight airlines operate 251 domestic and international routes; during the first half of 2024, passenger numbers rose by 37.12% compared to the same period in 2023. All transportation sectors have demonstrated steady development.

Chapter 2: Greenhouse Gas Emissions, Absorption Statistics, and Trend Analysis

Taiwan conducts greenhouse gas (GHG) emission statistics based on the 2006 Guidelines for National Greenhouse Gas Inventories published by the Intergovernmental Panel on Climate Change (IPCC) and by referencing international standards such as the IPCC's Good Practice Guidance and Uncertainty Management introduced in 2000. For continuous improvement, data statistics have been updated in accordance with the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and adjusted to align with national circumstances.

Taiwan's GHG emission statistics cover seven types of greenhouse 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). Among these, CO_2 is the primary greenhouse gas, with emissions amounting to 273,683 kilotons (excluding the Land Use, Land-Use Change, and Forestry sector), and accounting for 95.70% of the total GHG emissions, as shown in Figure 1.

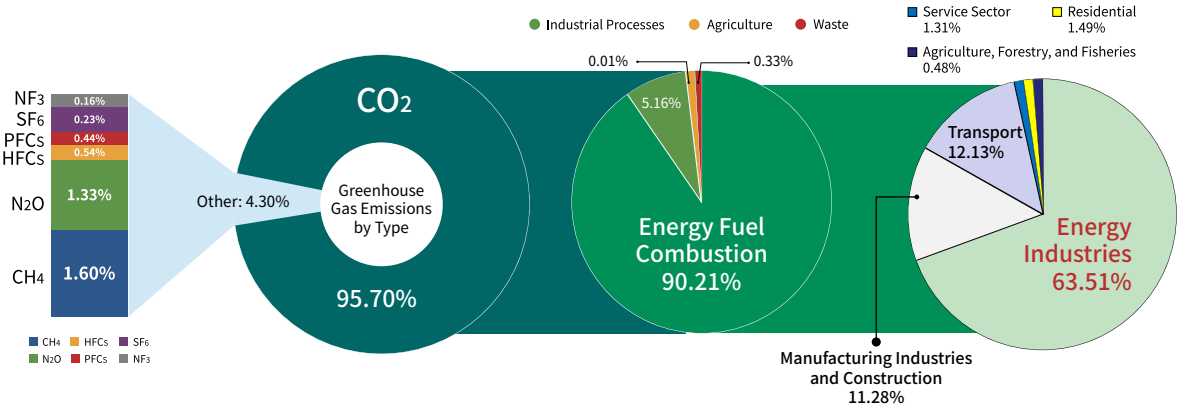


Figure 1. Proportions of Greenhouse Gas Emissions by Category in 2022

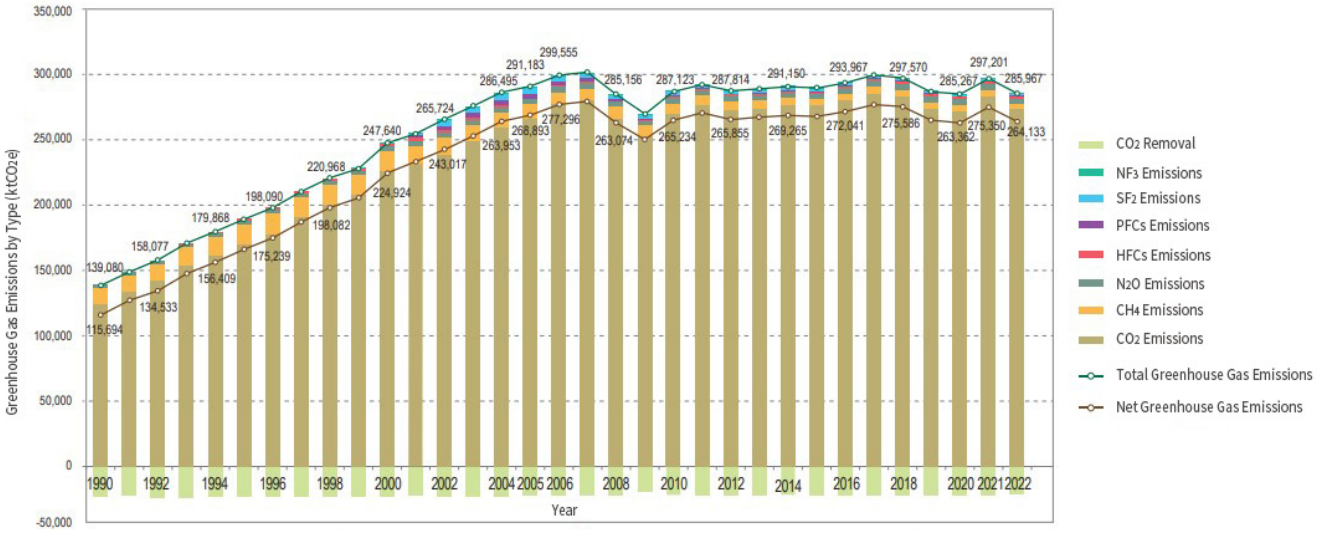


Figure 2. Trends in Total Greenhouse Gas Emissions and Removal in Taiwan, 1990–2022

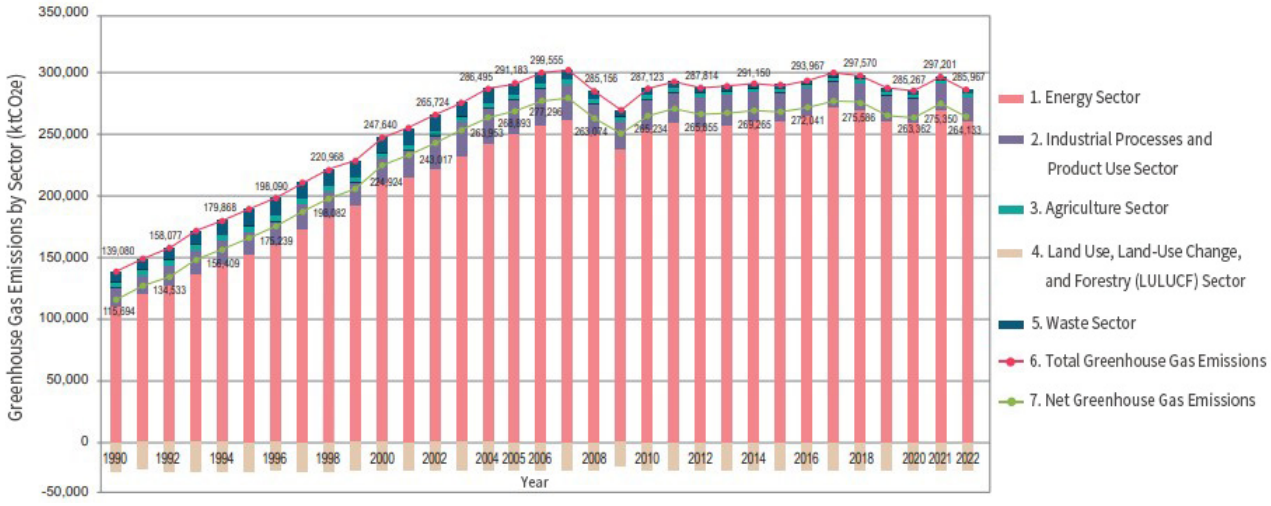


Figure 3. Trends in Greenhouse Gas Emissions by Inventory Sectors in Taiwan, 1990–2022

Chapter 3: Taiwan's Policies and Measures for Greenhouse Gas Reduction

Since Taiwan announced its intention to engage with the UNFCCC in 2009, the government has actively participated in the Conference of the Parties (COP) as a Government Observer and has issued both the National Greenhouse Gas Report and the Nationally Determined Contribution (NDC). In 2021, the government declared its commitment to achieving the 2050 net-zero emissions target, and in 2022, it published Taiwan's Pathway to Net-Zero Emissions in 2050, clearly outlining four major transformation directions and 12 key strategies. In 2023, Taiwan amended the *Climate Change Response Act* to strengthen provisions for a just transition, carbon fee collection, and adaptation strategies, as well as to implement mechanisms for information disclosure and public participation. In 2024, President Lai Ching-te established the National Climate Change Committee to further advance green growth and net-zero transformation. The

Committee focuses on cross-sector collaboration across areas such as energy, digital technology, and finance, driving policy implementation and laying the foundation for Taiwan's sustainable development.

In accordance with the *Climate Change Response Act*, Taiwan establishes phased control targets every 5 years. In 2022, the government approved the second phase of the Greenhouse Gas Reduction Action Plan and sector-specific action plans covering six major sectors, all aimed at achieving the 2050 net-zero emissions target. These sector-specific greenhouse gas reduction action plans are implemented based on phased targets, evaluation indicators, and annual objectives, with progress regularly reported to the Ministry of Environment and the Executive Yuan. The energy sector focuses on reducing greenhouse gas emissions by adjusting the energy structure and enhancing energy efficiency. The manufacturing sector promotes low-carbon transformation along with energy-saving and management. The transportation sector makes significant efforts to develop public transportation, promote electric vehicles, and improve the energy efficiency of transportation systems. The residential and commercial sector emphasizes the promotion of green buildings, the enhancement of energy efficiency in buildings, and the implementation of both voluntary and mandatory carbon reduction measures in the service industry, driving progress toward the net-zero target. The agriculture sector continues to implement measures such as afforestation and biogas power generation to achieve significant carbon reductions and increase carbon removal. The environmental sector works to reduce methane emissions by promoting waste-to-resource initiatives and improving wastewater treatment. Through the ongoing efforts and implementation of measures across these six major sectors, Taiwan is gradually advancing toward its long-term carbon reduction goals.

Chapter 4: Greenhouse Gas Emission Forecasts

In accordance with Article 10 of the *Climate Change Response Act*, Taiwan establishes phased greenhouse gas control targets every 5 years. The decision-making process involves consultations with scholars, experts, government agencies, and civil society organizations. The setting of phased control targets is based on the energy-saving and carbon reduction potential of each sector. This includes forecasting national and sector-specific greenhouse gas emission trajectories and evaluating the effectiveness of policies.

The enforcement rules of the *Climate Change Response Act* require central government agencies to project emissions trends and conduct scenario analyses. These analyses categorize emissions into six major sectors—energy, manufacturing, transportation, residential and commercial, agriculture, and environment—and unify the management of various greenhouse gases, such as carbon dioxide and methane. The government is

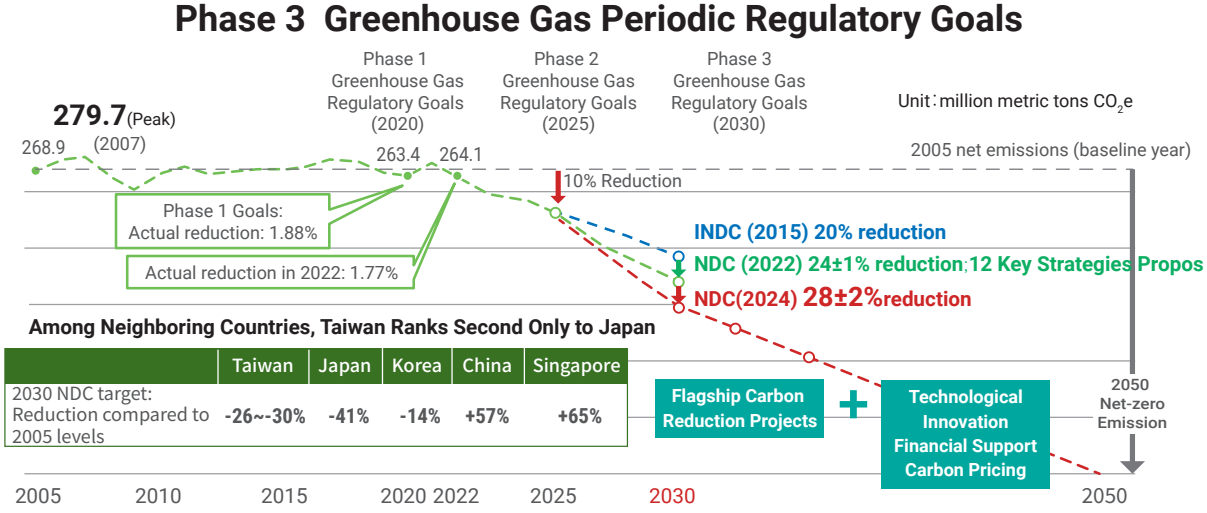


Figure 4. Net-Zero Greenhouse Gas Emissions Pathway

currently formulating the Third Phase Greenhouse Gas Phased Control Targets, which will forecast emissions for the period from 2026–2030. Using 2005 as the baseline year, the government plans to propose enhanced reduction targets for 2030, paving the way to achieve the ultimate goal of net-zero emissions by 2050.

To achieve these targets, the government has conducted projections for national energy demand, calculations of power emission factors, and emissions from both fuel combustion and non-fuel combustion across various sectors. Simultaneously, each sector employs different estimation models to simulate future emission scenarios, taking into account socioeconomic parameters such as overall economic growth rates and population figures. These projections serve as a basis for the effective implementation of policies and the planning of carbon reduction strategies.

Chapter 5: Impacts of Climate Change and Adaptation Strategies

Taiwan's complex topography and highly variable climate make it particularly vulnerable to typhoons and extreme weather throughout the year, leading to threats such as floods and landslides. As climate change intensifies, extreme weather events are expected to become more frequent, presenting significant challenges to national security and socioeconomic development. In 2024, Taiwan combined historical data with the latest IPCC climate change simulations to produce *Climate Change in Taiwan: National Scientific Report 2024*. This report examines the risks associated with climate change in Taiwan, including rising temperatures, changes in rainfall patterns, and rising sea-levels. Future warming in Taiwan is inevitable, with temperature increases potentially reaching 3.4°C by the end of the century under high-emission scenarios. This will lead to shorter winters and longer summers. Sea levels are also expected to rise due to global warming, with projections indicating an increase of up to 0.8 meters by 2100, posing severe threats to coastal regions. Moreover, rainfall during the dry season is projected to decrease, whereas wet-season rainfall will increase, exacerbating the differences between dry and wet seasons. This intensification of seasonal disparities will heighten the risks of droughts and floods.

To address these impacts of climate change, the Taiwan government emphasizes the necessity of climate adaptation and risk assessment. Efforts focus on enhancing water resource management, urban flood prevention, and disaster mitigation in hillside areas to reduce damage caused by extreme weather events. The government also calls for collaboration across all sectors to actively promote adaptation measures, ensuring the sustainability of national security and economic development.

Following the passage of the *Climate Change Response Act*, Taiwan formulated the *National Climate Change Adaptation Action Plan* (2023–2026), promoting adaptation actions across seven key sectors: infrastructure, water resources, land use, oceans and coasts, energy supply and industries, agricultural production and biodiversity, and health. The action plans for each sector aim to reduce climate risks, enhance societal and industrial resilience, and strengthen disaster prevention and ecological protection measures through policies, regulations, and inter-ministerial coordination. To date, significant progress has been made, including regulatory transformations, disaster early warning mechanisms, and climate risk management. These efforts are steadily advancing Taiwan toward its sustainable development goals.

Chapter 6: Climate Change and Systematic Observation Research

To achieve the goals of the Paris Agreement, global collaboration is essential to promote greenhouse gas reduction, advance climate adaptation technologies, and establish accurate meteorological forecasting systems. Taiwan actively engages in scientific research on climate change and shares its findings through international cooperation. The National Science and Technology Council (NSTC), as the competent authority, coordinates climate change research and interdisciplinary integration projects. These efforts aim to enhance local climate modeling, disaster early warning capabilities, and green energy technologies. Since 2011, Taiwan has developed its own climate simulation system and participated in international research initiatives, such as CMIP6, thereby contributing to the global scientific foundation for addressing climate change while strengthening

disaster countermeasures and advancing green, low-carbon technologies.

Taiwan's meteorological observation system is managed by the Central Weather Administration (CWA) under the Ministry of Transportation and Communications. It oversees nationwide meteorological observations, including oceanic conditions, ozone levels, and ultraviolet radiation, which are categorized into surface, upper-air, and specialized meteorological observations. Surface observations use instruments to measure meteorological elements near the Earth's surface, including maritime observations. Upper-air observations use balloons equipped with instruments to measure atmospheric conditions at various altitudes, focusing on wind direction, wind speed, and air pressure. Specialized observations target specific phenomena such as lightning, radar, and satellite monitoring.

As of 2023, Taiwan was operating 25 meteorological stations, 2 upper-air stations, and 644 automatic observation stations, which collect data on weather, precipitation, and temperature. As for satellite observation, the CWA receives data from multiple meteorological satellites, including those from the United States, the European Union, Japan, and Taiwan's own Formosat satellites. These data are used for meteorological analysis and environmental monitoring. The 11 radars composing the meteorological radar network provide dense coverage of Taiwan and surrounding seas, which enhances the detection of weather systems. They are particularly useful for monitoring severe weather events such as typhoons. Oceanic observations rely on buoys and tide stations to monitor wave heights and tides. This improves typhoon forecasting and maritime surveillance capabilities.

These observation data are widely applied in areas such as agricultural disaster early warning, weather parametric insurance, smart meteorological services, and disaster prevention and early warning, ensuring that Taiwan maintains efficient and accurate meteorological observation and forecasting capabilities for responding to climate change and natural disasters.

Chapter 7: Technology Development, Demand, and Transfer

To address climate change, the global community is actively advancing technological innovation and cooperation, leveraging market mechanisms and climate finance to accelerate the development and transfer of technologies. Taiwan has also invested in climate technologies and industrial development, focusing on three major areas: net-zero technologies, mitigation and energy technologies, and climate services and adaptation technologies. Since 2007, Taiwan has launched the National Energy Program, which promotes advancements in energy-saving, alternative energy, smart grids, and offshore wind power technologies. In 2023, the government approved the Net-Zero Science & Technology Program, allocating NT$15 billion annually for the research and development of sustainable energy and grid resilience technologies. In the field of mitigation and energy technologies, Taiwan's manufacturing sector, due to its high emissions, urgently needs to develop carbon reduction technologies such as carbon-free steel production, low-carbon petrochemicals, and greener electronics manufacturing processes. For adaptation technologies, the focus is on establishing comprehensive foundational data, such as typhoon and drought early warning systems, and enhancing risk assessment tools across various sectors. Regarding technology transfer, Taiwan promotes international cooperation in areas such as wind power, hydrogen energy, and power grids by introducing new technologies and conducting demonstration projects. Achieving a net-zero transition requires the support of a just transition mechanism to ensure fair resource allocation and societal consensus. Taiwan has established inter-ministerial task forces to drive these efforts and has strengthened the role of financial institutions in climate transition by advancing carbon disclosure and ESG information platforms to promote sustainable development.

Technology transfer plays a pivotal role in global climate action. The UNFCCC has established a technology mechanism promoting the development, dissemination, and transfer of technologies to address climate change challenges. Technology transfer involves the sharing of intellectual property rights and training, with the aim of facilitating technological collaboration among nations. Taiwan actively participates in international technology transfer through institutions such as the Ministry of Foreign Affairs and the International Cooperation

and Development Fund (ICDF). These efforts include promoting the application of climate technologies in allied and other nations. For example, Taiwan has implemented disaster early warning system enhancement projects in Guatemala and Belize, solid waste management and recycling initiatives in Saint Kitts and Nevis, and agricultural and environmental technology development programs in the Philippines and the Marshall Islands. These cases highlight the critical importance of technology transfer in strengthening the global community's capacity to respond to climate change.

Chapter 8: International Cooperation and Engagement

Although Taiwan cannot participate as a party to the UNFCCC, it actively expands its international involvement through multilateral and bilateral climate cooperation. These efforts strengthen the implementation of technology transfer, climate mitigation, and adaptation measures. Taiwan's climate action initiatives include technology research and development, industrial collaboration, and energy transition. Through the ICDF, Taiwan supports allied and friendly nations in addressing climate change challenges. These actions enhance Taiwan's visibility and influence in global climate action while demonstrating its commitment to contributing to global greenhouse gas reduction efforts.

Additionally, Taiwan participates in numerous international organizations that focus on cities as primary actors, fostering exchanges with global cities to demonstrate its determination to advance climate action. Among these organizations, Local Governments for Sustainability (ICLEI) is the world's largest network of local governments dedicated to sustainable development, comprising over 1,000 members from 86 countries. Twelve of Taiwan's city and county governments are members of ICLEI. Similarly, CityNet is an international network promoting sustainable urban development in the Asia-Pacific region. To date, Taipei, Taoyuan, Taichung, and Kaohsiung have joined CityNet, leveraging exchanges and collaborative initiatives to promote industrial development, accelerate energy transitions, and jointly advance low-carbon actions for sustainable urban development. Furthermore, Taiwan's industries and civil society organizations actively expand their participation in international organizations and play key roles in global climate forums. Through these diverse engagements, Taiwan shares its experiences in climate change mitigation and environmental protection, amplifying its voice and advancing its climate action on the international stage.

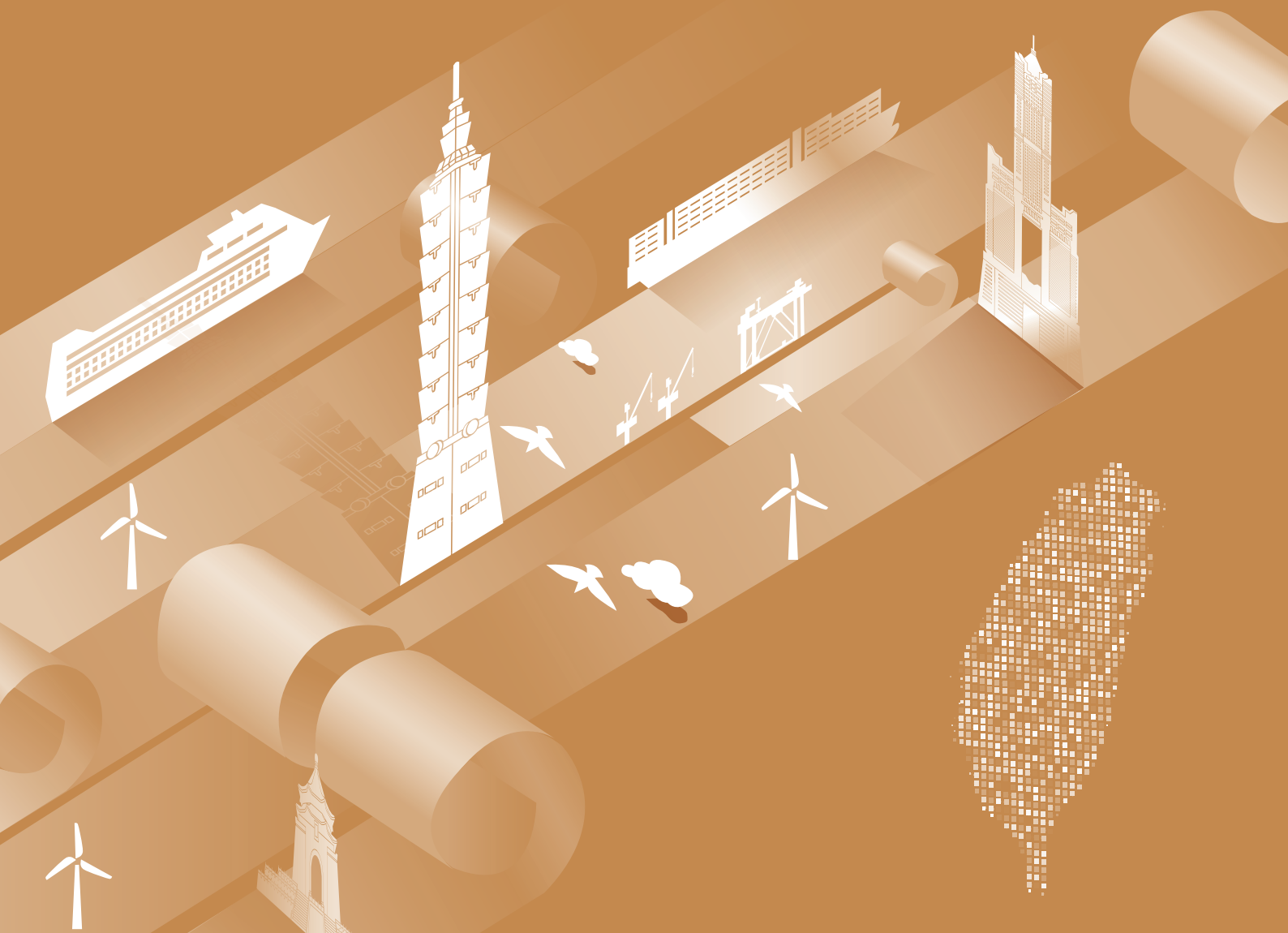
Chapter 9: Education, Training, and Outreach

In accordance with Article 6 of the UNFCCC, Taiwan's government agencies actively promote climate change education, talent training, and public communication programs aimed at raising public awareness of climate change and cultivating related expertise. In the field of education, the Ministry of Education has been implementing the New-generation Environmental Education Development (NEED) blueprint since 2020. This initiative integrates climate change, sustainable development education, and the United Nations Sustainable Development Goals (SDGs) into Taiwan's environmental education strategies. The program spans environmental education curricula from elementary school through high school, emphasizing whole-school governance and interdisciplinary learning. Through innovative teaching methods and living laboratories, the program fosters students' environmental literacy and practical skills. At the tertiary level, universities and colleges focus on cultivating specialized talents by offering interdisciplinary courses and promoting industry–academia collaboration. These initiatives provide practical opportunities to deepen students' understanding of climate change mitigation and adaptation.

Furthermore, to address the challenges posed by climate change in the future, Taiwan places great emphasis on vocational training for professionals. Various government agencies, based on their respective areas of responsibility, have launched talent cultivation programs for climate change mitigation and adaptation across six major sectors: energy, manufacturing, transportation, residential and commercial, agriculture, and environment. For example, the Ministry of Economic Affairs' Bureau of Energy conducts energy management training courses and promotes local energy governance capacity-building programs. In the manufacturing

sector, efforts focus on strengthening corporate carbon reduction capabilities through carbon inventory assessments and carbon reduction guidance. The Ministry of Agriculture prioritizes agricultural and water resource adaptation, advancing the renewal and protection of farmland irrigation infrastructure. The Ministry of Environment collaborates with the financial industry to promote green finance and sustainable development, enhancing corporate awareness of climate change and facilitating industrial transitions toward low-carbon practices. These comprehensive efforts are driving Taiwan's progress toward the 2050 net-zero emissions target.

1 National Circumstances and Basic Environmental Data



Chapter 1: National Circumstances and Basic Environmental Data

The development and transformation of a country's natural environment, society, and economic structures profoundly impact its greenhouse gas (GHG) emission pathways and the consequences of climate change. This chapter provides a comprehensive overview and explanation of Taiwan's national circumstances and environment from multiple perspectives, including government organization and legislation; demographics; geographic location and land use; climate characteristics; economy and industry; energy; transportation; building and urban structures; waste management; and the agricultural, forestry, fishery, and livestock sectors.

1.1 Government Organization and Legislation

I. Central Government

The national government's organizational structure is based on the Constitution, constitutional amendments, and relevant laws. The government comprises five branches: the Executive Yuan, the Legislative Yuan, the Judicial Yuan, the Examination Yuan, and the Control Yuan, each of which exercises its own powers. Furthermore, in accordance with the Constitution, a president is directly elected by the people to serve as the head of state. The president serves a four-year term, and is eligible for one re-election.

The Executive Yuan is the highest administrative authority in the country. The premier of the Executive Yuan is appointed by the president; the vice premier, ministers, and other political appointees are first nominated by the premier and then appointed by the president. The Executive Yuan oversees 31 organizations, including 14 ministries, 10 commissions, 3 independent agencies, 1 administration, 1 council, and 2 offices, as shown in Figure 1.1-1.

Figure 1.1-1. Current Organizational Structure of the Central Government in Taiwan

Source: Executive Yuan, Global Information Network.

The Legislative Yuan is the highest legislative body. It is composed of legislators directly elected by the people and represents the people in exercising legislative power. The Judicial Yuan is the highest judicial authority; it is responsible for civil, criminal, and administrative litigation, as well as disciplinary actions against public officials. The Examination Yuan is the highest examination authority of the state. The Control Yuan is the supreme oversight body; it exercises powers of impeachment, censure, and audit.

II. Local Governments

In accordance with the *Local Government Act*, which was revised and promulgated on August 7, 2024, Taiwan currently has six special municipalities (Taipei City, New Taipei City, Taoyuan City, Taichung City, Tainan City, and Kaohsiung City), 13 counties (Yilan County, Hsinchu County, Miaoli County, Changhua County, Nantou County, Yunlin County, Chiayi County, Pingtung County, Hualien County, Taitung County, Penghu County, Kinmen County, Lienchiang County), and three provincial cities (Keelung City, Hsinchu City, and Chiayi City), as shown in Figure 1.1-2. In total, Taiwan has 146 townships, 38 towns, 14 county-administered cities, and 170 districts.

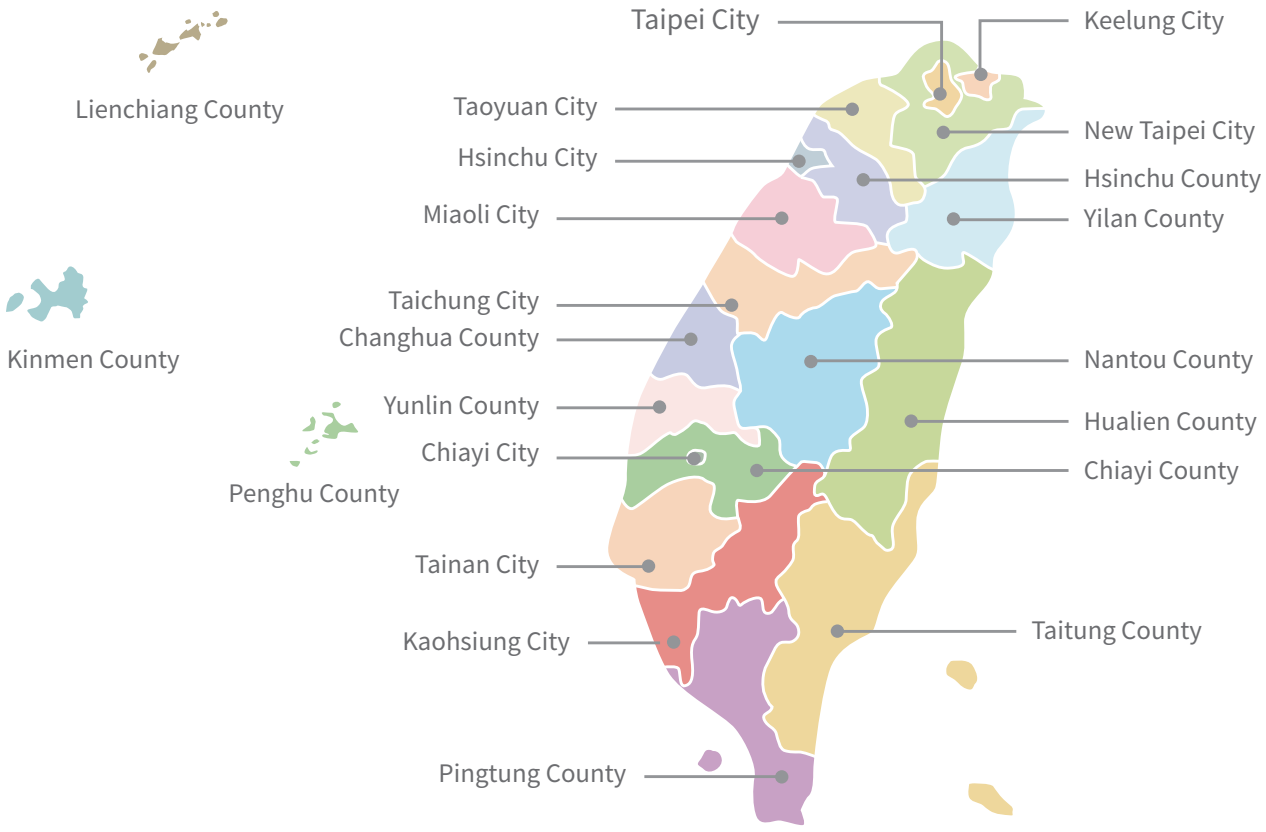


Figure 1.1-2. Administrative Divisions of Taiwan's Local Governments

Source: Executive Yuan, Global Information Network

1.2 Population

The total population of Taiwan began to decrease naturally in 2020 as the number of births fell below the number of deaths. Coupled with the impact of the COVID-19 pandemic, which halted international migration, social growth (i.e., net international household registration) turned negative and resulted in population decline. In 2024, Taiwan's total population was approximately 23.40 million, a decrease of 18,000 compared to the previous year.

A temporary rebound occurred after the pandemic, primarily due to Taiwanese nationals gradually returning to Taiwan and resuming household registration, along with net international household registration surpassing natural population decline. However, according to the *Population Projections for the Republic of China (2024–2070)* published by the National Development Council in 2024, the trends of low fertility and population aging in Taiwan are irreversible. It is projected that the number of births will continue to fall below the number of deaths and the scale of natural population decrease will expand to surpass social growth, leading to a sustained trend of population decline, as shown in Figure 1.2-1.

In terms of population density, in 2024, Taiwan had 646.46 people per square kilometer. Taipei City recorded the highest population density, with 9,164.36 people per square kilometer, followed by Hsinchu City with 4,390.12 people per square kilometer, and Chiayi City ranking third with 4,367.75 people per square kilometer.

In terms of population structure, in 2024, the proportion of the population aged 0 to 14 was 11.7%, reflecting a continued downward trend. The proportion of the working-age population (aged 15 to 64) declined from its peak of 74.2% in 2012 to 69.1% in 2024. Meanwhile, the proportion of the population aged 65 and above has increased annually, surpassing the proportion of those aged 0 to 14 in 2017 and rising to 19.2% in 2024.

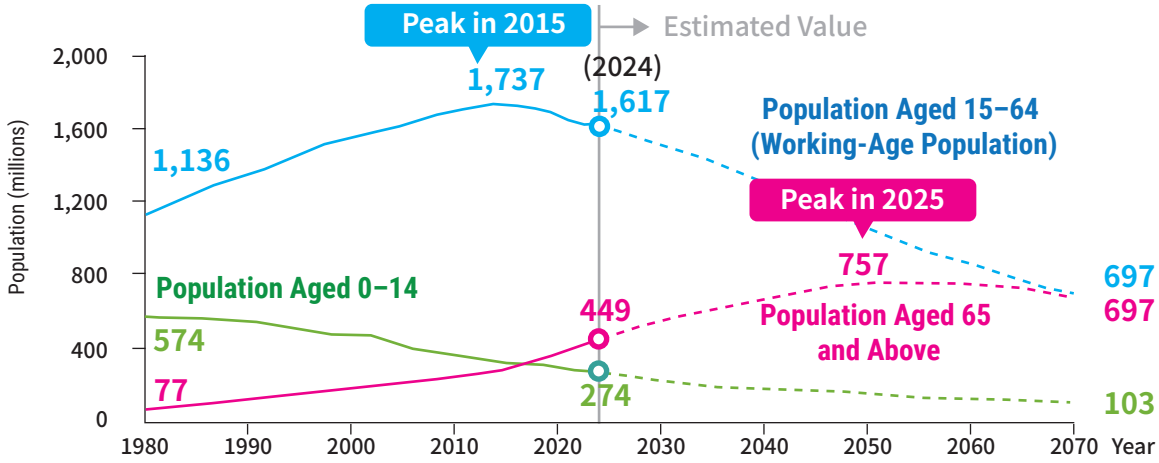


Figure 1.2-1. Trends of Taiwan's Population Growth

Source: National Development Council. Population Projections for the Republic of China (2022–2070). August, 2022.

1.3 Geographic Location and Land Use

I. Geographical Location

Taiwan's jurisdiction includes the main island of Taiwan and its affiliated islands (the Penghu Archipelago, the Kinmen Islands, the Matsu Islands, the Dongsha Islands, and the Nansha Islands) for a total area of 36,197.3371 square kilometers. The main island is located on the southeastern edge of the Asian continental shelf, situated between 21°N and 26°N latitude. The Tropic of Cancer (23.5°N) passes through Chiayi and Hualien Counties.

The main island stretches 394 kilometers from north to south and 144 kilometers from east to west at its widest point. It is surrounded by seas on all sides: the Pacific Ocean to the east, the Taiwan Strait to the west, and the Bashi Channel to the south. The total length of the coastline is 1,150.95 kilometers. The terrain slopes from east to west, with mountains, hills, basins, terraces, and plains forming the primary topographical features.

Mountains account for approximately two-thirds of the island's total area. Five major mountain ranges run from east to west: the Coastal Range, the Central Mountain Range, the Xueshan Range, the Yushan Range, and the Alishan Range. The Central Mountain Range, with its steep and towering terrain, forms the backbone of the main island, serving as the watershed between rivers flowing to the east and west. To the west of the Alishan Range, the terrain

gradually transitions into basins and plains, which, from north to south, include the Taipei Basin, the Taoyuan-Hsinchu-Miaoli Terrace, the Taichung Basin, the Chianan Plain, and the Pingtung Plain, as shown in Figure 1.3-1.

Figure 1.3-1. Topographic Map of Taiwan

Source: Executive Yuan, Global Information Network.

II. Land Use

In 2023, the breakdown of Taiwan's urban land and non-urban land (including national park land) use was as follows: urban land was primarily designated as protected zones (27.8%), agricultural zones (20.7%), and public facility land (19%); non-urban land was primarily designated as forest zones (43.9%), slope conservation zones, (21.9%), and national park zones (9.7%), as shown in figure 1.3-2.

The *Spatial Planning Act* was promulgated and implemented in 2016 to coordinate land territory (including urban land, non-urban land, and national park land) and maritime areas under Taiwan's jurisdiction. Currently, the Ministry of the Interior and municipal, city, and county governments are drafting and reviewing national land function zoning maps under the guidance of the National Spatial Plan and respective municipal, city, and county spatial plans. These zoning maps categorize land into four functional zones—environmental conservation zones, marine resource zones, agricultural development zones, and urban–rural development zones—based on the characteristics of land resources, conservation needs, utilization, and management. The objective is to guide the reasonable allocation of resources and industries in pursuit of sustainable national development.

Additionally, as stipulated in Article 5 of the *Spatial Planning Act*, a Spatial Planning White Paper has been released, which examines domestic and international environmental contexts, current land use status, and trend analysis. It also outlines policies

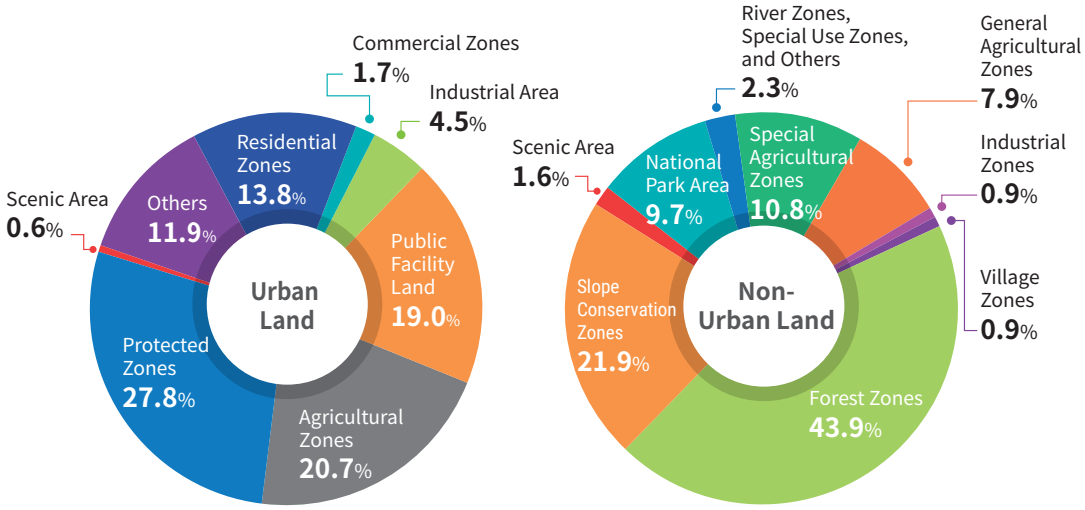


Figure 1.3-2. Urban and Non-Urban Land Use (Including National Park Land)
(Left: Proportion of Urban Planning Land by Zoning Category; Right: Proportion of Non-Urban Planning Land by Zoning Category)

Source: National Development *Council. Compilation of Urban and Regional Development Statistics.* 2023.

and principles for land use in terms of conservation, maritime utilization, agricultural production, and urban–rural development under the *National Spatial Plan*.

In response to global climate change, post-pandemic industrial restructuring, and other emerging challenges, the *National Spatial Plan* provides tailored, region-specific policies for land planning, which serve as roadmaps for sustainable land governance.

1.4 Climate

Taiwan is situated within the volatile seasonal Asian Monsoon System, which is characterized by the influence of the northeast monsoon during the winter and the southwest monsoon during the summer. The primary precipitation sources are plum rains and typhoons, which create a warm and rainy island climate.

In terms of temperature, Taiwan has experienced a continuous warming trend, with a pronounced rate of temperature increase over the past century compared to the global average. Based on data from six centennial meteorological stations operated by the Central Weather Administration (located in Taipei, Taichung, Tainan, Hengchun, Hualien, and Taitung), the average annual temperature in Taiwan in 2023 was 24.6°C, which was 1.1°C higher than the centennial average of 23.5°C for the period from 1961–1990, as shown in Figure 1.4-1.

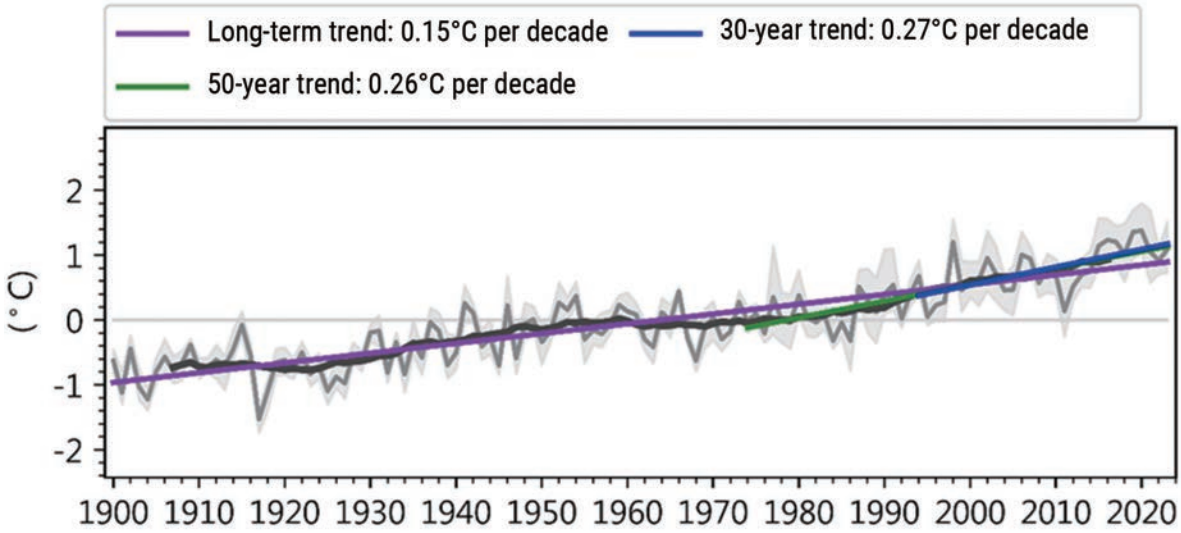


Figure 1.4-1. Trend of Annual Average Temperature Changes in Taiwan

Source: Central Weather Administration, Ministry of Transportation and Communications website.

In terms of precipitation, Taiwan's rainfall is influenced by East Asian Monsoon circulation, frontal systems, and typhoons. The main sources of rainfall include spring rains, plum rains, typhoons, southwest monsoon flows, and the northeast monsoon.

In 2023, the average annual total rainfall—calculated as the average from 11 stations (located in Keelung, Yilan, Taipei, Hsinchu, Taichung, Tainan, Hualien, Chenggong, Taitung, Dawu, and Hengchun)—was 1,883.5 mm, which was only 87.2% of the climate normal (the median of the annual total rainfall for the period from 1991–2020) of 2,161.1 mm. Rainfall distribution across Taiwan showed higher precipitation in the eastern and southeastern regions. The western and northeastern regions experienced lower rainfall.

1.5 Economy and Industry

In 2024, Taiwan's economic growth rate was 4.59%, primarily due to a cooling in the global demand for goods, which dampened Taiwan's external trade and corporate investment momentum. However, a surge in service consumption and cross-border tourism significantly boosted private

consumption. GDP per capita increased from NT$804,123 in 2019 to NT$1,091,374 in 2024, as shown in Table 1.5-1.

Looking ahead to 2025, the rapid development of emerging technologies, such as artificial intelligence (AI) and high-performance computing (HPC), is expected to drive strong product demand and export momentum. According to the Directorate-General of Budget, Accounting and Statistics, Executive Yuan, the economic growth rate for 2025 is projected to rise to 3.14%.

Additionally, President Lai Ching-te proposed the National Project of Hope in 2024, emphasizing three core policy pillars—Democratic Peace, Innovative Prosperity, and Just Sustainability—to address challenges such as the impacts of the pandemic of the century, the rise of regional hegemons, the restructuring of global supply chains, technological advancements, and climate change. The Executive Yuan, using the National Project of Hope as a blueprint, aims to drive national progress, respond to public needs, enhance societal well-being, and bring hope to the next generation. The project outlines eight key governance objectives and priorities: 1) Expanding social investment to reduce family burdens, 2) Fostering an innovative economy and building a smart nation, 3) Green growth and 2050 net-zero transformation, 4) Enhancing healthcare investment to build a healthy Taiwan, 5) Balanced regional development and local hope, 6) Strengthening soft power to establish a national brand, 7) Advancing a diverse and equitable society,

Table 1.5-1. Taiwan's Economic Growth Rate (2005–2024)

Year	Economic Growth Rate (%)	Gross Domestic Product (GDP) (Nominal Value, NT$1,000,000)		GDP Per Capita (Nominal Value, NT$)	
		Original Value	Annual Growth Rate (%)	Original Value	Annual Growth Rate (%)
2005	5.38	12,036,675	3.80	529,556	3.42
2006	5.77	12,572,587	4.45	550,863	4.02
2007	6.85	13,363,917	6.29	583,133	5.86
2008	0.80	13,115,096	-1.86	570,279	-2.20
2009	-1.61	12,919,445	-1.49	559,807	-1.84
2010	10.25	14,060,345	8.83	607,596	8.54
2011	3.67	14,262,201	1.44	614,922	1.21
2012	2.22	14,677,765	2.91	630,749	2.57
2013	2.48	15,270,728	4.04	654,142	3.71
2014	4.72	16,258,047	6.47	694,680	6.20
2015	1.47	17,055,080	4.90	726,895	4.64
2016	2.17	17,555,268	2.93	746,526	2.70
2017	3.66	18,012,387	2.60	764,678	2.43
2018	2.91	18,420,039	2.26	781,169	2.16
2019	3.06	18,974,097	3.01	804,123	2.94
2020	3.42	20,023,752	5.53	849,105	5.59
2021	6.72	21,773,291	8.74	927,776	9.27
2022	2.68	22,820,430	4.81	978,579	5.48
2023	1.12	23,596,734	3.40	1,010,890	3.30
2024	4.59	25,549,820	8.28	1,091,374	7.96

Source: National Statistics Website of the Republic of China (Taiwan).

and 8) Building a resilient Taiwan to safeguard security and peace.

Under the "innovative economy, smart nation" objective, the government will focus on four pillars—industrial innovation, technological innovation, financial innovation, and talent investment—utilizing innovation to drive Taiwan's economy and create a new wave of growth momentum. Taiwan's five trusted industry sectors—semiconductors, artificial intelligence (AI), military, security and surveillance, and next-generation communications—will serve as development priorities. The government aims to further promote the dual strategies of AI industrialization and industrial AI, thereby leveraging technological innovation and interdisciplinary collaboration to transform Taiwan into an AI Island.

To ensure green growth and achieve the 2050 net-zero transition in response to climate change, the government plans to invest over NT$1 trillion by 2030 to attract both domestic and international green investments. The focus will be on energy transition—ensuring a stable power supply while advancing the non-nuclear homeland initiative. This involves integrating carbon capture, utilization, and storage (CCUS) technologies; promoting deep energy efficiency; and advancing technological energy storage. Additionally, efforts will be made to strengthen grid resilience. The government will also guide industries toward low-carbon transformation by fostering green manufacturing and the circular economy. It will encourage a net-zero green lifestyle by promoting low-carbon transportation, green buildings, and other sustainable living practices. During the net-zero transition, the government will issue regular guidelines to assist industries in adapting to emerging trends and minimizing impacts. This approach aims to ensure that everyone has the opportunity to participate in and benefit from the development of the green economy.

1.6 Energy

Taiwan faces several inherent challenges in energy development, including a heavy reliance on imported energy and the isolated nature of its power grid. However, due to the accelerated global trend of greenhouse gas emissions reduction, advancements in related technologies have progressed rapidly. While addressing the pressures of energy transition, Taiwan seeks to turn challenges into opportunities by continuously increasing the proportion of renewable energy in its energy supply and improving energy efficiency on the demand side. These efforts aim to reduce Taiwan's dependence on imported fossil fuels and enhance energy security and autonomy.

I. Energy Supply

In terms of the overall energy supply structure, Taiwan remains heavily reliant on fossil fuels. In 2024, the breakdown of energy consumption was as follows: crude oil and petroleum products accounted for 43.67%, coal and coal products for 28.48%,

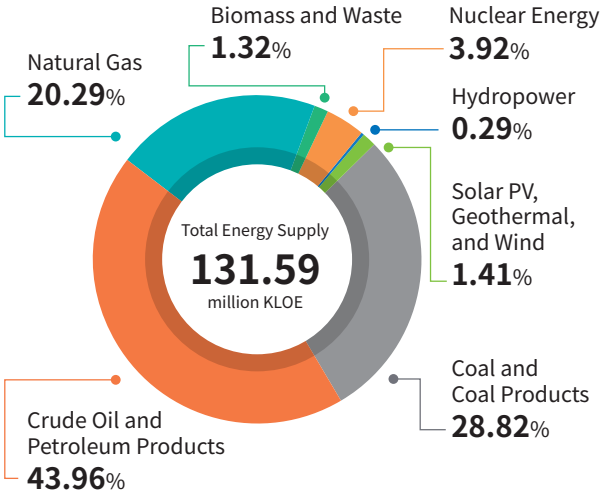


Figure 1.6-1. National Overall Energy Supply Structure in 2024

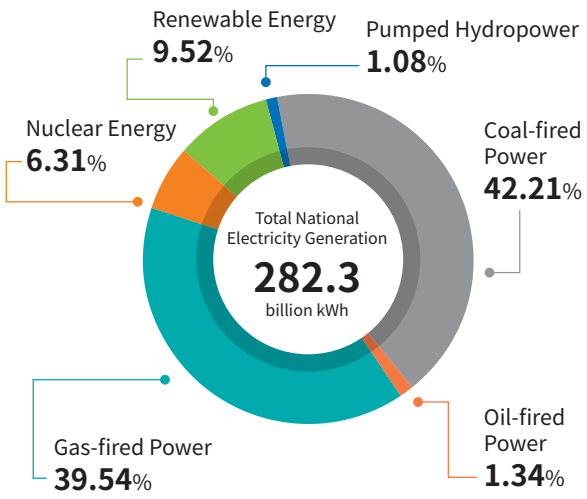


Figure 1.6-2. National Power Generation Structure in 2024

Source: Energy Administration, Ministry of Economic Affairs. (website)

Table 1.6-1. Annual Energy Supply by Energy Type

Unit: 10,000 KLOE

Year	Total Supply	Coal and Coal Product	Crude Oil and Petroleum Products	Natural Gas	Biomass and Waste	Nuclear Energy	Hydropower	Geothermal	Solar PV	Wind Power	Solar Thermal
2005	13,397.68	3,975.02	7,070.25	985.96	159.50	1,157.41	38.90	-	0.01	0.87	9.75
2006	13,671.51	4,121.70	7,122.97	1,057.59	162.81	1,154.47	39.07	-	0.01	2.64	10.24
2007	14,389.76	4,331.15	7,536.81	1,122.09	168.90	1,173.83	42.21	-	0.02	4.20	10.55
2008	13,844.53	4,218.83	6,993.15	1,219.64	172.98	1,182.16	41.14	-	0.04	5.62	10.95
2009	13,525.47	3,853.92	7,058.24	1,191.06	163.80	1,203.72	35.82	-	0.09	7.52	11.32
2010	14,166.60	4,223.62	7,026.47	1,478.91	170.69	1,205.38	40.08	-	0.21	9.81	11.43
2011	13,767.68	4,400.14	6,284.59	1,625.81	173.24	1,219.51	38.22	-	0.59	14.26	11.32
2012	14,055.06	4,253.54	6,665.86	1,708.73	175.90	1,170.43	54.18	-	1.53	13.51	11.40
2013	14,280.89	4,404.39	6,707.30	1,705.26	176.41	1,205.69	51.82	-	3.07	15.67	11.28
2014	14,714.44	4,394.08	7,045.45	1,802.63	173.01	1,227.40	41.26	-	5.05	14.34	11.22
2015	14,485.91	4,337.86	6,912.91	1,928.00	174.34	1,056.04	42.71	-	8.12	14.57	11.35
2016	14,521.27	4,303.72	7,030.74	2,003.00	168.60	916.77	62.70	-	10.60	13.92	11.21
2017	14,522.91	4,424.69	6,969.56	2,220.80	162.19	649.92	52.05	-	15.93	16.46	11.31
2018	14,744.89	4,375.52	7,042.37	2,260.64	169.46	801.44	42.82	0.00	25.83	16.34	10.47
2019	14,701.41	4,430.38	6,823.33	2,222.21	169.93	935.94	52.98	0.07	38.38	18.08	10.11
2020	13,711.23	4,160.08	5,975.75	2,377.42	168.02	910.37	28.85	0.18	58.05	22.06	10.44
2021	14,291.75	4,436.77	6,134.47	2,607.29	168.67	804.62	33.20	0.87	76.16	21.70	8.01
2022	14,049.16	4,162.16	6,152.96	2,681.41	170.42	687.83	55.77	2.39	102.02	34.18	-
2023	13,158.32	3,792.37	5,784.94	2,670.00	172.50	515.47	37.87	2.21	123.35	59.61	-
2024	13,080.18	3,724.99	5,711.76	2,831.60	175.30	352.69	40.19	2.56	142.40	98.70	-

Source: Energy Administration, Ministry of Economic Affairs. (website)

natural gas for 21.65%, nuclear power generation for 2.70%, solar photovoltaic for 1.09%, geothermal for 0.02%, wind power for 0.75%, biomass and waste for 1.34%, and hydropower for 0.31%, as shown in Figure 1.6-1.

Regarding the national power generation structure, in 2024, the majority of electricity was derived from liquified natural gas (42.45%), followed by coal (39.27%), renewable energy (11.55%), nuclear energy (4.22%), and oil (1.45%), as shown in Figure 1.6-2.

In terms of the trend of energy supply growth, Taiwan's total energy supply decreased from 133.98 million kiloliters of oil equivalent (KLOE) in 2005 to 130.80 million KLOE in 2024, representing a reduction of 2.37%. Compared to 2023, the energy supply in 2024 decreased by 0.59%. However, due to Taiwan's continued promotion of energy transition, solar photovoltaic and wind power generation increased by 15.45% and 65.58%, respectively, demonstrating initial progress toward policy goals, as shown in Table 1.6-1.

II. Energy Consumption

Petroleum products accounted for the largest share of Taiwan's overall energy consumption in 2024 at 47.51%, followed by electricity at 34.28%, natural gas at 7.76%, coal and coal products at 7.35%, thermal energy at 2.68%, and biomass and waste at only 0.42%.

Regarding the growth trend of total energy

Table 1.6-2. Annual Domestic Energy Consumption by Energy Type

Unit: 10,000 KLOE

Year	Total Consumption	Coal and Coal Product	Petroleum Products	Natural Gas	Biomass and Waste	Electricity	Solar Thermal	Thermal Energy
2005	7,691.83	746.03	4,428.43	248.04	47.49	2,087.48	9.75	124.59
2006	7,795.83	781.67	4,402.86	246.92	49.15	2,159.24	10.24	145.74
2007	8,264.42	794.98	4,722.38	256.91	49.51	2,231.06	10.55	199.04
2008	7,890.06	752.97	4,442.00	261.20	50.92	2,194.78	10.95	177.24
2009	7,797.13	686.00	4,491.54	264.41	46.45	2,109.05	11.32	188.35
2010	8,289.34	815.96	4,631.35	302.57	51.31	2,268.56	11.43	208.16
2011	8,106.97	877.91	4,322.34	338.53	48.85	2,313.27	11.32	194.75
2012	8,117.42	862.99	4,321.52	370.61	46.60	2,303.96	11.40	200.34
2013	8,352.53	929.32	4,463.41	368.33	46.71	2,342.29	11.28	191.20
2014	8,471.33	883.92	4,571.17	366.98	48.97	2,399.40	11.22	189.67
2015	8,504.13	887.04	4,598.52	385.10	49.44	2,389.07	11.35	183.60
2016	8,534.84	901.88	4,562.98	395.20	45.60	2,440.68	11.21	177.28
2017	8,509.03	848.03	4,505.66	432.94	43.13	2,497.77	11.31	170.19
2018	8,644.47	736.70	4,568.80	470.54	43.87	2,547.20	10.47	266.89
2019	8,362.46	736.08	4,305.18	482.64	43.04	2,539.13	10.11	246.29
2020	8,387.81	711.33	4,267.55	513.58	43.04	2,591.81	10.44	250.06
2021	8,827.20	745.24	4,491.17	564.27	44.39	2,705.93	8.01	268.19
2022	8,314.83	654.13	4,120.35	585.56	47.30	2,670.14	-	237.36
2023	7,871.25	580.78	3,806.64	593.68	34.23	2,642.29	-	213.62
2024	7,899.44	580.50	3,753.07	612.94	33.26	2,707.62	-	212.06

Source: Energy Administration, Ministry of Economic Affairs. (website)

consumption, Taiwan's energy consumption increased from 76.92 million KLOE in 2005 to 78.99 million KLOE in 2024, marking a growth of 2.69%. However, domestic energy consumption in 2024 decreased by 0.36% compared to 2023, as shown in Table 1.6-2.

In terms of energy consumption growth trends by sector, in 2024, the global economy was affected by inflation and high interest rates, leading to weak terminal demand and a reduction in Taiwan's industrial production capacity. The most significant decreases were observed in non-energy use and the industrial sector, which fell by 2.04% and 1.40%, respectively, compared to the previous year. In the services sector, increased leisure activities among the public drove the development of the entertainment, accommodation, and food services industries, resulting in an annual energy consumption growth rate of 0.36%, as shown in Table 1.6-3.

III. Energy Efficiency Indicators

Taiwan's per capita energy consumption decreased from 3,384.04 KLOE in 2005 to 3,371.82 KLOE in 2023, a reduction of 0.36%. In 2023, per capita energy consumption continued its downward trend compared to 2022, decreasing by 5.43%.

During the same period (2005–2023), Taiwan's energy productivity increased from NT$156.66 per KLOE to NT$279.58 per KLOE, representing a growth rate of 6.99% in 2023 compared to the previous year. This indicates that the economic output generated per unit of energy use has increased, reflecting a

Table 1.6-3. Annual Domestic Energy Consumption by Sector

Unit: 10,000 KLOE

Year	Total Consumption	Energy Sector	Industrial Sector	Transportation Sector	Agriculture Sector	Services Sector	Residential Sector	Non-Energy Use
2005	7,691.83	694.25	2,530.83	1,384.16	117.75	581.90	643.28	1,739.66
2006	7,795.83	698.34	2,626.65	1,380.60	83.75	597.20	636.37	1,772.93
2007	8,264.42	706.96	2,699.27	1,333.44	64.00	597.35	643.65	2,219.75
2008	7,890.06	634.66	2,532.81	1,255.70	80.23	597.21	638.70	2,150.74
2009	7,797.13	620.43	2,376.45	1,269.51	66.71	585.40	643.46	2,235.17
2010	8,289.34	655.17	2,667.68	1,311.23	65.08	601.42	639.40	2,349.35
2011	8,106.97	637.60	2,723.42	1,329.71	66.58	587.86	645.65	2,116.14
2012	8,117.42	649.93	2,693.51	1,302.28	71.52	577.14	629.39	2,193.65
2013	8,352.53	655.78	2,750.13	1,301.04	72.61	585.76	623.99	2,363.21
2014	8,471.33	718.42	2,716.57	1,314.36	75.48	596.30	636.14	2,414.06
2015	8,504.13	718.90	2,660.13	1,344.96	74.21	603.59	635.67	2,466.68
2016	8,534.84	715.15	2,682.41	1,383.74	73.72	603.73	662.01	2,414.08
2017	8,509.03	705.89	2,686.93	1,369.12	72.13	609.80	659.03	2,406.14
2018	8,644.47	737.21	2,766.09	1,331.80	82.61	593.89	640.86	2,492.03
2019	8,362.46	747.07	2,705.14	1,340.83	83.49	591.42	642.62	2,251.89
2020	8,387.81	706.66	2,718.16	1,351.26	78.92	591.90	677.30	2,263.61
2021	8,827.20	724.94	2,914.57	1,281.36	78.83	582.09	694.16	2,551.26
2022	8,314.83	725.96	2,754.48	1,312.50	80.26	603.93	674.69	2,163.01
2023	7,871.25	679.64	2,626.76	1,311.85	86.24	618.65	674.13	1,873.98
2024	7,899.44	685.33	2,663.43	1,300.39	89.08	636.05	689.42	1,835.74

Source: Energy Administration, Ministry of Economic Affairs. (website)

continuous improvement in overall energy efficiency, as shown in Table 1.6-4.

1.7 Transportation

The transportation sector encompasses land, sea, and air transportation and is managed by the Ministry of Transportation and Communications, which oversees national transportation administration and related industries. Its scope includes four major areas: transportation, tourism, meteorology, and postal services. Land transportation covers railways (including conventional rail, mass rapid transit, and high-speed rail) and road transportation. Sea transportation includes shipping and commercial port operations. Air transportation involves airlines and airports. A brief overview of the current status of Taiwan's land, sea, and air transportation, is shown in Table 1.7-1.

I. Land Transportation

Land transportation primarily includes road and rail transport. As of the end of 2023, Taiwan's total road length, including national highways, provincial highways, city highways, county highways, district highways, country roads, and special highways, reached 21,844 kilometers. The road network comprises 9 national highways, 97 provincial highways (48 main and 49 branch provincial

Table 1.6-4. Key Energy Indicators for Taiwan

Unit: 10,000 KLOE

Item/Year	Mid-Year Population	Per Capita Energy Consumption	Domestic Energy Consumption Elasticity	Energy Productivity (Real GDP/ Domestic Energy Consumption)	Energy Intensity (Domestic Energy Consumption/Real GDP)	Per Capita Electricity Consumption
Unit	1,000 Persons	KLOE/Person		NT$/KLOE	KLOE/NT$1,000	kWh/Person
2005	22,729.8	3,384.04	0.30	156.66	6.38	9,611.08
2006	22,823.5	3,415.71	0.23	163.49	6.12	9,900.64
2007	22,917.4	3,606.17	0.88	164.79	6.07	10,187.99
2008	22,997.7	3,430.81	-5.67	173.99	5.75	9,987.35
2009	23,078.4	3,378.54	0.73	173.22	5.77	9,563.70
2010	23,140.9	3,582.11	0.62	179.63	5.57	10,259.19
2011	23,193.5	3,495.36	-0.60	190.42	5.25	10,437.67
2012	23,270.4	3,488.31	0.06	194.40	5.14	10,361.32
2013	23,344.7	3,577.92	1.17	193.62	5.16	10,500.19
2014	23,403.6	3,619.66	0.30	199.91	5.00	10,729.12
2015	23,462.9	3,624.50	0.26	202.06	4.95	10,655.94
2016	23,515.9	3,629.38	0.17	205.69	4.86	10,861.57
2017	23,555.5	3,612.33	-0.09	213.15	4.69	11,096.96
2018	23,580.1	3,666.01	0.57	215.65	4.64	11,304.77
2019	23,596.0	3,544.01	-1.06	229.76	4.35	11,261.34
2020	23,582.2	3,556.84	0.09	236.82	4.22	11,501.73
2021	23,468.3	3,761.33	0.79	239.93	4.17	12,066.46
2022	23,320.0	3,565.54	-2.24	261.31	3.83	11,982.55
2023	23,342.5	3,371.82	-4.18	279.58	3.58	11,846.15

Source: Energy Administration, Ministry of Economic Affairs. *Energy Statistics Handbook* (2024 Edition).

Note 1: Due to revised declarations from energy providers, data from 2005–2020 may differ slightly from the 2021 edition of the report.

Note 2: Domestic energy consumption elasticity = Rate of change in domestic energy consumption / Rate of change in real GDP.

highways), 156 city and county highways, 2,267 district highways and township roads, and 35 special highways. The land transportation volume for 2023 is shown in Table 1.7-2.

As of the end of 2023, the Taiwan Railways Administration (TRA) operated a total of 241 stations and covered a service distance of 1,065.0 kilometers, including 751.1 kilometers of double-track railway, 313.9 kilometers of single-track railway, 997.7 kilometers of electrified sections, and 67.3 kilometers of non-electrified sections. During this period, the TRA owned 4,690 railway vehicles, consisting of 241 locomotives, 2,951 passenger cars, and 1,498 freight cars.

Additionally, the north–south high-speed rail (HSR) spans 350 kilometers, connecting Taipei Nangang Station in the north to Kaohsiung Zuoying Station in the south. The HSR has significantly shortened the travel time for land transportation between northern and southern Taiwan. With the convenience of well-integrated transportation systems connecting HSR stations, the western

Table 1.7-1. Transportation Volumes in Taiwan

Year	Road Length (km)	Road Surface Area (1,000 m²)	Motor Vehicles	Automobile Transport Volume		Civil Aviation Transport Volume		
			Registered Vehicles (1,000 Vehicles)	Passenger Transport Volume (Million Passenger-Kilometers)	Freight Transport Volume (Million Ton-Kilometers)	Takeoff and Landing Operations (1,000 Times)	Passenger Count (1,000 Persons)	Freight Volume (1,000 Metric Tons)
2010	40,353	478,911	21,650	16,307	29,632	360	41,091	2,336
2011	40,995	483,006	22,226	17,040	29,551	385	42,856	2,179
2012	41,924	490,797	22,346	17,586	29,851	405	46,860	2,091
2013	42,520	501,392	21,562	17,928	38,474	427	50,336	2,085
2014	41,916	489,678	21,290	18,384	37,852	455	55,357	2,222
2015	41,950	490,042	21,400	17,565	37,805	481	58,156	2,151
2016	43,365	526,241	21,511	17,379	38,533	527	63,253	2,233
2017	43,206	532,555	21,704	17,053	40,351	509	65,979	2,416
2018	43,133	533,968	21,871	17,136	44,169	547	68,904	2,463
2019	43,120	534,698	22,112	17,064	44,370	581	72,157	2,315
2020	42,138	532,827	22,297	14,303	33,199	343	18,998	2,435
2021	42,799	544,452	22,598	10,132	34,094	267	7,597	2,919
2022	42,949	546,513	22,844	10,287	33,963	307	15,486	2,635
2023	42,992	548,866	23,136	11,591	33,171	434	52,043	2,205

Source: Ministry of Transportation and Communications. *Statistical Abstract of Transportation and Communications,* 2023.

corridor has gradually developed into a one-day living circle.

To promote balanced regional development and improve the quality and efficiency of road and rail planning and operations, the *Comprehensive Plan for Freeway, Expressway, and Round-island High-efficiency Railway Networks*, as highlighted in the Ministry of Transportation and Communications' *2020 Transportation Policy White Paper*, will guide Taiwan's intercity transportation development. For railways, the core development concept is the 4×90-Minute High-efficiency Railway Network, which aims to reduce rail travel times between Taipei, Kaohsiung, Taitung, and Hualien to within 90 minutes. The plan envisions a fully connected nationwide rail network that enables round-island travel in 6 hours, with northern, central, southern, and eastern Taiwan serving as the nation's core regions.

Railway infrastructure will continue to expand, prioritizing safe transportation. Key initiatives include increasing HSR train frequency, enhancing capacity, and extending the HSR network to Yilan and Pingtung. Other projects involve dual-track electrification in the Hualien–Taitung area, improving alignment on the South Link Line and dual-tracking bottleneck sections, and dual-tracking the Coastal Line. These initiatives aim to enhance speed and expand capacity across the rail network.

Mass rapid transit (MRT) systems also serve as critical transportation modes in metropolitan areas. Currently, MRT systems are operational in Taipei City, New Taipei City (including the Danhai Light Rail, the Ankeng Light Rail, and the Circular Line), Kaohsiung, and Taichung, as well as at Taoyuan International Airport. These systems continue to progressively expand their service coverage.

II. Maritime Transport

Taiwan, which is surrounded by the sea, relies heavily on maritime transport for international trade and economic development. The island currently has seven international commercial ports and four domestic commercial ports. Maritime routes are divided into domestic and international routes, with international routes serving both cargo shipping and international cruise tourism. Meanwhile, island-wide

Table 1.7-2. Land Transportation Volumes (2021–2023)

Statistical Items				Units	2023	2022	2021
Railway	TRA Passenger Count			Million Person-Trips	219	170	155
	TRA Passenger-Kilometers			Million Passenger-Kilometers	10,300	7,968	7,030
	Seat Utilization Rate	Tze-Chiang Express		%	61.2	51.0	45.5
		Chu-Kuang Express		%	26.9	27.1	25.1
		Local Trains		%	54.2	46.4	43.5
		Ordinary Trains		%	36.7	29.3	97.0
	TRA Freight Volume (Tons)			Ten Thousand Metric Tons	692	681	661
	TRA Freight Ton-Kilometers			Million Ton-Kilometers	491	473	445
	MRT Passenger Count			Ten Thousand Person-Trips	82,762	65,446	58,888
	MRT Passenger-Kilometers			Million Passenger-Kilometers	6,809	5,418	4,908
	HSR Passenger Count			Ten Thousand Person-Trips	7,309	5,416	4,346
	HSR Passenger-Kilometers			Million Passenger-Kilometers	12,565	9,338	7,569
Highway	Road Length			Kilometers	42,992	42,949	42,799
	Total Passenger Transport	Passenger Count		Million Person-Trips	960	960	837
		Passenger-Kilometers		Million Passenger-Kilometers	11,591	11,591	10,287
	Urban Bus Passenger Transport	Passenger Count		Million Person-Trips	881	769	723
		Passenger-Kilometers		Million Passenger-Kilometers	7,560	6,829	6,580
	Highway Bus Passenger Transport	Passenger Count		Million Person-Trips	79	67	68
		Passenger-Kilometers		Million passenger-kms	4,031	3,458	3,573
	Highway Freight Transport	Tons		Million Metric Tons	504	514	517
		Ton-Kilometers		Million ton-kms	33,171	33,963	34,094
	Expressway	Vehicle Traffic Count	Total	10,000 Vehicle Trips	638,352	618,001	579,762
			Small Vehicles	10,000 Vehicle Trips	568,098	547,051	509,039
			Large Vehicles	10,000 Vehicle Trips	38,978	38,357	37,741
			Articulated Trucks	10,000 Vehicle Trips	31,277	32,593	32,982
	Motor Vehicle Registrations (by Type)	Total		1,000 vehicles	23,136	23,136	22,844
		Large Buses		1,000 vehicles	31	31	31
		Large Trucks		1,000 vehicles	176	176	173
		Small Passenger Vehicles		1,000 vehicles	7,336	7,336	7,210
		Small Trucks		1,000 vehicles	977	977	969
		Special Vehicles		1,000 vehicles	72	72	70
		Motorcycles		1,000 vehicles	14,545	14,545	14,391
	Motor Vehicles per 100 People			Vehicles per 100 People	98.8	98.2	96.7

Source: Ministry of Transportation and Communications. *Statistical Abstract of Transportation and Communications.* 2023.

transshipment routes have been used to develop a third transportation corridor that enables shipping companies to move cargo around the island via their own vessels or chartered foreign vessels. This approach shifts container transport from land to sea, effectively alleviating road congestion caused by containers traveling between the north and south .

Taiwan has six free trade ports, which are located in Keelung, Taipei, Taichung, Anping, Kaohsiung, and Su'ao. As of the first half of 2024, a total of 87 port enterprises were in operation, handling a total cargo volume of 2.67 million metric tons—a 45.12% increase compared to the same period in 2023. This growth can primarily be attributed to increased oil storage and transfer operations. However, compared to the same period in 2023, trade value decreased by 11.63% to NT$253.8 billion, mainly due to reduced semiconductor component shipments.

The *Future Development Plan for International Commercial Ports (2017–2021)* was approved by the Executive Yuan on November 12, 2016. Since then, several major projects have been completed, including the Taichung Port Offshore Wind Power Heavy Component Terminal, Phase II of the Kaohsiung Port Intercontinental Container Terminal, and the Kaohsiung Port Passenger Zone. The development of Kaohsiung Port aligns with multiple United Nations 2030 Sustainable Development Goals (SDGs), and the project earned the 2021 World Ports Sustainability Program (WPSP) Award for Resilient Physical Infrastructure.

The *Future Development Plan for International Commercial Ports (2022–2026)* was approved by the Executive Yuan for the purpose of creating high-quality port operating environments and improving overall port efficiency. The plan promotes various port construction projects, including land reclamation, terminal renovation and construction, and public infrastructure. These initiatives aim to enhance port services and improve Taiwan's international competitiveness. On the freight side, Taiwan will integrate its port network to establish a global shipping network. On the passenger side, local tourism resources will be combined to enhance terminal facilities for cruise ships. Green port development will also become a key policy direction for sustainable port development.

III. Air Transport

Civil aviation plays a critical role in Taiwan's overall economic development. To meet the growing demand for air transport, the government has actively negotiated and consulted on air service agreements, thereby expanding operational capacity and revitalizing Taiwan's aviation industry. As of the first half of 2024, eight civil aviation companies were operating scheduled domestic and international routes. Taiwan has signed air service agreements with 57 countries or regions, covering a total of 251 international scheduled routes (156 passenger routes and 95 cargo routes) and connecting 117 cities worldwide. Demand for international air passenger services has rebounded following the reopening of borders globally. During the first half of 2024, Taiwan's airports handled approximately 31.51 million passengers, which was a 37.12% increase compared to the same period in 2023.

1.8 Buildings structures

I. Green Building Labeling System

To address global climate change and resource scarcity while creating a healthy, comfortable, and sustainable living environment, the Ministry of the Interior (MOI), in its capacity as Taiwan's building regulatory authority, introduced energy-saving building regulations in 1995 and launched the Green Building Labeling System in 1999. The Green Building Labeling System is tailored to Taiwan's hot and humid subtropical climate and evaluates buildings based on four key dimensions: ecology, energy saving, waste reduction, and health. With the introduction of the Green Building Labeling System, Taiwan became the fourth country globally to implement a scientifically quantifiable green building evaluation system and the first to independently develop a green building assessment tailored to tropical and subtropical climates. Since 2017, Taiwan has also accepted applications for green building certification from overseas, thereby expanding the international influence of its certification system.

According to MOI statistics, as of the end of June 2024, a total of 13,060 green buildings had been certified nationwide. The number of green buildings certified across various counties and cities continue to rise, with private sector participation growing annually—from just 7 cases in 2002 to 585 cases in 2023.

To accelerate the promotion of green buildings, the Executive Yuan launched a series of green building initiatives in 2001, mandating that all new public buildings with construction budgets exceeding NT$50 million obtain a Green Building Label. Since 2014, public buildings with construction budgets below NT$50 million have also been required to meet two indicators: daily energy conservation and water conservation. These comprehensive green design regulations for public sector buildings have set the stage for private sector buildings to follow suit.

II. Building Energy-Efficiency Label

To enhance energy efficiency in buildings and achieve the 2050 vision for net-zero emissions in construction, the MOI established a Building Energy-Efficiency Rating and Labeling System that considers international trends and Taiwan's subtropical climate conditions. The system was initially launched on January 1, 2022, as a voluntary 1-year pilot program. Since July 1, 2023, the public building-led initiative has been used to guide private sector adoption. The program prioritizes large, energy-consuming buildings and is gradually being expanded to other types of structures. By integrating the Green Building Labeling System into the Building Energy-Efficiency Labeling System, the average building energy-saving rate is expected to improve from at least 20% to 50% by 2050. Relevant supporting measures are as follows:

1. Revised Application Guidelines

On May 31, 2023, the MOI issued the revised *Administrative Directions for Approval of Green Building and Building Energy-Efficiency Label*. The revisions enable applicants to apply for both labels simultaneously or separately, encouraging industry participation in the certification process.

2. Publication of Manuals

On December 12, 2022, the Architecture and Building Research Institute (ABRI) of the MOI published the 2023 editions of the *Green Building Evaluation Manual – Basic Version* and the *Green Building Evaluation Manual – Residential Building*. These manuals, effective from July 1, 2023, aim to align the Green Building Labeling System and the Building Energy-Efficiency Labeling System. Applicants for Green Building Label evaluation can voluntarily apply for Building Energy-Efficiency rating, either simultaneously or separately, thereby facilitating the execution of the government's net-zero emissions policy.

3. Building Energy-Efficiency Rating

The Building Energy-Efficiency Rating System (BERS) rates buildings from Level 1 to Level 7, with Level 1 being the most energy-efficient. Buildings in the top 50% of Level 1 are classified as Nearly Zero-Carbon Buildings (NZCB) and designated as Level 1+ (see Figure 1.8-1). Future buildings achieving the NZCB standard will reduce energy consumption by approximately 50%, and those that source their remaining electricity from zero-carbon renewable energy will qualify as Net-Zero Buildings (NZB).

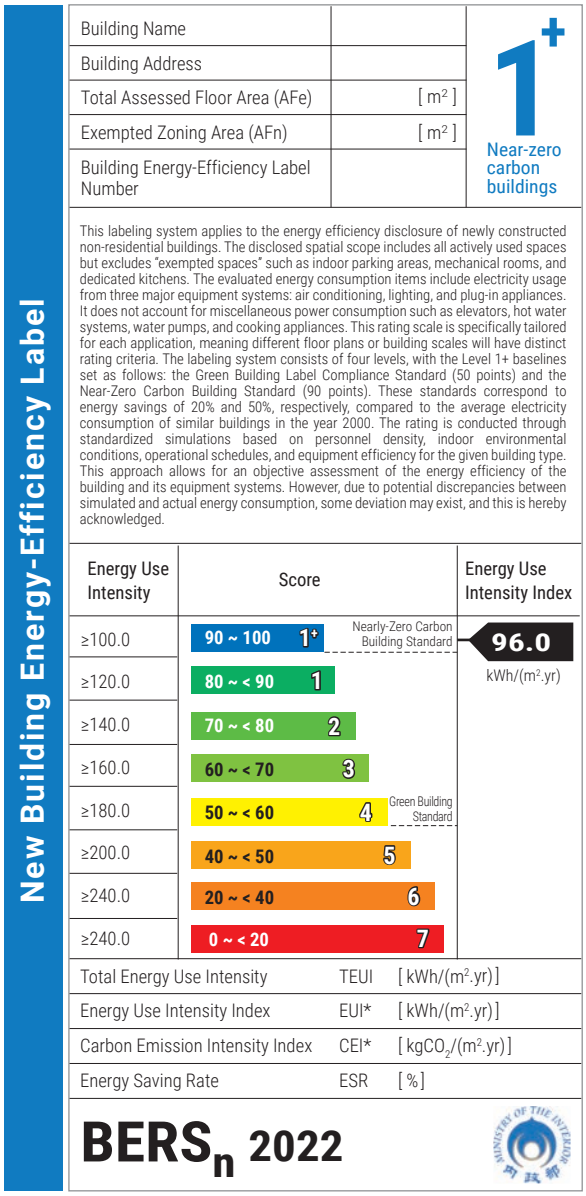


Figure 1.8-1. Example of Building Energy-Efficiency Label

Figure 1.8-2. Scheduled Timeline for the Mandatory Implementation of Building Energy-Efficiency Ratings in New Public Buildings

4. Public Sector Leadership

The initiative is being implemented in stages (see Figure 1.8-2). The first phase, starting July 1, 2023, requires new public office and service buildings to simultaneously apply for the Green Building Label and the Building Energy-Efficiency Label during their evaluations. This phased approach aims to achieve Level 1 or NZCB status for all new public buildings by 2030.

5. Codification of Building Energy-Efficiency

In 2023, the National Land Management Agency, MOI began drafting legislation to codify the Building Energy-Efficiency Rating System. Discussions and consultations with related industries are ongoing, with a target date of 2025 for completion of the legal framework.

6. Social Housing as a Model

Since 2023, all social housing and public urban renewal buildings tendered by the National Housing and Urban Regeneration Center have been required to incorporate Level 1 energy efficiency standards into their designs and planning. This initiative is expected to serve as a leading example in achieving the 2050 net-zero emissions goal. The completion of 120,000 social housing units is projected to contribute to annual carbon reduction of approximately 47,400 metric tons.

1.9 Waste Management

Early waste management policies in Taiwan primarily relied on landfills. However, with growing awareness of land use, environmental protection, and resource regeneration, these policies have undergone significant transformations. Key milestones include the establishment of large-scale incinerators in 1990, the 4-in-1 Recycling Program in 1997, the Zero Waste objective in 2004, mandatory waste sorting and recycling in 2005, Sustainable Materials Management in 2011, and the Net-Zero Transition: Resource Circulation and Zero Waste Strategy in 2023.

These policies have gradually shifted waste treatment from landfill disposal toward resource recycling and reuse, emphasizing source reduction and green design to suppress waste generation. This approach has continually reduced the amount of waste requiring final disposal, minimized the use of virgin resources, and improved resource efficiency to effectively decouple resource consumption from economic growth and advance Taiwan's net-zero transition goals.

According to the 2023 *Yearbook of Environment Statistics, Republic of China*, the treatment of general waste includes incineration, sanitary landfilling, resource recycling, and food waste recycling. In

2023, the total waste generation amounted to 12,148,718 metric tons, with the highest proportion treated through resource recycling (56.3%), followed by incineration (36.4%) and sanitary landfilling (1.3%).

Between January and June 2024, the total reported clearance volume of industrial waste was 9,861,267 metric tons, which was divided into categories such as entrusted or co-treatment, self-treatment, reuse, and overseas treatment. Reuse accounted for the largest proportion at 81.79%, followed by entrusted or co-treatment at 12.80%, demonstrating that Taiwan's waste management is predominantly focused on reuse.

The Ministry of Environment continues to subsidize local governments in establishing food waste recycling facilities tailored to regional needs. These facilities include high-speed fermentation composting equipment, traditional composting facilities, bioenergy facilities, and other diversified reuse methods, such as black soldier fly cultivation.

In 2023, the total volume of household food waste recycled nationwide was approximately 479,000 metric tons, of which feed production (for pig farming, etc.) accounted for about 198,000 metric tons (41.3%), fertilizer production (high-speed and traditional composting) accounted for about 233,000 metric tons (48.7%), energy production accounted for about 42,000 metric tons (8.7%), and other uses (e.g., black soldier fly farming and poultry farming) accounted for approximately 6,700 metric tons (1.4%).

From January to June 2024, the total volume of household food waste recycled nationwide was approximately 248,000 metric tons, of which feed production accounted for about 102,000 metric tons (41.3%), fertilizer production accounted for about 117,000 metric tons (47.2%), energy production accounted for about 24,000 metric tons (9.7%), and other uses accounted for about 5,000 metric tons (1.8%).

Currently, food waste treatment facilities in Taipei City, New Taipei City, Taoyuan City, Taichung City, Yunlin County, Tainan City, Yilan County, Hualien County, Miaoli County, and Penghu County have obtained fertilizer registration certificates approved by agricultural authorities. The Ministry of Environment will continue to assist other local governments in obtaining fertilizer registration certificates to strengthen the management mechanisms of compost products, ensure soil safety, and expand compost product distribution channels, thereby advancing the goal of circular reuse. Additionally, anaerobic digestion of food waste for energy production is particularly suitable for metropolitan areas with larger populations and higher food waste generation. Currently, Taichung City and Taoyuan City have established biomass energy plants through public–private partnerships to promote food waste-to-energy processing methods.

In terms of domestic wastewater treatment, sewer system construction has been prioritized to promote reuse of sludge and effluent from wastewater treatment plants. This initiative aims to incrementally increase the hookup rate of users to sewer systems and ensure centralized treatment to reduce public health risks and water pollution. As of 2023, the nationwide wastewater treatment rate had reached 70.0%.

Regarding industrial wastewater, the types of wastewater generated are becoming increasingly diverse and complex due to the demands of domestic and international production. To effectively manage wastewater discharge from businesses or sewer systems and to strengthen the maintenance of environmental ecosystems, the Ministry of Environment has aligned its efforts with the economic policy of resource circulation. It has also promoted amendments to the *Water Pollution Control Act* and its subsidiary regulations, actively enhancing measures for water pollution control and tightening effluent standards for specific industries. These efforts aim to improve water resource management and create a livable environment. In 2023, a total of 15,985 enterprises were monitored nationwide, with 32,589 inspections conducted. A total of 4,384 enterprises submitted 8,490 samples, and 1,309 enterprises were targeted for enforcement, resulting in 1,676 penalties.

1.10 Agriculture, Forestry, Fishery, and Animal Husbandry

I. Overview of Production

Taiwan is made up of in tropical and subtropical regions. The island has a warm climate suitable for crop growth, but it is also prone to pests and diseases, as well as frequent typhoons, heavy rains, and earthquakes, which limit agricultural development. Due to natural constraints, most

operations are small-scale, leading to high production costs. In recent years, both agricultural productivity and product quality have continuously improved. In 2023, the total agricultural production value reached NT$581 billion, with agriculture accounting for approximately 1.49% of the GDP. Nevertheless, the growth rate remains significantly lower than that of non-agricultural sectors.

In terms of agricultural land use, according to the *Agricultural Statistics Yearbook*, Taiwan had 778,516 hectares of cultivated land in 2023. Rice occupied the largest harvested area, totaling 222,413 hectares. Fruit trees occupied the second largest area, covering 173,766 hectares. Vegetables and miscellaneous grains occupied 136,732 hectares and 80,092 hectares, respectively.

In the livestock sector, pigs represented the highest single agricultural production value in 2023. In terms of livestock and by-product production, 7,484,000 pigs and 377 million chickens were supplied for slaughter, and 8 billion eggs were produced.

In the fishery sector, the total production in 2023 was approximately 895,000 metric tons, and total production value reached NT$90.52 billion. Distant-water fisheries accounted for the largest share, representing 48.6% of the total production, followed by inland aquaculture at 27.3%. Climate change caused significant fluctuations in the distribution of distant-water fishing grounds and fishery resources, leading to an 8.4% decrease in distant-water fishery production compared to that of 2022. Comparatively, coastal fisheries, inland aquaculture, and offshore fisheries demonstrated upward trends, with coastal and offshore fishery production increasing by 68.6% and 37.5%, respectively, and inland aquaculture experiencing a slight decrease of 0.5%..

II. Forestry and Nature Conservation

According to the results of the Fourth National Forest Resources Survey conducted by the Forestry and Nature Conservation Agency under the Ministry of Agriculture, Taiwan's total forest area (including Kinmen and Lienchiang County) is 2,197,090 hectares. The forest coverage rate is 60.71%, which is approximately twice the global average. Forest land as defined by the Forestry Act covers 1,781,660 hectares, whereas forests outside of designated forest land account for 415,430 hectares. The nationwide per capita forest area is 0.092 hectares per person. In terms of classification, broadleaf forests are the most prevalent, covering 1,469,898 hectares (67%), followed by coniferous forests at 299,216 hectares (14%), mixed broadleaf and coniferous forests at 171,346 hectares (8%), and bamboo forests at 112,548 hectares (5%), as shown in Figure 1.10-1. The total growing stock volume is approximately 502 million cubic meters, with an average stock volume of 228 cubic meters per hectare.

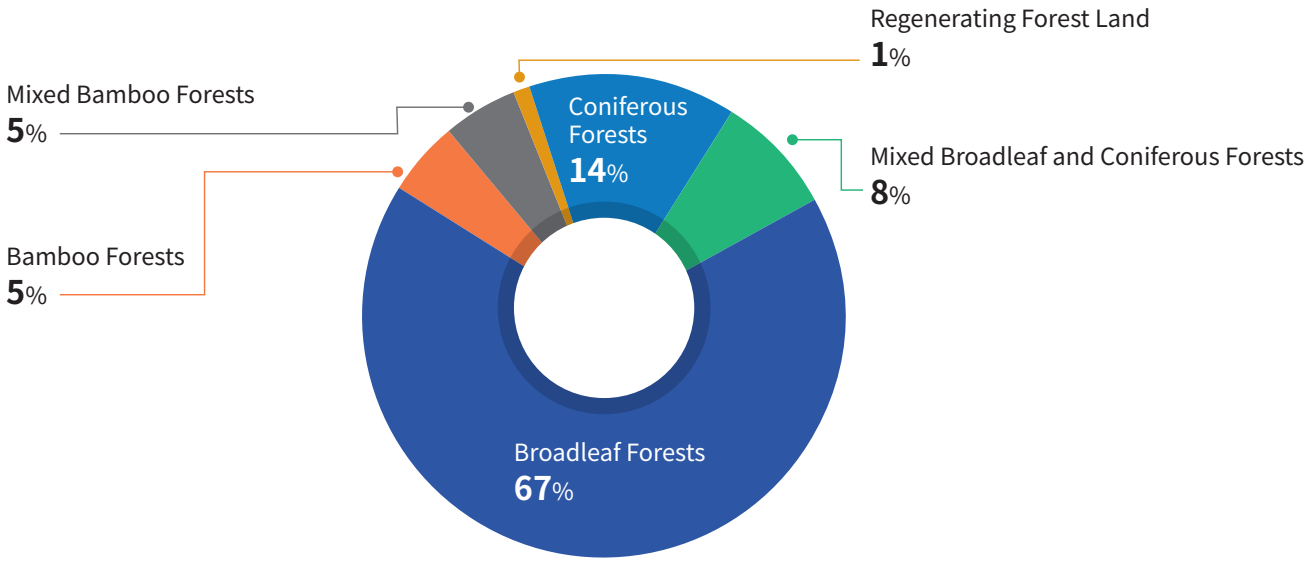


Figure 1.10-1. Forest Classifications in Taiwan

Source: Ministry of Agriculture, *Fourth National Forest Resources Survey Report,* 2016.

Currently, Taiwan's reliance on imported timber remains high. Development of the plantation forestry industry primarily focuses on private forests, with state-owned forests serving as a supplementary resource. The current policy objective is to promote the sustainable management and utilization of domestically produced timber and ensure a stable, consistent supply while expanding market demand for domestic wood and bamboo to support the growth of the forestry industry.

In 2017, the Forestry and Nature Conservation Agency introduced the Forestry Industry Revitalization Policy, which emphasizes both the development of timber products and the diversified use of non-timber resources. Key initiatives under this policy include the Counseling Program for Forestry Sustainability and Diversification and the Guidelines for the Review of Understory Economy Management and Use.

To further strengthen the bamboo industry, the Executive Yuan approved the Emerging Bamboo Industry Development Outline Plan in October 2021, followed by the Emerging Bamboo Industry Development Plan (2022–2025) in December 2022. These efforts, led by the Ministry of Agriculture, adopt an interagency approach that addresses five major dimensions: production, processing, market development, technical education, and regulatory frameworks. The plan is divided into three strategic phases: short-term revitalization, mid-term sustainability, and long-term excellence. Through this framework, the initiative aims to reconnect the bamboo supply chain—from production and processing to research, application, and sales—thereby revitalizing the entire industry ecosystem.

To implement sustainable forest management, Taiwan has adopted the Forest Stewardship Council (FSC) Certification System as a benchmark. Since 2016, demonstration forest areas have been utilized to practice FSC management standards. As of the end of 2023, over 1.22 million hectares of forest land have received FSC certification, aligning the management of state-owned forests with the strictest international standards. Sustainable forest management principles are continuously embedded into the practices and mindset of forestry personnel to ensure long-term ecological and economic benefits.

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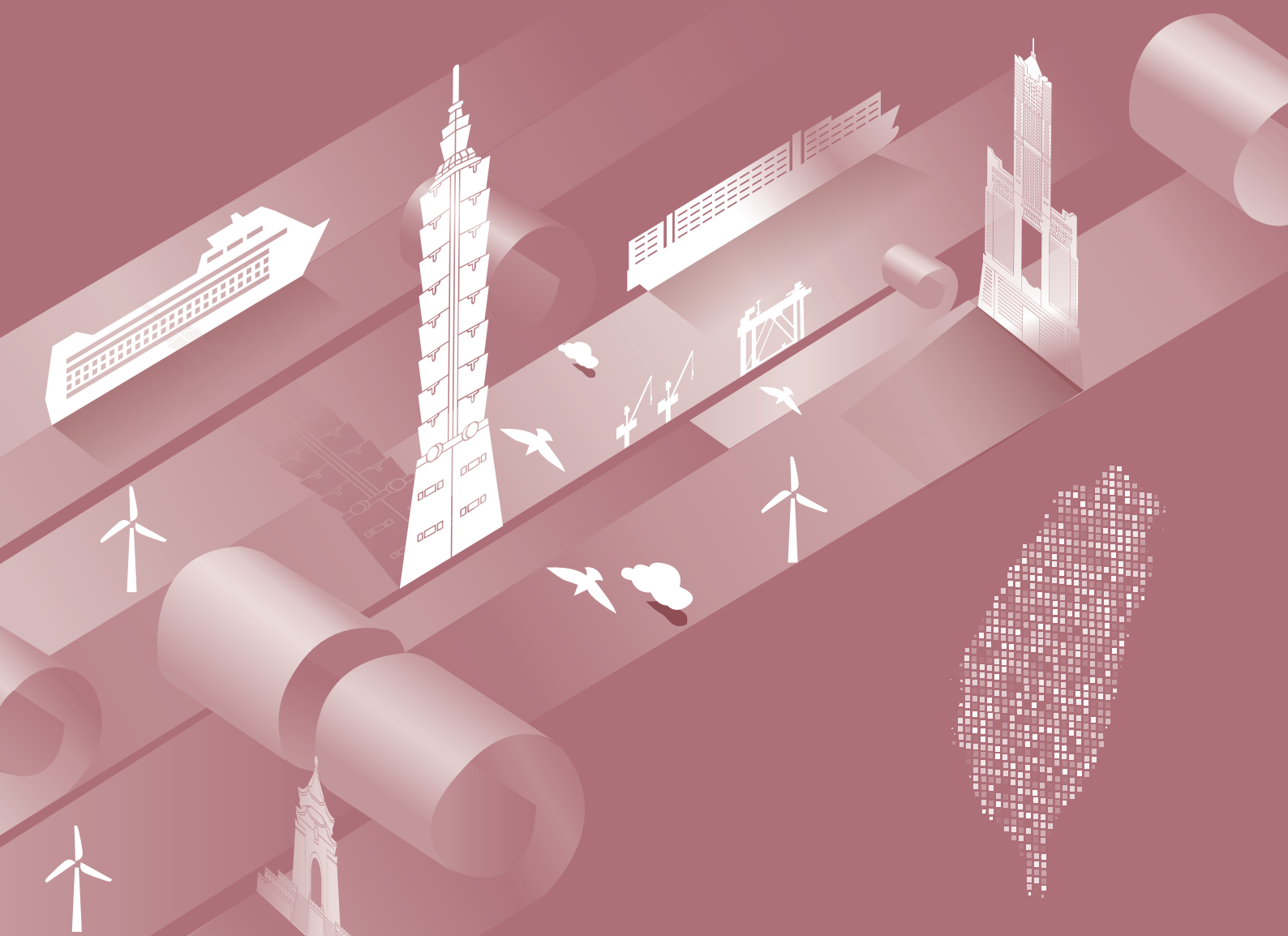
2 Greenhouse Gas Emissions, Absorption Statistics, and Trend Analysis



Chapter 2: Greenhouse Gas Emissions, Absorption Statistics, and Trend Analysis

Taiwan compiles greenhouse gas (GHG) emission statistics based on international standards, consolidating data from relevant central authorities, including the Energy Administration, Ministry of Economic Affairs; the Industrial Development Administration, Ministry of Economic Affairs, the Ministry of Agriculture; and the Ministry of Environment. These statistics are published annually in the National Greenhouse Gas Inventory Report (the "National Inventory" hereinafter) to present an overview and analysis of Taiwan's greenhouse gas emissions and trends.[1]

2.1 Compilation Process and Statistical Methods for the Greenhouse Gas Inventory

In terms of statistical methods, the inventory follows the Intergovernmental Panel on Climate Change (IPCC)'s *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, while also referencing international standards and guidelines such as the IPCC's *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (2000), and *Good Practice Guidance for Land Use, Land-Use Change, and Forestry* (2003). To support the preparation and continuous improvement of national greenhouse gas emissions and removals data, Taiwan has also incorporated the *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*, adapting its application to reflect local circumstances.

In compliance with Decision 18/CMA.1 (2018) and the requirements of the enhanced transparency framework, the National Inventory is compiled using the common reporting tables electronic format,

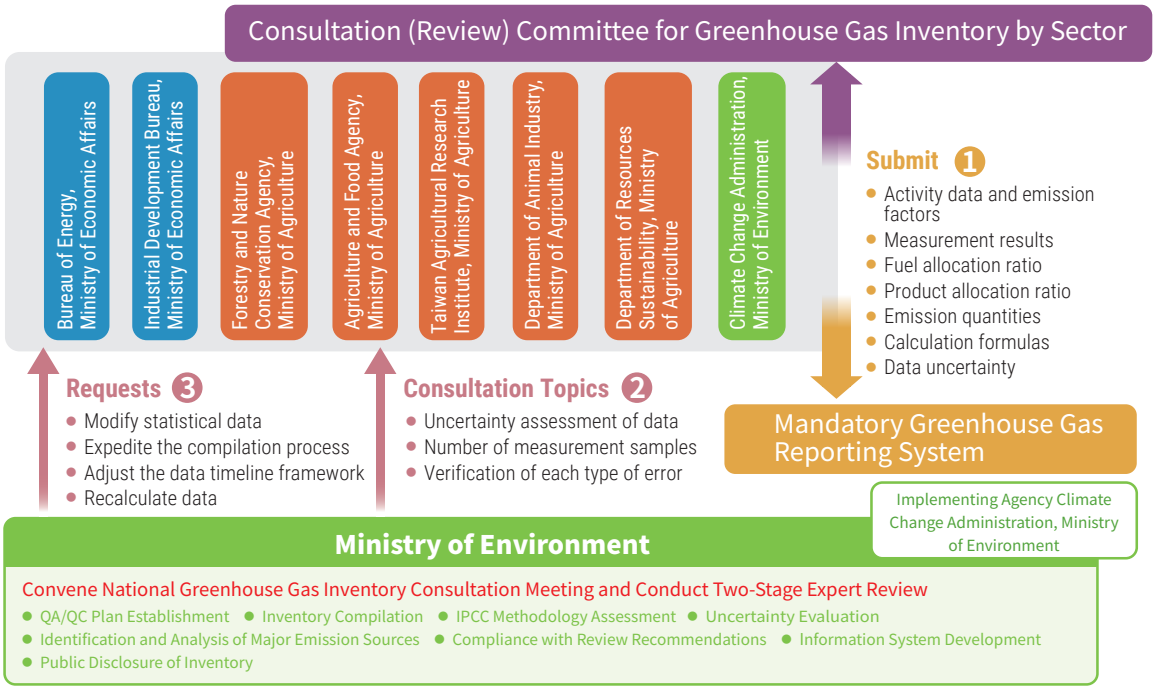


Figure 2.1-1. Preparation Process for Taiwan's National Greenhouse Gas Inventory

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

[1]In accordance with the standards for international reports, such as National Communications and National Greenhouse Gas Inventories, the units in this chapter are presented in kilotons of CO_2 equivalent ($ktCO_2e$).

following the modalities, procedures, and guidelines stipulated by the United Nations Framework Convention on Climate Change. Additionally, beginning in 2024, the National Inventory will adopt the global warming potential (GWP) values from the IPCC Fifth Assessment Report (AR5) in order to align with international requirements. The 2024 edition of the National Inventory reflects the adoption of AR5 GWP values in its calculations.

The compilation process begins with relevant ministries and agencies calculating GHG emissions for their respective sectors, followed by expert and scholarly reviews to verify accuracy of data and provide recommendations for improvement. The ministries then revise their inventories and submit them to the Ministry of Environment, along with uploading digital data to the Mandatory Greenhouse Gas Reporting System. The Ministry of Environment convenes discussions to consolidate and confirm the content of the National Inventory, which then undergoes a two-stage expert review process. Once finalized, the report is submitted and published annually, in accordance with the *Climate Change Response Act*, as shown in Figure 2.1-1.

In accordance with the standards outlined in the international guidelines, the National Inventory uses 1990 as the base year to compile data on emissions sources and sinks for the seven greenhouse gases defined in Article 3 of the *Climate Change Response Act:* carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). Data are categorized into five sectors: Energy; Industrial Processes and Product Use (IPPU); Agriculture; Land Use, Land-Use Change, and Forestry (LULUCF); and Waste. The responsible authorities for each sector are detailed in Table 2.1-1.

Table 2.1-1. Responsible Authorities for National Greenhouse Gas Inventory Sectors

Sector	Responsible Authority
Energy Sector	Energy Administration, Ministry of Economic Affairs
Industrial Processes And Product Use Sector	Industrial Development , Ministry of Economic Affairs
Agricultural Sector	Department of Resources Sustainability, Ministry of Agriculture
Land Use, Land Use Change And Forestry Sector	Forestry and Nature Conservation Agency, Ministry of Agriculture
Waste Sector	Climate Change Administration, Ministry of Environment

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

The data and emission factors for each sector in the National Inventory are described as follows:

I. Energy Sector

The greenhouse gases emitted by the energy sector include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The calculation methods for greenhouse gas emissions vary depending on the means of data classification. For CO_2, emissions are calculated based on the reference approach and sectoral approach outlined in the 2006 IPCC Guidelines. For non-CO_2 greenhouse gases, emission factors are used to estimate the emissions.

In terms of activity data, because classification of energy and fuel types in the energy sector aligns with the principles of the 2006 IPCC Guidelines, the activity data for the energy sector's greenhouse gas inventory is derived from the Energy Balance Table published by the Energy Administration, Ministry of Economic Affairs.

In terms of emission factor selection, the calculation of greenhouse gas emissions primarily utilizes the emission factors provided in the 2006 IPCC Guidelines, including carbon emission factors (CEF), fraction of carbon oxidized, and fraction of carbon stored. For emission factors not explicitly listed in the 2006 IPCC Guidelines, emission factors from other countries are adopted. For example, the emission factor for waste tires is based on the emission factor published by the U.S. Environmental Protection Agency (EPA), which is calculated using gross calorific value as the basis and is applicable to cogeneration plants in the United States.

II. Industrial Processes and Product Use Sector

The Industrial Processes and Product Use (IPPU) sector emits seven types of greenhouse

gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

Activity data for various industries and production processes within the IPPU sector are primarily sourced from government-published statistics. These data are credible, have low error rates, and ensure continuity. If government data are unavailable, statistics from industry associations are substituted, or data are obtained through direct surveys and statistical analysis conducted with industry operators.

In terms of emission factors, the calculation of greenhouse gas emissions primarily uses the emission factors provided in the 2006 IPCC Guidelines, which are adjusted to suit Taiwan's specific production conditions. Certain activities have established local emission factors, whereas others activities rely on direct measurement of actual emissions, eliminating the need for emission factors. Emissions are fully measured or local emission factors have been established for activities categorized under: the Electronics Industry (2.E), Product Uses as Substitutes for Ozone-Depleting Substances (2.F), Other Product Manufacture and Uses (2.G), and Other (2.H). Some emissions are measured directly or local emission factors have been established for the Mineral Industry (2.A), the Chemical Industry (2.B), and the Metal Industry (2.C).

III. Agricultural Sector

The greenhouse gases emitted by the agriculture sector include methane (CH_4), nitrous oxide (N_2O), and small amounts of carbon dioxide (CO_2). In terms of activity data, statistics for Taiwan's agriculture sector from 1990 to 1999 were sourced from the *Taiwan Agricultural Yearbook* published by the Department of Agriculture and Forestry, Provincial Government of Taiwan. Since 2000, the data have been derived from the *Agricultural Statistics Yearbook* compiled by the Ministry of Agriculture.

For emission factors, the calculation of greenhouse gas emissions primarily uses local values from research studies. Where local values are unavailable, the recommended values from the 2006 IPCC Guidelines are adopted. Activities that rely primarily on local emission factors include Enteric Fermentation (3.A), Manure Management (3.B), and Rice Cultivation (3.C). Activities that use emission factors provided in the 2006 IPCC Guidelines include Agricultural Soils (3.D), Field Burning of Agricultural Residues (3.F), and Urea Applications (3.H). Certain activities, such as Prescribed Burning of Savannahs (3.E), Liming (3.G), and Other Carbon-containing Fertilizers (3.I), are not currently estimated due to limited domestic management practices or low usage volumes.

IV. Land Use, Land Use Change, and the Forestry Sector

The primary greenhouse gas removed by the Land Use, Land-Use Change, and Forestry (LULUCF) sector is carbon dioxide (CO_2). Currently, calculations in Taiwan focus exclusively on the forestry component of the sector, specifically Forest Land (4.A), which includes two subcategories: Forest Land, Remaining Forest Land (4.A.1) and Land Converted to Forest Land (4.A.2).

The greenhouse gas emissions and removals in the forestry sector are estimated based on the recommendations of the 2006 IPCC Guidelines, with a methodology established based on adherence to measurable, reportable, and verifiable (MRV) principles. The calculations primarily rely on the Fourth National Forest Resources Survey for basic data and annual forestry statistics for activity data. For emission factors, Taiwan predominantly uses local data from relevant research studies. In cases where local emission factors are unavailable, the recommended values from the 2006 IPCC Guidelines are adopted.

V. Waste Sector

The greenhouse gases emitted by the waste sector include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The statistical data used to calculate greenhouse gas emissions from the waste sector encompass activity data for solid waste disposal, wastewater, incineration and open burning of waste, and other waste management activities. These data are sourced from official government statistics, including the *Yearbook of Environment Statistics, Republic of China*, biogas recovery data, incinerator data, the Water Pollution Control Management System, the Industrial Waste Report and Management System, sewer connection rates, and the Food Balance Sheet.

For emission factors, the calculation of greenhouse gas emissions primarily relies on the 2006 IPCC Guidelines and emission factors from other countries, such as Japan. Key activities include Biological Treatment of Solid Waste (5.B), Incineration and Open Burning of Waste (5.C), and

Wastewater Treatment and Discharge (5.D). Some activities, particularly Solid Waste Disposal (5.A), have established local emission factors specific to Taiwan.

To align with the phased greenhouse gas control targets, changes in greenhouse gas emissions are analyzed by using 2005 as the baseline year for the phased control targets. This analysis is linked to the national reduction goals, thereby providing a more effective means to evaluate the reduction performance for various gases and sectors in Taiwan since 2005.

2.2 Greenhouse Gas Emissions and Removal Statistics in Taiwan

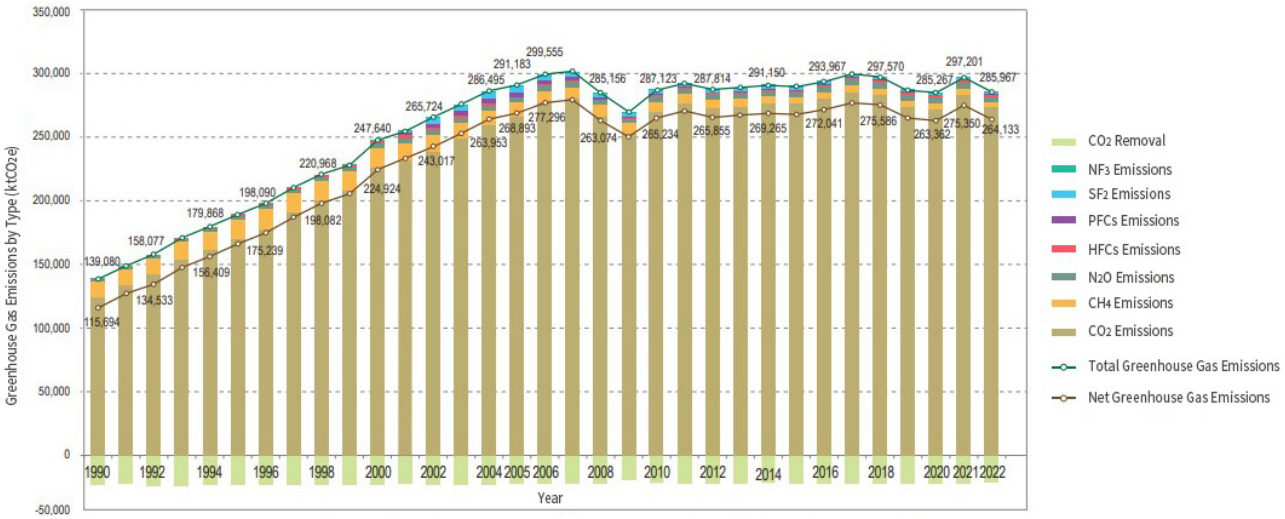


Figure 2.2-1. Trends in Taiwan's Total Greenhouse Gas Emissions and Removals (1990–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

Table 2.2-1.Taiwan's Greenhouse Gas Emissions and Removals by Type (1990–2022)

Unit: $ktCO_2e$

Greenhouse Gas	Global Warming Potential (GWP)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Carbon Dioxide (CO_2)	1	124,257	133,631	142,432	154,046	161,564	170,065	178,059	190,782	200,540	208,024	226,933
Methane (CH_4)	28	12,271	12,689	12,861	13,913	14,704	15,690	15,690	15,654	15,793	15,852	15,193
Nitrous Oxide (N_2O)	265	2,551	2,791	2,784	2,841	2,885	2,951	3,028	2,882	2,817	2,843	3,315
Hydrofluorocarbons (HFCs)	HFC-134a(1,300), etc.	NE	NE	NE	633	716	680	1,120	1,284	1,812	1,437	2,054
Perfluorocarbons (PFCs)	PFC-14(6,630), etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	2	12
Sulfur Hexafluoride (SF_6)	23,500	NE	NE	NE	NE	NE	NE	NE	NE	NE	120	124
Nitrogen Trifluoride (NF_3)	16,100	NE	NE	NE	NE	NE	NE	NE	NE	NE	10	9
Carbon Dioxide Removal	1	-23,386	-21,490	-23,544	-23,546	-23,459	-23,340	-22,851	-23,060	-22,887	-22,764	-22,717
Net GHG Emissions, Including LULUCF			127,621	134,533	147,886	156,409	166,045		187,541	198,082	205,524	224,924
Total GHG Emissions, Excluding LULUCF			149,111	158,077	171,432	179,868	189,385		210,601	228,288	228,288	247,640

Greenhouse Gas	Global Warming Potential (GWP)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Carbon Dioxide (CO_2)	1	231,431	238,568	249,129	259,397	266,888	276,536	280,076	266,884	253,033	270,715	276,773
Methane (CH_4)	28	14,367	13,580	12,750	12,004	11,386	10,623	9,831	8,978	8,058	7,525	7,173
Nitrous Oxide (N_2O)	265	3,366	3,437	3,447	3,584	3,357	4,124	4,168	3,811	3,957	4,311	4,211
Hydrofluorocarbons (HFCs)	HFC-134a(1,300), etc.	2,330	2,017	1,859	1,687	304	333	403	358	406	395	373
Perfluorocarbons (PFCs)	PFC-14(6,630), etc.	2,665	3,764	3,814	3,949	3,178	3,355	3,102	1,932	1,464	1,650	1,665
Sulfur Hexafluoride (SF_6)	23,500	769	3,986	4,471	5,288	5,052	3,940	3,485	3,001	2,527	2,286	1,976
Nitrogen Trifluoride (NF_3)	16,100	220	373	506	617	716	644	747	191	540	241	393
Carbon dioxide removal	1	-21,850	-22,707	-22,624	-22,540	-22,290	-22,259	-22,074	-22,082	-19,388	-21,889	-21,947
Net GHG Emissions, Including LULUCF		233,297		253,351	263,953	268,893	277,296	279,739		250,598	265,234	270,618
Total GHG Emissions, Excluding LULUCF		255,147		275,975	286,495	291,183	299,555	301,813		269,986	287,123	292,565
Greenhouse Gas	**Global Warming Potential (GWP)**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Carbon Dioxide (CO_2)	1	273,282	274,577	276,959	276,263	280,188	285,730	283,897	274,446	272,260	283,636	273,683
Methane (CH_4)	28	6,681	6,209	5,785	5,668	5,723	5,493	5,107	4,968	4,853	4,772	4,564
Nitrous Oxide (N_2O)	265	4,127	3,938	3,910	3,879	4,064	4,210	4,282	4,112	4,120	4,573	3,800
Hydrofluorocarbons (HFCs)	HFC-134a(1,300), etc.	398	534	646	650	757	895	1,043	1,163	1,304	1,429	1,555
Perfluorocarbons (PFCs)	PFC-14(6,630), etc.	1,054	1,253	1,449	1,250	1,336	1,304	1,421	1,315	1,336	1,354	1,250
Sulfur Hexafluoride (SF_6)	23,500	1,909	2,059	1,807	1,569	1,458	1,459	1,342	963	867	882	660
Nitrogen Trifluoride (NF_3)	16,100	363	723	624	626	442	412	477	443	528	556	455
Carbon dioxide removal	1	-21,960	-21,974	-21,886	-21,900	-21,926	-21,961	-21,984	-21,914	-21,905	-21,850	-21,834
Net GHG Emissions, Including LULUCF		265,855	267,320		268,005	272,041	277,542	275,586	265,493		275,350	264,133
Total GHG Emissions, Excluding LULUCF		287,814	289,294		289,905	293,967	299,504	297,570	287,410		297,201	285,967

Notes:

1.Global Warming Potential (GWP) values are sourced from the IPCC Fifth Assessment Report (AR5).
2.NE (Not Estimated) indicates that emissions and removals have not been investigated or estimated.
Source: Ministry of Environment. 2024 *Republic of China National Greenhouse Gas Inventory Report*. 2024.

In 2022, Taiwan's total greenhouse gas emissions amounted to 285,967 kilotons of CO_2 equivalent ($ktCO_2e$), representing a 1.79% decrease compared to 2005 (291,183 $ktCO_2e$) and a 3.78% decrease compared to 2021 (297,201 $ktCO_2e$). The trends and statistical data of Taiwan's greenhouse gas emissions are illustrated in Figure 2.2-2 and Table 2.2-1.

The trends in emissions and removals of various greenhouse gases from 2005 to 2022 are as follows:

1.Carbon Dioxide (CO_2):

From 2005 to 2022, emissions increased by 2.55%, with an average annual growth rate of 0.15%. Carbon sink removals decreased by 2.04% over the same period, with an average annual decline rate of -0.12%.

2.Methane (CH_4):

From 2005 to 2022, emissions decreased by 59.91%, with an average annual decline rate of 5.24%.

3.Nitrous Oxide (N_2O):

From 2005 to 2022, emissions increased by 3.90%, with an average annual growth rate of 0.23%.

4.Fluorinated Greenhouse Gases (SF_6, PFCs, HFCs, NF_3):

From 2005 to 2022, emissions decreased by 57.62%, with an average annual decline rate of 4.92%.

2.3 Greenhouse Gas Emissions and Removal Statistics by Gas

Taiwan's greenhouse gas inventory includes emissions data for seven types of greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_3), and nitrogen trifluoride (NF_3). Among these, CO_2 is the most significant greenhouse gas, with emissions amounting to 273,683 $ktCO_2e$ (excluding LULUCF), accounting for 95.70% of the total greenhouse gas emissions. Of the total CO_2 emissions, 90.21% originated from energy-related fuel combustion. The breakdown of greenhouse gas emissions in 2022 by gas type is illustrated in Figure 2.3-1. The following sections provide a detailed explanation of the emissions and removals for each type of greenhouse gas.

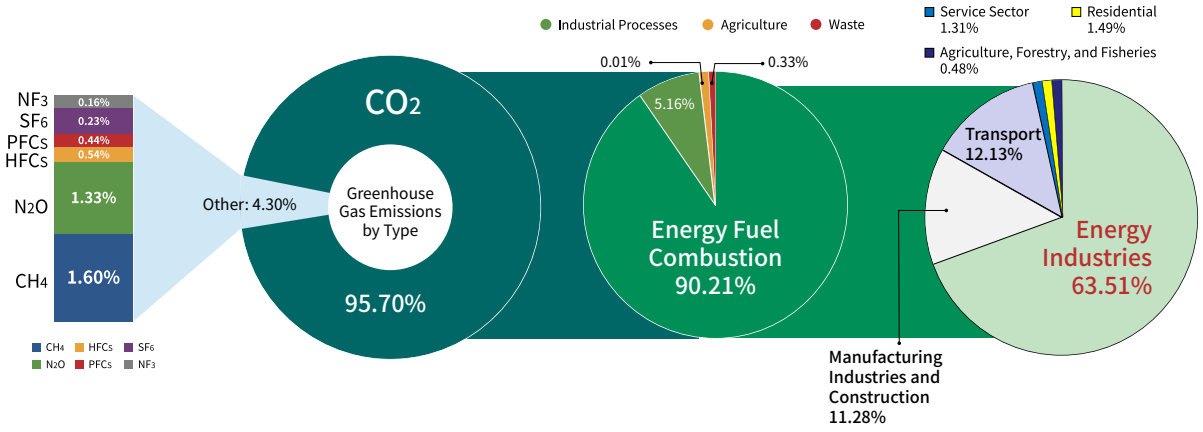


Figure 2.3-1. Greenhouse Gas Emissions by Type in 2022

Source: Ministry of Environment. 2024 *Republic of China National Greenhouse Gas Inventory Report*. 2024.

2.3.1 Carbon Dioxide (CO_2)

In terms of the overall emissions trend, Taiwan's carbon dioxide (CO_2) emissions increased from 266,888 $ktCO_2e$ in 2005 to 273,683 $ktCO_2e$ in 2022, representing a growth of 2.55% with an average annual growth rate of 0.15%. The emissions trend is illustrated in Figure 2.3.1-1.

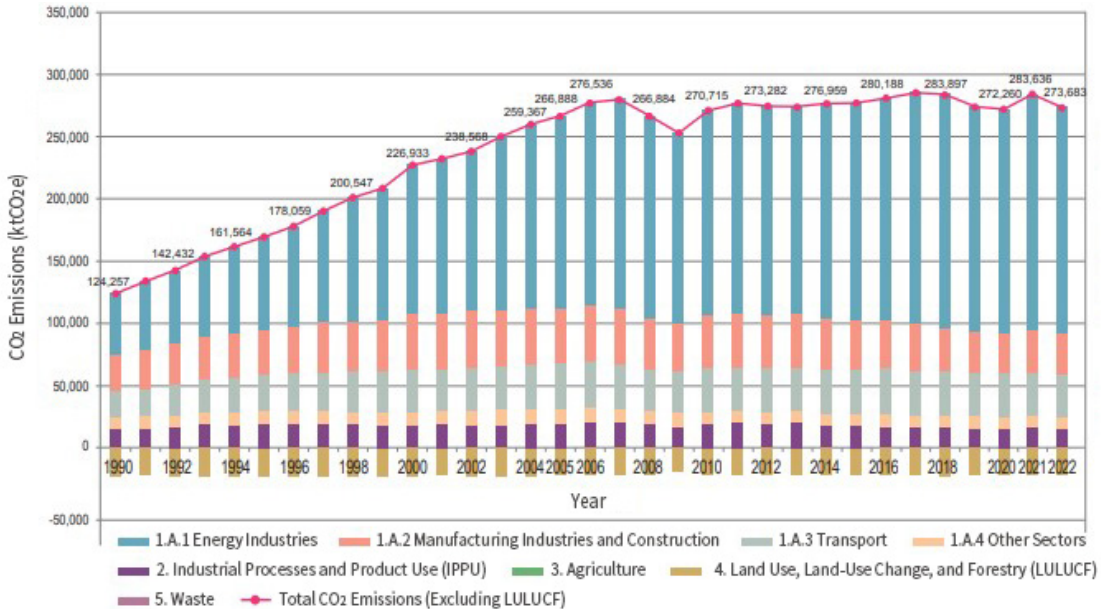


Figure 2.3.1-1. Carbon Dioxide (CO_2) Emissions Trend in Taiwan (1990–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

In terms of emission sources, the energy sector accounted for the largest share in 2022, contributing 94.25% of total CO_2 emissions. This included 66.36% from energy generation industries, 11.79% from manufacturing industries and construction, 12.68% from transport, and 3.43% from other sectors (commercial/institutional, residential, and agriculture/forestry/fishing). As for non-energy sectors, the Industrial Processes and Product Use (IPPU) sector contributed 5.40%, the agriculture sector contributed 0.01%, and the waste sector contributed 0.34%. The CO_2 emissions and removals of various sectors from 1990 to 2022 are detailed in Table 2.3.1-1.

Table 2.3.1-1. Carbon Dioxide (CO_2) Emissions in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy Sector	109,465	118,443	126,058	135,206	143,103	150,810	158,579	170,835	181,518	190,446	208,724
1.A.1 Energy Industries	49,123	55,126	57,508	64,745	69,487	75,214	80,103	90,168	99,375	104,827	119,268
1.A.2 Manufacturing Industries and Construction	30,124	31,963	34,410	34,835	35,876	36,956	37,942	40,323	40,360	42,269	45,284
1.A.3 Transport	19,646	20,888	24,033	26,103	27,540	28,822	29,801	30,536	31,844	32,772	33,207
1.A.4 Other Sectors	10,572	10,466	10,107	9,523	10,200	9,819	10,733	9,808	9,939	10,579	10,965
1.A.4.a Commercial/ Institutional	3,621	3,529	2,989	2,490	3,018	2,446	3,175	2,482	2,948	3,128	3,205
1.A.4.b Residential	4,005	4,238	4,446	4,359	4,461	4,596	4,754	4,851	4,950	5,410	5,398
1.A.4.c Agriculture/Forestry/ Fishing	2,946	2,700	2,672	2,675	2,721	2,777	2,805	2,475	2,041	2,040	2,362

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2. Industrial Processes and Product Use (IPPU) Sector	14,557	15,007	15,926	18,408	17,826	17,528	17,677	19,483	18,410	17,179	17,388
2.A Mineral Industry	10,683	10,698	11,854	13,879	13,259	12,766	12,645	13,394	11,564	10,746	10,486
2.B Chemical Industry	575	551	575	617	770	858	999	1,026	1,007	1,079	1,148
2.C Metal Industry	3,275	3,735	3,474	3,888	3,774	3,884	4,013	5,045	5,817	5,333	5,734
2.D Non-energy Products from Fuels and Solvent Use	0.00006	0.00006	0.00006	0.00007	0.00009	0.00008	0.00008	0.00008	0.00009	0.00009	0.00008
2.H Other	23	23	23	24	23	21	20	19	22	21	20
3. Agriculture Sector	142	146	139	131	135	151	151	134	127	118	131
4. LULUCF Sector	-23,386	-21,490	-23,544	-23,546	-23,459	-23,340	-22,851	-23,060	-22,887	-22,764	-22,717
5. Waste Sector	94	35	309	301	500	1,575	1,652	330	491	280	691
Net CO_2 Emissions (Including LULUCF)	100,871	112,141	118,888	130,500	138,105	146,725	155,208	167,722	177,660	185,260	204,216
Total CO_2 Emissions (Excluding LULUCF)	124,257	133,631	142,432	154,046	161,564	170,065	178,059	190,782	200,547	208,024	226,933

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. Energy Sector	212,554	220,123	229,841	239,929	247,956	255,330	259,215	247,537	235,868	251,708	257,097
1.A.1 Energy Industries	123,880	128,157	139,316	147,288	155,014	162,298	168,580	162,125	153,989	164,270	168,491
1.A.2 Manufacturing Industries and Construction	44,234	46,373	44,211	44,551	44,008	45,309	44,845	41,410	37,874	42,612	43,691
1.A.3 Transport	33,267	34,542	34,509	35,859	36,846	36,771	35,419	33,216	33,541	34,652	35,107
1.A.4 Other Sectors	11,174	11,052	11,806	12,230	12,089	10,952	10,371	10,785	10,463	10,174	9,808
1.A.4.a Commercial/ Institutional	3,538	3,487	3,952	4,120	4,227	4,272	4,232	4,226	4,264	4,203	3,898
1.A.4.b Residential	5,181	5,107	5,042	5,133	5,235	5,033	5,047	5,017	5,030	4,857	4,786
1.A.4.c Agriculture/Forestry/ Fishing	2,455	2,459	2,811	2,977	2,627	1,647	1,091	1,543	1,169	1,113	1,123
2. Industrial Processes and Product Use (IPPU) Sector	16,186	16,075	17,141	17,358	18,094	20,299	19,967	18,558	16,407	18,206	18,954
2.A Mineral Industry	9,974	10,648	10,341	10,691	11,257	11,014	10,369	9,289	8,467	8,616	9,577
2.B Chemical Industry	1,232	1,313	1,384	1,485	1,751	1,721	1,845	1,601	1,601	1,778	1,737

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.C Metal Industry	4,960	4,096	5,397	5,162	5,066	7,544	7,733	7,648	6,317	7,792	7,620
2.D Non-energy Products from Fuels and Solvent Use	0.00007	0.00008	0.00009	0.00011	0.00010	0.00007	0.00007	0.00007	0.00006	0.00005	0.00004
2.H Other	20	18	18	19	20	21	20	20	21	20	20
3. Agriculture Sector	94	93	82	84	62	59	57	57	55	54	53
4. LULUCF Sector	-21,850	-22,707	-22,624	-22,542	-22,290	-22,259	-22,074	-22,082	-19,388	-21,889	-21,947
5. Waste Sector	2,597	2,276	2,065	1,996	776	848	837	733	703	747	670
Net CO_2 Emissions (Including LULUCF)	209,582	215,860	226,505	236,825	244,599	254,277	258,002	244,802	233,645	248,826	254,826
Total CO_2 Emissions (Excluding LULUCF)	231,431	238,568	249,129	259,367	266,888	276,536	280,076	266,884	253,033	270,715	276,773

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1. Energy Sector	253,201	254,109	258,480	258,475	262,982	269,461	267,209	258,823	257,433	267,037	257,958
1.A.1 Energy Industries	166,836	167,021	173,747	173,695	177,209	185,761	187,895	180,206	179,435	188,383	181,621
1.A.2 Manufacturing Industries and Construction	42,515	43,309	40,386	39,577	39,656	38,115	34,858	33,902	32,895	35,520	32,261
1.A.3 Transport	34,284	34,209	34,666	35,506	36,584	36,202	35,202	35,438	35,715	33,905	34,696
1.A.4 Other Sectors	9,566	9,571	9,681	9,698	9,533	9,384	9,254	9,277	9,389	9,229	9,380
1.A.4.a Commercial/ Institutional	3,635	3,812	3,928	3,941	3,720	3,779	3,593	3,622	3,792	3,741	3,746
1.A.4.b Residential	4,672	4,484	4,411	4,469	4,537	4,402	4,145	4,137	4,269	4,170	4,266
1.A.4.c Agriculture/Forestry/ Fishing	1,259	1,274	1,343	1,287	1,276	1,203	1,515	1,518	1,328	1,318	1,368
2. Industrial Processes and Product Use (IPPU) Sector	19,369	19,605	17,704	17,251	16,583	15,625	16,019	14,890	13,999	15,663	14,770
2.A Mineral Industry	9,333	9,866	8,728	8,345	7,108	6,262	6,403	6,501	6,561	6,828	6,464
2.B Chemical Industry	1,714	1,749	1,884	1,842	1,760	1,709	1,684	1,666	1,550	1,730	1,270
2.C Metal Industry	8,301	7,970	7,072	7,044	7,696	7,634	7,913	6,706	5,870	7,090	7,020
2.D Non-energy Products from Fuels and Solvent Use	0.00004	0.00005	0.00006	0.00010	0.00008	0.00007	0.00006	0.00006	0.00006	0.00007	0.00006
2.H Other	21	19	19	20	19	20	19	17	18	15	15

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
3. Agriculture Sector	55	45	40	38	34	31	30	29	29	27	22
4. LULUCF Sector	-21,960	-21,974	-21,886	-21,900	-21,926	-21,961	-21,984	-21,917	-21,905	-21,850	-21,834
5. Waste Sector	657	817	736	499	589	613	639	703	798	910	933
Net CO_2 Emissions (Including LULUCF)	251,323	252,603	255,074	254,363	258,262	263,769	261,914	252,529	250,355	261,786	251,849
Total CO_2 Emissions (Excluding LULUCF)	273,282	274,577	276,959	276,263	280,188	285,730	283,897	274,446	272,260	283,636	273,683

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

2.3.2 Methane (CH_4)

In terms of the overall emissions trend, Taiwan's methane emissions decreased from 11,386 $ktCO_2e$ in 2005 to 4,564 $ktCO_2e$ in 2022, representing a reduction of 59.91% with an average annual decline rate of 5.24%. The emissions trend is illustrated in Figure 2.3.2-1.

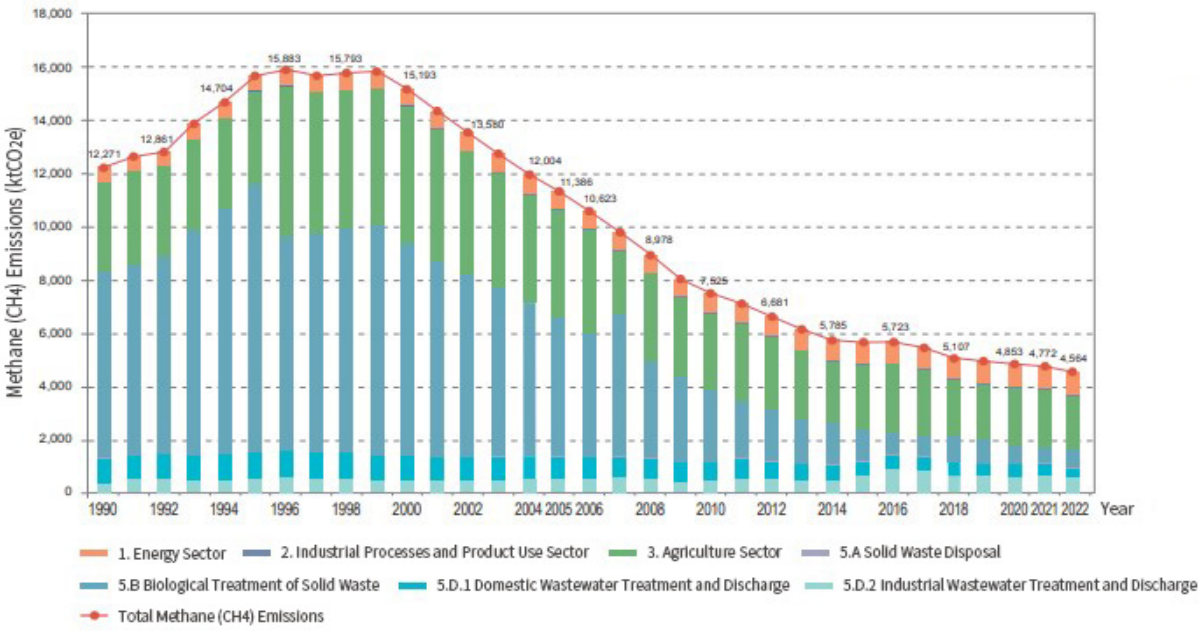


Figure 2.3.2-1. Methane Emissions Trend in Taiwan (1990–2022)

Source: Ministry of Environment. 2024 Republic of China National Greenhouse Gas Inventory Report. 2024.

In terms of emission sources, the agriculture sector accounted for the largest share of methane emissions in 2022, at 44.97%, followed by the waste sector at 36.23%, the energy sector at 18.27%, and the Industrial Processes and Product Use (IPPU) sector at 0.53%. The methane emissions of each sector from 1990 to 2022 are detailed in Table 2.3.2-1.

Table 2.3.2-1. Methane Emissions in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy Sector	592	567	557	572	589	597	582	575	599	628	643
2. Industrial Processes and Product Use (IPPU) Sector	6	8	7	8	9	11	13	13	11	13	15
3. Agriculture Sector	3,264	3,472	3,381	3,388	3,374	3,449	3,455	2,993	2,703	2,820	2,813
3.A Enteric Fermentation	750	819	826	868	883	921	921	820	755	778	775
3.B Manure Management	1,246	1,460	1,418	1,436	1,470	1,535	1,565	1,190	990	1,088	1,123
3.C Rice Cultivation	1,226	1,166	1,084	1,059	998	984	961	976	953	947	899
3.F Field Burning of Agricultural Residues	42	28	53	24	23	8	8	8	6	8	15
5. Waste Sector	8,410	8,643	8,917	9,945	10,731	11,632	11,833	12,073	12,479	12,391	11,722
5.A Solid Waste Disposal	7,102	7,206	7,431	8,492	9,252	10,112	10,231	10,496	10,962	10,958	10,310
5.B Biological Treatment of Solid Waste	13	0.6	0.9	0.5	0.2	0.7	0.3	1.6	0.06	2.2	0.3
5.D Wastewater Treatment and Discharge	1,295	1,436	1,485	1,452	1,479	1,520	1,602	1,575	1,517	1,431	1,411
5.D.1 Domestic Wastewater Treatment and Discharge	935	945	953	962	970	977	983	990	982	935	894
5.D.2 Industrial Wastewater Treatment and Discharge	360	492	531	490	509	542	619	586	534	497	517
Total Methane Emissions	12,271	12,689	12,861	13,913	14,704	15,690	15,883	15,654	15,793	15,852	15,193

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. Energy Sector	633	655	705	740	707	700	697	677	669	707	733
2. Industrial Processes and Product Use (IPPU) Sector	20	21	24	31	20	25	31	30	31	32	25
3. Agriculture Sector	2,717	2,565	2,451	2,363	2,495	2,461	2,371	2,303	2,247	2,244	2,278
3.A Enteric Fermentation	739	712	701	688	698	688	682	655	640	648	660
3.B Manure Management	1,074	1,022	1,019	1,024	1,071	1,058	994	965	924	931	944
3.C Rice Cultivation	887	816	721	643	717	706	690	676	678	659	668
3.F Field Burning of Agricultural Residues	17	14	10	9	9	9	5	7	6	6	6
5. Waste Sector	10,996	10,339	9,569	8,868	8,164	7,437	6,732	5,968	5,111	4,542	4,137
5.A Solid Waste Disposal	9,655	8,976	8,192	7,482	6,786	6,066	5,349	4,644	3,942	3,347	2,862
5.B Biological Treatment of Solid Waste	0.02	0.4	3	7	11	13	16	18	20	23	29
5.D Wastewater Treatment and Discharge	1,341	1,363	1,375	1,379	1,367	1,359	1,367	1,306	1,149	1,171	1,246
5.D.1 Domestic Wastewater Treatment and Discharge	883	868	860	833	808	783	752	728	700	689	661
5.D.2 Industrial Wastewater Treatment and Discharge	458	495	515	546	559	576	615	578	449	482	584
Total Methane Emissions	14,367	13,580	12,750	12,004	11,386	10,623	9,831	8,978	8,058	7,525	7,173

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1. Energy Sector	743	757	769	795	818	826	807	802	818	823	834
2. Industrial Processes and Product Use (IPPU) Sector	26	28	29	29	30	27	30	29	28	29	24

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
3. Agriculture Sector	2,252	2,237	2,180	2,158	2,166	2,166	2,165	2,174	2,172	2,115	2,052
3.A Enteric Fermentation	653	649	634	641	628	632	640	643	650	665	655
3.B Manure Management	904	874	840	834	829	827	832	844	845	842	821
3.C Rice Cultivation	688	710	702	678	705	704	689	684	677	608	576
3.F Field Burning of Agricultural Residues	6	4	4	5	4	4	3	2	1	1	1
5. Waste Sector	3,660	3,187	2,808	2,686	2,710	2,474	2,106	1,963	1,834	1,805	1,654
5.A Solid Waste Disposal	2,432	2,054	1,736	1,469	1,252	1,080	937	837	769	694	663
5.B Biological Treatment of Solid Waste	27	25	23	22	22	23	26	28	29	30	28
5.D Wastewater Treatment and Discharge	1,201	1,108	1,049	1,195	1,436	1,371	1,142	1,098	1,036	1,081	963
5.D.1 Domestic Wastewater Treatment and Discharge	631	609	593	572	537	512	491	445	423	395	373
5.D.2 Industrial Wastewater Treatment and Discharge	570	499	456	623	899	859	651	653	612	686	590
Total Methane Emissions	6,681	6,209	5,785	5,668	5,723	5,493	5,107	4,968	4,853	4,772	4,564

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

2.3.3 Nitrous Oxide (N_2O)

In terms of the overall emissions trend, Taiwan's nitrous oxide (N_2O) emissions increased from 3,657 $ktCO_2e$ in 2005 to 3,800 $ktCO_2e$ in 2022, representing a growth of 3.90% with an average annual growth rate of 0.23%. The emissions trend is illustrated in Figure 2.3.3-1.

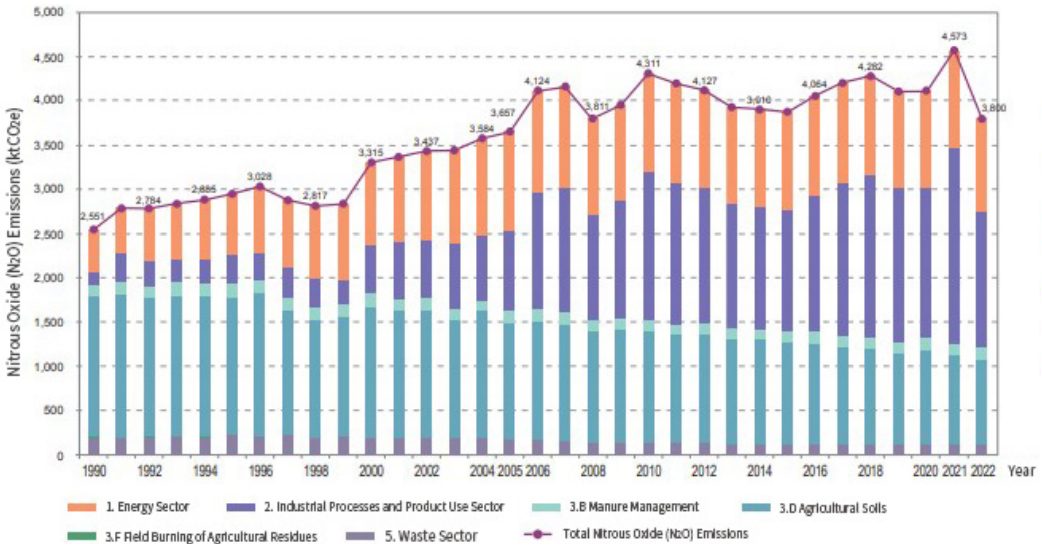


Figure 2.3.3-1. Nitrous Oxide (N_2O) Emissions Trend in Taiwan (1990–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

In terms of emission sources, the Industrial Processes and Product Use (IPPU) sector accounted for the largest share of N_2O emissions in 2022, at 40.15%, followed by the agriculture sector at 29.04% and the energy sector at 27.81%. The N_2O emissions of each sector from 1990 to 2022 are detailed in Table 2.3.3-1:

Table 2.3.3-1. Nitrous Oxide (N_2O) Emissions in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy Sector	477	514	580	626	660	692	734	770	815	861	933
1.A.1 Energy Industries	123	140	162	183	197	213	240	266	294	321	377
1.A.2 Manufacturing Industries and Construction	80	84	90	90	92	95	98	102	103	110	121
1.A.3 Transport	259	275	314	340	357	372	381	389	406	417	423
1.A.4 Other Sectors	15	15	14	12	14	13	14	12	12	13	14
2. Industrial Processes and Product Use Sector	147	313	289	268	283	307	305	333	340	277	556
3. Agriculture Sector	1,736	1,783	1,724	1,750	1,743	1,736	1,772	1,566	1,461	1,511	1,640
3.B Manure Management	129	146	145	147	154	160	167	143	129	137	140
3.D Agricultural Soils	1,597	1,630	1,567	1,597	1,583	1,574	1,603	1,422	1,331	1,372	1,496
3.F Field Burning of Agricultural Residues	10	7	13	6	6	2	2	2	2	2	4
5. Waste Sector	190	181	190	198	200	216	218	213	200	194	186
Total N_2O Emissions	2,551	2,791	2,784	2,841	2,885	2,951	3,028	2,882	2,817	2,843	3,315

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. Energy Sector	961	1,005	1,052	1,092	1,128	1,155	1,158	1,102	1,077	1,110	1,127
1.A.1 Energy Industries	403	423	472	492	518	543	566	546	526	535	539
1.A.2 Manufacturing Industries and Construction	122	128	125	127	127	130	129	118	111	121	129
1.A.3 Transport	422	441	440	456	469	469	452	425	427	442	449
1.A.4 Other Sectors	14	14	15	16	15	13	12	13	12	11	11
2. Industrial Processes and Product Use Sector	635	661	741	742	891	1,311	1,399	1,185	1,334	1,670	1,605
3. Agriculture Sector	1,574	1,576	1,460	1,565	1,468	1,493	1,462	1,388	1,413	1,398	1,343
3.B Manure Management	135	131	131	130	136	136	130	129	125	125	126
3.D Agricultural Soils	1,435	1,441	1,326	1,433	1,330	1,355	1,331	1,258	1,286	1,272	1,215
3.F Field Burning of Agricultural Residues	4	4	2	2	2	2	1	2	1	1	1
5. Waste Sector	196	195	195	185	169	164	149	136	134	133	136
Total N_2O Emissions	3,366	3,437	3,447	3,584	3,657	4,124	4,168	3,811	3,957	4,311	4,211

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1. Energy Sector	1,109	1,104	1,108	1,104	1,124	1,135	1,118	1,095	1,090	1,083	1,057
1.A.1 Energy Industries	534	528	531	519	527	550	561	537	530	544	520
1.A.2 Manufacturing Industries and Construction	124	126	120	119	118	111	93	91	89	92	80
1.A.3 Transport	440	439	445	456	468	463	453	457	461	437	446
1.A.4 Other Sectors	11	11	11	11	11	10	10	10	10	10	10
2. Industrial Processes and Product Use Sector	1,527	1,407	1,384	1,378	1,550	1,729	1,838	1,743	1,709	2,227	1,526

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
3. Agriculture Sector	1,363	1,306	1,298	1,272	1,270	1,225	1,203	1,154	1,201	1,141	1,104
3.B Manure Management	123	122	121	121	122	123	125	129	130	130	130
3.D Agricultural Soils	1,238	1,184	1,176	1,150	1,146	1,101	1,077	1,025	1,071	1,011	973
3.F Field Burning of Agricultural Residues	1.5	0.9	1.0	1.2	0.9	1.0	0.7	0.6	0.2	0.2	0.2
5. Waste Sector	128	121	120	124	120	121	123	119	121	121	114
Total N_2O Emissions	4,127	3,938	3,910	3,879	4,064	4,210	4,282	4,112	4,120	4,573	3,800

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report.* 2024.

2.3.4 Hydrofluorocarbons (HFCs)

In terms of the overall emissions trend, Taiwan's emissions of hydrofluorocarbons (HFCs) were 304 $ktCO_2e$ in 2005 and increased to 1,555 $ktCO_2e$ in 2022, representing a 410.95% increase. The average annual growth rate was 10.07%. The emissions trend is illustrated in Figure 2.3.4-1.

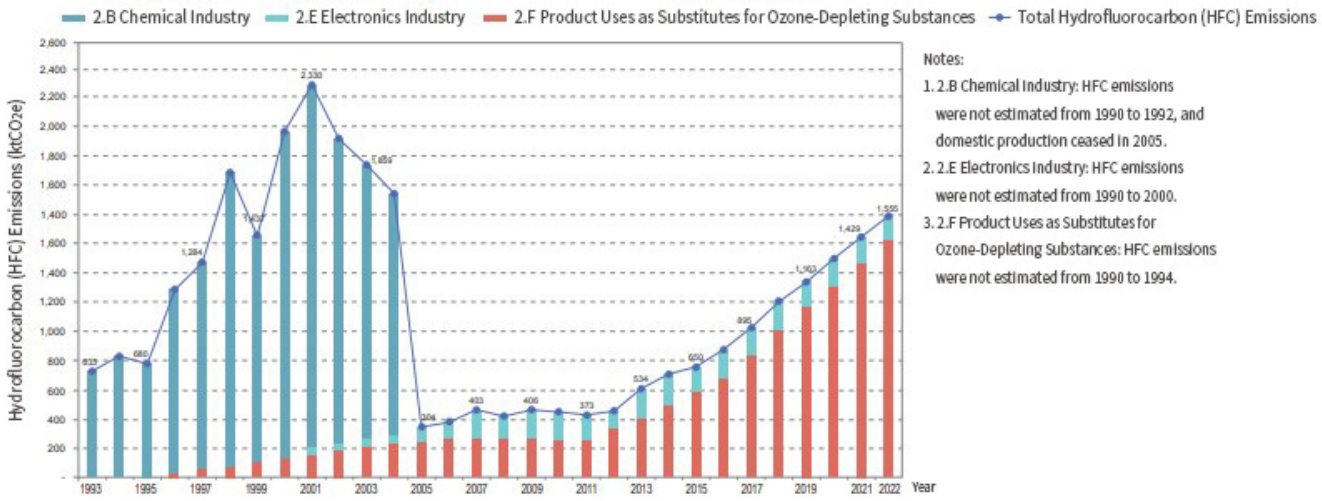


Figure 2.3.4-1. Hydrofluorocarbon (HFC) Emissions Trend in Taiwan (1993–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report.* 2024.

In terms of emission sources, the primary contributor is the Industrial Processes and Product Use sector. Regarding the chemical industry, Taiwan's sole producer of hydrochlorofluorocarbons (HCFCs), the Jenwu Plant of Formosa Plastics Corporation, ceased operations in 2004. Consequently, there have been no hydrofluorocarbon emissions since 2005. In response to the control schedule of the Montreal Protocol, Taiwan began using alternative substances in refrigeration and air-conditioning systems in 2011. This resulted in increased HFC-32, HFC-410A, and HFC-404A usage, leading to a marginal rise in emissions. Currently, mixed refrigerants are not included in the scope of the statistics. The inventory of HFC emissions from 1990 to 2022 is shown in Table 2.3.4-1.

Table 2.3.4-1. Hydrofluorocarbon (HFC) Emissions from Production in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emission	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2.B Chemical Industry	NE	NE	NE	633	716	671	1,094	1,238	1,745	1,348	1,943
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.F Product Uses as Substitutes for Ozone-Depleting Substances	NE	NE	NE	NE	NE	8	26	46	67	89	112
Total HFC Emissions	NE	NE	NE	633	716	680	1,120	1,284	1,812	1,437	2,054

Sources and Sinks of Greenhouse Gas Emission	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.B Chemical Industry	2,151	1,807	1,623	1,433	NO	NO	NO	NO	NO	NO	NO
2.E Electronics Industry	43	49	49	49	85	100	167	123	172	169	144
2.F Product Uses as Substitutes for Ozone-Depleting Substances	136	160	187	205	219	233	236	235	233	226	229
Total HFC Emissions	2,330	2,017	1,859	1,687	304	333	403	358	406	395	373

Sources and Sinks of Greenhouse Gas Emission	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2.B Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E Electronics Industry	104	173	184	142	160	169	169	152	161	156	151
2.F Product Uses as Substitutes for Ozone-Depleting Substances	294	361	431	508	597	725	875	1,012	1,143	1,273	1,405
Total HFC Emissions	398	534	616	650	757	895	1,043	1,163	1,304	1,429	1,555

Notes:

1.NO (Not Occurring) indicates no production or usage under this category in Taiwan, e.g., discontinued production. The sole domestic producer of HCFCs was only in operation from 1993 to 2004.

2.NE (Not Estimated) indicates that emissions or removals under this category have not been investigated or estimated.

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

2.3.5 Perfluorocarbons (PFCs)

In terms of the overall emissions trend, Taiwan's emissions of perfluorocarbons (PFCs) were 3,178 $ktCO_2e$ in 2005 and decreased to 1,250 $ktCO_2e$ in 2022, representing a 60.68% reduction. The average annual negative growth rate was 5.34%. The emissions trend is shown in Figure 2.3.5-1 and Table 2.3.5-1.

In terms of emission sources, the primary contributor is the semiconductor industry within the Industrial Processes and Product Use sector. In the early stages of integrated circuit or semiconductor production, comprehensive data on PFC emissions was unavailable, making it impossible to estimate emissions. Since 2004, the Taiwan Semiconductor Industry Association (TSIA) has collaborated with the government to promote voluntary reduction measures. These initiatives include the installation of abatement systems in industries such as semiconductors and optoelectronics, as well as the adoption of measurement procedures to improve processes. As a result, PFC emissions have decreased annually, as shown in Table 2.3.5-1.

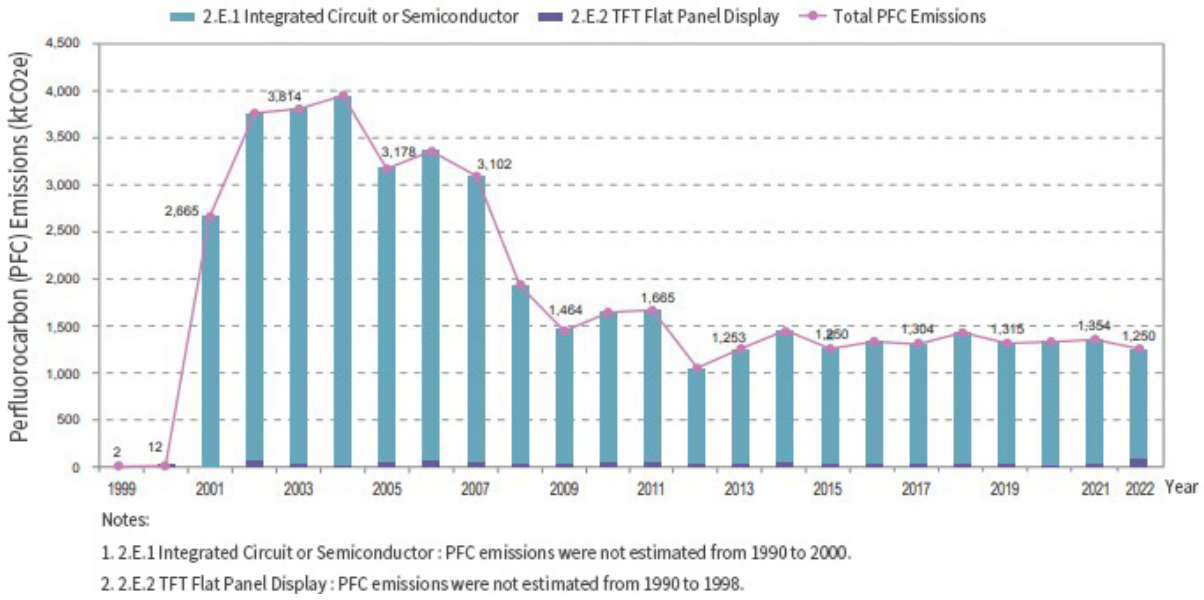


Figure 2.3.5-1. Perfluorocarbon (PFC) Emissions Trend in Taiwan (1999–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report.* 2024.

Table 2.3.5-1. Perfluorocarbon (PFC) Emissions from Production in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	2	12
2.E.1 Integrated Circuit or Semiconductor	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.E.2 TFT Flat Panel Display	NE	NE	NE	NE	NE	NE	NE	NE	NE	2	12
Total PFC Emissions	NE	NE	NE	NE	NE	NE	NE	NE	NE	2	12

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.E Electronics Industry	2,665	3,764	3,814	3,949	3,178	3,355	3,102	1,932	1,464	1,650	1,665
2.E.1 Integrated Circuit or Semiconductor	2,660	3,705	3,791	3,936	3,139	3,293	3,052	1,895	1,434	1,606	1,623
2.E.2 TFT Flat Panel Display	5	59	23	12	39	62	50	38	31	44	42
Total PFC Emissions	2,665	3,764	3,814	3,949	3,178	3,355	3,102	1,932	1,464	1,650	1,665

Sources and Sinks of Greenhouse Gas Emission	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2.E Electronics Industry	1,054	1,253	1,449	1,250	1,336	1,304	1,421	1,315	1,336	1,354	1,250
2.E.1 Integrated Circuit or Semiconductor	1,009	1,211	1,411	1,222	1,304	1,271	1,396	1,287	1,320	1,334	1,156
2.E.2 TFT Flat Panel Display	45	42	38	28	32	33	25	28	16	20	93
Total PFC Emissions	1,054	1,253	1,449	1,250	1,336	1,304	1,421	1,315	1,336	1,354	1,250

Notes:

NE (Not Estimated) indicates that emissions or removals under this category have not been investigated or estimated.

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

2.3.6 Sulfur Hexafluoride (SF_6)

In terms of the overall emissions trend, Taiwan's sulfur hexafluoride (SF_6) emissions were 5,052 $ktCO_2e$ in 2005 and decreased to 660 $ktCO_2e$ in 2022, representing an 86.93% reduction. The average annual negative growth rate was-11.28%. The emissions trend is shown in Figure 2.3.6-1 and Table 2.3.6-1.

In terms of emission sources, the primary contributors are the electronics industry and electrical equipment within the Industrial Process and Product Use sector. SF_6 emissions began to rise annually starting in 2002 due to increased use in TFT flat panel displays, electrical equipment, and magnesium production. Emissions peaked at 5,288 ktCO2e in 2004, and subsequently declined annually due to reduced use of SF_6, as shown in Table 2.3.6-1.

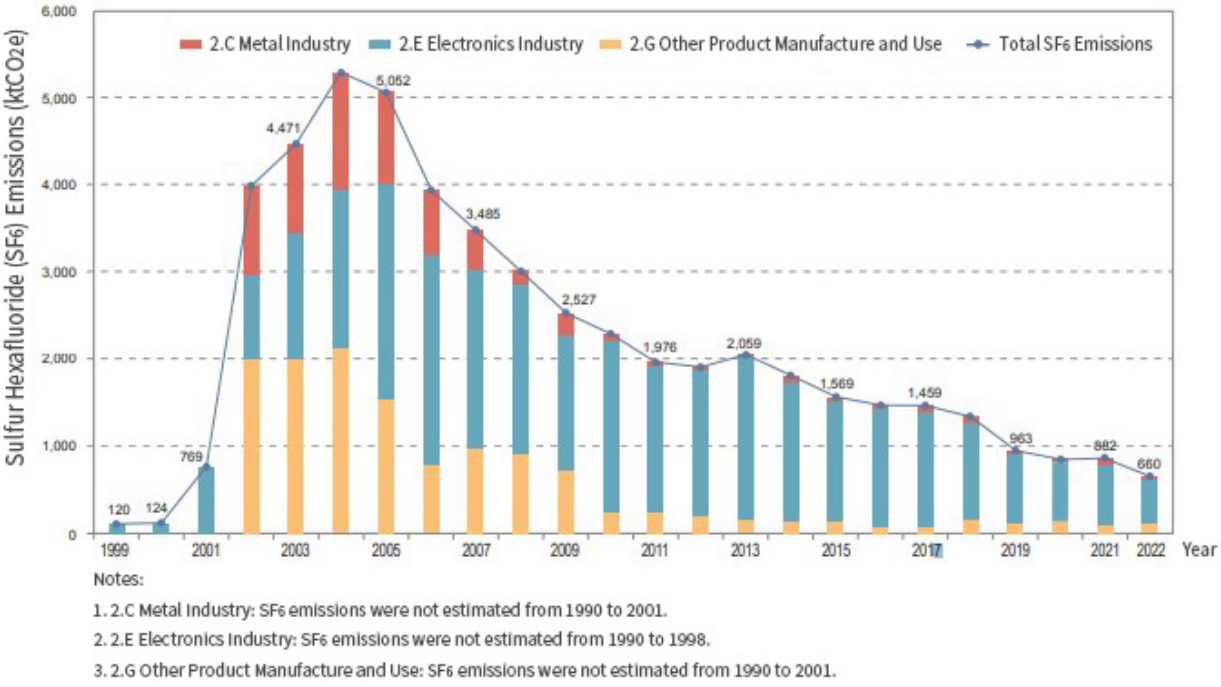


Figure 2.3.6-1. Sulfur Hexafluoride (SF_6) Emissions Trend in Taiwan (1999–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

Table 2.3.6-1. Sulfur Hexafluoride (SF_6) Emissions from Production in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2.C Metal Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	120	124
2.G Manufacturing and Use of Other Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total SF6 ☒ Emissions	NE	NE	NE	NE	NE	NE	NE	NE	NE	120	124

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.C Metal Industry	NE	1,009	1,009	1,334	1,046	757	454	149	242	59	52
2.E Electronics Industry	769	973	1,458	1,838	2,457	2,389	2,049	1,930	1,561	1,983	1,665

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.G Manufacturing and Use of Other Products	NE	2,003	2,003	2,116	1,549	794	982	923	724	245	260
Total SF6 ☒ Emissions	769	3,986	4,471	5,288	5,052	3,940	3,485	3,001	2,527	2,286	1,976

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2.C Metal Industry	31	39	58	44	39	61	84	45	37	62	27
2.E Electronics Industry	1,678	1,855	1,600	1,393	1,334	1,317	1,105	805	693	716	507
2.G Manufacturing and Use of Other Products	201	165	150	132	85	81	154	113	137	103	127
Total SF6 Emissions	1,909	2,059	1,807	1,569	1,458	1,459	1,342	963	867	882	660

Note: NE (Not Estimated) indicates that emissions from existing sources and removals by sinks have not been estimated.

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

2.3.7 Nitrogen Trifluoride (NF_3)

In terms of the overall emissions trend, Taiwan's nitrogen trifluoride (NF_3) emissions were 716 $ktCO_2e$ in 2005 and decreased to 455 $ktCO_2e$ in 2022, representing a 36.39% reduction. The average annual negative growth rate was -2.63%. The emissions trend is shown in Figure 2.3.7-1.

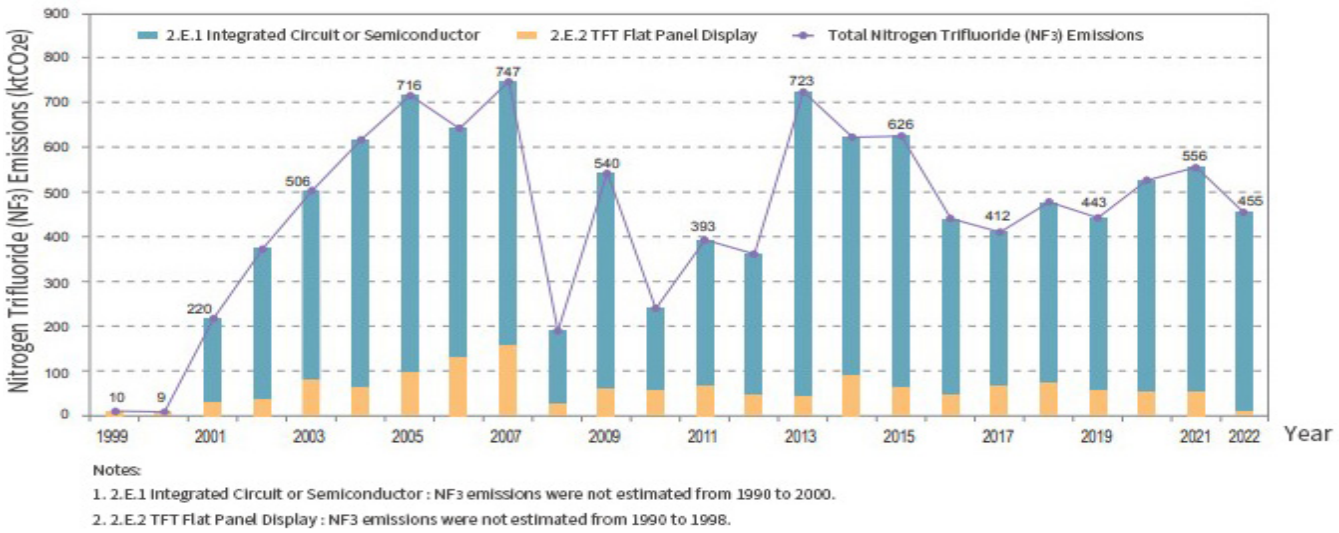


Figure 2.3.7-1. Nitrogen Trifluoride (NF_3) Emissions Trend in Taiwan (1999–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

In terms of emission sources, the primary contributor is the semiconductor industry within the Industrial Processes and Product Use sector. NF_3 emissions began to rise annually starting in 2001 due to increased semiconductor usage. However, in 2007, a sharp reduction in semiconductor usage led to decreased emissions in 2008. After 2012, increased usage of semiconductors and TFT flat panel displays caused NF_3 emissions to rise from 363 $ktCO_2e$ in 2012 to 723 $ktCO_2e$ in 2013. Starting in 2014, emissions decreased slightly each year, as shown in Table 2.3.7-1.

Table 2.3.7-1. Nitrogen Trifluoride (NF_3) Emissions in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	10	9
2.E.1 Integrated Circuit or Semiconductor	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.E.2 TFT Flat Panel Displays	NE	NE	NE	NE	NE	NE	NE	NE	NE	10	9
Total NF_3 ☒ Emissions	NE	NE	NE	NE	NE	NE	NE	NE	NE	10	9

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.E Electronics Industry	220	373	506	617	716	644	747	191	540	241	393
2.E.1 Integrated Circuit or Semiconductor	189	336	426	549	619	514	588	163	479	182	322
2.E.2 TFT Flat Panel Displays	31	36	80	67	97	130	160	29	62	59	71
Total NF_3 ☒ Emissions	220	373	506	617	716	644	747	191	540	241	393

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2.E Electronics Industry	363	723	624	626	442	412	477	443	528	556	455
2.E.1 Integrated Circuit or Semiconductor	312	680	533	562	392	343	400	385	473	504	448
2.E.2 TFT Flat Panel Displays	51	44	91	63	50	69	77	58	54	52	8
Total NF_3 ☒ Emissions	363	723	624	626	442	412	477	443	528	556	455

Note: NE (Not Estimated) indicates that emissions from existing sources and removals by sinks have not been estimated.

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

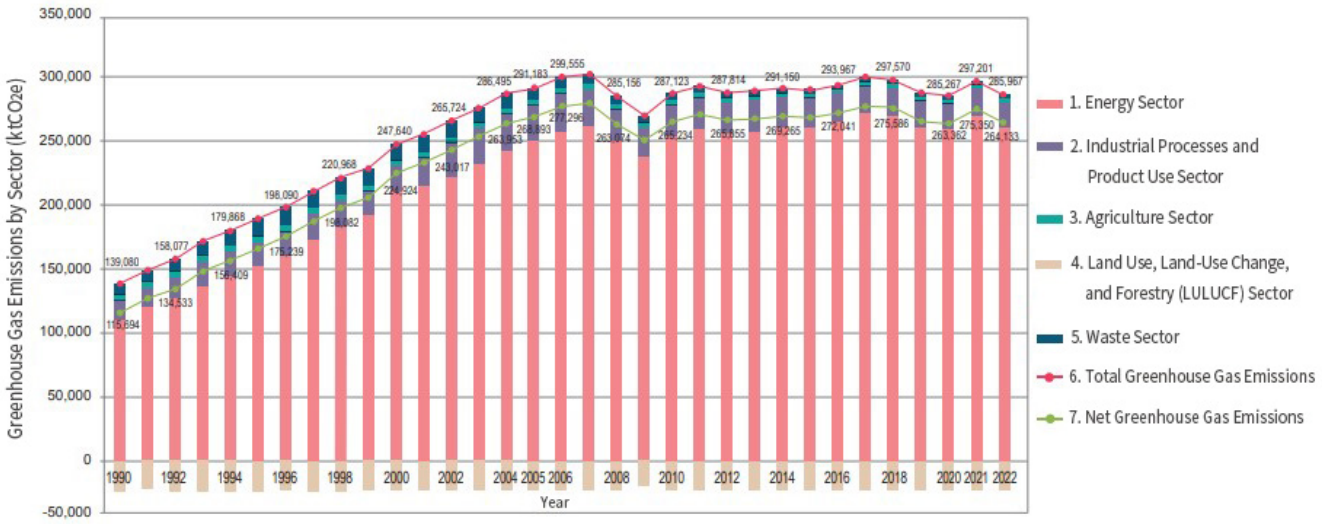


Figure 2.4-1. Greenhouse Gas Emissions Trends by Inventory Sector in Taiwan (1990–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

2.4 Greenhouse Gas Emissions and Absorption by Inventory Sector

In 2022, the total greenhouse gas emissions from the energy sector amounted to 259,849 $ktCO_2e$, accounting for 90.87% of the nation's total greenhouse gas emissions. The Industrial Processes and Product Use sector contributed 20,240 $ktCO_2e$, representing 7.08%; the agriculture sector contributed 3,178 $ktCO_2e$, accounting for 1.11%; and the waste sector contributed 2,700 $ktCO_2e$, representing 0.94%. Meanwhile, the net removals from the Land Use, Land-Use Change, and Forestry (LULUCF) sector amounted to 21,834 $ktCO_2e$. The greenhouse gas emissions trends by sector from 1990 to 2022 are illustrated in Figure 2.4-1 and detailed in Table 2.4-1.

The greenhouse gas emission profiles of each sector are as follows:

Table 2.4-1. Greenhouse Gas Emissions by Inventory Sector in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy Sector	110,535	119,523	127,195	136,404	144,352	152,099	159,894	172,180	182,933	191,935	210,300
2. Industrial Processes and Product Use Sector	14,710	15,328	16,222	19,316	18,834	18,526	19,114	21,113	20,574	19,038	20,158
3. Agriculture Sector	5,141	5,402	5,244	5,268	5,251	5,336	5,378	4,692	4,292	4,449	4,583
4. LULUCF Sector	-23,386	-21,490	-23,544	-23,546	-23,459	-23,340	-22,851	-23,060	-22,887	-22,764	-22,717
5. Waste Sector	8,694	8,858	9,415	10,444	11,430	13,424	13,703	12,616	13,170	12,865	12,599
Net Greenhouse Gas Emissions (Including LULUCF)	115,694	127,621	134,533	147,886	156,409	166,045	175,239	187,541	198,082	205,524	224,924
Total Greenhouse Gas Emissions (Excluding LULUCF)	139,080	149,111	158,077	171,432	179,868	189,385	198,090	210,601	220,968	228,288	247,640

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. Energy Sector	214,149	221,783	231,599	241,762	249,792	257,186	261,070	249,316	237,614	253,526	258,957
2. Industrial Processes and Product Use Sector	22,824	26,897	28,555	29,672	28,257	29,906	29,135	25,256	22,709	24,481	24,991
3. Agriculture Sector	4,385	4,234	3,993	4,012	4,026	4,013	3,890	3,748	3,716	3,696	3,674
4. LULUCF Sector	-21,850	-22,707	-22,624	-22,542	-22,290	-22,259	-22,074	-22,082	-19,388	-21,889	-21,947
5. Waste Sector	13,789	12,810	11,829	11,050	9,109	8,450	7,719	6,836	5,948	5,421	4,943
Net Greenhouse Gas Emissions (Including LULUCF)	233,297	243,017	253,351	263,953	268,893	277,296	279,739	263,074	250,598	265,234	270,618
Total Greenhouse Gas Emissions (Excluding LULUCF)	255,147	265,724	275,975	286,495	291,183	299,555	301,813	285,156	269,986	287,123	292,565

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1. Energy Sector	255,053	255,970	260,357	260,375	264,923	271,422	269,134	260,720	259,341	268,943	259,849
2. Industrial Processes and Product Use Sector	24,646	25,609	23,613	22,753	22,156	21,451	22,170	20,547	19,771	22,140	20,240
3. Agriculture Sector	3,670	3,588	3,518	3,468	3,469	3,423	3,397	3,358	3,402	3,283	3,178
4. LULUCF Sector	-21,960	-21,974	-21,886	-21,900	-21,926	-21,961	-21,984	-21,917	-21,905	-21,850	-21,834
5. Waste Sector	4,446	4,126	3,663	3,309	3,420	3,208	2,868	2,785	2,753	2,835	2,700
Net Greenhouse Gas Emissions (Including LULUCF)	265,855	267,320	269,265	268,005	272,041	277,542	275,586	265,493	263,362	275,350	264,133
Total Greenhouse Gas Emissions (Excluding LULUCF)	287,814	289,294	291,150	289,905	293,967	299,504	297,570	287,410	285,267	297,201	285,967

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report.* 2024.

2.4.1 Energy Sector

The greenhouse gases emitted by Taiwan's energy sector include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The total greenhouse gas emissions from this sector have shown an upward trend over the years, with the first decline observed in 2008. Emissions also decreased in 2009, 2012, and 2018. In 2022, emissions decreased by 3.38% compared to 2021, as shown in Table 2.4.1-1 and Figure 2.4.1-1.

In 2022, the total greenhouse gas emissions from the energy sector amounted to 259,849 $ktCO_2e$, accounting for approximately 90.87% of Taiwan's total greenhouse gas emissions. Of this total, 259,512 $ktCO_2e$, or 99.87%, came from Fuel Combustion Activities (1.A), whereas 337 $ktCO_2e$, or 0.11%, came from Fugitive Emissions from Fuels (1.B). Among Fuel Combustion Activities (1.A), the largest contributor was Energy Generation Industries (1.A.1), which emitted 182,243 $ktCO_2e$, accounting for 70.13% of the Energy sector's total emissions. This was followed by Transport (1.A.3), which emitted 35,451 $ktCO_2e$ (13.64%), and Manufacturing Industries and Construction (1.A.2), which emitted 32,400 $ktCO_2e$ (12.47%). Other Sectors (including commercial/institutional, residential, and agriculture/forestry/fishing) (1.A4), contributed 9,417 $ktCO_2e$, or 3.62%.

From 2005 to 2022, the energy sector's greenhouse gas emissions increased by 4.03%, with an average annual growth rate of 0.93%. During this period, emissions from Energy Generation Industries (1.A.1) increased by 17.10%, with an average annual growth rate of 0.73%. In contrast, emissions from Manufacturing Industries and Construction (1.A.2) decreased by 26.73%, with an average annual negative growth rate of -1.81%; emissions from Transport (1.A.3) decreased by 5.85%, with an average annual negative growth rate of -0.35%; and emissions from Other Sectors (1.A.4) decreased by 22.43%, with an average annual negative growth rate of -1.48%. However, emissions from Oil and Natural Gas (1.B.2) increased significantly by 120.68%, with an average annual growth rate of 4.77%.

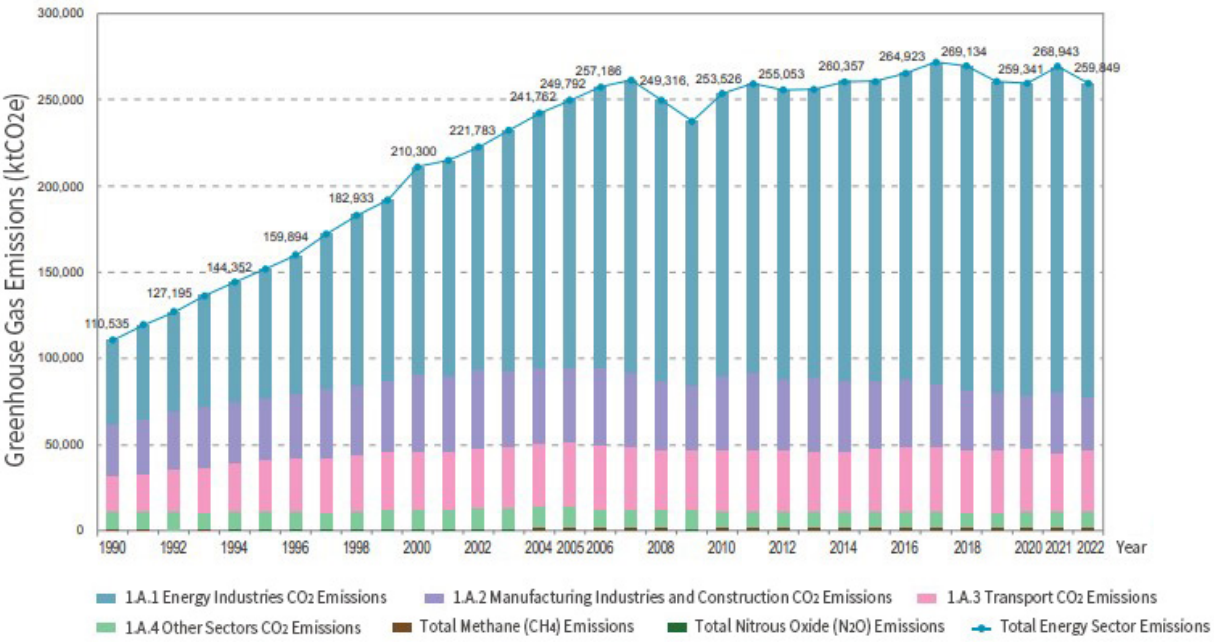


Figure 2.4.1-1. Greenhouse Gas Emissions Trend of Taiwan's Energy Sector (1990–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

Table 2.4.1-1. Greenhouse Gas Emissions from Taiwan's Energy Sector (1990–2022)

Unit: kt CO_2e

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total Carbon Dioxide Emissions	109,465	118,443	126,058	135,206	143,103	150,810	158,579	170,835	181,518	190,446	208,724
1.A.1 Energy Industries	49,123	55,126	57,508	64,745	69,487	75,214	80,103	90,168	99,375	104,827	119,268
1.A.2 Manufacturing Industries and Construction	30,124	31,963	34,410	34,835	35,876	36,956	37,942	40,323	40,360	42,269	45,284
1.A.3 Transport	19,646	20,888	24,033	26,103	27,540	28,822	29,801	30,536	31,844	32,772	33,207
1.A.4 Other Sectors	10,572	10,466	10,107	9,523	10,200	9,819	10,733	9,808	9,939	10,579	10,965
Total Methane Emissions	592	567	557	572	589	597	582	575	599	628	643
1.A.1Energy Industries	29	32	31	36	39	45	46	51	56	65	73
1.A.2 Manufacturing Industries and Construction	51	54	58	58	60	61	63	66	67	71	79
1.A.3 Transport	170	183	209	226	241	256	268	275	288	298	303
1.A.4 Other Sectors	34	33	31	29	31	30	33	29	30	31	33
1.B.1 Solid Fuels	182	155	129	126	110	90	57	38	30	35	32
1.B.2 Oil and Natural Gas	127	109	98	97	108	115	115	117	128	126	124
Total Nitrous Oxide Emissions	477	514	580	626	660	692	734	770	815	861	933
1.A.1 Energy Industries	123	140	162	183	197	213	240	266	294	321	377
1.A.2 Manufacturing Industries and Construction	80	84	90	90	92	95	98	102	103	110	121
1.A.3 Transport	259	275	314	340	357	372	381	389	406	417	423
1.A.4Other Sectors	15	15	14	12	14	13	14	12	12	13	14
Total Emissions from the Energy Sector	110,535	119,523	127,195	136,404	144,352	152,099	159,894	172,180	182,933	191,935	210,300

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Carbon Dioxide Emissions	212,554	220,123	229,841	239,929	247,956	255,330	259,215	247,537	235,868	251,708	257,097
1.A.1 Energy Industries	123,880	128,157	139,316	147,288	155,014	162,298	168,580	162,125	153,989	164,270	168,491
1.A.2 Manufacturing Industries and Construction	44,234	46,373	44,211	44,551	44,008	45,309	44,845	41,410	37,874	42,612	43,691
1.A.3 Transport	33,267	34,542	34,509	35,859	36,846	36,771	35,419	33,216	33,541	34,652	35,107
1.A.4 Other Sectors	11,174	11,052	11,806	12,230	12,089	10,952	10,371	10,785	10,463	10,174	9,808
Total Methane Emissions	633	655	705	740	707	700	697	677	669	707	733
1.A.1Energy Industries	78	77	87	90	93	98	100	98	91	96	97
1.A.2 Manufacturing Industries and Construction	81	85	83	86	85	88	87	80	76	83	89
1.A.3 Transport	305	311	321	330	339	333	324	308	314	319	322
1.A.4 Other Sectors	34	33	36	37	37	33	30	32	31	30	28

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.B.1 Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	136	148	178	197	153	148	155	159	157	180	197
Total Nitrous Oxide Emissions	961	1,005	1,052	1,092	1,128	1,155	1,158	1,102	1,077	1,110	1,127
1.A.1 Energy Industries	403	423	472	492	518	543	566	546	526	535	539
1.A.2 Manufacturing Industries and Construction	122	128	125	127	127	130	129	118	111	121	129
1.A.3 Transport	422	441	440	456	469	469	452	425	427	442	449
1.A.4Other Sectors	14	14	15	16	15	13	12	13	12	11	11
Total Emissions from the Energy Sector	214,149	221,783	231,599	241,762	249,792	257,186	261,070	249,316	237,614	253,526	258,957

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total Carbon Dioxide Emissions	253,201	254,109	258,480	258,475	262,982	269,461	267,209	258,823	257,433	267,037	257,958
1.A.1 Energy Industries	166,836	167,021	173,747	173,695	177,209	185,761	187,895	180,206	179,435	188,383	181,621
1.A.2 Manufacturing Industries and Construction	42,515	43,309	40,386	39,577	39,656	38,115	34,858	33,902	32,895	35,520	32,261
1.A.3 Transport	34,284	34,209	34,666	35,506	36,584	36,202	35,202	35,438	35,715	33,905	34,696
1.A.4 Other Sectors	9,566	9,571	9,681	9,698	9,533	9,384	9,254	9,277	9,389	9,229	9,380
Total Methane Emissions	743	757	769	795	818	826	807	802	818	823	834
1.A.1Energy Industries	96	95	98	102	103	105	105	101	100	103	102
1.A.2 Manufacturing Industries and Construction	86	88	85	84	84	79	67	66	65	67	59
1.A.3 Transport	317	318	320	327	337	331	321	321	325	301	309
1.A.4 Other Sectors	28	28	29	28	28	27	27	27	27	27	27
1.B.1 Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	216	228	238	254	267	284	288	288	302	325	337
Total Nitrous Oxide Emissions	1,109	1,104	1,108	1,104	1,124	1,135	1,118	1,095	1,090	1,083	1,057
1.A.1 Energy Industries	534	528	531	519	527	550	561	537	530	544	520
1.A.2 Manufacturing Industries and Construction	124	126	120	119	118	111	93	91	89	92	80
1.A.3 Transport	440	439	445	456	468	463	453	457	461	437	446
1.A.4Other Sectors	11	11	11	11	11	10	10	10	10	10	10
Total Emissions from the Energy Sector	255,053	255,970	260,357	260,375	264,923	271,422	269,134	260,720	259,341	268,943	259,849

Note: NO (Not Occurring) indicates that coal production in Taiwan ceased in 2001.

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

2.4.2 Industrial Processes and Product Use Sector

Taiwan's Industrial Processes and Product Use sector emits seven types of greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). Historical greenhouse gas emissions from this sector are shown in Figure 2.4.2-1 and Table 2.4.2-1.

In 2022, the total greenhouse gas emissions from this sector amounted to 20,240 $ktCO_2e$, accounting for approximately 7.08% of Taiwan's total greenhouse gas emissions. Among the subcategories, the Metal Industry (2.C) contributed the largest share, accounting for 34.82% of the sector's greenhouse gas emissions, followed by the Mineral Industry (2.A) at 31.94%, the Electronics Industry (2.E) at 15.86%, the Chemical Industry (2B) at 9.75%, Product Uses as Substitutes for Ozone-Depleting Substances (2F) at 6.94%, Other Product Manufacture and Use (2G) at 0.63%, Other (2.H) at 0.07%, and Non-energy Products from Fuels and Solvent Use (2D) at 0.0000003%.

From 2005 to 2022, greenhouse gas emissions from Industrial Processes and Product Use decreased by 24.64%, with an average annual negative growth rate of 1.75%.

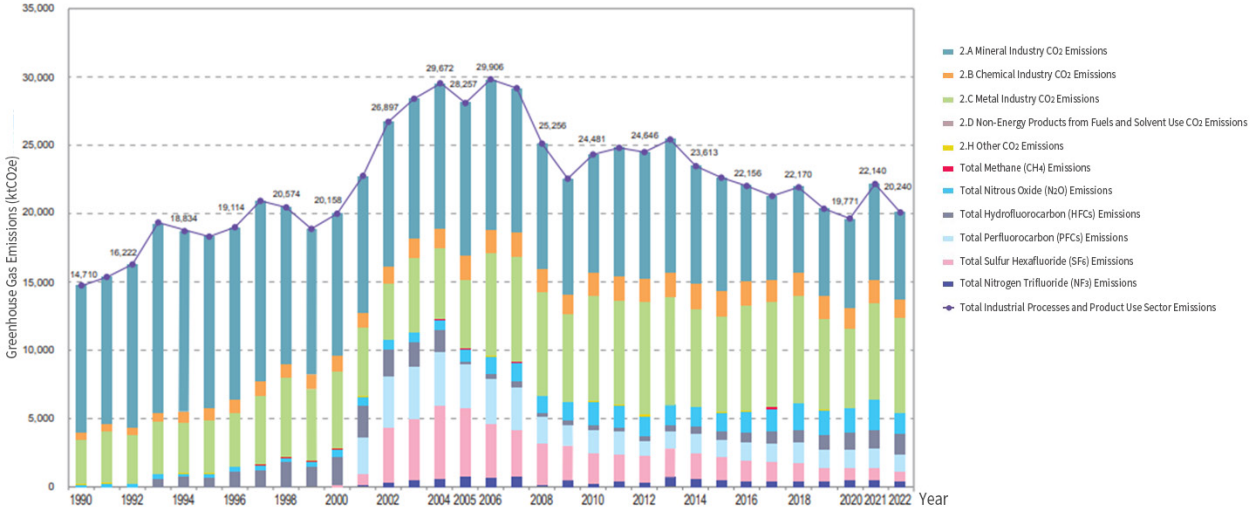


Figure 2.4.2-1. Greenhouse Gas Emissions Trend of the Industrial Processes and Product Use Sector in Taiwan (1990–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report.* 2024.

Table 2.4.2-1. Greenhouse Gas Emissions from the Industrial Processes and Product Use Sector in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total Carbon Dioxide Emissions	14,557	15,007	15,926	18,408	17,826	17,528	17,677	19,483	18,410	17,179	17,388
2.A Mineral Industry (Non-metal Products)	10,683	10,698	11,854	13,879	13,259	12,766	12,645	13,394	11,564	10,746	10,486
2.B Chemical Industry	575	551	575	617	770	858	999	1,026	1,007	1,079	1,148
2.C Metal Industry	3,275	3,735	3,474	3,888	3,774	3,884	4,013	5,045	5,817	5,333	5,734
2.D Non-energy Products from Fuels and Solvent Use	0.00006	0.00006	0.00006	0.00007	0.00009	0.00008	0.00008	0.00008	0.00009	0.00009	0.00008
2.H Other	23	23	23	24	23	21	20	19	22	21	20
Total Methane Emissions	6	8	7	8	9	11	13	13	11	13	15
2.B Chemical Industry	6	6	6	7	8	10	12	12	10	13	15

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2.C Metal Industry	0.2	2.0	1.5	1.2	1.0	1.4	1.3	1.3	1.3	0.4	0.2
Total Nitrous Oxide Emissions	147	313	289	268	283	307	305	333	340	277	556
2.B Chemical Industry	147	313	289	268	283	307	305	333	340	277	556
2.C Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total Hydrofluorocarbon (HFC) Emissions	NE	NE	NE	633	716	680	1,120	1,284	1,812	1,437	2,054
2.B Chemical Industry	NE	NE	NE	633	716	671	1,094	1,238	1,745	1,348	1,943
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.F Product Uses as Substitutes for Ozone-Depleting Substances	NE	NE	NE	NE	NE	8	26	46	67	89	112
Total Perfluorocarbon (PFC) Emissions (2.E Electronics Industry)	NE	NE	NE	NE	NE	NE	NE	NE	NE	2	12
Total Sulfur Hexafluoride (SF_6) Emissions	NE	NE	NE	NE	NE	NE	NE	NE	NE	120	124
2.C Metal Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	120	124
2.G Other Product Manufacture and Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total Nitrogen Trifluoride (NF_3) Emissions (2.E Electronics Industry)	NE	NE	NE	NE	NE	NE	NE	NE	NE	10	9
Total Emissions from the Industrial Processes and Product Use Sector	14,710	15,328	16,222	19,316	18,834	18,526	19,114	21,113	20,574	19,038	20,158

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Carbon Dioxide Emissions	16,186	16,075	17,141	17,358	18,094	20,299	19,967	18,558	16,407	18,206	18,954
2.A Mineral Industry (Non-metal Products)	9,974	10,648	10,341	10,691	11,257	11,014	10,369	9,289	8,467	8,616	9,577
2.B Chemical Industry	1,232	1,313	1,384	1,485	1,751	1,721	1,845	1,601	1,601	1,778	1,737
2.C Metal Industry	4,960	4,096	5,397	5,162	5,066	7,544	7,733	7,648	6,317	7,792	7,620
2.D Non-energy Products from Fuels and Solvent Use	0.00007	0.00008	0.00009	0.00011	0.00010	0.00007	0.00007	0.00007	0.00006	0.00005	0.00004
2.H Other	20	18	18	19	20	21	20	20	21	20	20
Total Methane Emissions	20	21	24	31	20	25	31	30	31	32	25
2.B Chemical Industry	20	21	24	31	20	20	26	24	27	26	25
2.C Metal Industry	0.1	0.2	0.3	NO	NO	4.8	4.8	5.5	3.9	6.2	0.02
Total Nitrous Oxide Emissions	635	661	741	742	891	1,311	1,399	1,185	1,334	1,670	1,605
2.B Chemical Industry	635	661	739	742	854	861	886	697	895	1,040	1,062
2.C Metal Industry	NO	0.4	1.5	NO	NO	84	85	81	68	107	NO
2.E Electronics Industry	NE	NE	NE	NE	37	365	428	407	371	523	543

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Hydrofluorocarbon (HFC) Emissions	2,330	2,017	1,859	1,687	304	333	403	358	406	395	373
2.B Chemical Industry	2,151	1,807	1,623	1,433	NO	NO	NO	NO	NO	NO	NO
2.E Electronics Industry	43	49	49	49	85	100	167	123	172	169	144
2.F Product Uses as Substitutes for Ozone-Depleting Substances	136	160	187	205	219	233	236	235	233	226	229
Total Perfluorocarbon (PFC) Emissions (2.E Electronics Industry)	2,665	3,764	3,814	3,949	3,178	3,355	3,102	1,932	1,464	1,650	1,665
Total Sulfur Hexafluoride (SF_6) Emissions	769	3,986	4,471	5,288	5,052	3,940	3,485	3,001	2,527	2,286	1,976
2.C Metal Industry	NE	1,009	1,009	1,334	1,046	757	454	149	242	59	52
2.E Electronics Industry	769	973	1,458	1,838	2,457	2,389	2,049	1,930	1,561	1,983	1,665
2.G Other Product Manufacture and Use	NE	2,003	2,003	2,116	1,549	794	982	923	724	245	260
Total Nitrogen Trifluoride (NF_3) Emissions (2.E Electronics Industry)	220	373	506	617	716	644	747	191	540	241	393
Total Emissions from the Industrial Processes and Product Use Sector	22,824	26,897	28,555	29,672	28,257	29,906	29,135	25,256	22,707	24,481	24,991

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total Carbon Dioxide Emissions	19,369	19,605	17,704	17,251	16,583	15,625	16,019	14,890	13,999	15,663	14,770
2.A Mineral Industry (Non-metal Products)	9,333	9,866	8,728	8,345	7,108	6,262	6,403	6,501	6,561	6,828	6,464
2.B Chemical Industry	1,714	1,749	1,884	1,842	1,760	1,709	1,684	1,666	1,550	1,730	1,270
2.C Metal Industry	8,301	7,970	7,072	7,044	7,696	7,634	7,913	6,706	5,870	7,090	7,020
2.D Non-energy Products from Fuels and Solvent Use	0.00004	0.00005	0.00006	0.00010	0.00008	0.00007	0.00006	0.00006	0.00006	0.00007	0.00006
2.H Other	21	19	19	20	19	20	19	17	18	15	15
Total Methane Emissions	26	28	29	29	30	27	30	29	28	29	24
2.B Chemical Industry	26	28	29	29	30	27	30	29	28	29	24
2.C Metal Industry	0.07	0.1	0.2	0.2	0.2	NO	0.01	0.01	0.0001	NO	NO
Total Nitrous Oxide Emissions	1,527	1,407	1,384	1,378	1,550	1,729	1,838	1,743	1,709	2,227	1,526
2.B Chemical Industry	904	694	647	614	854	991	987	828	541	1,053	679
2.C Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E Electronics Industry	623	713	737	764	696	738	851	916	1,168	1,174	847
Total Hydrofluorocarbon (HFC) Emissions	398	534	616	650	757	895	1,043	1,163	1,304	1,429	1,555
2.B Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E Electronics Industry	104	173	184	142	160	169	169	152	161	156	151
2.F Product Uses as Substitutes for Ozone-Depleting Substances	294	361	431	508	597	725	875	1,012	1,143	1,273	1,405

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total Perfluorocarbon (PFC) Emissions (2.E Electronics Industry)	1,054	1,253	1,449	1,250	1,336	1,304	1,421	1,315	1,336	1,354	1,250
Total Sulfur Hexafluoride (SF_6) Emissions	1,909	2,059	1,807	1,569	1,458	1,459	1,342	963	867	882	660
2.C Metal Industry	31	39	58	44	39	61	84	45	37	62	27
2.E Electronics Industry	1,678	1,855	1,600	1,393	1,334	1,317	1,105	805	693	716	507
2.G Other Product Manufacture and Use	201	165	150	132	85	81	154	113	137	103	127
Total Nitrogen Trifluoride (NF_3) Emissions (2.E Electronics Industry)	363	723	624	626	442	412	477	443	528	556	455
Total Emissions from the Industrial Processes and Product Use Sector	24,646	25,609	23,613	22,753	22,156	21,451	22,170	20,547	19,771	22,140	20,240

Notes:

1.NE (Not Estimated): Indicates that emissions from existing sources and absorption by sinks have not been estimated.

2.NO (Not Occurring): Indicates that there is no production or use under this category in Taiwan. For example, HCFC-22 was first produced in 1993 and ceased production in 2005.

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

2.4.3 Agriculture Sector

The greenhouse gases emitted by Taiwan's agriculture sector are methane (CH_4), nitrous oxide (N_2O), and a small amount of carbon dioxide (CO_2). In 2022, the agriculture sector emitted a total of 3,178 $ktCO_2e$, accounting for approximately 1.11% of Taiwan's total greenhouse gas emissions. N_2O emissions from Agricultural Soils (3.D) accounted for 30.61% of the sector's emissions, ranking it highest among the subcategories. Methane emissions from Manure Management (3.B), Enteric Fermentation (3.A), and Rice Cultivation (3.C) accounted for 29.92%, 20.60%, and 18.13% of the total, respectively. These trends are shown in Figure 2.4.3-1 and Table 2.4.3-1.

From 2005 to 2022, greenhouse gas emissions from the agriculture sector decreased by approximately 21.05%, with an average annual negative growth rate of 1.38%. The largest reductions were observed in Agricultural Soils (3.D), followed by Manure Management (3.B).

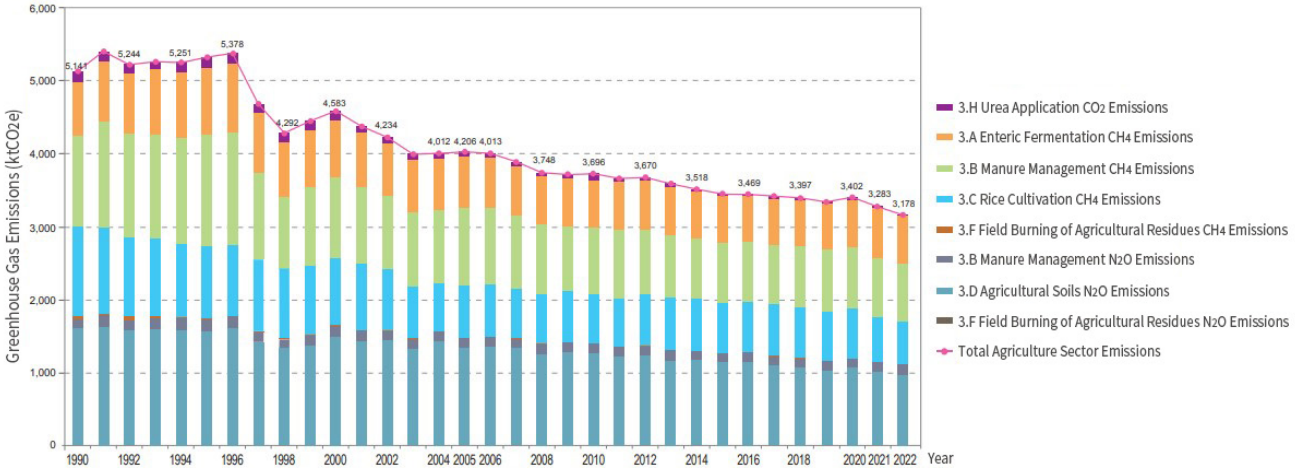


Figure 2.4.3-1. Greenhouse Gas Emissions Trend of Taiwan's Agriculture Sector (1990–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

Table 2.4.3-1. Greenhouse Gas Emissions from the Agriculture Sector in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total Carbon Dioxide Emissions (3.H Urea Application)	142	146	139	131	135	151	151	134	127	118	131
Total Methane Emissions	3,264	3,472	3,381	3,388	3,374	3,449	3,455	2,993	2,703	2,820	2,813
3.A Enteric Fermentation	750	819	826	868	883	921	921	820	755	778	775
3.B Manure Management	1,246	1,460	1,418	1,436	1,470	1,535	1,565	1,190	990	1,088	1,123
3.C Rice Cultivation	1,226	1,166	1,084	1,059	998	984	961	976	953	947	899
3.F Field Burning of Agricultural Residues	42	28	53	24	23	8	8	8	6	8	15
Total Nitrous Oxide Emissions	1,736	1,783	1,724	1,750	1,743	1,736	1,772	1,566	1,461	1,511	1,640
3.B Manure Management	129	146	145	147	154	160	167	143	129	137	140
3.D Agricultural Soils	1,597	1,630	1,567	1,597	1,583	1,574	1,603	1,422	1,331	1,372	1,496
3.F Field Burning of Agricultural Residues	10	7	13	6	6	2	2	2	2	2	4
Total Emissions from the Agriculture Sector	5,141	5,402	5,244	5,268	5,251	5,336	5,378	4,692	4,292	4,449	4,583

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Carbon Dioxide Emissions (3.H Urea Application)	94	93	82	84	62	59	57	57	55	54	53
Total Methane Emissions	2,717	2,565	2,451	2,363	2,495	2,461	2,371	2,303	2,247	2,244	2,278
3.A Enteric Fermentation	739	712	701	688	698	688	682	655	640	648	660
3.B Manure Management	1,074	1,022	1,019	1,024	1,071	1,058	994	965	924	931	944
3.C Rice Cultivation	887	816	721	643	717	706	690	676	678	659	668
3.F Field Burning of Agricultural Residues	17	14	10	9	9	9	5	7	6	6	6
Total Nitrous Oxide Emissions	1,574	1,576	1,460	1,565	1,468	1,493	1,462	1,388	1,413	1,398	1,343
3.B Manure Management	135	131	131	130	136	136	130	129	125	125	126
3.D Agricultural Soils	1,435	1,441	1,326	1,433	1,330	1,355	1,331	1,258	1,286	1,272	1,215
3.F Field Burning of Agricultural Residues	4	4	2	2	2	2	1	2	1	1	1
Total Emissions from the Agriculture Sector	4,385	4,234	3,993	4,012	4,026	4,013	3,890	3,748	3,716	3,696	3,674

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total Carbon Dioxide Emissions (3.H Urea Application)	55	45	40	38	34	31	30	29	29	27	22
Total Methane Emissions	2,252	2,237	2,180	2,158	2,166	2,166	2,165	2,174	2,172	2,115	2,052
3.A Enteric Fermentation	653	649	634	641	628	632	640	643	650	665	655

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
3.B Manure Management	904	874	840	834	829	827	832	844	845	842	821
3.C Rice Cultivation	688	710	702	678	705	704	689	684	677	608	576
3.F Field Burning of Agricultural Residues	6	4	4	5	4	4	3	2	1	1	1
Total Nitrous Oxide Emissions	1,363	1,306	1,298	1,272	1,270	1,225	1,203	1,154	1,201	1,141	1,104
3.B Manure Management	123	122	121	121	122	123	125	129	130	130	130
3.D Agricultural Soils	1,238	1,184	1,176	1,150	1,146	1,101	1,077	1,025	1,071	1,011	973
3.F Field Burning of Agricultural Residues	1.5	0.9	1.0	1.2	0.9	1.0	0.7	0.6	0.2	0.2	0.2
Total Emissions from the Agriculture Sector	3,670	3,588	3,518	3,468	3,469	3,423	3,397	3,358	3,402	3,283	3,178

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

2.4.4 Land Use, Land-Use Change, and Forestry (LULUCF) Sector

Greenhouse gas removals in the land use and forestry sector are primarily composed of carbon dioxide (CO_2). Over the years, the removal amounts have shown slight fluctuations, with relatively small annual variations. This stability is mainly due to the annual growth of forest resources contributing to increased removals; contributions from afforestation and reductions due to forest disturbances are less significant. In 2022, the sector removed a total of 21,834 $ktCO_2e$, representing a 2.04% decrease compared to the removal amount in 2005 (22,290 $ktCO_2e$). The overall trend remains relatively stable. However, notable events such as forest fires and typhoons in 1991 and 2001 led to significant carbon losses. Additionally, the severe impact of Typhoon Morakot in 2009 caused substantial forest volume loss, resulting in the lowest removal amount on record. These trends are illustrated in Figure 2.4.4-1 and detailed in Table 2.4.4-1.

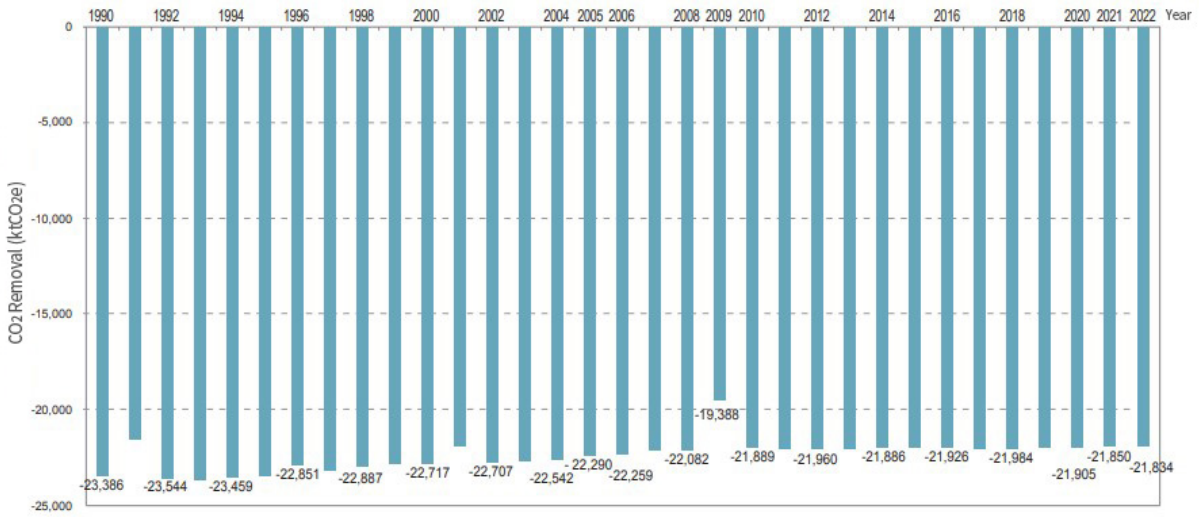


Figure 2.4.4-1. Carbon Removal Trend in the Land Use, Land-Use Change, and Forestry (LULUCF) Sector in Taiwan (1990–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

Table 2.4.4-1. Greenhouse Gas Emissions from the Land Use, Land-Use Change, and Forestry (LULUCF) Sector in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emissions and Removals		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
4.A.1 Forest Land Remaining Forest Land	Biomass Carbon Removal (△ CO_{2G})	-23,902	-23,902	-23,741	-23,580	-23,418	-23,257	-23,095	-22,934	-22,772	-22,611	-22,449
	Biomass Carbon Emissions (△ CO_{2L})	607	2,503[1]	333	216	190	202	559	266	326	401	389
	Net Biomass Carbon Removal (△ CO_2)	-23,295	-21,399	-23,408	-23,364	-23,228	-23,055	-22,536	-22,668	-22,446	-22,210	-22,061
4.A.2 Land Converted to Forest Land	Biomass Carbon Removal (△ CO_{2G})	-91	-91	-136	-182	-230	-285	-315	-392	-440	-553	-656
Total Carbon Removal by the LULUCF Sector (△ CO_2 ☒)		-23,386	-21,490	-23,544	-23,546	-23,459	-23,340	-22,851	-23,060	-22,887	-22,764	-22,717

Sources and Sinks of Greenhouse Gas Emissions and Removals		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
4.A.1 Forest Land Remaining Forest Land	Biomass Carbon Removal (△ CO_{2G})	-22,288	-22,127	-21,965	-21,804	-21,642	-21,481	-21,319	-21,158	-20,997	-20,889	-20,907
	Biomass Carbon Emissions (△ CO_{2L})	1,112[2]	167	227	243	369	251	308	199	2,753[3]	218	140
	Net Biomass Carbon Removal (△ CO_2)	-21,176	-21,960	-21,738	-21,560	-21,274	-21,230	-21,012	-20,959	-18,243	-20,671	-20,766
4.A.2 Land Converted to Forest Land	Biomass Carbon Removal (△ CO_{2G})	-673	-747	-886	-981	-1,016	-1,029	-1,062	-1,123	-1,145	-1,218	-1,181
Total Carbon Removal by the LULUCF Sector (△ CO_2 ☒)		-21,850	-22,707	-22,624	-22,542	-22,290	-22,259	-22,074	-22,082	-19,388	-21,889	-21,947

Sources and Sinks of Greenhouse Gas Emissions and Removals		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
4.A.1 Forest Land Remaining Forest Land	Biomass Carbon Removal (△ CO_{2G})	-20,932	-20,970	-21,004	-21,040	-21,068	-21,148	-21,202	-21,359	-21,271	-21,318	-21,359
	Biomass Carbon Emissions (△ CO_{2L})	145	135	197	189	153	83	116	114	90	121	114
	Net Biomass Carbon Removal (△ CO_2)	-20,787	-20,834	-20,807	-20,851	-20,915	-21,065	-21,086	-21,245	-21,181	-21,197	-21,245
4.A.2 Land Converted to Forest Land	Biomass Carbon Removal (△ CO_{2G})	-1,173	-1,139	-1,079	-1,049	-1,011	-918	-831	-589	-724	-654	-589
Total Carbon Removal by the LULUCF Sector (△ CO_2)		-21,960	-21,974	-21,886	-21,900	-21,926	-21,961	-21,984	-21,917	-21,905	-21,850	-21,834

Notes:

1. In 1991, other disasters included seven typhoons, which affected an area of 295.74 hectares, resulting in a total damage volume of 1,348,998.61 m^3 and a loss volume of 1,348,992.06 m^3.
2. In 2001, in addition to five major forest fires in Danda, Lishan, Xueshan East Peak, and Yangmingshan National Park, 59 smaller fire incidents occurred. These fires affected an area of 395 hectares, resulting in significant forest resource losses.
3. In 2009, Typhoon Morakot caused severe damage in central and southern Taiwan, particularly in parts of Kaohsiung and Pingtung, where more than 2,500 mm of rainfall was recorded over 3 days. This event produced approximately 1.25 million tons of driftwood, leading to substantial losses in forest volume.

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report.* 2024.

2.4.5 Waste Sector

The greenhouse gases emitted by Taiwan's waste sector are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). In 2022, the waste sector emitted a total of 2,700 $ktCO_2e$, accounting for approximately 0.94% of Taiwan's total greenhouse gas emissions. Among the subcategories, Wastewater Treatment and Discharge (5.D) contributed the largest share at 38.83%, followed by Incineration and Open Burning of Waste (5.C) at 34.86%. The remaining emissions came from Solid Waste Disposal (5.A) and Biological Treatment of Solid Waste (5.B), at 24.56% and 1.75%, respectively.

From 2005 to 2022, greenhouse gas emissions from the waste sector decreased by approximately 70.36%, with an average annual negative growth rate of 6.90%. These trends are shown in Figure 2.4.5-1 and detailed in Table 2.4.5-1.

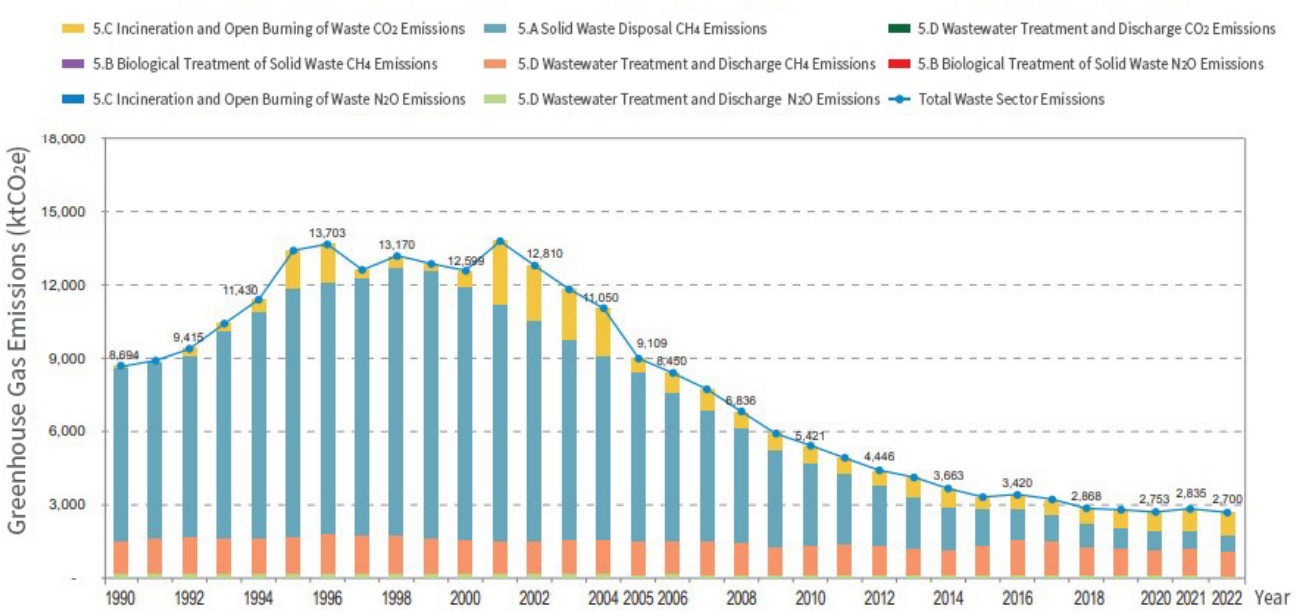


Figure 2.4.5-1. Greenhouse Gas Emissions Trend of the Waste Sector in Taiwan (1990–2022)

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report.* 2024.

Table 2.4.5-1. Greenhouse Gas Emissions from the Waste Sector in Taiwan (1990–2022)

Unit: $ktCO_2e$

Sources and Sinks of Greenhouse Gas Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total Carbon Dioxide Emissions	94	35	309	301	500	1,575	1,652	330	491	280	691
5.C Incineration and Open Burning of Waste	94	35	309	301	500	1,575	1,652	330	491	280	691
5.D Wastewater Treatment and Discharge	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total Methane Emissions	8,410	8,643	8,917	9,945	10,731	11,632	11,833	12,073	12,479	12,391	11,722
5.A Solid Waste Disposal	7,102	7,206	7,431	8,492	9,252	10,112	10,231	10,496	10,962	10,958	10,310
5.B Biological Treatment of Solid Waste	13	0.6	0.9	0.5	0.2	0.7	0.3	1.6	0.06	2.2	0.3
5.D Wastewater Treatment and Discharge	1,295	1,436	1,485	1,452	1,479	1,520	1,602	1,575	1,517	1,431	1,411
Total Nitrous Oxide Emissions	190	181	190	198	200	216	218	213	200	194	186
5.B Biological Treatment of Solid Waste	9	0.4	0.6	0.4	0.1	0.5	0.2	1.1	0.04	1.5	0.2
5.C Incineration and Open Burning of Waste	1.0	0.4	3	3	5	16	17	3	5	3	7
5.D Wastewater Treatment and Discharge	180	180	186	194	194	199	201	209	195	189	179
Total Emissions from the Waste Sector	8,694	8,858	9,415	10,444	11,430	13,424	13,703	12,616	13,170	12,865	12,599

Sources and Sinks of Greenhouse Gas Emissions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Carbon Dioxide Emissions	2,597	2,276	2,065	1,996	776	848	837	733	703	747	670
5.C Incineration and Open Burning of Waste	2,597	2,276	2,065	1,996	776	848	837	733	703	747	670
5.D Wastewater Treatment and Discharge	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total Methane Emissions	10,996	10,339	9,569	8,868	8,164	7,437	6,732	5,968	5,111	4,542	4,137
5.A Solid Waste Disposal	9,655	8,976	8,192	7,482	6,786	6,066	5,349	4,644	3,942	3,347	2,862
5.B Biological Treatment of Solid Waste	0.02	0.4	2.6	7	11	13	16	18	20	23	29
5.D Wastewater Treatment and Discharge	1,341	1,363	1,375	1,379	1,367	1,359	1,367	1,306	1,149	1,171	1,246
Total Nitrous Oxide Emissions	196	195	195	185	169	164	149	136	134	133	136
5.B Biological Treatment of Solid Waste	0.02	0.3	2	5	8	9	11	13	14	17	21
5.C Incineration and Open Burning of Waste	27	23	21	21	8	9	9	8	7	8	8
5.D Wastewater Treatment and Discharge	169	171	172	159	154	147	129	115	112	109	107
Total Emissions from the Waste Sector	13,789	12,810	11,829	11,050	9,109	8,450	7,719	6,836	5,948	5,421	4,943

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total Carbon Dioxide Emissions	657	817	736	499	589	613	639	703	798	910	933
5.C Incineration and Open Burning of Waste	657	817	736	498	589	613	639	703	798	909	932
5.D Wastewater Treatment and Discharge	NO	NO	NO	1.7	0.2	0.5	0.6	0.3	0.3	0.4	0.4

Sources and Sinks of Greenhouse Gas Emissions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total Methane Emissions	3,660	3,187	2,808	2,686	2,710	2,474	2,106	1,963	1,834	1,805	1,654
5.A Solid Waste Disposal	2,432	2,054	1,736	1,469	1,252	1,080	937	837	769	694	663
5.B Biological Treatment of Solid Waste	27	25	23	22	22	23	26	28	29	30	28
5.D Wastewater Treatment and Discharge	1,201	1,108	1,049	1,195	1,436	1,371	1,142	1,098	1,036	1,081	963
Total Nitrous Oxide Emissions	128	121	120	124	120	121	123	119	121	121	114
5.B Biological Treatment of Solid Waste	19	18	16	16	16	16	18	20	21	21	20
5.C Incineration and Open Burning of Waste	8	8	8	5	6	6	6	7	8	9	9
5.D Wastewater Treatment and Discharge	101	96	96	103	98	99	99	92	92	91	85
Total Emissions from the Waste Sector	4,446	4,126	3,663	3,309	3,420	3,208	2,868	2,785	2,753	2,835	2,700

Notes:

Source: Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024.

2.5 Key Sources of Greenhouse Gas Emissions and Trend Analysis

The energy sector has consistently been the largest contributor to Taiwan's total greenhouse gas emissions. In 2005 and 2022, the energy sector accounted for approximately 85.79% and 90.87% of total emissions (excluding LULUCF), respectively. In comparison, during the same years, the Industrial Processes and Product Use sector contributed 9.70% and 7.08%, the agriculture sector contributed 1.38% and 1.11%, and the waste sector contributed 3.13% and 0.94%.

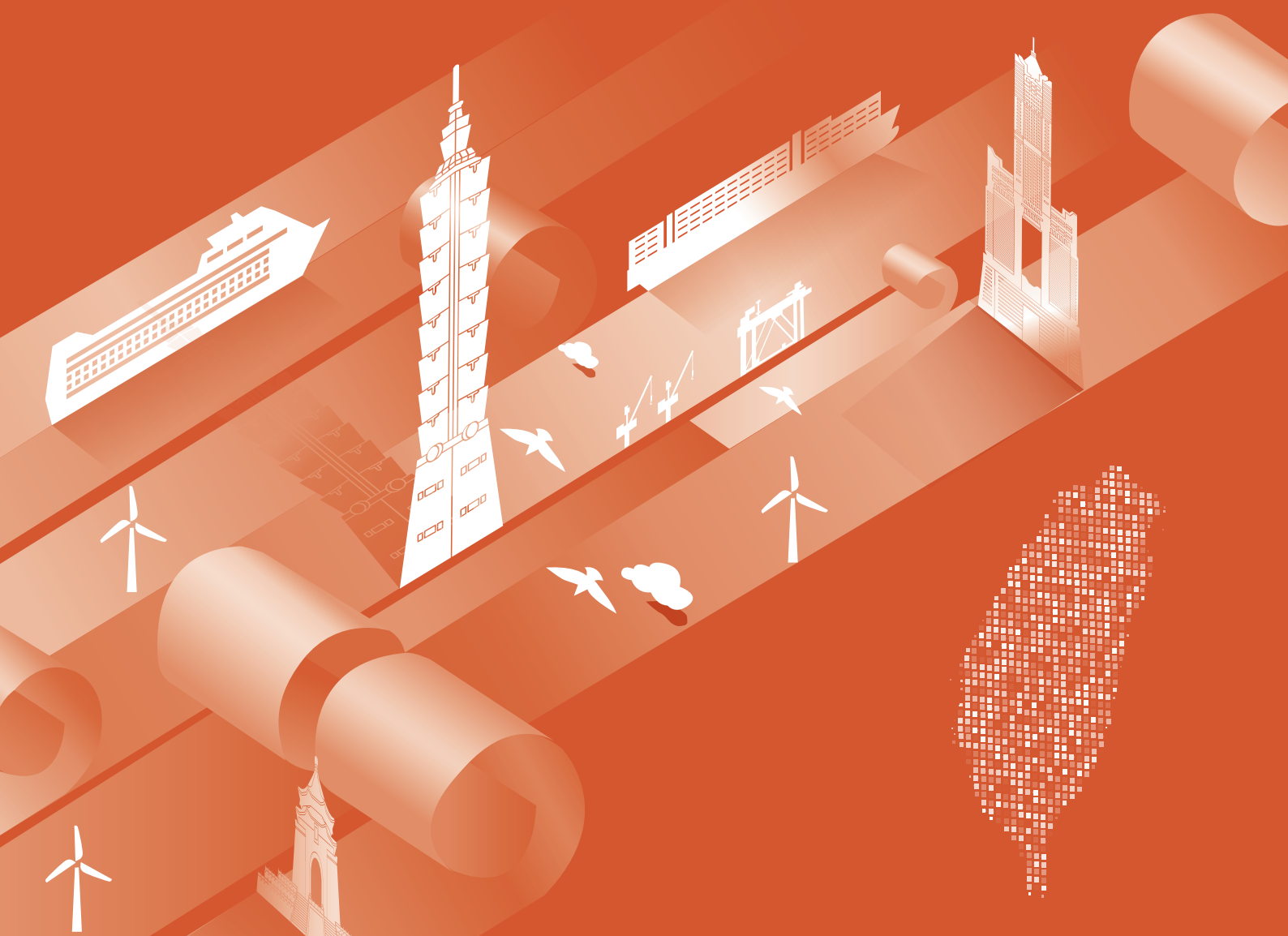
On the basis of trend analysis, total greenhouse gas emissions in 2022 decreased by 1.79% compared to 2005. Regarding the individual sectors, emissions from the energy sector increased by 4.03%, whereas emissions from the Industrial Processes and Product Use sector, the agriculture sector, and the waste sector decreased by 28.37%, 21.05%, and 70.36%, respectively. Meanwhile, carbon removal by the LULUCF sector decreased by 2.04%.

References

1.Ministry of Environment. *2024 National Inventory Report Data Update Meeting Materials*. 2024.

2.Ministry of Environment. *2024 Republic of China National Greenhouse Gas Inventory Report*. 2024: https://www.cca.gov.tw/information-service/publications/national-ghg-inventory-report/12003.html

3 Taiwan's Policies and Measures for Greenhouse Gas Reduction



Chapter 3: Taiwan's Policies and Measures for Greenhouse Gas Reduction

Adhering to the spirit and principles of the *United Nations Framework Convention on Climate Change* (UNFCCC), Taiwan has established a comprehensive domestic climate governance framework and implemented various greenhouse gas reduction policies and measures. Internationally, Taiwan actively promotes cross-border cooperation to address increasingly severe climate challenges. In 2021, Taiwan announced its commitment to achieving the 2050 net-zero emissions target, and on March 30, 2022, the government released Taiwan's Pathway to Net-Zero Emissions in 2050. On December 28, 2022, Taiwan introduced the *12 Key Strategies* action plan and submitted its *2030 Nationally Determined Contribution (2030 NDC)*, thereby completing its roadmap for the net-zero transition. On February 15, 2023, Taiwan announced amendments to the *Greenhouse Gas Reduction and Management Act*, renaming it the *Climate Change Response Act*. The amendments incorporated the 2050 net-zero emissions target and established a solid legal foundation for climate action, ensuring the nation's sustainable development.

3.1 Taiwan's Position on Climate Change Response

Since Taiwan formally announced its meaningful participation in the UNFCCC in 2009, it has actively sought to attend the Conference of the Parties (COP) as a Government Observer. Taiwan adheres to the spirit and principles of the UNFCCC by continuously publishing and updating convention-compliant documents, such as the National Communication, National Greenhouse Gas Inventory Report, and Nationally Determined Contributions (NDC). Additionally, Taiwan actively participates in climate conventions to stay informed of the latest developments in international climate change responses and carbon reduction regulations. Guided by the principle of building substantive cooperative relationships with other nations based on sincere friendship, Taiwan promotes its efforts and achievements in addressing climate change through various channels. Taiwan interacts with representatives of friendly nations and international organizations to gradually gain support and enhance its influence through substantive participation in climate conventions.

Domestically, Taiwan has been proactive in its climate action planning. The *Greenhouse Gas Reduction and Management Act* was passed in 2015, establishing a strategic framework for climate action. In 2016, the Executive Yuan set up a dedicated Office of Energy and Carbon Reduction to coordinate national energy policies, promote energy transition, and reduce greenhouse gas emissions. In response to the global push for net-zero emissions, Taiwan's government announced on January 1, 2021, that it would engage in dialogue with stakeholders to chart its climate governance pathway. On April 22, 2021 (World Earth Day), Taiwan declared its next-phase commitment for achieving the Net-Zero Transition, and in August 2021, the 2050 net-zero emissions target was formally included in the legislative amendment process.

Under the coordination of the Executive Yuan, the government announced Taiwan's Pathway to Net-Zero Emissions in 2050 on March 30, 2022, outlining the trajectory and action pathways for achieving net-zero emissions by 2050. Taiwan's net-zero pathway centers on four major transition strategies: Energy Transitions, Industrial Transitions, Lifestyle Transitions, and Social Transitions. The pathway

is supported by two governance foundations—Technology R&D and Climate Legislation—and further complemented by the 12 Key Strategies, which comprise action plans targeting critical areas for growth in energy, industry, and lifestyle transition policy forecasting. On December 28, 2022, Taiwan announced detailed actions under its 2030 Nationally Determined Contribution (2030 NDC) and the 12 Key Strategies action plan, thus completing its net-zero transition roadmap.

To implement the governance objective of Green Growth and Net-Zero Transition by 2050, as outlined in the National Project of Hope, the government plans to invest over NT$1 trillion by 2030 and promote domestic and international green investments. The aim is to address climate change and achieve the 2050 net-zero emissions target by transforming climate challenges into opportunities for green growth. To this end, the Ministry of Environment has launched the Implementation Plan for Strengthening Investment in Green Growth and Net-Zero Industries, which has been approved by the National Development Fund of the Executive Yuan. Under this plan, NT$10 billion will be allocated to establish a Green Growth Fund. Over the next decade, the fund will focus on investing in emerging net-zero industries such as resource circulation, sustainable energy, and carbon capture and utilization. It will also attract investments of private capital, thereby accelerating industrial innovation and the development of carbon reduction technologies while creating green job opportunities.

Additionally, in response to the increasing severity of climate change challenges and to accelerate Taiwan's national carbon reduction actions, the Ministry of Environment proposed amending the *Greenhouse Gas Reduction and Management Act* to create the *Climate Change Response Act*. This amendment was promulgated through a Presidential Order on February 15, 2023. The *Climate Change Response Act* comprises seven chapters and 63 articles that incorporate the 2050 net-zero emissions target, define the responsibilities of government agencies, and introduce several key measures: ensuring a just transition, strengthening emission controls and incentive mechanisms to promote reductions, and earmarking carbon fees. A dedicated chapter on climate change adaptation has been added, along with mechanisms for carbon footprint and product labeling, enhanced information transparency, and public participation. The Act establishes a robust legal foundation for Taiwan's climate governance and it aims to develop climate adaptation strategies; reduce and manage greenhouse gas emissions; and simultaneously uphold intergenerational justice, environmental justice, and a just transition, thereby underscoring Taiwan's shared responsibility to protect the global environment and ensuring the nation's sustainable development.

The Executive Yuan is actively promoting the Carbon Reduction Flagship Program to achieve Taiwan's net-zero transition goals. Moreover, in response to the COP29 requirement for countries to submit their third-round Nationally Determined Contributions (NDCs) by 2025, Taiwan has simultaneously adjusted its carbon reduction targets for 2032 and 2035 to demonstrate its commitment. The Flagship Program adopts both bottom-up and top-down approaches to assist ministries and agencies in optimizing their self-directed carbon reduction actions. Additionally, experts from the National Science and Technology Council have formulated 20 flagship carbon reduction initiatives covering six major sectors: energy, manufacturing, transportation, residential and commercial, agriculture, and environment. Under these initiatives, Taiwan's 2030 carbon reduction target will be raised from a 24%±1% reduction (compared to 2005 levels) to a 28%±2% reduction. The energy sector will accelerate the development of renewable energy sources, such as solar photovoltaic and offshore wind power; overcome the technical limitations of geothermal and small hydropower; advance technologies for energy storage; decarbonize hydrogen fuels; concentrate on hydrogen (including ammonia) supply chains; and implement carbon capture, utilization, and storage (CCUS). The manufacturing sector will prioritize self-regulated emission reduction and deep energy saving within the industry, and state-owned enterprises, including China Steel Corporation and CPC Corporation, will emphasize carbon reduction. In the transportation sector, initiatives will promote the electrification and decarbonization of commercial vehicles, as well as the development of sustainable aviation fuel (SAF). These comprehensive measures aim to enhance Taiwan's carbon reduction performance and advance the nation toward a net-zero transition.

3.2 Governance Framework for Climate Change

Given the cross-regional and cross-sectoral nature of climate change, advancing climate policies requires interministerial coordination and collaboration between central and local governments. In terms of regulations and policies, the *Climate Change Response Act* serves as the overarching framework for Taiwan's climate actions. It integrates energy and environmental regulations to provide comprehensive regulatory tools and economic incentives for climate action.

3.2.1 Government Organizational Structure

The Executive Yuan has established the Office of Energy and Carbon Reduction as well as the Task Force on Climate Change and Net Zero Emissions Transition under the National Council for Sustainable Development (NCSD). These bodies are responsible for coordinating Taiwan's efforts in sustainability, energy transition, and greenhouse gas reduction. Additionally, President Lai Ching-te inaugurated the National Climate Change Committee on June 19, 2024, underscoring the significance of addressing climate change issues. To further establish the responsibilities of various ministries in advancing climate change response policies, the *Climate Change Response Act* designates the Ministry of Environment as the central competent authority. The Act also establishes mechanisms for interministerial collaboration on greenhouse gas reduction management and defines a hierarchical structure for central and local government responsibilities. The following sections detail the organizational structures of the key government agencies involved in promoting Taiwan's climate change policies:

I. National Climate Change Committee

1. Background

To actively address global climate change challenges and approach climate governance and international cooperation from a national perspective, President Lai Ching-te announced the establishment of the National Climate Change Committee during a press conference on June 19, 2024. Under the Office of the President, the Committee brings together representatives from industry, government, academia, and research institutions to formulate national climate governance strategies, advance critical action plans, and enhance communication to strengthen resilience against climate change.

The Committee is set to convene quarterly at the Office of the President. It fulfills three primary roles: serving as a platform for public participation, acting as a bridge for social communication, and driving policy efficiency. These responsibilities aim to build societal consensus, implement effective actions, and steadily promote the nation's Green Growth Strategy.

On June 20, 2024, the Ministry of Environment established the Green Policy Office to support the Committee. The Office is responsible for integrating climate change and net-zero transition policies and fostering interministerial collaboration. The Minister of Environment emphasized that net-zero policies encompass a broad range of fields, including green energy strategies, dual transformation of digital and green industries, and green finance. The government aims to leverage international experience, introduce innovative tools, accelerate decarbonization processes, and align with President Lai's Green Growth Strategy.

2. Organizational Structure

The National Climate Change Committee consists of 28 members, with the President as the convener, three deputy conveners, and 24 appointed representatives from government agencies, industries, civic organizations, and academia. Additionally, two advisors are appointed. The remaining members are selected from among representatives of government agencies, industries, civic organizations, and academia. Each member is appointed for a one year term, with the possibility for reappointment or new appointments as needed. Advisors may also be appointed, and representatives from various sectors may be invited to attend.

The committee is supported by an Executive Secretary and a Deputy Executive Secretary. The Ministry of Environment serves as the main advisory body for deliberations, whereas the First Bureau of the Office of the President and other related units handle administrative tasks.

Discussions within the committee address seven core themes: net-zero pathway, diverse green energy and carbon reduction technology, green and digital twin transformation, sustainable green lifestyle, just transition, green finance, and

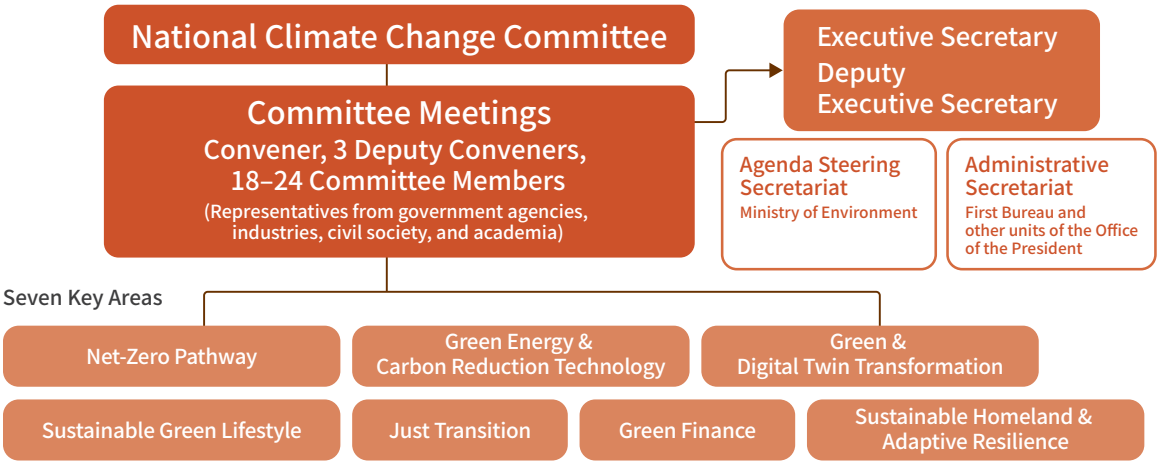


Figure 3.2.1-1. Organizational Structure of the National Climate Change Committee

Source: National Climate Change Committee, Office of the President.

sustainable homeland and adaptive resilience.

3. Implementation Progress

The Office of the President convened the inaugural meeting of the National Climate Change Committee on August 8, 2024, chaired by President Lai Ching-te. In his remarks, President Lai emphasized that the nuclear-free homeland is a shared goal as part of sustainable development. The meeting reached two key consensuses on energy governance. The first consensus acknowledged that various energy options face challenges at different levels, and that a balance must be achieved between development and sustainability, as well as between transformation and adaptation. The development of renewable energy emerged as the greatest common denominator, and the government, private sector, and civil society must collaborate to address these challenges. The second consensus was the committee's proposal to establish a shared and transparent information platform. This platform aims to bridge information gaps by providing full disclosure of information on various energy options, facilitating rational public discussions, and preventing division.

The second meeting, held on October 23, 2024, focused on setting Taiwan's new carbon reduction target for 2032, advancing the second phase of the energy transition, and aligning with international targets for 2035. Key topics included deep energy saving, the establishment of the Public Sector Sustainability Alliance, and the carbon fee mechanism, with an emphasis on enhancing energy efficiency, developing forward-looking technologies, and promoting public participation through transparent energy information. The conclusions of the meeting were as follows: (1) regarding the Committee's seven main pillars, it was recommended that subgroup discussions be conducted monthly, with consolidated consensuses presented at quarterly committee meetings to improve focus and policy feasibility; (2) regarding the two critical tasks—setting Taiwan's 2032 carbon reduction target and developing the energy information platform—members were urged to engage in more frequent exchanges and provide concrete recommendations at the next meeting; (3) to align with global NDC planning for 2035, the Ministry of Environment reported on the 2032 target-setting plan and announced its intent to present a consensus proposal at the January 2025 committee meeting that pragmatically addresses challenges, proposes countermeasures, and strengthens implementation; (4) the Ministry of Environment was instructed to accelerate the development of the energy information platform and invite members to participate in discussions to foster rational and in-depth dialogue across society based on shared facts; (5) the climate change response measures of the Executive Yuan, the establishment of the Sustainability Alliance, and the Deep Energy Saving Action Plan of the Ministry of Economic Affairs, as reported during the meeting, will subsequently be adjusted based on members' feedback to ensure effective policy implementation and to maximize benefits.

The third meeting, held on January 23, 2025, proposed Taiwan's new carbon reduction targets for 2032 and 2035. To ensure the achievement of these targets, the National Development Council simultaneously introduced Taiwan's Comprehensive Carbon Reduction Action Plan, which includes 80 carbon reduction initiatives proposed by various ministries and agencies through a bottom-up approach, as well as 20 flagship carbon reduction initiatives formulated by the Task Force on Climate Change and Net-Zero Emissions Transition under the National Council for Sustainable Development, Executive Yuan (the "Net-Zero Task Force") through a top-down approach. Additionally, six key pillars were proposed, encompassing technological innovation, financial support, carbon pricing, regulatory adjustment, green collar talent, and community-driven initiatives. Through government leadership and public–private collaboration, along with the mechanisms of the Net-Zero Task Force and the Sustainability Alliance, these efforts aim to realize the National Project of Hope's vision and goals for Green Growth and the 2050 Net-Zero Transition

II. NCSD Task Force on Climate Change and Net Zero Emissions Transition

1. Background

To urge nations to take collective action toward sustainable human development, the United Nations established the United Nations Commission on Sustainable Development in 1993. In response to this global trend, in 1997, the Executive Yuan upgraded and expanded its Global Change Policy Guidance Task Force to the National Council for Sustainable Development (NCSD). The *Basic Environment Act* of 2002 established the legal foundation for the NCSD, making it responsible for decision-making on matters related to the nation's sustainable development, while tasking relevant ministries with implementation.

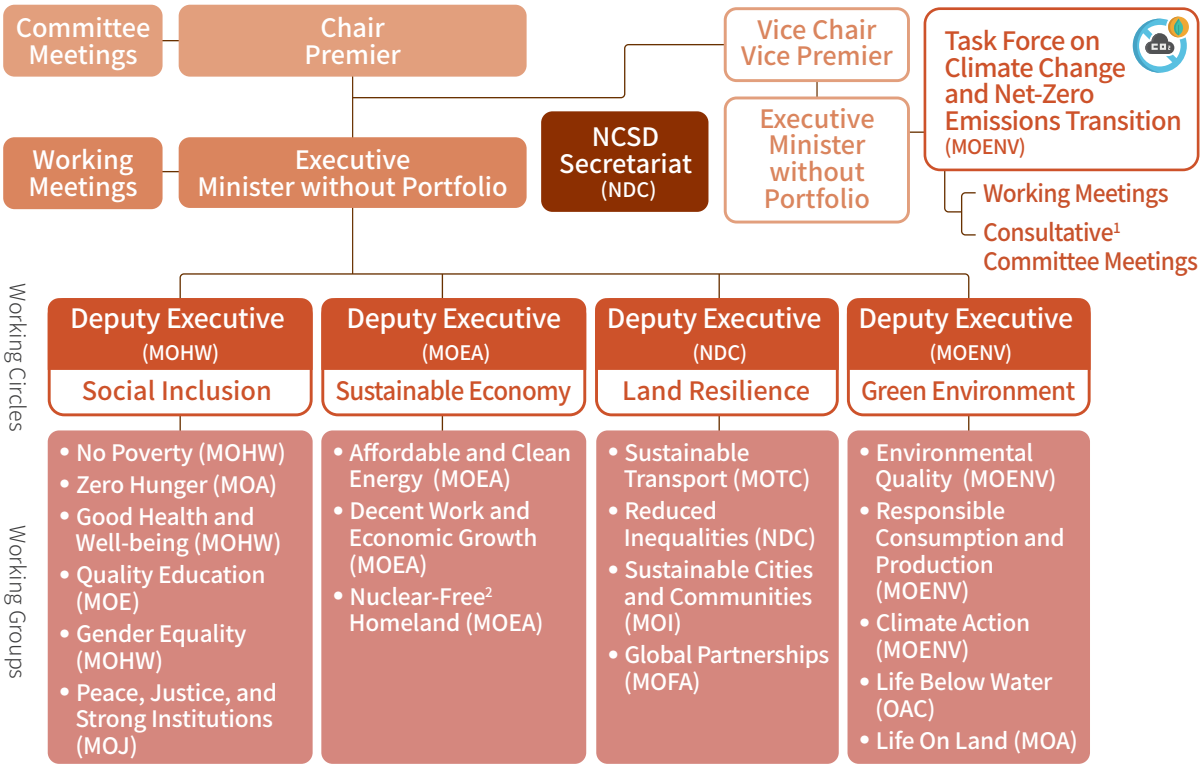
To promote climate change response and enhance cross sectoral governance for sustainable development, the *Climate Change Response Act* of 2023 elevated climate governance under the NCSD's purview. Article 8 of the Act stipulates that the NCSD shall coordinate, assign, or integrate basic policies for national climate change response and major important strategies for cross sectoral climate change response affairs.

2. Organizational Structure

The NCSD's membership is composed equally of representatives from government agencies, academic experts, and civil society organizations. The Premier of the Executive Yuan serves as the Chair, the Vice Premier serves as the Vice Chair, and a Minister without Portfolio acts as the Executive to strengthen inter-ministerial coordination and oversee policy implementation.

Based on Taiwan's 18 sustainable development goals (Taiwan SDGs), the NCSD operates through 17 working groups and the Task Force for the Promotion of a Nuclear-Free Homeland. The SDGs are split among four working circles, which are supervised by their respective Deputy Executives: Social Inclusion (Deputy Minister of Health and Welfare), Sustainable Economy (Deputy Minister of Economic Affairs), Land Resilience (Deputy Minister of National Development Council), and Green Environment (Deputy Minister of Environment).

To further strengthen coordination and integration of national climate change policies and cross-ministerial affairs, the NCSD established the Task Force on Climate Change and Net-Zero Emissions Transition. The Vice Premier oversees the task force's initiatives, whereas the Executive chairs cross-ministerial coordination meetings and the Ministry of Environment acts as the secretariat. Together, they guide the nation toward sustainable development and build a more resilient foundation for climate governance. The organizational structure of the NCSD is illustrated in Figure 3.2.1-2.



1. The Task Force on Climate Change and Net-Zero Emissions Transition may invite the NCSD and engage additional scholars and experts to hold 1–2 consultative committee meetings annually as needed.
2. Nuclear-Free Homeland Promotion Task Force is chaired by the Executive, who also serves as the convener.

Figure 3.2.1-2. Organizational Structure of the National Council for Sustainable Development, Executive Yuan

Source: Secretariat of the National Council for Sustainable Development, Executive Yuan.

3. Implementation Progress

The Task Force on Climate Change and Net-Zero Emissions Transition operates within the NCSD framework. Through cross-ministerial collaboration and public engagement, in 2022, the Task Force completed Taiwan's Pathway to Net-Zero Emissions in 2050 and the 12 Key Strategies action plan. These plans were submitted for discussion at NCSD meetings and subsequently made public. To facilitate ongoing monitoring and evaluation of net-zero transition efforts, the Task Force consolidates and reviews progress and implementation outcomes. Each year, the results from the previous year are reported to the NCSD, submitted to the Executive Yuan for approval, and then disclosed to the public.

In accordance with Article 8 of the *Climate Change Response Act*, the NCSD shall coordinate, assign, or integrate basic policies for national climate change response and major important strategies for affairs related to cross sectoral climate change response. Following the Act's enactment in 2023, the Task Force on Climate Change and Net-Zero Emissions Transition convened multiple cross-ministerial meetings to review the planning of the 12 Key Strategies action plan and discuss topics such as Taiwan's carbon trading system. The Task Force also proposed updates to the *National Climate Change Action Guidelines* and the National Climate Change Adaptation Action Plan (2023–2027), submitting them to the NCSD for advisory opinions. Looking ahead, the Task Force will continue to enhance the integration and coordination of mitigation, adaptation, and net-zero policies to strengthen climate governance.

III. Office of Energy and Carbon Reduction, Executive Yuan

1. Background

The Office of Energy and Carbon Reduction, Executive Yuan, was established in 2016 to coordinate the planning of national energy policies, promote energy transition, and reduce greenhouse

gas emissions. It serves as a hub for integrating and coordinating interministerial affairs related to energy and climate change response. The office's main tasks include formulating and drafting national energy policies, coordinating legislation and regulations related to national energy and climate change response, reviewing and monitoring major energy and climate initiatives, facilitating interministerial collaboration, organizing strategic meetings on energy and climate issues, and regularly reporting to the premier on the progress of energy and climate change policies.

2. Organizational Structure

The Office of Energy and Carbon Reduction has one convener and two co-conveners , all of whom are appointed by the premier of the Executive Yuan and concurrently hold the position of minister without portfolio or secretary-general. The two deputy conveners are the minister of economic affairs and the minister of environment. In addition to the convener, the co-conveners, and the deputy conveners, who serve as ex officio members, the office includes 22 to 28 members. These members are appointed or invited by the Executive Yuan and include: (1) the deputy minister of the interior, (2) the deputy minister of transportation and communications, (3) the deputy minister of agriculture, (4) the deputy chairperson of the National Development Council, (5) the deputy chairperson of the National Science and Technology Council, (6) the deputy chairperson of the Financial Supervisory Commission, (7) the deputy chairperson of the Public Construction Commission, (8) the deputy chairperson of the Nuclear Safety Commission, (9) the general manager of Taiwan Power Company, (10) the general manager of China Steel Corporation, (11) the general manager of CPC Corporation, Taiwan, (12) the executive director of the Green Energy Industry Promotion Center, (13) the executive director and deputy executive director of the Office of Energy and Carbon Reduction, and (14) 3 to 9 scholars, experts, or civil society organization representatives.

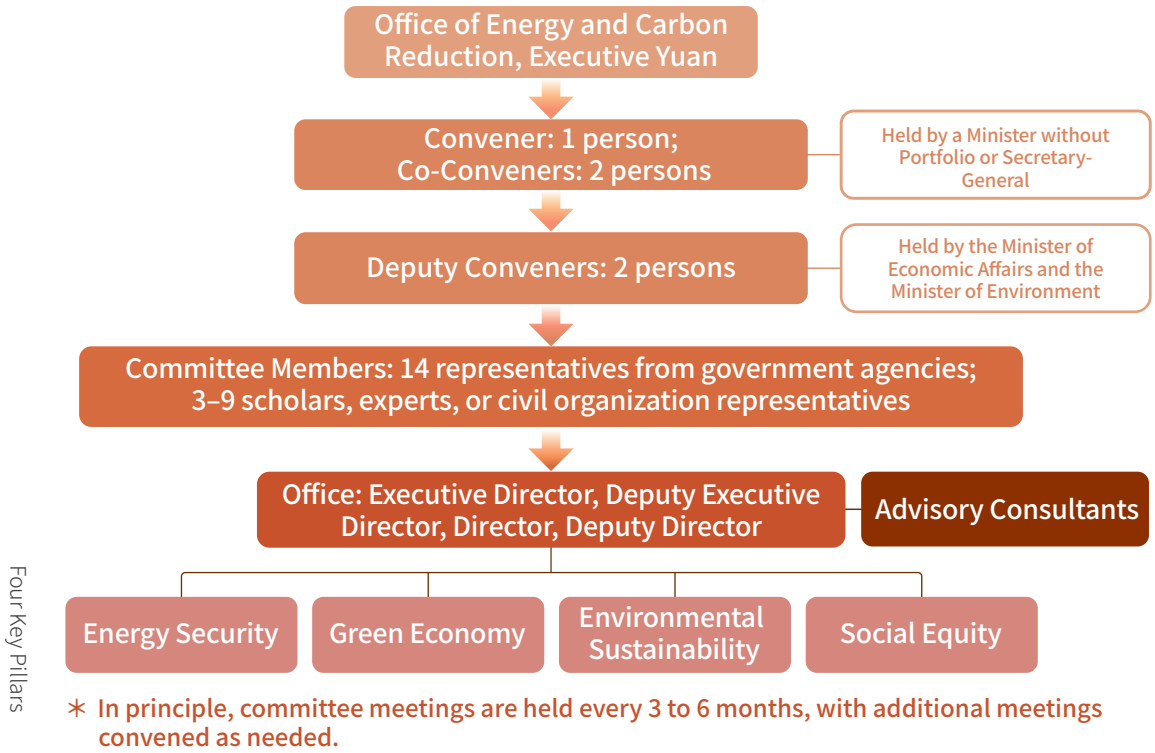


Figure 3.2.1-3. Organizational Structure of the Office of Energy and Carbon Reduction, Executive Yuan

Source: Website of the Office of Energy and Carbon Reduction, Executive Yuan

3. Implementation Progress

The key focal areas of the Office of Energy and Carbon Reduction, Executive Yuan, span six domains: climate change, energy policy, renewable energy, smart grids, green energy technology, and environment and economics. In terms of legislative progress, the office has assisted in amending key laws, including the *Electricity Act*, the *Renewable Energy Development Act*, the *Energy Administration Act*, and the *Climate Change Response Act*. Regarding policy implementation, the office has played a vital role in advancing critical energy-related policies. These include the *Guidelines on Energy Development*, the *New Power Saving Campaign*, the *4-Year Wind Power Promotion Plan*, the *2-Year Solar PV Promotion Plan*, the *Green Finance Action Plan*, the *6.5 GW Solar PV Target Plan for 2020*, the *Smart Grid Master Plan*, the *Energy Transition White Paper*, the *Forward-Looking Infrastructure Development Program: Green Energy Infrastructure*, and the *5+2 Innovative Industries Plan: Green Energy*. In terms of net-zero-related initiatives, the office has supported major policies such as the *Pathway to Net-Zero Pathway Framework Plan (2023–2026)*, the *Net-Zero Science and Technology Program (2023–2026)*, and the *12 Key Strategies Action Plan for Net-Zero Transition*.

IV. Division of Responsibilities and Operational Mechanism under the *Climate Change Response Act*

The Ministry of Environment serves as the competent authority under the *Climate Change Response Act*, overseeing nationwide efforts to reduce greenhouse gas emissions. In terms of policy implementation, the Act identifies six major greenhouse gas emission sectors: energy, manufacturing, transportation, businesses and residences, agriculture, and environment. The central industry competent authorities are responsible for formulating specific emission reduction strategies for their respective sectors. Additionally, Article 8 of the Act outlines 20 initiatives for greenhouse gas reduction and climate change adaptation. The Executive Yuan coordinates the division of responsibilities among central government agencies to implement these initiatives. The interministerial division of responsibilities is illustrated in Figure 3.2.1-4.

Climate Change Response Act

Article 8 Relevant central government agencies shall promote matters related to GHG reduction and climate change adaptation.

	Promotion Matters	Primary Authority	Secondary Authority
1	Development of renewable energy and energy technology	Ministry of Economic Affairs	National Science and Technology Council
2	Improvement of energy efficiency and energy conservation	Ministry of Economic Affairs	Central industry competent authorities
3	Reduction in GHG emissions by manufacturing sectors	Ministry of Economic Affairs	National Science and Technology Council
4	Transportation management, development of mass transit systems, and reduction in GHG emissions by other transportation sectors	Ministry of Transportation and Communications	Ministry of Economic Affairs
5	Implementation of low carbon energy transportation	Ministry of Transportation and Communications	Ministry of Economic Affairs, Ministry of Environment
6	Reduction and management of GHG emissions from buildings	Ministry of the Interior	Central industry competent authorities
7	Reduction and management of GHG in the service sector	Ministry of Economic Affairs	Central industry competent authorities
8	Waste recycling and reuse	Ministry of Environment	Central industry competent authorities
9	Natural resource management, biodiversity conservation, and strengthening of natural carbon sinks	Ministry of Agriculture	Ministry of the Interior, Ocean Affairs Council
10	Reduction and management of GHG in agriculture, promotion of low-carbon diets, and guarantee of food security	Ministry of Agriculture	-
11	Green finance and GHG reduction incentive mechanisms	Financial Supervisory Commission, Ministry of Environment	Ministry of Economic Affairs, Ministry of Finance
12	Comprehensive assessment of ghg reduction impacts on the economy and the planning of response measures	National Development Council	Ministry of Economic Affairs
13	Establishment of GHG cap-and-trade scheme including allocation, auction, allowance sale, trade, and facilitation of an international emission reduction cooperation mechanism	Ministry of Environment	Ministry of Economic Affairs, Ministry of Foreign Affairs, Financial Supervisory Commission
14	Research, development, and implementation of GHG reduction technologies	National Science and Technology Council	Ministry of Economic Affairs
15	Research and analysis of laws related to international GHG conventions and participation in international conferences	Ministry of Environment	Central industry competent authorities
16	Development and implementation of matters connected with climate change adaptation	Ministry of Environment, National Development Council	Central industry competent authorities
17	Education and advocacy of climate change adaptation and GHG reduction	Ministry of Education, Ministry of Environment	Central industry competent authorities
18	Promotion of a just transition	National Development Council	Central industry competent authorities
19	Indigenous peoples' adaptation to climate change and GHG reduction matters	Council of Indigenous Peoples	Central industry competent authorities
20	Other climate change adaptation and GHG reduction matters	National Council for Sustainable Development	-

Figure 3.2.1-4. Interministerial Division of Responsibilities under the *Climate Change Response Act*

3.2.2 Climate Change Regulations and Strategies

Taiwan's greenhouse gas reduction policies are primarily based on the *Climate Change Response Act*. Faced with the escalating global climate crisis, increasing demands for carbon reduction across international industrial supply chains, and the impending implementation of stricter international carbon emission controls, Taiwan amended the *Greenhouse Gas Reduction and Management Act* to become the *Climate Change Response Act* on February 15, 2023. The amendments strengthen Taiwan's legal framework for climate governance with an aim to support its net-zero transition, enhance industrial competitiveness, and address global climate change. The Act establishes strategies for climate adaptation, reduces and manages greenhouse gas emissions, upholds intergenerational and environmental justice, ensures a just transition, and fulfills Taiwan's shared responsibility to protect the global environment while securing sustainable development for the nation.

I. Framework of the *Climate Change Response Act*

The *Climate Change Response Act* aligns with the principles of the United Nations Framework Convention on Climate Change (UNFCCC), emphasizing shared but differentiated responsibilities, environmental justice, and the collective responsibility to protect the global environment while ensuring national sustainable development. The Act comprises seven chapters and 63 articles, with significant provisions including the incorporation of the 2050 net-zero emissions target, the definition of ministerial responsibilities, the inclusion of principles for a just transition, the strengthening of emission controls and incentive mechanisms, the establishment of earmarked carbon fees, the addition of a specific chapter on climate adaptation, and the integration of mechanisms for carbon footprint and product labeling management.

1. Codifying the 2050 Net-Zero Target and Defining Ministerial Responsibilities

Article 4 of the Act codifies the 2050 net-zero emissions target, elevating it from a declarative goal to a binding legal requirement and demonstrating the government's commitment to implementation. Regulatory targets will follow international practices and are set on a 5-year incremental basis.

Since greenhouse gas reduction and climate adaptation span multiple ministries, the Act designates the National Council for Sustainable Development, Executive Yuan, to coordinate, assign, or integrate basic policies for national climate change response. It also specifies the responsibilities of individual ministries, assigning primary and secondary authorities to ensure effective decision-making and interministerial collaboration.

2. Ensuring a Just Transition that Leaves No One Behind

Recognizing the potential impact of emission reduction policies on specific communities, the Act requires ministries to respect human rights and labor dignity, consult with communities affected by the net-zero transition, and adopt public participation mechanisms to gather broad input. Ministries are tasked with formulating just transition action plans and ensuring that Indigenous rights are respected by integrating community-based and Indigenous-led approaches into comprehensive climate adaptation policies and measures.

The Act also strengthens transparency through public participation mechanisms, such as requiring the details of public hearings to be published online at least 30 days in advance. Additionally, annual reports on greenhouse gas reduction and climate adaptation outcomes, prepared by central and local governments, must be made publicly accessible.

3. Earmarking Carbon Fees and Introducing Diverse Incentives

Carbon pricing is a critical strategy in reducing emissions. The Act establishes carbon fees on emission sources, with the proceeds earmarked for greenhouse gas reduction projects, the development of low-carbon and negative-emission technologies and industries, and the subsidization or incentivization of investments in emission-reduction technologies.

Entities subject to carbon fees who switch to low-carbon fuels, adopt negative emission technologies, increase energy efficiency, use renewable energy, or improve manufacturing processes to reach specified goals may propose voluntary reduction plans to apply for preferential rates. The Act also encourages voluntary reduction measures by allowing companies to trade, transfer, or auction the resulting reduction credits. By incorporating diverse economic incentives into the carbon fee system, the Act aims to accelerate corporate reduction of greenhouse gas emissions.

4. Strengthening Climate Adaptation for a Resilient Taiwan

The revised Act adds a dedicated chapter on climate adaptation, which focuses on building foundational capabilities, aligning scientific research with impact assessments, and establishing a robust implementation framework. The central competent authority and the National Science and Technology Council are tasked with advancing climate change science, conducting research and development related to adaptation to climate change impacts, and periodically publicizing scientific reports on climate change. These reports guide early warning systems and monitoring mechanisms at all levels of government. The adaptation framework requires central industry competent authorities to develop *Sectoral Adaptation Action Programs*, integrate them into a *National Climate Change Adaptation Action Plan*, and task local governments with formulating localized implementation plans. Annual reports on adaptation progress must be published to ensure transparency and public participation, thereby fostering tailored and effective strategies for a resilient Taiwan.

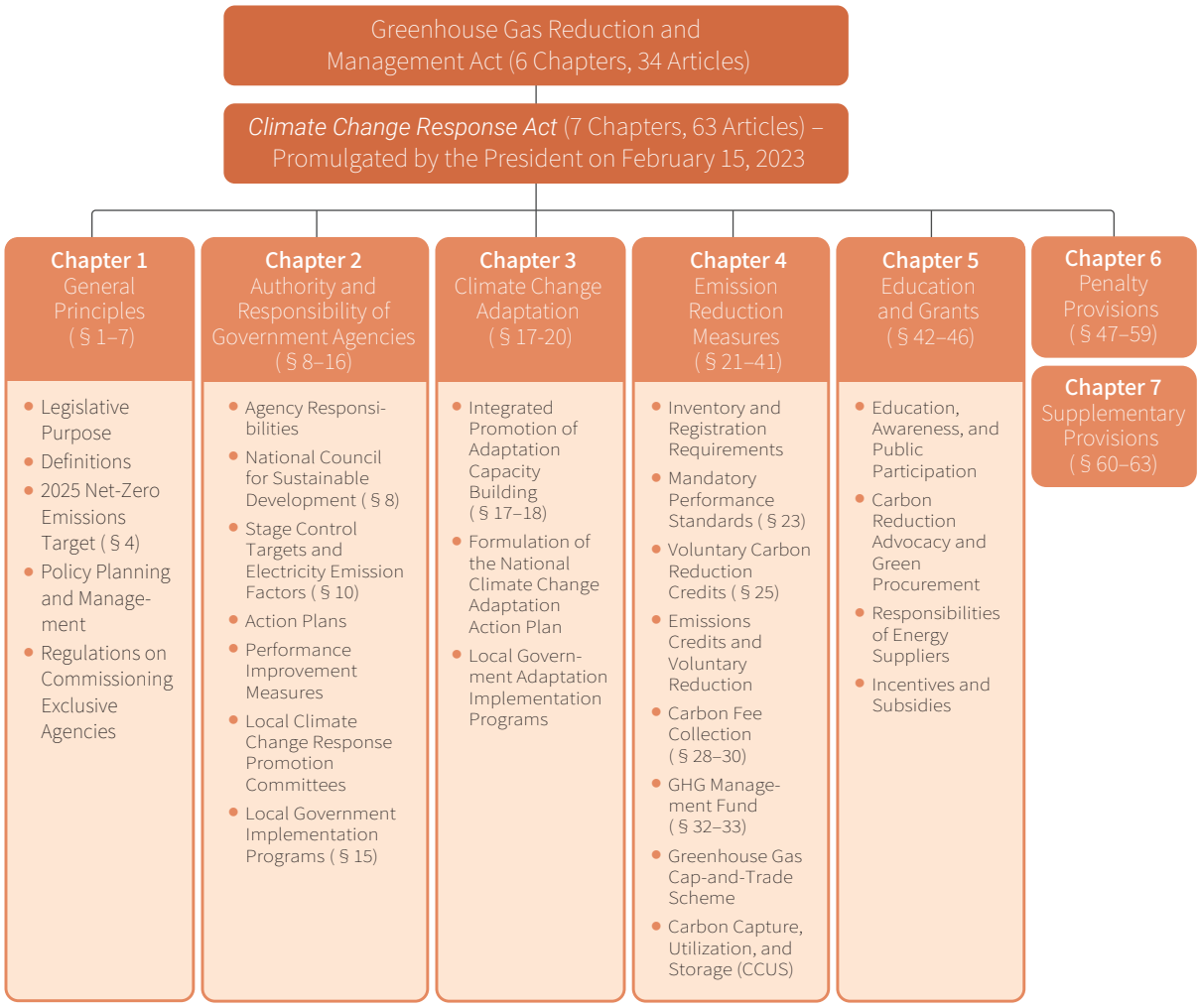


Figure 3.2.2-1. Framework of the *Climate Change Response Act*

II. Nationally Determined Contributions and Greenhouse Gas Reduction Targets

The 2015 Paris Agreement requires nations to propose post-2020 climate actions, including mitigation measures, reduction targets, and adaptation strategies to address climate change impacts. These are collectively referred to as Intended Nationally Determined Contributions (INDCs), which are to be updated and submitted every five years. Taiwan proposed its INDC in 2015, setting the 2030 net greenhouse gas emissions target at a 50% reduction from the business as usual (BAU) scenario projected under current development trends. This corresponded to a 20% reduction

relative to the 2005 baseline (reference year). To align with the 2021 Glasgow Climate Pact reached at COP26, Taiwan updated its Nationally Determined Contribution (NDC) in 2022, strengthening its ambition and enhancing the targets by increasing the 2030 target to a 24±1% reduction relative to the 2005 baseline. This reflected stronger mitigation ambitions and a commitment to achieving net-zero emissions by 2050.

To achieve Taiwan's long-term greenhouse gas reduction goals, the government has established periodic regulatory goals to be implemented on a five-year basis. These goals include:

1. National periodic regulatory goals.
2. Periodic regulatory goals for the sectors of energy, manufacturing, businesses and residences, transportation, agriculture, and environment.
3. Periodic goals for electricity sector carbon emission factors.

The Executive Yuan approved Taiwan's first and second phase of greenhouse gas regulatory goals on January 23, 2018, and September 29, 2021, respectively. These goals will be periodically reviewed to assess progress. The first phase (2016–2020) set a 2% emission reduction target by 2020 relative to 2005, whereas the second phase (2021–2025) aims for a 10% reduction by 2025 relative to 2005. All sectors are currently implementing initiatives to meet these targets.

The Ministry of Environment proposed a draft for the third phase (2026–2030) of greenhouse gas periodic regulatory goals in accordance with the law and submitted it to the Net-Zero Task Force to establish a coordination mechanism and facilitate inter-ministerial consultations. Since August 2024, the Net-Zero Task Force has convened ten intensive inter-ministerial consultation meetings, two high-level decision-making meetings, and three Net-Zero Task Force sessions to review data submitted by various sectors, including greenhouse gas emissions trend projections and scenario analyses, electricity emission factors, power demand growth, sector-specific emission reduction scenarios, reduction contributions, and cost estimates. It was resolved that Taiwan's carbon reduction targets should be assessed through both top-down and bottom-up approaches, as outlined below:

(1) Top-down approach: The Ministry of Environment and the National Development Council will identify national carbon reduction targets and allocate them through supplementary targets.

(2) Bottom-up approach: Each ministry will aggregate carbon reduction targets and propose action plans while listing related requirements and support measures.

(3) For the six major sectors, the gap between the bottom-up carbon reduction efforts and the top-down targets will be addressed by compiling 20 cross-sector flagship carbon reduction initiatives to strengthen the national periodic regulatory goals:

1. Accelerating Renewable Energy – Solar Photovoltaic: Increase solar power generation and enhance the share of renewable energy through government promotion of rooftop solar panel installations, optimization of application procedures, and organization of public building demonstration projects to drive private sector participation.
2. Accelerating Renewable Energy – Offshore Wind Power: Expand offshore wind power development by promoting zonal development, continuously identifying potential sites, enhancing technological capabilities and investment appeal through industrial supply chain localization, and fostering international cooperation.
3. Breakthroughs in Renewable Energy – Geothermal: Promote the development of geothermal power generation technology by introducing drilling equipment through state-owned enterprises, expanding deep geothermal drilling projects, and streamlining administrative procedures to accelerate geothermal development.
4. Breakthroughs in Renewable Energy – Small Hydropower: Develop small-scale hydropower plants in suitable areas, assess project potential, provide feed-in tariff incentives, and integrate land resources through private-public cooperation models to enhance development efficiency.
5. Technologies for Energy Storage: Develop high-efficiency energy storage technologies, including behind-the-meter storage with time-of-use pricing systems and fuel cell demonstration zones, to improve grid stability and promote renewable energy utilization.

6. Decarbonized Hydrogen Fuels: Establish hydrogen blending power generation pilot sites, advance decarbonized hydrogen fuel technologies, and gradually scale up low-carbon hydrogen production from natural gas to lay the foundation for hydrogen power generation and low-carbon transition.
7. Hydrogen (including Ammonia) Supply Chain: Develop hydrogen and ammonia fuel supply chains, expand hydrogen refueling stations and liquid ammonia storage facilities, introduce low-carbon ammonia imports, and advance domestic hydrogen production technologies to enhance energy security.
8. Carbon Capture, Utilization, and Storage (CCUS): Develop efficient, low-cost carbon capture technologies and establish pilot and commercial carbon storage sites to reduce emissions from large industrial facilities and power plants.
9. Industrial Self-Regulated Emission Reduction: Provide expert guidance to the top 500 emission sources; implement low-carbon production, energy transition, and circular economy measures; and support the green transformation of 140,000 small and medium-sized manufacturers.
10. Deep Energy Saving – Manufacturing Sector: Promote the adoption of energy-saving technologies through Energy Service Companies (ESCOs), assist enterprises in optimizing energy management systems, improve industrial electricity efficiency, and expand the promotion of green factory labels.
11. State-Owned Enterprise Decarbonization – China Steel Corporation: Reduce carbon emissions in the steel industry by using low-carbon raw materials in blast furnaces, increasing the proportion of scrap steel, and introducing carbon-free fuels.
12. State-Owned Enterprise Decarbonization – CPC Corporation: Optimize refinery production processes, improve energy efficiency, and integrate renewable energy and low-carbon feedstocks to advance low-carbon refinery transformation.
13. Net-Zero Buildings: Promote energy efficiency regulations for buildings, enhance energy efficiency in new construction projects, encourage energy retrofits in existing buildings, and advance low-carbon construction methods and smart net-zero technologies.
14. Deep Energy Saving – Residential and Commercial Sector: Implement subsidy programs for replacing old household appliances, raise energy efficiency standards for air conditioners and refrigerators, mandate energy-saving targets for large commercial users, and introduce ESCO energy efficiency management services.
15. Electrification and Decarbonization of Commercial Vehicles: Promote the adoption of electric taxis, light trucks, and heavy trucks by providing subsidies and improving the charging infrastructure, thereby gradually increasing the share of electric vehicles.
16. Sustainable Aviation Fuel (SAF): Promote the use of SAF among domestic airlines starting in 2025, aiming for a 5% usage rate by 2030, while establishing a SAF feedstock supply chain to reduce carbon emissions in the aviation industry.
17. Agricultural Ecosystem Resilience and Carbon Sinks: Enhance carbon sink functions of forests, wetlands, and seagrass beds; improve soil carbon sequestration through agricultural management practices; and strengthen climate risk management.
18. Low-Carbon Sustainable Agriculture: Promote energy-efficient water wheels, reuse of livestock biogas, electrification of agricultural machinery, and low-carbon aquaculture to reduce emissions from agricultural production and develop circular agriculture models.
19. Resource Circulation: Strengthen waste reduction and recycling, promote climate circular technology parks, electrify recycling vehicles, and establish carbon capture and recycling systems to improve resource utilization efficiency.
20. Net-Zero Sustainable Green Living: Promote low-carbon sustainable community certification, green building materials, eco-labels, and green procurement policies to guide consumers toward low-carbon products and encourage public participation in the net-zero transition.

To compile and refine the overall strategic measures for carbon reduction in the six major

sectors, on December 30, 2024, the Ministry of Environment formally proposed a draft for the third phase of greenhouse gas periodic regulatory goals. The proposal raised Taiwan's 2030 greenhouse gas emissions reduction target from a 24±1% reduction (relative to the 2005 baseline), as originally published in the 2022 NDCs, to a 28+-2% reduction. The proposal also set the 2030 electricity emissions target at 0.319 tons CO2e per KWh and introduced periodic regulatory goals for the six major sectors (energy, manufacturing, residential and commercial, transportation, agriculture, and environment). A public hearing was held on February 7, 2025, to communicate with the public. After consultation, the proposal was sent to the Executive Yuan for ratification.

The Conference of the Parties calls on all countries to propose their 2035 NDCs (NDC 3.0) prior to COP30 in 2025. Taiwan's ministries and agencies have adopted a bottom-up approach to propose sectoral voluntary carbon reduction plans and rolling inspections of existing strategies. They also use a top-down approach to focus on the six major sectors through the Carbon Reduction Flagship Program, which aims to increase the effectiveness of carbon reduction through the six pillars of technological innovation, financial support, carbon pricing, regulatory adjustment, green collar talent, and community-driven initiatives. By employing these dual approaches, the government hopes to systematically integrate the six major sectors' carbon reduction measures, complete all financial matchmaking projects, and steadily promote the goal of net-zero by 2050. At the third meeting of the National Climate Change Committee on January 23, 2025, President Lai proposed a draft of the revised national carbon reduction targets for 2032 and 2035, setting them at reductions of 32±2% and 38±2%, respectively, relative to the base year of 2005. The government will continue to communicate with each sector to expand public understanding, and it will join the international community in proposing its NDC 3.0 prior to COP30. In the future, the 2032 goals will be actively applied to domestic actions, and Taiwan will pursue the 2032 goals in alignment with the international carbon reduction process to contribute to global climate governance.

III. National Climate Change Action Guidelines

1. Formulation Process and Content

The *National Climate Change Action Guidelines* ("the Guidelines") were initially approved by the Executive Yuan on February 23, 2017. Following the enactment of the *Climate Change Response Act* on February 15, 2023, the Ministry of Environment, pursuant to Article 9 of the Act, consulted with central industry competent authorities to review and revise the Guidelines. This process incorporated considerations from the UNFCCC, related international agreements, and domestic developments. A draft of the second edition was submitted to the 35th meeting of the National Council for Sustainable Development on August 15, 2023, and was approved by the Executive Yuan on November 3, 2023 .

The revised Guidelines respond to international climate agreements by emphasizing both mitigation and adaptation while incorporating the 2050 net-zero emissions target as a vision. The revision adds principles such as a just transition, risk assessment, and nature-based solutions to outline Taiwan's climate adaptation strategies and create a blueprint for achieving net-zero emissions, guiding the construction of a low-carbon, climate-resilient homeland, and ensuring sustainable national development.

2. Vision and Goals

The Guidelines aim to develop strategies for climate adaptation and a blueprint for achieving net-zero emissions and creating a low-carbon, climate-resilient homeland. The goals include enhancing Taiwan's climate adaptation capacity, strengthening resilience, reducing vulnerabilities, and achieving the long-term target of net-zero greenhouse gas emissions by 2050.

3. Established General Principles

(1) Comply with the provisions of the Paris Agreement to enhance greenhouse gas mitigation and gradually phase out the use of hydrofluorocarbons (HFCs) pursuant to the Kigali Amendment to the Montreal Protocol. Advance climate, biodiversity, and human sustainability under the Kunming–Montreal Global Biodiversity Framework (K-M GBF).

(2) Enhance intergenerational justice, environmental justice, and a just transition, while ensuring easy public access to pertinent climate change information. Consider nature-based solutions while also taking into account strategies that mutually benefit adaptation and mitigation efforts.

(3) Implement a cap-and-trade scheme for greenhouse gases and taxation to put carbon pricing and green finance into

practice and utilize economic incentives to expedite the reduction of greenhouse gas emissions, assist industrial transformation, improve national competitiveness, and promote social welfare.

(4) Comply with the objective of a nuclear-free homeland, such that expansion in nuclear power will not be adopted as a means of combating climate change, with the goal of diminishing reliance on fossil fuels and working toward achieving renewable energy targets.

(5) Take mitigation and adaptation strategies into consideration while performing environmental impact assessments.

(6) Enhance capacities with regard to basic science, early warning, adaptive response to climate change, and resilience development.

(7) Improve energy and resource utilization efficiency, boost resource recycling, and ensure national energy security and sustainable utilization of resources.

(8) Establish a communication platform on which to build partnerships between the central and local governments, as well as cooperation between the public and private sectors to practically execute localized adaptation and mitigation measures.

(9) Boost international cooperation and authentic participation, based on the principle of reciprocity, to maintain industries' international competitiveness.

(10) Raise public awareness and build the capacity to respond to climate change, and proactively assist non-governmental organizations to participate in related events.

IV. Strategies for Promoting Greenhouse Gas Reduction

1. Comprehensive Greenhouse Gas Inventory and Verification Management System

An inventory refers to the process by which emission source enterprises conduct self-assessments, collect data, and report their greenhouse gas emissions in accordance with government regulations. This process aims to provide a comprehensive understanding of an enterprise's emissions during its production and operations, while offering accurate data to the government and regulatory agencies. According to the *Regulations for Gas Emission Inventory Registration and Inspection Management*, designated emission source enterprises must register their greenhouse gas inventory and submit an inventory report for the previous year by April 30 annually. These reports include details such as production processes, product output, emission units, fuel types, carbon content, lower heating values, fuel consumption, reduction measures implemented, methods used to calculate annual emissions, and relevant parameters. The enterprises must also upload verification summary reports and statements to a designated platform before October 31 of each year. The primary objective of the inventory process is to ensure that enterprises are aware of their emissions and can identify opportunities for improvement of reduction measures. It also helps enterprises ensure compliance and avoid penalties or other repercussions due to missing or inaccurate data. Moreover, the inventory process enables better planning of future greenhouse gas reduction actions, thus supporting the nation's long-term emission reduction goals.

Data accuracy during the inventory process is critical. Enterprises must calculate their emissions using methods prescribed by the Ministry of Environment, such as the emission factor method, mass balance method, or direct monitoring method, depending on the characteristics of their emission sources and industries. To maintain transparency, enterprises are required to retain inventory, registration, and verification data for six years to facilitate inspection by the competent authorities.

Verification involves independent third-party audits of enterprises' self-reported inventory results to ensure the truthfulness, accuracy, and consistency of greenhouse gas emissions data. Ministry of Environment-approved verification bodies, which have undergone rigorous certification and possess professional experience in greenhouse gas verification, conduct on-site inspections, data audits, and technical analyses to ensure that reported greenhouse gas emissions comply with government standards. Verification provides external validation of inventory results, which enhances the credibility of the overall greenhouse gas management system. It also increases corporate accountability and encourages the implementation of more precise emission reduction measures, thereby forming a robust foundation for achieving the nation's 2050 net-zero emissions target.

2. Offsetting Emission Increases

The *Regulations for Greenhouse Gas Emission*

Offset Management ("Offsetting Regulations") were revised and officially published in October 2023. These regulations address emissions from new development projects to mitigate their impact on the climate and ensure a consistent national approach to managing incremental emissions. Historically, for development projects such as science parks, industrial zones, and high-rise buildings to meet environmental impact assessment (EIA) standards, central and local governments required developers to offset a certain proportion of the additional greenhouse gas emissions. The Offsetting Regulations formalize these requirements and provide clear guidelines.

Under the Offsetting Regulations, projects subject to mandatory offsets include large-scale factories (factories with annual emissions exceeding 25 $ktCO_2e$), new or expanded industrial park projects, new or modified units at thermal power plants, and cogeneration facilities. However, exemptions apply to projects using natural gas as fuel and to new units with a capacity below 25 MW. The implementation of these regulations promotes a more sustainable development model by ensuring that developers take necessary compensatory measures for incremental emissions to minimize the environmental impact of their activities.

3. Voluntary Emission Reduction Projects

On October 12, 2023, the Ministry of Environment announced the *Regulations for Voluntary Emission Reduction Project Management* ("Voluntary Reduction Regulations"). These regulations align with international trends in voluntary carbon markets and adopt the 3+5 Principles: measurable, reportable, and verifiable (MRV), along with additionality, conservativeness, permanence, avoidance of environmental harm, and prevention of double-counting. Drawing on Taiwan's previous experience with the *Regulations for Greenhouse Gas Emission Offset Management*, the Voluntary Reduction Regulations were updated to provide a robust framework.

Applicants must design and implement reduction measures in accordance with methodologies approved and published by the Ministry of Environment. These measures may include removal projects, such as afforestation, or reduction/avoidance projects, such as energy efficiency improvements. Applications proceed in two stages: registration and credit review. During this process, third-party verification bodies must confirm and certify the measures. For projects involving mature reduction technologies with clear methodologies and established domestic examples—such as replacing lighting or chillers—the certification stage may be waived to reduce the burden on applicants. Applicants must execute their projects and monitor emissions in accordance with the approved registered plans before applying to the Ministry of Environment for the issuance of emission reduction credits. These credits can be used to offset carbon fees, or they can be traded with entities requiring offsets. As of June 2024, a total of 95 greenhouse gas offset projects and 4 voluntary reduction projects had been registered, collectively accruing approximately 2,558 $ktCO_2e$ in reduction credits supported by 143 announced methodologies.

On July 1, 2024, the Ministry of Environment further introduced the *Regulations for Transfer, Trading, and Auction of Greenhouse Gas Emission Reduction Credits*, which established a transparent trading market for voluntary reduction credits. The domestic trading environment is managed by the Taiwan Carbon Solution Exchange and facilitates the gradual implementation of Taiwan's carbon pricing system to achieve net-zero transition goals.

4. Earmarking of Carbon Fees

Carbon pricing is a critical strategy for emission reduction. To accelerate decarbonization efforts, the *Climate Change Response Act* incorporates carbon fees as an economic incentive mechanism. These fees are exclusively earmarked for greenhouse gas reduction projects, the development of low-carbon and negative-emission technologies and industries, and subsidies or incentives for investments in emission reduction technologies to promote greenhouse gas reductions and the development of a low-carbon economy.

The carbon fee system will be implemented in phases based on national reduction targets. Initially, fees will be imposed on power generation, gas supply, and manufacturing industries with annual emissions exceeding 25 $ktCO_2e$. In accordance with Article 28, Paragraph 3 of the Act, the Carbon Fee Rate Review Committee established by the central competent authority shall periodically perform reviews based on the current status of domestic greenhouse gas reduction, types of emission sources, types of greenhouse gas emissions, scales of emissions, the voluntary reduction situation, their effectiveness, and other relevant factors. Subsequently, the review of the committee will be submitted to the central competent authority for approval and official announcements.

Carbon fees serve as an economic tool rather than a fiscal measure, and their purpose is to incentivize actual emission reductions. Article 29 of the Act stipulates that entities subject to carbon fees who switch to low carbon fuels, adopt negative emission technologies, increase energy efficiency, use renewable energy, or take measures to reduce greenhouse gas emissions effectively by improving manufacturing processes and reaching goals designated by the central competent authority, may propose voluntary reduction plans and apply for a preferential rate from the central competent authority. This differential rate design encourages high-emission enterprises to proactively adopt reduction measures.

On August 29, 2024, the Ministry of Environment formulated three complementary sub-laws to support the carbon fee system: the *Regulations Governing the Collection of Carbon Fees,* the *Regulations Governing Self-Determined Reduction Plans*, and the *Designated GHG Emissions Reduction Goals for Entities Subject to Carbon Fees*. Subsequently, on October 21, 2024, the Ministry announced the Fee-charging Rates of Carbon Fees, which went into effect on January 1, 2025. Through carbon pricing and market mechanisms, enterprises are encouraged to pursue low-carbon transitions, and the launch of the carbon fee system marked Taiwan's official entry into the era of carbon pricing. To allow sufficient time for entities to evaluate reduction targets, formulate strategies aimed at achieving the 2030 goals, and submit voluntary reduction plans, carbon fee collection will begin in 2025, and entities will calculate and pay carbon fees in May 2026 based on their total GHG emissions for the year 2025.

Revenue from carbon fees is incorporated into the GHG Management Fund to finance greenhouse gas reduction and climate adaptation initiatives. Article 33 of the Act specifies the uses of the fund, which include the development of low-carbon and negative-emission technologies, subsidies and incentives for reduction investments, promotion of climate adaptation efforts, carbon footprint management mechanisms, education and outreach, and support for a just transition initiatives. The well-planned allocation of revenue will maximize reduction outcomes, and the implementation progress is publicly disclosed on a regular basis.

3.3 Greenhouse Gas Reduction Policies and Measures

The *Climate Change Response Act* establishes a hierarchical driving framework for the central authorities, related bureaus, and local governments. The Ministry of Environment is the central competent authority, which engages in interministerial cooperation with the Ministry of Economic Affairs, the Ministry of Transportation and Communications, the Ministry of the Interior, the Ministry of Agriculture, and related offices to jointly implement greenhouse gas reduction policies and measures.

Taiwan's *Climate Change Response Act* was promulgated and implemented on February 15, 2023, stipulating that the 2050 net-zero emissions targets will be gradually implemented through periodic regulatory goals established on a 5-year basis. To achieve net-zero transition, the government places equal emphasis on the principles of mitigation and adaptation, and it periodically reviews and develops *National Climate Change Action Guidelines*. The central industry competent authorities establish Sectoral GHG Reduction Action Programs and Sectoral Climate Change Adaptation Action Programs and submit them to the central competent authority, which reports the programs to the Executive Yuan for approval and conducts reviews on a rolling basis. These programs are supplemented by local governments' GHG Reduction Action Programs and Climate Change Adaptation Action Programs. Through horizontally and vertically integrated communication mechanisms, the government promotes cross-sector greenhouse gas reduction and climate change adaptation capability, thereby facilitating sustainable social, economic, and environmental development while protecting the entire population's health and collective benefit.

3.3.1 National Greenhouse Gas Periodic Regulatory Goals

I. Taiwan's Short-, Medium-, and Long-Term Greenhouse Gas Reduction Targets

Under the former *Greenhouse Gas Reduction and Management Act*, Taiwan established phased short-term and medium-term targets with five-year intervals to achieve the long-term goal of reducing greenhouse gas emissions to no more than 50% of 2005 levels by 2050.

The first-phase greenhouse gas regulatory goal (2016–2020) and the second-phase regulatory goal (2021–2025) were approved by the Executive Yuan on January 23, 2018, and September 29, 2021,

respectively. These regulatory goals were integrated into Taiwan's long-term reduction pathway for achieving 2050 net-zero emissions. Following the February 15, 2023 enactment of the *Climate Change Response Act*, the 2050 net-zero emissions target was formally incorporated into law, solidifying Taiwan's commitment to the net-zero transition. Moreover, a draft of the third phase of greenhouse gas periodic regulatory goals was proposed on December 30, 2024. In accordance with legal procedures, a public hearing was held on February 7, 2025, and the collected feedback from various sectors will be submitted to the Executive Yuan for approval. Taiwan's short-term, medium-term, and long-term greenhouse gas reduction trajectory is illustrated in Figure 3.3.1-1; the sectoral reduction targets are detailed in Table 3.3.1-1.

(1) First Phase (2016–2020) Goal: A 2% reduction in 2020 compared to the baseline year (2005).

(2) Second Phase (2021–2025) Goal: A 10% reduction in 2025 compared to the baseline year (2005).

(3) Third Phase (2026–2030) Goal: A 28%±2% reduction in 2030 compared to the baseline year (2005).

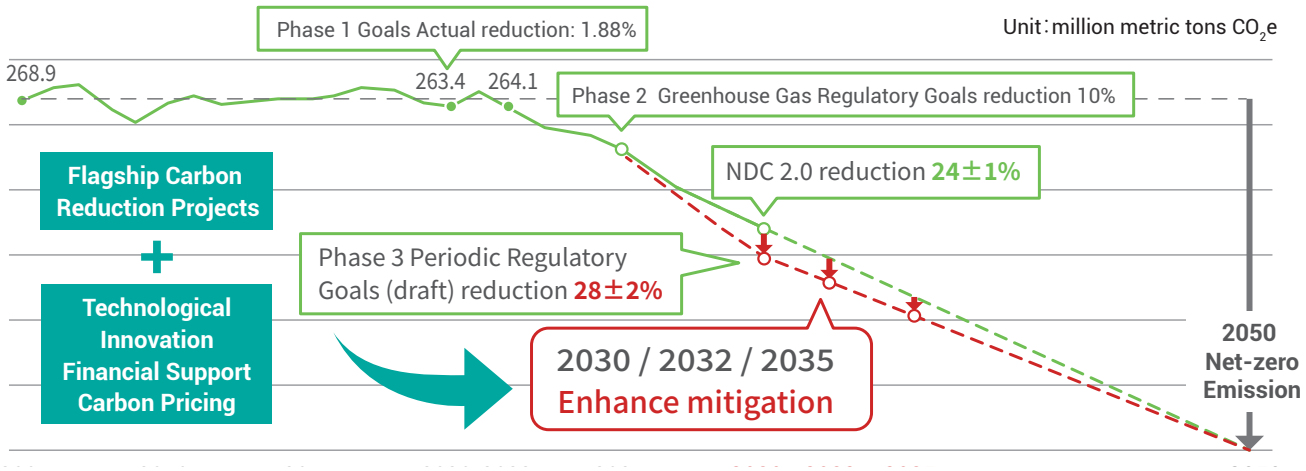


Figure 3.3.1-1. Taiwan's Greenhouse Gas Reduction Pathway

Source: Ministry of Environment News Portal, December 30, 2024.

Table 3.3.1-1. National and Sectoral Greenhouse Gas Periodic Regulatory Goals

Unit: million metric tons CO_2e

Category		2025 Greenhouse Gas Emission Target	Second-Phase Control Target (Total Greenhouse Gas Emissions for 2021–2025)
National		241.011	1,400.284
Six Major Sectors	Energy	34.000	182.504
	Manufacturing	144.000	753.454
	Transportation	35.410	181.626
	Residential and Commercial	41.421	241.331
	Agriculture	5.006	27.814
	Environment	2.564	13.555
Electricity Emission Factor		0.388 $kgCO_2e$/kWh (2025 Target)	0.447 $kgCO_2e$/kWh (Yearly Average)

Note: Excludes electricity and emissions from power plant auxiliary use, self-generated auxiliary use, and line losses.
Source: Ministry of Environment. Phase 2 Greenhouse Gas Periodic Regulatory Goals. 2021.

3.3.2 Sectoral Greenhouse Gas Reduction Action Programs

In accordance with the *Climate Change Response Act*, Taiwan establishes periodic regulatory goals in stages, which are implemented on a 5-year basis. On January 10, 2022, the Executive Yuan approved the Second (2021–2025) Greenhouse Gas Reduction Action Plan. Subsequently, on September 16, 2022, it approved the Phase 2 Sectoral Greenhouse Gas Reduction Action Program, which set periodic regulatory goals and evaluation indicators for six major sectors in order to achieve the 2050 net-zero emissions goal.

The realization of national periodic regulatory goals relies on the implementation of sector-specific greenhouse gas reduction action programs. Each of the six sectors is tasked with meeting its respective periodic regulatory goals, including those for electricity emission factors. To monitor progress toward periodic regulatory goals, relevant ministries are required to submit annual sectoral action program performance reports to the central competent authority (the Ministry of Environment) by September of each year. The reports are then forwarded to the Executive Yuan for approval and public disclosure. Additionally, the Ministry of Environment must report on the status of periodic regulatory goal implementation to the Executive Yuan by November of each year. Performance reports for sectoral action programs play a critical role in tracking and evaluating the effectiveness of periodic regulatory goals. These reports serve as a key medium for the Executive Yuan and stakeholders to assess Taiwan's progress in greenhouse gas reduction initiatives.

The following sections outline the strategies, measures, and highlights of greenhouse gas reduction efforts based on the Phase 2 (2021–2025) action programs and the 2022 and 2023 performance reports for the six major sectors.

I. Energy Sector

The greenhouse gas emission target for the energy sector in 2025 is set at 34.000 million metric tons CO_2e, representing a 4.16% reduction compared to 2005 levels. To achieve this target, the Executive Yuan approved the Phase 2 Sectoral Greenhouse Gas Reduction Action Program on September 16, 2022, which promotes the following strategies:

1. **Adjusting the Energy Structure**
   - (1) Increase the share of renewable energy in electricity generation.
   - (2) Gradually expand the use of natural gas and raising its share in electricity generation.
   - (3) Reduce the share of coal-fired power generation and implementing load reductions during periods of deteriorated air quality, while ensuring stable power supply.
   - (4) Support measures for low-carbon energy supply.
2. **Enhancing Energy Production and Transmission Efficiency**
   - (1) Improve energy production efficiency.
   - (2) Advance smart grid infrastructure.
   - (3) Promote proactive energy management and pollution prevention.

The energy sector's action program encompasses a total of 48 projects. Recent years have seen significant progress in green energy expansion, with notable achievements in renewable energy deployment. By 2023, cumulative installed solar photovoltaic capacity reached 12.4 GW, and offshore wind power installations totaled 1.7 GW, representing year-on-year increases of 27.8% and 143%, respectively. Key evaluation indicators and annual targets for the energy sector are summarized in Table 3.3.2-1.

Table 3.3.2-1. Evaluation Indicators and Annual Targets for the Energy Sector

Evaluation Indicators	2022 Performance	2023 Performance	2024 Target	2025 Target
Renewable Energy Installed Capacity Target	14.12 GW	17.96 GW	-	The renewable energy installed capacity target for 2025 is 30.161 GW.
Cumulative Installed Capacity of Solar PV	9.724 GW	12.4 GW	16.21 GW	20.0 GW
Cumulative Installed Capacity of Offshore Wind	0.745 GW	1.7 GW	2.7–3.6 GW	5.6 GW

Source: Annual Targets of the Phase 2 Sectoral Greenhouse Gas Reduction Action Program.

Table 3.3.2-2. Highlights of the Greenhouse Gas Reduction Action Program: Energy Sector 2023 Performance Report

2023 Energy Sector Greenhouse Gas Reduction Action Program Performance		
Strategy	**Effectiveness**	**Details**
Adjusting Energy Structure	12.4GW	The cumulative installed capacity of solar PV reached 12.4 GW in 2023.
	3.51 million certificates	By 2023, 665 renewable energy projects issued over 3.51 million certificates, equivalent to 3.18 billion kWh of green power.
	82.64 billion kWh	The actual electricity generation from gas-fired units reached 82.64 billion kWh in 2023.
Improving Energy and Transmission Efficiency	2.707 million units	A total of 2.707 million smart meters were cumulatively installed by 2023.
	143 million kWh	Major energy users set energy-saving targets and implemented plans, achieving an additional savings of 143 million kWh.
	57%	Improved transmission and distribution efficiency, with 57% of automated feeder line downstream faults restored within 5 minutes.

Source: Phase 2 Greenhouse Gas Reduction Action Program: Energy Sector 2023 Performance Report.

II. Manufacturing Sector

The greenhouse gas emissions target for the manufacturing sector in 2025 is set at 144 million metric tons of CO_2e, representing a 0.22% reduction compared to 2005. To achieve this target, the Executive Yuan approved the Phase 2 Sectoral Greenhouse Gas Emissions Reduction Action Program on September 16, 2022, implementing the following strategies:

1. Facilitating Low-Carbon Industrial Transformation

(1) Promote low-carbon industrial transformation by accelerating process improvements and equipment upgrades and advancing the development of cutting-edge industrial technologies for low-carbon, high-value growth.

(2) Encourage the adoption of renewable energy, clean fuels, and biofuels within the industrial sector.

(3) Subsidize boiler transitions to low-carbon fuels.

(4) Strengthen regional energy and resource recycling, as well as waste reutilization, to establish mechanisms for industrial linkage and symbiotic collaboration.

(5) Enhance industrial emission reduction responsibilities by encouraging enterprises to join international initiatives and set carbon reduction targets.

2. Implementing Greenhouse Gas Reduction Measures

(1) Enhance industrial energy-saving technical services to reduce GHG emissions.

(2) Promote intelligent energy management by assisting industries in establishing energy management systems.

(3) Provide systematic energy-saving improvement subsidies to enterprises to improve overall energy efficiency for energy users.

(4) Align the manufacturing sector with international carbon reduction measures and development trends.

(5) Transform greenhouse gas reduction performance into certified reduction credits.

(6) Facilitate the reduction of fluorinated GHG emissions within the electronics industry.

(7) Promote GHG inventory and reporting guidance for science parks.

(8) Assist enterprises in establishing climate change adaptation management mechanisms.

3. Transitioning to Sustainable Production Processes

(1) Promote the integration of green design and material flow cost analysis to reduce the environmental impact of products.

(2) Strengthen green supply chain management strategies and assist enterprises in disclosing environmental information related to corporate social responsibility.

(3) Support enterprises in implementing cleaner production practices and advancing the Green Factory Labeling System.

(4) Introduce consumption-based feedback mechanisms to promote green consumption.

The action plan for the manufacturing sector encompasses a total of 48 measures. In recent years, the sector has driven low-carbon industrial transformation through three main policy frameworks: facilitating low-carbon industrial transformation, implementing greenhouse gas reduction measures, and transitioning to sustainable production processes. A summary of implementation results is presented in Figure 3.3.2-1. As shown in Table 3.3.2-3, the carbon intensity of the manufacturing sector decreased by 56% in 2022 compared to 2005.

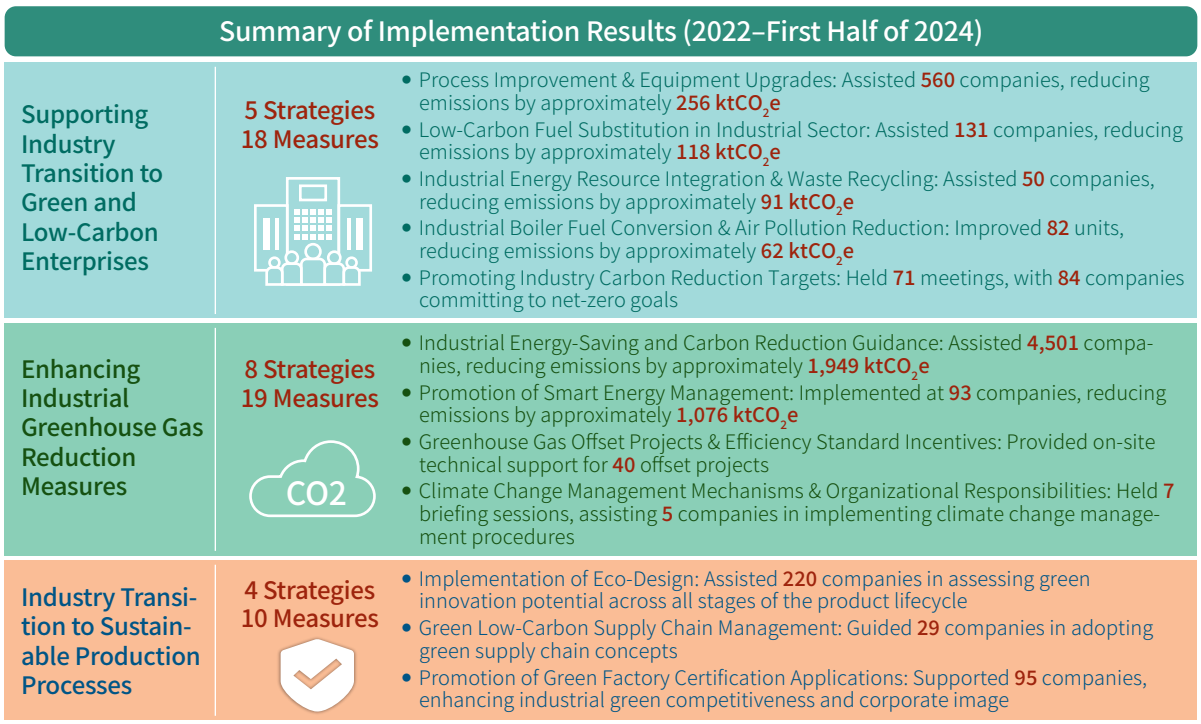


Figure 3.3.2- 1. Summary of Recent Implementation Results for the Manufacturing Sector Action Program

Table 3.3.2-3. Evaluation Indicators and Annual Targets for the Manufacturing Sector

Evaluation Indicators	2022 Performance	2023 Performance	2024 Target	2025 Target
Carbon Intensity of the Manufacturing Sector in 2025	56% reduction in 2022 compared to 2005	-	-	55% reduction in 2025 compared to 2005; 60% reduction in 2030 compared to 2005.

Table 3.3.2-4. Highlights of the Greenhouse Gas Reduction Action Program: Manufacturing Sector 2023 Performance Report

Greenhouse Gas Reduction Action Program: Manufacturing Sector 2023 Performance Report		
Strategy	**Effectiveness**	**Details**
Facilitating Low-Carbon Industrial Transformation	403 factories	Completed on-site guidance for 403 factories to promote equipment upgrades and process improvements.
	32 boilers	Completed improvements and subsidies for 32 boilers.
	21 factories	Completed energy and resource integration consulting diagnoses for 21 factories.
Implementing Greenhouse Gas Reduction Measures	3,214 factories	Guided 3,214 factories in energy-saving and carbon reduction, providing energy-saving technical services.
	43 factories	Assisted 43 factories in establishing energy management systems and adopting intelligent energy management applications.
	20 projects	Provided greenhouse gas offset project consulting services, completing on-site technical support for 20 projects.
Transitioning to Sustainable Production Processes	120 firms	Supported 120 firms in adopting environmental footprint assessment, green product design, and green procurement declarations.
	15 firms	Guided 15 firms to publish their first international CSR reports.
	44 firms	Assisted 44 firms in obtaining the Green Factory Label or passing the Cleaner Production Compliance Review.

Source: Phase 2 Greenhouse Gas Reduction Action Program: Manufacturing Sector 2023 Performance Report.

III. Transportation Sector

The greenhouse gas emissions target for the transportation sector in 2025 is set at 35.410 million metric tons of CO_2e, representing a 6.79% reduction compared to 2005. To achieve this target, the Executive Yuan approved the Phase 2 Sectoral Greenhouse Gas Emissions Reduction Action Program on September 16, 2022, implementing the following strategies:

1. Developing Public Transportation Systems

(1) Increase the use of public transportation on highways.

(2) Enhance Taiwan Railway's passenger capacity.

(3) Boost high-speed rail passenger volumes.

(4) Increase metro system ridership.

(5) Enhance seamless transfer services in public transportation.

(6) Strengthen transportation demand management.

2. Establishing a Green Transportation Network

(1) Build a high-efficiency green transportation network.

(2) Promote electric and low-carbon vehicles.

(3) Create a favorable environment for low-carbon transportation usage.

(4) Develop capacity for low-carbon transportation advancement.

3. Improving Energy Efficiency in Transportation

Systems and Vehicles

(1) Develop intelligent transportation systems.

(2) Enhance the efficiency of freight transportation.

(3) Improve energy efficiency standards for new vehicles.

(4) Phase out high-energy-consuming vehicles.

The action program for the transportation sector includes a total of 8 measures. In recent years, the sector has advanced toward net-zero goals through initiatives such as developing public transportation systems, promoting electric and low-carbon vehicles, building intelligent transportation systems, and phasing out high-energy-consuming vehicles. A summary of evaluation indicators and annual targets for the transportation sector is presented in Table 3.3.2-5.

Table 3.3.2-5. Evaluation Indicators and Annual Targets for the Transportation Sector

Evaluation Indicator	2022 Performance	2023 Performance	2024 Target	2025 Target
Highway Public Transportation Ridership	837 million trips, a 31.26% reduction compared to 2015.	960 million trips, a 21.13% reduction compared to 2015.	1.008 billion trips, a 17.19% reduction compared to 2015.	1.274 billion trips, a 4.5% increase compared to 2015.
Taiwan Railway Ridership	170 million trips, a 26.68% reduction compared to 2015.	219 million trips, a 5.7% reduction compared to 2015.	239.6 million trips, a 3.2% increase compared to 2015.	240 million trips, a 3.5% increase compared to 2015.
High-Speed Rail Ridership	54.16 million trips, a 7.12% increase compared to 2015.	73.08 million trips, a 44.5% increase compared to 2015.	65.52 million trips, a 29.6% increase compared to 2015.	66.59 million trips, a 31.7% increase compared to 2015.
Metro System Ridership	663 million trips, a 14.67% reduction compared to 2015.	841 million trips, a 4.49% increase compared to 2015.	878 million trips, a 12.89% increase compared to 2015.	890 million trips, a 15.6% increase compared to 2015.
Electric Urban Bus Penetration Rate	10.87%	16.76%	25%	35%
Electric Passenger Vehicle Market Share	-	5.93%	6%	10%
Electric Scooter Market Share	-	9.16%	17%	20%
Improving Energy Efficiency for New Vehicles	Passenger vehicle energy efficiency improved by 38% compared to 2017. Commercial vehicle efficiency improved by 25%. Scooter efficiency improved by 10%.	Passenger vehicle energy efficiency improved by 38%, reaching 20 km/l. Commercial vehicle efficiency improved by 25%, reaching 13.7 km/l. Scooter efficiency improved by 10%, reaching 46.1 km/l.	Passenger vehicle efficiency is expected to improve by 38%, reaching 20 km/l. Commercial vehicle efficiency is expected to improve by 25%, reaching 13.7 km/l. Scooter efficiency is expected to improve by 10%, reaching 46.1 km/l.	Passenger vehicle efficiency is expected to improve by 38%, reaching 20 km/l. Commercial vehicle efficiency is expected to improve by 25%, reaching 13.7 km/l. Scooter efficiency is expected to improve by 10%, reaching 46.1 km/l.

Source: Phase 2 Greenhouse Gas Reduction Action Program: Transportation Sector 2023 Performance Report.

Table 3.3.2-6. Highlights of the Greenhouse Gas Reduction Action Program: Transportation Sector 2023 Performance Report

Greenhouse Gas Reduction Action Program: Transportation Sector 2023 Performance Report		
Strategy	**Effectiveness**	**Details**
Developing Public Transportation Systems	960 million trips	Continued to improve the highway public transportation environment and provide optimized public transportation services, facilitating 960 million trips in 2023.
	219 million trips	Taiwan Railway restructured and integrated the ticketing system and provided discounted fares, facilitating 219 million trips in 2023.
	73.08 million trips	The High-Speed Rail increased ticket price diversification, provided discounted rates, and accelerated cross-industry collaboration, facilitating 73.08 million trips in 2023.
Establishing a Green Transportation Network	841 million trips	The MRT network expanded its scope of service in Taipei, New Taipei City, Kaohsiung, Taoyuan, Taichung, facilitating 841 million trips in 2023.
	1,831 vehicles	1,831 electric buses were registered in 2023.
	5.93%	Sales of electric passenger vehicles accounted for 5.93% of the market in 2023.
Improving Energy Efficiency in Transportation Systems and Vehicles	8,922 charging stations	A total of 8,922 public charging stations for electric vehicles were established as of 2023, including 6,863 slow charging stations and 2,059 fast charging stations.
	13.01 million hours	By subsidizing plans of local governments' to alleviate traffic congestion in transport corridors, a total of 13,012,250 man-hours were saved in 2023.
	960 million trips	Continued to improve the highway public transportation environment and provide optimized public transportation services, facilitating 960 million trips in 2023.

Source: Phase 2 Greenhouse Gas Reduction Action Program: Transportation Sector 2023 Performance Report.

IV. Residential and Commercial Sector

The greenhouse gas emissions target for the residential and commercial sector in 2025 is set at 41.421 million metric tons of CO_2e, representing a 27.9% reduction compared to 2005. To achieve this goal, the Executive Yuan approved the Phase 2 Sectoral Greenhouse Gas Emissions Reduction Action Program on September 16, 2022, advancing the following carbon reduction strategies:

1. Residential Sector

The Phase 2 Action Program for the residential sector, jointly implemented by four agencies, promotes eight strategies, including green building promotion, the formulation of new building regulations, and the development of energy efficiency standards and energy-saving certifications for equipment. These measures are estimated to reduce 1.6095 million metric tons of CO_2e. The strategies include:

(1) Promoting Green Buildings: Continue issuing green building labels and candidate certificates for residential buildings.

(2) Nearly-Zero Carbon Building Development Strategies: Public buildings will lead by example, encouraging private buildings to follow suit. New buildings will initially adopt voluntary measures, followed by mandatory regulatory implementation. Additionally, measures to enhance energy-saving appliances and research on energy-saving technologies and renewable energy applications will be pursued.

(3) Promoting Renewable Energy: Promote the installation of solar photovoltaic (PV) systems in social housing. Where local government regulations do not mandate

solar installations, buildings must install solar panels on rooftops with a minimum capacity of 2 kW per unit.

(4) Enhancing Energy Efficiency of New Buildings: Revise green building benchmarks under the Building Technical Regulations, along with standards for central air conditioning systems to improve efficiency and reduce greenhouse gas emissions. Green design for building sites will mitigate heat island effects and improve air quality.

(5) Building Energy-Efficiency Labeling System: Plan to improve energy efficiency by starting with public sector buildings and gradually expanding to private and energy-intensive buildings.

(6) Incentives and Subsidies: Encourage urban renewal and hazardous building reconstruction projects to achieve green building standards through bulk rewards and by prioritizing subsidies for green materials, green energy, and green construction methods.

(7) Reducing Urban Heat Island Effect: Enhance urban ecological features, improve environmental quality, and reduce urban heat island effects through environmental and landscape improvements.

(8) Managing Emissions of Existing Buildings: Revise Minimum Energy Performance Standards (MEPS) for appliances, phase out inefficient products, and enhance the energy efficiency of energy label-certified products while promoting high-efficiency equipment.

2. Commercial Sector

The Phase 2 Action Program for the commercial sector, which is executed by 11 government agencies, promotes eight strategies to improve equipment energy efficiency, strengthen carbon reduction capacity in the service industry, and promote green buildings. These measures are estimated to reduce 2.1537 million metric tons of CO_2e. The strategies include:

(1) Mandatory Energy Efficiency Measures for the Service Industry: Promote energy audits, provide technical energy-saving guidance, and implement comprehensive energy-saving measures in government agencies and schools.

(2) Voluntary Carbon Reduction in the Service Industry: Encourage voluntary carbon reduction initiatives in telecommunications, financial institutions, and social welfare organizations to drive green transformation.

(3) Guiding Corporate Carbon Reduction: Provide energy-saving consultation and track effectiveness, promote energy management systems, and support small and medium-sized enterprises with energy-saving measures.

(4) Incentives and Subsidies: Promote performance-based energy-saving projects and assist service users in adopting systematic energy-saving improvements and energy management systems.

(5) Sustainability in Investments and Financing: Integrate sustainability into investment and loan decisions to encourage enterprises to reduce environmental pollution and achieve carbon reduction goals.

(6) Promoting Green Buildings: Continue issuing green building labels and candidate certificates.

(7) Enhancing Energy Efficiency of New Buildings: Revise energy-saving regulations and standards under the Building Technical Regulations and assist local governments with green building audits and promotional work.

(8) Managing Emissions of Existing Buildings: Implement minimum energy performance standards for energy equipment and certify energy-saving products to improve energy efficiency.

The action programs for the residential and commercial sector encompass 12 strategies and 48 specific carbon reduction measures. Recent efforts include promoting green buildings, developing renewable energy, enhancing energy efficiency in new and existing buildings, and implementing mandatory and voluntary carbon reduction measures in the service industry. Significant progress has been made in green building promotion, with 1,150 green building candidate certificates and labels issued, exceeding the target of 700. Energy label certifications and equipment energy standards have also met annual targets, and energy efficiency in the public sector has improved by 10.7% compared to 2005, achieving the 2025 goal ahead of schedule. A summary of evaluation indicators and annual targets for the residential and commercial sector is presented in Table 3.3.2-7.

Table 3.3.2-7. Evaluation Indicators and Annual Targets for the Residential and Commercial Sector

Evaluation Indicators and Annual Targets	2022 Performance	2023 Performance	2024 Target	2025 Target
Control Measures and Certification of MEPS and Energy Label Products	-	Completed draft energy efficiency standards for LED tubes and MEPS for refrigeration cabinets in 2023.	Develop or revise 1–2 MEPS or energy label standards annually.	Develop or revise 1–2 MEPS or energy label standards annually.
Measures for Obtaining Green Building Candidate Certificates and Green Building Labels	1,032 Green Building Certificates and Eco-Labels have been issued.	1,150 Green Building Certificates and Eco-Labels have been issued.	Issue approximately 700 new Green Building Certificates and Eco-Labels.	Issue approximately 700 new Green Building Certificates and Eco-Labels.
Amendment of Energy-Saving Design Standards for New Buildings	-	Drafted amendments to expand energy-saving standards for new buildings, including EAC standards for central HVAC systems.	Draft amendments to the energy-saving design standards for new buildings.	Finalize amended energy-saving design standards for new buildings by 2025.
Electricity Efficiency in Public Sector Buildings	In 2022, electricity efficiency in government agencies and schools improved by approximately 9.4% compared to 2015.	In 2023, electricity efficiency in government agencies and schools improved by 10.7% compared to 2015, achieving the target ahead of schedule.	-	By 2025, a 10% improvement compared to 2015 is expected, meeting the announced Energy Usage Index (EUI) standards.
Establishment of Building Energy Database and Energy Passports	-	-	-	Research and establish a building energy database and develop energy passports by 2025.

Sources: Phase 2 Sectoral Greenhouse Gas Reduction Action Program: Residential and Commercial Sector 2023 Performance Report; 2022 Performance Evaluation Report on the Electricity Efficiency Management Plan for Government Agencies and Schools; and the approved Phase 2 (2021–2025) Greenhouse Gas Reduction Action Program.

Table 3.3.2- 8. Highlights of the Greenhouse Gas Reduction Action Program: Residential and Commercial Sector 2023 Performance Report

Greenhouse Gas Reduction Action Program: Residential and Commercial Sector 2023 Performance Report		
Strategy	**Effectiveness**	**Details**
Residential	3,239.64 kW	In 2023, photovoltaic systems were installed at 210 completed or under-construction social housing sites nationwide, with a total installed capacity of 3,239.64 kW.
	10.830 $ktCO_2e$	In 2023, newly constructed buildings with construction permits implemented green design measures, achieving a carbon reduction of approximately 10.830 $ktCO_2e$.
	210.8 $ktCO_2e$	Improved the efficiency standards for energy-label products and promoted the adoption of high-efficiency products, resulting in an actual carbon reduction of 210.800 $ktCO_2e$ in 2023.

Greenhouse Gas Reduction Action Program: Residential and Commercial Sector 2023 Performance Report		
Strategy	**Effectiveness**	**Details**
Commercial	1,400 companies	In 2023, approximately 1,400 large energy users in the service industry implemented energy audit systems and the 1% energy-saving requirement, with on-site inspections conducted for 400 large energy users. Additionally, 235 energy users, including corporate groups, received on-site guidance to identify energy-saving potential.
	16.8 million kWh	Government agencies, schools, and other public sectors implemented energy-saving measures in 2023, achieving a carbon reduction of 8 $ktCO_2e$ and saving 16.188 million kWh of electricity.
	15 companies	Assisted 15 service sector energy users in establishing energy management systems.
Others	263 cases	In 2023, urban renewal and hazardous building reconstruction incentive measures were promoted, with 263 cases approved, resulting in a carbon reduction of approximately 2.3905 $ktCO_2e$.
	38 projects	Subsidized 38 energy performance guarantee projects in 2023, including projects for government agencies, schools, hospitals, and the service industry.
	Over 202,000 trees	Maintenance was conducted on facilities and over 200,000 trees in metropolitan parks in Taichung and Kaohsiung , and an additional 2,500 native trees were planted in 2023.

Source: Phase 2 Greenhouse Gas Reduction Action Program: Residential and Commercial Sector 2023 Performance Report.

V. Agriculture Sector

The greenhouse gas emissions target for the agriculture sector in 2025 is set at 5.006 million metric tons of CO_2e, representing a 37.38% reduction compared to 2005. To achieve this goal, the Executive Yuan approved the Phase 2 Sectoral Greenhouse Gas Emissions Reduction Action Program on September 16, 2022, implementing the following strategies:

1. Promoting Environmentally Friendly Agricultural Practices

(1) Promote organic and environmentally friendly farming practices.
(2) Implement green environmental payments.
(3) Adjust rice paddy irrigation areas according to annual water conditions.
(4) Use rice husks (rough rice) as a substitute for fuel oil to save energy and reduce emissions.
(5) Implement the Big Granary Project (nitrogen fixation).
(6) Promote the use of biological resources.

2. Facilitating Sustainable Transformation of Livestock and Fisheries

(1) Maintain biogas utilization (power generation) on livestock farms.
(2) Sustain and ensure the self-sufficiency rate of domestic livestock and poultry products.
(3) Implement fishing boat (or raft) buyback and disposal programs.
(4) Incentivize fishing moratorium programs.
(5) Promote energy-saving aerator projects.

3. Strengthening Forest Resource Management

(1) Afforestation:
- Coastal and offshore afforestation.
- Afforestation in national forests.
- Incentivized afforestation on sloped lands.

(2) Enhanced Forest Management:
- Restoration and reforestation.
- Mid-to-late-stage forest maintenance operations.

The action program for the agriculture sector includes 12 carbon reduction measures. In recent years, the sector has increased greenhouse gas removal through sustained afforestation efforts and enhanced forest management, contributing to the progress toward net-zero goals. Additionally, by 2023, the installed capacity of agricultural solar photovoltaics reached 3.273 GW, helping to reduce the national electricity emission factor and contributing across sectors. A summary of evaluation indicators and annual targets for the agriculture sector is presented in Table 3.3.2-9.

Table 3.3.2-9. Evaluation Indicators and Annual Targets for the Agriculture Sector

Evaluation Indicator	2022 Performance	2023 Performance	2024 Target	2025 Target
Area of Organic and Friendly Farming	19,408 hectares	24,114 hectares	25,500 hectares	27,000 hectares
Afforestation	Cumulative afforestation of 3,951 hectares	Cumulative afforestation of 5,132 hectares	Cumulative afforestation of 5,852 hectares	Cumulative afforestation of 6,600 hectares
Biogas Reuse (Power Generation) in Pig Farms	Carbon reduction of 74.2 $ktCO_2e$	Carbon reduction of 69.73 $ktCO_2e$	Carbon reduction of 71.97 $ktCO_2e$	Carbon reduction of 73.90 $ktCO_2e$
Self-Sufficiency in Livestock and Poultry Products	Maintained self-sufficiency rate of 90% for pigs and 80% for poultry products	Maintained self-sufficiency rate of 90% for pigs and 80% for poultry products	Maintain self-sufficiency rate of 90% for pigs and 80% for poultry products	Continue to maintain self-sufficiency rate of 90% for pigs and 80% for poultry products
Fishing Moratorium Incentive Program	9,624 fishing vessels participated	9,268 fishing vessels participated	9,000 fishing vessels participating	9,000 fishing vessels participating
Energy-Saving Aerator Program	Cumulative subsidy for 2,458 units, reducing 8.929 $ktCO_2e$	Cumulative subsidy for 3,042 units, reducing 12.723 $ktCO_2e$	Cumulative subsidy for 3,600 units, reducing 17 $ktCO_2e$	Cumulative subsidy for 4,200 units, reducing 22 $ktCO_2e$
Green Environmental Payment Program	Actual implemented area: 447,000 hectares	369,000 hectares (including 77,000 hectares of green manure crops)	378,000 hectares (including 78,000 hectares of green manure crops)	387,000 hectares (including 78,000 hectares of green manure crops)
Fishing Vessel Buyback and Disposal Program	Cumulative carbon reduction of 7.77 $ktCO_2e$	80 fishing vessels participated in buyback	70 fishing vessels participate in buyback	50 fishing vessels participate in buyback
Enhanced Forest Management	Cumulative forest management of 5,240 hectares	Cumulative forest management of 7,348 hectares	Cumulative forest management of 8,453 hectares	Cumulative forest management of 9,648 hectares

Sources: Phase 2 Greenhouse Gas Reduction Action Program: Agriculture Sector 2023 Performance Report; Ministry of Agriculture (2024), Annual Targets for the Agriculture Sector.

Table 3.3.2-10. Highlights of the Greenhouse Gas Reduction Action Program: Agriculture Sector 2023 Performance Report

Greenhouse Gas Reduction Action Program: Agriculture Sector 2023 Performance Report		
Strategy	**Effectiveness**	**Details**
Promoting Environmentally Friendly Agricultural Practices	17,365 hectares	By 2023, a total of 7,414 farms had been certified organic, covering an area of 17,365 hectares.
	241.14 million hectares	By 2023, the cumulative area of organic and environmentally friendly farming reached 24,114 hectares.
	79,000 hectares	In 2023, 79,000 hectares of green manure crops were planted, resulting in an estimated reduction of 22,100 metric tons of CO_2e.
Facilitating Sustainable Transformation of Livestock and Fisheries	75,000 metric tons	In 2023, biogas power generation equipment was installed at pig farms, achieving a cumulative carbon reduction of 75,000 metric tons of CO_2e.
	9,024 vessels	In 2023, the fishing moratorium incentive program involved 9,024 fishing vessels.

Greenhouse Gas Reduction Action Program: Agriculture Sector 2023 Performance Report		
Strategy	**Effectiveness**	**Details**
Strengthening Forest Resource Management	235 hectares	In 2023, afforestation covered an area of 235 hectares, removing approximately 32,200 metric tons of CO_2e.
	783 hectares	In 2023, enhanced forest management was conducted over an area of 783 hectares, resulting in a carbon removal of approximately 15,270 metric tons of CO_2e.

Source: Phase 2 Greenhouse Gas Reduction Action Program: Transportation Sector 2023 Performance Report.

VI. Environmental Sector

The greenhouse gas emissions target for the environmental sector in 2025 is set at 2.564 million metric tons of CO_2e, representing a 65.02% reduction compared to 2005. To achieve this goal, the Executive Yuan approved the Phase 2 Sectoral Greenhouse Gas Emissions Reduction Action Program on September 16, 2022, implementing the following strategies:

1. Waste-to-Energy Resource Utilization

(1) Recover landfill biogas.

(2) Construct food waste-to-biogas energy plants to reduce emissions from biological waste treatment.

(3) Promote the transformation of industrial waste into fuel.

2. Reduction of Domestic Wastewater

(1) Continuously improve wastewater treatment rates.

(2) Promote the installation of anaerobic sludge digestion facilities at wastewater treatment plants.

(3) Develop a reporting system for biogas recovery in wastewater treatment plants.

3. Reduction of Industrial Wastewater

(1) Determine domestic emission factors.

(2) Promote the installation of anaerobic treatment facilities at wastewater plants in specific industries.

The action program for the environmental sector includes a total of 16 carbon reduction strategies. In recent years, efforts have focused on increasing domestic wastewater treatment rates, promoting anaerobic digestion and biogas recovery at public wastewater treatment plants, and converting combustible industrial waste into solid recovered fuel, which all contribute to progress toward net-zero goals. A summary of evaluation indicators and annual targets for the environmental sector is presented in Table 3.3.2-11.

Table 3.3.2-11. Evaluation Indicators and Annual Targets for the Environmental Sector

Evaluation Indicator	2022 Performance	2023 Performance	2024 Target	2025 Target
Increase in Domestic Wastewater Treatment Rate	Wastewater treatment rate reached 68.6%	Wastewater treatment rate reached 70.0%	Wastewater treatment rate to reach 70.3%	Wastewater treatment rate to reach 70.5%
Increase in Anaerobic Digestion at Large Secondary Wastewater Treatment Plants	Proportion of wastewater treated via anaerobic digestion reached 92.0% at large secondary treatment plants	Proportion of wastewater treated via anaerobic digestion reached 92.0% at large secondary treatment plants	The proportion of wastewater treated via anaerobic digestion at large secondary wastewater treatment plants will be maintained at 90%	The proportion of wastewater treated via anaerobic digestion at large secondary wastewater treatment plants will be maintained at 90%
Promotion of Landfill Biogas Recovery for Power Generation	-	Methane recovery rate reached 5.2%	Methane recovery rate to reach 5.4%	Methane recovery rate to reach 5.0%

Table 3.3.2-12. Highlights of the Greenhouse Gas Reduction Action Program: Environmental Sector 2023 Performance Report

Greenhouse Gas Reduction Action Program: Environmental Sector 2023 Performance Report		
Strategy	**Effectiveness**	**Details**
Waste-to-Energy Resource Utilization	4 sites	In 2023, biogas power generation facilities were operated at four landfill sites (Shanzhuku, Fudekeng, Wenshan, and Xiqingpu), reducing methane emissions by approximately 880 metric tons.
	2 facilities	Constructed two food waste-to-biogas energy plants: the Waipu Green Energy Ecological Park in Taichung City and the Taoyuan City Food Waste Biogas Energy Plant. Additionally, planned the second phase of the biomass energy plant at Waipu Green Energy Ecological in Taichung City.
	780,000 metric tons	By 2023, the use of waste-derived fuels reached 780,000 metric tons, including 330,000 metric tons of solid recovered fuel (SRF).
Reduction of Domestic Wastewater	70.0%	Under the 6th Stage of the Sewer Construction Plan, the national wastewater treatment rate reached 70.0%.
	92.0%	The proportion of wastewater treated via anaerobic digestion at large secondary wastewater treatment plants reached 92.0%.
	0.059 million metric tons of CO_2e	Conducted inspections at 10 wastewater treatment plants and developed a biogas recovery reporting mechanism. It is estimated that 6.8 million cubic meters of biogas can be recovered annually, equivalent to a reduction of 0.059 million metric tons of CO_2e.
Reduction of Industrial Wastewater	16 facilities	To establish domestic emission factors, measurements were conducted at 7 paper mills, 6 food processing plants, and 3 printed circuit board manufacturing facilities.
	92%	Promoted the installation of anaerobic treatment facilities for wastewater and industrial effluents. The proportion of wastewater treated via anaerobic digestion at large secondary wastewater treatment plants reached 92%.

Source: Phase 2 Greenhouse Gas Reduction Action Program: Environmental Sector 2023 Performance Report.

3.3.3 Local Government Greenhouse Gas Reduction Implementation Plan

The Ministry of Environment has long established partnerships with local governments to collaboratively implement climate change adaptation plans. Using the Low-Carbon Sustainable Homeland program as a foundation, these efforts incorporate local characteristics and refined strategies to jointly promote mitigation and adaptation actions while enhancing public carbon reduction awareness and societal decarbonization potential.

I. Principles for Local Government Implementation Programs

In accordance with Article 15 of the *Climate Change Response Act*, special municipality, county, and city governments shall submit GHG Reduction Implementation Programs in accordance with the Action Guidelines and Sectoral Action Programs, after widely gathering opinions from other relevant agencies, scholars, experts, and NGOs through holding forums or other means. These plans must align with the action guidelines and sectoral action plans, convene relevant agencies, scholars, experts, and non-governmental organizations for consultations, and employ other appropriate methods to gather opinions. The Reduction Implementation Program shall be delivered to the climate change response steering group in the special municipality, county, or city, which shall submit it for approval. After approval by the central competent authority, in consultation with the central industry competent authorities, the program shall be released to the public.

The contents of the GHG Reduction

Implementation Programs include:

(1) Analysis of current situation.

(2) Plan objectives.

(3) Implementation timeline.

(4) Implementation strategies, including responsible and assisting agencies as well as budget allocation.

(5) Expected benefits.

(6) Monitoring and evaluation mechanisms.

II. Highlights of Local Government Implementation Program Achievements

Local governments develop implementation programs that consider both the content of national and sectoral action plans and local governance characteristics. County and city reduction targets and carbon reduction measures are summarized by emission sectors as follows:

1. Reduction Targets by County and City

(1) Among the 22 counties and cities, only 14 counties and cities (63%) have proposed mid-term carbon reduction targets for 2030. Additionally, 19 counties and cities (86%) have set net-zero targets for 2050. Penghu County aims to establish a low-carbon net-zero island by 2035, and six counties and cities—Kinmen County, Hsinchu County, Hsinchu City, Nantou County, Yunlin County, and Chiayi County—have proposed 2050 targets, but not 2030 targets.

(2) Among the six major municipalities, only Taipei City, Tainan City, and Kaohsiung City have actively set short-term 5–10-year milestones toward achieving net-zero by 2050. For Taipei City: Using 2005 as the baseline year, aims for a 25% reduction by 2025, 40% by 2030, and net-zero by 2050. For Tainan City: Using 2005 as the baseline year, aims for a 5% reduction by 2025, 30% by 2030, and net-zero by 2050, demonstrating a pragmatic and gradual decarbonization approach. For Kaohsiung City: Using 2005 as the baseline year, aims for a 3.2% reduction by 2025, 30% by 2030, and net-zero by 2050.

(3) Hualien County stands out with a unique reduction target: using 2000 as the baseline year, it aims for a 59% emissions reduction by 2030, leveraging its vast forest and agricultural lands as well as abundant natural resources. Hualien's pathway to net-zero by 2050 focuses on three dimensions: energy transition, industrial transformation, and local and lifestyle transition, integrating collaborative efforts from the energy, manufacturing, agriculture, residential, transportation, and environmental sectors to achieve the net-zero goal.

Table 3.3.3-1. Local Government Greenhouse Gas Reduction Targets, by County/City

County/City	Reduction Target			
	2025	2030	2040	2025 Target
Taipei City	25% reduction compared to 2005	40% reduction compared to 2005	65% reduction compared to 2005	Net Zero Emissions
New Taipei City	12% reduction compared to 2005	30% reduction compared to 2005	-	Net Zero Emissions
Taoyuan City	10% reduction compared to 2005	50% reduction compared to 2005	-	Net Zero Emissions
Keelung City	-	30% reduction compared to 2005	60% reduction compared to 2005	Net Zero Emissions
Yilan County	10% reduction compared to 2005	30% reduction compared to 2005	-	Net Zero Emissions
Penghu County	No reduction target set	-	-	-

County/City	Reduction Target			
	2025	2030	2040	2025 Target
Kinmen County	10% reduction compared to 2005	20% reduction compared to 2005	-	Net Zero Emissions
Lienchiang County	No reduction target set	-	-	-
Taichung City	Total reduction of 2,050 $ktCO_2e$ from 2021 to 2025 (approximately 6.4% of baseline year emissions)	30% reduction compared to 2005	65% reduction compared to 2005	Net Zero Emissions
Hsinchu City	-	-	-	Net Zero Emissions
Hsinchu County	-	-	-	Net Zero Emissions
Miaoli County	No reduction target set	-	-	-
Changhua County	10% reduction compared to 2005	20% reduction compared to 2005	-	Net Zero Emissions
Nantou County	-	-	-	Net Zero Emissions
Yunlin County	10% reduction compared to 2005	-	-	Net Zero Emissions
Tainan City	5% reduction compared to 2005	30% reduction compared to 2005	65% reduction compared to 2005	Net Zero Emissions
Kaohsiung City	Total reduction of 2,170 $ktCO_2e$ from 2024 to 2025 (approximately 3.2% of baseline year emissions)	30% reduction compared to 2005	-	Net Zero Emissions
Chiayi City	10% reduction compared to 2005	45% reduction compared to 2005	-	Net Zero Emissions
Chiayi County	10% reduction compared to 2013	-	-	Net Zero Emissions
Pingtung County	Additional reduction of 370 $ktCO_2e$ in 2025 (approximately 7.9% of baseline year emissions)	30% reduction compared to 2005	-	Net Zero Emissions
Hualien County	16% reduction compared to 2020	59% reduction compared to 2020	-	Net Zero Emissions
Taitung County	10% reduction compared to 2005	30% reduction compared to 2005	-	Net Zero Emissions

2. Sectoral Reduction Methods by County and City

(1) Common Reduction Measures

Aligned with the six major sectors and the Twelve Key Strategies for net-zero transition, the common reduction strategies adopted by local governments are summarized in the table below.

Table 3.3.3-2. Common Reduction Strategies of Local Governments

Sector	Corresponding Strategy for Net-Zero Transition (12 Key Strategies)	Local Collaboration Tasks	Common Reduction Strategies of Local Governments
Energy Sector	Wind Power/Solar PV	■ Promote distributed renewable energy. ■ Promote renewable energy certificates. ■ Assist with certification of renewable energy generation facilities.	■ Enhance solar photovoltaic (PV) installations: • Various installation types across counties and cities include rooftop systems, ground-mounted systems, and agro-aquaculture-solar symbiosis. • Total solar PV installations across counties and cities amount to approximately 12.4 GW. ■ Promote offshore wind power generation. ■ Build capacity in renewable energy: • Conduct energy literacy and promotion courses on campuses
	Energy Saving & Efficiency	■ Promote energy conservation	■ Organize energy-saving and carbon reduction seminars.
Manufacturing Sector	Energy Saving & Efficiency	■ Encourage local businesses to apply for carbon reduction guidance. ■ Request verification results or coordinate to with the park to conduct audits and guidance	■ Establish energy-saving and carbon reduction guidance teams: • Form green transformation guidance teams in each county and city and provide subsidies for low-carbon industries. ■ Replace high-polluting boilers. ■ Provide energy-saving guidance for industrial and commercial sectors: • Propose concrete improvement plans and management measures. ■ Conduct greenhouse gas inventories and provide reduction guidance for businesses: • Select audit and guidance targets based on emission volume and characteristics. • Form net-zero guidance teams.
Transportation Sector	Carbon-Free & Electric Vehicles	■ Continuously enhance the appeal of public transportation to increase ridership. ■ Build a friendly last-mile public transportation environment. ■ Reflect the true cost of private vehicle usage to moderately reduce ownership and usage. ■ Coordinate with local traffic authorities and bus operators in replacing old vehicles with electric buses. ■ Create a friendly environment for electric vehicle usage. ■ Conduct green transportation education and advocacy.	■ Expand mass transportation systems: • Including MRT, bus stations, light rail, and bicycles. ■ Promote public transportation passes (TPASS): • Implement TPASS with 22 subscription plans nationwide, covering all counties and cities on the main island (except three outlying islands). ■ Promote electric buses: • Support operators in transitioning to electric buses and secure central government subsidies. ■ Increase the proportion of electric motorcycles: • Provide subsidies for replacing old motorcycles with new electric ones. ■ Public bicycles: • Promote systems such as U-BIKE and T-BIKE. ■ Install more EV charging stations. ■ Introduce AI for real-time monitoring: • Utilize drone aerial data and CCTV footage for traffic flow monitoring.

Sector	Corresponding Strategy for Net-Zero Transition (12 Key Strategies)	Local Collaboration Tasks	Common Reduction Strategies of Local Governments
Residential and Commercial Sector	Wind Power/Solar PV	■ Promote the installation of solar photovoltaic (PV) systems in social housing. ■ Assist local governments in guiding fruit, vegetable, and flower wholesale markets to install PV facilities through leasing arrangements	■ Low-Carbon Sustainable Homeland: • Conduct solar photovoltaic (PV) advocacy and promotion seminars.
	Energy Saving & Efficiency	■ Strengthen the promotion of green building programs. ■ Encourage local businesses to adopt energy label-certified products when replacing old equipment. ■ Require implementing agencies and schools to report energy and resource-related data annually. ■ Provide energy efficiency guidance and resource information to local commercial service users. ■ Promote energy-saving guidance for schools ■ Advocate for energy-saving and carbon reduction policies among businesses. ■ Assist with urban renewal and hazardous building reconstruction proposals and handle review processes in collaboration with the Construction and Planning Agency	■ Energy creation, storage, and conservation subsidy programs. ■ Smart net-zero buildings. ■ Low-Carbon Sustainable Homeland: • Promote low-carbon certification and assist the private sector with low-carbon retrofitting and climate actions. • Conduct education, training, and advocacy programs • Provide guidance and retrofitting for building greening to reduce heat ■ Offer energy-saving subsidies for the service sector to replace equipment. ■ Replace streetlights with LED lamps.
Agriculture Sector	Resource Recycling & Zero Waste	■ Promote organic and environmentally friendly farming practices. ■ Maintain biogas reuse (power generation) on livestock farms.	■ Increase green space: • Local governments build and expand parks, plant street trees, establish farmland bases, conserve wetlands, and create green walls. ■ Rooftop greening. • Plant vegetation and install green walls.
	Carbon Sinks	■ Afforestation	■ Increase green space: • Local governments build and expand parks, plant street trees, establish farmland bases, conserve wetlands, and create green walls. ■ Rooftop greening • Plant vegetation and install green walls.

Sector	Corresponding Strategy for Net-Zero Transition (12 Key Strategies)	Local Collaboration Tasks	Common Reduction Strategies of Local Governments
Environmental Sector	Resource Recycling & Zero Waste	■ Guide large-scale wastewater treatment plants to conduct greenhouse gas emissions surveys. ■ Encourage key industrial wastewater facilities to install anaerobic digestion and biogas recovery systems. ■ Organize experience-sharing sessions on anaerobic digestion and biogas recovery, or climate change education. ■ Support businesses in adopting low-carbon solid recovered fuel (SRF). ■ Continue to assist landfill sites in biogas recovery for power generation. ■ Reduce organic waste sent to landfills.	■ Promote circular economy and resource reuse, including: • Use recycled aggregates in public works projects. • Second-hand flea markets and eco-friendly clothing • Green energy ecoparks • Kitchen waste processing • Return biogas and digestate to fields as fertilizer • Recycle household and classroom furniture ■ Construct sewage systems. ■ Reuse livestock manure and urine • Utilize centralized treatment plants to convert livestock manure into biogas and digestate for use as fertilizer and power generation. ■ Reuse agricultural waste: • Use discarded straw as cover for bare land and construction sites, reducing dust emissions. • Produce biochar to reduce chemical fertilizer use and open burning. ■ Develop water resource recovery centers and water purification plants: • Reduce household wastewater discharge and increase the reuse rate of treated water from water resource recovery centers.
	Green Lifestyle		■ Promote the use and rental of reusable cups.

(2) Distinctive Reduction Approaches of Local Governments

Local governments have proposed unique reduction methods based on the characteristics of their respective counties and cities. A summary of some distinctive reduction approaches by local governments is presented in the table below.

Table 3.3.3-3. Distinctive Reduction Approaches of Local Governments

County/City	Distinctive Greenhouse Gas Reduction Practices
Taipei City	■ Energy Creation, Storage, and Conservation Subsidy Programs for Residential Communities: Subsidies of up to NT$6 million are provided for residential communities to install energy creation, storage, and conservation equipment, encouraging the practice of self-generated green energy. ■ Energy Creation and Storage Demonstration Sites: Promote energy creation, storage, and conservation concepts and practices for application in communities, schools, and institutions. Distributed Power Generation: Utilize small-scale power generation and storage systems distributed across various locations to supply electricity. • Highway Solar Power Generation: Installed Taiwan's first solar power system on highway sound barriers, generating 3.8 kW of power across 128 panels, and 5 kWh storage capacity. This system improves the working environment for cleaning crews by powering air-conditioning and lighting under the bridge. • Low-Carbon Solar-Powered Mobile Toilets: Mobile toilets equipped with flexible solar PV panels produce 3.84 kW of power and have 5 kWh storage capacity, achieving reductions in carbon emissions, pollution, and noise. • Da'an Park Restroom Solar System Demonstration: Rainbow solar PV panels that generate approximately 1.3 kW of power and have 2.4 kWh storage capacity were installed in a public restroom. • Public–Private Solar Power Collaboration at Qu Yuan Temple: Flexible solar PV panels generating 4.8 kW were installed on the Dragon Boat House, with plans to expand to 8 kW and storage capacity of 15 kWh. ■ Biodiesel Demonstration Project: Tested the use of biodiesel blends (5–20%) on street washers, mini-loaders, and eco-equipment, achieving combined effects of carbon reduction and pollution mitigation.
New Taipei City	■ Low-Carbon Community Label – Energy Efficiency Certification (E-Home): Established a graded management system for energy efficiency in community public buildings to monitor energy usage. ■ Energy-Saving E-Butler: Provides daily energy tracking and a household energy journal service for residents. ■ Low-Carbon Campus Label Certification: Developing future standards for carbon-neutral campus certification. ■ Smart Microgrid Net-Zero Demonstration: Uses energy management systems to validate off-grid power generation, energy storage, and grid coordination for buildings or communities. Also provides auxiliary power services for economic benefits, alleviating grid congestion and enhancing stability. ■ Low-Carbon Consumption and Carbon Reduction Incentives: Encourages residents to exchange footsteps for New Taipei Dollars. ■ Wan Jin Shi Marathon: Used eco-friendly, recyclable materials for athletic apparel and merchandise to reduce environmental impact. ■ Geothermal Power Plants in Commercial Operation: • Jinshan Sihuangziping Geothermal Power Plant • Jinshan Liuhuangziping Geothermal Power Plant
Taoyuan City	■ AI-Driven Real-Time Water Spraying System: Implemented AI monitoring to detect abnormal smoke emissions and dispatch inspection personnel through a digitalized system. First applied at Taoyuan Airport Terminal 3, successfully reducing dust pollution caused by construction activities. ■ Recycled and Reused Aggregates: Recycled materials include bottom ash from waste incinerators and slag from steel production. Proper use of these materials facilitates sustainable resource utilization while maintaining environmental protection and engineering quality.

County/City	Distinctive Greenhouse Gas Reduction Practices
Taichung City	■ Taichung Incentives for Green Architecture and Facilities: Encourages developers to create green vertical gardens and balconies by exempting stairways from floor area calculations. ■ AI Smoke Detection Technology for Taxi Fleets: ■ Taxis are equipped with AI-based devices to identify high-polluting vehicles, capturing images of non-compliant motorcycles and "squid" cars. Promotes replacement of old, high-polluting vehicles to improve air quality. ■ Residential and Commercial Energy-Saving Competition ■ Low-Carbon Transportation Incentives: The Environmental Protection Bureau, in conjunction with commuter pass policies, introduced Taichung Low-Carbon Transportation Incentive Measures, offering up to 2,700 prizes, with a top reward of a NT$5,000 gift card.
Tainan City	■ Promoting Solar Electric City: Encourages the installation of solar photovoltaic (PV) systems on rooftops and in residential communities. ■ Smart Parking Posts and EV Charging Stations: • Reduces carbon emissions by minimizing time spent searching for parking spaces. • Saves time by reducing parking search time by an average of 5–6 minutes per instance. • Diversifies payment methods and reduces paper use, saving approximately 2.46 million parking tickets annually. ■ Smart Recycling Island: Taiwan's first 24-hour automated and unmanned urban recycling station increases system capacity and offers point rewards or vouchers for recycled materials. ■ Large-Scale Kitchen Waste Composting Machines: Process at least 100 kg of kitchen waste and leaves daily, using special microbes to convert waste into compost. Reduces fertilizer costs for schools. • Fuxing Elementary School, East District, • ORIGINLIMIT CO., LTD. ■ Anping Green Harbor Shore Power System: Installed 39 shore power systems at Anping, reducing emissions by allowing ships to use onshore electricity instead of burning diesel fuel for power.
Kaohsiung City	■ Nation's First Physical Net-Zero Academy: • Certification Courses: ISO inspection agency courses • General Education Courses: Rooting net-zero concepts through foundational education.
Keelung City	■ Promotion of Caisson-Based Wave Power Generation Facilities: Utilizes the up-and-down oscillation of multiple resonance water columns within caissons to compress air in chambers, driving air turbines and generators for power generation, thus reducing air pollution. ◦
Hsinchu City	■ ESG matching program Facilitates collaboration between businesses to achieve ESG goals, creating a livable and sustainable city. Provides 34 cooperative topics spanning 12 Sustainable Development Goals (SDGs). ■ Greater Hsinchu Light Rail Project Planned integration with Taoyuan-Hsinchu-Miaoli TPASS to increase public transportation usage.
Hsinchu County	■ Solar Power Facilities on Livestock Facility Rooftops Provided guidance for the installation of 128 solar power sites.
Miaoli County	■ Participation in Singapore's Global Carbon Exchange Platform (CIX)

County/City	Distinctive Greenhouse Gas Reduction Practices
Changhua County	■ Promotion of Local Plant-Based Diets and Community Dining: • Schools: Use traceable fresh produce to improve lunch quality, with additional subsidies for serving one organic vegetable meal per week. • Community Meal Services: Provided in 309 villages and communities, achieving a 90.61% implementation rate. ■ Transforming Worship Practices: Over 70% of worship practices are eco-friendly. Initiatives include promoting low-carbon temples (37 temples) and replacing monetary offerings with goods donations to support underprivileged groups. ■ Building Greening and Cooling Projects: Implemented in 28 schools and communities, covering a total area of 672.2 m². ■ Taipower Wind Operation and Maintenance Center: Operates with self-sufficient energy and feeds surplus electricity back into the grid.
Nantou County	■ Establishment of Agricultural Energy-Saving Demonstration Zone for Water Bamboo: In 2023, a demonstration zone was created for farmers to propose innovative energy-saving solutions reflecting local characteristics, replacing a total of 300 high-pressure sodium lamps.
Yunlin County	■ Demonstration Zone for Offshore Wind Farm Localization: Planned installation of 80 typhoon- and earthquake-resistant offshore wind turbines off Yunlin County's coast, with a total capacity of 640 MW. To date, 45 single-pile foundations and 30 turbines are operational. ■ Promotion of Building Greening and Cooling Projects: Total greening area reached 146 m² • Promoted the installation of vegetated walls or green hedges. • Established rooftop gardens.
Chiayi City	■ Creating Wood City 3.0: Promoted the Chiayi City Livable Architecture Implementation Project, incorporating wooden structures as a new architectural option. • Potential sites for wooden building renovation and maintenance. • Strategic urban renewal locations. • Promotion of livable architecture.
Chiayi County	■ Wood Resource Recycling and Disposal: Established the General Waste (Waste Wood) Resource Recycling and Disposal Guidelines, set up temporary storage facilities for waste wood, and promoted the establishment of biomass gasification power plants. ■ Recycling and Reuse of Used Oyster Ropes and Fishing Nets: From 2019 to 2023, public–private partnerships processed and recycled 786 metric tons. The recycled material produced 3,000 metric tons of nylon fiber, and national recycling capacity is expected to reach 9,000 metric tons by 2024. ■ Energy Conservation Action for Vulnerable Energy Users: • 37 disadvantaged households: Provided support to reduce electricity burdens, replaced 310 light fixtures, and achieved approximately 58,590 kWh of energy savings. • 3 social welfare organizations: Guided institutions to enhance energy conservation awareness.
Pingtung County	■ Electric Self-driving Buses ■ Dafu Cluster Wastewater Treatment Facility: Constructed cluster wastewater treatment facilities in Liuqiu Township, tailored to local conditions, to reduce carbon emissions from domestic wastewater. ■ Smart Traffic Corridor: Integrated AI at 170 smart intersections, creating Taiwan's longest (110 km) traffic corridor and reducing travel time by 20%. ■ Livestock Waste Activation: Anaerobically treated livestock wastewater to produce digestate and liquid fertilizer for farmland, reducing chemical fertilizer use. In 2023, approved 446 organizations and businesses for irrigation applications totaling 1.4 million metric tons.

County/City	Distinctive Greenhouse Gas Reduction Practices
Taitung County	■ Taitung Slow Food Festival: Promoted Farm-to-Table and Eat Local, Eat Seasonal concepts, adhering to sustainable food and low-carbon dietary standards. Achieved ISO 20121 Event Sustainability Management System certification in 2023. ■ Energy Conservation Management and Promotion: • Subsidized low-energy homestay replacement programs, saving 58,760 kWh. • Supported agricultural experimental zone subsidy programs, saving 77,840 kWh. ■ Establishment of Green Transportation Network: Promoted shared green transportation to create a zero-carbon transport system. • Installed 104 charging and battery exchange stations. • Offered free electric scooter trials. • Introduced electric scooters at major events. • Connected Taitung TPASS commuter pass with three major public transportation systems. ■ Development of Net-Zero Sustainable Agriculture: Guided agricultural and specialty industries in voluntary carbon reduction, established zero-carbon stores, and integrated tourism promotion, gradually transforming Taitung into Taiwan's first zero-carbon agricultural economic demonstration city.
Hualien County	■ Net-Zero Environmental Education Center: Expanded foundational net-zero education by integrating environmental education activities and experiential courses in Hualien County schools. ■ Promotion of Shore Power Systems: Installed 29 shore power systems at Hualien Port and Heping Port to reduce emissions from docked ships. Ship and Vehicle Speed Reduction: Hualien Port Authority implemented an e-gate system, reducing average vehicle gate passage time from 4 minutes to 20 seconds and achieving a 71.3% ship speed reduction compliance rate.
Yilan County	■ Lanyang Museum – Net Zero Museum: In 2023, provided energy-saving and carbon-reduction diagnostics and retrofits for 9 facilities, including local cultural museums and tourism factories, promoting and implementing energy conservation and carbon reduction initiatives. ■ Promotion of Geothermal Power Generation: • Qingshui Geothermal Power Plant (4.2MW) • Renze Geothermal Power Plant (0.84 MW)
Penghu County	■ Marine Revitalization and Restoration: Regulated pollution sources in inner seas by reducing aquaculture feed waste and prohibiting the use of chemical net-cleaning agents. ■ Submarine Cable Activation to Reduce Fossil Fuel Power Generation: • Total greenhouse gas emissions decreased from 278,796.763 metric tons CO_2e in 2021 to 204,647.183 metric tons CO_2e in 2022, achieving an year-on-year reduction of 74,149.58 metric tons CO_2e.
Kinmen County	■ Shared Electric Motorbikes: Collaborated with electric vehicle companies to establish 6 rental stations, providing a total of 42 shared electric scooters. ■ Promotion of Kinmen Reusable Cup Initiative: • Established 40 borrowing and return points countywide, with the Environmental Protection Bureau regularly conducting food safety inspections to ensure hygiene. • Partnered with local businesses to reward 500 eco-points for each reuse of the cup.
Lienchiang County	■ Installation of Green Walls: Prioritized implementation in public sector facilities, using native plant species suitable for the local climate.

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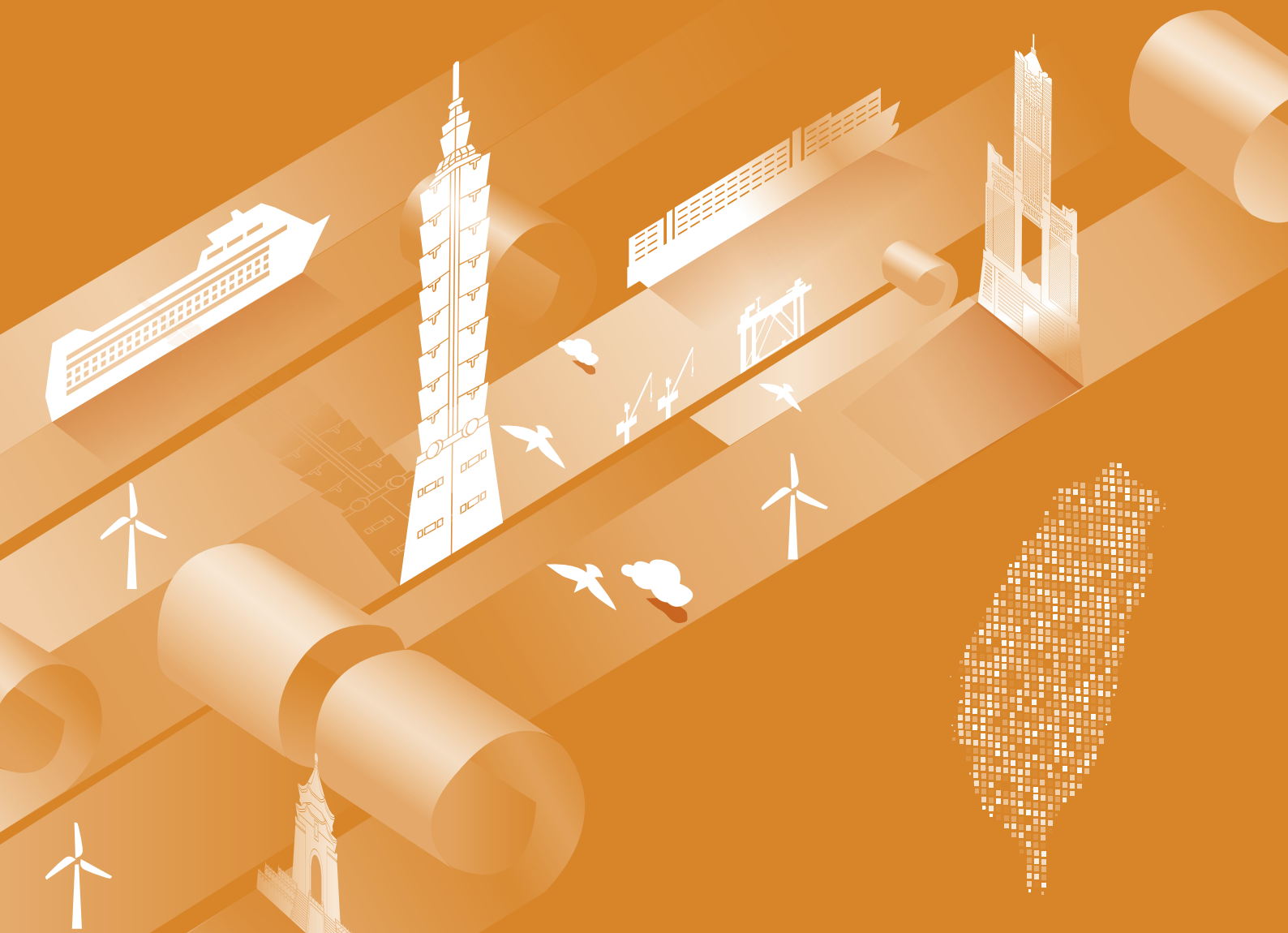
4 Greenhouse Gas Emission Forecasts



Chapter 4: Greenhouse Gas Emission Forecasts

In accordance with Article 10 of the *Climate Change Response Act*, to achieve the national long-term greenhouse gas reduction goal, the central competent authority shall invite relevant central and local agencies, scholars, experts, and non-governmental organizations (NGOs) to participate through public hearing processes and also invite scholars, experts, NGOs from local and central government levels. After public hearing procedures, the authority should establish periodic regulatory goals in stages, implemented on a five-year basis, to progressively implement reduction policies. To appropriately set these periodic regulatory goals, greenhouse gas emission pathways at the national and sectoral levels are forecast based on the cross-sector reduction potential of energy-saving and carbon reduction strategies. The following sections detail the forecast results for greenhouse gas emission pathways, evaluation of the reduction effects under the aforementioned policy measures, and related methodologies.

4.1 Emission Pathway Forecasts

In accordance with Article 5 of the *Enforcement Rules of the Climate Change Response Act*, to aid in establishing periodic regulatory goals, the pertinent central authorities shall conduct greenhouse gas emissions trend estimation and scenario analysis. They shall also propose electricity emission coefficients by considering the growth of electricity demand and the reduction of greenhouse gases across various departments (summarized in Table 4.1.1-1).

I. Gas Categories

Greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). All gases are converted into carbon dioxide equivalents (CO_2e) based on their global warming potential.

II. Emission Types

In accordance with national inventory standards, greenhouse gas emissions (or removals) are categorized into three types:

- Fuel combustion emissions (Energy).
- Non-fuel combustion emissions (Industrial Processes and Product Use, Agriculture, and Waste).
- Carbon sinks (Land Use, Land-Use Change, and Forestry).

III. Sectoral Classification

In line with the division of responsibilities under the *Climate Change Response Act*, industries are categorized into six main sectors:

- Energy Sector: Management of renewable energy development, energy efficiency improvement, and energy conservation.
- Manufacturing Sector: Management of industrial greenhouse gas reduction.
- Transportation Sector: Transportation management, public transport development, the use of low-carbon energy vehicles, and other transportation-related greenhouse gas reductions.
- Residential and Commercial Sector: Management of building-related greenhouse gas reduction.
- Agriculture Sector: Management of forest resource management, carbon sequestration enhancement, and agricultural greenhouse gas reduction.
- Environmental Sector: Management of waste recycling, processing, and reuse.

This sectoral classification differs from that in the *National Greenhouse Gas Inventory Report*, as emissions from electricity use are allocated to the respective electricity-consuming sectors.

IV. Forecast Timeline

Taiwan plans to propose the Phase 3 Periodic Regulatory Goals in 2024, forecasting the greenhouse gas emission pathways for 2026–2030.

Table 4.1.1-1. Scope Definitions

Scope	Description
Gas Categories	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).
Emission Types	Greenhouse gas emissions from fuel combustion (Energy sector), non-fuel combustion emissions (Industrial Processes and Product Use, Agriculture, and Waste sector), and carbon sinks (Land Use, Land-Use Change, and Forestry sector).
Sector Classification	Energy, manufacturing, transportation, residential and commercial, agriculture, and environmental sectors.
Forecast Period	2026 to 2030.

Source: Climate Change Administration, Ministry of Environment.

4.2 Evaluation of Reduction Effects

This section evaluates the greenhouse gas reduction effects of Taiwan under the With Existing Measures Scenario. The With Existing Measures Scenario includes all policies and measures currently implemented or approved in Taiwan.

Under this scenario, using 2005 as the base year, it is estimated that greenhouse gas emissions will be reduced by 1.77% in 2022, 10% in 2025, and 26–30% in 2030, with the aim of achieving net-zero emissions by 2050, as shown in Table 4.2-1 and Figure 4.2-1.

Table 4.2-1. GHG Net Emissions Pathway Under Policy Scenarios

Policy Scenario	Forecast Value (Unit: $MtCO_2e$)		
	2022	2025	2030
Base Year (2005) Net Emissions (A)	268.893	268.893	268.893
GHG Net Emissions With Existing Measures Scenario (B)	264.133	242.004	188.225 to 198.981
GHG Reduction Volume (B-A)	-4.760	-26.889	-80.668 to -69.912

Source: Climate Change Administration, Ministry of Environment.

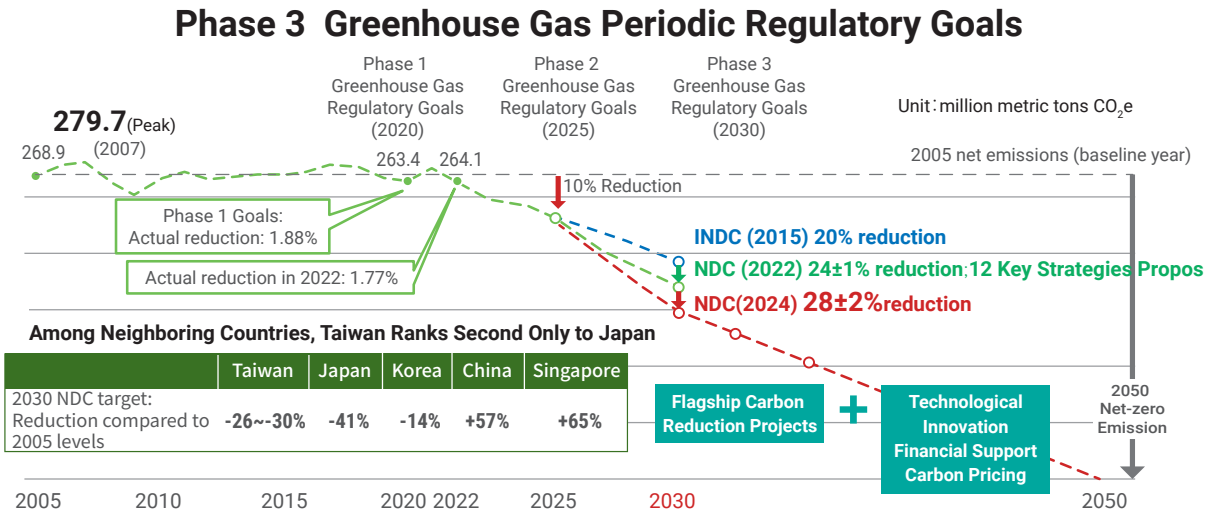


Figure 4.2-1. GHG Net-Zero Pathway

Source: Report Item 3 at the 3rd Meeting of the National Climate Change Committee: Taiwan's Comprehensive Carbon Reduction Action Plan (National Development Council)

4.3 Description of Forecasting Methodology

The planning of Taiwan's greenhouse gas emission pathway is based on the aggregation of greenhouse gas emission pathways from various sectors. Each sector's central industry competent authority estimates energy consumption and greenhouse gas emissions based on unified parameter assumptions (e.g., economic growth, population) and plans corresponding energy-saving and carbon reduction strategies. Forecasts for greenhouse gas emissions from fuel combustion are conducted by the Energy Administration, Ministry of Economic Affairs, based on the nation's energy consumption, planned energy-saving strategies, and energy supply planning. Emissions from non-fuel combustion are determined by the Climate Change Administration, Ministry of Environment, based on consolidated forecast data from various sectors. Forecasts for carbon sinks are conducted by the Ministry of Agriculture. The nationwide greenhouse gas emission pathway forecasting process is illustrated in Figure 4.3-1.

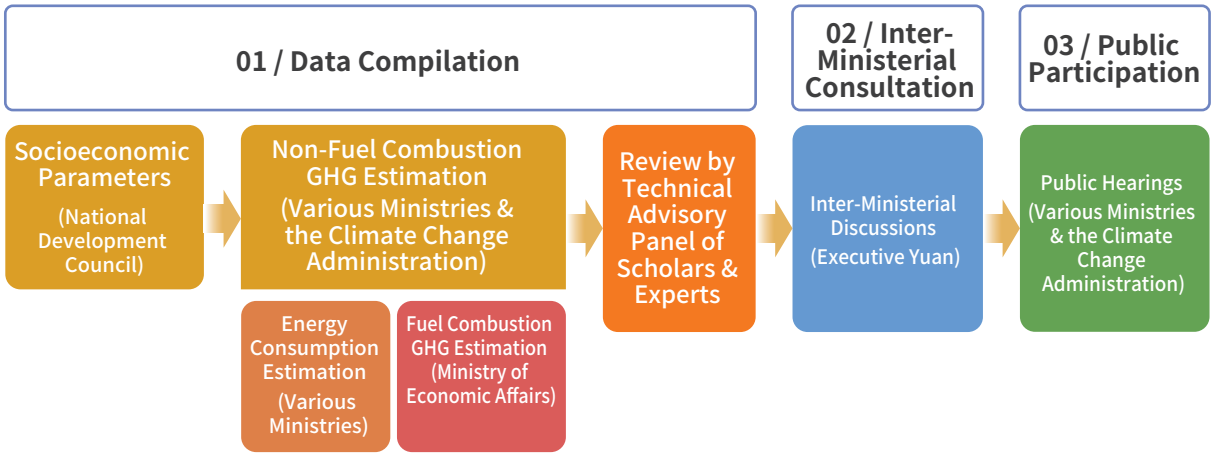


Figure 4.3-1. GHG Emission Pathway Forecasting Process

Source: Climate Change Administration, Ministry of Environment.

4.3.1 Parameter Assumptions

To ensure that all sectors apply a consistent baseline scenario for greenhouse gas emissions simulations, parameter assumptions[2] are established for key indicators, including overall economic growth, population, and energy. The details are as follows:

I. Gross Domestic Product (GDP) Forecast

The GDP forecast considers domestic and international economic trends, including population, international energy prices, global trade and economic environment, total factor productivity, and the industrial development trends and policy directions provided by respective central industry competent authorities. These factors are used to estimate Taiwan's medium- to long-term GDP and the share of the three major industry sectors.

As of August 2023, the overall economic growth rate was projected to reach 3.55% by 2025, with the proportion of GDP derived from services decreasing (59.60%), the proportion derived from industry increasing (38.98%), and the proportion derived from agriculture decreasing (1.42%). By 2030, the overall economic growth rate is expected to increase to 2.78%, with the share of services further declining (58.65%), while industry (39.89%) and agriculture (1.46%) experience slight increases. The forecast economic growth rates and changes in the three-sector structure are summarized in Table 4.3.1-1.

Table 4.3.1-1. Taiwan's Economic Growth Rate and Three-Sector Structure Forecast

Year	Economic Growth Rate (%)	Three-Sector Share (%)		
		Agriculture	Industry	Services
2026	3.37	1.43	39.28	59.29
2027	3.22	1.44	39.50	59.07
2028	3.12	1.44	39.63	58.92
2029	3.03	1.45	39.75	58.80
2030	2.78	1.46	39.89	58.65

Source: National Development Council. 2023.

II. Population Forecast

According to the *Population Projections for the Republic of China (Taiwan) 2022–2070* report released by the National Development Council in August 2022, the report adopted the cohort-component method, which is commonly used internationally. The selected baseline was the registered population by single year of age and sex as of the end of 2021. Assumptions for fertility, mortality, and net international migration are applied, advancing each person's age incrementally year by year to estimate the future population by single year of age and sex.

The forecast indicates that Taiwan's total population rebounded slightly to 23.42 million in 2023 due to post-COVID-19 return migration. Under three different scenarios of low, medium, and high projections, the total population is expected to decline to between 15.02 million and 17.08 million by 2070, which is approximately 64.1% to 72.9% of the 2023 population. The trend of Taiwan's total population growth is shown in Figure 4.3.1-1, with the medium projection used as the baseline for greenhouse gas emission pathway forecasts.

[2]The estimated data on GDP, population, etc. cited in this chapter's parameter assumptions are used to estimate GHG emissions from the six major sectors.

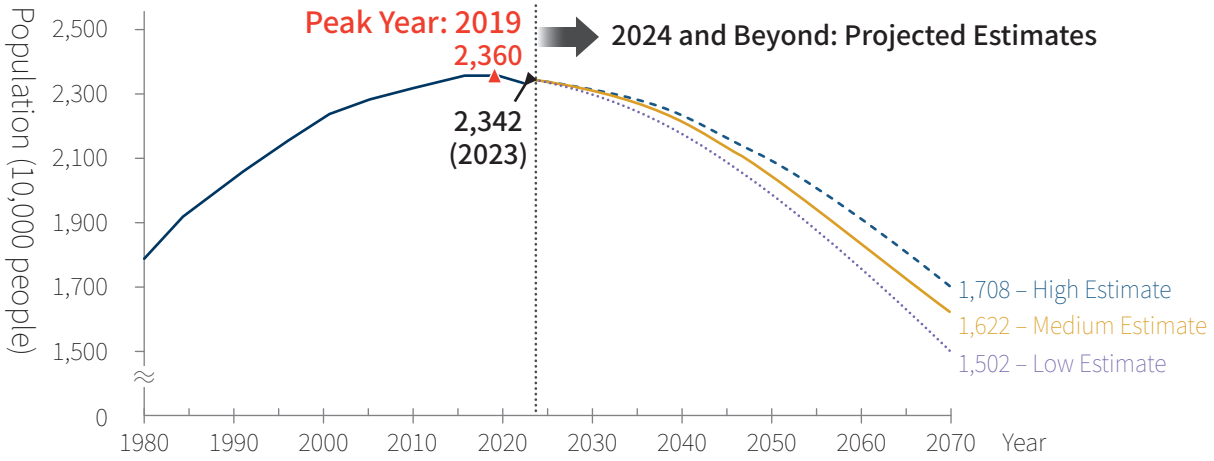


Figure 4.3.1-1. Total Population Growth Trend (High, Medium, and Low Projections)

Source: National Development Council. 2022.

III. Energy Transition Policy

To achieve the 2050 net-zero target and fulfill international carbon reduction commitments, Taiwan has implemented an energy transition policy and 12 key strategies. These measures address the rapidly evolving domestic and international political, economic, and energy environments and their challenges, aiming to reduce coal-fired and oil power generation, increase the share of low-carbon energy (natural gas and renewable energy) in power generation, and achieve the following targets by 2025: 30% coal, 50% natural gas, and 20% renewable energy. At the same time, nuclear power plants reaching the end of their operational life are being decommissioned, with most units expected to be phased out by 2025.

The pathway for the energy generation structure of various power plants is shown in Figure 4.3.1-2 and Table 4.3.1-2.

Since 2016, the government has been actively promoting energy transition. By the end of 2024, the cumulative installed capacity of renewable energy had reached 21.05 GW, accounting for approximately 31.1% of the nation's total power generation capacity—a 4.5-fold increase compared to 2016. Renewable energy generation also hit a record high of 33.3 TWh, representing 11.6% of total electricity generation. Moreover, through the implementation of the policy of "increase gas, and reducing coal", carbon emissions from the power system have continuously decreased. In 2024, gas-fired power accounted for 42.4%, and coal-fired power decreased to 39.3%. In 2023, the electricity emission factor reached a historic low of 0.494 kg CO_2e per kWh.

Table 4.3.1-2. Operational Lifespan of Nuclear Power Plants

Operational Settings / Unit	Shutdown Time	Decommissioning at End of Operational Life
Nuclear Power Plant I, Unit 1	December 2018	December 2018
Nuclear Power Plant I, Unit 2	July 2019	July 2019
Nuclear Power Plant II, Unit 1	March 2021	December 2021
Nuclear Power Plant II, Unit 2	March 2023	March 2023
Nuclear Power Plant III, Unit 1	July 2024	July 2024
Nuclear Power Plant III, Unit 2	May 2025	May 2025

Source: Taiwan Power Company. *Current Status and Performance of Nuclear Operations*. 2024.

The global economy has been affected by geopolitical factors such as the Russo–Ukrainian War, resulting in high inflation and high-interest rates that have directly impacted domestic industrial production and economic activities. In 2023, many industries adopted conservative strategies for inventory preparation, adjusted stock levels, and optimized production capacity, which suppressed overall electricity demand, resulting in a roughly 1.04% decrease in power consumption compared to the previous year. However, the vibrant development of emerging technologies like Artificial Intelligence (AI) and cloud information services has driven the production of electronics, with businesses and consumers maintaining cautious optimism about the future. The Directorate-General of Budget, Accounting, and Statistics has revised the 2024 economic growth rate upwards to 4.59% and projected that the annual average growth rate of electricity demand from 2024 to 2028 will be approximately 2.5%. The electricity demand driven by AI technology alone is expected to increase by 2 million kilowatts by 2028, an approximately eight-fold growth compared to 2023. After stable applications are established, it is estimated that the annual average growth rate of electricity demand from 2024 to 2032 will be about 2.8%. In terms of energy supply, due to the growing demand for renewable energy, the government is actively promoting renewable energy development. As of 2024, the installed capacity of renewable energy had reached 21.052 GW. The government plans to expand gas-fired units and energy storage systems, integrating them with grid infrastructure and intelligent management to enhance the integration and utilization efficiency of renewable energy, thereby ensuring a sustainable and stable energy supply.

The installation targets for offshore wind power, solar photovoltaic, geothermal power, and small hydropower, as stipulated in the Carbon Reduction Flagship Program, are shown in Figures 4.3.1-2, 4.3.1-3, 4.3.1-4, and 4.3.1-5.

The cumulative targets include:

1. Offshore wind power: 10.9 GW by 2030 and over 18.4 GW by 2050.
2. Solar photovoltaic: 31.2 GW by 2030 and over 35.02 GW by 2050.
3. Geothermal energy: over 1.2 GW by 2030 and over 1.7 GW by 2050.
4. Small hydropower: over 195 MW by 2030 and over 237 MW by 2050.

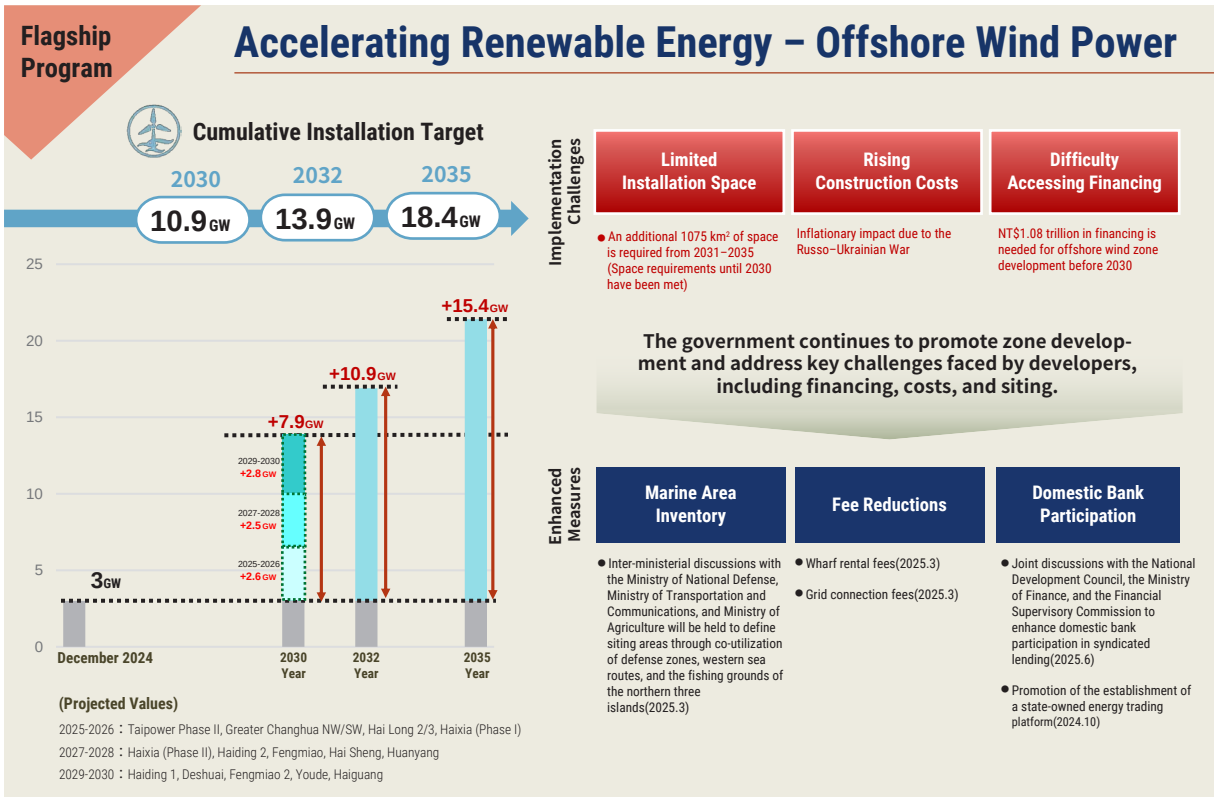


Figure 4.3.1-2. Cumulative Installation Targets for Offshore Wind Power

Source: Report Item 3 at the 3rd Meeting of the National Climate Change Committee: Carbon Reduction Action Plans by Six Major Sectors

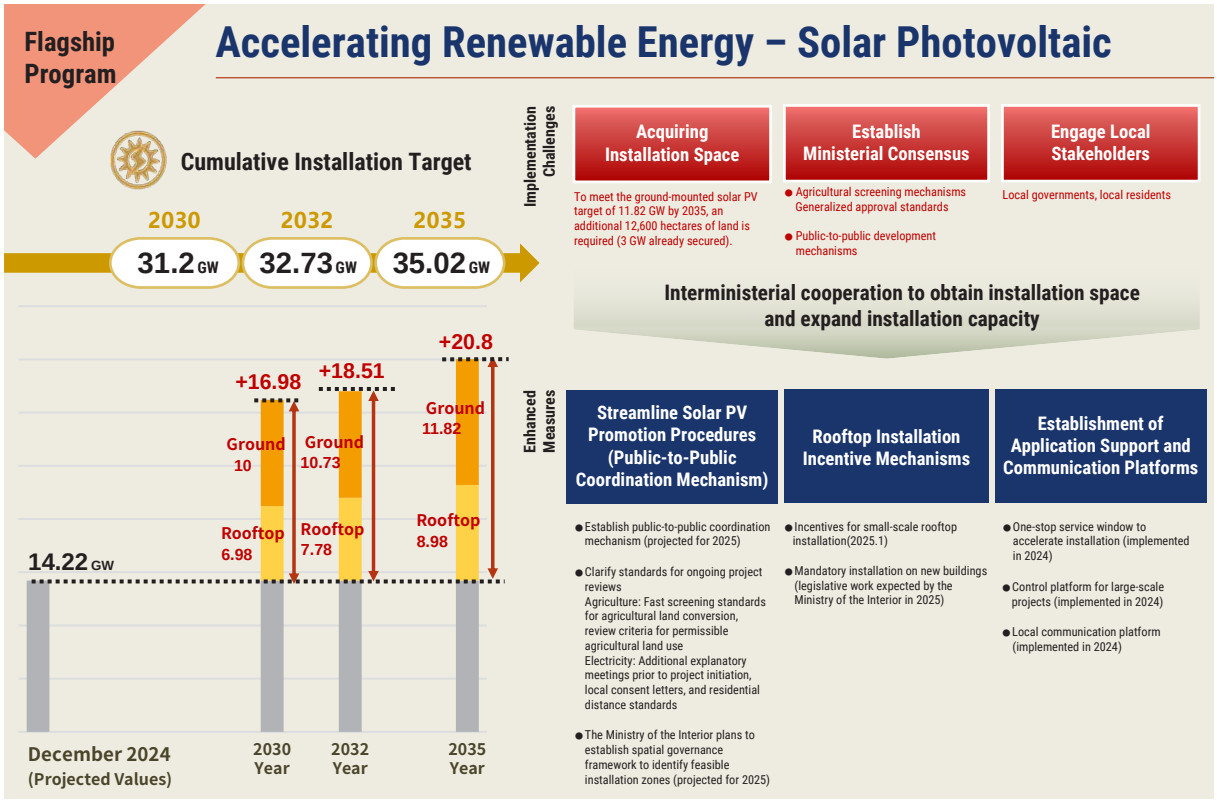


Figure 4.3.1-3. Cumulative Installation Targets for Solar Photovoltaic

Source: Report Item 3 at the 3rd Meeting of the National Climate Change Committee: Carbon Reduction Action Plans by Six Major Sectors

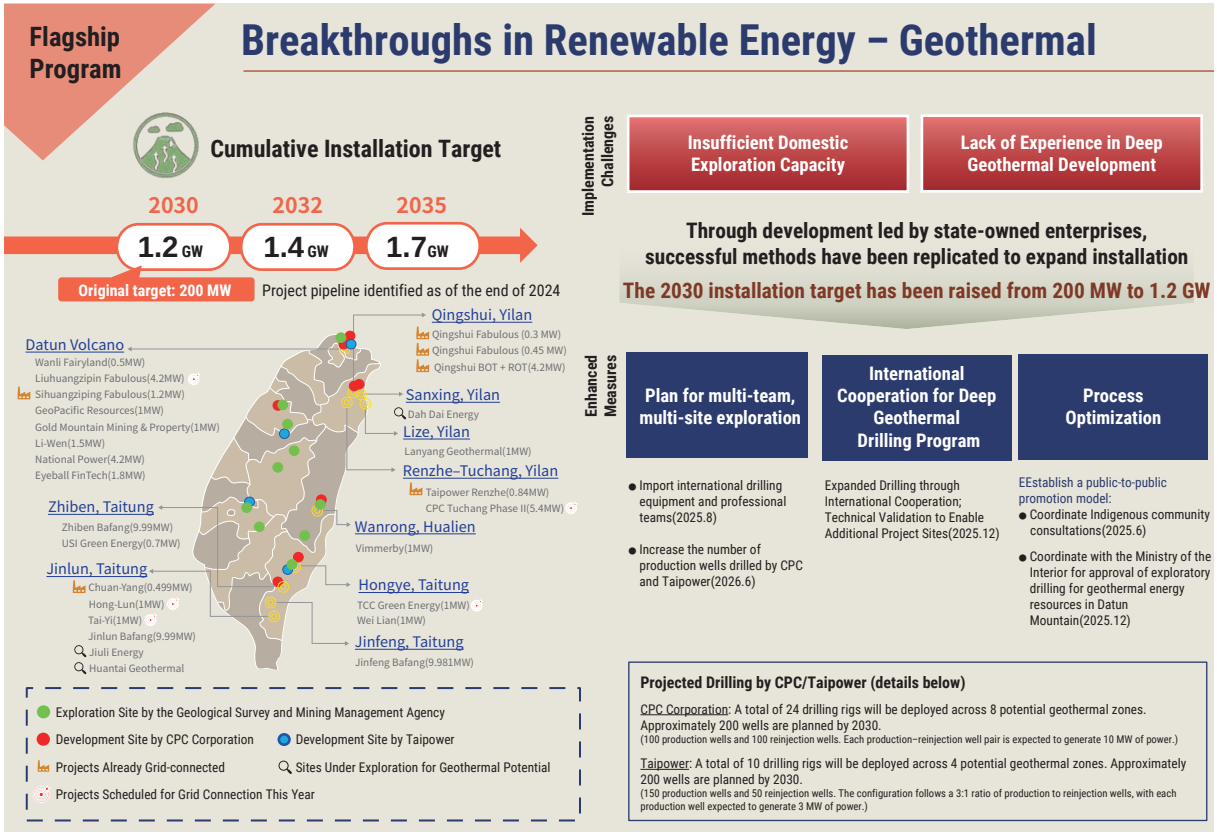


Figure 4.3.1-4. Cumulative Installation Targets for Geothermal Power

Source: Report Item 3 at the 3rd Meeting of the National Climate Change Committee: Carbon Reduction Action Plans by Six Major Sectors

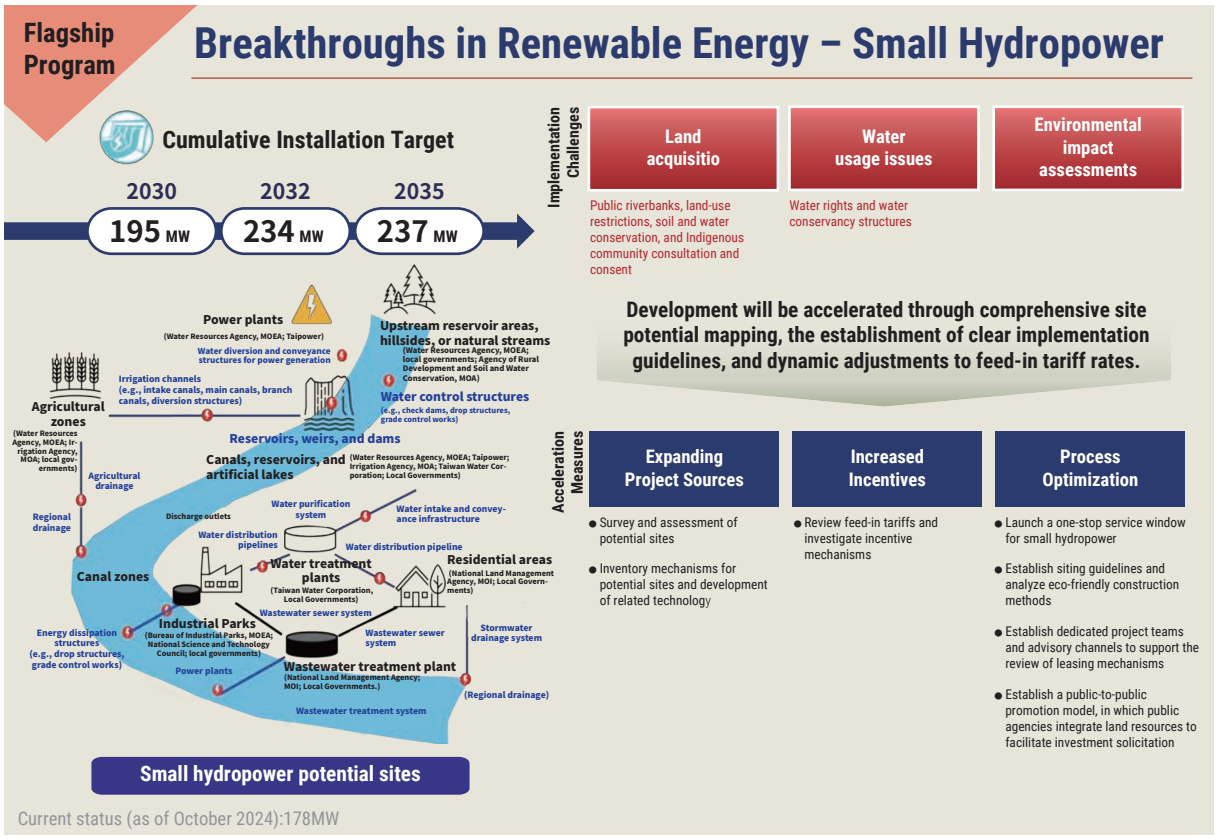


Figure 4.3.1-5. Cumulative Installation Targets for Small Hydropower

Source: Report Item 3 at the 3rd Meeting of the National Climate Change Committee: Carbon Reduction Action Plans by Six Major Sectors

4.3.2 Forecasting Methodology

In accordance with the operational procedures and implementation plans for the Phase 3 Periodic Regulatory Goals, the following processes are used to estimate greenhouse gas emissions trends across six major sectors:

I. Process of Estimating the Greenhouse Gas Emissions Trend in the Energy Sector (Self-Use)

Sectors other than the energy sector reference socioeconomic parameters provided by the National Development Council (NDC) to forecast future energy consumption. The Energy Administration consolidates this data as the basis for estimating energy consumption in the energy sector (self-use). Energy supply planning is conducted based on domestic electricity consumption and is used to calculate the power emission coefficient. Subsequently, emissions from fuel combustion and non-fuel combustion (fugitive emissions from natural gas and oil) are aggregated to determine the greenhouse gas emissions for the energy sector (self-use). The process flowchart is as follows:

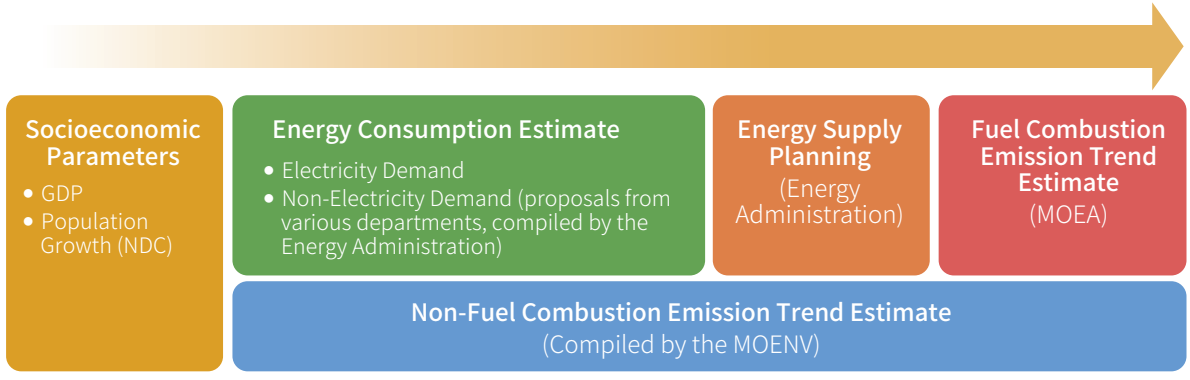


Figure 4.3.2-1. Flowchart for Estimating Energy Sector's (Self-Use) Greenhouse Gas Emissions Trend

II. Manufacturing Sector

The manufacturing sector, referencing the socioeconomic parameters provided by the NDC, completes the estimate of greenhouse gas emissions from non-fuel combustion and energy consumption within the sector. Subsequently, the Energy Administration conducts nationwide energy and electricity supply planning (including the evaluation of power emission factors) based on the energy demand plans of various sectors, providing unified estimates of greenhouse gas emissions from fuel combustion for each sector.

In response to the requirements of the Phase 3 Greenhouse Gas Reduction Program, the manufacturing sector utilized GDP growth estimates for the overall economy, tertiary industries, and detailed industrial sectors, which were provided by the NDC in December 2023. By assessing industrial development trends and conducting surveys on carbon reduction measures, the sector completed its estimate of greenhouse gas emissions from non-fuel combustion and energy consumption within the manufacturing sector. The process flowchart is as follows:

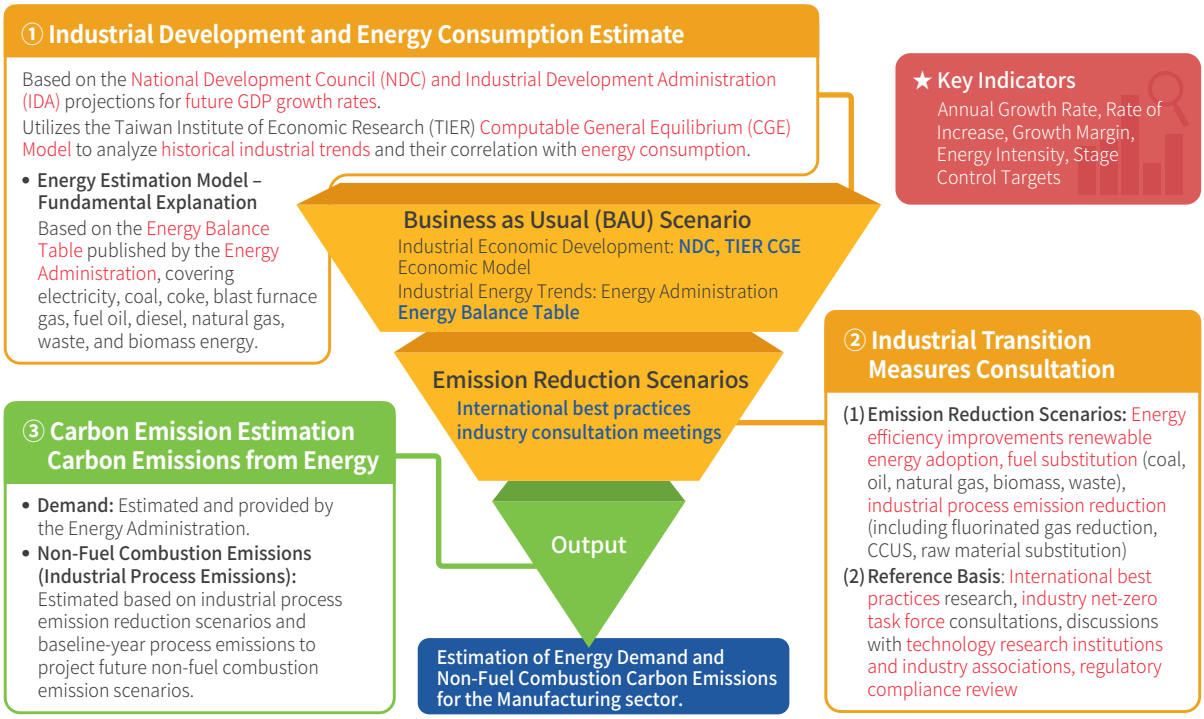


Figure 4.3.2-2. Flowchart for Estimating Manufacturing Sector's Greenhouse Gas Emissions Trend

III. Residential and Commercial Sector

The residential and commercial sector includes both residential and commercial departments. Due to the varying business types under the jurisdiction of different ministries, the current approach allows each responsible department to select appropriate estimation models for their assessments. The residential sector utilizes the Monte Carlo Method for estimation; the commercial sector utilizes the Low Emission Analysis Platform (LEAP) model.

The estimation process for baseline greenhouse gas emissions (Business as Usual, BAU) in the residential sector is illustrated in the figure below. Factors such as the total number of households nationwide, climate, average household size by region in Taiwan, per capita GDP, and greenhouse gas emission factors change over time. Therefore, it is necessary to conduct annual rolling reviews to adjust the estimates, bringing them closer to actual conditions. The total national residential electricity consumption, as well as gas and natural gas consumption, is multiplied by the respective emission factors—electricity carbon emission factor and gas or natural gas carbon emission factor—to determine the total national residential greenhouse gas emissions. By calibrating these figures with actual historical greenhouse gas emissions, the national residential greenhouse gas emission baseline (BAU) can be determined.

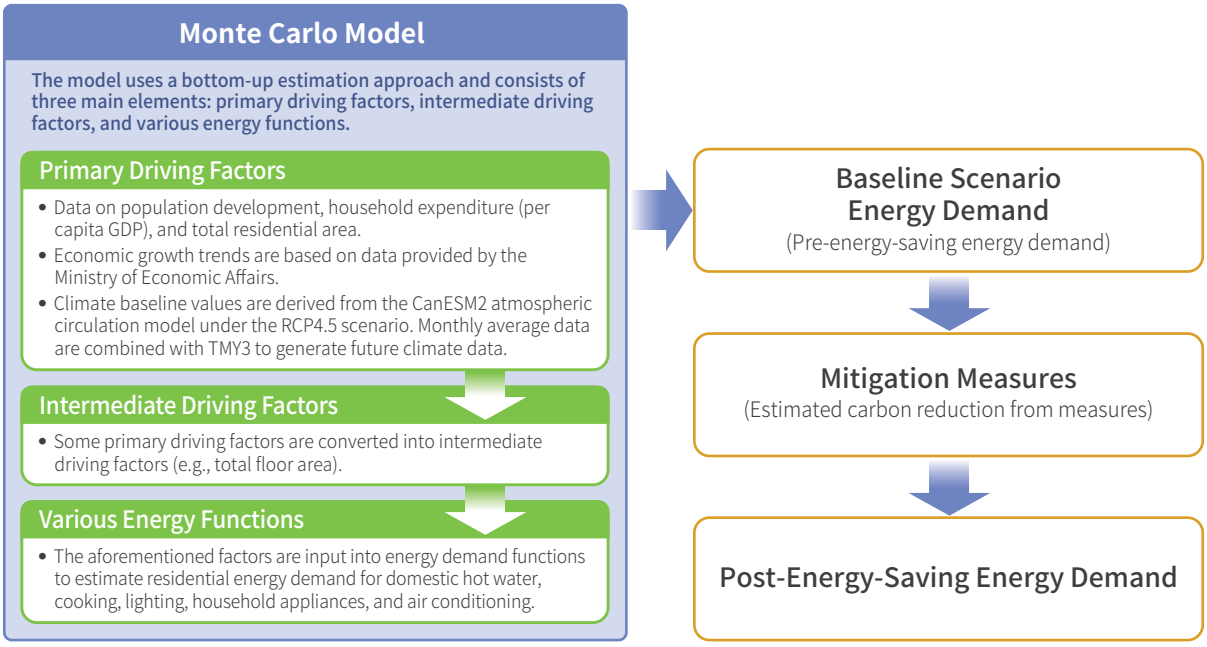


Figure 4.3.2-3. Flowchart for Estimating Residential and Commercial Sector's Greenhouse Gas Emissions Trend

The commercial sector utilizes the Low Emission Analysis Platform (LEAP) model, applying socioeconomic parameter assumptions such as GDP and total population estimates derived from the NDC's latest projections. Statistical regression is applied to estimate the floor area for different energy users and industries, then energy service demands for equipment such as air conditioning, lighting, refrigeration, appliances, and heating are calculated and equipment efficiency parameters are incorporated to establish a baseline scenario for the commercial sector. Supplemented by reduction measures for the commercial sector, the model estimates the greenhouse gas emissions trend under a reduction scenario

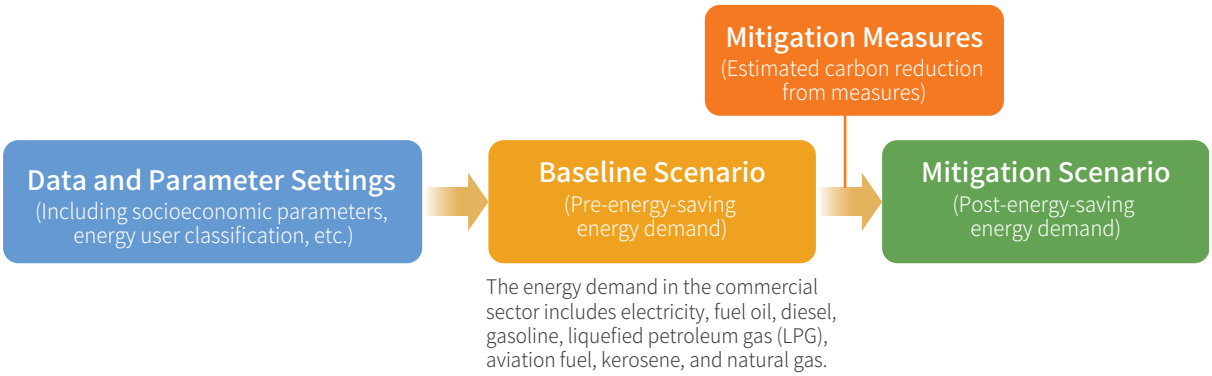


Figure 4.3.2-4. Flowchart for Estimating Commercial Sector's Greenhouse Gas Emissions Trend

IV. Transportation sector

The transportation sector uses the national population data and GDP forecast trends that were provided by the NDC in December 2023, then employs the Computable General Equilibrium (CGE) Model and specific policy tools to estimate the sector's greenhouse gas emissions trend. The estimation process is illustrated in the flowchart below.

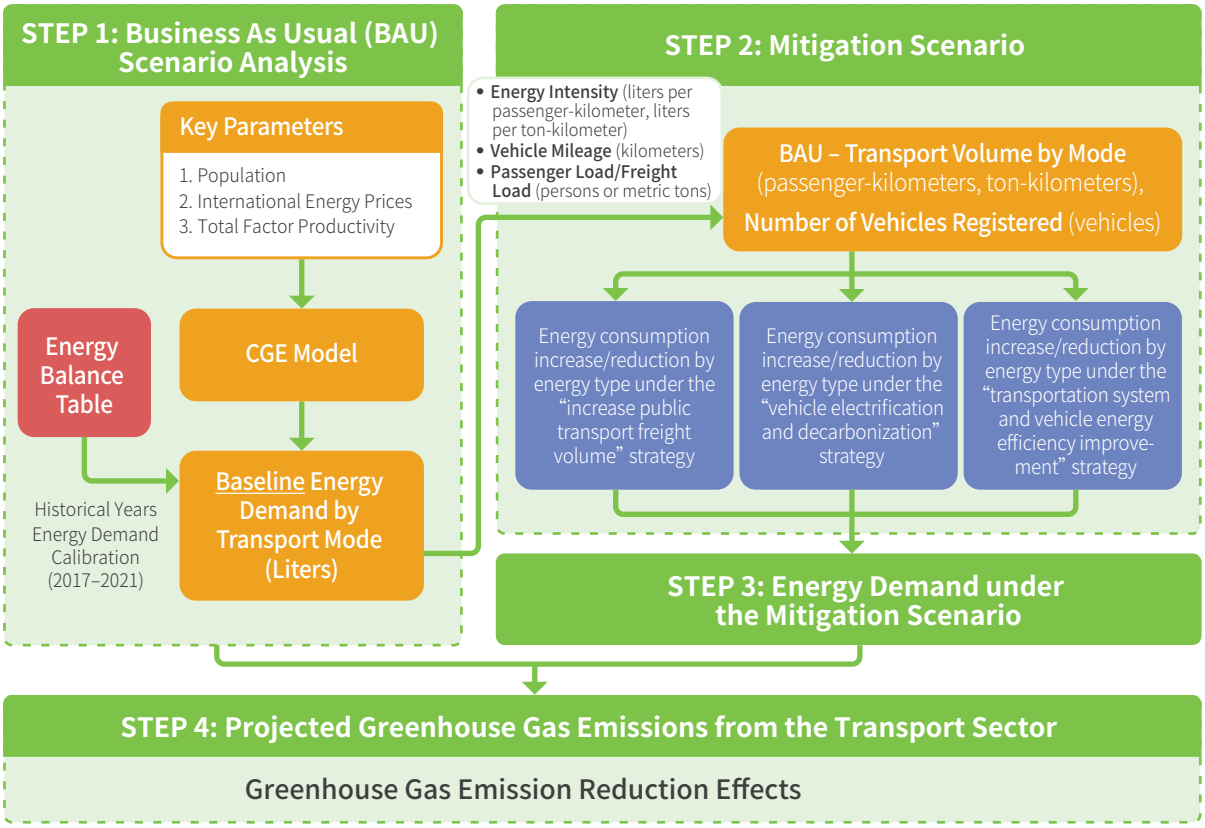


Figure 4.3.2-5. Flowchart for Estimating Transportation Sector's Greenhouse Gas Emissions Trend

V. Agriculture Sector

The agriculture sector uses the estimated real GDP growth rates for various industries and national population data that were provided by the NDC in December 2023 to estimate the sector's greenhouse gas emissions trend. The estimation process is illustrated in the flowchart below.

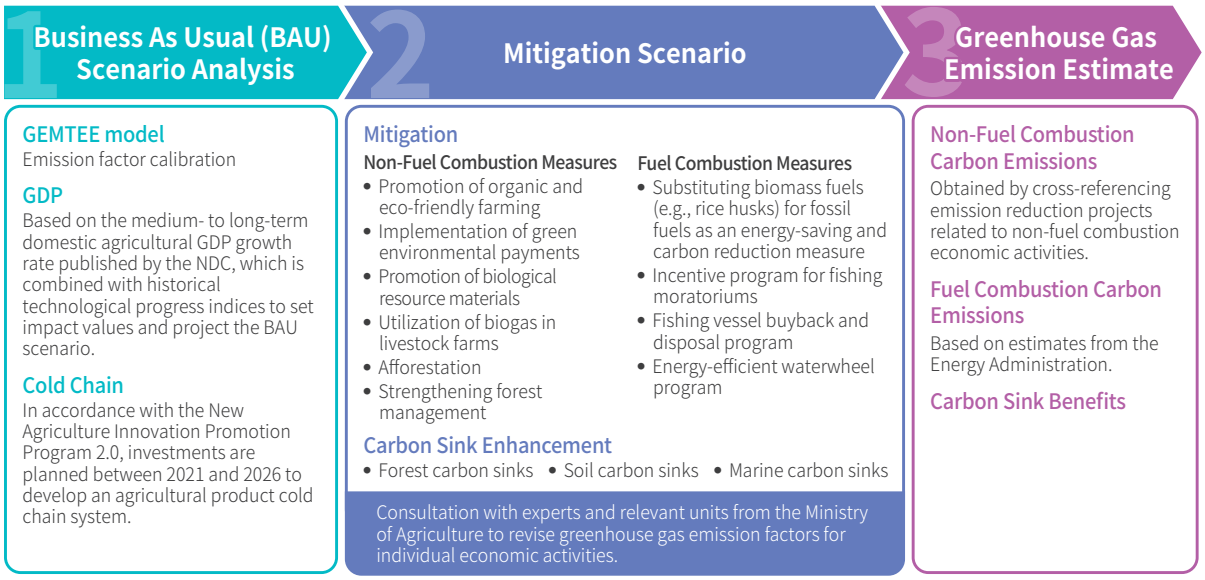


Figure 4.3.2-6. Flowchart for Estimating Agriculture Sector's Greenhouse Gas Emissions Trend

VI. Environmental Sector

The environmental sector uses the estimated real GDP growth rates for various industries and the national population data that were provided by the NDC in December 2023 to estimate the sector's greenhouse gas emissions trend. The estimation process is illustrated in the flowchart below.

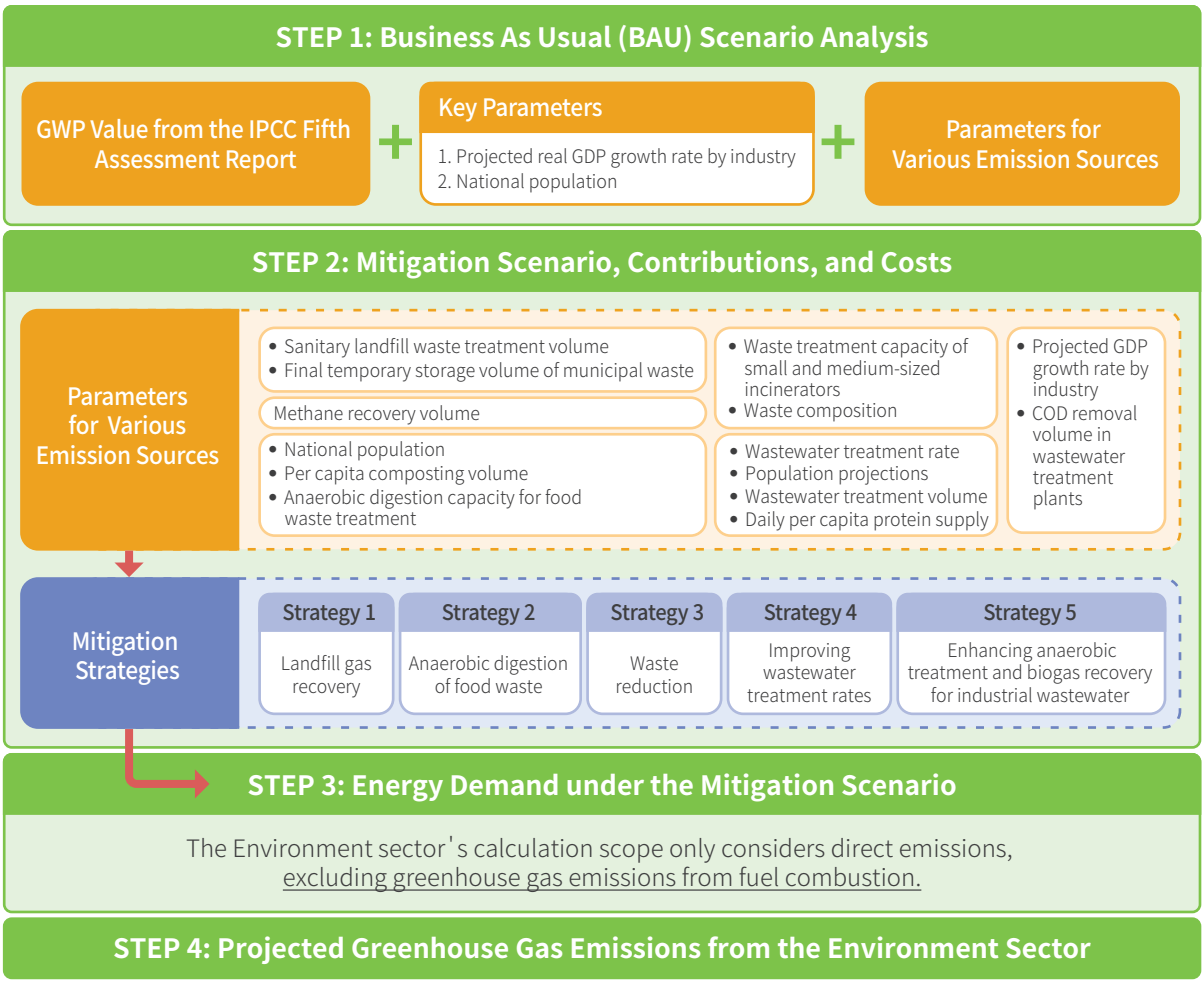


Figure 4.3.2-7. Flowchart for Estimating Environmental Sector's Greenhouse Gas Emissions Trend

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5 Impacts of Climate Change and Adaptation Strategies

Chapter 5: Impacts of Climate Change and Adaptation Strategies

Taiwan is characterized by steep terrain, swift rivers, and frequent typhoons that bring heavy rains and strong winds, often causing floods and landslides. Global climate change is expected to increase the frequency of extreme weather events, which will pose greater threats to the country. Effectively addressing these challenges has become a critical issue for Taiwan.

In response to the latest scientific data from the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) and in accordance with the *Climate Change Response Act*, the National Science and Technology Council (NSTC) and the Ministry of Environment jointly released *Climate Change in Taiwan: National Scientific Report 2024* on May 8, 2024. This report is the first climate change science report to be completed following the release of the *Climate Change Response Act* in 2023. It presents Taiwan's historical climate change data and the most recent projections, offering research findings on climate change impacts from Taiwan's scientific community to help stakeholders understand how climate change affects the country.

5.1 Climate Change Hazards

This section combines historical meteorological observation data and future climate projections to describe the hazards of climate change in Taiwan. Meteorological observations are based on historical meteorological data from the Central Weather Administration, Ministry of Transportation and Communications. Projections adopt scenarios from both the IPCC Fifth Assessment Report (AR5) and the IPCC Sixth Assessment Report (AR6), including four Representative Concentration Pathways (RCPs) for greenhouse gas emissions and five Shared Socioeconomic Pathways (SSPs).

5.1.1 Temperature

Reviewing historical temperature records in Taiwan, observations from the Central Weather Administration's six centennial meteorological stations (located in Taipei, Taichung, Tainan, Hengchun, Hualien, and Taitung) indicate that the average temperature slowly increased from 1920 to 1940, stabilized from 1940 to 1980, and then rose significantly after 1980. The temperature increase after 1980 is notably higher than in other periods. Trends over the past 30 years, the past 50 years, and the long term (1900 to 2022) reveal a per-decade temperature increase of 0.27°C, 0.25°C, and 0.15°C, respectively, demonstrating an increasingly pronounced warming trend in recent years. The temperature trends are depicted in Figure 5.1.1-1.

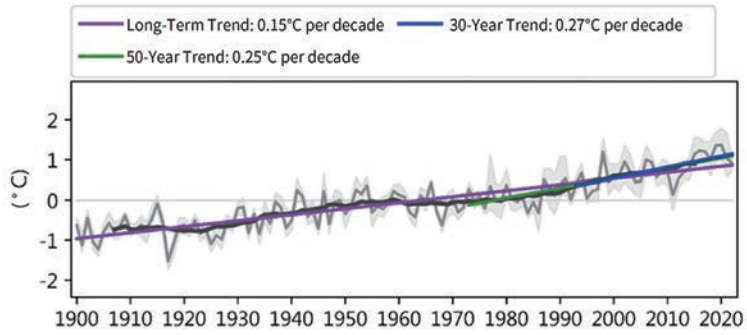

Figure 5.1.1-1. Trend of Taiwan's Annual Average Temperature Anomalies (Six Centennial Meteorological Stations)

Source: National Science and Technology Council (NSTC) and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024*.

Future projections show that the global surface temperatures have risen continuously over the past century, with anthropogenic greenhouse gas emissions as the primary cause. According to climate simulations of the four shared socioeconomic pathways (SSPs) using Phase 6 of the Coupled Model Intercomparison Project (CMIP6) with the current climate (1995–2014) as the benchmark, researchers have discovered that under different scenarios, Taiwan's warming will continue until at least the middle of the century. In the short term (2021–2040) there is no noticeable difference between scenarios, with the average temperature rise showing a median increase of 0.6°C–0.8°C. There are slight differences among the medium-term (2041–2060) scenarios, with a low emission (SSP1-2.6) warming of 1°C and a very high emission (SSP5-8.5) warming of 1.6°C. In the long-term (2081–2100) scenarios, the differences are even more apparent. Under the low emission scenario, Taiwan can maintain the medium-term warming range of (1°C), but under the very high emission scenario, warming will increase to 3.4°C, as shown in Figure 5.1.1-2.

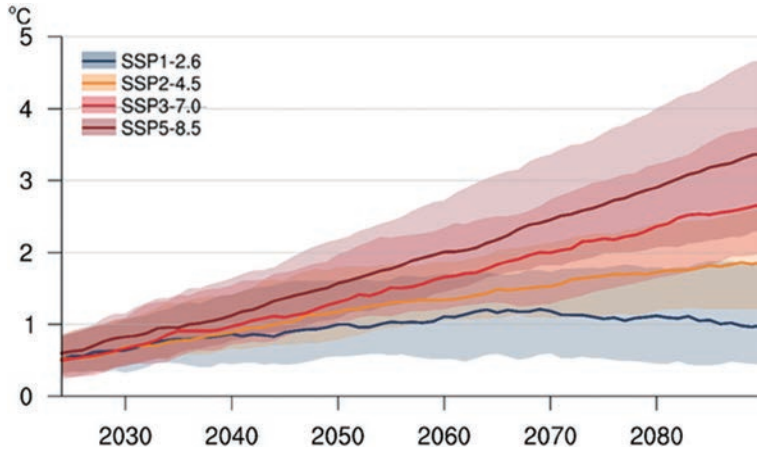

Figure 5.1.1- 2. Future Trend of Taiwan's Annual Average Temperature Anomalies (CMIP6 Temperature Model)

Source: National Science and Technology Council (NSTC) and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024*.

Regarding the length of seasons , past observations and future projections show similar trends: winters will become shorter and summers will become longer, with summers starting earlier and ending later, and winters starting later and ending earlier. Over the past 50 years, summer has lengthened by approximately 6.31 to 12.88 days per decade, whereas winter has shortened by approximately 6.19 to 12.20 days per decade. Under the low-emission scenario (SSP1-2.6), winters will stabilize at approximately 45 days in length after 2050. However, under other future scenarios, winter will continue to shorten and could disappear as early as 2060 under the very high-emission scenario. Daily temperature fluctuations also exhibit changes: the date of the highest summer temperature is shifting earlier and the peak temperature is rising, whereas the date of the lowest winter temperature is shifting later and the lowest temperature is rising.

Meanwhile, the trend of increasing summer days corresponds to the severity of warming scenarios, particularly after 2040. Under the low-emission scenario, summer remains approximately five months long. However, in the very high-emission scenario, summer extends to nearly seven months by the end of the century. In this scenario, Taiwan's climate would resemble that of tropical countries, as shown in Figure 5.1.1-3.

Comparing the historic average temperatures of the warmer half of the year (May to October) and the cooler half of the year (November to April) reveals a steady rise in temperatures during the warmer half of the year since 1900. The long-term trends for both the warmer and cooler halves of the year align with the trend in annual average temperature, increasing by 0.15°C per decade. Examining trends over the past 30 years, the past 50 years, and the long term (1900–2022), the per-decade warming rates are 0.27°C, 0.25°C, and 0.15°C, respectively, demonstrating an increasingly significant warming trend in recent years. Moreover, the 50-year trend reveals a sharper increase in the warming rate during the cooler half of the year compared to the warmer half of the year. Forecasts

predict a continuous rise in temperatures for each region.

In the short term (2021–2040), regional differences in Taiwan's average temperature increase are minimal, with a rise of 0.6°C to 0.8°C. In the mid-term (2041–2060), scenarios show slight differences, with warming under SSP5-8.5 (the worst-case global warming scenario in IPCC AR6) reaching 1.6°C. In the long term (2081–2100), projections indicate more significant differences, with warming under SSP5-8.5 increasing to 3.4°C. During the short term (2021–2040), regional differences across future development scenarios are not pronounced, although under SSP5-8.5, northwestern Taiwan shows slightly higher warming. In the mid-term (2041–2060), regional differences increase slightly compared to the short term, with northwestern Taiwan still experiencing the most significant warming. By the end of the century (2081–2100), regional warming projections show more pronounced differences between scenarios, with SSP5-8.5 reaching up to 3.5°C, as illustrated in Figure 5.1.1-4. From 2020 to 2040, the length of summer increases over time, and after 2040, the trend of increasing summer days becomes more divergent depending on the severity of the warming scenario. By the end of the 21st century, compared to the present, summer in Taiwan extends to nearly seven months, with winters almost disappearing. Taiwan's climate will be predominantly warm to hot year-round, resembling the temperature characteristics of tropical countries.

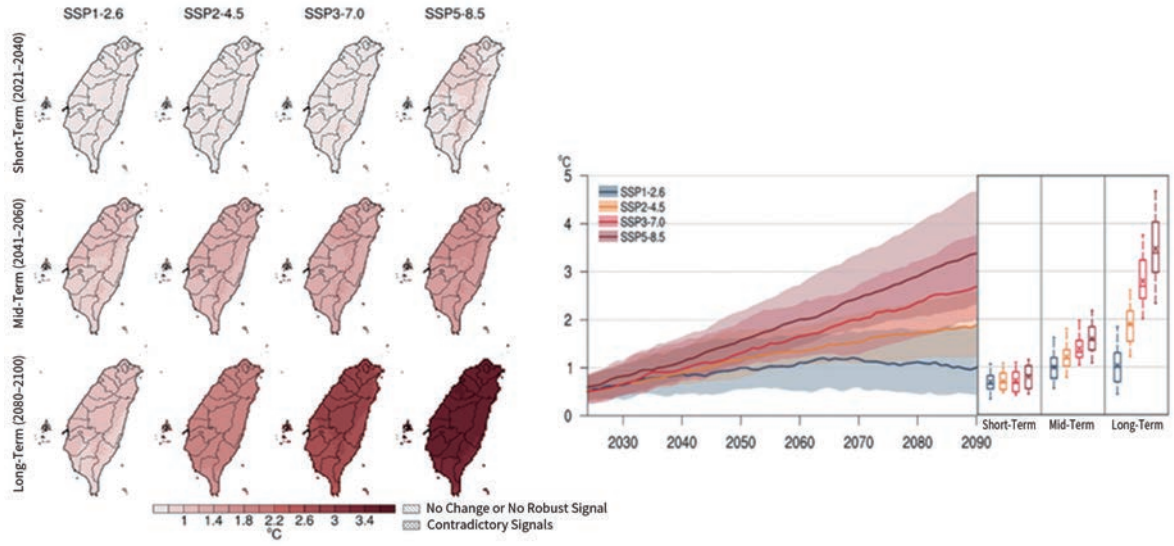

Figure 5.1.1-3. Projected Trends of Taiwan's Future Temperature Models

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

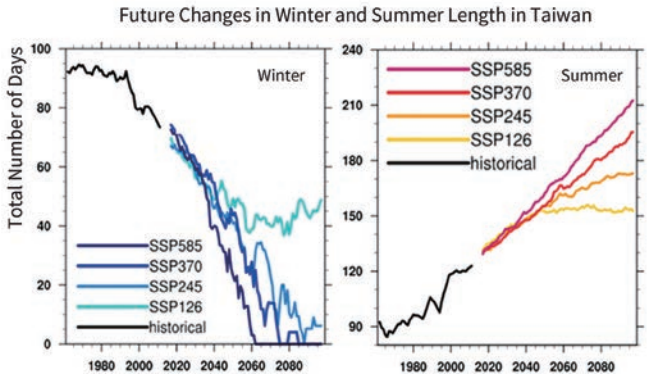

Figure 5.1.1-4. Taiwan's Winter (left) and Summer (right): Historical Length and Simulation of Projected Changes (CMIP6 Climate Model)

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

5.1.2 Sea Level and Sea Temperature

The trends in sea level changes around Taiwan are influenced by the El Niño–Southern Oscillation and the Pacific Decadal Oscillation. From 1993 to 2015, the average annual rise in sea level was approximately 2.2 ± 0.3 mm, which was slightly lower than the global average of 3.2 ± 0.1 mm per year. This may be related to the significant decline in the average sea level around Taiwan after 2013. However, by the end of the 21st century, the average sea level rise around Taiwan is projected to be higher than the global average, with changes on the eastern coast being more pronounced than those on the western coast. This spatial distribution is associated with the thermal expansion of seawater and changes in ocean circulation driven by atmospheric wind fields. By the end of the century, under low-emission and very high-emission scenarios, the sea level is expected to rise by approximately 0.4 meters and 0.8 meters, respectively.

Regional changes in sea temperature and sea level due to global warming have a critical impact on marine ecosystems as well as marine and coastal industries. Observational data from the Taiwan Strait indicate a long-term warming trend in sea temperatures over the past century. During the warming hiatus from 1998 to 2012, there was a pause in sea surface temperature increases, but warming resumed after 2012. From 2012 to 2018, the warming trend was approximately 0.63°C per decade, as shown in Figure 5.1.2, and this warming is expected to continue through the end of the century.

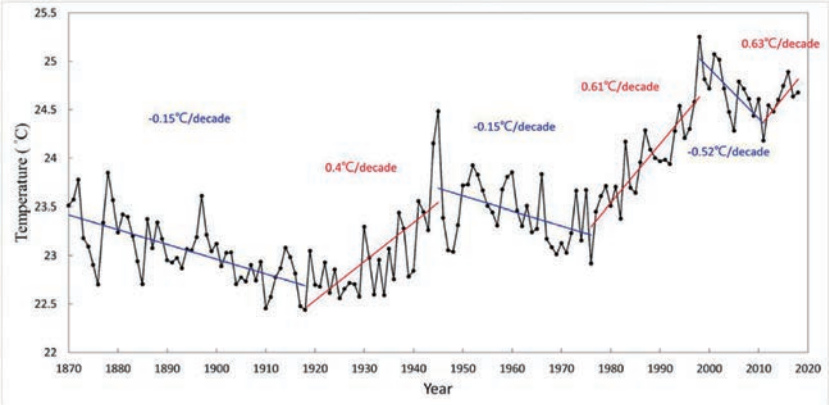

Figure 5.1.2-1. Long-term Sea Temperature Trends in the Taiwan Strait (Adapted from Lee et al., 2021)

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024*.

5.1.3 Rainfall

Observational records of rainfall trends in Taiwan over the past century have not shown statistically significant changes. Future projections of rainfall changes under warming scenarios also show no clear trends due to large model discrepancies and high uncertainty. However, the difference between dry (November to April) and wet (May to October) seasons is expected to become more pronounced with increasing levels of global warming. During the dry season, most regions in Taiwan are projected to experience reduced rainfall, particularly in the northeastern and eastern areas. However, under a Global Warming Level (GWL) of 1.5°C to 2°C, regions in the southwest—historically drier areas—are projected to see an average increase in rainfall, albeit with low model consistency. Long-term trends in annual maximum consecutive dry days and the Standardized Precipitation Index show no significant changes, but interannual variability is greater at stations in central and southern Taiwan. Since 1960, the frequency of meteorological drought events has increased significantly at stations in Tainan, Hengchun, and Taitung. Historically, severe droughts have occurred most frequently in central and southern Taiwan, followed by northern regions. Spring is the most common season for such events, followed by autumn and winter. The frequency of meteorological droughts exhibits distinct regional characteristics and low-frequency oscillations, with large-scale circulation patterns driving reduced rainfall.

Conversely, under a GWL of 4°C, rainfall increases significantly across Taiwan during the wet season, with high model agreement. Coastal areas in Central and southern Taiwan, Taitung, and Penghu could see rainfall increase by over 30%. This indicates that with higher levels of global warming, Taiwan's rainfall trends will likely be characterized by drier dry seasons and wetter wet seasons. It is worth noting that while different models produce varying results, at GWLs of 3°C and 4°C, over 75% of the models exhibit similar patterns of increase and decrease, as shown in Figure 5.1.3-1.

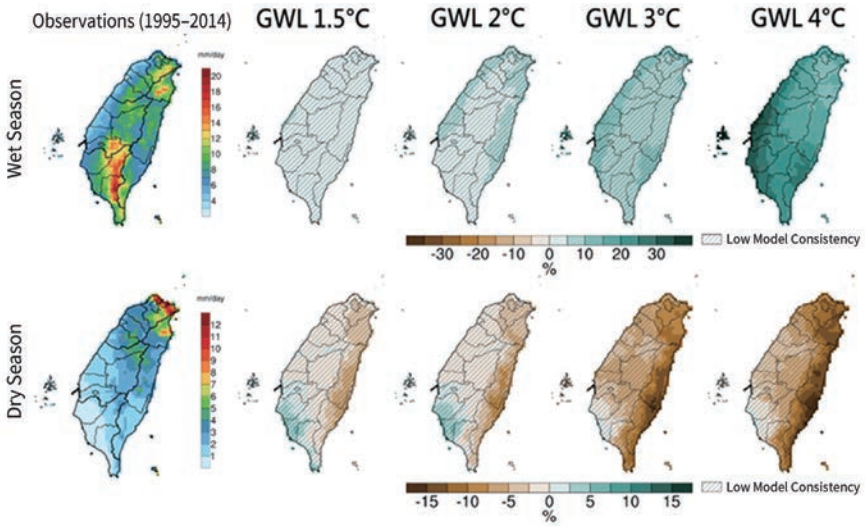

Figure 5.1.3-1. Spatial Variations in Average Rainfall across Taiwan during the Wet Season (top) and Dry Season (bottom) under Historical Conditions and Different Global Warming Levels (GWLs)

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024*.

Under warming scenarios, Taiwan's extreme rainfall trends primarily exhibit precipitation polarization: the maximum number of consecutive dry days (CDD) shows an increasing trend, but the hydrological frequency of annual rainfall also becomes more severe. For example, during the spring season at the end of the century, as emission scenarios worsen (from low to very high emissions), CDD increases across Taiwan. Southern regions, which already have a relatively long dry period during this season, are projected to see an even more pronounced increase in CDD, particularly in Chiayi, Tainan, Kaohsiung, Pingtung, and Taitung, as shown in Figure 5.1.3-2. Analysis of the 10-year and 50-year rainfall return periods, which are commonly used to assess extreme rainfall intensity, reveals that under a GWL4°C scenario, the 10-year rainfall intensity is projected to be 468 mm, which is comparable to the 50-year return period rainfall intensity under current conditions (GWL1°C, 485 mm). This indicates that under a 4°C warming scenario, extreme rainfall events that currently occur only once every 50 years may occur every 10 years in the future, which poses significant challenges to slope stability and flood control measures.

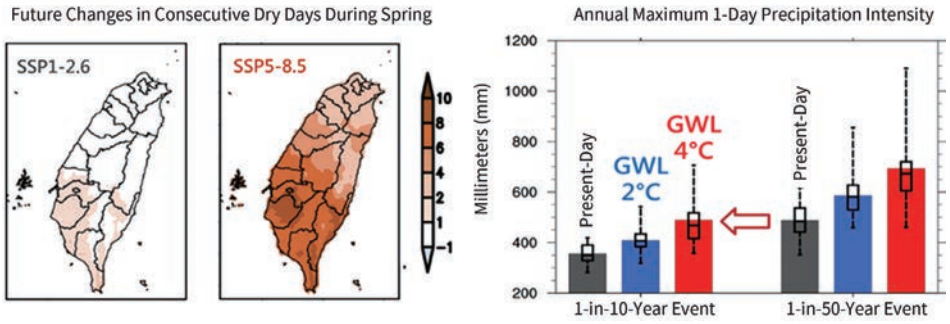

Figure 5.1.3-2. (Left) Projected Changes in Spring CDD (unit: days/year) at the End of the Century under Different Warming Scenarios.
(Right) Average Maximum 1-day Extreme Rainfall Intensity for Taiwan under Different GWL Scenarios.

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024*.

5.1.4 Typhoons and Extreme Weather

I. Typhoons

The long-term trend in the number of typhoons and severe typhoons affecting Taiwan is unclear and exhibits characteristics of decadal variability. Changes in typhoon paths are influenced by large-scale weather circulation patterns and show no significant association with global temperature increases. Future projections indicate that typhoons affecting Taiwan will show a trend of fewer occurrences but greater intensity, which is consistent with the broader trend of typhoon changes in the Northwest Pacific. For example, under the RCP8.5 scenario, the number of typhoons is projected to decrease by approximately 10% and 50% in the mid- and late-21st century, respectively. However, the frequency of severe typhoons is expected to increase by approximately 105% and 60%, respectively. Both wind speed and rainfall are also projected to increase. The maximum wind speed near the center of the typhoon is expected to increase by about 9%, which is critical for assessing storm surges and related impacts on coastal areas. The aforementioned increases and decreases represent average results. However, variations in the spatial distribution of sea surface warming used in models can affect changes in typhoon frequency. The box-and-whisker plots in Figure 5.1.4-1 represent potential outcomes.

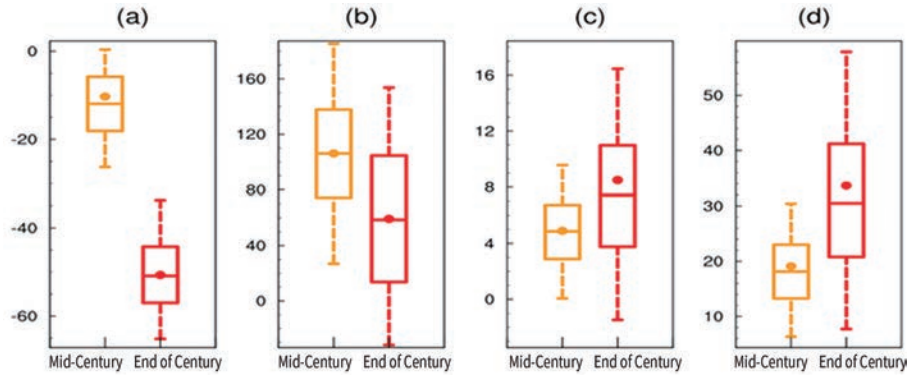

Figure 5.1.4-1. Simulation Results under the RCP8.5 Scenario for the Mid-21st Century (yellow) and Late 21st Century (red): (a) Frequency of typhoons affecting Taiwan, (b) Frequency of severe typhoons, (c) Maximum wind speed near the typhoon center, (d) Average rainfall within 200 km of the typhoon center.

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

II. Extreme High Temperatures

The warming trend and lengthening of the summer season are expected to impact agriculture, ecosystems, and public health. The trend in extreme temperatures shows an increase in the number of hot days, a decrease in the number of cold days, and a diminishing magnitude of nighttime cooling. The Central Weather Administration issues high-temperature advisories when daily maximum temperatures reach 36°C or higher, and based on future projections from CMIP6, the number of days with daily maximum temperatures exceeding 36°C serves as an indicator of extreme heat events. In Taiwan's lowland areas (below 500 meters in elevation), the number of hot days will continue to rise. In the short term (2021–2040), the increase is approximately 14 to 17 days, which is not significant. By the mid-term (2041–2060), differences between warming scenarios become apparent: under the most severe emission scenario (SSP5-8.5), hot days increase by 41 days, whereas the least severe scenario (SSP1-2.6) shows only a slight increase. In the long term (2081–2100), the differences become more pronounced, with 87 days separating the severe (SSP5-8.5) and mitigated (SSP1-2.6) scenarios, demonstrating that reducing greenhouse gas emissions directly correlates with fewer hot days, as illustrated in Figure 5.1.4-2. Under the highest emission scenario, the annual average number of hot days across Taiwan increases by 75 days by the end of the century. Using the GWL framework (global warming levels, relative to pre-industrial levels [1850–1900]), GWL4°C is projected to result in 55 additional hot days. In terms of spatial distribution, regions with the greatest increases include the Taipei Basin, areas near the mountains in central Taiwan, and areas near the mountains in Kaohsiung and Pingtung, including valleys (river valleys and longitudinal valleys). These trends are influenced by factors such as limited sea breeze regulation and enclosed topography, as shown in Figure 5.1.4-3.

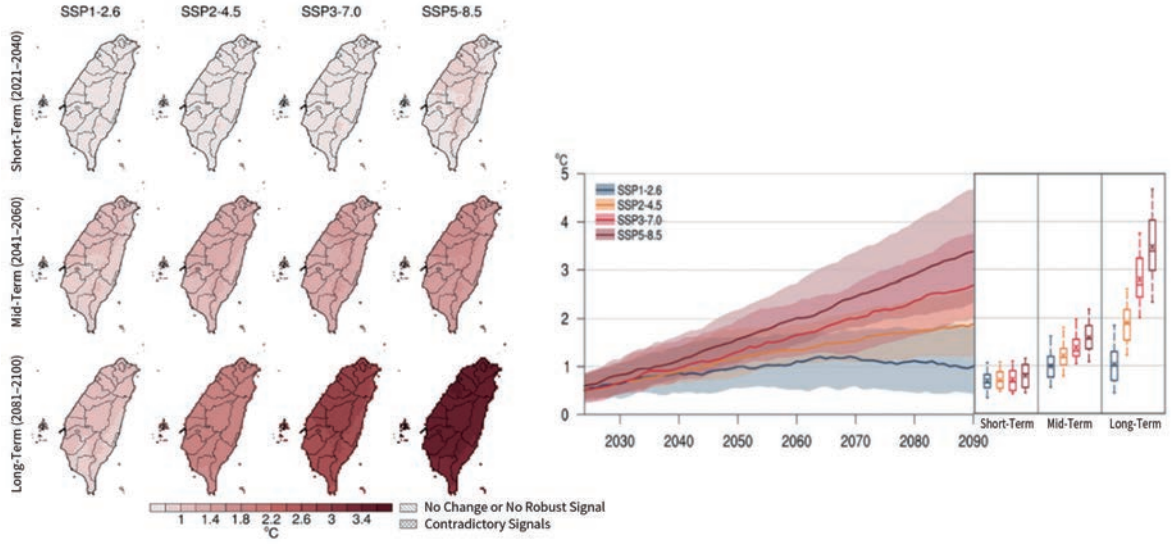

Figure 5.1.4-2. Projected Trends in Temperature Patterns across Taiwan Based on Future Climate Model

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

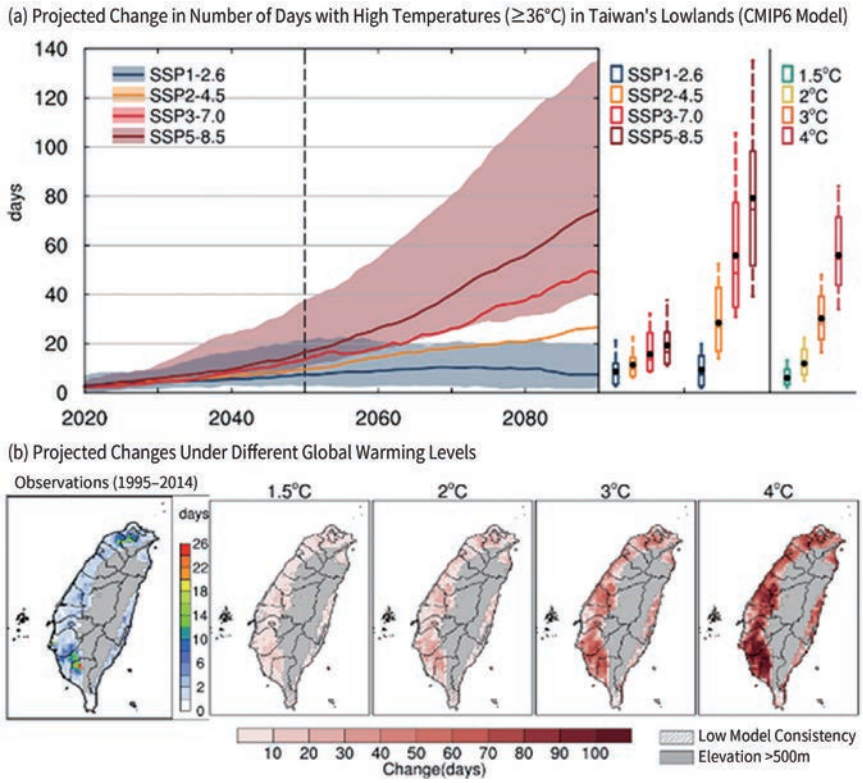

Figure 5.1.4-3. Projected Change in Number of Days with High Temperatures (≥36°C) in Taiwan's Lowlands (CMIP6 Model)

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

III. Extreme Rainfall

Time series analysis of heavy rainfall and torrential rainfall days indicates more pronounced interannual variability in mountainous regions, with an increase in the anomaly values of these days after 2000. Regarding historical observations of extreme rainfall in Taiwan, data from the Central Weather Administration's observation stations on days with heavy rainfall, torrential rainfall, and extremely torrential rainfall show no significant long-term trends across various regions since 1950. However, mountainous regions exhibit greater interannual variability, particularly after 2000, as shown in Figure 5.1.4-4.

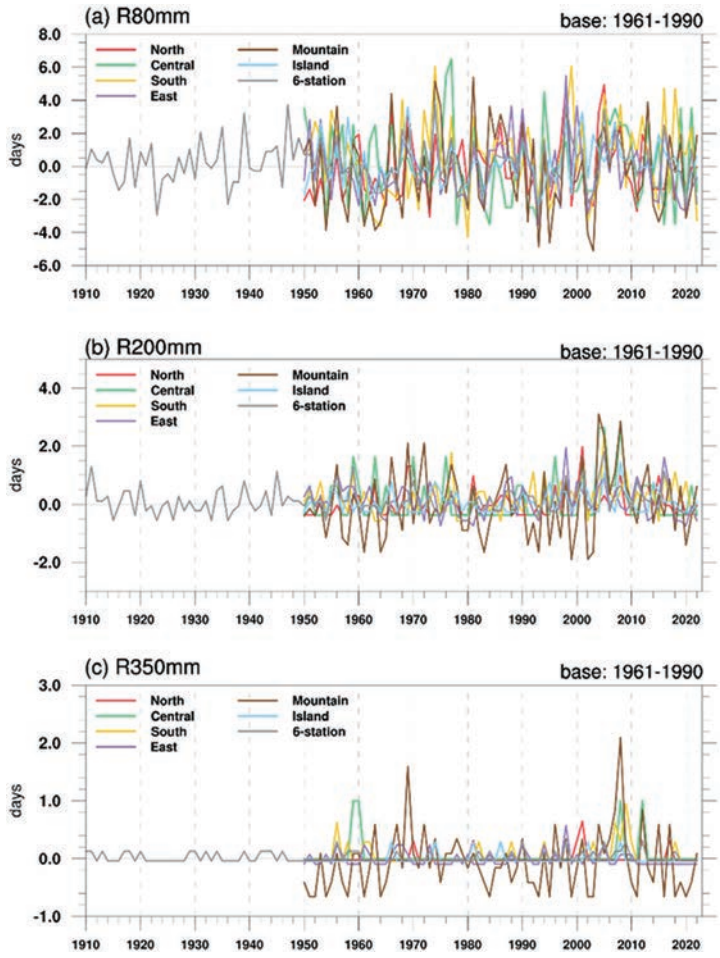

Figure 5.1.4-4. Annual Anomaly Time Series of Total Days with Rainfall Exceeding (a) 80 mm (Heavy Rain Threshold), (b) 200 mm (Torrential Rain Threshold), and (c) 350 mm (Extremely Torrential Rain Threshold) from 1910 to 2021.

Note: Climate normals for each station are based on the 1961–1990 average. Line colors represent different regions: Northern Taiwan (red), Central Taiwan (green), Southern Taiwan (yellow), Eastern Taiwan (purple), mountainous areas (brown), outlying islands (light blue), and six centennial stations (gray).
Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

Afternoon convective rainfall during Taiwan's summer season (June to August) is an important water resources but also a frequent cause of flooding disasters. Data from observation stations between 1961 and 2012 indicate an increasing trend in the frequency of summer afternoon convection in Northern Taiwan, whereas other regions show a decreasing trend. In terms of changes in the intensity of summer afternoon convection, most regions exhibit an increasing trend, with the exception of mountainous stations, where a weakening trend is observed, as shown in Figure 5.1.4-5.

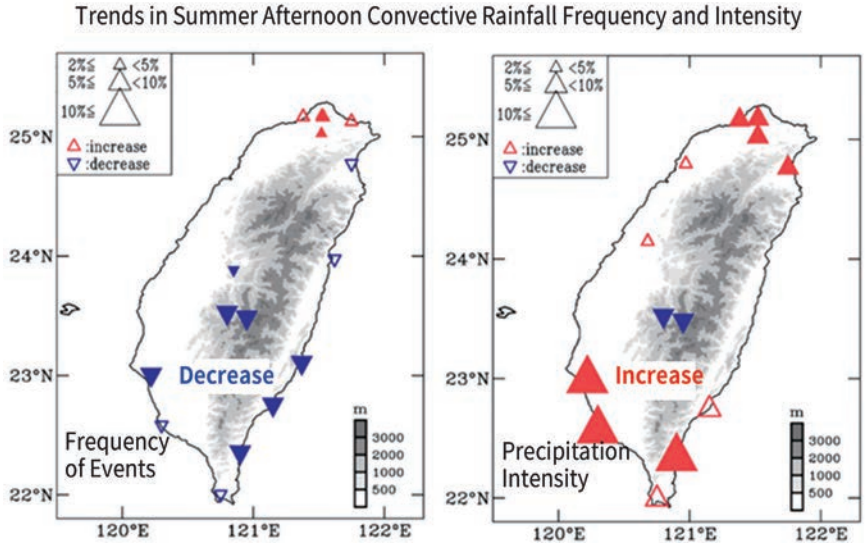

Figure 5.1.4-5. Characteristics of Summer Afternoon Convective Rainfall Frequency and Intensity, Based on Surface Observation Data from Taiwan (1961–2012).

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

For future changes in extreme rainfall, dynamical downscaling data (HiRAM-WRF) under the RCP8.5 scenario indicate that by the end of the 21st century, summer afternoon convective rainfall will exhibit a decrease in frequency but an increase in intensity, as shown in Figure 5.1.4-5. Further analysis of the environmental conditions reveals that the decrease in frequency is associated with the west-southwest extension of the Pacific Subtropical High, which increases atmospheric stability. Meanwhile, the accompanying strengthening of the southwesterly flow and increased low-level convergence are favorable for offshore rainfall systems moving into Taiwan, thereby enhancing rainfall intensity.

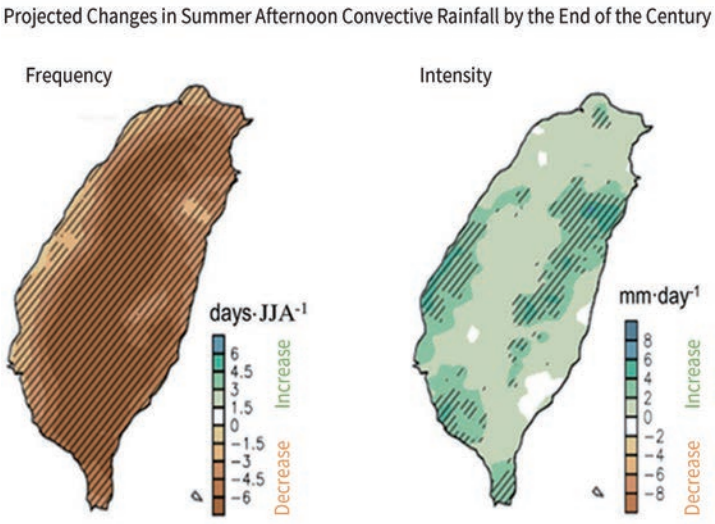

Figure 5.1.4-6. Projected Frequency and Intensity of Summer (June to August) Afternoon Convective Rainfall at the End of the 21st Century under the RCP8.5 Scenario, Based on HiRAM-WRF Dynamical Downscaling.

Note: Hatched areas represent changes that pass the 90% confidence level statistical test.
Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

5.1.5 Air Quality

To quantify historical and future air quality in Taiwan, this section uses ozone, one of the two main pollutants responsible for poor air quality in Taiwan (the other being fine particulate matter, PM2.5), as an example. Assuming emissions remain constant, historical and future air quality simulation results indicate that during the 2011–2015 period, the number of poor air quality days (ozone) was relatively high in Central Taiwan. Under future warming scenarios (GWL 4°C), simulated weaker low-level wind speeds during autumn (September to November) and winter (December to February) are expected to hinder pollutant dispersion, leading to increased ozone formation and consequently a rise in the number of poor air quality days, as shown in Figure 5.1.5-1.

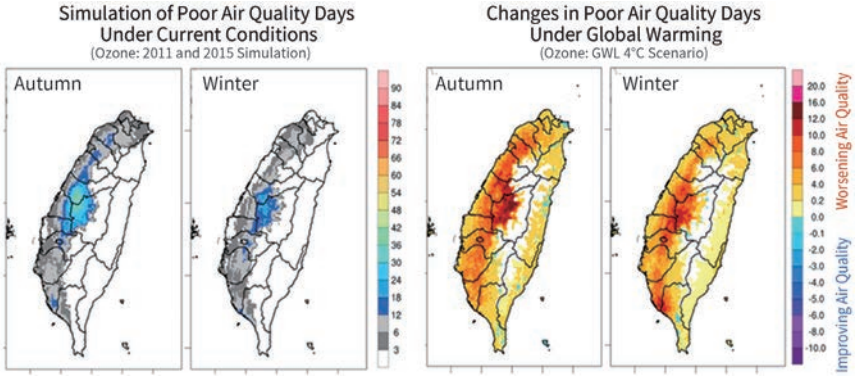

Figure 5.1.5-1. Number of Poor Air Quality Days During Autumn and Winter: Current Conditions (left two images) and Changes under GWL 4°C Scenario (right two images)

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

5.1.6 Models and Methodology

Currently, the global climate model data used in Taiwan is produced by climate centers and research institutions worldwide. The National Science and Technology Council has established localized climate change projection databases for AR4 and AR5. Since 2020, Taiwan has also adopted the Coupled Model Intercomparison Project Phase 6 (CMIP6), which is analyzed in IPCC reports, to provide the latest and most comprehensive climate change projection information. Compared to the AR5 dataset, AR6 not only includes more climate model data but also introduces the Shared Socioeconomic Pathways (SSP) framework in its climate change scenario settings, as shown in Figure 5.1.6-1. This framework integrates socioeconomic factors with the warming pathways from CMIP5, enabling simultaneous consideration of mitigation and adaptation needs in scenario applications.

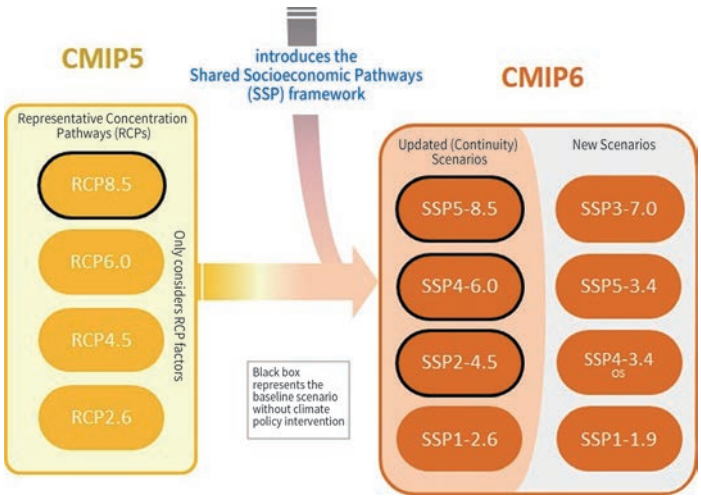

Figure 5.1.6-1. Explanation of CMIP6 Warming Scenarios

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

Due to the low spatial resolution of raw global model data (approximately 150–300 km), these models are too coarse for application in Taiwan's localized climate change risk assessment and impact analysis. Currently, the National Science and Technology Council employs two downscaling methods to increase the spatial resolution of global climate models to 5 km for areas around Taiwan.

I. Statistical Downscaling

Statistical downscaling uses high-resolution observational grid data as a basis to correct and enhance the resolution of global model data, thereby aligning it with Taiwan's climate characteristics. Because this method is fast and can be applied across multiple models, it helps address uncertainties in future climate projections that are critical for adaptation policy-making. However, this method is limited by the density of existing observational data and the resolution of the original global models, which cannot adequately represent extreme weather systems such as typhoons and plum rains. As a result, it is unable to provide comprehensive meteorological variables or simulation results.

II. Dynamical Downscaling

To assess the impacts of extreme weather events under warming scenarios, physical model-based dynamical downscaling methods are applied. This approach can generate necessary meteorological variables (e.g., wind field changes), hourly-scale data, and extreme weather events (e.g., typhoons). It is particularly useful for high-impact typhoon disaster assessments, such as flooding, slope stability, and coastal areas, and it provides the scientific data required for climate change risk evaluation.

5.2 Impacts of Climate Change

Among the disasters caused by extreme weather events, flooding, droughts, and landslides have been studied most extensively in Taiwan. The primary risk driver for these disasters is rainfall quantity, although socioeconomic factors also play a role. Flooding and landslides mainly occur during the plum rain season (May–June) and typhoon periods, whereas droughts typically occur between spring and summer.

Under global warming scenarios, future rainfall amounts, and the frequency and intensity of extreme rainfall events in Taiwan are projected to increase. This will elevate the risks of river flooding, urban inundation, and slope collapses. The growing disparity between wet and dry seasons is also expected to lead to a higher percentage of drought-affected areas.

The *Climate Change in Taiwan: National Scientific Report 2024*, which was jointly published by the National Science and Technology Council and the Ministry of Environment, summarizes domestic journal articles, research funded by the National Science and Technology Council, and research projects commissioned by various central government agencies. This comprehensive review aims to understand Taiwan's risks and vulnerabilities under climate change, which are categorized as follows:

5.2.1 Flooding

In flooding risk assessments, changes in rainfall distribution were calculated relative to a baseline period (1979–2008) for the mid-century (2039–2065) and late century (2075–2099). Short-duration intense rainfall events are projected to become more frequent, with total rainfall amounts increasing in both the mid- and late-century periods, as shown in Figure 5.2.1. Using these climate change scenarios in impact analyses, flooding depth thresholds of 0.5 meters or greater were employed as indicators. The results revealed that, compared to the baseline period, the probability of flooding is projected to increase by approximately 1.2 times by the mid-century and 2.3 times by the late century. Overall, both rainfall patterns and flooding impacts exhibit a trend of gradual intensification. However, specific regions may experience varying changes due to unique event conditions, such as rainfall intensity and event duration.

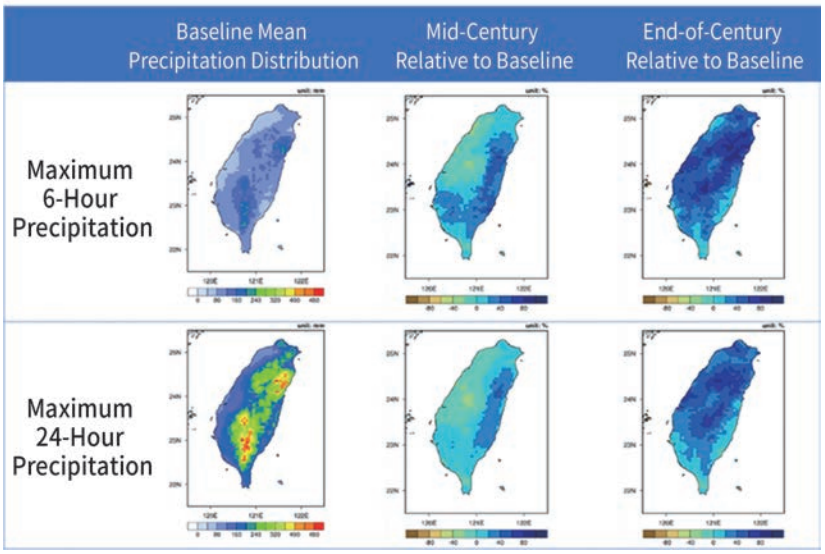

Figure 5.2.1-1. Hazard Distribution Map for Taiwan

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024*..

5.2.2 Drought

In 2022, the Water Resources Planning Branch of the Water Resources Agency conducted an analysis of consecutive dry days (daily rainfall <1.0 mm) for Taiwan's 10 major river systems under different climate change scenarios. The analysis also evaluated the climate change impacts on northern, central, and southern Taiwan. The results indicated that the baseline consecutive dry days were approximately 25 days in northern Taiwan, 33 days in central Taiwan, and 39 days in southern Taiwan. Under the influence of climate change, consecutive dry days showed a consistent increase across all three regions, regardless of the scenario, as illustrated in Figure 5.2.2. For example, under a 2°C warming scenario, consecutive dry days were projected to increase by 16.9%, 11.1%, and 13.7% in northern, central, and southern Taiwan, respectively. This suggests that Taiwan will face significantly longer periods without rainfall in the future.

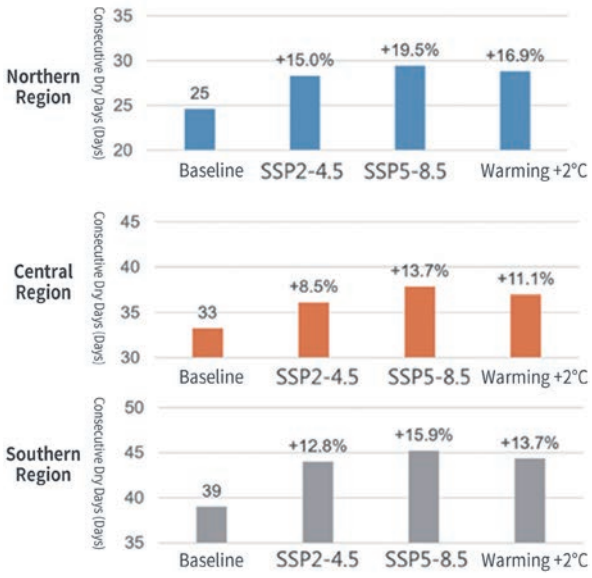

Figure 5.2.2-1. Change in Consecutive Dry Days under Different Climate Change Scenarios

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

5.2.3 Slope Land

The IPCC AR6 indicates that landslide hazards may increase significantly as global warming reaches 1.5°C to 3°C. By combining statistically downscaled AR6 rainfall data with slope geomorphological characteristics and population density data, an assessment of slope disaster risks under different global warming levels was conducted for Taiwan. The evaluation showed that, under a 2°C warming scenario, the mountainous areas of central and southern Taiwan are classified as high-risk for slope disasters. Risk levels in the northern and eastern mountainous areas also increase. If warming reaches 4°C, certain mountainous areas experience a more significant rise in risk levels, as illustrated in Figure 5.2.3.

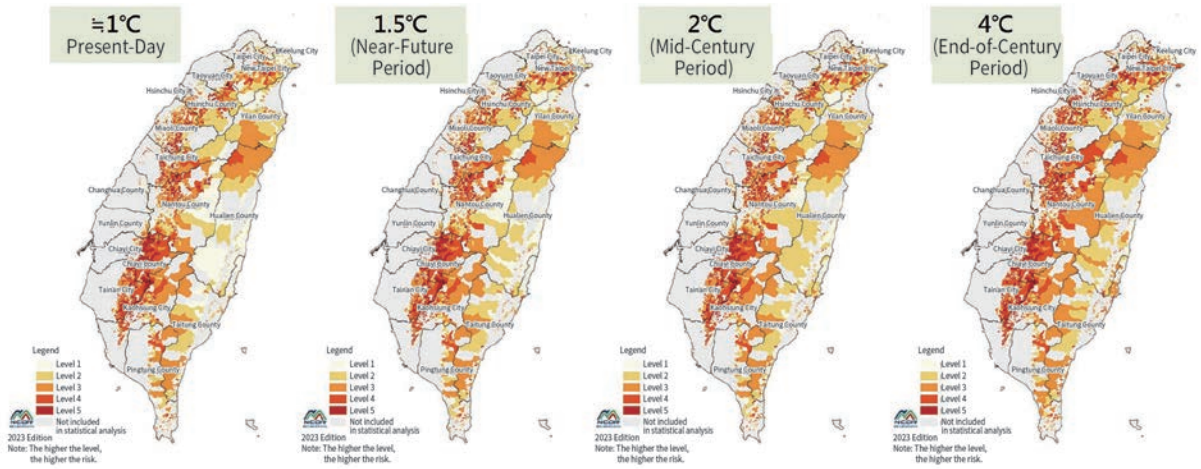

Figure 5.2.3. Slope Disaster Risks in Taiwan's Least Populated Areas under Different Global Warming Scenarios

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.*

5.2.4 Water Resources

Taiwan's annual rainfall reaches approximately 88.502 billion metric tons, which is abundant but unevenly distributed. After accounting for evapotranspiration and losses to the sea, the annual runoff is approximately 64.742 billion cubic meters. However, during the dry season (November to April), runoff is only 15.254 billion cubic meters, accounting for 23.56% of the annual total. The significant disparity between wet and dry seasons necessitates water resource adaptation measures to ensure water security. Since 2017, numerous local studies in Taiwan have used AR5 or AR6 data to simulate changes in rainfall or runoff under different climate change scenarios. Results indicate varying degrees of change, but the overall trends are consistent. Using the latest AR6 data, multi-model simulations of runoff change rates under GWL 2°C and GWL 4°C scenarios (median results) show the following: annual runoff change rates range from -1% to +27%; wet season runoff change rates range from -2% to +31%; dry season runoff change rates range from -13% to +3%. These projections highlight increasing challenges in water resource allocation, as illustrated in Figure 5.2.4-1.

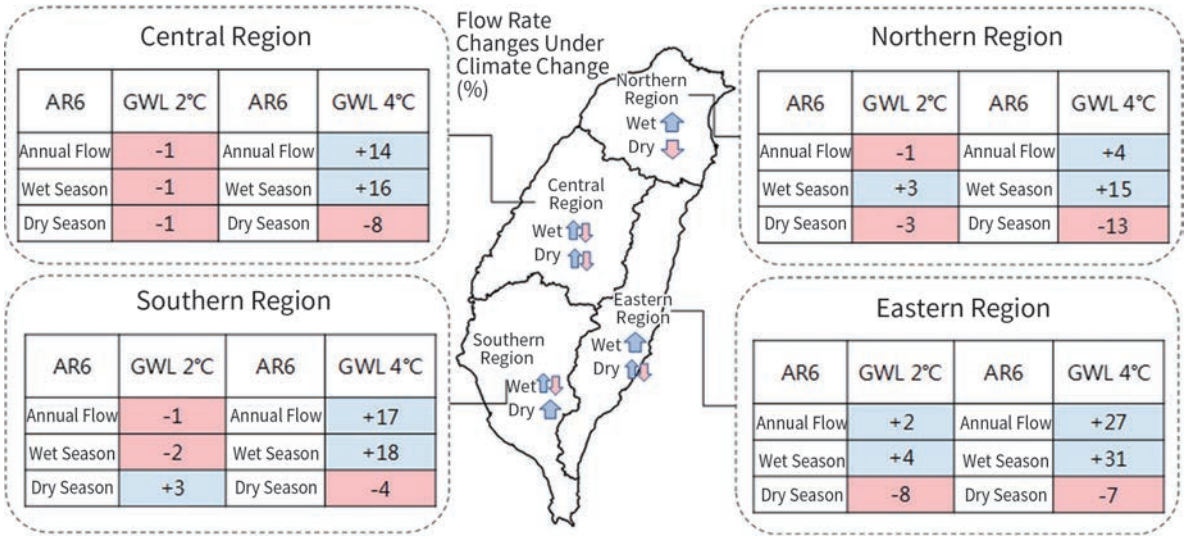

Figure 5.2.4-1. Runoff Change Rates (%) under the Impact of Climate Change

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.* 2024.
Note: The values in the table represent the median of all models (ranging from the 5th percentile to the 95th percentile of the models). The GWL 2°C and GWL 4°C scenarios correspond to global warming levels reaching 2°C and 4°C, respectively, relative to the model's baseline period (1995–2014). These results represent change rates derived from 86 and 26 models, respectively. Since the timing of reaching each GWL varies among models, the corresponding periods for adaptation purposes are approximately 2041–2060 (mid-term) for GWL 2°C and 2081–2100 (long-term) for GWL 4°C.
The calculation of runoff uses key water intake points within major watersheds as control points, with nearby streamflow stations as reference stations. For example, in the northern region, the major water supply from the Dahan River has control points at Shihmen Reservoir and the Sanxia River intake point, with corresponding streamflow simulation reference stations at Shihmen Reservoir and Sanxia Station.
Runoff estimation is a nonlinear process influenced by other hydrological fluxes, such as evapotranspiration and groundwater discharge. These factors can cause discrepancies between the ranges of runoff changes and rainfall changes.

5.2.5 Coastline

According to IPCC AR6 projections for sea level rise, Taiwan's average sea level is expected to rise by 20 cm and 34.5 cm under global warming levels of 1.5°C and 2.0°C, respectively. Based on the percentage of each county or city's area affected by coastal inundation due to sea level rise, the top three most affected regions under both warming levels are Yunlin County, Tainan City, and Changhua County, as illustrated in Figure 5.2.5-1.

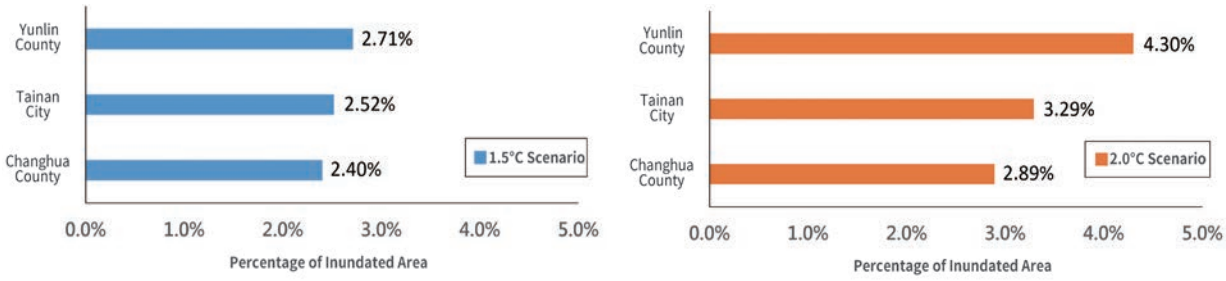

Figure 5.2.5-1. Counties/Cities in Taiwan Most Affected by Coastal Inundation Due to Sea Level Rise under Global Warming Scenarios of 1.5°C (top) and 2.0°C (bottom)

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.* 2024.

5.2.6 Agriculture

Domestic and international studies indicate that climate change impacts agricultural crops, resulting in reduced yields and economic losses. The Taiwan Climate Change Projection Information and Adaptation Knowledge Platform (TCCIP) team used the Decision Support System for Agrotechnology Transfer (DSSAT) crop growth model, incorporating future climate model data, to assess changes in rice and corn yields in Taiwan. Under the high-emission RCP8.5 global warming scenario, rice yields are projected to decrease overall, with reductions of 13% and 18% by the mid- and late-21st century, respectively. Similarly, corn yields are expected to decline, with average reductions of 10% and 17% by the mid- and late-21st century, respectively, as shown in Figure 5.2.6-1.

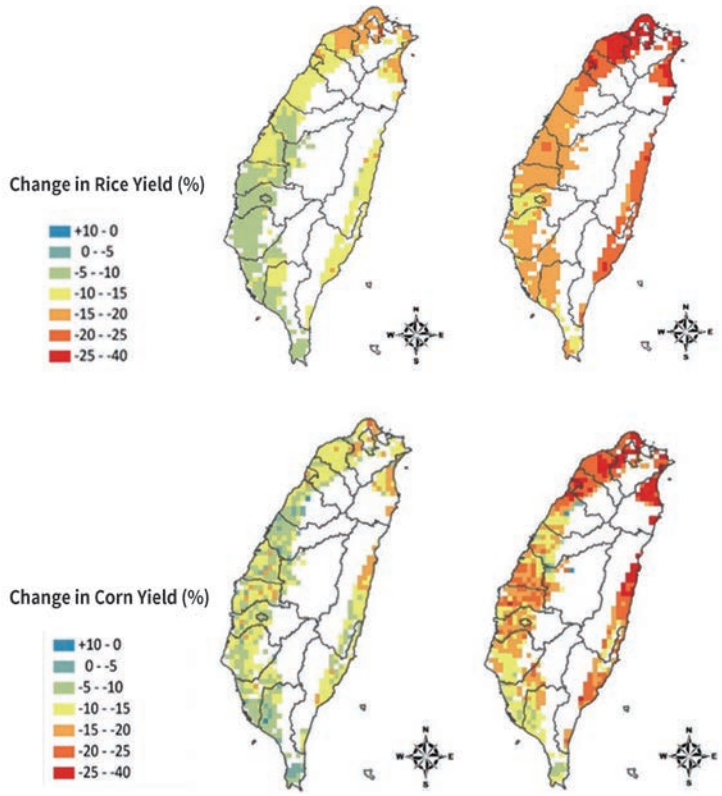

Figure 5.2.6-1. Changes in Rice and Corn Yields under Future Climate Scenarios (RCP8.5)

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024*. 2024.

5.2.7 Livestock

In recent years, global events such as severe floods that sharply reduced crop yields, disruption of international transport during the COVID-19 pandemic, inflated feed prices, and rising energy costs due to the Russo-Ukrainian war have led to continuously increasing costs for imported feed and hay. Combined with rising temperatures and an increasing number of hot days, Taiwan's livestock industry faces challenging environmental conditions. Under prolonged high-temperature conditions, livestock are susceptible to heat stress, resulting in decreased feed intake, endocrine imbalances, infertility, weakened immunity, and, in severe cases, death. The Taiwan Livestock Research Institute and the National Science and Technology Council's TCCIP team used the Temperature–Humidity Index (THI) and its empirical formula to assess the degree of heat stress on livestock under future climate change scenarios. The results indicated that under global warming levels of 2°C and 4°C, the THI in Taiwan will change significantly. Heat stress risks (using a THI threshold of >72) are expected to expand from southern to northern Taiwan and from plains to foothills, impacting livestock productivity (e.g., eggs, meat, and milk), as illustrated in Figure 5.2.7-1.

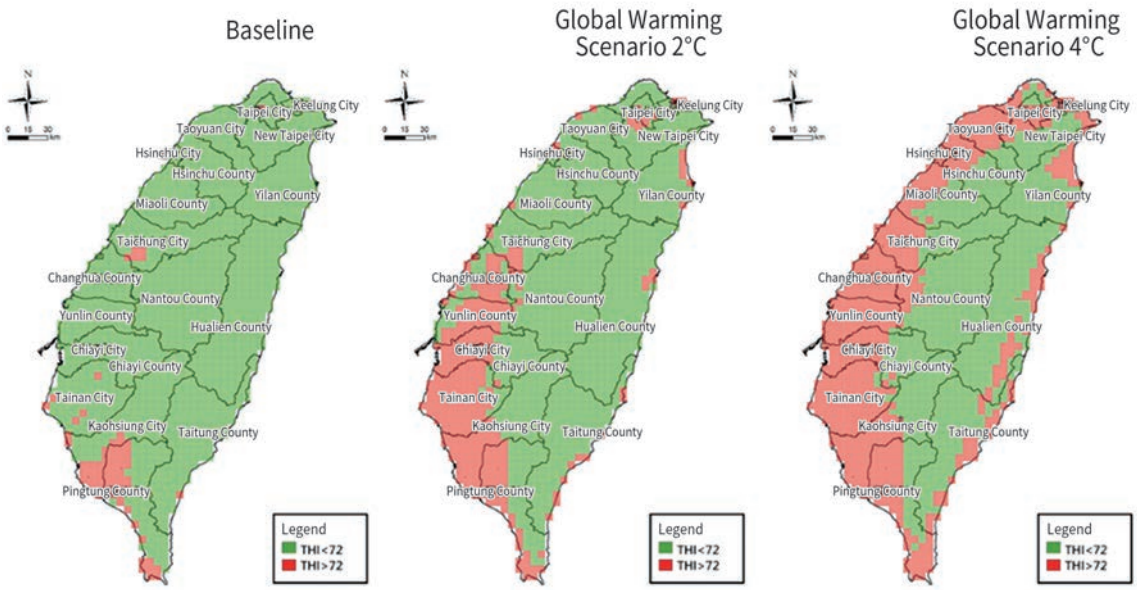

Figure 5.2.7-1. Trends in Temperature-Humidity Index (THI) Changes Across Taiwan under Climate Change

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024*. 2024.

5.2.8 Aquaculture

In recent years, Taiwan's aquaculture industry has been increasingly affected by climate change, with frequent extreme high- and low-temperature events. The southwestern coastal region of Taiwan, a major hub for aquaculture, often experiences short-duration heavy rainfall events, leading to flooding in low-lying areas and abrupt changes in water quality. These conditions have caused mass mortality of farmed fish, reducing fishery yields and resulting in financial losses for farmers. The National Science and Technology Council's TCCIP team analyzed changes in extreme high- and low-temperature events under AR6 global warming scenarios (+1.5°C and +2°C). The results revealed that under a 2°C global warming scenario, low-temperature events in the coastal areas of Changhua decrease, reducing the risk of cold stress for milkfish. Conversely, high-temperature hazards and exposure risks continue to intensify, with clams facing increased high-temperature risks under the 2°C scenario, as illustrated in Figure 5.2.8-1.

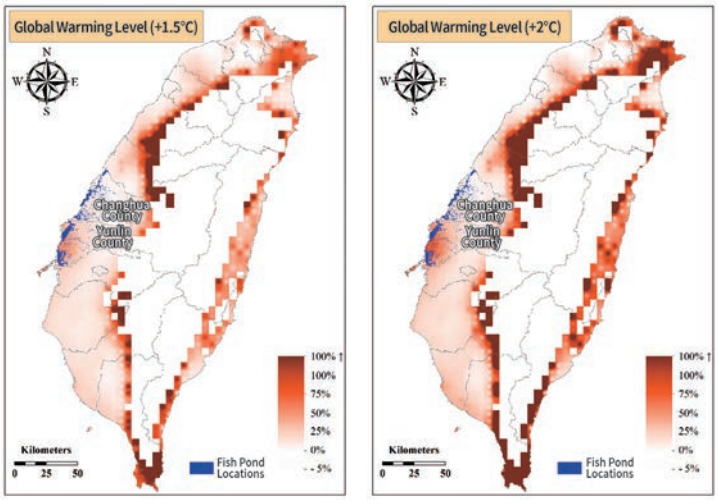

Figure 5.2.8-1. Changes in High-Temperature Hazard Rates for Clam Aquaculture under AR6 Global Warming Scenarios

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024*. 2024.

5.2.9 Marine Fisheries

The IPCC AR5 and AR6 reports both indicate that sea temperatures around Taiwan will inevitably be affected in the future, posing significant challenges to Taiwan's fishing industry. The Fisheries Research Institute (FRI) utilized historical catch records and sea temperature data to estimate changes in fishing grounds and habitats. The findings revealed that marine fisheries are noticeably impacted by rising sea temperatures, which will lead to the gradual migration of traditional fishing grounds and shifts in the seasonal patterns of migratory fish species, potentially destabilizing the marine fishing industry. For example, the traditional fishing season for swordtip squid (Uroteuthis edulis) takes place in the waters near Pengjia Islet, where the average sea temperature is 25°C. Using AR6 emission scenarios SSP1-2.6 and SSP2-4.5 provided by TCCIP, FRI conducted an analysis of swordtip squid catch data. Results demonstrated that for every 1°C increase in sea temperature, the logarithmic catch per unit effort (LnCPUE) of swordtip squid decreases by 15%. However, under the mitigation scenario (SSP1-2.6), habitat suitability for swordtip squid increases in areas near the Three Northern Islands and closer to 30°N latitude, as illustrated in Figure 5.2.9.

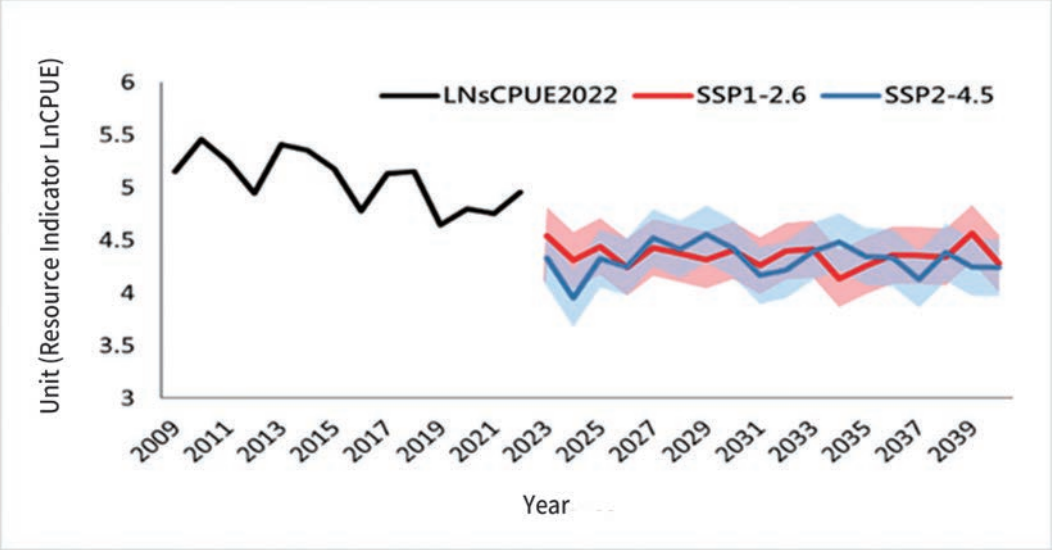

Figure 5.2.9. Projected Trend in Swordtip Squid Resources by 2040 under SSP1-2.6 and SSP2-4.5 Scenarios

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.* 2024.

5.2.10 Terrestrial Ecology

Climate change affects species growth rates and reproductive success, or drives populations—or parts of populations—to migrate to other areas in search of optimal habitats. Species or populations unable to relocate to more suitable habitats or swiftly evolve adaptive behaviors face the risk of extinction. Using RCP4.5 and RCP8.5 scenarios, scholars projected changes in suitable habitat areas and locations. The results indicated that by 2100, the suitable habitat area for certain forest types may decline to just 16.08% and 2.58% of their current extent, respectively. The suitable habitat altitude is projected to rise by approximately 173 meters under RCP4.5 and 268 meters under RCP8.5. Under these conditions, the suitable habitat altitude would approach the ridgelines of Taiwan's Central Mountain Range. These areas are characterized by limited growth potential due to narrow habitat areas, shallow soils, and strong winds, making it difficult for plants to establish roots and thrive. For tree species with adjacent or overlapping altitude distributions, climate change may shift the boundaries of their suitable habitat areas or increase the degree of overlap. In other words, high-altitude tree species may face intense competition for suitable habitat from low-altitude species in the future.

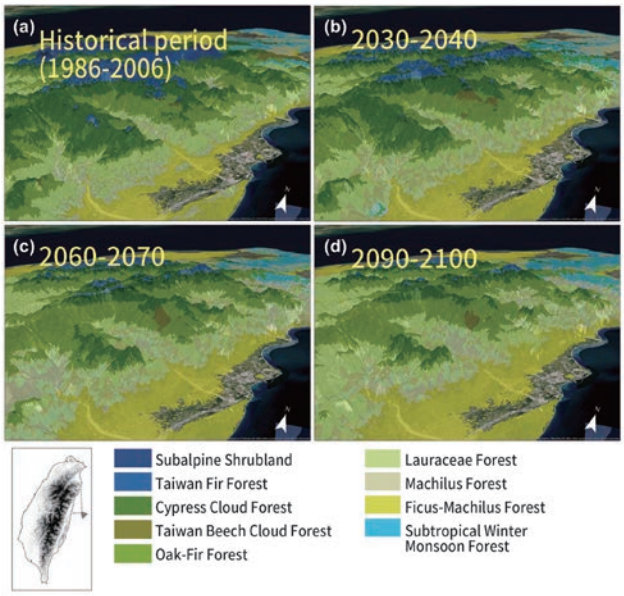

Figure 5.2.10. Distribution of Natural Forests in Taiwan under AR5 RCP4.5, and Projected Changes across Three Future Periods

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.* 2024.
Note: (a) Historical period from 1986 to 2006, (b) 2030 to 2040, (c) 2060 to 2070, and (d) 2090 to 2100. The figure illustrates how high-altitude forests are highly vulnerable to climate change, leading to a reduction in suitable habitat areas.

5.2.11 Marine Biodiversity

Although Taiwan's land area accounts for only 0.025% of the Earth's landmass, its surrounding waters are home to organisms from approximately 10% of the world's marine species. From 2012 onward, due to the influence of climate change, the Taiwan Strait has experienced an average sea surface temperature increase of about 0.63°C per decade. Ocean warming may drive adaptive changes in marine organisms. International research using the latest generation of Coupled Model Intercomparison Project (CMIP6) data has projected global marine ecosystem transitions from 2015 to 2099. Results indicate that under both strong-mitigation and high-emission warming scenarios, global marine biomass will decrease progressively after 2030. Under the high-carbon emission scenario, the magnitude and rate of biomass decline will become significantly more severe after 2060, as illustrated in Figure 5.2.11.

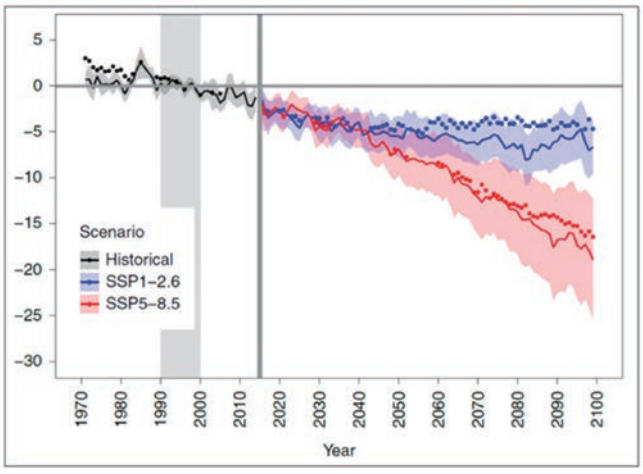

Figure 5.2.11. Projected Trend of Global Marine Biomass Changes (CMIP6)

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.* 2024.
Note: The blue sections represent the strong-mitigation scenario, whereas the red sections represent the high-emission scenario.

5.2.12 Health

Extreme weather events, such as floods and extreme temperatures, are major drivers of infectious diseases. Extreme temperatures may also increase the risk of respiratory and cardiovascular-related mortality. Between 2016 and 2020, Taiwan's average temperature increased by 0.11°C, while its average maximum temperature increased by 0.32°C. Rising temperatures, sudden drops, and abrupt temperature fluctuations can trigger acute conditions such as myocardial infarction or asthma in individuals with cardiovascular, respiratory, or chronic illnesses, and may even result in sudden death. In addition to directly or indirectly impacting physical health, climate change may also lead to psychological health issues, potentially inducing new acute, chronic, or long-term mental disorders. For people in Taiwan who are exposed to high or low-temperature environments, the risk of mental health issues such as major depressive disorder increases. In regions where the annual mean temperature exceeds the median of 23°C (as shown in Figure 5.2.12), every 1°C increase is associated with a 7% rise in the incidence of major depressive disorder. The impact is particularly pronounced among individuals aged 65 and older. For those aged 20 to 64, women are at higher risk.

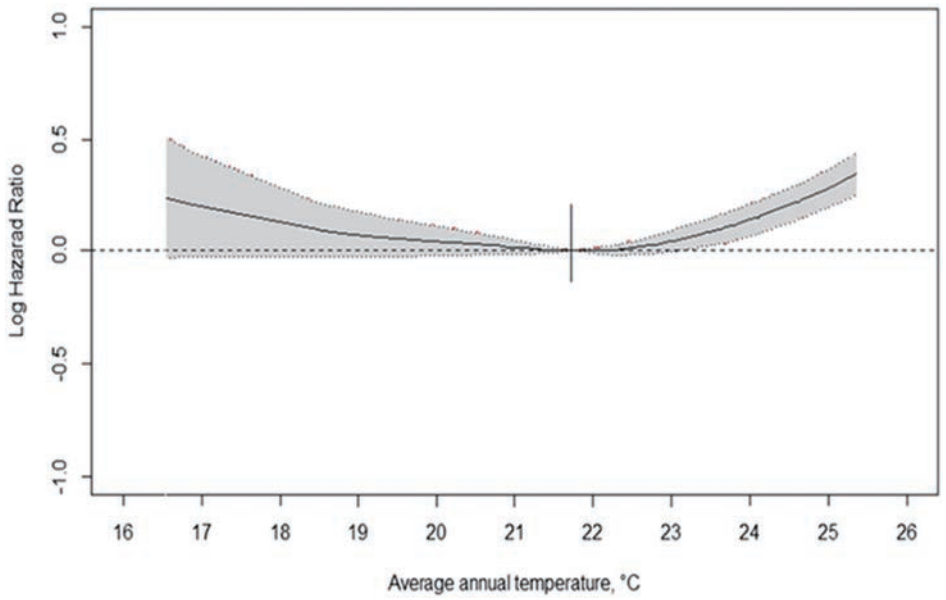

Figure 5.2.12. Long-Term Exposure to Extreme Temperature and Incidence of Major Depressive Disorder (Dose–Response Curve)

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.* 2024.
Note: The solid line represents the logarithmic risk ratio, and the gray shaded area indicates the 95% confidence interval.

5.2.13 Urban Heat Island

In the past, Taiwan's urban heat island intensity ranged from 2°C to 2.5°C. On June 29, 2020, Taipei City recorded a high temperature of 38.9°C, breaking the previous record for June. On July 24, 2020, Taipei recorded a further high of 39.7°C, which was the highest temperature in 124 years at the Taipei monitoring site. An analysis of temperature distribution in Taipei on that day revealed that the Wanhua, Zhongzheng, and Datong districts were the hottest zones. Observations of the urban heat island intensity and spatial extent in Taipei from July 2020 to 2023 indicate that central city temperatures continued to rise, with high-temperature zones expanding and extending toward the Taoyuan area. This expansion of the urban heat island's high-temperature center is a growing concern. Taiwan's urban heat island phenomenon is highly pronounced and continues to intensify with global warming; the physiological equivalent temperature also shows a year-on-year increase, as illustrated in Figure 5.2.13 (progressing from left to right). As outdoor thermal conditions in urban areas worsen, adapting to the impacts of the urban heat island has become a critical issue.

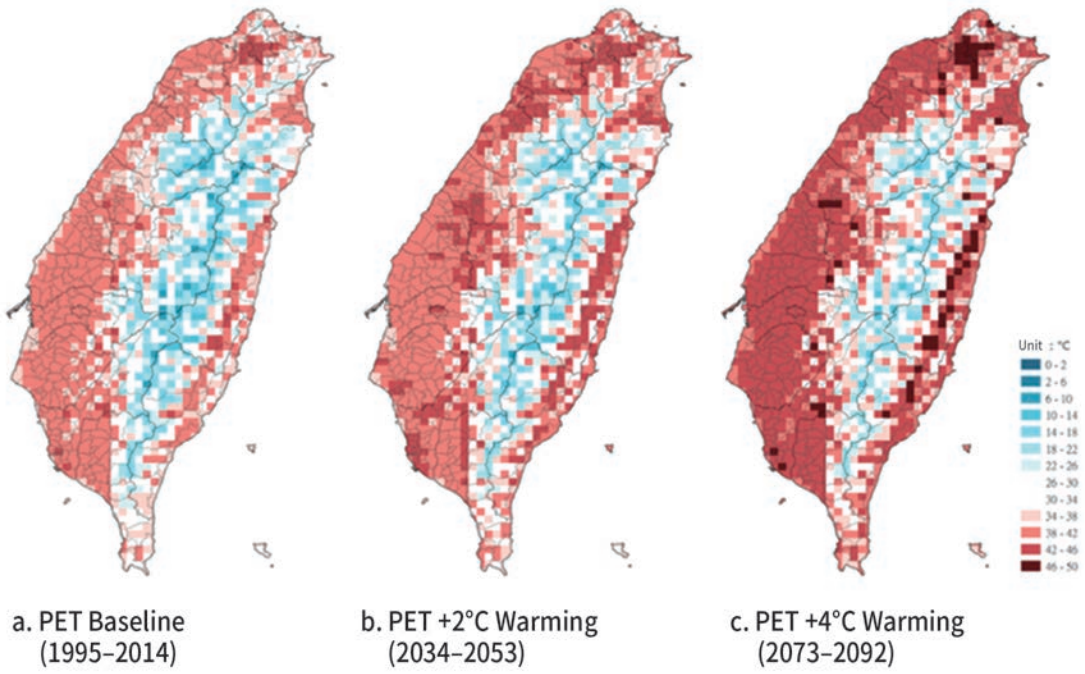

Figure 5.2.13. Distribution Map of Physiological Equivalent Temperature (PET) Across Taiwan

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024.* 2024.
Note: Images a, b, and c represent the baseline period, the RCP8.5 global warming scenario with a 2°C temperature rise, and the RCP8.5 scenario with a 4°C temperature rise, respectively. The Physiological Equivalent Temperature (PET) was estimated for 2:00 p.m. in July. The results show that highly developed urban areas exhibit significantly higher PET values than surrounding suburban areas, highlighting a pronounced urban heat island effect. Additionally, as the RCP8.5 global warming scenario progresses (from left to right), PET values demonstrate a clear upward trend over the years.

5.2.14 Urban and Rural Land Use

Urban and rural land use in Taiwan can be broadly categorized into three spatial types: urban areas, rural areas, and national conservation / marine resource areas. Adaptation measures for climate change vary according to these spatial categories. The National Climate Change Science Report 2024 consolidates recent research findings on climate change adaptation for different spatial types, focusing on three aspects: climate change impacts, vulnerability assessments, and adaptation strategies. These findings highlight future challenges and areas requiring effort, as illustrated in Figure 5.2.14. In Taiwan, the increasing proportion of impervious surfaces due to urban development and human activities exacerbates the risks and socioeconomic losses caused by flooding under the effects of climate change. The transportation system urgently needs to identify vulnerability hotspots impacted by climate change in order to plan adaptation strategies and measures for high-risk areas. The increasing frequency of summer heatwaves in Taiwan elevates the burden on the energy sector to ensure stable power supply during the summer. The energy sector must also accelerate efforts to address the pressing impacts on hydropower resulting from warming temperatures. Taiwan's water supply stability has historically been affected by hydrological conditions, environmental changes, land use, and economic development. Given the additional impacts of climate change, it is necessary to reassess current strategies for water resource management and land use planning.

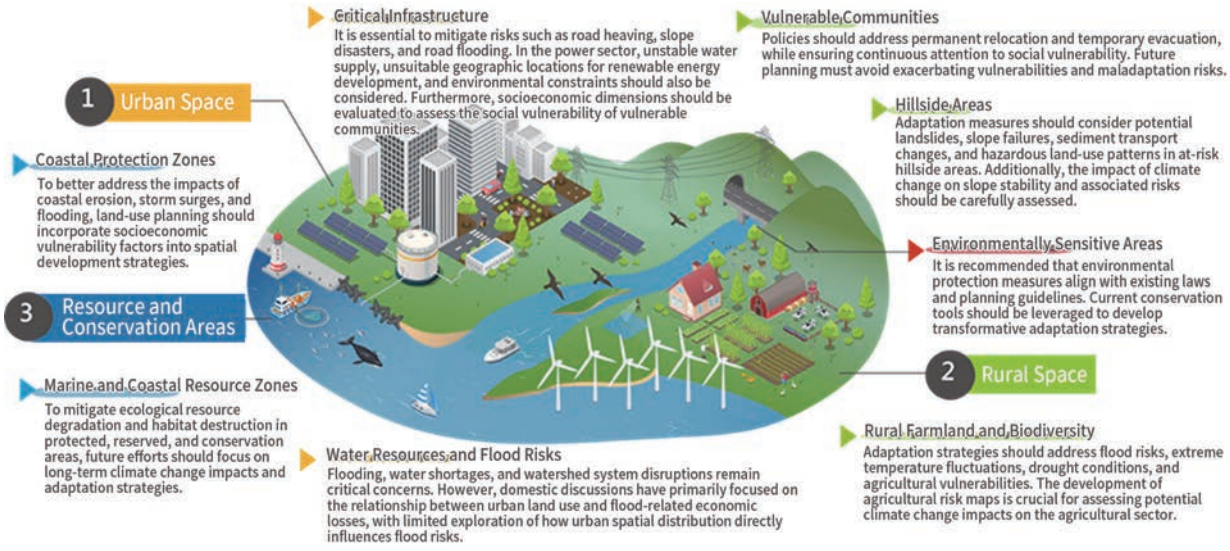

Figure 5.2.14. Impacts of Urban and Rural Land Use

Source: National Science and Technology Council and Ministry of Environment. *Climate Change in Taiwan: National Scientific Report 2024*. 2024.

5.3 Adaptation Measures and Achievements

To enhance national adaptation capabilities in response to climate change, following the passage of the *Climate Change Response Act* in 2023, the Ministry of Environment proposed an action framework to serve as the overarching structure for advancing adaptation initiatives in Taiwan. This includes revising land use-related regulations and promoting and reviewing the *National Climate Change Adaptation Action Plan.*

5.3.1 Evolution and Structure of the Adaptation Plan

Taiwan's adaptation strategy for climate change originated in 2009 with the establishment of a project team by the Executive Yuan's Council for Economic Planning and Development (now the National Development Council). This team included relevant government agencies, experts, and representatives from non-governmental organizations and industries. The team held project meetings, review sessions, regional forums, and a national climate change conference to gather diverse opinions and build consensus. On June 25, 2012, the Executive Yuan approved the *Adaptation Strategy to Climate Change in Taiwan*. Drawing from international practices while considering Taiwan's unique environmental characteristics and historical experiences, the framework identified eight key adaptation areas and laid out strategies for implementation and coordination. On May 22, 2014, the Executive Yuan approved the *National Climate Change Adaptation Action Plan (2013–2017)*, which was jointly promoted by various government agencies.

The *Greenhouse Gas Reduction and Management Act* was promulgated on July 1, 2015, mandating the development of a *National Climate Change Action Framework*. This framework reaffirmed the importance of the eight adaptation areas and proposed corresponding strategies to serve as guiding principles for Taiwan's adaptation policy.

On February 15, 2023, the *Greenhouse Gas Reduction and Management Act* was revised and renamed the *Climate Change Response Act*. Under the chapter on climate change adaptation within the Act, the Ministry of Environment, considering the results and issues identified in the implementation of the previous two action plans, collaborated with various government agencies to draft the *National Climate Change Adaptation Action Plan (2023–2026)*. The Action Plan focuses on the "capacity building" domain, encompassing seven major adaptation areas: critical infrastructure, water resources, land use, coasts and oceans, energy supply and industry, agricultural production and biodiversity, and health. Responsibilities for each area are clearly assigned to the relevant authorities (see Figure 5.3.1-1).

In accordance with Article 8 of the *Climate Change Response Act*, the National Council for Sustainable Development (NCSD) under the Executive Yuan shall coordinate, assign, or integrate cross-agency climate

change response policies and major national strategies. Article 8, Paragraph 2, Item 16 of the Act further stipulates that matters connected with climate change adaptation will be led by the Ministry of Environment and the National Development Council, and co-led by the central industry competent authorities. For issues requiring cross-departmental and cross-agency coordination, the National Development Council and the Ministry of Environment co-chair the project team for the action plan. This project team reviews adaptation-related issues, supervises key outcomes, and conducts rolling reviews to ensure effective implementation.

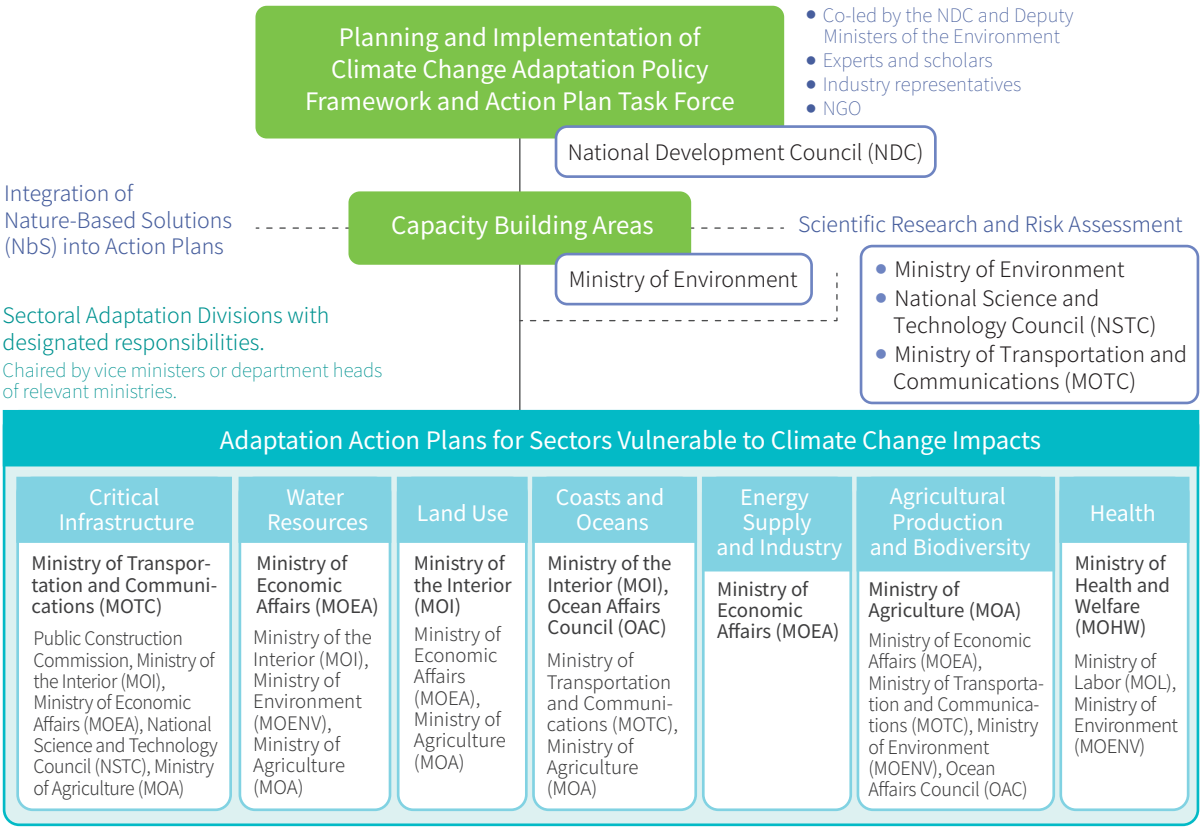

Figure 5.3.1-1. National Climate Change Adaptation Division of Responsibilities

Source: National *Climate Change Adaptation Action Plan (2023–2026)* (Officially Approved).

5.3.2 Achievements in Implementing the Adaptation Plan

Since May 2014, Taiwan has progressively revised its national adaptation plans. The National Climate Change Adaptation Action Plan (2023–2026) is the currently active plan, developed under Article 19 of the *Climate Change Response Act*. It mandates the formulation of 4-year sectoral adaptation action programs for areas vulnerable to climate change impacts, culminating in an integrated plan.

The vision of the National Climate Change Adaptation Action Plan (2023–2026) is to formulate strategies to respond to climate change, enhance adaptive capacity, strengthen resilience, and reduce vulnerability to climate change impacts, thereby ensuring national sustainable development. The objective is to apply the findings of scientific research and development in the formulation of adaptation strategies across all sectors, while enhancing climate actions that advance both adaptation and mitigation.

I. Achievements in Building Climate Change Adaptation Capacity

Capacity building is the foundation of climate change adaptation efforts. The National Climate Change Adaptation Action Plan (2023–2026) identifies eight strategic initiatives for capacity building as defined in the *Climate Change Response Act*. The implementation results as of 2024 are as follows:

1. Advancing Adaptation-Related Legal and Policy Transformations

With the enactment of the *Climate Change Response Act*, climate change adaptation efforts now have a legal foundation for administrative action. Given the broad scope of adaptation, all agencies are required to review and revise their respective regulations and policies to align with climate change adaptation needs. This serves as a universal guideline for agencies to implement adaptation measures. In accordance with Article 19 of the *Climate Change Response Act*, the National Climate Change Adaptation Action Plan (2023–2026) was reviewed and amended, with the standard operating procedures for public hearings completed. The plan was officially approved and implemented on October 4, 2023. Other related legal and regulatory revisions are outlined as follows:

(1) *Spatial Planning Act*

To address climate change, ensure national security, preserve natural environments and cultural assets, promote rational resource and industrial allocation, strengthen integrated land management, restore the nation's environmentally sensitive and damaged areas, and pursue national sustainable development, the government enacted the *Spatial Planning Act* on May 1, 2016. Key elements include establishing a spatial planning system, prioritizing spatial plans, delineating functional zones, implementing a usage permit system, promoting information transparency, fostering public participation and supervision, rehabilitating the nation's degraded lands, advancing environmentally sustainable development, protecting people's existing rights, and developing compensation and relief mechanisms.

In accordance with the provisions of the Act, on April 30, 2018, the Ministry of the Interior announced the National Spatial Plan as the top-level legal framework for land use planning in all of Taiwan's terrestrial and marine territories, setting a targeted, policy-based, overall strategy for special planning. By 2021, spatial plans for all municipalities and counties (or cities) had been announced and implemented, presenting concrete development and control strategies, emphasizing public participation and information transparency, and guiding rational land use through a multi-level spatial planning process.

(2) Coastal Zone Management Act

Taiwan is surrounded by the sea with a total coastline of approximately 1,566 kilometers and large coastal land areas. In recent years, rapid social, economic, and population growth has made coastal areas an indispensable part of national development. However, coastal land use involves comprehensive and irreversible impacts. To harmoniously preserve coastal resources while protecting, defending, and developing coastal areas, proper judgment and an integrated perspective are required.

The *Coastal Zone Management Act* was enacted in February 2015 to maintain natural systems, ensure zero loss of natural coasts, address climate change, prevent coastal disasters and environmental damage, conserve and restore coastal resources, drive integrated coastal management, and promote sustainable coastal development. The Integrated Coastal Zone Management Plan establishes guiding principles for comprehensive coastal land use, directing and integrating coastal zone management. It also specifies locations for coastal protection and coastal defense, as well as the planning authorities and deadlines. Subsequently, the Coastal Zone Protection Plan and Coastal Zone Defense Plan were enacted to actively protect natural resources and prevent disasters. The Act also guides review and approval mechanisms for coastal area development and construction, and further controls the exclusive use of near-shore waters and construction of artificial installations to ensure public access and public use.

(3) *Ocean Basic Act*

As a maritime nation, Taiwan enacted the *Ocean Basic Act* in 2019 to align with key international conventions and regulations related to oceans. This law establishes fundamental principles and directions for national ocean development, drawing from frameworks such as the United Nations Convention on Biological Diversity, the UNESCO Convention on the Protection of

Underwater Cultural Heritage, the United Nations Sustainable Development Goals, foreign legislation, Taiwan's National Oceans Policy Guidelines, and the Ocean Policy White Paper. Article 8 of the Act specifies that in response to climate change, "The government shall integrate and make good use of domestic resources, formulate marine pollution prevention and control measures, reduce pollution at its source, strengthen pollution prevention and control energy, effectively respond to climate change, prudently promote national spatial planning, strengthen marine disaster prevention, accelerate marine rehabilitation, and actively promote regional and international cooperation to protect the marine environment."

(4) *Wetland Conservation Act*

Taiwan announced the *Wetland Conservation Act* in July 2013, and the Act came into force in February 2015. The purpose of the Act is to ensure the natural flood retention functions of wetlands, maintain biodiversity, promote wetland ecological conservation and wise use, and achieve zero net loss of critical wetlands while strengthening interactions between wetlands and local communities.

The *Wetland Conservation Act* emphasizes "wise use" as its core principle. Recognizing that important wetlands are distributed across the country, the Act calls for conservation and utilization plans tailored to the unique characteristics of each wetland, ensuring effective management while respecting traditional local uses. The Act aims to strike a balance between the public interest, local development, and environmental conservation.

(5) *National Park Law*

The establishment of national parks in Taiwan aims to protect unique natural landscapes, wildlife, and historical sites while providing opportunities for recreation and research. National (natural) parks, with their extensive areas of natural vegetation, serve as critical carbon sinks and contribute to climate change mitigation. In response to global environmental changes, the Act promotes ecological restoration, environmental education, and ecotourism experiences. These initiatives help reduce the environmental impacts of recreational activities, raise public awareness of global warming, and encourage actions toward sustainable development.

(6) *Water Act*

The *Water Act* serves as the legal foundation for water administration and water resource development in Taiwan, ensuring the balance of water supply and demand. Due to climate change, the increasing frequency of extreme rainfall events, high urbanization, and extensive land development in the middle and upper reaches of river basins, flooding risks are being elevated. To address these challenges, the *Water Act* was amended in 2016 to include Article 84-1, providing a legal basis for imposing water conservation fees. The purpose of this amendment is to promote efficient use of water resources, encourage major water users to conserve water, and incentivize the adoption of recycled water and water-saving technologies. On June 20, 2018, the Act was further amended to include provisions on runoff sharing and discharge control, implementing policies to manage floodwaters through land-based runoff sharing and discharge control mechanisms. On February 19, 2019, a subsidiary regulation was promulgated, the Runoff Sharing Implementation Scope and Plan Approval and Execution Guidelines, retroactively effective as of February 1, 2019. In 2020, the Executive Yuan approved the Integrated Guidelines for Enhancing National Flood Resilience and Water Management, which aimed to improve flood resilience. The same year, amendments to the Geological Sensitive Area Investigation and Safety Evaluation Guidelines were introduced to further strengthen flood management and resilience. On January 6, 2023, under the authorization of Article 84-1, the Water Conservation Charge Collection Regulations were issued, specifying that water rates for public water utilities must account for costs related to water conservation and drought preparedness.

To accelerate runoff sharing efforts, nine runoff sharing projects in high flood-risk areas were prioritized in 2019. Additionally, from 2020 to 2024, the government plans to implement runoff sharing evaluations for 18

central government-managed river systems in four phases over 5 years. Starting in 2020, the runoff sharing initiative expanded to local governments, with subsidies provided for 16 runoff sharing evaluation projects.

(7) Agricultural Insurance Act

Statistics show that over the past 20 years, Taiwan has experienced annual agricultural losses of approximately NT$12.3 billion on average due to natural disasters. In light of the increasing severity of global warming and climate change, a dedicated law was deemed necessary to help farmers, foresters, fishers, and ranchers mitigate agricultural business risks through agricultural insurance measures. The Agricultural Insurance Act was implemented on January 1, 2021, introducing key measures such as subsidizing farmers' insurance premiums, establishing risk-sharing mechanisms, providing tax incentives for insurers, and assisting with damage assessments to safeguard farmers' incomes.

Under the authority of the Agricultural Insurance Act, the Ministry of Agriculture issued the Rice Income Insurance Implementation and Premium Subsidy Regulations on May 5, 2023, and the Sorghum Income Insurance Pilot Program and Premium Subsidy Regulations on April 21, 2022. These initiatives aim to promote the adoption of rice and sorghum income insurance.

(8) Climate Change Adaptation Principles

In accordance with the *National Climate Change Action Guidelines*, the principles of adaptation are as follows:

- Enhance intergenerational justice, environmental justice, and a just transition, while ensuring easy public access to pertinent climate change information. Consider nature-based solutions while also taking into account strategies that mutually benefit adaptation and mitigation efforts.
- Take mitigation and adaptation strategies into consideration while performing environmental impact assessments.
- Enhance capacities with regard to basic science, early warning, system monitoring, adaptive response to climate change, and resilience development.
- Establish a communication platform on which to build partnerships between central and local governments, as well as cooperation between the public and private sectors to practically execute localized adaptation and mitigation measures.
- Enhance resilience of infrastructure, including flood control, transport, communications, and information systems, to improve adaptability of facilities against climate change.
- Maintain a balance between water supply and demand, promote diversified water resource acquisition strategies as well as water conservation and water circulation habits, reasonably allocate water resources for different purposes, and strengthen water saving ability, so as to respond to the drastic increase in rainfall, and increased volatility of water levels during wet and dry seasons.
- Facilitate the rational allocation of land use. In light of the growing trend of extreme rainfall, lead both urban and rural areas to implement a range of adaptation strategies. Enhance water storage capacity, re-evaluate spatial planning and land use controls, and enhance the adaptation of natural ecosystems to bolster national land resilience.
- Prevent coastal hazards and ensure sustainability of marine resources. Establish appropriate prevention facilities or mechanisms, preserve marine resources and marine wildlife habitats, and strengthen monitoring and an early warning mechanism to respond to coastal hazards and impacts of coastal change.
- Improve adaptability of the energy supply system and industries. Proactively manage increased power demand during high-temperature periods. Enhance businesses' capabilities in risk management and opportunity exploration, with a focus on improving industrial climate risk management and the development of climate-resilient products and services. Build an environment that reduces climate risks and strengthens adaptive capacities.
- Secure agricultural production and ensure

biodiversity. Stabilize the foundation of ecological production and ecological resilience, enhance the agriculture sector's climate risk management capabilities and tighten regulations related to financial risks in the agricultural industry due to climate factors, and optimize the economic resilience of agricultural products.

- Reinforce the public health and epidemic prevention system. Enhance the capabilities of the public health, epidemic prevention, medical, and care systems for prevention, mitigation, preparedness, and recovery in response to extreme weather conditions, and enhance the capacity for health risk monitoring, impact assessment, and prevention.

2. Cultivating Green Finance Talent and Promoting Corporate Climate Risk Governance and Information Disclosure

To meet climate change adaptation needs, the government has continued to promote fiscal soundness and green finance initiatives to enhance financial capacity, ensure fair fiscal distribution, and effectively utilize public resources. With increasing international attention on corporate responsibilities for climate change adaptation, mandatory disclosure of climate-related information by businesses has become a growing trend. Taiwan is also advancing related policies.

To align with Taiwan's 2050 net-zero transition goal and encourage the financial sector to assist businesses in transitioning toward sustainability and carbon reduction, the Financial Supervisory Commission (FSC), in collaboration with the Ministry of Environment, Ministry of Economic Affairs, Ministry of Transportation and Communications, and Ministry of the Interior, issued the *Guidelines for the Determination of Sustainable Economic Activities* on December 8, 2022. The Guidelines encourage companies to voluntarily disclose how their primary economic activities align with sustainability criteria and urge financial institutions to incorporate the guidelines into their investment and financing assessments. The guidelines define sustainable economic activities as those making a substantial contribution to any environmental objective without causing significant harm to other environmental objectives or social safeguards. They establish technical screening criteria for activities that contribute to climate change mitigation and emphasize avoiding harm to other objectives, such as climate change adaptation and water resource conservation. The initial focus includes 16 general economic activities and 13 forward-looking activities, such as manufacturing, construction and real estate, transportation, and warehousing, which are key investment sectors for Taiwan's financial industry. In January 2025, the second edition of the *Guidelines for the Determination of Sustainable Economic Activities* was released, along with the *Recommended Elements for Transition Plans*. These documents expanded the scope of applicable sectors to include certain manufacturing industries, waste management and recycling, as well as agriculture and forestry. Additionally, the term "forward-looking activities" was changed to "supportive economic activities" and expanded to cover 14 categories, including renewable energy and hydrogen energy. The guidelines assess the sustainability of corporate economic activities based on three criteria and require that activities provide substantial environmental benefits without causing significant harm. Companies are classified into three categories based on their sustainability performance: Sustainable, Transitioning, and Noncompliant. Furthermore, the guidelines introduce methods for calculating the proportion of sustainable financing, sustainable investment, and sustainable financial products within the financial sector and encourage financial institutions to disclose relevant information as well as direct capital flow toward sustainable economic activities. At the same time, the *Recommended Elements for Transition Plans* assist enterprises in formulating comprehensive transition strategies to facilitate an orderly industrial transformation. The Elements also aim to foster collaboration between financial institutions and enterprises to jointly achieve net-zero transition and sustainable development goals.

The FSC has tasked the Taiwan Academy of Banking and Finance to organize various training programs on a continuous basis, including the International Syndicated Loans and Sustainable Lending Practices workshop, the Sustainable Finance and Risk Management workshop, the Training Sustainable Finance Talents course series, the 2024 ESG-focused Green Finance for Construction training course, and the Corporate Governance and Sustainable Operations workshop. Other initiatives include collaborations with the Bankers Association, international financial training institutions, and the Financial Net Zero Transition Platform to

host events such as the Advanced Course for Banking Professionals – Sustainable Finance, the International Course for Banking Professionals – Sustainable Financial Product Planning, Application, and Practical Use Workshop, the 2023 Green Finance Roundtable – Promoting Sustainable Finance that Incorporates National Net Zero Efforts, the Conference on Energy Saving and Carbon Reduction in the Financial Sector, and the 2023 Sustainable Finance Forum.

The FSC also oversees the Taipei Exchange in establishing a sustainable bond trading platform, directing market funds toward green and socially impactful investments. These include the Development of Renewable Energy and Energy Technology project and the Greenhouse Gas Reduction project. Since the issuance of Taiwan's first green bond in 2017, the domestic sustainable bond market has grown steadily. By June 2024, a total of 214 sustainable bonds had been issued, with a total value of NT$607.8 billion. These bonds encompass a range of products, including green bonds, social bonds, sustainability bonds, and sustainability-linked bonds (SLBs), demonstrating their critical role in funding sustainable development for both businesses and the government.

The FSC has also promoted the development of Taiwan's sustainable bond market in stages. On May 18, 2021, the Taipei Exchange launched a social bond trading platform, which was integrated into existing green and sustainability bond platforms to form a unified Sustainability Platform. Issuance of sustainable bonds has shown annual growth, with amounts reaching NT$62.4 billion in 2020, NT$105.83 billion in 2021, and NT$112.2 billion in 2022. Additionally, the government has encouraged the development of climate insurance, including 24 commercial agricultural insurance products and offshore wind farm insurance involving at least 13 participating insurance companies. To further incentivize innovation, the FSC has simplified the review process for customized long-term credit insurance products and encouraged the development of green insurance solutions.

3. Implementing Climate Change Research and Risk Assessment

Scientific research is the foundation for climate change risk assessments. The government continues to promote climate change research programs to provide the data, knowledge, tools, and risk assessment services needed for adaptation efforts, while maintaining active collaboration with relevant international organizations.

The National Science and Technology Council (NSTC) launched the third-generation Taiwan Climate Change Projection Information and Adaptation Knowledge Platform (TCCIP), integrating years of research findings for public and governmental reference. Additionally, the NSTC and the Ministry of Environment released *Climate Change in Taiwan: National Scientific Report 2024* on May 8, 2024, offering various climate projection data for agency use.

The National Environmental Research Academy, Ministry of Environment, developed CO_2, CH_2, and N_2O flux detection techniques applicable to agricultural greenhouse gas measurements. The Ministry of Agriculture has established agricultural meteorological stations to collect long-term data on climate change impacts on agriculture. Meanwhile, the Taiwan Biodiversity Research Institute assesses climate change impacts on Taiwan's ecological diversity.

The Energy Administration gathers climate-related geospatial data and maintains a climate adaptation platform for the Energy sector, providing tools to assess climate risks to energy infrastructure.

The Ministry of Culture has implemented micro-meteorological data collection for cultural heritage sites, and currently monitors 85 of Taiwan's 124 national heritage sites for outdoor environmental changes. Indoor temperature and humidity sensors are also being installed to collect data on indoor conditions. These findings are integrated into the Cultural Heritage Disaster Information Network and the Cultural Heritage Preservation Science Data Management Platform to guide restoration and maintenance efforts. Archaeological site monitoring systems also track and record topographical and geomorphological changes.

The Ministry of Health and Welfare enhanced its infectious disease reporting system by incorporating climate-related factors into its database for future research needs.

Considering national development goals, societal needs, and regional balanced development, Taiwan formulates science and technology policies and promotes research and development in these areas. According to the *Fundamental Science and Technology Act*, the National Science and Technology

Council (NSTC) is required to propose a National Science and Technology Development Plan every 4 years.

To enhance the nation's marine adaptation strategies and disaster response capabilities, the Ocean Affairs Council has established the National Ocean Data Bank and Sharing System. This platform integrates comprehensive and real-time hydrological, ecological, and territorial monitoring data from across Taiwan's marine areas. It facilitates foundational and long-term research, providing scientific data and technical support for the development of smart aquaculture, green energy, marine adaptation strategies, and national security. These efforts aim to strengthen disaster response capabilities and address the increasing challenges posed by climate change.

From technology development to implementation, the Industrial Development Administration, Ministry of Economic Affairs collaborates with academia, government, and industry to research and develop innovative waste management technologies. It has created various Best Available Control Technologies and established management systems and standards to incorporate waste into the circular economy, thereby improving resource efficiency.

The Water Resources Agency (WRA), Ministry of Economic Affairs, promotes the research of early warning systems for floods and droughts. It adopted the European Centre for Medium-range Weather Forecasts (ECMWF) Integrated Forecasting System, then performed bias correction and downscaling with the help of statistical post-processing technology to optimize its forecasts of short-, medium-, and long-term rainfall in reservoir catchment areas. Next, it integrated the rainfall forecasts into hydrological models to develop extended and long-term flow prediction technology, which provided inflow forecasts for key reservoirs and weirs throughout Taiwan. These data serve as a reference for estimating reservoirs' future water storage capacity and assessing the nation's water supply.

Additionally, the WRA, has proactively implemented smart monitoring and management systems to mitigate the impact of future climate disasters on water resources. To prevent environmental disasters caused by excessive groundwater extraction and to support the planning of integrated surface and groundwater management, the WRA has gradually developed a real-time automated groundwater usage monitoring and management system. This initiative also aims to address the risks of land loss due to rising sea levels. Moreover, to reduce water losses from leaks, the WRA has implemented smart monitoring systems for water supply networks at national universities. By integrating big data analytics, these systems optimize water pressure distribution across pipelines in real-time. This proactive approach addresses the risks associated with increased drought frequency and ensures stable water supply in the future.

In 2023, the Ministry of the Interior launched a 3-year National Park Carbon Management Program, which focuses on forest carbon inventory methodologies and three key aspects of carbon management in national parks: forests, organizational management, and low-carbon tourism. Through workshops, the program aims to enhance the carbon inventory skills of national park staff. Additionally, since 2011, the Ministry has supported commissioned research on wetland carbon sinks, and it implemented wetland carbon sink survey projects from 2017 to 2019 and again from 2023 to 2024. These efforts identified emission coefficients for 12 types of wetlands and strengthened the foundation for natural carbon sink strategies.

The Ministry of Agriculture and the Ministry of Culture have established agricultural meteorological stations and cultural heritage meteorological stations, respectively, to collect long-term data on the impacts of climate change on agriculture and cultural heritage. Additionally, the Taiwan Biodiversity Research Institute is responsible for assessing the effects of climate change on Taiwan's ecological diversity.

4. Strengthening Climate Change Public Education, Talent Development, and Civic Awareness

The government continues to promote the dissemination of adaptation related knowledge and its integration into everyday life. Starting with school education and expanding to the general public, government initiatives aim to make adaptation knowledge accessible and intuitive, encourage behavioral changes, and foster a collective consensus to address climate change.

The Ministry of Education has included Environmental Education as one of the 19 key issues in the Curriculum Guidelines of 12-Year Basic Education, with Climate Change as a thematic

focus under this topic. The Ministry also funds universities and colleges to conduct climate change teaching activities, organizes interdisciplinary and interuniversity industry–government–academia exchanges, and hosts living lab courses and climate change camps for high school students, thereby embedding and expanding climate change adaptation education. The National Science and Technology Museum's planning team also launched a Climate Change Special Exhibition to promote public science education.

The Ministry of Environment promotes public climate action by organizing professional talks such as Climate Change: Zero-Carbon Game and the Taiwan Climate Action Exposition. It has conducted segmented surveys to assess public awareness of climate literacy and is developing a long-term climate change literacy database. This initiative focuses on the long-term and segmented needs of the database's structure and query system while fostering knowledge exchange and visual communication. Additionally, the Ministry is promoting rain gardens and will conduct educational training at pilot sites in 2024. Meanwhile, the National Science and Technology Museum's project team is advancing science education through its Climate Change Special Exhibition.

Government agencies conduct promotional and educational training activities based on their respective operational needs. For example, the Industrial Development Administration, Ministry of Economic Affairs holds Climate Change Adaptation Promotion Seminars for the Manufacturing Industry to enhance climate adaptation awareness among the industry. The Ministry of Health and Welfare developed educational tools for download and provided training for environmentally friendly hospitals. It has also developed communication channels for sharing information on climate-related injuries and mechanisms for monitoring medical visits, using heat-related injuries as an example. The Forestry and Nature Conservation Agency has worked to establish foundational knowledge of Nature-Based Solutions (NbS) among its organizing and implementing personnel. It has compiled and organized relevant domestic and international theories and case studies and conducted co-learning workshops and exchange forums. These efforts aim to familiarize central government agencies with the concept and practical application of NbS. Taiwan International Ports Corp., Ltd. received environmental education site certifications from the Ministry of Environment for Taichung Port in 2022 and Keelung Port in 2023. These certifications were supported by educational programs designed to enhance public engagement in creating sustainable environments. Efforts are currently underway to achieve similar certifications for Kaohsiung Port and Hualien Port.

5. Promoting Emerging Climate Change Industries and Adaptation-Derived Products and Opportunities

To ensure the sustainability of climate change adaptation efforts, establishing business models and markets is a critical task. In alignment with national development goals, the government continues to enhance supporting measures and promote climate services.

The Taiwan Climate Change Projection Information and Adaptation Knowledge Platform (TCCIP) produces climate data for academic, research, and industrial applications, offering value-added services for corporate climate risk assessments, environmental sustainability reporting, and climate-related financial disclosures. Several schools and organizations have utilized the platform's data for research on green energy, green finance, and climate services. To date, the platform has provided 47 climate data services supporting emerging climate industries.

The Ministry of Economic Affairs has initiated the Smart Water Management Industry Innovative Technology Development Project, which leverages IoT technology to create detection systems for reservoirs, groundwater, and irrigation networks, thereby forming an integrated smart water resource monitoring system. The plan encourages businesses to integrate upstream, midstream, and downstream industrial chains and foster opportunities for comprehensive service solutions. The Smart Water Management Technology Development initiative guides the industry in developing critical technologies for diverse water-related applications. It also improves training for underwater reservoir operations, enhances safety inspections of reservoir facilities and hydraulic equipment, and boosts agricultural water management efficiency. These efforts strengthen the foundation for industrial sustainability and unite Taiwan's water industry players in creating innovative solutions for water-related challenges.

The Ministry of Agriculture is advancing the Facility-Based Agriculture Program, assisting

farmers in constructing reinforced greenhouses and net houses. These facilities enhance resilience to climate-related disasters, reduce pest infestations, lower pesticide use, and improve agricultural robustness. The program also promotes the integration of automated agricultural facilities to drive the transition toward precision agriculture.

The Ministry of Transportation and Communications is implementing the Marine Environment Disaster Prevention Service System Plan, which includes a series of marine hazard early warning technologies. In the future, the Ministry expects to collaborate with marine engineering industries to establish disaster prevention mechanisms for offshore operations.

The Ministry of the Interior has launched a pilot program for recycling treated water from public wastewater treatment plants. Several plants now produce reclaimed water daily, supplying it to the Linhai Industrial Park and the Tainan Science Park. This initiative serves as a reference for expanding future water reclamation projects.

6. Enhancing Regional Adaptation Capacity

Climate change adaptation involves diverse and interconnected aspects, requiring cross-sector, cross-level, and cross-agency collaboration. A cross-ministerial platform is essential to continuously advance interdisciplinary and interregional adaptation efforts and leverage Nature-Based Solutions (NbS) to address climate challenges.

The Taiwan Climate Change Projection Information and Adaptation Knowledge Platform (TCCIP) offers crucial support for interagency cooperation. It provides foundational data for regional-scale climate change research, including grid observation data and climate projections using statistical and dynamical downscaling at the county and city levels.

The Bureau of Cultural Heritage, Ministry of Culture, has commissioned professional teams to establish specialized service centers for designated national monuments. These centers provide individualized guidance, assisting property owners and managers with disaster risk assessments, prevention, training, and drills. Additionally, they support local governments in establishing county-level professional centers to collaboratively safeguard cultural heritage.

The Ministry of Agriculture has implemented agricultural disaster mitigation measures in six high-risk regions. Since 2014, it has collaborated in the Ministry of Economic Affairs' flood control projects to improve drainage infrastructure in aquaculture areas, with the goal of enhancing water retention and flood control capacity to reduce aquaculture losses during flood seasons. The Forestry and Nature Conservation Agency has strengthened foundational knowledge of NbS by compiling international and domestic definitions, guidelines, tools, case studies, and restrictions. It has organized promotional exchange forums to collect information on interagency operations and NbS application needs. It also released an NbS co-learning camp activity manual and organized co-learning camps for central government agencies to establish familiarity with NbS concepts and highlight their practical applications.

In response to extreme climate, the Water Resources Agency has developed resilience enhancement strategies to assist local governments in responding to water-related disasters and improve disaster awareness and preparedness. The Taiwan Centers for Disease Control has established mosquito surveillance mechanisms in various regions to monitor the distribution of dengue vector mosquitos under different climate conditions. This system provides early warnings to the public and supports disease control efforts. Additionally, the Ministry of Agriculture has strengthened disaster mitigation measures in six high-risk regions and enhanced flood and wastewater drainage capacity in coastal aquaculture areas.

7. Promoting Localized and Community-Based Climate Adaptation

By enhancing communication and collaboration mechanisms between local governments and central agencies, Taiwan integrates adaptation policies and emphasizes localization. Local climate change adaptation builds upon central regulations and incorporates local needs, extending beyond municipalities to townships and communities. This process highlights local participation and fosters collaboration among local governments, non-profit organizations, private entities, and community groups to develop stakeholder engagement models that are tailored to local requirements.

At the municipal level, the Taiwan Climate Change Projection Information and Adaptation Knowledge Platform (TCCIP) supports three localized projects with climate change data, including gridded observational and statistical downscaling

data. Through the ARK website, TCCIP provides municipalities with impact assessment mapping services, consolidates domain-specific geospatial data, and shares adaptation practices, tools, and case studies from Taiwan and abroad. Meanwhile, the Ministry of Culture leverages localized cultural heritage characteristics and microclimate monitoring data to guide local governments in conducting regular inspections of cultural relics. It supported five disaster management and maintenance plans for cultural relics, conducted one disaster scenario simulation and emergency drill, and enhanced the disaster response capabilities of custodians to mitigate disaster risks.

At the community level, adaptation measures are being implemented locally. For example, the Ministry of Environment's Low-Carbon and Sustainable Homeland Promotion Plan encourages communities to adopt practices such as ecological greening, green transportation, resource recycling, carbon reduction, and energy-efficient initiatives. To date, 1,169 low-carbon and sustainable community certifications have been issued. Additionally, the Ministry has established 14 Multi-functional Smart Rain Gardens across seven municipalities (Taoyuan, Hsinchu City, Hsinchu County, Taichung, Chiayi City, Tainan, and Kaohsiung) to create water-retentive and cooling community landscapes using softscape designs.

The Ministry of Health and Welfare publicly shares data on heat-related emergencies requiring medical attention through its Real-time Outbreak and Disease Surveillance (RODS) system on the government's open data platform. The Health Promotion Administration website hosts a heat injury prevention section offering brochures, quick guides, prevention manuals, and flyers. Annually, the Ministry sends an official letter to central agencies, local governments, health bureaus, and hospitals to assist in promoting heat injury prevention and improving public self-protection awareness.

The Ministry of Agriculture is engaged in spatial planning of agricultural land resources with consideration for the effects of climate change. Based on vulnerability assessments of farmland, it develops localized agricultural spatial development plans to meet future adaptation needs. Through workshops, the Ministry has promoted the development and application of agricultural risk mapping processes. Preliminary results have been achieved in Taichung City and Chiayi County.

8. Strengthening Adaptation Capacity for Vulnerable Groups

Subparagraph 8, Article 17 of the *Climate Change Response Act* stipulates that the government must promote adaptation capacity building to "Strengthen the capacity of vulnerable groups to respond to climate change." This provision aims to analyze vulnerable groups at risk of climate change impacts and implement measures to strengthen their adaptive capacity.

Preliminary studies assessed potential risks from air pollution, health hazards, high temperatures, and environmental sanitation across Taiwan's 19 counties and cities. Researchers compiled data on geographic, socioeconomic, and long-term climate change trends as well as frequency of hazardous events, then conducted principal component analysis of variables such as hazard severity, exposure, sensitivity, and adaptive capacity to develop a social vulnerability assessment index. Corresponding distribution maps were also created.

The Ministry of Labor has established the mobile information Network for Heat Stress Prevention in High Temperature Outdoor Operations, which connects to data from the Central Weather Administration, Ministry of Transportation and Communications. This platform allows businesses to check the heat index for specific regions and access related management measures, heat illness response guidelines, and information on nearby medical facilities. To enhance outdoor workers' knowledge of heat hazard prevention, the platform also features notifications of heat hazard risk levels and recommendations for preventive actions. Based on weather updates from the Central Weather Administration, the Ministry of Health and Welfare issues timely press releases to remind the general public and vulnerable populations (e.g., the elderly, infants and young children, outdoor workers, individuals with chronic illnesses, and those with obesity) to take precautions against heat and cold injuries. For disadvantaged individuals, such as the homeless, the Ministry provides enhanced care services through dedicated projects.

II. Implementation Outcomes of Priority Adaptation Action Plans for Various Sectors

The action plans encompass 126 adaptation action plans across 7 major sectors, including 68 priority adaptation action plans. The implementation

outcomes are as follows:

1. Critical Infrastructure

The primary goal of the critical infrastructure sector is to enhance comprehensive risk assessment capabilities and strengthen the adaptation capacity of public works and transportation systems.

For transportation systems, the Ministry of Transportation and Communications has conducted analyses and evaluations for high-risk transportation facilities and implemented the Provincial Highway Improvement Project, which includes disaster prevention and mitigation improvements; the Zengwenxi Bridge Construction Project on the West Coast Expressway; the Taiwan Line 7 Yingshi Bridge (left and right) and Taiwan Line 7A Dunhou Bridge, Bishui Bridge, Zeqian Bridge (left) Reconstruction Feasibility Assessment; slope safety maintenance commissioned service work on Taiwan Line 7 (85k+500 – 102k+000) and under Taiwan Line 7 (0k – 10k); risk assessment and protection design for scoured cross-river bridges along the HSR; update and upgrade of slope safety monitoring systems; climate risk assessment for the HSR extension to Pingtung; reinforcement of protections for tunnel entrances and steep vegetated slopes along the HSR Line; climate adaptation capacity promotion plans for airports under the Civil Aviation Administration; and climate adaptation operations for the Taoyuan Airport zone in line with ISO climate adaptation guidelines. The Ministry has also enacted guidelines for enhancing the climate adaptation capacity of the railway systems. For public works, the Public Construction Commission has promoted the National Public Construction Inspection Task Force, which assists in the review of flood prevention and preparedness operations.

2. Water Resources

The main objectives in the water resources sector include ensuring a stable water supply, enhancing supply resilience, and improving the water supply environment. This sector has 15 priority adaptation action plans.

To enhance climate adaptation capacity and stabilize the water supply for various uses, from 2017 onward, the Water Resources Agency, Ministry of Economic Affairs, has implemented strategies focused on resource development, conservation, allocation, backup, and management. These include developing diverse water sources such as the Wuxi-Niaozuitan Artificial Lake, reclaimed water, subsurface flows, and seawater desalination plants in Tainan and Hsinchu, ensuring water supply security across regions. Additionally, advanced water-making technologies have been adopted to create water sources unaffected by rainfall, thus diversifying and stabilizing the supply. Efforts have been directed toward developing the Western Corridor Water Supply Network (the "Pearl Necklace Project"), which involves connecting pipelines such as the Zengwen–Nanhua Interconnection Pipeline, the Daan–Dajia River Interconnection Pipeline, and the Shimen Reservoir-Hsinchu County Interconnection Pipeline, along with backup and transfer pipelines. The project aims to strengthen interregional allocation capabilities for more flexible water resource utilization. To improve the water supply environment, measures such as watershed management, groundwater conservation, land subsidence prevention, smart water management, and water conservation have been implemented. These efforts have alleviated the burden on resource development and enhanced demand management—since their implementation, daily water supply increased by 2.21 million cubic meters, equivalent to 20% of the nation's total water usage. To continuously promote integrated basin management. The Water Resource Agency holistically considers upstream, midstream, and downstream regions and collaborates with other ministries to strengthen soil and water conservation and afforestation in reservoir watersheds, based on local conditions. These measures have restored 17.94 million cubic meters of reservoir capacity, supplying 508,000 cubic meters of water per day to central and southern Taiwan as of the end of 2022. Regarding advanced water-making technologies, the Ministry of Economic Affairs has approved a total of 11 water reclamation plants and expanded the mandate for industrial use of recycled and reclaimed water. When the plants are fully operational, they are expected to supply 289,000 cubic meters daily. The Reclaimed Water Resources Development Act has also been amended to expand the mandatory use of reclaimed water beyond specific areas. Moreover, in accordance with Article 84-1 of the *Water Act*, the Regulations on the Water Conservation Charge were enacted on February 1, 2023. Finally, rainwater harvesting has been promoted nationwide by assisting institutions, schools, and scenic areas that have the potential for rainwater utilization in installing collection systems. These systems comprise a rainwater collection area spanning 300,000 square meters and provide irrigation water for over 296,000

square meters of land as well as toilet flushing water for approximately 64,000 people daily.

3. Land Use

The primary objectives in the land use sector are to reduce climate change impacts, promote rational national land use, and implement six key strategies. This sector has 13 priority adaptation action plans.

As of the end of 2022, the land use sector had recorded several achievements. Spatial planning efforts focused on comprehensive reviews for 497 approved urban plans, as required by the Regulations Governing Comprehensive Periodic Reviews of Urban Planning. These reviews emphasized avoiding intensive development in disaster-prone areas, low-impact urban design and development guidelines, and multipurpose use of public facilities. Additionally, the Ministry conducted continuous inspection and improvement of storm drains, completing 57.2 km of upgrades and increasing urban flood detention capacity by 935,000 cubic meters. In terms of land use regulation, integrated watershed governance enhanced flood protection along central, county, and city-managed rivers and regional drainage systems, increasing protective coverage by 111.86 square kilometers in these areas and improving approximately 135.71 km of levees, embankments, and drainage systems. Efforts to develop the water environment included creating 381.62 hectares of water-friendly spaces. Moreover, conservation and utilization plans for 38 important wetlands were approved, and reevaluations were announced for 37 provisional local-level wetlands to bolster the conservation of wetland flora, fauna, and water resource systems. To build a robust adaptation foundation, the National Land Management Agency (formerly the Construction and Planning Agency) developed a National Park Biodiversity Geographic Information System, amassing over 755,000 biological resource records and producing GIS-based distribution maps for more than 11,000 species in Taiwan's national parks.

The land use sector encompasses national spatial planning, land use regulation, and development activities aimed at mitigating climate change impacts and optimizing land use allocation. Strategies address extreme rainfall and rising temperatures through actions such as master plan guidance from the National Spatial Plan, urban land use controls, national park conservation, wetland and water environment development, and agricultural land resource allocation.

The 2023–2026 adaptation plan for the land-use sector outlines 17 measures across the three major dimensions of risk identification, adaptation actions, and capacity building. Risk identification efforts include incorporating climate change risk analyses into the National Spatial Plan by the National Land Management Agency and research of agricultural resource spatial strategies by the Ministry of Agriculture. Adaptation actions focus on flood, drought, and heat impacts, with the National Land Management Agency reviewing storm drain systems in flood-prone and aging urban areas to enhance urban flood protection standards and integrate comprehensive water management strategies. As for capacity building, the Architecture and Building Research Institute is researching smart monitoring systems for urban wind corridors, buildings, and community rainwater detention facilities, while the National Park Service carries out educational outreach in national parks and wetlands to promote conservation awareness.

4. Coasts and Oceans

The coastal and marine sector focuses on promoting monitoring, early warning, and assessment mechanisms for marine resources. Its three major strategic actions are: enhancing coastal adaptation capacity, strengthening monitoring and early warning mechanisms, and reinforcing marine environment monitoring and biodiversity conservation.

Achievements in the coastal and marine sector as of the end of 2022 are as follows. Regarding the enhancement of coastal adaptation capacity, the National Land Management Agency (formerly the Construction and Planning Agency) reviewed and approved the first-class and second-class coastal protection plans stipulated in the Coastal Zone Management Act to safeguard coastal settlements, guide land use, reduce disaster risks, and implement coastal management. Additionally, the Water Resources Agency and the Ocean Affairs Council collected and analyzed data on the impacts of climate change on water resources and industries, and they established assessment data to develop effective early warning and response measures for spatial changes in Taiwan's maritime areas. By strengthening monitoring and early warning mechanisms, the Ministry of the Interior continued to

enhance the Marine Disaster Prevention Information Service Platform. This included installing abnormal wave monitoring stations, developing intelligent marine meteorological information, increasing disaster prevention information products, advancing smart routing information service technology, improving coastal and marine environment change monitoring technologies, and establishing national geographic information on coastal disaster risk potential. The Ocean Conservation Administration, Ocean Affairs Council, conducted marine environment conservation and investigation, monitoring 105 marine areas nationwide and strengthening monitoring at 20 water quality monitoring sites. These monitoring data were analyzed and compared against marine environment quality standards to study the impacts of climate change on marine environments, aiming to improve disaster response and early warning capabilities. Furthermore, the Administration conducted ecological and biodiversity investigations in Taiwan's coastal and nearshore areas, completing surveys at 24 marine flora and fauna conservation zones, documenting indicator fish species and biomass as a foundation for future climate change adaptation policy development.

Regarding coastal adaptation capacity, the Water Resources Agency, Ministry of Economic Affairs, and the Ministry of the Interior are currently promoting resilient disaster prevention and climate change water environment risk assessment research. This includes conducting baseline surveys on coastal resilience and implementing coastal protection plans for the overall planning of coastal land use to reduce disaster risks and safeguard coastal settlements. Strengthening of monitoring and early warning mechanisms is executed by the Central Weather Administration, Ministry of Transportation and Communications; the Administration is working to establish the Marine Disaster Prevention Information Service Platform to provide enhanced disaster prevention and early warning services for fisheries, shipping, and disaster prevention sectors. The Ocean Affairs Council conducts marine environmental conservation and investigation through quarterly coastal water quality surveys, long-term data collection, and related investigations into Taiwan's coastal and nearshore ecosystems and biodiversity. Surveys have mapped 7 salt marshes, 33 mangrove forests, 22 seagrass beds, 36 mudflat ecosystems, and 521 artificial coastal sites on Taiwan's main island, as well as seven monitoring stations for Taoyuan's algal reefs and marine conservation wildlife population surveys. Additionally, the National Academy of Marine Research, Ocean Affairs Council, conducts long-term and systematic baseline surveys of Taiwan's maritime areas from the sea surface to the seabed, increasing the spatial coverage of marine observations. Through comprehensive investigations, it monitors essential marine scientific parameters. It has constructed ten hydrological real-time observation stations, completed five topographic surveys in northeastern Taiwan, established 105 sites for environmental DNA display as well as a search platform, and conducted marine biological resource surveys across six stations in northern Taiwan's waters. This marine research data has been integrated to create a long-term marine observation network: the National Ocean Database and Sharing System (NODASS), which contains 200TB of data. This platform enhances diverse applications of marine big data and strengthens national marine research capabilities to address variations in ocean characteristics caused by global climate change and improve monitoring and early warning of coastal disasters and oceanic changes. It also establishes multiple stability mechanisms for socio-ecological systems, which increase coastal settlements' adaptive capacity to cope with the impacts of environmental change.

5. Energy Supply and Industry

The energy supply and industry sector has three main goals: enhancing climate risk identification capabilities and promoting adaptation strategies in the energy and industry sector, improving climate risk management in the manufacturing sector, and raising climate risk awareness and opportunity identification capabilities for small and medium-sized enterprises. This sector has three priority adaptation action plans.

To enhance climate risk identification capabilities and promote adaptation strategies in the energy industry, the Energy Administration updates and expands climate mapping annually. For climate impacts such as flooding, strong winds, and slope-related disasters, it developed risk assessment methods applicable to the energy sector and formulated reference guidelines. It also upgraded the ECCA platform to provide one-stop services, including geographical data, methodological tools, guidelines and manuals, and adaptation knowledge, supporting

the establishment of adaptation management systems in the energy industry. These initiatives help the sector assess climate change risks to energy facilities. As of 2024, the Administration has assisted a total of 61 energy facilities in completing risk assessments, including power plants (thermal, hydroelectric, wind, and photovoltaic), distribution and transmission systems, oil supply centers, gas supply centers, refineries, and liquified natural gas plants. Moreover, 31 training sessions have been conducted to develop adaptation professionals for the energy industry, with a cumulative total of 1,194 participants trained.

To improve climate risk management in the manufacturing sector and raise climate risk awareness and opportunity identification capabilities among small and medium-sized enterprises, the Industrial Development Administration, Ministry of Economic Affairs, promoted specialized corporate guidance projects, consulting services, and industry efficiency improvement programs. Using standards such as the Task Force on Climate-related Financial Disclosures (TCFD) Framework, the Administration developed climate change adaptation management procedures to assist companies with in-depth guidance, problem diagnosis, and the evaluation of transitional and physical risks. To address future water resource pressures from climate change, the Administration also helped companies adopt water resource recycling and reuse measures, thus improving water use efficiency.

The Small and Medium Enterprise and Startup Administration, Ministry of Economic Affairs, conducted climate change adaptation promotion and education initiatives for small and medium-sized enterprises to help them understand trends and risks. The Administration also compiled the Climate Change Adaptation Guidelines for the Manufacturing Sector, the Climate Change and TCFD Case Handbook for the Manufacturing Sector, and climate change adaptation educational films to strengthen enterprises' adaptation capacities. The Administration assisted small and medium-sized enterprises in establishing water resource recycling and reuse measures to address future climate change-induced water stress. Additionally, it conducted advocacy and education on climate change adaptation capacity of small and medium-sized enterprises to help companies understand related trends and risks. Moreover, the Administration held eight seminars on Climate Change Mitigation and Adaptation, which drew more than 3,000 participants.

To support enterprises in assessing future risks, the Energy Administration developed the Climate Change Risk Assessment Guidelines for the Energy Sector to guide energy companies in conducting flood and strong wind risk assessments. It prioritized state-owned enterprises, providing guidance to 33 companies. Furthermore, the Industrial Development Administration created Adaptation Guidance Tools to assist manufacturing companies in evaluating climate-related risks. To date, 12 companies representing the steel, cement, textiles, chemicals, paper, electronics, machinery, and metal products industries have received guidance. Finally, to practically promote adaptation efforts, the Energy Administration developed the Climate Change Adaptation Strategy Planning Guidelines for the Energy Sector. These guidelines have assisted four energy companies in prioritizing and executing adaptation work for high-risk facilities. The Industrial Development Administration also supported two companies from the electronics industry in conducting adaptation and TCFD demonstration projects, which encouraged the industry to implement adaptation actions while aligning with international adaptation trends.

6. Agricultural Production and Biodiversity

The agricultural production and biodiversity sector has six major adaptation strategies: preserving agricultural production resources and the environment, developing climate-smart agricultural technologies, adjusting agricultural business models and enhancing production and marketing early warning systems, establishing disaster early warning and response systems, strengthening agricultural disaster relief and insurance systems, and conducting regular monitoring and improved management of protected areas. The sector has nine priority adaptation action plans.

Efforts to preserve agricultural production resources and the environment have resulted in a continuous push toward organic agriculture, and the movement has seen steady progress since 2017. By the end of 2023, organic farming areas had cumulatively reached 24,114 hectares. Developments in climate-smart agricultural technologies include a genetic resources preservation database that safeguards agricultural and livestock genetic materials and intensive research on resilient

crop varieties and breeding methods. Facility-based agricultural programs (such as disaster-resilient greenhouses and net houses) have been promoted to adjust agricultural business models and enhance production and marketing early warning mechanisms. Additionally, early warning mechanisms for agricultural product production and marketing have been developed. As for disaster early warning and response systems, data sources for the Agricultural Meteorological Early Warning Platform have been expanded and customized services such as mobile apps and cultivation calendars have been introduced. To strengthen agricultural disaster relief and insurance systems, insurance coverage and product offerings have been continually expanded. Since 2017, insurance participation rates have steadily increased. Legislative efforts for the Agricultural Insurance Act are also ongoing. As of June 30, 2024, agricultural insurance initiatives have resulted in the development of 28 products and 41 policy types. A cumulative total of 814,000 policies have been issued, covering an area of 723,000 hectares and insuring a total amount of NT$120.8 billion. Development of commercial insurance policies continues, while policy-based insurance products are being further promoted. Policies under development include those for tea, grapes, peaches, dragon fruit, peanuts, loquats, sugar apples, wax apples (Kaohsiung), and garlic. Efforts to strengthen the management of protected areas, ecological monitoring, and operational efficiency assessments include continuous improvement of the National Biodiversity Indicator Monitoring and Reporting System. Marine ecosystem surveys and shoreline ecosystem conservation have also been enhanced. Seagrass restoration techniques have been further refined to improve efficiency. Restoration efforts target suitable marine areas, underutilized fishing ports, and idle fishponds, aiming to enhance habitat diversity and enrich fishery resources.

7. Health

The health sector has three primary goals: ensuring environmental quality under climate change; enhancing emergency medical treatment, epidemic prevention systems, and labor health protection under climate change; and improving public adaptation capabilities. This sector has 10 priority adaptation action plans.

From January 2022 to June 30, 2024, the health sector achieved the following outcomes: To ensure environmental quality under climate change, the Ministry of Environment has continued monitoring water quality in environmental water bodies and conducted 24-hour air quality monitoring as a basis for adaptation and management planning. In 2023, groundwater quality monitoring was expanded to Kinmen County and Lienchiang County, with results published on the National Environmental Water Quality Monitoring Information Network. Additionally, the Ministry of Environment collaborated with the National Health Research Institutes to project changes in major vector mosquito populations. The data facilitate responses to changes in vector mosquito distribution, thus improving local agencies' environmental cleanup efficiency and provides early warning for disease prevention and response. The ministry also researched and developed green chemical substances to be used as substitutes for environmental agents, identifying six plant-based components as effective replacements.

As part of its effort to promote disaster prevention drills and strengthen epidemic prevention knowledge and education, the Ministry of Health and Welfare enhanced measures for cold weather healthcare and cardiovascular disease prevention, and distributed 9,298 cold-weather care packages. To strengthen emergency medical treatment, epidemic prevention systems, and labor health protection under climate change, the Ministry organized 373 training sessions, exercises, and seminars across six Regional Emergency Medical Response Centers to refine emergency medical coordination mechanisms. To raise public and professional awareness of climate-change related infectious disease prevention, the Ministry conducted six vector-related training sessions, with 5,128 participants completing the program. It also provided subsidies for local health bureaus to conduct education and training on foodborne, waterborne, and zoonotic disease prevention, with cumulative participation of 689,779 attendees. The Ministry also continued integrating databases for disease monitoring, including vectors, intestinal diseases, zoonoses, and flood-related infectious diseases, and improved case and resource reporting systems for epidemic control.

The Ministry of Labor incorporated outdoor heat hazard prevention into its annual labor inspection guidelines, urging businesses to implement necessary measures. From June to September in 2023 and 2024, the Ministry conducted High-risk Special Inspections for Working Outdoors in Hot

Summer, which targeted high-risk outdoor work environments and shortened the time between initial inspections and follow-ups to enhance oversight. A total of 21,735 inspections were conducted between 2022 and June 2024.

Additionally, a dedicated heat hazard prevention section was established to provide guidance, illustrated manuals, multilingual posters, and promotional videos for outdoor workers, raising awareness of heat hazard prevention. The labor inspection agency also organized 21 events, observations, and informational meetings on heat hazard prevention for outdoor workers between 2022 and June 2024 to share case studies and encourage peer learning among enterprises.

To strengthen emergency medical treatment, epidemic prevention systems, and labor health protection under climate change, the Ministry organized 373 training sessions, exercises, and seminars across six Regional Emergency Medical Response Centers to refine emergency medical coordination mechanisms.

To raise public and professional awareness of climate change-related infectious disease prevention, the Ministry conducted four vector-related training sessions, with 3,446 participants completing the program. It also provided subsidies for local health bureaus to conduct education and training on foodborne, waterborne, and zoonotic disease prevention, with cumulative participation of 305,227 attendees as of December 31, 2023. The Ministry also continued integrating databases for disease monitoring, including vectors, intestinal diseases, zoonoses, and flood-related infectious diseases, and improved case and resource reporting systems for epidemic control.

Finally, to improve public adaptation capabilities, the Ministry provided 124,995 instances of care services, such as cold and heat-related assistance and material distribution, to homeless individuals and other vulnerable groups such. To prevent heat-related injuries, central ministries, local governments, health bureaus, and hospitals collaborated to disseminate information through brochures, websites, and a total of 118 radio broadcasts produced by the National Police Agency's Police Radio Station. Educational materials were developed for elderly and child populations, and the Lohas Weather - Health Meteorology Service app was launched through a collaboration between the Central Weather Administration, Academia Sinica, and the Health Promotion Administration. Furthermore, 42 news articles on cold and heat injury prevention were issued and widely shared using Facebook posts, LINE messages, and other channels.

The Ministry of Labor will continue to monitor international climate change adaptation trends and revise regulations and response plans as needed. It will actively improve companies' ability to prevent heat hazards under changing weather conditions through oversight, guidance, promotional efforts, and the development of relevant tools, resources, and guidelines. These measures aim to enhance companies' awareness and adaptation capabilities, thereby ensuring workplace safety and maintaining a healthy and robust workforce in Taiwan.

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6 Climate Change and System Observation Research

6.1 Climate Change Scientific Research

6.2 Meteorological Obervations of Climate Change

Chapter 6: Climate Change and System Observation Research

To achieve the goals of the Paris Agreement, countries must collaborate to drive global greenhouse gas emission reduction and the innovation and application of adaptation technologies. At the same time, countries must establish stable meteorological observation systems and accurate weather prediction models to address the impacts of climate change. Taiwan has actively invested resources in scientific research on climate change and shares its findings with the world through international collaboration.

6.1 Climate Change Scientific Research

In Taiwan, the National Science and Technology Council (NSTC) is the central authority responsible for coordinating and planning the country's overall technological development, including its scientific research on climate change. The NSTC promotes interdisciplinary integrated research programs to build key capabilities in climate modeling, projection, and interpretation, and it contributes to implementing climate-related policies in collaboration with other ministries.

6.1.1 Promotion and Management Mechanisms for Scientific Research on Climate Change

In accordance with the *Fundamental Science and Technology Act*, the Executive Yuan convenes a National Science and Technology Conference every 4 years. This conference serves as an important platform for coordinating national science and technology policies. Following each conference, a National Science and Technology Development Plan is published and serves as the primary basis for promoting science and technology policies across various sectors. The plan's implementation is managed and evaluated by the NSTC, and the results are reported to the Executive Yuan annually.

After the sixth National Science and Technology Conference in 2000, climate change issues were incorporated into Taiwan's science and technology development policies. The latest edition of the National Science and Technology Development Plan (2021–2024) focuses on four primary objectives—Innovative Intelligence, Inclusive Low Carbon, Health, and Sustainability—encompassing 15 sub-goals, and 44 strategies. The scientific and technological development directions directly related to addressing climate change include:

1. Enhancing Adaptation and Disaster Early Warning: Strengthening climate resilience and the capacity of scientific research services.
2. Diversified Deployment of Advanced Green Energy Technologies: Advancing the development of green energy technologies.

To assist government ministries in achieving these goals, the NSTC developed the Taiwan Science and Technology Roadmap based on the National Science and Technology Development Plan. The Roadmap serves as a guide for concrete actions and addresses the challenges facing Taiwan by setting out five key issues and 20 response strategies, along with plans for future scientific exploration and technological deployment, as illustrated in Figure 6.1.1-1

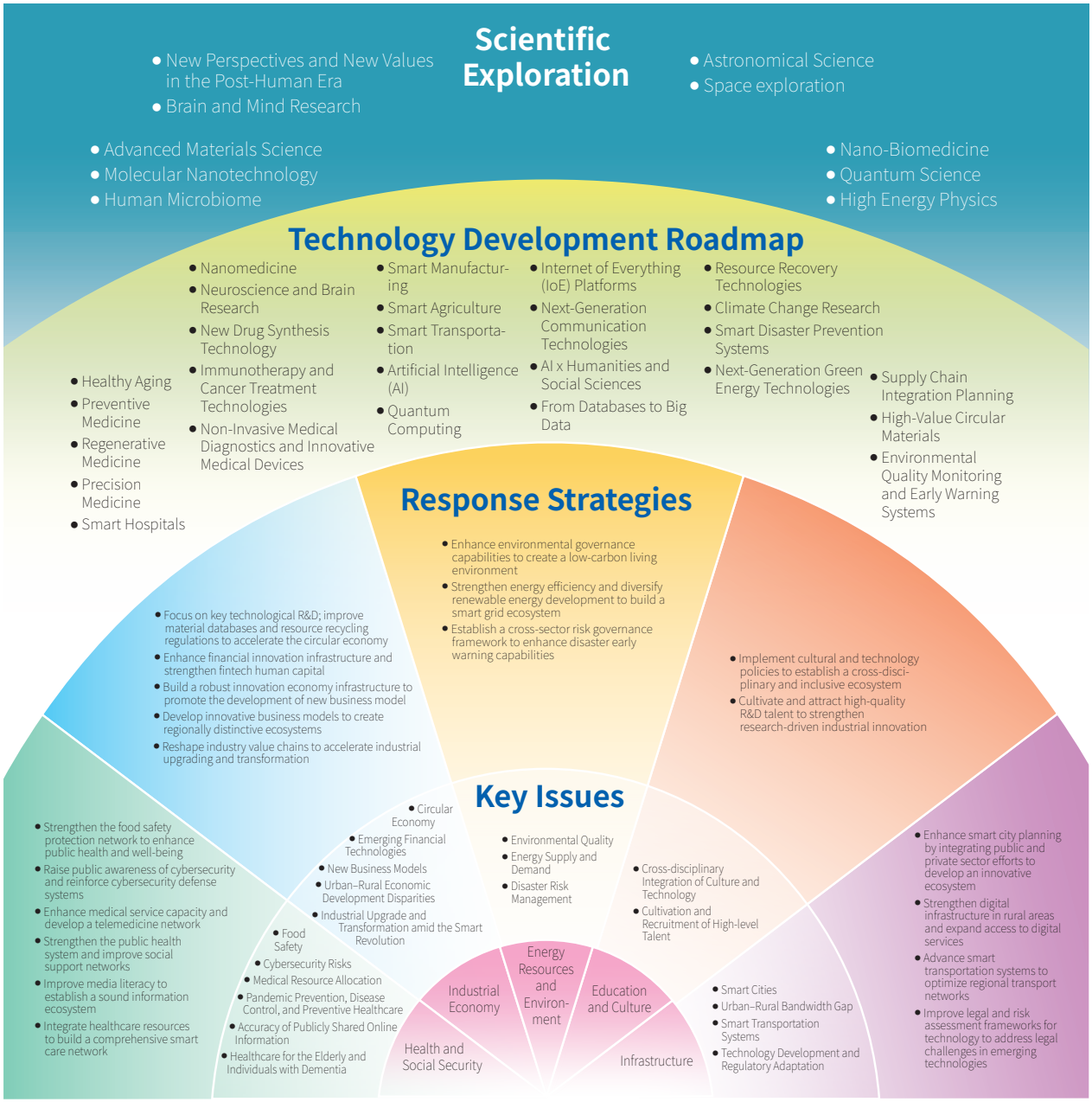

Figure 6.1.1-1. Latest Edition of the Taiwan Science and Technology Roadmap

Source: *Taiwan Science and Technology Roadmap (2019–2022).*

In the Roadmap, the issue directly related to addressing climate change is Energy Resources and Environment, with a central focus on building a green, low-carbon environment and strengthening disaster resilience and mitigation capabilities. The corresponding strategies are as follows:

1. Environmental Quality: Establish environmental sensing networks to enhance monitoring and inspection capabilities, strengthen incentives for greenhouse gas reduction, encourage active participation from industries, promote the development of circular technologies, and expand the benefits of demonstration zones.
2. Energy Supply and Demand: Implement energy-saving and carbon-reduction measures to improve energy efficiency, introduce innovative models to promote energy development, and strengthen smart grid construction to ensure a stable power supply quality.

3. Disaster Risk Management: Develop a cross-sectoral risk governance framework to optimize disaster risk management, collect and effectively utilize disaster-related data to enhance early warning capabilities, and promote the development of related industries.

In the plans for future scientific exploration and technological deployment focus on the core themes of Intelligence, Health, Sustainability, and Scientific Exploration. The priorities in science and technology development related to addressing climate change focus on the following aspects:

I. Enhancing Energy and Resource Utilization Efficiency

1. High-Value Recyclable Materials: Develop recyclable high-value materials and key technologies that support circular processes.

2. Resource Recovery Technologies: Innovate technologies to achieve the recycling and reuse of organic, inorganic, and electronic waste, thereby reducing the consumption of natural resources.

3. Production Chain Integration Planning: Drawing inspiration from natural ecosystems, promote industrial symbiosis and resource integration among industries, enabling factories' waste and thermal energy to be effectively utilized by nearby units. Assist businesses in transitioning from traditional waste management to resource regeneration and circular economy models.

II. Developing High-Efficiency Low-Carbon Energy

1. Alternative Energy: Develop cost-effective solar cell and module technologies, enhance offshore wind turbine engineering capabilities, and promote the development of bioenergy.

2. Smart Grids: Address the intermittent nature of renewable energy by leveraging information and communication technologies as well as automation to regulate power distribution, improving supply quality and stability.

3. Energy Storage Technologies: Develop energy storage technologies and integrated systems to buffer the power grid and support the demands of electric vehicles and other transportation modes.

4. Advanced Energy-Saving Technologies: Focus on demand-side measures to reduce energy consumption while enhancing the international competitiveness of industrial products.

III. Building a Disaster-Resilient and Pollution-Resilient Homeland

1. Smart Disaster Prevention Systems: Establish intelligent and automated monitoring and early warning systems to enable governments and the public to prepare for disasters in advance.

2. Environmental Quality Monitoring: Combine international disaster prevention technologies with Taiwan's information systems to develop disaster monitoring and forecasting systems suitable for the region's complex terrain.

3. Climate Change Research: Integrate local data with global climate model changes to establish localized climate simulation systems, laying the foundation for formulating climate adaptation strategies.

6.1.2 Key Measures and Achievements in Scientific Research on Climate Change

I. Fundamental Research on Climate Change

Global climate change has become a critical area of scientific research worldwide, with a particular focus on projecting regional climate change trends and their impacts.

In Taiwan, climate change modeling research has been a priority. Since 2011, the National Science and Technology Council (NSTC) has spearheaded the independent development of a Taiwan Climate Modeling System. It funded the Taiwan Climate Modeling System Development Team, composed of climate researchers from Academia Sinica and leading universities, to develop the Taiwan Earth System Model (TaiESM, 100-km resolution), the High-Resolution (25/50 km) Atmospheric Model (HiRAM), and a very high-resolution (3–5 km) regional model

(WRF). This comprehensive model ensemble, ranging from global to regional scales, is used to analyze the potential impacts of global climate change on East Asian climate, monsoons, and extreme weather events in Taiwan such as typhoons, heavy rainfall, and droughts.

Building on this foundation, Academia Sinica, with NSTC's support, launched the Anthropogenic Climate Change: Analysis, Capacity Advancement, and CMIP6 Participation project. Taiwan participated in the Coupled Model Intercomparison Project Phase 6 (CMIP6) of the World Climate Research Programme, contributing to the scientific basis for the IPCC's Sixth Assessment Report (AR6). This project aimed to explore the potential impacts of global warming on the world's climate systems, as well as those of East Asia and Taiwan. Utilizing the Taiwan Earth System Model, Taiwan conducted simulations and projections, providing locally produced climate change information to the international research community for the first time and showcasing its scientific expertise. According to assessments based on multiple modern climate indicators, the Taiwan Earth System Model ranked 8th among 37 global models. It is comparable to the model developed by the Meteorological Research Institute of Japan, and outperforms models from other Asian countries such as South Korea.

Building on these research accomplishments, the National Science and Technology Center for Disaster Reduction (NCDR), in collaboration with Academia Sinica, related universities, and government agencies, developed the Taiwan Climate Change Projection Information and Adaptation Knowledge Platform. Using HiRAM and WRF, the platform conducts climate change simulations from global to urban and rural scales. It predicts future trends in extreme weather events under global warming scenarios, such as typhoons, heavy rainfall, afternoon thunderstorms, droughts, and heatwaves in Taiwan. These simulation results are used to assess the impacts of climate change on natural disasters, water resources, ecosystems, public health, agriculture, forestry, fisheries, livestock, society, economy, and public welfare in Taiwan and to formulate adaptation strategies.

NSTC has consistently focused on advancing fundamental research, fully supporting high-quality academic teams in scientific innovation and the pursuit of academic excellence. It encourages data sharing and collaboration among projects and strengthens international connections.

II. Interdisciplinary Integrated Research

The Taiwan Climate Change Projection Information and Adaptation Knowledge Platform (TCCIP) was launched in November 2009 and has now entered its fourth phase. Building on the foundation of the first three phases, the fourth phase aligns with the NSTC's 4-year medium-term master plan initiated in 2022, titled Building a Resilient Taiwan to Address Climate Emergencies. This program aims to strengthen integration capacities in climate change scientific services and achieve comprehensive climate research and service capabilities wherever possible.

To align with the NSTC's role in the medium-term master plan, the TCCIP will continue to act as a critical integrated service platform. It will support the scientific research of academic and research institutions, the adaptation policy implementation of the government, public dissemination of scientific knowledge, and applications in various industries. Figure 6.1.2-1 illustrates the envisioned role of the integrated climate change service platform in supporting national policies externally and research projects internally during the drafting of the medium-term master plan.

The key objectives of the TCCIP project are summarized as follows:

1. Support for NSTC Missions:

In addition to addressing the NSTC's goals for adaptation-related scientific research under the national 2030 Sustainable Development Goals, the project aims to support the third phase of the National Adaptation Action Plan (2023–2026) and assist with tasks related to climate adaptation applications under the jurisdiction of central science and technology authorities following the revision of the *Greenhouse Gas Reduction and Management Act* into the *Climate Change Response Act*.

2. Production and Analysis of Taiwan Climate Change Data and Trends:

Previous project phases focused on producing a large volume of climate change data for local impact applications. In this phase, the project will add higher-resolution climate simulation data and regional ocean simulation data to support fisheries and ecological impact studies in Taiwan. Furthermore, scientific analyses of climate trends will be enhanced to provide

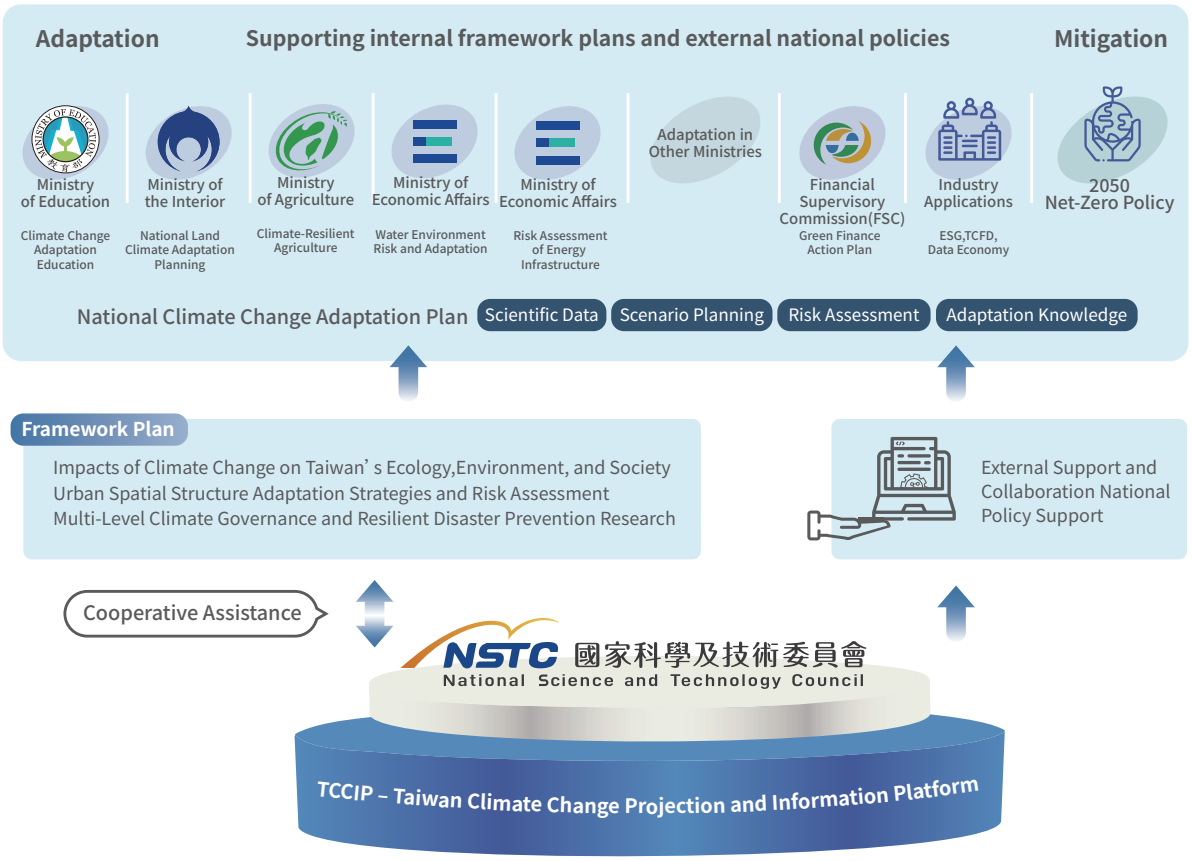

Figure 6.1.2-1. TCCIP's Role in the NSTC Master Plan and Government and Industry Climate Adaptation

Source: TCCIP Official Website.

the public with accessible and understandable localized climate information.

3. Accumulation of Risk Assessment and Adaptation Capacity:

National climate change adaptation efforts are the result of interministerial collaboration, and the knowledge generated by NSTC research projects plays a critical role in guiding ministries to implement adaptation measures. Following the amendment of the *Climate Change Response Act*, the central technology authority may take on a key role. The project will continue to accumulate experience, tools, geospatial data, and knowledge that can be applied to climate change impact and risk assessments as well as adaptation frameworks across various fields.

4. Enhancing Climate Change Scientific Research Service Capabilities:

The TCCIP project has already established itself as a crucial climate change service platform in Taiwan, with a significant userbase spanning industry, government, academia, and research. The project will continue to deepen its service capabilities, reduce barriers to professional knowledge, and bridge gaps across different interfaces for smoother applications.

5. Building Research Capacity, Talent, and Achievements:

The project will sustain the progress of national climate change-related research efforts by cultivating interdisciplinary applications, services, and communication expertise. The ultimate goal is sustainable management to address the increasingly challenging national climate change tasks.

III NSTC Participation in Climate Change Policy Implementation

1. Carbon Capture, Utilization, and Storage (CCUS) Key Strategy

Building on the outcomes of the previous

National Energy Program and aligned with the current goal of net-zero transition, the NSTC established a CCUS technology development roadmap under the Negative Carbon Technology Taskforce. On November 28, 2022, a CCUS outreach meeting was held to gather valuable feedback from stakeholders. Following the release of the Net Zero Transition Key Strategies Action Plan (Draft) at a forum on December 28, 2022, plans were made for small-scale demonstration and gradual upscaling of carbon capture and utilization technologies, along with continued investment in forward-looking research. For carbon storage, efforts will continue to focus on geological surveys, the development of data platforms, and the implementation of demonstration projects to validate storage monitoring technologies. Outreach activities will also be organized to garner public support:

(1) International Collaboration

- In September 2023, the NSTC collaborated with the British Office Taipei to co-host the UK–Taiwan Net Zero Academic Research Forum, which featured a session on CCUS. Experts and scholars from both countries were invited to analyze key challenges and strategies related to critical net-zero technologies.
- The NSTC collaborated with Norway's Technology Centre Mongstad (a carbon capture demonstration site) to facilitate exchanges with 27 Taiwanese units, including government agencies, technical organizations, private enterprises, and academic experts.

(2) Technology Development

- Completed energy spectrum analysis under laboratory conditions using domestically developed ocean bottom nodes (OBNs) and SmartSolo three-dimensional seismic receivers and deployed first batch of seismic equipment in the intertidal zone at Guanyin to collect background noise in shallow waters.
- The Industrial Technology Research Institute (ITRI) partnered with China Steel Corporation to build a steel and chemicals co-production pilot plant, achieving 1,000 hours of continuous operation. The captured carbon monoxide reached a purity of 98.5%, and the purified CO_2 achieved a purity of 99%.
- CPC Corporation completed the construction of a CO_2 capture trial facility capable of capturing 20 kilograms per day (approximately 6 metric tons annually) in 2022. In 2023, a methanol conversion trial facility was completed, producing 3 kilograms of methanol daily (approximately 1 metric ton annually).

(3) Promoting CCUS Demonstration Projects

- The Energy Administration developed distributed fiber optic geotechnical monitoring technologies for future application in experimental fields.
- Taiwan Power Company initiated the construction of a carbon capture demonstration plant, obtained approval to modify its environmental impact statement, and began planning a carbon storage testing site alongside a smart greenhouse plant and an educational exhibit center.
- CPC Corporation conducted five science outreach activities to promote accurate understanding of carbon capture and storage technologies.

(4) Regulatory Framework Development

- A draft framework for the Regulations Governing the Capture and Storage of Carbon Dioxide has been completed. The framework includes provisions for the approval, modification, extension, and revocation of experimental and implementation plans; procedures for reporting, monitoring, recording, and verifying CCS storage operations; as well as the delineation of CCS responsibilities and associated penalties.

2. Tiezhenshan CCS Pilot Site

CPC Corporation has planned a CCS trial facility in the Tiezhenshan area of Tongxiao Township, Miaoli County. To meet future demands for large-scale carbon reduction, many countries are actively capturing and storing CO2 emissions from facilities such as thermal power plants and steel mills. Currently, 41 CCS projects are operational worldwide. CPC Corporation plans to conduct drilling operations at the Tiezhenshan trial facility, then construct surface installations to inject CO2 into a sandstone saline aquifer approximately 1,700 meters underground. The aquifer will be capped by a dense shale layer 150 to 200 meters thick to prevent CO2 leakage. Environmental monitoring will be carried out to validate Taiwan's carbon storage technology.

Additionally, CPC Corporation has conducted a detailed safety assessment of the underground reservoir and plans to closely monitor key parameters such as pressure, temperature, and CO_2 concentration during the storage process to prevent large-scale CO_2 emissions or leaks. The project is currently in the planning stage. CPC Corporation is actively engaging with local residents to gain support and refining its monitoring and response plans to ensure safe implementation. This initiative aims to contribute to achieving Taiwan's 2050 net-zero emission goals.

3. Forward-Looking Infrastructure Plan

In coordination with the national Green Energy Technology Industry Innovation Promotion Plan and the Forward-Looking Infrastructure Development Program, the NSTC has supported construction and development of the core area of Shalun Smart Green Energy Science City, and is also helping to improve the surrounding infrastructure. The key aspects of building a low-carbon, smart environment under this plan include:

(1) Low-Carbon Smart Environment Construction in the Science City:

Promote the development of low-carbon smart transportation systems, smart ecological parks, and autonomous vehicle testing fields while gradually incorporating green energy infrastructure. This project will integrate efforts from universities, research institutions, Taiwan Sugar Corporation, and the Tainan City Government's exhibition centers and business districts. It aims to attract domestic and international enterprises and organizations to accelerate the development of Shalun Smart Green Energy Science City.

(2) Green Energy Technology Joint R&D Projects:

Support research projects in four key areas—energy conservation, energy creation, energy storage, and system integration—through industry–academia collaboration. These efforts will enhance the effectiveness of technological innovation, foster industrial development, and promote the emergence of new green energy industries, driving industrial transformation.

6.2 Meteorological Observations of Climate Change

Meteorological observations can be broadly split into three categories based on their scope, purpose, and methods: surface meteorological observations, upper-air meteorological observations, and specialized meteorological observations.

Surface meteorological observations involve measuring various atmospheric elements near the Earth's surface. These measurements are conducted either visually by observers or using meteorological instruments installed at ground-based stations. Observations conducted on ships at sea are also considered surface meteorological observations because they measure atmospheric elements similar to those observed on land, only with the addition of parameters related to the ocean.

Upper-air meteorological observations primarily utilize free-floating balloons equipped with meteorological instruments to measure atmospheric elements such as air pressure, temperature, humidity, and wind speed at various altitudes, typically below 40,000 meters. In some cases, wind direction and wind speed at different altitudes are determined by tracking the trajectory of free-floating balloons.

Specialized meteorological observations use advanced equipment or instruments for specific purposes. These include lightning detection, weather radar monitoring, and the reception and processing of meteorological satellite data.

I. Promotion and Management Mechanism for Meteorological Observations

In accordance with the *Meteorological Act*, Taiwan's governing authority for meteorological observations is the Ministry of Transportation and Communications, and relevant operations are executed by the Central Weather Administration (CWA). The CWA is responsible for the planning, construction, management, and R&D of national meteorological operations. Its meteorological observation activities include surface meteorological observations, upper-air meteorological observations, satellite meteorology, and weather radar monitoring. Additionally, the CWA conducts marine observations, covering parameters such as tides, waves, and sea surface temperatures, as well as physical and chemical observations of atmospheric characteristics such as ozone and ultraviolet indices.

II. Monitoring Systems for Meteorological Observations in Taiwan

1. Surface and Upper-Air Observations

Currently, Taiwan has established 25 synoptic weather stations, 2 upper-air meteorological stations, and 3 observation site zones, which are complemented by 11 cooperative observation stations and 644 automated observation stations (495 weather stations and 149 rainfall stations). This network enhances regional monitoring of heavy rainfall, forming a robust system for collecting rainfall and meteorological data, as illustrated in Figure 6.2-1. The weather elements monitored daily by observation stations include weather conditions, wind direction, wind speed, cloud cover, cloud type, cloud base height, visibility, air temperature, humidity, air pressure, precipitation, evaporation, sunshine duration, solar radiation, and soil temperature. Automated observation stations primarily monitor rainfall, wind direction and speed, air pressure, air temperature, and relative humidity. Upper-air meteorological stations focus on monitoring vertical profiles of wind direction, wind speed, temperature, humidity, and air pressure. Observations are typically conducted once per day; however, during periods of approaching significant weather systems or typhoons, observations are conducted every 6 hours.

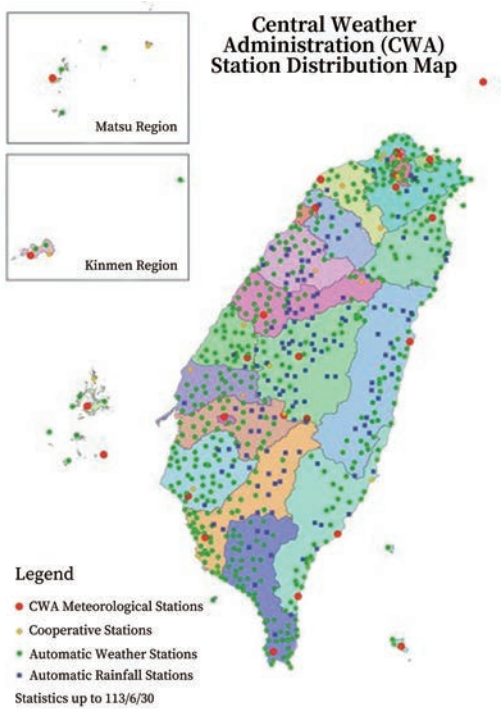

Figure 6.2-1. Distribution of CWA Observation Stations

Source: Central Weather Administration, Ministry of Transportation and Communications.

2. Satellite Observations

The CWA regularly receives and processes observational data from geostationary meteorological satellites, polar-orbiting meteorological satellites, and Taiwan's FORMOSAT satellites, as illustrated in Figure 6.2-2. These include high spatial and temporal resolution multi-channel observational data from Japan's Himawari-9 and South Korea's GeoKompsat-2A (GK-2A), with applications primarily derived from Himawari-9 data. Additionally, the CWA receives and processes observational data from nine environmental satellites: the United States' NOAA satellites (NOAA-18/19/20/21), the Earth Observing System (EOS) satellites (Terra, Aqua, Suomi NPP), and the European Union's Metop satellites (Metop-B/C). These data are used for weather analysis and environmental trend monitoring. The CWA is also responsible for processing meteorological data from Taiwan's FORMOSAT-7 and TRITON satellites. FORMOSAT-7 employs radio occultation technology to provide information on the vertical structure of the atmosphere. TRITON uses reflected radio signals to deduce sea surface wind field information.

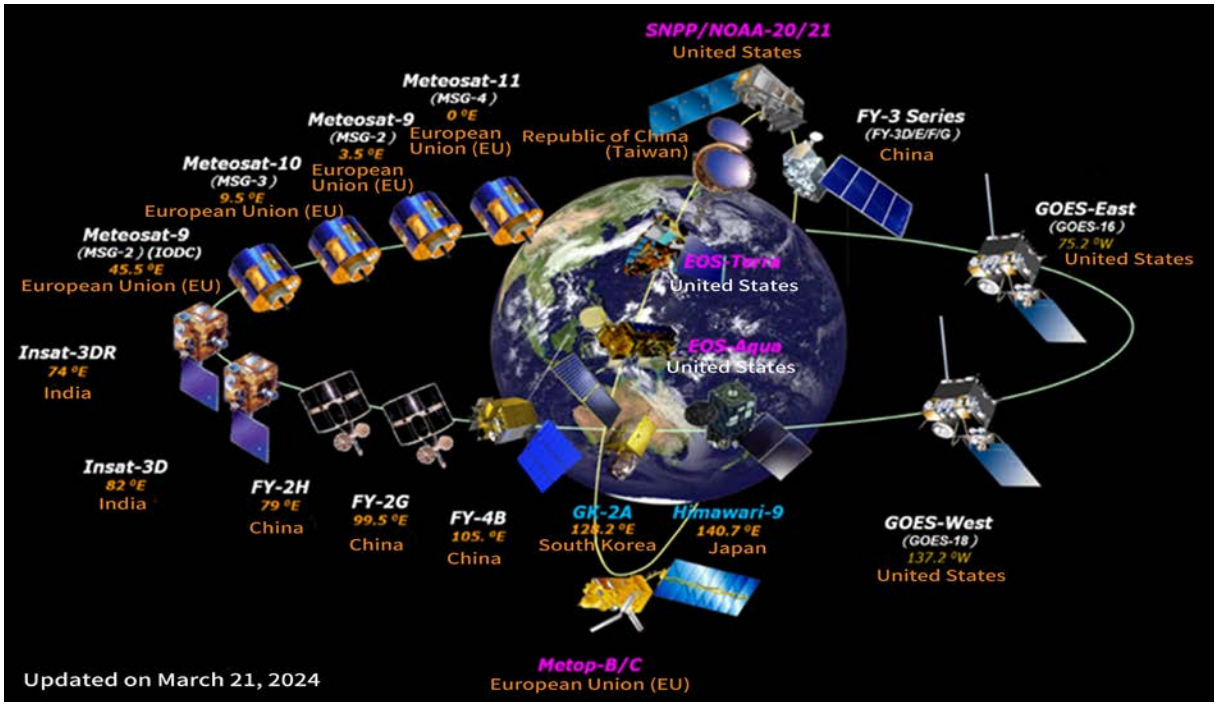

Figure 6.2-2. Global Meteorological Satellite Observation Network - Created by the CWA Based on WMO Earth Observation System Information

Source: Central Weather Administration, Ministry of Transportation and Communications.

Currently, satellite operations produce dozens of satellite base images and product maps, as well as datasets for various applications. These include true-color images, cloud cover, daytime and nighttime fog areas, rainfall, surface solar radiation, land and sea surface temperatures, sea surface chlorophyll concentrations, atmospheric wind fields, aerosol optical depth, aerosol types, PM10 and PM2.5 concentrations, fire detection, dust storms, temperature, pressure, vertical variations in water vapor partial pressure, and sea surface wind speed. The CWA utilizes these weather and environmental monitoring products for weather monitoring and forecasting. The products are also used by environmental and energy departments, academic institutions, media, and the general public.

Figure 6.2-3. Satellite observations from the Suomi National Polar-orbiting Partnership satellite (SNPP) received by the CWA at 2:19 a.m. on March 10, 2023 (Lunar Calendar: 19th day of the 2nd month). From left to right, the images display: a day-night band (DNB) image, a multi-channel composite combining DNB and infrared, and an infrared enhanced cloud-top image. In the left and center images, the blue circles clearly highlight the extensive sea fog stretching from the Yellow Sea to the East China Sea. Over land areas with clear skies, city lights are distinctly visible.

Source: Central Weather Administration, Ministry of Transportation and Communications.

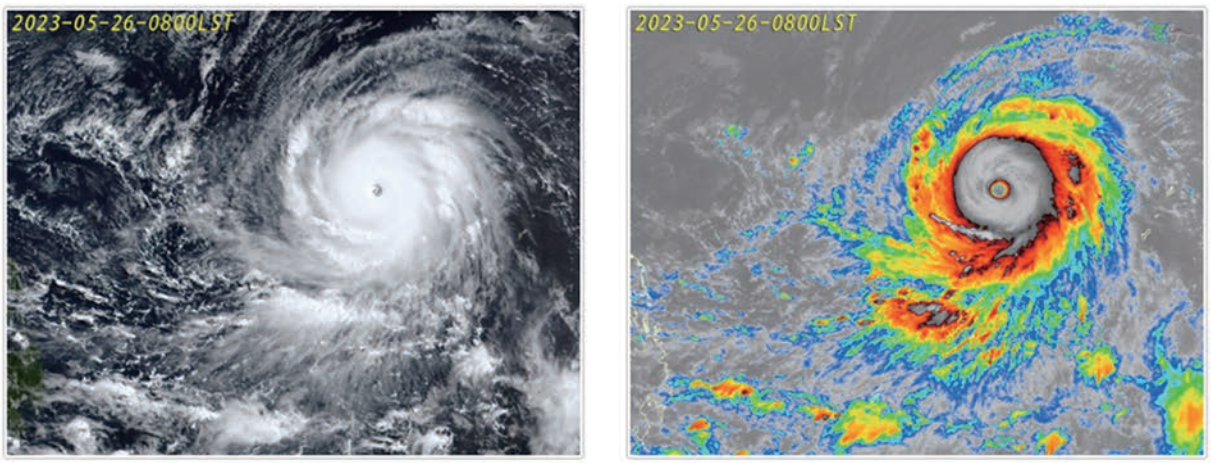

Figure 6.2-4. True-color (left) and infrared (right) images from Himawari-9 showing Typhoon Mawar (No. 202302), the first typhoon of the 2023 pacific typhoon season, in the sea east of the Philippines. The cloud structure is solid and round, with a thick cloud wall and a clearly visible eye.

Source: Central Weather Administration, Ministry of Transportation and Communications.

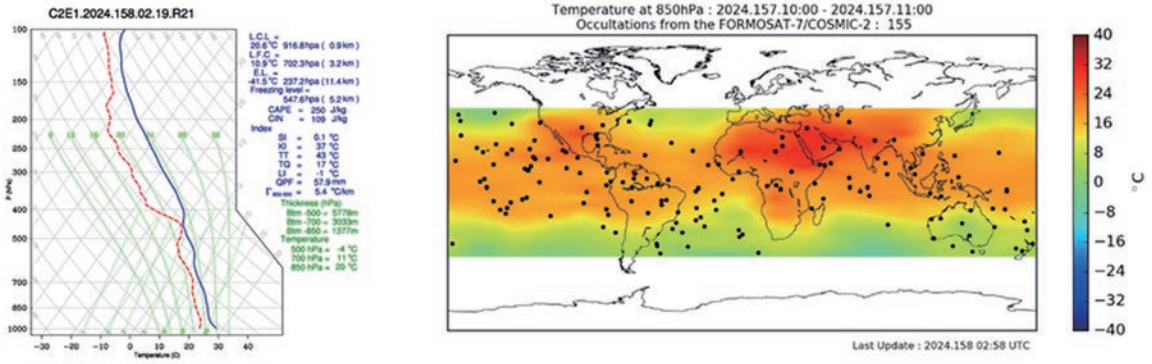

Figure 6.2-5. Atmospheric Vertical Profile (left) and Global Temperature Product Map (right) Generated by the Central Weather Administration Using Data Received from FORMOSAT-7.

Source: Central Weather Administration, Ministry of Transportation and Communications.

3. Weather Radar Observations

As of 2023, Taiwan's operational weather radar network consists of 11 weather radars. Due to Taiwan's mountainous terrain and steep topography, this dense radar network helps compensate for observation blind spots caused by terrain obstructions, enabling more comprehensive monitoring of weather systems. The locations of the radar stations are shown in Figure 6.2-4. The CWA operates four S-band (10 cm wavelength) dual-polarization Doppler radars in Hualien, Kenting, Qigu, and Wufenshan as well as three C-band (5 cm wavelength) disaster-prevention rainfall radars in Linyuan, Nantun, and Shulin. Additionally, the Civil Aeronautics Administration operates a C-band Doppler weather radar at Taoyuan Airport, and the Air Force operates three C-band dual-polarization weather radars in Ching Chuan Kang, Magong, and Ludao. The Kenting radar underwent a dual-polarization system upgrade between June and October 2022, and the Hualien radar was upgraded between October 2022 and March 2023. Furthermore, the new Qigu weather radar station was

Figure 6.2-6. Taiwan's Weather Radar Observation Network

Source: Central Weather Administration, Ministry of Transportation and Communications.

officially launched on December 28, 2022.

The current radar observation network covers Taiwan's land and adjacent sea areas, operating continuously 24 hours a day. It performs a full-volume scan every 7.5 minutes and provides real-time updates, allowing the CWA to monitor the dynamics of weather systems, especially the internal structures of severe systems like typhoons. These observational data are critical for analyzing the development of weather systems and serve as essential references for Taiwan's aviation, disaster response systems, and resource management.

4. Marine Observations

Marine observations are divided into two main categories: wave observations and tidal observations. Wave observations primarily rely on data buoys. Currently, 31 buoy stations are in operation. These buoys collect data on wave height, wave direction, and sea surface temperature, while also recording meteorological data such as wind direction, wind speed, air pressure, and air temperature at the sea surface. During typhoons, these buoys serve as offshore observation outposts, providing crucial references for forecasting typhoon paths and intensity and enhancing marine meteorological forecasting capabilities in Taiwan's southern waters.

To facilitate tidal observations, the CWA has established 30 tidal stations, and an additional 43 tidal stations have been set up in collaboration with other government agencies. These stations primarily monitor tides and storm surges caused by typhoons. Among them, 23 tidal stations are equipped with high-frequency sampling and real-time data transmission capabilities, making them suitable for tsunami monitoring, as illustrated in Figure 6.2-7. In addition to providing early warnings of storm surges and aiding coastal protection, tidal stations also supply long-term water level monitoring data, which serve as a reliable basis for land surveying and national mapping.

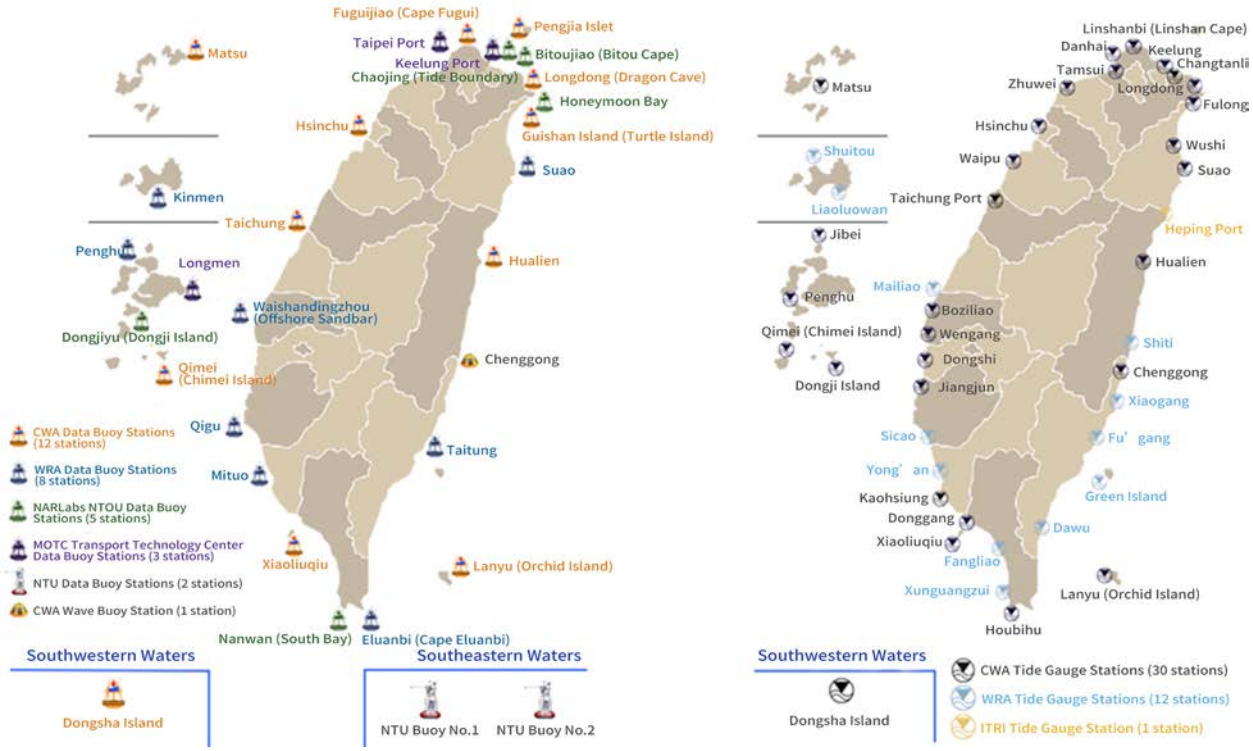

Figure 6.2-7. Taiwan's Marine Observation Network

Source: Central Weather Administration, Ministry of Transportation and Communications.

III. Integrated Applications of Meteorological Observations in Taiwan

1. Crop Disaster Early Warning System

The Crop Disaster Early Warning System, developed by the Taiwan Agricultural Research Institute, Ministry of Agriculture, is a specialized system for agriculture. The CWA provides this system with observational and forecast data from meteorological stations across Taiwan and designated agricultural zones. These data are combined with GIS systems and crop information to provide farmers with real-time local weather updates and early warnings, helping to reduce agricultural losses.

2. Supporting Evidence for Agricultural Natural Disaster Relief

The Agriculture and Food Agency, Ministry of Agriculture, is responsible for managing agricultural natural disaster relief. In recent years, the increasing frequency of extreme or abnormal weather has made it increasingly difficult to ascertain whether disasters are due to natural events or mismanagement, assess the scale of damages, and determine eligibility for relief funds. Therefore, the Agency relies on observational data provided by the CWA as scientific evidence, effectively minimizing disputes.

3. Meteorological Parameters for Agricultural Insurance Claims

To support weather index insurance promoted by the Agricultural Finance Agency, Ministry of Agriculture, meteorological parameters such as wind speed, precipitation, and temperature recorded by the CWA are used as objective benchmarks for initiating insurance claims. This eliminates the need for damage assessment and allows for the quick calculation of compensation after adverse weather events.

4. Toward Smart Weather Information Application and Service Project (II)

Toward Smart Weather Information Application and Service Project (II) – Digital Innovation, was implemented by the CWA from 2020 to 2023. This

project aimed to continuously develop meteorological technologies, enhance weather-related public services and information infrastructure, improve professional meteorological and interdisciplinary collaboration services, and expand safety and early warning services. By leveraging emerging information and communication technologies, the project strengthened information processing and service platforms and promoted smart applications of meteorological information to prepare for potential future climate change disasters. The tangible outcomes of this plan include:

(1) Developing advanced meteorological forecasting technologies and enhancing seamless weather prediction techniques by aligning with international trends, thereby strengthening climate monitoring and early warning capabilities.

(2) Incorporating past achievements in monitoring and forecasting technologies into operational practices and developing automated drone observation systems for upper-air monitoring and gas sampling analysis. These systems provide environmental monitoring data and support research on issues such as air pollution.

(3) Establishing an integrated meteorological early warning platform that utilizes new transmission technologies to rapidly disseminate special reports and warnings, enhancing the application of meteorological data in disaster prevention and response operations.

(4) Integrating digital science education and voice interaction technologies to offer user-friendly and customized public meteorological services, improving professional awareness and judgment on climate change-related issues.

(5) Enhancing seamless meteorological prediction technologies by improving model resolution and advancing the development of an integrated short-term weather-to-climate seamless prediction system, thereby providing reliable meteorological forecast product data.

5. Improving the Disaster Warning Techniques of Weather Radar

The Improving the Disaster Warning Techniques of Weather Radar project (2019 to 2025) aims to improve Taiwan's ability to monitor and forecast severe weather over the main island and surrounding seas. By integrating new radar observation data and advanced numerical weather prediction technologies, the plan provides more accurate meteorological warnings. Key achievements include upgrading the Kenting and Hualien radars to dual-polarization systems and enhancing the Wufenshan radar system with updated signal processors and software. Dual-polarization radar data have been combined with raindrop spectrometer observations, and localized quantitative precipitation estimation (QPE) technologies for S- and C-band radars have been developed to improve rainfall estimation accuracy. A radar data assimilation system with 1-km resolution and 30-minute update frequency has been established, integrating radar echoes, QPE, 0- to 1-hour radar rainfall forecasts, and wind field synthesis across East Asia. For disaster prevention, regional rainfall radar integration now updates every 2 minutes.

Taiwan's Very-Short-Term Quantitative Precipitation Forecasting System has also been enhanced to integrate numerical forecasts and radar observations using big data analytics and data mining techniques. This system provides optimal 0- to 6-hour rainfall forecasts. Since May 1, 2023, forecasts for the next 48 hours have been issued at 12-hour and 6-hour intervals, extending the forecast range from 24 to 48 hours.

To enhance water safety, the Central Weather Administration has implemented disaster early warning services for areas at high risk of flash floods caused by heavy rainfall. Stream weather forecasts and Mountainous Area Flash Flood Warnings were piloted in 2022 at Shuangxi in Taipei City, as well as Dabao Stream and Hubao Pond in New Taipei City. By 2023, the program expanded to 19 stream regions across 10 counties and cities; throughout the year, 117 warnings were issued, with validation data available for 90 events. 70% of the warnings were followed by actual flash floods, and over 60% demonstrated effective early warning capabilities, with an average lead time of 53 minutes.

6. Intelligent Marine Environmental Disaster Prevention Services

The Intelligent Marine Environmental Disaster Prevention Services project (2021 to 2026) aims to strengthen Taiwan's marine and coastal monitoring

networks, improve forecasting technologies, and advance smart marine meteorological services. The goal is to maximize government capabilities in marine environmental management and realize the vision of sustainable development. As of December 2023, specific achievements include:

The installation of 81 automatic meteorological stations along Taiwan's coastline, the deployment of AIS systems on 20 cooperative observation vessels, and the construction of five coastal radar stations in Taoyuan. These efforts enhance marine meteorological monitoring capabilities and provide essential data for disaster prevention and response applications.

The establishment and updating of 12 optical anomaly monitoring stations and 9 county-level and city-level abnormal wave probability early warning subsystems. These measures expand the scope of marine early warning services and improve the effectiveness of coastal wave anomaly warnings.

The launch of a Knowledge Exchange Platform for meteorological and green energy collaboration between public and private sectors. The Marine Meteorology Information Website was also expanded to offer diverse applications for users, including forecasts of spatiotemporal fishery distribution, high-resolution tidal current forecasts for ports, and smart wave and wind routing information services.

The development of Taiwan's Marine Disaster Prevention Information Service Platform, which integrates OpenStreetMap and maps from the Ministry of the Interior. This platform has been promoted to agencies such as the Maritime and Port Bureau, Taiwan International Ports Corporation, the Coast Guard Administration, the Naval Meteorological and Oceanographic Office, the Water Resources Agency, the Tourism Administration, various National Park Headquarters, the Ocean Conservation Administration, CPC Corporation, and others. The platform supports disaster prevention and early warning, navigational safety, marine disaster response efficiency, and marine pollution prevention. Moreover, the platform has been expanded to provide technical services and products for disaster prevention operations, including regional wave and tidal current forecasts for shipping, coastal recreation risk assessments, fishery forecasts, coastal tide line predictions, and abnormal sea surface temperature early warnings.

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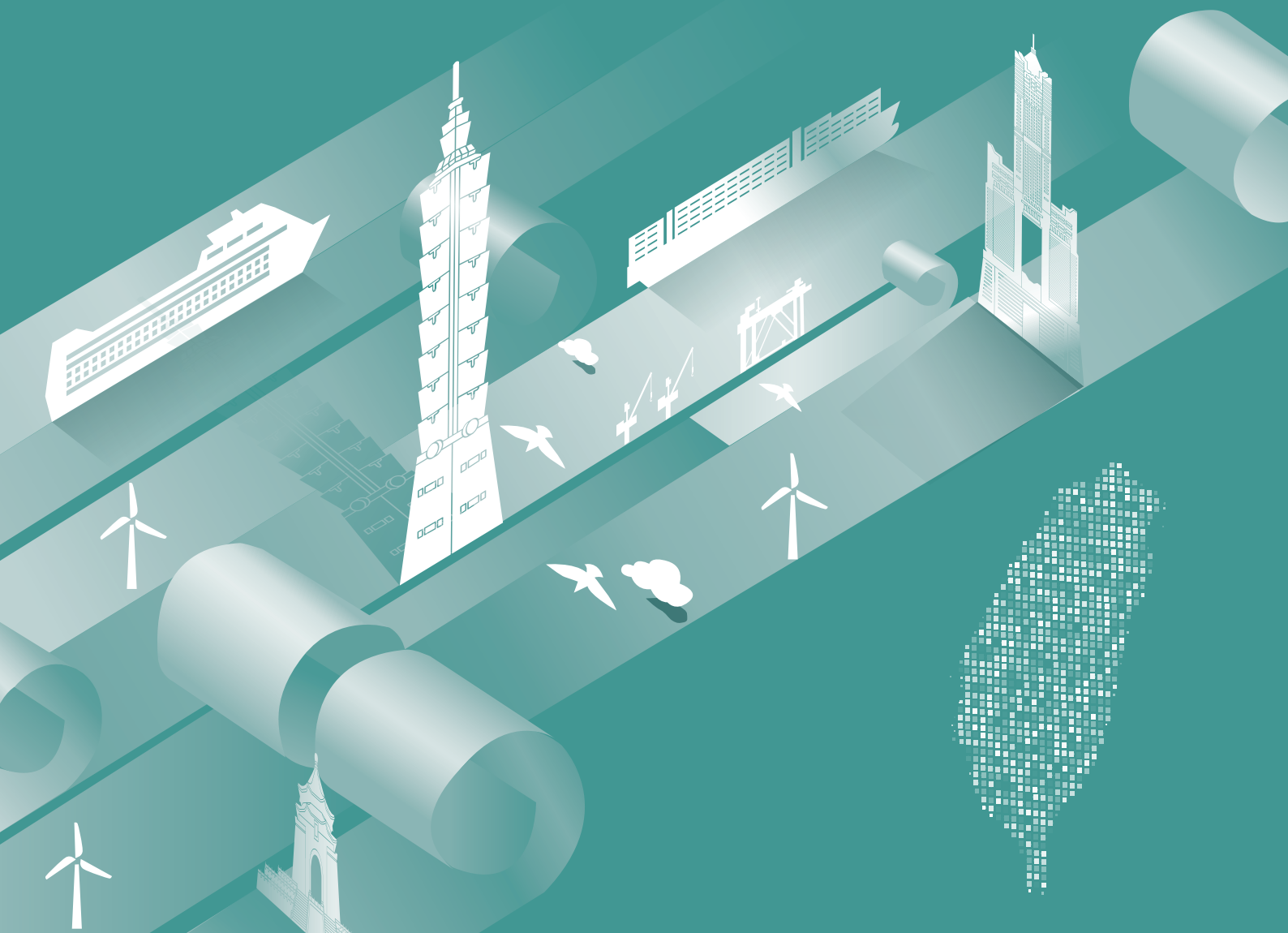
7 Technology Development, Demand, and Transfer

7.1 Technology Research and Development

7.2 Technology Demand and Transfer



Chapter 7: Technology Development, Demand, and Transfer

To address climate change, the international community has been actively promoting development, innovation, and collaboration related to climate technologies. By employing global market mechanisms and climate financing, countries have identified specific technological needs, planned and implemented domestic action plans, and pursued the import and export of technologies to achieve technology diffusion and transfer. Taiwan has also invested in the development of climate technologies, climate services, and industries. This chapter provides an overview of Taiwan's climate technology development in three main areas—Net-Zero Technologies, Mitigation and Energy Technologies, and Climate Services and Adaptation Technologies—and discusses technology demand and transfer case studies.

7.1 Technology Research and Development

Global carbon dioxide emissions primarily stem from energy use and power generation, making the development of low-carbon energy technologies a critical strategy for climate change mitigation. The National Science and Technology Council (NSTC) launched two phases of the National Energy Program in 2007 and 2014, integrating resources from multiple government agencies to serve as the core of Taiwan's energy and low-carbon technology research and development. The National Energy Program encompasses six major areas: energy-saving technologies, alternative energy technologies, smart grid technologies, offshore wind and marine energy, geothermal energy and natural gas hydrates, and carbon-reduction clean coal technologies. Energy-saving technologies emphasize system integration and industrial applications; alternative energy focuses on bioenergy, solar energy, and energy storage; smart grid technologies support the integration of renewable energy and grid stability; offshore wind and marine energy technologies enhance offshore power generation capacity; geothermal energy and natural gas hydrate technologies explore non-volcanic geothermal resources and seabed methane; and carbon-reduction clean coal technologies aim to reduce emissions through carbon capture, storage, and utilization in coal-fired power plants and industrial applications. These technological and research outcomes provide critical support for Taiwan's green energy industry development and carbon reduction goals, forming the foundation for the Net-Zero Technology Plan.

7.1.1 Development of Net-Zero Technologies

The Net-Zero Technology Plan was approved by the Executive Yuan on March 28, 2023, with an annual investment of approximately NT$11.5 billion in technology-related budgets. The plan focuses on building the technological governance foundation necessary to achieve Taiwan's 2050 net-zero goal. It outlines research and development (R&D) in five key technological fields, guided by the principles of human-centric development, goal-oriented planning, future-oriented strategies, and global alignment. These strategies aim to establish the governance infrastructure required for advancing net-zero transformation through technology. In addition to aligning with the 12 key strategies announced by the National Development Council (NDC), the Net-Zero Technology Plan integrates resources across government ministries, fosters public–

private partnerships, and engages in international cooperation. This systemic approach accelerates cross-disciplinary, cross-sector, and cross-border net-zero technology R&D, driving Taiwan closer to its 2050 net-zero emissions target.

The plan encompasses five major technological fields, with related scientific and technological R&D topics planned as follows:

I. Sustainable and Forward-looking Energy

In advancing Taiwan's net-zero transition, a localized framework has been developed to address the country's industrial, environmental, and societal constraints. Achieving the vision of a net-zero generation relies on the development of sustainable and forward-looking energy technologies. In addition to fostering new energy sources, constructing a stable power supply system is crucial. Government agencies must integrate renewable energy with other energy sources while addressing risks to power stability. The development of energy storage and smart grid systems is vital to Taiwan's sustainable energy goals, supported by advancements in green energy technologies to meet net-zero objectives. The development status and purposes of key technologies in the sustainable and forward-looking energy field are described below.

1. Renewable Energy

Renewable energy plays a pivotal role in Taiwan's 2050 net-zero emissions blueprint. It is expected to account for 60–70% of the total electricity supply, reducing dependence on imported energy from 97.4% in 2021 to less than 50% by 2050. This will mitigate the impacts of global energy market fluctuations on energy security. Development efforts focus on (1) solar photovoltaic technologies, i.e., intensive development of high-efficiency PV modules; (2) offshore wind turbines, i.e., commercializing large-scale (15 MW) floating offshore wind turbines; (3) geothermal technology, i.e., conducting deep geothermal resource surveys as well as building and integrating materials; and (4) marine energy, i.e., researching wave power, ocean thermal energy conversion (OTEC), and marine current energy (Kuroshio Current).

2. Hydrogen Energy

Hydrogen energy is a critical technology for achieving net-zero emissions, with applications in zero-carbon industrial processes, heavy transport, and carbon-free power generation. Taiwan's hydrogen energy technology is currently in the R&D and demonstration phase, with efforts focused on developing efficient, stable, and cost-effective hydrogen production and storage. Key priorities include (1) regulatory adjustments to prepare for future hydrogen applications and public outreach to reduce resistance to hydrogen infrastructure development; (2) development and validation of decarbonized hydrogen production technologies and innovative green hydrogen generation techniques; (3) R&D of hydrogen distribution and storage infrastructure, including feasibility studies for liquid hydrogen receiving stations, hydrogen transportation, and alternative technologies (e.g., ammonia and methane); and (4) establishing technologies for hydrogen-powered systems, including operational testing and validation of high-temperature fuel cell power systems.

3. Energy Storage

Energy storage R&D emphasizes improving efficiency, safety, and cost-effectiveness while promoting resource recycling. Future efforts will emphasize (1) battery systems, including the development of low-cost, high-energy-density solid-state batteries, verification of next-generation advanced battery systems, and promotion of sustainable recycling and reuse of battery resources; (2) small-scale distributed energy storage systems, including the development of bidirectional charging technologies for Vehicle-to-Grid (V2G) and Grid-to-Vehicle (G2V) applications; and (3) energy storage management systems, particularly power control systems (PCSs), battery management systems (BMSs), and testing and validation of long-duration energy storage systems.

Additionally, efforts are being directed toward the integration of distributed energy storage (e.g., residential storage, V2G) and microgrid technologies. These systems enhance grid resilience (dispatch) under normal operating conditions, provide emergency backup power, can operate self-sufficiently, and store energy to reduce grid burden during nighttime peak hours. The grid can also operate independently when needed (i.e., during disasters) to ensure an essential power supply.

4. Grid Resilience and System Integration

To address transmission congestion in areas where renewable energy is heavily integrated, grid infrastructure and resilience must be strengthened and enhanced. Moreover, as the share of renewable

energy in the power mix increases, it is essential to improve the predictive capabilities of renewable energy supply, expand resource integration, and enhance flexibility to bolster grid resilience. In the future, grids will trend toward decentralization and intelligentization, necessitating load management and market mechanisms. Digitalized power systems combined with machine learning can significantly improve the accuracy of supply and demand forecasts. Key initiatives include advancing grid information and communication technology integration, refining smart grid technologies, implementing aggregation of distributed resources, and developing diverse resource scheduling and control technologies. Furthermore, efforts are being made to enhance the auxiliary capabilities of green energy and energy storage systems, improving the efficiency of renewable energy grid integration. Beyond power and grid-related infrastructure, system analysis and other critical technologies are required. By integrating resources across industry, government, and academia, this initiative aims to promote both horizontal and vertical localization and deepen technological expertise in the energy sector.

5. Other Energy Sources

Other energy sources include new energy options such as bio-energy and nuclear fusion. Bio-energy is not only considered a low-carbon energy source but also a negative-carbon technology option. Efforts are planned for initiatives such as utilizing solid recovered fuel (SRF) and agricultural waste for energy production, expanding the availability of biomass feedstocks, improving regulatory frameworks, and mitigating environmental impacts. Nuclear fusion, a clean energy source with high potential for carbon reduction, requires ongoing attention to international developments in fusion technology and commercialization. At an appropriate time, relevant regulatory frameworks will need to be established. Current efforts focus on international collaboration in the development of magnetic confinement high-temperature plasma technology, fostering talent in net-zero technologies, and building evaluation capabilities for the introduction of new energy technologies.

II. Low Carbon and Carbon Reduction

Taiwan plays a crucial role in the global supply chain, particularly excelling in the industrial products and the electronic information and communications technology sectors. Industrial exports account for over 50% of Taiwan's gross domestic product, (GDP) Taiwan dominates the semiconductor industry, accounting for 78% of global wafer foundry production and 60% of packaging and testing; however, this also results in high electricity consumption and carbon emissions in the manufacturing sector. For example, in 2019, greenhouse gas emissions from the manufacturing sector reached 147.46 million metric tons of CO_2 equivalent ($MtCO_2e$), representing approximately 51% of the nation's total emissions. Given the manufacturing sector's significant role in Taiwan's economy and employment, aligning with global decarbonization trends is imperative. Taiwan's products must progressively move toward decarbonization to enhance its competitiveness in the global supply chain. In response to international decarbonization trends and governmental policies, Taiwan's industries have actively implemented carbon reduction measures. These efforts include adopting zero-carbon electricity, enhancing energy efficiency, utilizing low-carbon fuels, developing innovative decarbonization technologies, and reducing fluorinated gases in the electronics industry. Industries are also exploring transformation strategies and identifying new business opportunities. According to reports from the International Energy Agency (IEA), the carbon reduction potential of current technologies is limited and insufficient to achieve net-zero emissions targets. Consequently, future decarbonization efforts will require breakthroughs in innovative technologies. Demonstration projects and pilot implementations are targeted after 2030, with an aim to accelerate commercialization and achieve net-zero emissions by 2050.

1. Industrial Sector

The industrial sector focuses on technological development and upgrades in steel, petrochemical, and electronics processes. Planned efforts include: (1) carbon-free steelmaking: developing reduction technologies using alternative fuels or materials, phasing out coal in favor of carbon-free steelmaking processes, improving material and energy efficiency, enhancing the recycling and reuse of scrap steel and slag, and adopting CCUS technologies; (2) low-carbon petrochemical processes: accelerating the development of alternative fuels and new low-carbon feedstocks, advanced processes for CO_2 reuse, electrification of steam cracking units, high-efficiency processes, thermal cycle integration, and

high-temperature energy management technologies; and (3) electronics manufacturing: developing greenhouse gas reduction technologies with high carbon equivalence, as well as key technologies for energy-saving semiconductor processes and energy-efficient peripheral equipment.

2. Residential and Commercial Sector

The residential and commercial sector emphasizes: (1) high-efficiency equipment, i.e., establishing energy efficiency standards and aftermarket management for appliances and improving the energy efficiency of vehicles and chillers; (2) energy management systems and assistance, including mandatory energy-saving regulations and assistance for large energy users in the service sector, energy-saving diagnostics for small and medium-sized users, training of energy-saving diagnostic professionals, implementing smart energy management technologies in buildings, and promoting energy data collection and open applications for smart buildings; (3) big data analysis and policy planning, such as innovative research on energy consumption and energy efficiency data science; and (4) low-carbon transformation in the commercial sector, including constructing smart low-carbon models to assist enterprises in transitioning to low-carbon operations and providing energy consumption equipment planning and diagnostics to help businesses adopt new business models.

3. Green Construction Engineering

Green construction engineering efforts focus on: (1) Smart design and supervision, e.g., integrating passive energy-saving designs into green buildings, establishing a carbon reduction platform for construction projects, employing artificial intelligence (AI) for energy-saving supervision, and developing applications like Building Information Modeling (BIM), carbon reduction calculations, and evaluation technologies; (2) low-carbon construction methods and materials, including collecting and adopting precast methods, upgrading technologies, analyzing carbon reduction performance, developing low-carbon concrete mixtures, applying 3D printing to concrete blocks, utilizing waste materials in low-carbon construction methods, carbon storage in building materials, passive energy-saving buildings, and fire-resistant wood construction technology validation; and (3) Introducing net-zero procurement guidelines and regulations, such as integrating circular materials or low-carbon construction methods into public works bidding and government procurement procedures, with government bureaus leading the private sector in related technological development.

4. Green Transportation

Green transportation focuses on: (1) electric vehicles, including the development of key technologies for bidirectional charging at charging stations; and (2) heavy-duty hydrogen-powered vehicles, e.g., the development of medium-sized hydrogen buses and medium-to-heavy hydrogen-powered trucks.

III. Carbon Negative

The Intergovernmental Panel on Climate Change (IPCC) reports define negative emission technologies (NETs) as technologies that remove carbon dioxide from the atmosphere, also known as Carbon Dioxide Removal (CDR). To achieve the goals of the Paris Agreement, large-scale deployment of negative emission technologies will be required during the second half of this century. According to IPCC calculations, approximately 12 billion metric tons of carbon dioxide—equivalent to one-third of current global emissions—must be captured and stored annually after 2050. In addition to significantly increasing the use of renewable energy, Taiwan must also adopt carbon negative technologies to achieve its net-zero transition goals. Specific measures will include the development of carbon capture, utilization, and storage (CCUS) technologies, as well as enhancing the carbon sequestration capacities of forests, soils, and oceans. Details are as follows:

1. Carbon Capture, Utilization, and Storage (CCUS)

After carbon dioxide is captured, subsequent processing is required to achieve carbon-negative benefits. This can be achieved by reutilizing CO_2 within a circular economy concept or by sequestering it. Planned efforts include (1) advancing mature carbon capture technologies and developing innovative techniques, such as chemical absorption, calcium looping, and membrane technologies; (2) developing cutting-edge carbon utilization technologies, including CO_2 conversion into fuels or chemicals and high-efficiency and novel catalysts; (3) establishing and operating demonstration production lines for integrated steelmaking and carbon capture, along with building related technologies; (4) advancing carbon sequestration

technologies through geological exploration, storage potential assessments, site evaluations, geological surveys, public communication, injection and storage operations, and monitoring and maintenance technologies; and (5) creating environmentally friendly and highly effective carbon-negative solutions using microalgae and solid materials for direct air carbon capture, as well as conducting advanced trials on Bio-energy with Carbon Capture and Storage (BECCS) technologies and derivatives.

2. Natural Carbon Sinks

Natural carbon sink pathways to achieving net-zero emissions primarily focus on three potential areas: forests, soils, and oceans. Natural carbon sink efforts depend heavily on technological advancements—international reports and consensus indicate that relying solely on existing technologies will make it challenging to meet net-zero emission targets within the set timeframe. To ensure the effective implementation of natural carbon sink measures, significant resources must be invested in technological innovation during the early stage (before 2030). The aim is to increase carbon sequestration through scientific research, industry guidance, and creating a sustainable environment that encourages participation from farmers and related industries.

To maximize carbon sequestration benefits and align with international methodologies for natural carbon sinks, Taiwan focuses on developing research strategies in three key areas: forests, soils, and oceans. These strategies include advancing management models and technological research for forest carbon sequestration, developing carbon-negative agricultural practices, conducting studies and benefit assessments of marine and fisheries carbon sink technologies, and establishing methodologies for measuring agricultural carbon sequestration along with mechanisms to incentivize sequestration. These efforts aim to facilitate the implementation of future natural carbon sink initiatives and enhance overall sequestration effectiveness.

Ⅳ. Circular Economy

The circular economy emphasizes the cyclical regeneration of resources through production, consumption, recycling, and reuse, aiming to replace the current linear economic model. This economic approach seeks to reduce waste generation and enhance recycling by utilizing renewable materials, redesigning products, or improving manufacturing processes. On the basis of data from Taiwan's greenhouse gas inventory, the waste sector accounts for 1% of total emissions, whereas the agriculture sector (including agriculture, forestry, fisheries, and livestock) accounts for 2.1%. Emissions from the waste sector primarily arise from waste treatment processes, including wastewater, landfills, and incineration. In the agriculture sector, emissions come from direct agricultural operations (e.g., composting), electricity consumption for agricultural activities, and fuel combustion during operations. To achieve the goals of a circular economy, future technological developments will focus on three areas: industrial and domestic waste recycling, water resource recycling, and biological recycling.

1. Industrial and Domestic Waste Recycling

In 2018, greenhouse gas emissions from Taiwan's waste sector accounted for 1% of total national emissions, with emissions from waste treatment processes comprising 90% thereof. Key sources included industrial and domestic wastewater (approximately 63%), landfills (25%), and waste incineration (6%). Therefore, accelerating the adoption of innovative waste recycling technologies is critical for carbon reduction. Future efforts will focus on (1) recyclable (regenerated) materials, i.e., promoting material recycling to enhance steel regeneration, increasing the usage rate of recyclable materials in domestic construction mixtures, developing recyclable raw materials for paper products, and advancing technology for food-grade recycled materials; (2) waste heat power generation and thermal applications, such as utilizing waste heat generated during anaerobic pyrolysis of biomass materials for thermal recycling and converting residual heat into electricity for on-site lighting; (3) process waste recycling, i.e., developing material recycling technologies for energy applications (including easily disassembled solar panels), recycling wind turbine blades, and reusing coal ash from thermal power plants; (4) establishing comprehensive recycling models and mechanisms for construction waste, advancing asbestos recycling technologies, promoting the reuse of construction waste, and developing asphalt milling recycling techniques; (5) creating comprehensive recycling models and mechanisms for plastic and textile waste, eliminating unnecessary plastic packaging through source design, recycling waste plastics to

reduce carbon emissions, developing key optical modules for waste plastic identification, innovating plastic pyrolysis technologies, and producing sustainable textiles; and (6) recycling and reusing domestic waste, such as precious metals from consumer electronics, batteries, and other devices.

2. Water Resource Recycling

Greenhouse gas emissions from waste treatment processes constitute 90% of the total emissions in the waste sector, with 34% originating from industrial wastewater treatment and 29% from domestic wastewater treatment. Industrial wastewater emissions primarily stem from the manufacturing, chemical, and electronics industries. However, Taiwan's current sewage treatment rate remains low (below 70%), and technologies for methane recovery during wastewater treatment are still lacking. Therefore, increasing the sewage treatment rate and methane recovery efficiency are key priorities. Furthermore, with water resources becoming increasingly scarce, developing emerging water resources is also a critical area for future development. Future efforts will focus on (1) domestic water recycling, i.e., developing technologies for collecting low-flux, low-concentration methane from wastewater; (2) agricultural irrigation water recycling, i.e., developing resource recycling technologies for ammonia and nitrogen-rich wastewater; (3) industrial water recycling, i.e., utilizing upflow anaerobic sludge bed systems for industrial wastewater treatment, advancing technologies for recovering valuable materials from wastewater, and developing and applying techniques for treating hard-to-degrade substances; and (4) emerging water resources, such as researching and developing low-carbon brackish water desalination technologies.

3. Biological Recycling

Future efforts will focus on the reuse of resources and waste from the agricultural, forestry, fishery, and livestock industries. This includes developing agricultural recycling technologies, employing biological control methods to manage nutrient release and enhance fertilizer efficiency, converting biological processes into energy and chemicals (bioenergy and biochemicals), producing plastics from biomass materials, researching high-value applications for surplus materials, advancing innovative waste-to-energy technologies (such as anaerobic digestion for biogas power generation), and promoting the treatment and disposal of by-products.

V. Humanities and Social Sciences

Taiwan's net-zero transition not only focuses on sustainable energy, low-carbon and carbon-negative approaches, and circular economy initiatives but also emphasizes the critical role of humanities and social sciences. Greenhouse gas emissions fundamentally result from services and products designed to meet societal needs, meaning that people's lifestyle choices and consumption behaviors significantly influence carbon emissions. Establishing dialogue platforms, promoting civic participation, and implementing net-zero lifestyles can foster demand-side solutions that drive changes in industry supply chains, further reducing emissions in residential, commercial, and transportation sectors, and accelerating Taiwan's progress toward net-zero goals. Integrating social sciences with natural sciences is essential to creating a virtuous cycle of sustainable development, with national strategies playing a pivotal role in the overall net-zero transition. It is imperative to construct effective evaluation models and conduct ongoing reviews of the implementation outcomes of various strategies. Moreover, in accordance with the national net-zero transition strategy, it is critical to ensure transparency and fairness throughout the planning process by establishing mechanisms for public information disclosure and equitable transition policies. Creating a robust carbon trading platform and pricing mechanism will guide the healthy development of the carbon market. Collaboration with the financial sector is also necessary to channel funding to green and sustainable industries, which will facilitate harmonious economic, social, and environmental prosperity.

1. Net-Zero Green Living (Low-Carbon Living)

To promote net-zero green living, fundamental changes in people's habits regarding food, clothing, housing, and transportation are essential. Additionally, businesses must be encouraged to develop carbon-reducing commercial models to adapt to shifting consumption patterns. Future efforts will focus on: (1) expanding the participation of civic groups in advancing net-zero green living by providing grants and subsidies to help scale up and broaden innovative net-zero services, achieving comprehensive promotion through initiatives such as net-zero living demonstration projects; (2) spatial planning and environmental research, including the

implementation of pilot programs for smart and climate-friendly campuses; (3) cultural industries, i.e., conducting carbon inventories for cultural venues, drafting and promoting net-zero guidelines for the cultural sector, and assisting arts and cultural groups in adopting carbon-reducing measures for exhibitions and performances; and (4) net-zero public venues and facilities, including strengthening connections between public transportation hubs, green transport options, and pedestrian-friendly environments.

2. Green Finance

To encourage the financial sector and businesses to prioritize climate change mitigation and sustainable development, the Financial Supervisory Commission has drawn on international trends to establish a framework and foundation for fostering a green and sustainable financial market. This includes enhancing the quality and transparency of ESG information disclosures, developing methods to classify sustainable economic activities, and guiding financial institutions to invest in and finance green energy industries. These efforts also extend to providing financial support for green and sustainable development and building the financial sector's resilience to climate change risks. Future green finance initiatives will continue to explore guidelines and measures for the financial industry, actively aligning with international practices. These initiatives aim to drive financial institutions to set carbon reduction targets and strategies while channeling funds toward sustainable economic activities, which will encouraging more businesses to transition toward decarbonization and sustainable development.

3. Just Transition Mechanism

The core of Taiwan's just transition strategy is to incorporate diverse perspectives and establish a comprehensive implementation mechanism with the goal of leaving no one behind. Strategies must include the establishment of transparent public–private communication platforms and, more importantly, the identification of affected key groups and areas, such as labor rights, industrial transformation, regional resource allocation, and public livelihood needs. By defining the impacted stakeholders within each primary focus area, resources from public and private sectors can be combined to develop feasible just transition strategies and support measures. Future efforts will focus on (1) regulatory adjustments, such as refining mechanisms for conflict resolution and dispute management; (2) establishing support systems, such as building the necessary social science foundation for net-zero policies and societal adaptation; (3) green employment, e.g., implementing professional training programs for automotive repair technicians to adapt to the electrification of vehicles; and (4) public communication and civic engagement to ensure communication with stakeholders including industries, the public, youth, and civic groups.

4. Net-Zero Strategies and International Collaboration

To promote net-zero emissions and achieve national net-zero goals, a comprehensive approach is required, encompassing the formulation of national net-zero strategies, regular assessments of carbon emissions trends and mitigation effectiveness, and assisting enterprises in complying with domestic and international regulations while investing in carbon reduction equipment and technologies. Efforts will focus on (1) national net-zero strategies, including strategy planning, pathway evaluation, mechanism design, and outcome promotion; (2) international collaboration, including the analysis of Article 6 of the Paris Agreement on market and non-market mechanisms, development of mitigation methodologies, and international cooperation roadmaps; (3) talent development, such as fostering carbon management professionals, establishing sustainable education demonstration bases, and conducting societal dialogue and empowerment activities; (4) policy support and adaptation, e.g., decision-making assistance for net-zero transition and industry compliance with regulations; and (5) digital carbon footprinting and audits, along with the development of relevant systems and environments and the provision of resources, training, guidance, and diagnostics for carbon inventory processes.

5. Impact Assessment

Leveraging expertise in social sciences, a comprehensive evaluation of the overall effectiveness of national net-zero strategies is conducted to assess the economic and social impacts of various policies. From a social science perspective, recommendations are provided to refine or improve net-zero strategies, aiming to achieve the 2050 net-zero transition goal. Efforts are directed toward (1) net-zero system modeling and scenario simulations, such as using integrated models to assess the effectiveness of implementing 12 key strategies; (2) socio-economic

impacts and co-benefit assessments, such as establishing models for Taiwan's net-zero green lifestyle scenarios; (3) net-zero investment and economic modeling; (4) evaluation of decarbonization benefits and strategic analysis from a humanities and social sciences perspective; and (5) national net-zero financial analysis.

7.1.2 Development of Adaptation Technologies

In May 2024, the National Science and Technology Council (NSTC) and the Ministry of Environment published *Climate Change in Taiwan: National Scientific Report 2024*, which reviewed the current state of domestic research and technology applications in impact assessment data, tools, and methodologies. The findings highlighted foundational data gaps and areas for improvement in impact assessment methods and tool development, providing a reference for subsequent planning and investment in research resources.

I. Foundational Data

Taiwan needs to enhance the production of high-resolution hourly typhoon rainfall data to ensure that flood estimation outcomes accurately reflect the island's terrain and rainfall distribution patterns. Additionally, capabilities in drought frequency and scale forecasting and early warning systems require significant advancement.

II. Terrestrial Ecology

Efforts should focus on completing forest dynamic plot monitoring, high-altitude grassland ecosystem plots, and the Taiwan Breeding Bird Survey. Promoting fundamental biological research is essential, particularly in examining the relationships between meteorological factors and species growth responses.

III. Health Sector

This includes strengthening Taiwan-specific climate risk indicators, large cohort study data, historical diurnal temperature range observation data, physiological equivalent temperature (PET) indices, and composite temperature–heat indices. Such advancements will facilitate the validation of various predictive models analyzing the links between climate change and health impacts. Furthermore, analyzing the consistency of results across models is crucial to improving the reliability and validity of assessments.

IV. Coastal Areas

It is essential to complete predictive models encompassing various spatial and multi-scale data, including estimates of coastal topographic changes across Taiwan, on-site measurements, and underwater observation data. Efforts should also focus on providing more precise simulations of shoreline or coastal topography change trends. In fisheries, environmental monitoring data for aquaculture zones should be strengthened, and sustained spatial and temporal coverage of surveys on current marine fishing activities and ecosystems should be expanded.

V. Water Resources

Enhancements in climate model parameterization and the establishment of heavy rainfall observation equipment or region-specific observation methods are needed. Additionally, collaboration with neighboring countries to improve typhoon trajectory and rainfall estimation techniques should be considered.

VI. Land Use

Efforts should integrate and construct hazard scenarios related to climate change, develop the relationship between spatial social drivers and disaster response adaptation capabilities, and improve risk assessment methods and case studies. The integration of land-use change technologies with spatially complex vulnerability assessment techniques will further refine risk evaluation.

VII. Marine Research Topics

Priority should be given to developing ecological impact assessment and predictive climate impact models for economically significant marine species. Comprehensive underwater observation data are necessary to enhance model validation capabilities.

VIII. Sloped Land Areas

Research should focus on understanding the interactions between slope hydrology and stability. This foundation will support the development of advanced monitoring technologies and predictive modeling tools. Efforts should also aim to better analyze the effects of temperature fluctuations and alternating rainfall patterns, such as drought–flood cycles.

IX. Reducing Uncertainty in Projections and Tool Applications

To strengthen evidence-based governance in adaptation applications, reducing uncertainties in climate modeling projections and assessment tools remains a key objective. For example, in flood analysis, employing irregular grids and supporting parallel computations could integrate the strengths of various flood simulation tools. This approach would enhance multi-model flood evaluations and address uncertainties in climate change-induced flood disaster analyses.

7.2 Technology Demand and Transfer

As the greenhouse effect intensifies, the impacts of climate change on the global environment have grown increasingly severe. To address this challenge, the United Nations Framework Convention on Climate Change (UNFCCC) has proposed four key strategies: The first is climate change mitigation through the reduction of greenhouse gas emissions. The second is adaptation, i.e., implementing measures to adjust to and manage environmental changes. The third is developing the technology required to support mitigation and adaptation actions, and the fourth is securing the necessary finance for essential resources.

7.2.1 Technology Demand

On March 30, 2022, the National Development Council (NDC), in collaboration with various ministries, announced Taiwan's Pathway to Net-zero Emissions in 2050. This document established four transformation pathways (energy transition, industrial transition, lifestyle transition, and social transition) as well as two governance foundations (technology R&D and climate legislation). Additionally, it outlined 12 Key Strategies to guide action plans across sectors and facilitate public communication efforts:

I. Wind/Solar PV

To expand offshore wind farm development into deeper waters, Taiwan is advancing floating wind power demonstration projects, guiding the construction of floating offshore wind farms, and promoting the testing and validation of floating wind technologies. These efforts aim to establish autonomous technical capabilities in deepwater maritime engineering. Additionally, Taiwan is developing localized digital operation and maintenance (O&M) technologies to reduce costs and ensure stable power generation. Specific initiatives include leveraging Taiwan's strengths in information and communication technology and the Internet of Things (IoT) to develop unmanned inspection and intelligent diagnostic technologies. Furthermore, integrated O&M information platforms and maritime engineering scheduling systems are being created to enhance efficiency by consolidating climate windows, component logistics, and vessel information.

II. Hydrogen

To ensure a stable hydrogen supply and promote its applications, strategies focus on three key areas: supply, application, and infrastructure. In terms of supply, Taiwan is developing blue hydrogen technologies by integrating natural gas reforming with carbon capture and storage systems. Efforts also include fostering international cooperation on hydrogen supply chains, evaluating the feasibility of liquid hydrogen receiving terminals, and initiating preliminary demonstration projects. With regard to applications, Taiwan is actively engaged in international collaboration to introduce hydrogen–ammonia co-firing technologies, test hydrogen–natural gas and ammonia–coal co-firing demonstration units, and develop domestic operation and maintenance capabilities for co-firing or dedicated hydrogen power generation. Additional initiatives include the development of hydrogen-based steelmaking technologies and demonstration projects for hydrogen fuel cell buses on actual public transit routes. As for infrastructure, Taiwan is establishing hydrogen distribution networks, conducting natural gas pipeline hydrogen blending tests, and developing hydrogen monitoring systems. Efforts also include constructing mobile hydrogen refueling stations to support vehicle demonstrations, enhancing high-pressure hydrogen storage facilities, and building infrastructure for liquid hydrogen storage and distribution, with a focus on demonstrating and applying these technologies.

III. Innovative Energy

To facilitate geothermal energy development, incentives have been enhanced through rolling reviews of feed-in tariffs (FITs), including preferential FITs for small-scale power plants and additional

benefits for projects in indigenous communities. A demonstration reward mechanism has been introduced to share risks with developers. Public agencies are actively engaged in geothermal resource exploration, and the exploration data is made publicly available to reduce industry risks. Further efforts include expanding drilling capacity and fostering international cooperation to advance cutting-edge geothermal technologies. For biomass energy, market development is supported through FITs and demonstration rewards. Large-scale dedicated biomass systems are being introduced, alongside the establishment of robust logistical mechanisms for material supply. Technological optimization focuses on multi-fuel conversion techniques and the reutilization of by-products. For marine energy, steps are being taken to streamline application processes and revise FITs to provide reasonable incentives. R&D, as well as the introduction of new technologies, are being carried out to enable deployment testing and validation in marine environments. These efforts aim to improve energy efficiency and address challenges posed by extreme weather and seismic activities.

IV. Power Systems & Energy Storage

Measures to facilitate the coordinated development of renewable energy and power systems include enhancing grid engineering, optimizing regional grid transmission capacity, introducing power quality control equipment, and upgrading traditional power plants' ability to respond to the challenges of renewable energy integration. Targeted grid reinforcement projects are being planned in areas with concentrated offshore wind and solar power generation. Centralized grids are being transformed into distributed grids to alleviate load and improve supply stability. The implementation of devices like static synchronous compensators strengthens system voltage stability, and upgrading technology in newly built gas-fired combined-cycle power units improves their capacity to manage fluctuations in renewable energy generation. Advancements in renewable energy forecasting and the widespread adoption of smart meters have enhanced monitoring accuracy and improved grid dispatch efficiency renewable energy. Energy storage systems are also being integrated to improve grid flexibility and regulatory capacity. Finally, interoperability and information integration within smart grids, coupled with refined regional grid dispatch mechanisms, make grids more adaptable to future energy challenges. This transition is supported by the establishment and revision of relevant national standards to ensure successful implementation.

V. Energy Saving & Efficiency

Carbon reduction technologies have been developed for steelmaking processes, including the adoption of automated digital simulation systems and temperature-resistant ceramic coating materials, which have significantly enhanced furnace temperature precision, reducing thermal losses and energy consumption by 11.5%. Efforts to achieve self-sufficiency in rare earth elements have resulted in breakthroughs, such as the extraction of kilogram-level neodymium and a 50% recycling rate for waste acids, which have substantially lowered energy consumption. Newly developed high-efficiency refrigeration and air conditioning equipment utilizing R1234ze refrigerant has surpassed the performance of comparable refrigerants by 2%, achieving energy savings and carbon reduction goals. Additionally, an active step-down power factor correction circuit for GaN devices has been developed, achieving a prototype power supply efficiency of 95%, with patents filed for the innovation.

VI. Carbon Capture, Utilization & Storage (CCUS)

Taiwan faces challenges in implementing carbon capture and storage technologies, particularly high costs and scaling issues. Currently, CO_2 capture costs remain high, which has hindered widespread commercial application. Future efforts aim to innovate capture agents and processes to reduce costs to below US$35 per ton and progressively scale up verification systems to ensure technical feasibility. The Ministry of Economic Affairs has outlined plans to invest in technology development, implement projects through state-owned enterprises, and promote industrial applications. A phased approach will be adopted for critical carbon cycle technology development and pilot projects. These initiatives include the development of low-temperature adsorption–desorption technology, long-life CO_2 capture agents, and site validation techniques for petrochemical upstream feedstock in combination with green hydrogen technologies. China Steel Corporation and CPC Corporation are responsible for practical implementation, including the construction of pilot production lines for steel–carbon integration and CO_2 capture facilities. The goal is to achieve annual carbon reductions of 2.9 million tons by 2040. Concurrently, the Energy Administration is advancing a CCS trial project in alignment with the 2050 net-

zero emissions pathway to validate the feasibility and safety of geological storage, laying the groundwork for future commercial operations and supporting the development of related legal frameworks.

VII.Carbon-free & Electric Vehicles

The government offers subsidies to assist motorists in transitioning from conventional gasoline vehicles to electric vehicles (EVs), thereby driving market demand for EVs and related industries. It has also adjusted vehicle management regulations and mechanisms to establish a conducive technical environment for EV development. Strategies to address the challenge of EV charging include expanding the installation of charging facilities, optimizing technical standards, and increasing the accessibility of charging infrastructure. These measures aim to lower the technological barriers for transitioning from gasoline vehicles to EVs. The strategies also emphasize upgrading and transforming the vehicle industry by enhancing technical capabilities and cultivating technical talent. This approach fosters local development of EV production, manufacturing, and maintenance technologies while exploring emerging technological fields.

VIII. Resource Recycling & Zero Waste

Efforts focus on the circular utilization of biomass, plastics, solid recovered fuel (SRF), chemicals, and inorganic recycled aggregates. To facilitate biomass resource recycling, cross-agency collaboration is conducted to inventory domestic biomass resources, analyze optimal treatment methods, establish demonstration models, and develop reuse technology guidelines to promote efficient utilization. In plastics recycling, the emphasis is on promoting recyclable designs, expanding the recycling system, increasing the proportion of recycled materials, and streamlining the application processes for the use of rPET pellets made from PET plastics. To increase SRF recycling, waste conversion technologies have been promoted and management mechanisms for SRF production and use have been established to ensure environmental benefits. Regarding chemical recycling, national industrial networks are assessed to identify priority chemicals, encourage the segregation and purification of waste chemicals, and develop an information-sharing platform to facilitate cross-industry recycling. In the realm of inorganic recycled aggregates, upstream management and classification have been implemented to improve resource utilization efficiency, and new technologies are being developed to enhance aggregate quality and carbon reduction benefits. Digital tools are also employed to increase adoption rates among engineering units.

IX. Carbon Sinks

Measures to increase forest carbon sinks include the use of remote sensing imagery and regression models to precisely estimate forest stock. Additionally, a material volume model for Taiwan incense cedar has been established to improve carbon sink calculation accuracy. Research on the use of domestic timber and carbon sequestration estimates is in progress, accompanied by the development of relevant standards and guidelines. For soil carbon sinks, non-destructive measurement technologies have undergone field validation, resulting in the establishing of methods for estimating soil carbon storage and potential. Carbon-negative agricultural practices are also being promoted, with the aim of increasing organic matter in soil. Efforts related to marine carbon sinks include identifying potential marine carbon sink sites, developing techniques and measurement methods for seagrass restoration and wetland protection, and promoting the application and demonstration of mangrove and seagrass restoration technologies. These measures strengthen the management and technological development of various carbon sinks, providing technical support for achieving carbon neutrality.

X. Green Lifestyle

Zero-waste and low-carbon dining measures, such as planned purchasing, shared tableware, and reusable containers, are implemented to reduce food waste and single-use items. Eco-friendly green fashion promotes environmentally friendly materials for in clothing and functional apparel and employs carbon footprint labels to enhance the sustainability of production and consumption. Residential quality is improved through the promotion of passive energy-saving building designs and smart control technologies, along with low-carbon construction materials to reduce operational carbon emissions in buildings. Technical measures for the development of low-carbon transportation networks include shared vehicles, transit-oriented land use, promotion of green freight, and green tourism to reduce carbon emissions from transportation. In shopping, business models that emphasize use over ownership are encouraged, along with the promotion of environmentally friendly products, component recycling technologies, and extended product lifespans. These technological initiatives foster green transformation across sectors,

enhance public engagement and education, and encourage nationwide participation in achieving net-zero green living.

XI. Green Finance

The Financial Supervisory Commission (FSC) is fostering a collaborative network of financial institutions to encourage information exchange and the formulation of carbon reduction strategies. This initiative aims to amplify the financial sector's influence on the net-zero transition while steering the broader industrial supply chain toward sustainable development. Regarding carbon emissions disclosure, the FSC is advancing efforts for financial institutions to conduct carbon emission inventories across Scopes 1, 2, and 3. It also requires publicly listed companies to undertake greenhouse gas inventories, which inform businesses and financial entities of their high-emission areas and enable them to adjust their operational strategies. Furthermore, the FSC is working to integrate corporate ESG and climate-related data by establishing an ESG information platform. This platform supports climate risk management for businesses and financial institutions by facilitating data integration and application, thereby enhancing climate resilience and risk mitigation capabilities.

XII. Just Transition

The Ministry of Labor, the Council of Indigenous Peoples, and the various agencies responsible for overseeing the key strategies have formed a cross-ministerial task force to ensure just transition. The task force identifies the groups and regions affected by the net-zero transition and develops strategies to promote equitable resource allocation and complementary policies. Additionally, the Just Transition Committee, comprising representatives from government and civil society, oversees and advises on just transition policies to ensure alignment with the principles of fairness and transparency. To strengthen the scientific foundation and social consensus of these policies, academic and strategic review groups have been established. These groups systematically examine the technologies, budgets, and social communication aspects of key strategies, providing quantified impact assessments and risk analyses. Moreover, an issue identification group focuses on cross-strategy just transition issues, ensuring that such issues are fully considered and effectively addressed in policymaking. These mechanisms, combined with technological innovations, provide a robust foundation for equity and sustainability during Taiwan's journey toward a net-zero future.

7.2.2 Technology Transfer

The United Nations Framework Convention on Climate Change (UNFCCC) has established a technology mechanism comprising the Conference of the Parties (COP), the Technology Executive Committee (TEC), and the Climate Technology Centre and Network (CTCN). These entities collaboratively promote the development, dissemination, and transfer of technologies as essential tools for advancing climate actions. During the technology development phase, lifecycle analysis and prioritization are conducted for various technologies. The diffusion phase focuses on societal application and acceptance, emphasizing market, industry, and economic drivers. After technologies mature, their transfer can address regional challenges and contribute to achieving global climate action goals. In alignment with the UNFCCC and the Paris Agreement, Taiwan's Ministry of Foreign Affairs collaborates with the International Cooperation and Development Fund (TaiwanICDF) and other government agencies to enhance Taiwan's participation in international climate cooperation. These efforts aim to promote the international application of Taiwan's mitigation and adaptation technologies while assisting allied and partner countries in strengthening their capacity to tackle climate change. This section highlights key examples of Taiwan's contributions to international climate cooperation through technology transfer.

Table 7.2.2-1. Objectives and Implementation Methods for Technology Development, Deployment, and Transfer

Domain-Specific Technology Policy Tools	Objectives	Implementation Methods
Technology Development	1. R&D 2. Technology Assessment 3. Capacity Building	Analysis of technology life cycle stages: introduction, growth, maturity, saturation Technology classification: emerging, key, and foundational technologies Analysis of technological efficacy and sustained R&D investment 7-21
Technology Deployment	1. Social acceptance and application of technology 2. Industrial development of technology	Relationship between technology and commercialization: technology maturity, commercialization timeline, research knowledge, predictability, and sustained product viability Comprehensive industry analysis: evaluation of technological maturity, market value, and potential application of various adaptation technologies
Technology Transfer	1. Application through international cooperation. 2. Technology needs assessment 3. Technology training. 4. Capacity building	Intellectual property rights transfer Licensing and utilization of know-how Establishment of domestic and international technology transfer mechanisms and pathways

Source: Official Website of the United Nations Framework Convention on Climate Change (UNFCCC) - Support.

I. Guatemala Early Warning and Disaster Management System Project

Guatemala faces numerous natural disasters annually, particularly during the rainy season, which brings heavy rains, tropical storms, and hurricanes that trigger floods and landslides. These challenges are exacerbated by the country's rugged terrain and the concentration of many residents in high-risk disaster-prone areas. This project integrates climate information with disaster prevention tools to establish an early warning and decision-support system for the Cahabón River Basin, aiming to enhance flood and landslide response capabilities in San Pedro Carchá and Cobán in Alta Verapaz Province and reduce post-disaster response times in demonstration communities by over 30%. As of June 2024, the project's key outcomes include:

1. Updating disaster prevention maps for the Cahabón River Basin and establishing a disaster early warning information platform to support decision-making.
2. Strengthening environmental monitoring systems in demonstration areas by installing three rainfall and water level observation stations in the Cahabón River Basin. IoT was used to transmit real-time meteorological data and improve disaster warning accuracy.
3. Assisting three disaster-resistant communities in formulating landslide evacuation plans and enhancing community disaster awareness and response capabilities through disaster education and drills.

II. Flood Warning Capacity Improvement for the Belize River Basin Project

This project builds on the achievements and experiences of the Belize Urban Resilience Disaster Prevention Project by adopting a strategy of comprehensive watershed disaster governance. An early flood warning system for the Belize River Basin was designed to assist the Belizean government in disaster management. The project focuses on key locations, including the capital, Belmopan; the largest

city, Belize City; and the tourist city, San Ignacio. Capacity building and education training are provided to strengthen the technical skills of Belize's disaster prevention and relief agencies. The project aims to improve flood warning capabilities in critical cities and facilities within the Belize River Basin, extending the early warning time to 3 hours. As of June 2024, the project's key outcomes include:

1. Updating disaster prevention maps for San Ignacio, Belmopan, and Belize City; completing the installation of three hydrometeorological stations; and integrating advanced monitoring technologies to gradually establish a flood early warning notification system.
2. Completing a disaster preparedness drill for the Santa Familia demonstration community, including the restoration of one emergency disaster radio and preparation of disaster relief materials.
3. Inviting 10 personnel from Belizean disaster response agencies to Taiwan to participate in Rapid Disaster Response Team training, which aimed enhancing flood response capabilities.

III. Saint Kitts and Nevis Solid Waste Management and Recycling Project

This project responds to the severe environmental impact of plastic waste, a pressing issue raised by Saint Kitts and Nevis at COP25. It aligns with the global focus on waste management and United Nations Sustainable Development Goal (SDG) 12: ensure sustainable consumption and production patterns. TaiwanICDF collaborated with this Caribbean island nation, which is renowned for its tourism industry, to implement a resource recycling program. By leveraging Taiwan's expertise in waste recycling systems and reduction initiatives, the project promotes a circular economy, enhances environmental management capacity, increases resource reuse rates, and reduces waste generation, fostering an eco-friendly environment. As of June 2024, the key achievements include:

1. Organizing 70 resource recycling promotion sessions aimed at tourists and local residents to instill concepts of waste classification, recycling, and reduction, embedding the principles of resource recycling into the culture of Saint Kitts and Nevis and fostering a new eco-friendly lifestyle.
2. Hosting 53 public–private sector recycling model seminars and 48 recycling industry chain workshops to connect stakeholders, including the tourism industry, supermarkets, waste collection companies, and recyclers. This initiative establishes a comprehensive recycling model in Saint Kitts and Nevis, covering: waste source education (promoting waste classification among the public), collection and transportation (introducing diversified collection methods), preprocessing (establishing recycling compression and packaging facilities), and waste treatment (developing overseas recycling channels).
3. Conducting a recycling system survey and analysis, combined with strategic planning, to establish 68 recycling points. This effort enhances the efficiency of waste management in Saint Kitts and Nevis, doubling the amount of waste recycled.

IV. Agri-Cluster Consolidation and Cooperation Project in the Philippines

The Philippines, Taiwan's closest neighbor, faces an average of 20 typhoons annually. Coupled with heavy rainfall during the June-to-November rainy season, flooding severely impacts agricultural production, creating an urgent need to develop resilient agriculture. In response, TaiwanICDF's technical team in the Philippines collaborated with the Philippine Department of Agriculture to implement the Farm and Fisheries Clustering and Consolidation (F2C2) initiative, aimed at supporting small farming communities. Since 2022, the Agri-Cluster Consolidation and Cooperation Project (ACCC Project) has been promoted on Luzon Island. The project provides farmers with resources such as small agricultural machinery, facilities, and seedlings while offering farmers' associations diverse guidance to strengthen resource integration and build resilience in agricultural production.

The Tabon San Jose Farmer's Association (TSJFA) in the Province of Pampanga was the first agricultural community to be supported under this project. The technical team helped TSJFA establish a vegetable production demonstration base, mentoring 16 farmers (6 [38%] under 35 years old and 7 [44%] women) as the co-op's core team. Using the Farmer Field School Approach (FFS), the demonstration base introduced resilience-enhancing practices such as rainproof and flood-resistant infrastructure, drought-tolerant and flood-resistant crop varieties, disease-resistant grafted seedlings, field micro-meteorological stations, and disaster mitigation information dissemination via social media. This

practical training developed the core team's capacity to manage extreme climate events. The cultivation methods used at the demonstration base achieved higher yields and quality compared to traditional farming practices, with significant increases in bitter melon (+46.27%), tomato (+106.18%), eggplant (+102.7%), and cabbage (+92.07%). As a result of these improvements, the co-op farmers generated over five times the net income that would have resulted from a comparable area of rice production.

Additionally, to address the need for rapid recovery from agricultural losses caused by extreme weather, the technical team utilized typhoon-resistant greenhouses at the demonstration farm to produce emergency seedlings. This quick response allowed co-op farmers to resume farming promptly after disasters, mitigating losses and increasing income. For instance, following Typhoon Doksuri's devastation in late July 2023, the team partnered with the provincial government to provide 15,600 emergency seedlings, helping affected farmers restart production.

V. Innovative Project for Recycling and Reusing Plastic Waste in the Marshall Islands

Leveraging Taiwan's impressive 95% plastic bottle recycling rate and its mature recycling technologies, TaiwanICDF's technical team in the Marshall Islands collaborated with the College of the Marshall Islands (CMI) in 2021 to launch the Innovative Project for Recycling and Reusing Plastic Waste in the Marshall Islands. This project introduced Taiwan's recycling equipment and methods, applying circular economy concepts to help the Marshall Islands convert waste into usable resources. Additionally, it integrated the technical team's agricultural promotion initiatives by repurposing recycled plastics as materials for agricultural production, thereby enhancing agricultural resilience and amplifying the benefits of the technical cooperation project. This initiative also aimed to reduce single-use waste, carbon footprints, and marine pollution, while fostering an eco-friendly environment.

CMI established a Waste Plastic Recycling Facility using customized recycling equipment from Taiwanese providers, successfully transforming local plastic waste into planting containers. The project also supported CMI in calculating operational costs and suggesting pricing strategies for the recycled products, which were marketed as decorative flowerpots or as materials for school and home gardens promoted by the technical team. To further encourage recycling, CMI installed plastic bottle collection points on campus, motivating faculty and students to participate in resource recovery. A cashback incentive was introduced for community members recycling plastic bottles. Additionally, the technical team collaborated with the Public School System (PSS) to host environmental education activities in schools and communities, raising awareness about waste segregation and resource reuse. These efforts engaged 200 participants, fostering a new perspective on discarded plastic bottles and encouraging proactive recycling behavior.

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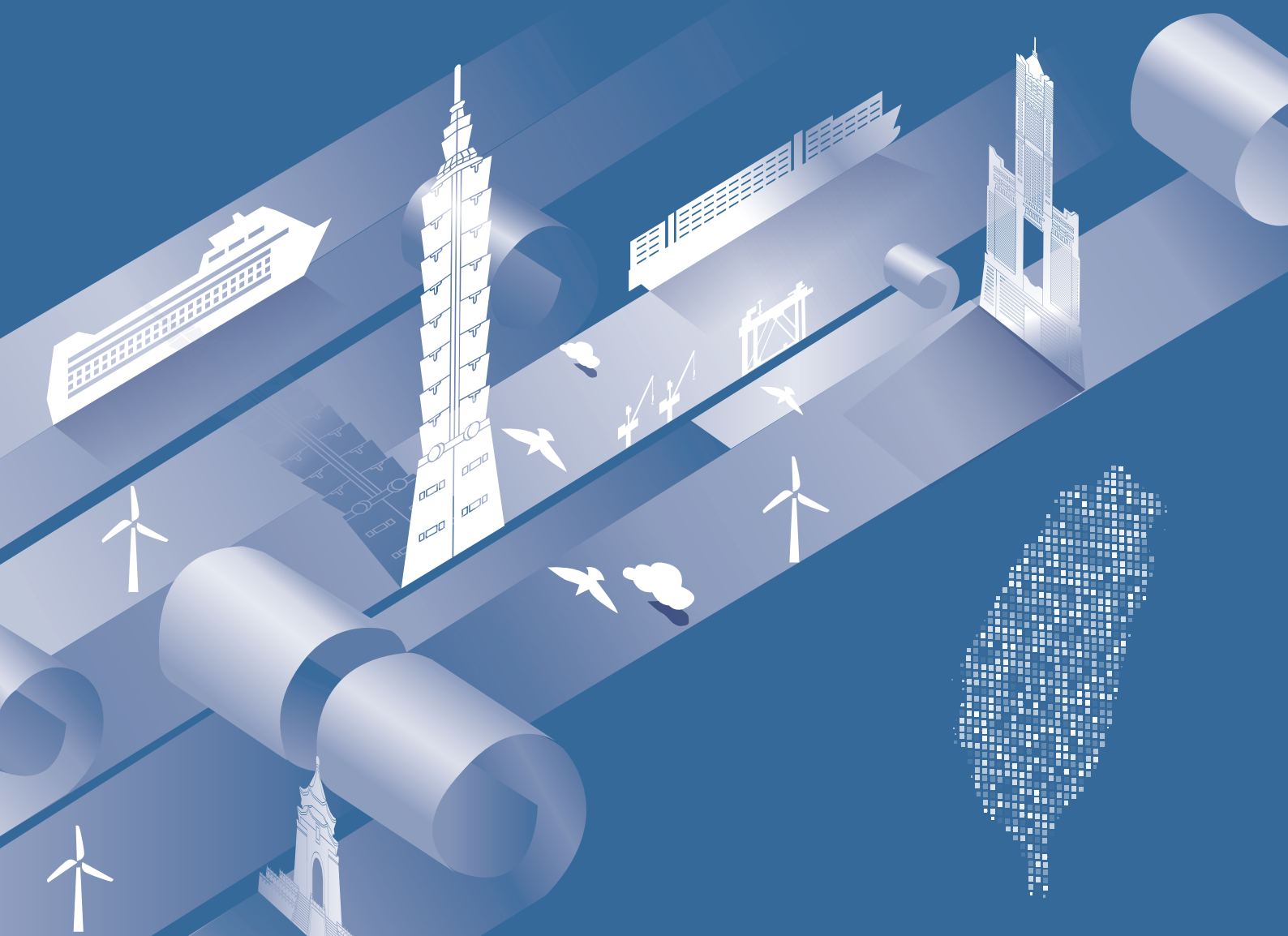
8 International Cooperation and Engagement



Chapter 8: International Cooperation and Engagement

The *Sustainable Development Goals Report 2024* published by the United Nations highlights that global climate financing has increased by 30% since 2021, reaching $115.9 billion in 2022 and meeting developed countrie's target of mobilizing $100 billion annually between 2020 and 2025. However, global greenhouse gas emissions also hit a record high of 57.4 billion metric tons of CO_2e in 2022. To limit global warming to 1.5°C, emissions need to be reduced by 42% by 2030. Yet, current national policies project a global temperature rise of 3°C, making the 2030 reduction target challenging to achieve. Although Taiwan's unique political situation prevents it from participating in the United Nations Framework Convention on Climate Change (UNFCCC) as a party, Taiwan actively supports global carbon reduction efforts and embraces the principle of common but differentiated responsibilities. Through collaboration among central government agencies, local municipalities, industries, academic institutions, and civil society, Taiwan has expanded its multilateral and bilateral channels for climate change cooperation. This strategy enhances Taiwan's international visibility and capacity in climate action, integrates Taiwan into global and regional cooperation networks, and allows Taiwan to share its environmental protection efforts while contributing to the international community and nations in need.

8.1 Participation in the United Nations Framework Convention on Climate Change (UNFCCC)

Although Taiwan is not currently a member of the United Nations and cannot sign the UNFCCC or related agreements, it actively abides by international environmental conventions and fulfills its responsibilities as a member of the global community. Taiwan also participates in UNFCCC-related conferences, where delegates engage with representatives from industries, governments, and academic and research institutions worldwide to foster exchange and cooperation. Based on genuine goodwill, Taiwan has established substantive cooperative relationships with other nations and achieved a series of significant milestones.

I. During the Drafting Stage of the UNFCCC (1991)

Taiwan participated in Intergovernmental Negotiating Committee (INC) meetings as an observer through its non-governmental organizations (NGOs).

II. During the Implementation Stage of the UNFCCC (1995–Present)

Since attending the First Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC COP1) in Berlin, Germany, in 1995, Taiwan has continuously participated as an NGO observer. Upholding the principles of professionalism, pragmatism, and contribution, Taiwan has actively engaged in related meetings and activities, exchanged climate policies with international representatives, and highlighted Taiwan's efforts and determination in addressing climate change.

To broaden its avenues for participating in UNFCCC activities, Taiwan has recently increased its involvement In response to growing government support and heightened public awareness of

climate change, Taiwan has recently increased its involvement and broadened its avenues for participating in UNFCCC activities. Beyond attending and participating in side events and meetings, Taiwan has also actively organized exhibition booths at conference venues. Through diverse and dynamic displays, Taiwan has showcased its achievements in renewable energy, climate legislation, and climate policies. These efforts communicate Taiwan's commitment to collaborating with international partners in combating climate change and advancing toward 2050 Net-Zero Emissions. Taiwan's initiatives have been well-received and praised by international participants.

III. Adhering to International Standards Recognized by the UNFCCC Since 2002

Taiwan has consistently published and updated key documents, including the National Communication, National Greenhouse Gas Inventory Report, Intended Nationally Determined Contribution (INDC), and the Update of Taiwan's Nationally Determined Contribution to align with international norms established by the UNFCCC.

IV. Achievements in Promoting Taiwan's Participation in the UNFCCC Conference of the Parties (COP)

Climate change is a critical global issue that directly impacts Taiwan's national and industrial sustainability. Since 2009, when the government officially declared its intent to pursue meaningful participation in the UNFCCC, Taiwan has become an essential partner in the global effort to combat climate change and has demonstrated its commitment to the UNFCCC through tangible actions.

International participation depends on the support and understanding of other nations. As climate change affects humanity's survival and development, Taiwan's legitimate participation should not be excluded. The Ministry of Foreign Affairs continues to uphold the principle of building substantive cooperative relationships with other nations based on sincere friendship. By playing a more active role in international forums, Taiwan ensures its contributions cannot and will not be ignored.

1. COP 29

The 29th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC COP29) was held from November 11 to November 22, 2024, in Baku, Azerbaijan. The outcomes of Taiwan's delegation at COP29 are as follows:

(1) A total of 10 diplomatic allies—including the Marshall Islands, Tuvalu, Eswatini, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Guatemala, Belize, Saint Lucia, and Haiti—delivered statements in support of Taiwan. Additionally, Paraguay issued a written National Statement endorsing Taiwan's participation in international climate governance mechanisms.

(2) In line with Taiwan's "integrated diplomacy" strategy and the government's commitment to advancing the 2050 net-zero emissions goal, the Taiwanese delegation held 37 high-level bilateral meetings and expert consultations with diplomatic allies, like-minded countries, and international organizations. These engagements covered a wide range of topics, including carbon diplomacy, climate policy, carbon pricing, energy transition, and the climate rule of law, fostering in-depth exchanges with senior representatives to garner broad support for Taiwan's participation in the UNFCCC.

(3) Taiwan was invited to present at the Palau Pavilion, where it exhibited the environmental partnerships built through the combination of Taiwanese technology with the natural environments of allied countries. Taiwan also matched four domestic NGOs with allied countries to host peripheral meetings highlighting cooperation between Taiwan and its allies in the area of UNFCCC, as well as the constructive role Taiwanese NGOs play in climate change exchanges with various countries, helping nations to join hands in response to the challenges of climate change.

2. COP 28

The 28th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC COP28) was held from November 30 to December 13, 2023, in Dubai, United Arab Emirates. The outcomes of Taiwan's delegation at COP28 are as follows:

(1) Paraguay, Palau, Saint Lucia, Saint Vincent, Saint Kitts and Nevis, Tuvalu, Eswatini, Haiti, Belize, the Marshall Islands, and Guatemala made official statements or sent letters urging the UNFCCC to allow Taiwan's participation in the Conference of the Parties.

(2) During COP28, the Taiwanese delegation held 46 bilateral meetings with heads of state from allied countries, senior officials and parliamentarians from allied and friendly nations, and representatives from intergovernmental organizations. These meetings covered discussions on climate change policies, energy transition, renewable energy development, 2050 net-zero emissions, green finance, and carbon pricing, while also emphasizing Taiwan's appeal to participate in the UNFCCC.

(3) Taiwan announced a US$10 million contribution to establish the Climate Transition Fund for its Pacific allies. This initiative not only aligns with the international trend of developed countries supporting developing nations in promoting climate adaptation but also demonstrates Taiwan's commitment to contributing to the international community.

(4) Taiwan facilitated the co-organization of five side events between five NGOs and five allied nations. These events addressed internationally significant topics such as net-zero transition, climate justice, climate adaptation, and climate financing, and fully showcased the constructive role of Taiwan's NGOs in climate change exchanges with other nations. Domestic NGOs also took the initiative to co-organize events with foreign NGOs or participate in invited sessions, which demonstrated the critical role NGOs play in promoting Taiwan's participation in the UNFCCC.

3. COP 27

The 27th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC COP27) was held from November 6 to November 20, 2022, in Sharm el-Sheikh, Egypt. The key outcomes of Taiwan's delegation at COP27 are as follows:

(1) During COP27, ten allied nations spoke up for Taiwan during the first-week Climate Implementation Summit and the second-week High-Level Segment. All of Taiwan's allies sent letters to UNFCCC Executive Secretary Simon Stiell. Additionally, parliamentarians from six friendly countries in Europe, Asia, and Latin America, members of the European Parliament, and representatives from the 21 Latin America and Caribbean member nations that form the Formosa Club, also joined the letter-writing campaign in support of Taiwan.

(2) Taiwan's delegation conducted 40 high-level bilateral meetings during COP27 with representatives from allied and like-minded countries, as well as international organizations. Topics discussed included climate change policies, the 2050 net-zero emissions target, carbon pricing, energy transition, and renewable energy development.

(3) During COP27, Taiwan's NGOs co-hosted six side events within the Blue Zone venue. Four of these were co-organized with allied nations, including Palau, Saint Kitts and Nevis, Belize, and Eswatini, whereas the remaining two were co-hosted by international NGOs and government departments. These efforts fully demonstrated the vital role of NGOs in advancing Taiwan's participation in the UNFCCC.

8.2 Cooperation and Exchanges with National and Intergovernmental Organizations

Taiwan's international cooperation efforts are led by the Ministry of Foreign Affairs and implemented by the International Cooperation and Development Fund (ICDF). The ICDF was established in accordance with the Act for the Establishment of the International Cooperation and Development Fund and focuses on assisting developing countries in priority areas such as agriculture, public health and medicine, education, information and communications technology, environment, and small and medium-sized enterprises. In alignment with

Articles 4.1 and 4.5 of the Paris Agreement, Taiwan provides support to partner countries through financial resources, technology, and capacity-building initiatives. These efforts aim to assist partner nations in implementing climate change-related projects and to demonstrate how partnerships can effectively strengthen these nations' climate resilience.

8.2.1 Investment and Financing Cooperation

I. Multilateral Climate Financing Cooperation

Due to constraints imposed by international political circumstances, Taiwan is unable to participate in the various multilateral climate cooperation platforms under the United Nations and the UNFCCC. Nevertheless, Taiwan has maintained long-term cooperation with international partners such as the Asian Development Bank (ADB), the Central American Bank for Economic Integration (CABEI), the Inter-American Development Bank (IDB), the Organization of American States (OAS), and the European Bank for Reconstruction and Development (EBRD). Through these partnerships, Taiwan provides financial assistance to allied and friendly nations to address climate change challenges.

TaiwanICDF is currently engaged in the following major multilateral climate financing cooperation projects:

1. In 2011, the TaiwanICDF collaborated with the EBRD to establish the EBRD Green Energy Special Fund. This fund aims to provide financing to EBRD beneficiary countries for adopting green technologies to promote municipal infrastructure projects, such as LED streetlights, solar power, energy-efficient public transportation, and industrial green transformation. Currently, two projects are underway: the BiH Elektrokrajina Power Distribution Upgrade Project in Bosnia and Herzegovina, which is expected to save 80 million kWh of electricity annually and improve the accuracy of electricity consumption monitoring; and the BiH Elektro-Bijeljina Smart Metering Expansion Project in Bosnia and Herzegovina, which deploys smart meters with remote reading and disconnection functionalities, reducing distribution losses to save 17 million kWh of electricity annually--equivalent to a reduction of approximately 15,000 metric tons of CO_2 emissions per year.
2. In line with the spirit of the UNFCCC and the Paris Agreement, the EBRD, building on its experience with the Green Energy Special Fund, established the High Impact Partnership on Climate Action in 2021. This platform seeks to scale up climate action in the EBRD region by leveraging public and private sector capital through blended finance mechanisms. TaiwanICDF responded to the EBRD's call and became the first contributor to the platform. The platform aligns with Sustainable Development Goal (SDG) 13: "Take urgent action to combat climate change and its impacts" and SDG 17: "Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development." Through this platform, the ICDF has provided funding for the following two projects:
   (1) Vilnius Trolleybus Fleet Renewal Project in Lithuania: This project supports Vilnius, the largest city in Lithuania, in replacing 91 outdated 20-year-old trolleybuses with a modern fleet of electric trolleybuses. The initiative enhances the quality of public transportation and establishes a low-emission public transport model. The project will benefit 810,000 residents, including those in surrounding suburban areas, and is expected to achieve an annual reduction of 2,240 metric tons of CO_2 emissions.
   (2) Zabka Poland Sustainable Loan Project: This project provides a sustainability-linked loan to Zabka, a Polish retail chain, to support its growth and implementation of sustainability and climate change strategies. The financing terms are linked to decarbonization performance indicators, encouraging the company to meet goals related to climate action and the circular economy. These include sustainable investments, operational decarbonization, plastic reduction, and achieving plastic neutrality.
3. In 2023, TaiwanICDF collaborated with the CARICOM Development Fund (CDF) to promote the CRAF Women SMEs Program (the Caribbean). Details of the program are outlined in the following section.

II. Multilateral Climate Finance Cooperation Case Study: CARICOM Development Fund – Women's Green Credit Guarantee Program

1. In November 2023, the TaiwanICDF collaborated with the CARICOM Development Fund (CDF) to launch the CRAF – Women SMEs Program. This initiative is built on the framework of the Credit Risk Abatement Facility (CRAF) established by the CDF. It aims to promote renewable energy and energy efficiency investments among small and medium-sized enterprises (SMEs) through financial intermediaries and green energy service providers in the Caribbean, thereby supporting the energy transition of enterprises.
2. The CRAF provides partial credit guarantees to financial intermediaries and green energy service companies (ESCOs) to reduce the risks associated with green energy financing. Additionally, the mechanism incorporates a Technical Assistance Program in collaboration with organizations such as the Caribbean Center for Renewable Energy and Energy Efficiency (CCREEE). This program supports capacity building for financial intermediaries and ESCO personnel through training, technical guidance, and business consulting. It also aids SMEs intending to undergo energy transition by helping them develop feasible renewable energy and energy efficiency investment plans, thereby increasing their access to financing opportunities.
3. Small Island Developing States (SIDS) in the Caribbean are heavily dependent on imported fossil fuels and face high energy transportation costs due to limited local resources and technology, making green energy transition challenging for local SMEs. For SMEs led by women, the difficulty is even greater. As the global community transitions toward a low-carbon, sustainable future, it is crucial to protect the economic development and livelihoods of vulnerable groups such as women and youth. In light of this, the TaiwanICDF has partnered with the CDF to create the CRAF – Women SMEs Program. This program ensures that Caribbean nations can achieve the goals of a Just Transition while promoting energy transformation.

Figure 8.2.1-1. Secretary General Charles Li of the ICDF and Rodinald Soomer, Executive Director of the CDF, sign the agreement for the CRAF – Women SMEs Program

Source: TaiwanICDF.

Figure 8.2.1-2. TaiwanICDF and the EBRD are collaborating to assist Vilnius, Lithuania, in comprehensively renewing its urban trolleybus system, enabling 810,000 residents in the Vilnius metropolitan area to benefit from convenient and low-carbon public transportation

Source: TaiwanICDF

III. Bilateral Financial Cooperation Initiatives

Through bilateral cooperation, Taiwan has promoted loans and development investment programs with its allied and partner countries to foster local public and private sector growth. These efforts aim to support economic and social stability while enhancing the capacity of societies and industries to address climate change. The cooperation spans three main areas: economic infrastructure and services, social infrastructure and services, and productive sectors.

In the area of economic infrastructure and services, Taiwan has assisted recipient countries in establishing climate-resilient and sustainable economic models through public infrastructure projects; microfinance initiatives; and micro, small,

and medium-sized enterprise (MSME) refinancing programs. For social infrastructure and services, Taiwan has leveraged projects in education facilities and environmental protection to focus on human resource development, environmental improvements, and public health enhancement while incorporating considerations of the long-term impacts of climate change into disaster relief and reconstruction efforts. Additionally, in the productive sector, Taiwan has implemented agribusiness and regional agricultural programs to help recipient countries improve production efficiency in agriculture, forestry, fisheries, livestock, and industrial sectors, thereby strengthening their resilience to climate change.

IV. Bilateral Climate Finance Cooperation Case Study: Women and Youth Entrepreneurs and MSMEs Re-lending Project (Palau)

1. The UNFCCC COP 28 resolution establishing the Fund for Responding to Loss and Damage marked a milestone in acknowledging the responsibility of developed nations to compensate climate-vulnerable countries for economic and non-economic losses caused by climate change. It also underscored the importance of integrating considerations for human rights, sustainability, gender equality, youth, local communities, and indigenous peoples in global climate actions. This highlights the need for climate finance allocation to strengthen gender equality and policies that promote intergenerational equity.
2. Women and youth in climate-vulnerable nations are among the most disadvantaged groups and are significantly affected by the impacts of climate change. To address these challenges, TaiwanICDF provided concessional loans to the Palau government in 2020, enabling the National Development Bank of Palau (NDBP) to offer loans to women, entrepreneurial youth, and micro, small, and medium-sized enterprises (MSMEs). The program aims to stimulate private sector economic development and encourage women and youth entrepreneurship, thereby enhancing their economic standing and climate resilience. It empowers women and youth with resources to cope with both short-term climate disasters and the long-term environmental changes (e.g., displacement due to rising sea levels) impacting their economic, social, environmental, and cultural well-being. By the end of 2022, 161 businesses owned by women or youth had benefited from concessional loans under this program.

Figure 8.2.1-3. Women and Youth Entrepreneurs and MSMEs Re-lending Project (Palau) beneficiary Melnguis Mesubed proudly displays mangrove crabs caught by local fishermen and sold at his store. Mr. Mesubed started his business not only to support his family financially but also with the goal of helping the local community market their distinctive products. Currently, products from eight small enterprises are being sold in Mr. Mesubed's store.

Source: TaiwanICDF.

Figure 8.2.1-4. TaiwanICDF's implementation of the Women and Youth Entrepreneurs and MSMEs Re-lending Project (Palau) includes sending Taiwanese experts to evaluate local initiatives managed by Palauan women's groups, such as local cuisine services and cultural tourism experiences. This evaluation aims to understand the impact of the development of Palau's tourism industry on local communities.

Source: TaiwanICDF.

8.2.2 Technical Cooperation

I. Overview of Technical Cooperation

Accelerating research on climate change-related technologies and transferring them to developing and least-developed countries is a responsibility explicitly outlined in Article 4.5 of the UNFCCC. Currently, global technology transfer is coordinated through the Technology Mechanism established by the Conference of the Partiesto the UNFCCC. This mechanism comprises the Technology Executive Committee (TEC), which consolidates global climate technology research and policy, and the Climate Technology Centre and Network (CTCN), which serves as a platform for international collaboration on technology development and transfer.

Although Taiwan faces restrictions due to international political considerations and cannot utilize the UNFCCC Technology Mechanism to share domestic research outcomes, TaiwanICDF continues to engage in climate change-related technical cooperation with allied and friendly nations. Drawing upon the UNFCCC's three-stage principle of Technology Development, Technology Diffusion, and Technology Transfer, Taiwan actively promotes these efforts.

II. Technical Cooperation Case: The Climate and Ocean Risk Vulnerability Initiative in Belize

To assist developing countries in addressing climate change, the Stimson Center, a U.S. think tank, has developed the Climate and Ocean Risk Vulnerability Index (CORVI): a precise, small-scale risk assessment tool tailored for coastal cities in developing nations. CORVI innovatively integrates data across three key areas—environmental, financial, and political sectors—establishing a risk assessment framework suitable for informing policymaking and investment decisions in developing countries.

The International Cooperation and Development Fund (ICDF), in collaboration with marine experts from Taiwan's Ocean Affairs Council, leveraged its extensive experience in developmental assistance as well as the Stimson Center's research methodology and global network to jointly advance the CORVI international initiative. The ICDF coordinated on-site surveys and data collection in Belize, which provided researchers from the Ocean Affairs Council with the necessary information to conduct analyses based on the Stimson Center's CORVI methodology. The assessment evaluated the vulnerability of Belize City to climate and ocean-related risks, focusing on critical areas such as coastal resilience, economic sustainability, and community adaptation strategies. It also provided actionable recommendations to help the city address future climate challenges.

8.2.3 Capacity Building

I. Overview of Capacity Building Initiatives

TaiwanICDF actively strengthens human resource development and organizational capacity to enhance the professionalism of its foreign aid programs. Efforts are focused on transforming TaiwanICDF into a body capable of providing specialized technical recommendations for decision-making. Collaboration plans are designed around the core goal of building adaptive capacity to address climate change while aligning with the strategic objectives of allied and friendly nations

II. Capacity Building Collaboration Case: Saint Kitts and Nevis

To assist Saint Kitts and Nevis in mitigating the impact of waste generated by tourists, Taiwan has partnered with the Ministry of Agriculture since 2021 to implement the Solid Waste Management and Recycling Project. This initiative combines Taiwan's expertise in waste recycling and reduction with the principles of a circular economy, extending the scope of Taiwan's foreign aid efforts. The project aims to enhance environmental management capabilities, improve resource reuse rates, and reduce waste generation to create an eco-friendly environment. The main components of the project include strengthening public awareness campaigns, promoting recycling and waste reduction, coordinating relevant industries such as tourism, supermarkets, waste collection companies, and recyclers, conducting recycling system surveys and analyses, and developing strategies with demonstration projects. The initiative has effectively improved resource recycling awareness among the citizens of Saint Kitts and Nevis and helped the government establish an initial waste recycling model and mechanism, contributing to the country's waste recycling development.

As of the end of May 2024, a total of 70 resource recycling points have been established

nationwide, with 9,378 individuals participating and a cumulative recycling total of 101 metric tons. The project also organized 56 public–private sector resource recycling model seminars, 43 resource recycling industry chain workshops, and 71 recycling promotion briefings. These efforts have effectively enhanced public awareness of resource recycling in Saint Kitts and Nevis, supported the government in establishing an initial waste recycling model and mechanism, facilitated the development of waste recycling and utilization, increased resource reuse rates, and reduced waste generation. This aligns with international trends in green environmental protection and net-zero emissions and contributes to the achievement of sustainable development goals, as shown in Figure 8.2.3-1.

Figure 8.2.3-1. TaiwanICDF's St. Kitts and Nevis Solid Waste Management and Recycling Project in collaboration with local elementary schools, established resource recycling bins. The event was attended by Prime Minister Terrance Drew, Minister of Environment Joyelle Clarke, Ambassador Michael C.H. Lin of the Embassy of the Republic of China (Taiwan) in Saint Christopher and Nevis, and Taiwan Technical Mission Leader Yuan-Hung Lo.

Source: TaiwanICDF.

Ongoing projects include the St. Kitts and Nevis Layer Chicken Industry Sustainable Development Project, St. Kitts and Nevis Digital Identity Authentication Project, Renewable Energy Consultant-dispatching Project (St. Kitts and Nevis), and Assisting the Economic Empowerment of Women Project in Latin America and the Caribbean in the Post COVID-19 Era Project/St. Kitts and Nevis.

III. Professional Workshops

These workshops, organized by TaiwanICDF, aim to cultivate professionals in policy planning and specialized fields required for the economic and social development of allied and friendly countries, with climate change being a priority area for cooperation between Taiwan and other nations.

In line with global trends and the needs of allied and friendly countries, the program leverages Taiwan's experience and shares its approaches to addressing global climate change challenges. The workshops focus on the prevention and monitoring of climate change related disasters, the development of clean energy, and the application of green technologies across various industries. The goal is to provide participants with insights into Taiwan's strategies for responding to climate change and its experiences in international engagement, which can serve as a reference, enabling participants to implement related policies in the future.

For example, the 2022 Sustainable Disaster Prevention Workshop invited experts from the National Science and Technology Center for Disaster Reduction; the Water Resources Agency; Taoyuan City Government; National Taiwan University; Tzu Chi Foundation; Japan's Ministry of Land, Infrastructure, Transport and Tourism; and Kyoto University. A total of 39 foreign participants joined the forum online. To enhance Taiwanese involvement in international cooperation, domestic participants were also encouraged to register. Experts highlighted the importance of public participation in disaster prevention, emphasizing that as global demographics shift toward aging populations, community disaster prevention and self-rescue teams may face manpower shortages in the future. Therefore, the primary objectives are to increase the participation of younger generations, expand the application of disaster prevention technologies, and enhance first-line disaster resilience and sustainability.

The 2023 Waste Management Workshop was conducted in collaboration with Taiwan's Environmental Protection Administration (EPA), the U.S. Environmental Protection Agency, and Taiwan's Ocean Affairs Council. The workshop focused on Pacific island nations and countries with similar geographic constraints, using Taiwan's Four-in-One Recycling Program and Taiwan–U.S. circular economy strategy outcomes as core instructional topics to train government policymakers and professionals. The Taiwanese and U.S. EPAs also presented the workshop's content at the Pacific Islands Environmental Conference held that year.

To enhance net-zero transition competitiveness, each country must develop energy-saving transportation and accelerate the decarbonization of enterprises. Since 2023, TaiwanICDF has introduced workshops such as the Green Supply Chain Workshop and the Energy-Efficient Transport Workshop – Promoting the Electric Vehicle Industry. These programs included visits to Taiwan's key industries, such as electronics, textiles, and electric bus manufacturers, providing examples of Taiwanese enterprises' efforts in carbon reduction and clean energy utilization as references for policy planning in other nations.

From 2022 to June 2024, TaiwanICDF organized international human resource training workshops, with climate change-related courses detailed in Table 8.2.3-1.

Table 8.2.3-1. TaiwanICDF Professional Workshops (2022–2024)

Year	Workshop Name	Number of Participants	Participant Nationalities
2022	Remote Workshop on Sustainable Disaster Mitigation	39	Asia: Tuvalu, Marshall Islands, Palau, Philippines, Vietnam, Jordan, Mongolia, Fiji, Turkey, India, Indonesia, Bahrain, Israel, Palestine, Nauru, Thailand, Saipan, American Samoa, Malaysia, Sri Lanka Latin America and the Caribbean: Haiti, Guatemala, Paraguay, Belize, Saint Vincent and the Grenadines, Saint Kitts and Nevis, Barbados, Costa Rica, Jamaica, Brazil, Chile, Ecuador, Colombia, Peru, Mexico North America: United States Africa: Eswatini, Somaliland, Ivory Coast, South Africa, Tunisia Europe: Lithuania, Slovakia, Albania, Hungary, Bulgaria, Poland, Czechia, North Macedonia, Greece
	Remote Workshop on Clean Energy Development Strategies	26	
	Workshop on Water Resource Recycling	22	
2023	Workshop on Waste Management	26	
	Workshop on Green Supply Chains	13	
	Workshop on Energy-efficient Transportation: Promoting the Electric Vehicle Industry	18	
2024	Workshop on Smart and Resilient Cities	25	
	Workshop on Energy-efficient Transportation: Promoting the Electric Vehicle Industry	16	
	Workshop on Marine Conservation	18	

Source: TaiwanICDF.

Figure 8.2.3-2. Opening Ceremony of the 2023 Waste Management Workshop with Senior Officials from TaiwanICDF, Taiwan's Environmental Protection Administration (EPA), the U.S. Environmental Protection Agency, and Taiwan's Ocean Affairs Council in Attendance

Source: TaiwanICDF.

Figure 8.2.3-3. 2022 Sustainable Disaster Prevention Workshop Featuring Dialogue Among Taiwanese and Japanese Experts from Industry, Government, Academia, and Research Institutions

Source: TaiwanICDF.

IV. International Environmental Partnership

The International Environmental Partnership (IEP) was jointly established in 2014 by Taiwan's Environmental Protection Administration (now the Ministry of Environment) and the United States Environmental Protection Agency. It aims to provide a platform for the exchange of environmental regulations and technical expertise for developing countries in the Asia-Pacific region. As of April 2024, the program has assisted over 60 countries and more than 80 international environmental institutions and organizations in advancing collaborative projects and exchange activities. These efforts span various domains, including air pollution, electronic waste, environmental enforcement, and environmental education, with a particular emphasis on the connection between environmental education and climate change.

At the program's inception, environmental education leaders from various countries were invited to discuss how environmental education and public participation could address climate change issues. During the discussions, there was unanimous agreement on the need to establish a centralized platform to share case studies and resources on environmental education. To this end, Taiwan's Environmental Protection Administration (now the Ministry of Environment), the U.S. Environmental Protection Agency, and the North American Association for Environmental Education jointly launched the Global Environmental Education Partnership (GEEP). The GEEP focuses on strengthening networks, cultivating leadership, and promoting exemplary case studies to advance environmental education.

Today, the GEEP has become an integrated platform for international environmental and climate education information. Climate action stakeholders can quickly access national-level environmental and climate education policies from around the world via the platform. They can also connect with local environmental institutions and organizations involved in the GEEP network to further climate education initiatives with the assistance of senior advisors. Moreover, the platform provides a repository of climate education case studies, serving as valuable references for climate education training in various countries.

8.2.4 Partnerships

I. Partnership Progress

The impacts of climate change are global, but Small Island Developing States (SIDS) are disproportionately affected. These countries, despite having low carbon emissions, are on the frontlines of rising sea levels and increasingly frequent extreme weather events. In response, the ICDF not only collaborates with partner country governments but also actively works with international NGOs. By

leveraging collective expertise, these partnerships aim to strengthen the climate resilience and adaptive capacities of partner developing countries.

II. Partnership Case Study: The Stimson Center

To mitigate disasters caused by extreme weather events and enhance national resilience, countries worldwide have been investing in research to establish climate risk indices and ensure effective resource allocation. However, developing countries often lack the necessary resources for such research, leaving cities with insufficient infrastructure even more vulnerable to the threats of climate change. These nations urgently require relevant standards to improve disaster prevention efficiency and strengthen climate resilience. To assist developing countries in addressing climate change, the Stimson Center developed the Climate and Ocean Risk Vulnerability Index (CORVI). This innovative tool integrates data from three key domains: environmental, financial, and political to provide a tailored risk assessment framework suitable for developing nations, which can serve as a reference for policymaking and investment planning.

The Stimson Center, ranked among the top 10 think tanks in the United States, collaborated with TaiwanICDFand the Ocean Affairs Council to assist Basseterre, the capital of Saint Kitts and Nevis, in implementing CORVI. In 2021, TaiwanICDF, the Stimson Center, the Ocean Affairs Council, and the Saint Kitts and Nevis Ministry of Environment jointly established a CORVI research team. After 20 months of investigation, the team successfully created a CORVI database for Saint Kitts and Nevis and produced risk indicators.

According to the report, Saint Kitts and Nevis exhibits significant ecological, financial, and political vulnerabilities, with fisheries identified as the highest risk sector, followed by ecosystems and economic development. The report recommends that Saint Kitts and Nevis promote cross-sector collaboration and establish coordination mechanisms, improve data management systems, strengthen marine ecosystem monitoring, reduce reliance on fossil fuels, enhance the stability and resilience of the power grid, implement fiscal incentives, foster public–private partnerships, and accelerate the development of the blue economy (fisheries, tourism, and renewable energy).

TaiwanICDF also showcased the project outcomes at major international climate and ocean conferences such as COP26, COP27, and the United Nations Ocean Conference (UNOC). These efforts not only raised global awareness of the risks faced by Saint Kitts and Nevis due to climate change but also served as a key reference for future investments in the region. Additionally, the initiative supports Saint Kitts and Nevis in applying for international climate funding and highlights the significant achievements of the partnership between TaiwanICDF and the Stimson Center.

8.3 Collaboration and Exchanges among Local Governments and Cities

8.3.1 ICLEI – Local Governments for Sustainability

The International Council for Local Environmental Initiatives (ICLEI – Local Governments for Sustainability)was established in September 1990 during the United Nations' World Congress of Local Governments for a Sustainable Future. ICLEI currently includes over 1,000 local government members from 86 countries, encompassing 12 megacities, 100 super cities and metropolitan areas, 450 large cities, and 450 small to medium-sized cities and towns, making it the world's largest network of local governments dedicated to sustainability.

Taiwan has 12 counties and cities participating in ICLEI: Taipei City, New Taipei City, Taoyuan City, Hsinchu City, Hsinchu County, Taichung City, Yunlin County, Chiayi County, Tainan City, Kaohsiung City, Yilan County, and Pingtung County. In recent years, Taiwan has actively promoted energy-saving and carbon reduction policies and actions at the local government level. Under the Ministry of Environment's leadership, Taiwan has established a legal framework and policy measures to address climate change. The Ministry of Environment has also frequently invited experts to share ICLEI's strategies and successful experiences in advancing global low-carbon city partnerships.

Kaohsiung City has established the ICLEI Kaohsiung Capacity Center (ICLEI KCC), which currently serves as the East Asia Operations Hub. The Center is responsible for executing tasks assigned by the ICLEI World Secretariat, supporting regional

offices in East Asia, and providing member cities with training, expertise, and information exchange on environmental sustainability policy management. In 2019, Taoyuan City signed an agreement with ICLEI to become the world's first EcoLogistics Chair City, promoting eco-logistics initiatives such as green energy, smart warehousing, and low-carbon transportation. Taoyuan is committed to reducing packaging and energy consumption during the delivery of goods and has actively developed five key eco-logistics demonstration areas to showcase its leadership in sustainable development on a global scale. At the 2020 ICLEI Taiwan Members Conference and Sustainable City Forum, the Chiayi City Government shared its experience in implementing sustainable city initiatives. Furthermore, in 2021, the Mayor of Taoyuan City, serving as the EcoLogistics Chair, was invited to deliver a speech at the ICLEI World Congress 2021. On March 30, 2023, the ICLEI Kaohsiung Smart and Sustainable City Summit and Members Meeting was co-hosted by ICLEI, the Kaohsiung City Government, the Industrial Technology Research Institute, and the International Climate Development Institute. During the event, a tripartite memorandum of understanding was signed to promote the Local Energy Governance and Self-Assessment System (LEGRS) guidelines and tools. This initiative aims to facilitate urban industrial development, accelerate energy transitions, and strengthen local energy governance capabilities.

8.3.2 CityNet

CityNet was established in 1987 with the support of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), the United Nations Development Programme (UNDP), and the United Nations Human Settlements Programme (UN-Habitat). The organization is dedicated to promoting sustainable development across the Asia-Pacific region. Headquartered in Seoul, South Korea, CityNet currently has 110 Full Members, 58 Associate Members, and 5 Corporate Members. Additionally, the organization collaborates with 20 multilateral or bilateral regional international organizations that act as partners, including the United Nations Economic and Social Council (ECOSOC), United Nations Educational, Scientific and Cultural Organization (UNESCO), Asian Development Bank (ADB), Japan International Cooperation Agency (JICA), United Cities and Local Governments (UCLG), and the World Bank. Together, these partners support CityNet's operations and development.

CityNet supports member cities in addressing challenges such as climate change and disasters by creating platforms for knowledge exchange, fostering urban cooperation, and implementing concrete projects, all aimed at advancing urban sustainability. Taiwan has four member cities in CityNet: Taipei City, Taichung City, Kaohsiung City, and Taoyuan City. During the global COVID-19 pandemic in 2020, Taiwan's exceptional performance in pandemic prevention led CityNet to organize a series of virtual seminars, inviting Taoyuan City to share its experiences in urban and community-level pandemic response. These seminars provided global members with insights into the pandemic situation in the Indo-Pacific region. On March 19, 2024, CityNet Secretary-General Jeongkee Kim met with the Taipei City Government to discuss the tentative plans for hosting the 2024 Disaster Cluster Seminar in Taipei in September 2024. Additionally, Jeongkee Kim and his team met with the Kaohsiung City Government to explore key topics, including sustainable development, smart cities, and collaborative governance.

8.4 Collaboration and Exchanges with Non-Governmental Organizations

8.4.1 Industry and Corporate Organizations

I. RE100

RE100 is a global initiative jointly led by The Climate Group (TCG) and the Carbon Disclosure Project (CDP), aimed at achieving 100% renewable energy usage. This initiative brings together some of the world's most influential companies to drive the adoption of green energy from the demand side, promoting an environmentally friendly future. Companies joining RE100 must publicly commit to achieving 100% renewable energy usage between 2020 and 2050 and are required to report their progress annually.

In Taiwan, over 100 companies have joined RE100, including 33 locally headquartered companies. These members span industries such as biotechnology, semiconductor manufacturing, cosmetics manufacturing, textile and apparel,

computer and peripheral equipment manufacturing, telecommunications, and finance. Each company has set a target year for achieving 100% renewable energy usage. The electronics sector accounts for 70% of the members, significantly driving the demand for green energy and fostering growth in related industry supply chains in Taiwan.

II. Climate Action 100+

Climate Action 100+ is a 5-year climate action initiative that was launched on December 12, 2017, by the Principles for Responsible Investment (PRI) and four major global institutional investor climate alliances. This investor-led initiative aims to engage with 167 companies worldwide that are critical for the transition to net-zero emissions. Investors participating in this initiative commit, upon signing, to engaging with at least one of these key companies and seeking specific commitments on critical issues, such as implementing robust climate governance frameworks, taking action to reduce greenhouse gas emissions across the supply chain, and enhancing corporate information disclosure. These actions are facilitated and managed through an investor platform that coordinates interactions between investors and target companies.

In Taiwan, participating institutions include Cathay Life Insurance, Cathay Securities Investment Trust Enterprise, Fubon Life Insurance, and Fubon Securities Investment Trust Enterprise. Participating companies include Formosa Petrochemical Corporation, Foxconn Technology Group, and China Steel Corporation. Cathay Life joined the initiative in 2017 and has since collaborated with three Taiwanese companies on the list. Among them, two have committed to achieving net-zero carbon emissions across their supply chains by 2050.

III. Science Based Targets initiative (SBTi)

The Science Based Targets initiative (SBTi) was jointly launched by the Carbon Disclosure Project (CDP), the United Nations Global Compact (UNGC), the World Resources Institute (WRI), and the World Wide Fund for Nature (WWF). SBTi focuses on developing science-based carbon reduction targets for businesses and provides tools, guidelines, and technical support to help companies set scientifically grounded decarbonization goals. In 2021, SBTi raised the minimum standards for corporate carbon reduction targets, requiring stricter criteria when setting goals. From July 2022 onward (and no later than 2027), businesses are required to establish carbon reduction targets based on the standard of limiting global warming to within 1.5°C.

As of the first half of 2024, a total of 8,615 companies worldwide have participated in SBTi, including 145 Taiwanese applicants. Among them, 99 are in the manufacturing sector, accounting for approximately 68% of the total. The electronics sector leads with 59 companies, followed by the textile and other manufacturing sectors, each with 15 companies. Out of the manufacturing companies in Taiwan, 51 have passed SBTi validation, among which 49 have committed to achieving net-zero emissions.

IV. Task Force on Climate-related Financial Disclosures (TCFD)

The Task Force on Climate-related Financial Disclosures (TCFD) was established in 2015 by the Financial Stability Board (FSB). Its mission is to develop a consistent set of voluntary recommendations for climate-related financial disclosures, enabling investors and decision-makers to better understand the significant climate risks organizations face and to more accurately assess climate-related risks and opportunities. The TCFD's recommendations apply to various types of organizations, including financial institutions, and emphasize the risks and opportunities associated with the transition to a low-carbon economy. The framework aims to provide forward-looking financial impact information that supports informed decision-making.

As of May 11, 2023, over 4,000 organizations worldwide have signed on to support the TCFD initiative, including 133 organizations in Taiwan. According to data from the Risk Society and Policy Research Center at National Taiwan University, the number of companies conducting climate-related financial disclosures has nerly doubled, increasing from 8.7% to 14.3%. The banking sector in Taiwan was the earliest to adopt the TCFD framework, aligning with international sustainable finance trends. Banks have adhered to the Principles for Responsible Investment (PRI), Principles for Responsible Banking (PRB), Principles for Sustainable Insurance (PSI), and the Equator Principles, incorporating environmental and social factors into their risk management processes. To support these efforts, the Financial Supervisory Commission (FSC) launched the Corporate Governance 3.0 – Sustainable Development Roadmap in August 2020. Based on the TCFD framework, the FSC introduced climate-related disclosure requirements, mandating publicly listed companies to include such information in their

annual reports and sustainability reports starting in 2023. Companies are required to identify climate risks and opportunities, establish effective metrics and management targets based on their findings, and mitigate the financial impacts of climate risks on operations. In March 2022, the FSC issued the Sustainable Development Roadmap for Listed Companies, which phases in mandatory greenhouse gas (GHG) inventory disclosures and verification based on industry characteristics and paid-in capital. The roadmap sets the following milestones: all listed companies must complete GHG inventory disclosures by 2027 and achieve verification by 2029. In September 2023, the FSC released the Green Finance Action Plan 3.0, aiming to deepen the sustainable development of the financial sector. The plan focuses on collaborative efforts to achieve the 2050 Net-Zero Target, disclose carbon emission information, drive decarbonization across industries through investment and financing, and integrate data and analytics to enhance climate resilience and risk management capabilities.

8.4.2 Civil Society Organizations

I. Delta Electronics Foundation

The Delta Electronics Foundation has been actively participating in the United Nations Framework Convention on Climate Change (UNFCCC) Conferences of the Parties (COP) over the years. In 2021, during COP26, the foundation hosted a side event to share low-carbon solutions for sustainable cities, assisting urban areas in achieving Conserve and Net Zero goals. In 2022, during COP27, the foundation organized a side event to present energy storage technologies aimed at enhancing the resilience of microgrids on islands. In 2023, the Delta Electronics Foundation partnered with international business organizations and climate opinion leaders to host a side event in the official negotiation zone (Blue Zone) at COP28. The event highlighted how Delta's internal carbon pricing mechanism was integrated with management mechanisms to aid the company in carbon reduction.

II. Environmental Quality Protection Foundation

The Environmental Quality Protection Foundation has long been dedicated to promoting environmental education both domestically and internationally. It focuses on key issues such as climate change, climate policies and legislation, water resource conservation, waste management, biodiversity, and low-carbon consumption, and it regularly participates in COP climate conferences. The Foundation is currently an observer to the United Nations Framework Convention on Climate Change (UNFCCC) and the Global Environment Facility (GEF), as well as a member of the International Council for Local Environmental Initiatives (ICLEI). During COP25 in 2019, the Foundation co-hosted a side event with the Asian-Pacific Resource and Research Centre for Women (ARROW), the Green Club, the Taiwan Youth Climate Coalition (TWYCC), and the Taiwan International Climate Development Institute (ICDI). The event shared insights on Multi-stakeholder Solutions for Communities in Asia and highlighted the Foundation's efforts in forest restoration and the connection between Taiwan's Indigenous peoples, socio-economic issues, and climate sustainability as part of its theme of Indigenous Peoples as Guardians and Beneficiaries under Climate Change. At a side forum during the COP28 Taiwan-Palau Climate Summit, the Foundation also explored how integrating Indigenous knowledge into sustainable transformation can enhance climate resilience.

III. Mom Loves Taiwan Climate Action Alliance

On December 6, 2023, Palau and the Mom Loves Taiwan Climate Action Alliance co-hosted the side event Building Climate-Resilient Agri-food Systems in Vulnerable Countries with Indigenous Knowledge. The event featured speakers from Palau and Taiwan, who shared experiences on climate adaptation in agricultural and food systems. Representing Taiwan, a member of the Puyuma Tribe from the Jiben Community, dressed in traditional attire, presented Indigenous agricultural practices and experiences in the context of climate resilience.

IV. Taiwan Institute for Sustainable Energy (TAISE)

The Taiwan Institute for Sustainable Energy (TAISE) focuses on aligning Taiwan's sustainability efforts with global standards and has long been committed to connecting Taiwan with international sustainable development initiatives. This year, TAISE participated in the COP28 conference, then hosted a post-conference seminar titled Post-COP28 Global Stocktake Report Analysis and Exchange upon returning to Taiwan. The event invited representatives from government, businesses, and NGOs who attended COP28 to share their observations and insights, fostering connections across sectors and

promoting climate action through understanding the latest global trends.

V. Taiwan Climate Partnership

To address the challenges of climate change, eight leading Taiwanese technology companies—AUO, Delta Electronics, TSMC, Microsoft Taiwan, Lite-On Technology, Acer, Pegatron, and ASUS—jointly launched the Taiwan Climate Partnership. The alliance aims to lead by example, driving carbon reduction across the supply chain and responding to international brand clients' demands while raising awareness of climate change issues among Taiwanese businesses and society. The Alliance established the Taiwan Climate Institute to cultivate sustainability talent within enterprises. The Institute offers tailored training programs based on different roles and needs within companies, enabling systematic integration of sustainability planning into corporate operations while keeping abreast of the latest global and industrial developments. In 2023, the Taiwan Climate Partnership participated in COP28, setting up the Digital & Green Pavilion in the Blue Zone. The Pavilion emphasized the dual transformation of digitalization and sustainability, showcasing how digital solutions can be leveraged for carbon reduction. The event featured discussions with international partners, including Oliver Wilson, Co-Chair of RE100; Kaori Miyake, Co-Chair of Japan Climate Leaders' Partnership (JCLP); and Luis Neves, Chair of the European Green Digital Coalition (EGDC).

VI. Taiwan Youth Climate Coalition (TWYCC)

The Taiwan Youth Climate Coalition (TWYCC) is one of Taiwan's most active youth organizations participating in the United Nations Framework Convention on Climate Change (UNFCCC). In 2012, TWYCC collaborated with East Asian youth to establish the Asian Youth Climate Network (AYCN). In 2013, TWYCC members were selected as official liaisons between the United Nations NGO Youth Constituency (YOUNGO) and the UNFCCC Secretariat, highlighting the pivotal role and influence of Taiwanese youth in international climate issues.

Since 2009, TWYCC has annually sent Taiwanese youth representatives to the UN Climate Change Conferences. As a participant in YOUNGO, the coalition has consistently tracked the progress of international climate negotiations, built networks with global youth, and brought international climate trends and insights back to Taiwan. To date, TWYCC has accumulated over a decade of active engagement in the global climate arena.

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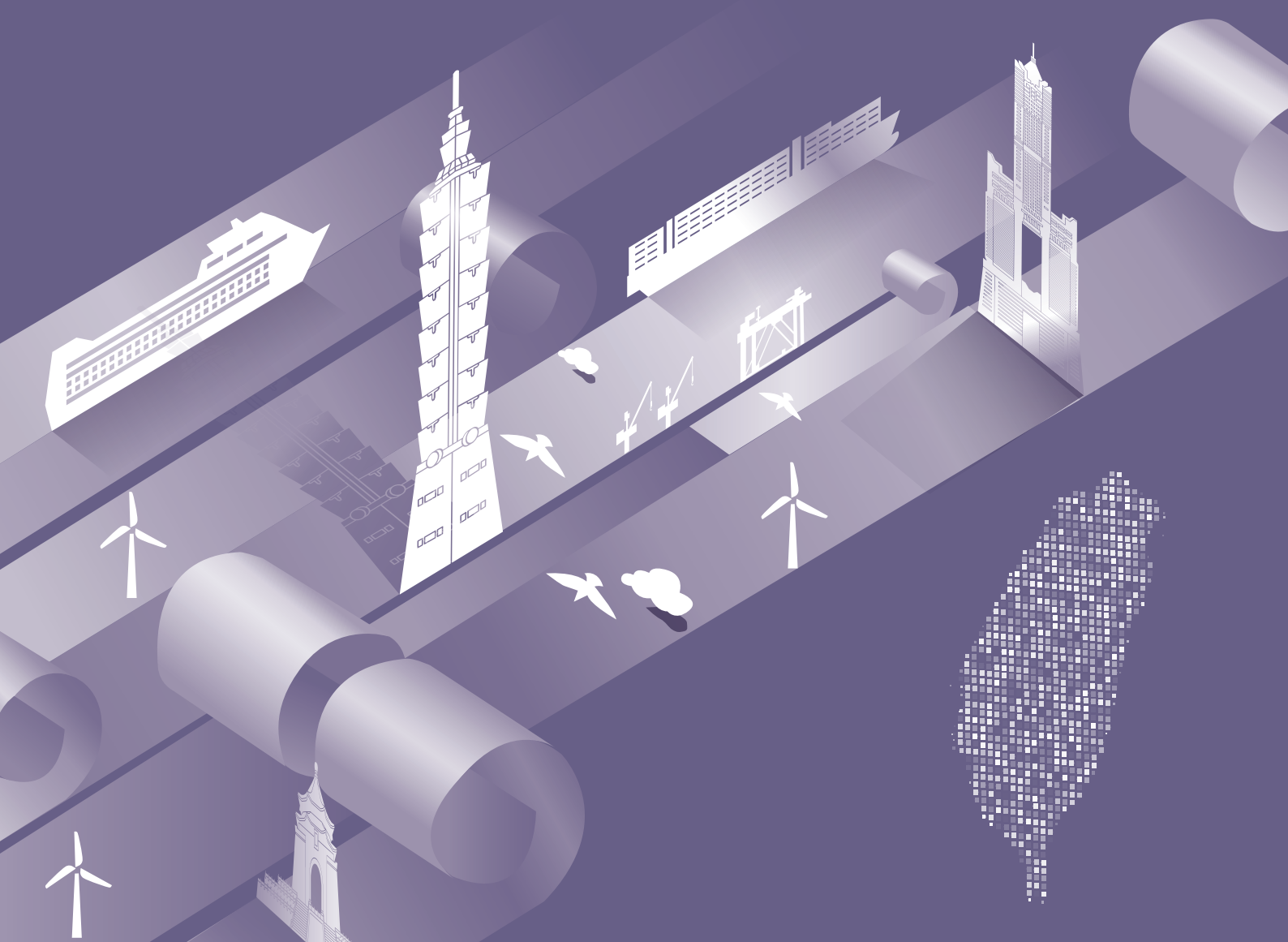
9 Education, Training, and Outreach



Chapter 9: Education, Training, and Outreach

In response to Article 6 of the United Nations Framework Convention on Climate Change (UNFCCC), which emphasizes the promotion of climate change education, training, and public awareness, various ministries of the Taiwanese government have implemented climate change education, talent development, and public communication programs within their respective areas of authority. This chapter is divided into three sections to detail Taiwan's measures and achievements in the areas of education, training, and outreach. These include integrating climate change into the education system, training professionals in climate change mitigation and adaptation, and fostering public collaboration in climate action.

9.1 Education

In accordance with Article 8 of the *Climate Change Response Act*, education and advocacy of climate change adaptation and greenhouse gas reduction shall be led by the Ministry of Education and the Ministry of Environment, and co-led by central industry competent authorities. Additionally, the Adaptation Strategy to Climate Change in Taiwan and the National Climate Change Adaptation Action Plan, approved by the Executive Yuan, task the Ministry of Education with enhancing public understanding and skills related to climate change while cultivating talent to address these challenges. To align with national policies, the Ministry of Education has developed and implemented climate change education programs aimed at training professionals so they are equipped to tackle climate change.

In 2020, the Ministry of Education introduced the New-generation Environmental Education Development (NEED) blueprint to address the pressing climate emergency. This initiative aims to enhance the environmental education competencies of teachers and students in the new generation. By integrating Climate Change, Education for Sustainable Development (ESD), and the Sustainable Development Goals (SDGs) into existing environmental education strategies, the program seeks to align with the United Nations' 2030 Agenda for Sustainable Development and its 17 SDGs. The Ministry of Education also proposed the Mid- and Long-term New-generation Environmental Education Development Policy (2022–2025) to strengthen foundational environmental education in Taiwanese schools (grades 1–12). This policy emphasizes a whole-school approach for innovation and transformation, encompassing four dimensions: school leadership and governance, campus environment and resource management, curriculum development and instruction, and collaborative learning with communities. This approach integrates innovative and alternative values, situational teaching methods, and emerging technologies while promoting school engagement in local community development to cultivate the sustainability competencies of teachers and students, ensuring that sustainability-oriented environmental education is effectively implemented in schools. The policy identifies seven strategic areas: strengthening policy support systems, enhancing teacher professional development, promoting high-quality curriculum development, optimizing learning and training environments, encouraging youth environmental action, developing local sustainable solutions, and establishing international partnerships. To achieve these objectives, the policy outlines 17 action plans and 28 implementation measures.

Climate change education is divided into two major directions: mitigation education and adaptation education. Mitigation education promotes campus carbon audits, enabling students to directly understand the greenhouse gas emissions generated by campus activities and encouraging them to propose specific mitigation solutions. Additionally, by strengthening industry–academia collaboration, students are provided with more practical

opportunities to engage with representatives from government, academia, and the private sector in fields such as mitigation technologies and energy innovation. Adaptation education focuses on implementing campus adaptation actions based on the geographic and climatic characteristics of the school's location. It integrates living laboratories and interdisciplinary teaching methods to identify suitable adaptation areas and guide students in taking specific actions. Furthermore, collaboration with climate services units from government, academia, and industry deepens the practical application of adaptation education.

Based on educational needs at different learning stages, climate change education is further divided into general education and specialized education. General education targets primary and secondary school students by integrating climate change literacy into Taiwan's 12-year Basic Education curriculum and leveraging local environmental education support teams to enhance students' understanding of climate change. Teaching alliances have also been expanding and revitalized, incorporating primary and secondary school teachers into the K-12 Education Teaching Alliance and establishing a cross-level climate change teaching support platform. This platform facilitates learning and exchange opportunities between teachers and students, integrates teaching resources across educational levels, and fosters a dynamic of "big hands helping small hands" for comprehensive learning outcomes.

Specialized education focuses on cultivating climate change professionals at the university level. This involves incorporating climate change-related materials into textbooks to deepen the content of climate change education. Through interdisciplinary learning and living laboratories, students are encouraged to take climate action and enhance their practical skills. The program also leverages networks within various professional fields to foster partnerships among industry, government, and academia. This includes establishing a mechanism where corporations or government agencies pose challenges and universities propose solutions, making such collaborations more profound. Additionally, the Climate Change Innovation Competition is held to promote university students' practical skills in the climate change field, bridging theory and practice.

The following sections detail Taiwan's specific strategies for cultivating generalists and specialists in climate-related fields, as well as an overview of the current state of energy education.

9.1.1 Climate Change Education

I. National Basic Education

The cultivation of climate change generalists primarily takes place through Taiwan's basic education system, which includes 6 years of elementary school, 3 years of junior high school, and 3 years of high school. The Curriculum Guidelines of 12-year Basic Education were first developed in 2007 and officially implemented in 2019 after years of planning and extensive dialogue. These guidelines now serve as the most important framework for elementary, junior high, and high school education.

The Curriculum Guidelines of 12-year Basic Education explicitly outline 19 issues that form the structure and content of the national knowledge system. This includes climate change-related topics, such as environmental education, energy education, and disaster prevention education, providing a solid foundation for general education in climate change. The content of these guidelines is summarized in the following table:

The design philosophy behind the 19 issues aims to strengthen the connection between education and society. Schools and teachers can flexibly integrate these issues into their curricula based on the needs of students and schools, encouraging students to develop analytical, critical thinking, and interdisciplinary problem-solving skills through various topics and issues. For elementary, junior high, and high school levels, the National Academy for Educational Research has further defined substantive content tailored to students' developmental stages for each issue. This step-by-step approach helps students progressively understand contemporary issues, such as climate change.

Taking Environmental Education as an example, the knowledge framework encompasses five learning themes: environmental ethics, sustainable development, climate change, disaster prevention and response, and sustainable use of energy resources. The climate change theme is approached in the context of addressing environmental

Table 9.1.1-1. Taiwan's National Basic Education: Climate Change-Related Issues and Content

Issue	Learning Objectives
Environmental Education	Understand and recognize the environmental crises and challenges facing human survival and development; explore issues such as climate change, resource depletion, biodiversity loss, social injustice, and environmental inequity; reflect on the meaning of individual, national, and human development; and adopt actions that promote green, simple, and sustainable living.
Energy Education	Enhance understanding of basic energy concepts; develop proper energy values; and cultivate habits, attitudes, and practices of energy conservation.
Disaster Prevention Education	Understand the causes of natural disasters; build disaster risk management and prevention capabilities; and strengthen responsibility, attitude, and practical skills for disaster prevention and response actions.

Source: National Academy for Educational Research. *Manual for Integrating Issues into Curriculum*. 2017.

challenges faced by humanity, and includes topics such as global warming and the resulting changes in climate patterns, as well as the impacts and implications for human societies. Lessons focus on enhancing students' awareness of climate change in their daily lives, helping them understand its causes and effects, and encouraging them to implement climate change mitigation and adaptation measures in their everyday activities.

At the elementary school level, the focus is on cultivating students' awareness of how climate change impacts their daily lives. At the junior high school level, the emphasis shifts to understanding the greenhouse effect, climate change resilience and vulnerability, and basic concepts related to climate policies. At the high school level, students delve into the development of international climate change initiatives and treaties, and they are encouraged to participate in regional climate change actions. This phased approach to education aims to gradually enhance students' understanding of and capacity to respond to climate change.

II. Promotion of Climate Change Education in Primary and Secondary Schools

1. Teaching Materials

To deepen teachers' understanding of climate change and climate change education (CCE) and to establish a systematic approach that aligns with international sustainable development education, the Ministry of Education has launched the Primary and Secondary School Climate Change Education Capacity Building and Lesson Plan Workshop. This workshop aims to equip school representatives and teachers with the skills to design school-based curricula, integrated activity courses, and club programs centered on CCE and education for sustainable development (ESD). It also ensures that these lesson modules align with the requirements of the Curriculum Guidelines of 12-year Basic Education.

To support the implementation of the 12-year curriculum, the Ministry of Education encourages teachers in primary and secondary schools to actively develop climate change-themed courses and elective modules. It also organizes a National Primary and Secondary School Climate Change Education Teaching Module Competition to select outstanding teaching models as demonstration cases. These cases serve as guides for schools at all levels to adopt climate change as a theme for both featured and elective courses.

Additionally, the Ministry of Education selects pilot schools to actively promote climate change education. These schools are encouraged to integrate their unique school and regional characteristics into climate change education, developing school-based curricula that other schools can observe, adopt, or promote. The Ministry also supports the development of teaching modules under the framework of Climate Change Education

for Sustainable Development Goals (CCESDG = CCE + ESD + SDG).

To date, the following resources have been developed: 48 sets of climate change-related teaching materials for elementary, junior high, and high school levels, including climate adaptation resources for secondary schools; 36 climate change teaching resources aligned with the Curriculum Guidelines of 12-year Basic Education; over 30 teaching modules for climate change lesson plans in primary and secondary schools; and one popular science teaching material specifically for high school students. All these materials and lesson plans are available for download on the Climate Change Education Promotion Platform.

2. Incentive Measures

While promoting climate change education alongside the 12-year basic education curriculum, the Ministry of Education has actively introduced the Living Laboratory teaching concept to enhance educational effectiveness. The Living Laboratory emphasizes using student's real-life environments as teaching contexts, encouraging continuous research and innovation. This approach enables students to gain knowledge while solving practical life problems, fostering their independent thinking abilities.

The concept of the Living Laboratory was proposed by Professor William Mitchell of the Massachusetts Institute of Technology (MIT). In Taiwan's climate change education, the concept is applied at three levels: the elementary school level focuses on helping students become aware of climate change and develop adaptation strategies; the junior high school level builds on awareness by introducing related knowledge and encouraging students to propose strategies; the high school level emphasizes students' ability to independently gather data, identify potential factors, propose hypotheses and predictions, take action, and refine factors and models based on outcomes.

To encourage the implementation of the Living Laboratory teaching concept in primary and secondary schools, the Ministry of Education selected three schools in 2010 to serve as pilot schools for climate change education in primary and secondary schools. Guided by National Taiwan Normal University, these schools utilized teaching resources available on the Climate Change Education Promotion Platform and incorporated local and regional characteristics to develop tailored teaching materials and activities that align with the United Nations SDGs. These pilot schools' achievements provided demonstration models for other schools to observe, adopt, or promote, while also supporting the development of related teaching materials and activities in other schools.

III. Strengthening Climate Change Education in Higher Education

1. Teaching Alliances and Seed Teacher Training

The Climate Change Adaptation Education Teaching Alliance Program focuses on nine key areas related to climate change—health, land use, disasters, energy supply and industry, water resources, agricultural production, coasts, infrastructure (transportation systems), and biodiversity. This program aims to facilitate in-depth professional knowledge exchange and multidisciplinary discussions, cultivating more talent with expertise in climate change. The program assesses the professional backgrounds and teaching fields of faculty members at higher education institutions. To promote climate change education, the initiative continuously invites interested teachers to join the Climate Change Teaching Alliance, enhancing their teaching capabilities and fostering the exchange of teaching experiences. This program is illustrated in Figure 9.1.1-1.

2. Teaching Activity Subsidies and Material Development

To provide university and college students with opportunities to learn about climate change-related issues and implement the National Climate Change Adaptation Policy, the Ministry of Education has established a subsidy program for climate change teaching activities in higher education institutions. This program encourages the development of courses in climate change-related fields or interdisciplinary areas, the creation of supplementary teaching materials, and the organization of relevant teaching activities. The aim is to enhance students' literacy and abilities in climate change and cultivate professionals equipped with knowledge and skills in this field.

In addition to subsidizing course offerings, the Ministry of Education has developed climate change teaching materials for use across various fields. To date, the following materials have been completed:

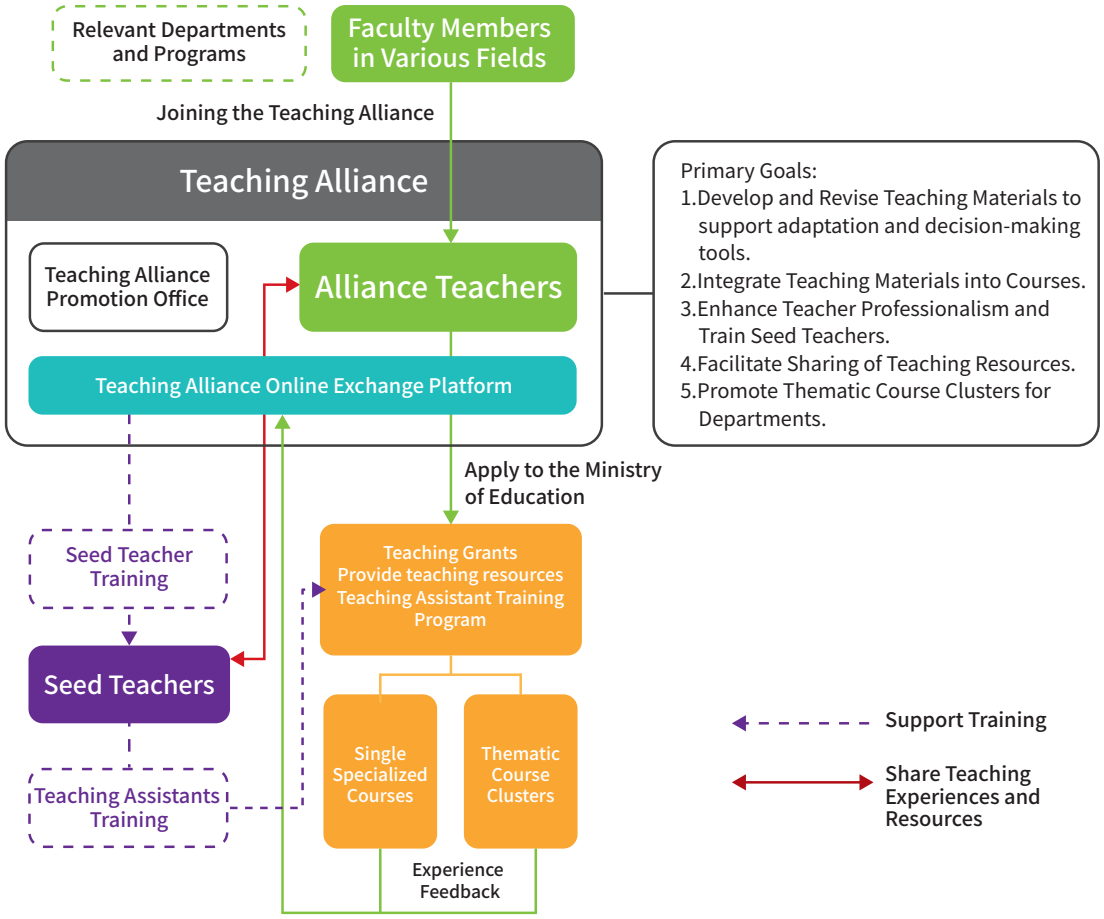


Figure 9.1.1-1. Operational Mechanism of the Climate Change Adaptation Education Teaching Alliance

Source: Climate Change Education Promotion Platform

16 general education materials for universities, including 7 core modules and 9 specialized modules; 18 materials on integrating climate change into specialized courses across nine fields, comprising 9 practical guides and 9 sets of supplementary materials; a guide for implementing interdisciplinary teaching; a guide for promoting the Living Laboratory; and digital materials, including a Climate Special Report video series and an English abridged version of the teaching materials. All these resources are available for download or viewing on the Climate Change Education Promotion Platform.

3. Interdisciplinary Teaching

Interdisciplinary teaching and practical skills aim to develop student's capacity for climate action. Interdisciplinary teaching emphasizes exchanges among students and teachers from different fields. In recent years, various interdisciplinary activities, such as creative competitions, course subsidies, panel discussions, workshops, micro-lectures, and exchange events, have facilitated mutual learning and understanding among students and teachers from diverse disciplines. These activities not only deepen participants knowledge of other fields but also enhance their understanding of interdisciplinary concepts. In the process, participants naturally integrate interdisciplinary thinking, which is then reflected in their learning and teaching practices. This is illustrated in Figure 9.1.1-2

4. Living Laboratory

In 2019, the Climate Change Education Promotion Platform published the Living Laboratory Implementation Guide, which aims to compile successful cases of living laboratories at Taiwanese universities and colleges. It also assists alliance teachers in planning and promoting projects based on a thorough understanding of the core principles of the Living Lab concept. The Living Laboratory concept, proposed by Professor William Mitchell of the Massachusetts Institute of Technology (MIT),

Figure 9.1.1-2. 7th SDGs Ecological Urban–Rural Planning and Practice Workshop

Source: Ministry of Education.

emphasizes using students' real-life environments as teaching contexts. It fosters ongoing research and innovation, enabling students to gain knowledge through solving real-life problems while cultivating their independent thinking abilities.

According to the Whole-Institute Approach, promoting behavioral education through the concept of schools as Living Laboratories encourages students to take climate action. At the primary and secondary school levels, this concept is reflected in the promotion of Green Schools. At the university level, it evolves into Green Universities, sustainable campuses, or campus Living Laboratories, enhancing sustainability education and practices across campuses, as illustrated in Figure 9.1.1-3.

5. Climate Change Innovation Competition

In recent years, the Ministry of Education has actively promoted climate change education initiatives aimed at fostering a deeper understanding of climate change issues among students while inspiring creative thinking in climate change adaptation. By strengthening theoretical frameworks, students are encouraged to transform creative ideas into practical applications, enhancing their awareness and practical abilities in climate change adaptation. Since 2016, the Ministry of Education has organized the Climate Change Innovation Competition and related capacity-building camps for universities and colleges. These initiatives encourage students to actively engage with climate change

Figure 9.1.1-3. Living Laboratory for the Water Resources Teaching Alliance: Irrigation and Drainage Engineering Course

Source: Ministry of Education.

issues, express creativity, and explore innovative solutions for addressing climate challenges.

The creative works produced in these competitions are diverse and unconstrained, encouraging participants to bring about positive change through proactive climate action. By leveraging creativity and interdisciplinary thinking, students create opportunities and possibilities for sustainable development. The winning projects cover a wide range of topics, including education, urban planning, architecture, urban farming, aquaculture, and product design, reflecting the diversity and broad relevance of climate change issues. These projects have received high praise from review panels and yielded significant results, as illustrated in Table 9.1.1-2.

Table 9.1.1-2. 2023 Innovation Competition Winners

Rank	No.	Team Name	Project Title	Advisor	Student Departments	Team Members		
Gold	05	Membrane Master of MemClean	The Yellow River's Water Sunward	Tung Kuo-lun	National Taiwan University, Department of Chemical Engineering	Chou Ting-hsun	Wu Po-chun	Yeh I-jui
Silver	14	Space WetBase	Grilled Mushroom	Hsieh Jui-ching	National Chin-Yi University of Technology, Department of Mechanical Engineering	Liao Chen-hao	Hsieh I-chi	Chang Chieh-mou
Silver	23	Green Future	Carbon-Negative Green Power	Chang Chia-yao	National Taiwan University of Science and Technology, Department of Chemical Engineering; National Defense University, College of Science and Engineering, Department of Chemical and Materials Engineering	Chang Po-yuan	Ko Pin	
Bronze	07	Earl Fresh Milk Tea	Tea Branch Cultivation Cup	Li Kai-shu	National Taipei University of Education, Department of Art and Design	Chen Yu-ting	Lin Chung-wei	
Bronze	02	Turtle Mommy	Sea Turtle Protection Shield	Li Kai-shu	National Taipei University of Education, Department of Art and Design	Hsueh Kai-chieh	Chang Hsun-yu	
Honorable Mention	11	Pineapple Pear	Recycled Pineapple Bag	Li Kai-shu	National Taipei University of Education, Department of Art and Design; Ming Chi University of Technology, Department of Industrial Desi	Chang Yen	Chien Yu-jui	
Honorable Mention	13	I Am Not a Thug, I Am a Bamboo Craftsman	Bamboo Craft Revival - Designing a Carbon-Negative Circular Economy for Taiwan's Bamboo Forests	Chang Kuo-pin	National Taichung University of Science and Technology, Department of Creative Product Design	Cheng I-cheng	Lu Tse-min	

Rank	No.	Team Name	Project Title	Advisor	Student Departments	Team Members		
Honorable Mention	16	Cattle and Fish for Eternity	HWP Urban Forest - Carbon Calculation Platform	Chiu Chi-jung	National Taiwan University, Department of Forestry and Environmental Resources	Hsu Ting-yu	Cheng Hsun-chien	Tseng Yun-ching
Honorable Mention	01	NTNU Industrial Education	Developing a Closed-Loop Algorithm for Cable Insulation Processes to Reduce Earth's Impact	Kuo Chin-kuo	National Taiwan Normal University, Graduate Institute of Industrial Education, Technology Application and Management Program	Sung Chun-i	Chen Po-nien	
Honorable Mention	24	Water Beauties	Come Come Net	Yu Hung-chang	National Yunlin University of Science and Technology, Department of Creative Design	Lin I-chun	Chung I-hsin	Chan I-chen
Best Popularity Award	03	Delivery Is So Difficult	Circular Packaging Application	Lin Chen-yu	National Yang Ming Chiao Tung University, Department of Transportation and Logistics Management	Yeh Hung-i	Lin Ko-wen	Huang Ming-fei
Ministry of Agriculture Special Awards	Gold	09	Snack Monster	Food Bank	Lin Shih-ping	National Yang Ming Chiao Tung University, Institute of Technology Management; Institute of Industrial Engineering and Management	Chu Hsiang-yu	Wu Pin-hsuan	Chang Ming-hao
	Silver	22	Chicken Grows Vegetables	Campus Health and Low-Carbon Lifestyle Game - Little Chick Farm	Su Ying-min	National Taipei University of Technology, Graduate Program of Architecture and Urban Design	Lin I-hsuan	Chou Chia-ti	Lin Fu-yu
	Bronze	11	Pineapple Pear	Recycled Pineapple Bag	Li Kai-shu	National Taipei University of Education, Department of Art and Design; Ming Chi University of Technology, Department of Industrial Design	Chang Yen	Chien Yu-jui	
	Bronze	16	Cattle and Fish for Eternity	HWP Urban Forest - Carbon Sequestration Calculation Platform	Chiu Chi-jung	National Taiwan University, Department of Forestry and Environmental Resources	Hsu Ting-yu	Cheng Hsun-chien	Tseng Yun-ching
Ministry of Environment	Special Award for Net-Zero Transition Practice	14	Space WetBase	Grilled Mushroom	Hsieh Jui-ching	National Chin-Yi University of Technology, Department of Mechanical Engineering	Liao Chen-hao	Hsieh I-chi	Chang Chieh-mou
	Special Award for Adaptation Capacity Building	24	Water Beauties	Come Come Net	Yu Hung-chang	National Yunlin University of Science and Technology, Department of Creative Design	Lin I-chun	Chung I-hsin	Chan I-chen

Source: Climate Change Education Promotion Platform.

9.1.2 Climate Change Adaptation Education

The Climate Change Teaching Alliance is the Ministry of Education's primary vehicle for promoting the cultivation of campus climate change professionals. The main objectives of the Alliance are to assist university and college educators in advancing knowledge of climate change adaptation, facilitate connections with industry, and foster professional talent in climate change adaptation. After joining the Alliance, educators can access resources via the online exchange platform, including teaching materials, teaching assistant training courses, and mentorship from experienced seed teachers.

Materials from the online exchange platform can be used to develop both single-semester professional courses and progressive, multi-semester specialized course series. Course development is determined on the basis of each department's specialized focus, integrating the department's specialized textbooks with the Alliance-provided supplementary specialized materials and practical specialized materials. This approach allows students to cultivate specialized expertise while understanding the connection between their field of study and climate change, distinguishing it from the generalist education described in the previous section, which focuses primarily on basic concepts.

Taking the health field as an example, the Climate Change Teaching Alliance reviewed the current community health nursing textbooks used by nursing departments and analyzed sections related to climate change adaptation. On this basis, the Alliance developed the Climate Change and Health Adaptation Specialized Practical Materials, which became part of the required courses for nursing departments, directly or indirectly reaching the 30 nursing programs nationwide. In 2023, the Alliance completed the 2023 Edition of Climate Change Adaptation Supplementary Specialized Materials - Health Field. For Chapter 2: Health Impacts of Temperature Changes and Adaptation to Climate Change, the materials incorporated recent domestic and international literature. Additionally, through interdisciplinary collaboration with Academia Sinica and Chi Mei Hospital, the health field explored preparedness and response mechanisms for heat injuries caused by climate change. This included the development of an early warning system, preventive and adaptive guidelines for heat injuries, and health education materials. These findings and literature were integrated into the relevant chapters of the supplementary materials to serve as teaching references for Alliance educators.

The Alliance has now completed the development of materials across various fields and continues to refine and update these materials based on feedback from Alliance educators during the teaching process.

9.1.3 Energy Educationcation

The Ministry of Education has integrated energy education into the official curriculum, designating it as one of the 19 key issues in the Curriculum Guidelines of 12-year Basic Education (General Guidelines). Specific learning themes and substantive content related to energy education have also been established. By developing supplementary materials on energy education, the Ministry leverages the existing education system to help students understand both the positive and negative impacts of energy on the environment and the economy, as well as the value of energy use. These materials also incorporate the core elements of national green energy development and energy transition policies, emphasizing the sustainable use of energy resources. Through this approach, students are encouraged to practice these principles in their studies and develop into independent and critical-thinking citizens.

Additionally, in alignment with the United Nations SDGs, the Ministry promotes the Talent Cultivation of Sustainable Energy Interdisciplinary Application Project, which aims to cultivate talent for the interdisciplinary application of sustainable energy. The project focuses on deepening the training of talent in energy creation, conservation, and storage while strengthening practical teaching in areas such as smart technologies, energy management, smart grids, and green energy technologies related to net-zero emissions. To align with national energy transition policies, the project also incorporates interdisciplinary issues in fields such as environment, economics, finance, law, and politics. This approach helps teachers and students at all educational levels develop a more holistic understanding of Taiwan's energy development and current situation, enhancing their energy literacy and critical thinking about energy issues, as illustrated in Figure 9.1.3-1.

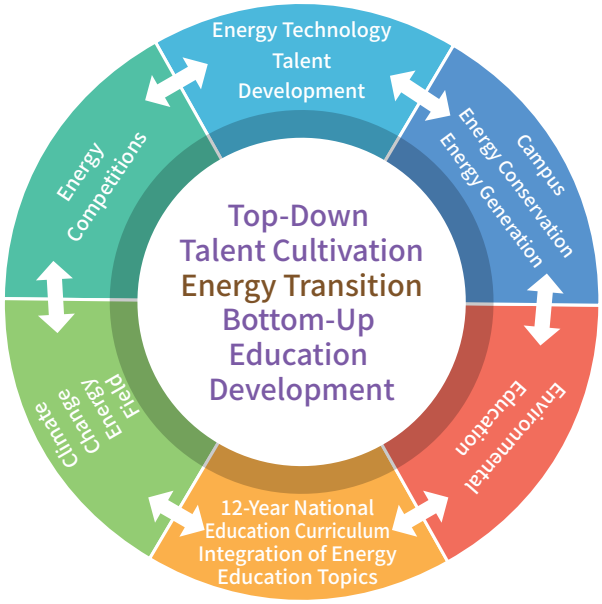


Figure 9.1.3-1. The Ministry of Education's Educational Promotion Structure

Source: Energy Education Resource Center

9.1.4 Net-Zero Green Living Education

The Ministry of Environment has developed storybooks and teaching materials focused on net-zero green living for elementary and junior high school students. These materials address aspects of daily life such as food, clothing, housing, transportation, recreation, and shopping. In collaboration with the Green School Partnership Program of the Ministry of Education, these resources promote campus-based education on net-zero green living, disseminate information and practices related to sustainable living, and strengthen the foundation of education. The initiative aims to enhance public awareness and actions toward adopting a net-zero green lifestyle.

Figure 9.1.4-2. Net-Zero Green Living Teaching Materials and Lesson Plans (15 Volumes)

Figure 9.1.4-1. Illustrated Storybooks on Food, Clothing, Housing, Transportation, Recreation, and Shopping

The Ministry of Environment, in collaboration with public and private universities and colleges, approved seven institutions in 2024 to jointly organize or subsidize projects. These initiatives include implementing campus net-zero green living lesson plans; creating demonstration areas for green living; hosting green living experiential activities; and identifying stakeholders, issues, and strategies for a just transition. Tailored to local needs, these efforts aim to disseminate the principles of net-zero green living to nearby communities, industrial parks, and enterprises.

9.2 Training

Considering that the impacts of climate change in the future will not be limited to specific sectors or professions, Taiwan is actively promoting training programs for climate change professionals. These initiatives are led by relevant authorities within various government departments, tailored to the specific needs of different professions. This section introduces the ongoing training measures in the areas of mitigation and adaptation.

9.2.1 Climate Mitigation Professionals

In addition to classifying Energy, Manufacturing, Transportation, Residential and Commercial, Agriculture, and Environment as six key sectors, Taiwan's *Climate Change Response Act* mandates the development of greenhouse gas reduction strategies for each sector. Furthermore, the Act requires these six sectors to conduct training activities related to mitigation. Below are examples of the mitigation-related training measures being implemented by each sector.

I. Energy Sector

To enhance the energy governance capabilities of local energy personnel, the Energy Administration, Ministry of Economic Affairs, has been conducting at least three Local Energy Governance Capacity-Building Courses annually since 2018. These courses include assistance for local governments in identifying local issues, recognizing stakeholders, analyzing local energy data, planning and implementing renewable energy or energy conservation strategies, and designing mechanisms for public participation. To strengthen energy awareness among younger generations, the Bureau has also been organizing the Youth Energy Issue Deliberation Training Course annually since 2022. Additionally, the Energy Administration has established the Energy Management Institute digital learning platform. This initiative aligns with Article 11 of the *Energy Administration Act*, the Regulations on the Establishment and Registration of Energy Users' Self-Set or Entrusted Engineers or Qualified Energy Managers, and the Qualifications for Engineers or Energy Managers to Perform Energy Management Tasks. The platform aims to promote comprehensive training programs for energy management personnel nationwide and encourages industrial and commercial enterprises to adopt energy management practices, reducing energy costs and improving efficiency. As of 2024, the platform has launched the Energy Manager Training Program.

II. Manufacturing Sector

To help enterprises comply with regulations or supply chain requirements by enhancing their carbon accounting and reporting capabilities, the Industrial Development Administration, Ministry of Economic Affairs, has been conducting talent training programs in collaboration with industrial associations, trade associations, local industry associations, industrial park manufacturers' associations, and professional organizations since 2022. These initiatives include low-carbon talent training courses, the establishment of a digital service platform, and the provision of enterprise support to strengthen industries' carbon inventory and reduction capabilities. The training programs offer various courses, such as CEO Masterclasses, seminars, seed training courses, carbon footprint classes, and 1-day training sessions on the EU Carbon Border Adjustment Mechanism, aiming to build talent capacity within industries. A total of 945 training sessions and three talent training-related briefings were conducted between 2022 and June 2024, training over 34,000 participants. Additionally, starting in April 2024, the Administration introduced the iPAS Advanced Program, a professional engineering certification issued by the Ministry of Economic Affairs, recognized by the Ministry of Education, and supported by the industry. This program has accumulated 1,075 participants across 29 classes and encouraged students to achieve the iPAS for Net-Zero Carbon Planning and Management Specialist qualification.

Figure 9.2.1-1. Talent Training Courses for the Manufacturing Industry

III. Transportation Sector

To promote a net-zero green transportation lifestyle, the Ministry of Transportation and Communications (MOTC) initiated pilot activities in 2023 targeting student groups. These activities included classroom promotion, interactive sessions, and demonstrations, allowing participants to gain both knowledge and hands-on experience in green transportation with the goal of encouraging participants to adopt green transportation practices. The Tourism Administration, MOTC, has also promoted green tourism itineraries at environmental education facilities managed by various national scenic area administrations. In 2023, a total of 27 green tourism itineraries were launched. Additionally, certification assistance initiatives will culminate in a 2024 certification ceremony for label-accredited businesses and an international green label certification briefing session.

In 2024, Taiwan Railways Administration (TRA) began conducting carbon footprint assessments for passenger transportation services, which cover three train types (Tze-Chiang Limited Express, Chu-Kuang Express, and local trains) and include greenhouse gas inventories at 32 stations (4 special-class stations and 28 first-class stations). To enhance employee competencies, TRA organized four training sessions on May 23, 24, 28, and 29, 2024, with 137 participants. Additionally, two ISO 14067 internal carbon footprint verifier training sessions were held on July 20 and 27, 2024, training 30 participants.

From 2022 to 2024, Taiwan International Ports Corporation (TIPC) conducted 35 training sessions on climate change, sustainable governance, and carbon reduction. These included courses aimed at improving the quality of greenhouse gas inventories, such as ISO 14064-1:2018 Greenhouse Gas Inventory Implementation and Verification Training and Lead Verifier Training for ISO 14064-1:2018 Greenhouse Gas Inventory Standards. TIPC also invited port-area businesses to participate in related courses to raise awareness of climate change and carbon management. Chunghwa Post conducted the Stepping Toward Net-Zero Emissions training course on April 8 and 9, 2024, to align with Taiwan's 2050 Net-Zero Emissions Policy and implement ESG sustainability practices. The training aimed to enhance employee expertise in environmental sustainability topics.

IV. Residential and Commercial Sector

In the residential sector, activities designed to promote energy-saving in buildings, improve building energy efficiency, and strengthen the public's understanding of green building concepts were conducted between 2022 and 2023. A total of 112 events were held, including workshops, briefings, case study visits, training courses, and promotional

activities. These events invited participation from central government agencies, universities, architects, refrigeration and air-conditioning engineers' associations, and the general public, aiming to comprehensively disseminate energy-saving and carbon reduction concepts. These activities attracted a total of 7,238 participants.

In the commercial sector, ongoing initiatives include carbon reduction training programs, talent cultivation for campus energy-saving personnel, and sector-specific energy-saving and carbon reduction courses to train professionals in the service industry. Activities were combined with member meetings of trade associations, industry exchange seminars, educational training sessions, and the development of promotional and training materials. A total of 286 energy-saving and carbon reduction promotion events were conducted between 2022 and 2023, enhancing the service industry's knowledge and skills in greenhouse gas mitigation and reaching over 26,000 participants.

V. Agriculture Sector

To address new environmental challenges posed by global warming and climate change, the Ministry of Agriculture has been promoting the Guidelines for Ecological Engineering Planning, Design, Supervision, and Management in Farmland Water Conservation Projects since 2014. To further implement policies on ecological engineering, energy-saving, and carbon reduction applications, the Ministry has been maintaining and updating the Energy-Saving and Carbon-Reduction Assessment System for Farmland Water Conservation Projects since 2016. Additionally, advanced training programs have been conducted for seed personnel responsible for guiding and interpreting farmland irrigation associations.

In 2021, the Ministry organized 18 local engagement sessions, 4 local governance sessions, and 5 industry-focused seminars across the country. These sessions invited local farmers, agricultural enterprises, rural communities, agricultural agencies, legal entities, and government institutions to engage in discussions. The outcomes were consolidated into four major themes: Reduction, Enhancement of Carbon Sinks, Circular Economy, and Green Trends. These themes were further developed into 19 strategies and 59 measures. To promote knowledge of net-zero practices, the Ministry has strengthened training for personnel at its various research stations to produce seed lecturers. Furthermore, to enhance social communication and convey the importance of net-zero emissions, the Ministry has organized promotional courses tailored to various regions, groups, and audiences, targeting local governments, farmers' associations, agricultural societies, and related professionals.

VI. Environmental Sector

To strengthen climate governance in government departments, accelerate carbon reduction and transformation in enterprises and industries, and establish a foundation for net-zero practices, the Ministry of Environment continues to promote the Climate Change Talent Development Program. This program provides professional climate change courses targeting personnel from central and sector-specific government agencies, environmental protection agencies at all levels, enterprises, verification institutions, green-collar youth, and the general public. Basic and professional courses are offered to support climate change mitigation initiatives in both the public and private sectors.

Since 2022, the Ministry has implemented the Net-Zero Green Living Training and Promotion Program, conducting five seed personnel training sessions with a total of 223 participants and 22 net-zero green living promotion training courses with 965 participants. In 2023, the Ministry executed the Net-Zero Emissions Enterprise Transformation Technical Training Program, the Net-Zero Emissions Public Promotion Program, and the Greenhouse Gas Inventory Professionals Training and Enterprise Net-Zero Emissions Exchange Program, training a total of 2,060 participants. In 2024, the Ministry will continue to implement the Net-Zero Talent Development and Promotion Program and the Climate Change and Circular Economy Environmental Professional Training Program, and plans to train an estimated 2,500 participants.

9.2.2 Climate Adaptation-Related Personnel

The latest edition of Taiwan's National Climate Change Adaptation Action Plan categorizes climate change adaptation actions into eight major domains: disasters, critical infrastructure, water resources, land use, coastal zones, energy supply and industries, agricultural production and biodiversity, and health.

The plan also requires each responsible ministry to conduct adaptation-related training for personnel. Examples of mitigation-related training measures for each of the eight major domains are described below.

I. Disaster Domain

To address various disaster scenarios, the National Science and Technology Council has developed disaster risk maps at national and municipal scales and promoted the Taiwan Climate Change Projection Information and Adaptation Knowledge Platform Project (see Chapter 6 for details). The Water Resources Agency, as part of its Flood Disaster Prevention and Mitigation Plan, has been advancing public disaster prevention awareness and promoting community-based flood prevention initiatives across all municipalities. These initiatives involve recruiting and training volunteers to enhance disaster prevention and response capabilities nationwide. Furthermore, to strengthen the conservation and management of reservoir catchment areas, the Water Resources Agency has implemented measures for restoration, early warning systems for soil and water disasters, and investigations into sedimentation control. Additionally, the Bureau of Cultural Heritage conducts annual adaptation training programs to address the increasing frequency of extreme weather events and their impact on archaeological sites. The Council of Indigenous Peoples has also implemented plans for the preservation of traditional sites and ecological resources in Indigenous areas to mitigate the impacts of natural disasters on the traditional territories of Indigenous peoples.

II. Critical Infrastructure Domain

To cultivate climate change adaptation expertise among transportation personnel, the Institute of Transportation, Ministry of Transportation and Communications, planned a series of adaptation-related courses for 2023 and 2024. These courses invite participation from relevant internal units and subordinate agencies of the Ministry of Transportation and Communications, railway and metro companies, local transportation authorities, and consulting firms involved in transportation projects. The curriculum includes foundational topics such as climate change and climate disasters, climate change risk assessment and adaptation case studies, national adaptation regulations and policies, and climate risk decision-making reference information. It also features tool- and guideline-based courses, such as the application of domestic climate change scenario information. The aim is to enhance transportation personnel's professional knowledge of climate change adaptation and strengthen the overall adaptive capacity of the transportation system, thereby reducing the risks of climate change related impacts on transportation infrastructure.

To improve adaptation capacity of highways during the planning phase, the Institute of Transportation organized two training sessions on the Guidelines for Climate Change Adaptation in Highway System Planning and Case Studies in 2023, drawing approximately 40 participants. An expert workshop was also held in 2023, inviting climate change experts, highway system authorities, and major domestic engineering consulting firms to help verify the appropriateness and feasibility of the highway system adaptation guidelines.

III. Water Resources Domain

To address the impacts of climate change on the utilization of agricultural water resources, the Ministry of Agriculture has promoted the modernization and improvement of agricultural irrigation facilities and the enhancement of irrigation water quality management and maintenance. These efforts are complemented by training programs aimed at improving the capacity of agricultural personnel to adapt to climate change. Additionally, the Water Resources Agency, Ministry of Economic Affairs, has implemented a water-saving guidance program for industries to mitigate the impacts of climate change on industrial water usage. This program was simultaneously carried out in northern, central, and southern regions, providing consulting services to 1,069 major water users. These consultations identified a total water-saving potential of 21,511 metric tons per day. Furthermore, water-saving incentive measures were introduced to strengthen the capacity of industrial personnel to adapt to climate change.

IV. Land Use Domain

To effectively reduce the vulnerability of land use, the Ministry of the Interior, along with municipal and county (city) governments, has formulated national spatial plans, urban plans, and national park plans based on Taiwan's spatial planning framework. These plans incorporate adaptation strategies to address the impacts of climate change,

with a continuous focus on training spatial planning professionals. The mid-term plans for national parks emphasize cultivating conservation research personnel in fields such as ecology, flora and fauna, forests, wetlands, and oceans. These plans will also provide research sites for long-term investigations and monitoring by conservation researchers. Additionally, the plans include the development of interdisciplinary professionals in areas such as humanities, geology, landscape, recreation, environmental education, natural conservation, and engineering for comprehensive park management and operation.

V. Coastal and Ocean Domains

To enhance Taiwan's marine and meteorological disaster prevention service system, the Central Weather Administration organized the Marine Environmental Information Platform Application Workshop from 2019 to 2023. This workshop invited representatives from industry, government, academia, and disaster prevention agencies to participate, promoting meteorological disaster prevention information and attracting the involvement of multiple academic teams. Additionally, the Central Weather Administration collaborated with the U.S. National Oceanic and Atmospheric Administration (NOAA) National Severe Storms Laboratory to conduct talent training activities. These initiatives introduced an automated real-time forecasting system and supported the development of autonomous radar data processing and research talent, strengthening Taiwan's capacity to respond to marine and meteorological disasters.

VI. Energy Supply and Industry Domains

The Energy Administration, Ministry of Economic Affairs, continues to conduct climate change adaptation training programs for professionals in the energy sector. It also researches the latest international trends in climate change adaptation and publishes the Energy Sector Climate Change Adaptation E-Newsletter to raise awareness of adaptation within the energy industry. The Industrial Development Administration organizes ongoing Climate Change Adaptation Promotion Seminars for the manufacturing industry. Through climate change adaptation workshops, it provides information and practical exercises on adaptation strategies. Meanwhile, the Small and Medium Enterprise and Startup Administration supports small and medium enterprises by offering education and training programs to help them build knowledge and capacity for responding to climate change.

VII. Agricultural Production and Biodiversity Domains

To mitigate the impacts of climate change on agricultural production, the Ministry of Agriculture has continued to promote measures such as enhanced structural greenhouse facilities, crop disaster mitigation systems, and agricultural insurance. Additionally, it organizes climate change adaptation training programs for agricultural professionals. These include education and training on tools such as the risk assessment application Agricultural Climate Scenario Inquiry Platform and the Crop Disaster Early Warning Platform. Workshops on stress-tolerant cultivation techniques and new facility designs, as well as various lectures and seminars, are held to enhance adaptation knowledge among industry professionals and stakeholders.

To further improve agricultural adaptation capacity and innovation, as well as increase marine habitat biodiversity and fishery resources, industry–academia collaboration, material dissemination, corporate lectures, and ESG-themed events are actively promoted. The Ministry of Agriculture has also introduced organic ingredients into school lunches for 1.79 million students across 3,100 primary and secondary schools in Taiwan's 22 municipalities and counties. The Ministry of Environment has encouraged restaurants to join the Cherish Food initiative, with over 80 establishments participating, aiming to reduce the climate impact of food production from the consumer end.

The Ministry of the Interior has implemented a National Park Carbon Management Plan that trains park personnel in carbon inventory and management to promote greenhouse gas reduction and low-carbon tourism.

Additionally, on April 2, 2024, Chunghwa Post held a special lecture titled Climate Change Adaptation and Net Zero: Sustainability in Taiwan's Agriculture. The lecture discussed the impact of climate change on agriculture, inspiring employees to adapt and embrace sustainable practices.

VIII. Health Domain

To prevent occupational injuries caused by outdoor work in high-temperature environments, the Ministry of Labor has, since 2019, conducted campaigns and observation activities to raise

awareness about the hazards of high-temperature outdoor work. It also revised the Guidelines for Preventing Heat Hazards for Outdoor Workers in High-Temperature Environments. The Ministry also completed a study titled Impact of Climate Change on Heat Stress and Physical Workload in the Construction Industry, which analyzed the risk levels of heat exposure for outdoor workers due to extreme high temperatures caused by climate change. This research serves as a foundation for future professional studies, aiming to enhance employers' and workers' understanding of extreme heat and strengthen workplace adaptation strategies.

IX. Capacity Building Domain

On September 26, 2022, the Financial Supervisory Commission (FSC) announced the Green Finance Action Plan 3.0. The plan includes five key focus areas, one of which is capacity building. This initiative aims to enhance training and develop sustainable finance talent within financial institutions, embedding the principles of sustainable finance into their organizational structures and culture from the top down. It also seeks to extend this influence to investment and financing targets, thereby impacting the broader industry and society to accelerate Taiwan's net-zero transition. Implementation details are as follows:

1. **Strengthening Sustainability Finance Training for Financial Sector Executives and Staff:**

The Bankers Association, the three major associations for securities and futures, and the associations for property and life insurance have incorporated sustainability finance training for directors, supervisors, senior managers, and general employees into their self-regulatory guidelines.

2. **Developing Certifications in Sustainable Finance:**

The FSC issued a press release on January 25, 2024, announcing the launch of sustainable finance certifications in the first quarter of 2024. In April 2024, the Fundamental Competency Test for Sustainable Development was conducted, and Fundamental and Advanced competency courses are scheduled to begin in July 2024.

3. Incorporating Green and Sustainable Finance Knowledge into Financial Education and Advocacy to Promote Social Communication on Green and Sustainable Issues:

   (1) By the fourth quarter of 2023, a total of 85 financial education and advocacy activities on the theme of Green and Sustainable Finance had been held, attracting over 80,000 participants.

   (2) On December 6, 2023, the Net-Zero Promotion Task Force for the Financial Industry Domestic and International Outreach Team hosted a sustainable finance forum. The event invited the Asian Corporate Governance Association, representatives from domestic and international financial institutions, and local enterprises to participate in keynote speeches and panel discussions. Topics included corporate low-carbon transitions, alignment between financial institutions and clients, sustainable governance, and transformation, fostering exchange of ideas.

4. Continuously encouraging the Taiwan Academy of Banking and Finance to organize relevant training courses and seminars, inviting domestic and international experts to share experiences and exchange insights. The goal is to develop green project financing models suitable for Taiwan, enhance local project financing capabilities, and support the financial industry in managing climate change risks. In 2022, a total of 86 sessions were held, attracting 5,826 participants. In 2023, a total of 171 sessions were conducted, drawing 10,177 participants. In 2024, as of the end of June, a total of 90 sessions had been held, with a total of 4,812 participants.

To assist various sectors in managing climate risks and enhancing adaptation resilience to the impacts of climate change, the Central Weather Administration, Ministry of Transportation and Communications, in collaboration with the Taiwan Climate Services Partnership, has been offering the Climate Services Competency Training series since 2023. These courses provide foundational meteorological knowledge and practical skill training, improving basic interpretation of meteorological information and interdisciplinary application capabilities. They also address the demands and awareness of applications such as green energy and climate finance. Completed course plans include the use of meteorological information for offshore wind power and the application of climate data in Task Force on Climate-Related Financial Disclosures (TCFD). As of June 2024, four sessions of the offshore wind power meteorological information

application course have been conducted, with a total of 108 participants. Two sessions of the climate data application in TCFD course are scheduled for the second half of 2024.

On January 16, 2024, Chunghwa Post held a special lecture titled Finance Supporting Sustainable and Resilient Development, which explored topics ranging from climate change to green financial products and corporate net-zero transitions.

To strengthen climate governance within government departments, encourage businesses and industries to accelerate decarbonization transitions, and achieve net-zero implementation goals, the Ministry of Environment continues to promote the Climate Change Talent Development Program. This initiative provides professional climate change courses for a wide range of participants, including personnel involved in climate change efforts from central and specialized authorities, environmental protection agencies at all levels, businesses, verification organizations, green-collar youth, and the general public. Both basic and advanced courses are offered to assist the public and private sectors in advancing climate change mitigation efforts.

Since its implementation in 2022, the Net-Zero Green Living Training Promotion Program has provided 5 seed training courses for 223 participants and 22 promotional training sessions on net-zero green living for 965 participants. In 2023, the Ministry carried out the Net-Zero Emissions Enterprise Transformation Technical Training Program, the Net-Zero Emissions Public Awareness Program, and the Greenhouse Gas Inventory Professional Training and Corporate Net-Zero Emissions Exchange Program, training a total of 2,060 participants.

In 2024, the ministry continues to execute the "Net-Zero Talent Development and Promotion Program" and the "Climate Change and Circular Economy Environmental Professional Talent Development Program," with a target of training 2,500 participants.

9.3 Social Dialogue and Public Communication

Addressing climate change relies on the collaborative participation of both the government and the public. Effective public communication serves to enhance policy-making, and public–private partnerships foster climate empowerment to jointly create a sustainable environment. The following sections introduce Taiwan's social dialogue and public engagement in climate and energy policies, as well as actions by civil society organizations to promote climate empowerment.

9.3.1 Social Dialogue and Public Engagement in Climate and Energy Policies

Taiwan has established a comprehensive mechanism for public engagement during the policy implementation phase. In addition to holding expert advisory meetings and public hearings as required by regulations, the government also makes use of livestreams, forums, and other formats to broaden and deepen social communication. In recent years, public engagement mechanisms have also been gradually integrated into the policy planning phase, allowing the government to gather input from various sectors and explore critical technologies or issues related to net-zero emissions.

To further enhance public participation, the government has developed the Climate Talks platform which provides interactive policy information and online consultations, enabling the public to participate directly in policy discussions. Through workgroups, large-scale seminars, and other formats, the government collaborates with representative groups on specific issues, extensively collecting public opinions to refine overall policy planning. This diverse public engagement mechanism not only improves policy transparency but also enhances inclusivity and feasibility.

I. Social Dialogue Outcomes of the 12 Key Strategies

1. Wind/Solar PV

(1) Offshore Wind Power

- The 18 offshore wind farms under administrative contracts with the Ministry of Economic Affairs have fully complied with the Ministry's requirements. Before wind farm planning, developers avoided sensitive areas and, as part of the required documentation for establishing wind farms, obtained letters of opinion or consent from all relevant stakeholders.

- The Ministry of Economic Affairs continues to supervise developers to ensure compliance with the *Environmental Impact Assessment Act* and the *Guidelines for Public Explanation Meetings of Environmental Impact Assessments*. Public explanation meetings are held to enhance information transparency and public participation, thereby increasing stakeholder understanding of offshore wind power development.

(2) Solar PV

- To build consensus on photovoltaic development, the draft Energy Land Use White Paper was created through interviews with central government agencies, local energy authorities, solar industry associations, experts, scholars, civic groups, and representatives from the agriculture and fisheries industries. These interviews, which outlined the future development of solar energy and spatial policies while collecting feedback, totaled 47 sessions by the end of 2023. Additionally, five focused consultation meetings were held, during which 19 participants were invited to on-site inspections at operational aquavoltaic sites in Chiayi and Tainan and a pilot agrivoltaic site. Attendees exchanged ideas and provided suggestions for future directions of the white paper, with positive feedback on the value of such on-site activities.
- Hotspot service stations for photovoltaic installation were established in key areas (Chiayi and Tainan) to address local residents' concerns in real time, including complaints about road damage, noise, light pollution, and mosquitoes, thereby minimizing the impact of solar installations on community life.
- The Ministry of Economic Affairs established the Fisheries and Environmental Friendly Reserve Fund to support related agencies under the Ministry of Agriculture and the Ministry of Economic Affairs, as well as local governments. This fund subsidizes conservation measures for plants and animals, ecological environment monitoring and adaptation efforts, aquaculture guidance, and the promotion of aquavoltaics, aiming to improve the overall environment for aquaculture and solar installation coexistence.
- To align with the National Spatial Plan and guide future photovoltaic development, the Ministry of Economic Affairs has been drafting the White Paper on Land Use for Energy (Photovoltaic Chapter) since 2022, aiming to outline the current status of photovoltaic development, and the guiding principles for prioritization of land use for solar energy. The white paper serves as a foundation for inter-ministerial communication and public dialogue. It has been repeatedly revised to incorporate diverse perspectives over the course of nearly 50 stakeholder interviews, 5 targeted consultation sessions, and 2 inter-ministerial meetings. The result is the *White Paper on Land Use for Energy (Photovoltaic Chapter)* 1.0, which was officially released in August 2024.

2. Hydrogen

(1) The Energy Administration announced the Permit Management Regulations for Hydrogen Refueling Stations on November 1, 2023, clearly stipulating the zoning, equipment, application procedures, and operation and management of hydrogen refueling stations. The establishment of hydrogen refueling stations affects various stakeholders, necessitating communication with communities. CPC corporation has communicated with the public through visits with local representatives, village heads, and key opinion leaders.

(2) On August 10, 2023, and March 6, 2024, the Energy Administration invited relevant stakeholders (central and local government units, gas station operators) to participate in meetings discussing the draft amendments to the Regulations on Gas Station Establishment. A consensus was reached, and the amendments to the Regulations on Gas Station Establishment were promulgated on June 28, 2024.

3. Innovative Energy

(1) Geothermal Power Generation:

- To encourage public participation, large-scale exhibitions such as Renewable Energy Week and the Taiwan Innotech Expo were held, featuring interactive models, videos, and

on-site explanations. Related informational sessions were also organized to help the public understand the basic concepts and benefits of geothermal power generation.

- To enhance social engagement and communication with stakeholders, meetings and informational sessions were conducted to introduce the basic concepts and benefits of geothermal power generation and provide updates on government initiatives and relevant legislative progress.
- The Regulations on the Exploration, Development, and Management of Geothermal Energy under the Geothermal Chapter of the *Renewable Energy Development Act* were promulgated on May 13, 2024. These regulations unify the application procedures for geothermal exploration and development, with approvals jointly reviewed by central, local, and related ministries. The duration of water rights has been extended from the original 2–3 years to 20 years, aligning with the operational lifespan of geothermal power plants. The regulations also mandate reinjection of at least 90% of geothermal wastewater to ensure sustainable use of natural resources. Additionally, geothermal developers are required to submit impact analysis reports on the hot spring industry and comply with Indigenous consultation procedures.

(2) Biomass Energy and Ocean Energy:

- On September 5, 2023, the Energy Administration, Ministry of Economic Affairs convened a forum titled Calculation Formula for the 2024 Feed-In Tariffs for Renewable Energy Power—Initial Installation Cost Parameters for Wind Power, Biomass Energy, and Other Renewable Energy Generation. The forum gathered representatives from relevant ministries, scholars, experts, and organizations to conduct a rolling review and set feed-in tariffs for various types of renewable energy. This ensures that promoting renewable energy, such as biomass energy, achieves carbon reduction and contributes to multiple environmental sustainability benefits.
- In 2023, biomass energy promotional activities were held during the 2023 Tainan Green Industry Expo (May 24–26), the 2023 Taiwan Innotech Expo (October 12–14), and the 2023 Energy Taiwan (October 18–20). These events featured professional explanations and video presentations to introduce relevant technical details to the public, helping them understand the benefits of developing biomass energy.

4. Power Systems & Energy Storage:

(1) To conduct rolling reviews and updates of the latest annual costs for strengthening the renewable energy power grid, Taiwan Power Company (Taipower) convened informational meetings with associations and other stakeholders. These meetings aimed to preliminarily communicate the process, understand the issues faced by renewable energy developers, and gather feedback. This input will aid the energy regulatory authority in reviewing Taipower's proposed plans. During the meetings, Taipower addressed fee-related issues raised by the industry. However, certain topics involved regulatory or policy-level matters. Suggestions from representatives of associations were categorized and documented for consideration by the regulatory authority in reviewing amendments to the Principles for Sharing and Fee Calculation of Renewable Energy Power Grid Enhancement Costs.

(2) Two counseling sessions were conducted (in Taipei and Tainan) to assist energy storage manufacturers with technical upgrades and provide guidance on accessing government subsidies. These sessions included 43 experts and scholars from academia and industry who participated in discussions on applying for government resources and the current state of energy storage technology in Taiwan.

(3) To ensure the safety of large-scale outdoor energy storage systems in Taiwan, the Bureau of Standards, Meteorology and Inspection has announced the Technical Specifications for Site Validation of Outdoor Battery Energy Storage Systems. To align these specifications with the regulations of various governing authorities, continuous communication and explanatory meetings were held with outdoor energy storage system manufacturers and industry experts.

On May 2, 2023, a meeting was convened to discuss the verification system for outdoor battery energy storage systems, including related regulations and revisions to technical specifications.

5. Energy Saving & Efficiency

(1) In December 2023, the Ministry of the Interior held four social dialogue meetings on net-zero buildings. These meetings invited government agencies, NGOs, industry associations, and think tanks to exchange opinions and engage in dialogue on the Ministry's key initiatives for promoting net-zero building pathways. Topics included improving energy efficiency in new buildings, enhancing energy efficiency in existing buildings, and managing building energy use. Feedback from various stakeholders was collected to gather suggestions for advancing net-zero building efforts.

(2) The Energy Administration, Ministry of Economic Affairs, held 25 social dialogue meetings throughout 2023, inviting government agencies and relevant industries to discuss energy conservation policies. Topics included energy performance guarantees, waste heat and cold recovery, equipment subsidies, and regulatory revisions. Opinions from participants were collected to support the implementation of net-zero goals. By the end of June 2024, an additional 16 social dialogue meetings had been held.

(3) On November 23, 2022, the Industrial Development Administration, Ministry of Economic Affairs hosted an in-person and online social dialogue meeting titled Energy Conservation Strategy—Industrial Energy Conservation (see Figure 9.3.1-1). Experts, scholars, industry associations, civic groups, and relevant government units participated. The meeting facilitated two-way communication and exchange of ideas with society, providing government agencies with recommendations for future energy conservation work plans to progressively achieve carbon reduction objectives.

Figure 9.3.1-1. Social Dialogue Meeting on Energy Conservation Strategy—Industrial Energy Conservation, November 23, 2022

6. Carbon Capture, Utilization, and Storage (CCUS)

The Social Sciences Team of the National Science and Technology Council (NSTC) held the event Taiwan's Path to Just Transition: Concepts, Assessments, and Practices on June 5, 2023, organized by the NSTC Research Institute for the Humanities and Social Sciences and National Taiwan University. The event explored how to refine related concepts within Taiwan's context, identify key industries and regions impacted by the transition, and translate abstract principles into concrete practices. Scholars, NGO representatives, and government officials from relevant ministries were invited to discuss Taiwan's approach to a just transition.

The forum addressed topics such as defining the concept of a just transition, potential impacts of net-zero transformation, related legislative efforts,

and social dialogue. It brought together experts, NGO representatives, and government officials from various fields for an inclusive discussion.

The Energy Administration, Taiwan Power Company, and CPC Corporation have been advancing the Carbon Dioxide Capture and Storage Pilot Project, which includes social communication components and activities. These efforts involve establishing educational exhibition centers, smart greenhouse plant factories, and collecting environmental monitoring data. Local residents and stakeholders are engaged through science education activities, informational campaigns, and outreach. Digital content such as infographics and short videos has been created to promote accurate information about carbon storage and the importance of carbon reduction.

Additionally, the NSTC has invested in research and planning for just transition strategies, gathering and analyzing international case studies to serve as a foundation for social communication guidelines and policy recommendations.

7. Carbon-free & Electric Vehicles

To ensure a just net-zero transition in Taiwan and uphold the core value of leaving no one behind, the Ministry of Transportation and Communications (MOTC) held the 2023 Social Dialogue Meeting for Key Strategy 7: Carbon-free & Electric Vehicles, on November 28, 2023. The action forum, titled The Electric Era: A Net-Zero Future, brought together government agencies, academia, research institutions, public and private associations, and civic groups. During the forum, the MOTC presented the current status and outcomes of initiatives for Carbon-free & Electric Vehicles and facilitated discussions on three major topics: policies and directions for accelerating transportation electrification, measures and strategies for installing charging stations within communities, and strategies for advancing the localization of key technologies and enhancing the talent development of Taiwan's electric vehicle industry.

The MOTC consolidated the opinions collected during the forum and incorporated them into discussions during the Key Strategy 7: Carbon-free & Electric Vehicles Action Plan 2024 Q1 Review Meeting held on February 23, 2024. This ongoing review process will continue to refine the action plan and progressively advance the transportation sector toward a net-zero future.

8. Resource Recycling & Zero Waste

Figure 9.3.1-2. Action Forum: The Electric Era - A Net-Zero Future, November 28, 2023

Source: Ministry of Environment. *2023 Key Strategy Implementation Report: Carbon Free & Electric Vehicles*. 2024.

To minimize the negative impacts of this strategy's implementation on stakeholders and ensure sufficient channels for participation in the policy's development process, relevant information was conveyed through on-site visits, meeting exchanges, and other methods. Feedback was collected to foster dialogue and collaboration, thereby promoting social participation and shared responsibility in line with the principles of a just transition.

During the planning and implementation phases of each key initiative, stakeholders were identified, and communication and discussions were conducted through consultations, informational sessions, and press conferences. Stakeholder feedback was incorporated into considerations, promoting mutual understanding, consensus, and cooperation.

9. Carbon Sinks

(1) Forest Carbon Sinks

- From 2022 to 2023, the Forestry and Nature Conservation Agency held 28 policy informational sessions on bamboo forest renewal incentives in indigenous townships across various counties. These sessions, attended by approximately 970 participants, aimed to expand bamboo forest renewal areas within indigenous reserves, enhance bamboo forest health and carbon sequestration capacity, and produce high-quality bamboo materials.
- Between May and October 2023, the Forestry and Nature Conservation Agency organized four workshops under the 2024 Regional Emerging Bamboo Industry Development Plan (attended by 106 participants). Through guidance from consultants and experts, municipal representatives were encouraged to assess local bamboo industry resources and advantages. The initiative supported 12 counties and cities, resulting in the development of 17 project proposal frameworks to outline work items for 2024.
- On December 18, 2022, the Forestry and Nature Conservation Agency held the 2022 Taiwan Bamboo Congress—Next Generation Bamboo in Taipei as the first preparatory event for the 12th World Bamboo Congress, which was held in Hsinchu and Nantou, from April 18–22, 2024. The 12th World Bamboo Congress featured 17 international speakers and covered topics ranging from circular economy to sustainable housing, architecture to design, and community development to environmental protection, jointly exploring the potential and innovations of bamboo in various fields.
- To showcase the achievements of the Emerging Bamboo Industry Development Plan, the Forestry and Nature Conservation

Figure 9.3.1-3. Guidance Activities at the 2023 Emerging Bamboo Industry Development Plan Workshops

Figure 9.3.1-4. Group Photo of Distinguished Guests at the 2024 World Bamboo Congress

Agency organized the Sustainable Development—Emerging Bamboo Industry Focus Forum, with one session held on November 4, 2022, in Taipei, and another on November 20, 2023, in Pingtung. The forums invited Arief Rabik, founder of the breakthrough program Bamboo Village Trust, as well as domestic experts from academia, industry professionals, and technical developers specializing in bamboo production and applications. Participants exchanged experiences to collaboratively promote the sustainable development of the emerging bamboo industry. A total of 242 participants attended these events.

- To revitalize the bamboo industry and support businesses interested in enhancing bamboo product processing technologies and applications, the Forestry and Nature Conservation Agency organized a set of

Figure 9.3.1-5. Group Photo of Distinguished Guests at the Sustainable Development—Emerging Bamboo Industry Focus Forum

cross disciplinary technology integration demonstration and matchmaking events, titled Realizing Bamboo Dreams: Transforming Bamboo into Gold. The events were held on October 7, 2022, and December 4, 2023, in Taichung. By leveraging cross-disciplinary technology integration capabilities from academic and research institutions, the events provided immediate technical assistance to bamboo industry stakeholders and facilitated technological upgrades. The initiative aimed to establish high-value applications for bamboo, develop high-quality domestic bamboo products with unique features and branding, and enhance the technology and competitiveness of Taiwan's bamboo industry.

- The Forestry and Nature Conservation Agency organized Forest Markets from October 15–17, 2021, April 28–30, 2023, and April 26–28, 2024, and participated in the Taipei Building Show from December 9–12, 2021, December 8–11, 2022, and December 7–10, 2023. These events attracted tens of

Figure 9.3.1-6. Realizing Bamboo Dreams: Transforming Bamboo into Gold Cross-Disciplinary Technology Integration Demonstration and Matchmaking Events

thousands of visitors, introducing the public to domestically produced wood and bamboo forest products. The exhibitions highlighted the significance of forest carbon sinks and forest conservation in supporting global carbon neutrality goals. These efforts brought domestic forest products closer to everyday life while enhancing the international visibility of Taiwan's timber.

- Between April and May 2023, the Forestry and Nature Conservation Agency organized five policy informational sessions on incentive-based afforestation and sustainable forestry support programs in areas with forestry development potential. These sessions facilitated dialogue between the public and forestry personnel, with a total attendance of 502 participants. The feedback

Figure 9.3.1-7. 2023 Forest Market

Figure 9.3.1-8. 2023 Taipei Building Show

collected served as a reference for revising incentive-based afforestation guidelines and sustainable forestry support programs, aiming to increase incentives for afforestation and forest management, thereby enhancing forest coverage and carbon sequestration capacity.

- On January 27, 2023, and March 5, 2024, the Forestry and Nature Conservation Agency announced two drafts for amendments to the incentive-based afforestation guidelines and solicited public feedback. Additionally, on May 3 and September 6, 2023, the bureau held consultation forums with civic groups, academic and research institutions, and relevant government agencies to discuss the proposed amendments. On June 3, 2024, a meeting with experts, scholars, and forest

Figure 9.3.1-9. Policy Informational Sessions on Incentive-Based Afforestation and Sustainable Forestry Support Programs

farmers was convened to engage in two-way discussions on contentious issues. These efforts aimed to refine the regulations further to support the implementation and promotion of afforestation policies.

(2) Soil Carbon Sinks

One international forum on the current development of soil carbon sinks and corporate ESG was held, with approximately 390 participants. Additionally, three workshops on monitoring, reporting, and verification (MRV) techniques for agricultural soil organic carbon; three site visits showcasing the outcomes of scientific projects; and four training sessions were conducted, with a cumulative total of 738 participants. These initiatives effectively communicated accurate knowledge about soil carbon sinks.

(3) Marine Carbon Sinks

- On December 15, 2023, the Fisheries Agency, Ministry of Agriculture, hosted the Marine Carbon Sink Measurement Methodology Research Seminar at National Taiwan Ocean University. Experts and scholars from the Ministry of Environment, Fisheries Research Institute, and academic institutions were invited to share insights on two topics: Coastal Blue Carbon Measurement Methods and Marine Habitat Carbon Storage Measurement Methods. The seminar also included discussions on the national greenhouse gas emissions status and the 2023 research findings on marine carbon sinks. Over 140 participants, including representatives from central ministries, county and city governments, universities, and fishery groups attended. Through public–private collaboration, the seminar facilitated brainstorming and dialogue on marine carbon sink measurement methods and emission factor research, advancing the goal of net-zero emissions.
- The Fisheries Research Institute conducted related workshops and knowledge dissemination activities, including four educational outreach sessions on seagrass restoration in potential rehabilitation areas such as the Chunguang, Hujing, and Gangzi communities in Penghu, and the Qingwan Genetic Resource Bank at of Penghu Marine Biology Research Center. A total of 249 participants attended. Additionally, seven sessions were held for marine education programs aimed at teachers and students, including training sessions for seed educators, courses on seagrass bed ecology and conservation, and coastal biodiversity workshops, with 260 participants in total.
- On May 18, 2023, the Ocean Affairs Council hosted the Chiayi County Marine Carbon Sink Restoration Promotion Business Exchange Meeting at Budai Junior High School in Chiayi County. The event was attended by 15 representatives, including those from the Urban and Rural Development Branch, National Land Management Agency, Ministry of the Interior; Chiayi County Government; the Ocean Conservation Administration, Ocean Affairs Council; experts; scholars; and local groups. Discussions focused on the current state of marine carbon sinks along Chiayi's coast, their management, and evaluations for future restoration efforts.
- The Fisheries Research Institute, Ministry of Agriculture, and the Ocean Conservation Administration, Ocean Affairs Council, jointly organized the Seagrass and Coral Restoration Workshop in Penghu on July 3–4, 2023. Over 60 participants from academia, central government agencies, local governments, private enterprises, and organizations gathered to discuss ways to promote the restoration of seagrass beds and coral reefs. Addressing global climate change and net-zero carbon emission goals, the workshop facilitated discussions on the latest scientific research. Participants also engaged in hands-on activities, planting seagrass in the Chunguang waters and corals at the Penghu Ocean Conservation Education Center. This event fostered interagency collaboration and created opportunities for cooperation, advancing Taiwan's efforts to protect and restore blue carbon ecosystems across disciplines.
- In September 2023, the Ocean Affairs Council hosted the 22nd APEC Roundtable Meeting on the involvement of the Business/Private Sector in the Sustainability of the Marine Environment. The event, which was held in

Taipei, invited delegates of the APEC Ocean and Fisheries Working Group from Japan and four other countries to discuss solutions for climate change, marine environmental conservation, and sustainable use of marine resources.

- On October 13, 2023, the Ocean Conservation Administration convened the Local Government Participation in Marine Habitat Restoration Promotion meeting, inviting representatives from municipal and county governments. The meeting encouraged local governments to use marine carbon sink data provided by the Ocean Conservation Administration to identify and prioritize suitable conservation and restoration sites within their jurisdictions.
- On October 17, 2023, the Ocean Affairs Council held an interactive training session titled Empowerment for Net-Zero Just Transition, with 39 participants from the Council and its affiliated agencies. Dr. Luo Kailing from the Industrial Technology Research Institute shared insights on the fundamental concepts, international development trends, global case studies, and domestic concerns related to net-zero just transition. The interactive course provided a foundational understanding of the topic for participants.
- The Fisheries Research Institute, Ministry of Agriculture, and the Ocean Affairs Council jointly organized the Blue Horizons: Oceans and Net Zero from a Just Transition Perspective forum and the Negotiation Practices of Just Transition in Oceans and Net Zero theatrical performance on November 4–5, 2023. More than 200 participants, including stakeholders, scholars, NGOs, and government representatives from the fields of marine science, blue carbon, coastal communities, and just transitions for net zero, attended to exchange views on constructing pathways for net-zero transitions that promote harmony among the environment, society, and economy from a marine perspective.
- On October 23, 2023, the National Academy of Marine Research and the Fisheries Research Institute announced the successful collaboration to establish a large-scale seaweed cultivation facility at the Mariculture Research Center. This facility marked the first successful cultivation of large seaweeds in offshore wind farm areas in Taiwan, challenging the previous belief that the subtropical waters around Taiwan were unsuitable for large seaweed cultivation due to high summer temperatures and low nutrient levels. With marine artificial surface seaweed cultivation techniques, harvested seaweed can be applied in high-value industries such as food, biomedicine, energy, and environmental protection. This development also supports marine carbon sink research and the coexistence of offshore wind farms and fisheries, contributing to the government's 2050 Net-Zero Transition policy by enhancing marine carbon sequestration and ecological conservation benefits.
- On March 26, 2024, the Ministry of Agriculture, in collaboration with the Ocean Affairs Council (Ocean Conservation Administration), submitted drafts for new greenhouse gas reduction methodologies, application examples, and application forms for Seagrass Restoration and Mangrove Afforestation to the Ministry of Environment for approval.
- The Ocean Affairs Council surveyed 14 seagrass bed habitats in Taiwanese waters to identify the most suitable restoration sites. A seagrass optimal restoration habitat model and restoration guidelines were developed. In 2024, habitat recovery and seagrass restoration experiments were conducted at Duziping, Xiao Liuqiu, as a reference for evaluating large-scale restoration projects.
- The Penghu Marine Biology Research Center of the Fisheries Research Institute hosted the 2024 World Seagrass Day Penghu Declaration event on March 1, 2024. It invited relevant units in Penghu, stakeholders from local communities (Gangzi, Chunguang, Hujing, Jiangmei, and Nanliao), schools, and media to participate. The event attracted 60 attendees.
- The Fisheries Research Institute of the Ministry of Agriculture collaborated with CTBC Financial Holding on seagrass restoration efforts. From April to July 2024, two seagrass awareness sessions and two

restoration activities were held, involving 161 participants, including teachers and students from Gangzi Community and nearby schools in the restoration area.

- The Ministry of the Interior organized a series of wetland conservation policy promotional activities in 2023, attracting over 1,000 participants. Key events included: on May 17, the First Review of the National-Level Conservation and Utilization Plan for Dapo Pond Important Wetland, a public exhibition at the Chishang Township Office, Taitung County; on May 18, the First Review of the National-Level Conservation and Utilization Plan for Menghuan Lake Important Wetland, a public exhibition at the Yangmingshan National Park Administration Office; on July 28, a wetland conservation lecture on the Changhua Coast Wetlands; from July to October, eight workshops and environmental education activities; on August 4, the First Review of the Conservation and Utilization Plan for Zhouzi Important Wetland (National Level), a public exhibition at the Zuoying District Office, Kaohsiung City; on August 5, a beach cleanup and discussion under the Fuxing Township Wetland Environmental Education Plan at Fubao Wetland; on October 21, an exchange meeting on wetland restoration achievements for the Guanshan Artificial Wetland Operation and Maintenance Management Plan, Taitung County; on October 28, the Kaohsiung Wetlands Joint Results Presentation Forum at the Zhouzi Wetland Ecological Management Center, Kaohsiung City; on November 12 and 25, the results forum for the Tainan City Erjen River Estuary Wetland Conservation Action Plan at the Erjen River Basin Education Center, located in the Tainan City Gangweikou Creek Detention Basin; on November 27, a wetland restoration results forum for the Neiliao Important Wetland Conservation Promotion Plan; and on December 5, the results presentation for the Chenglong Wetland Conservation and Utilization Plan at Chenglong Community, Yunlin County.

10. Green Lifestyle

(1) Promoting Planned Purchases and Tableware Sharing

- Planned Purchases: Four meetings were held to help businesses understand policy directions and gather feedback on challenges they face in promoting the reduction of single-use beverage cups.
- Tableware Sharing: Thirty-one meetings were conducted to educate government agencies and schools on methods for reducing the use of disposable tableware and packaged drinking water. Discussions with relevant businesses were also held to encourage the use of reusable containers for delivery services.

(2) Extending Product Lifespans

- Carefully Assessing Product Needs: Efforts focused on extending the use of items, recycling old goods, and purchasing products made from recycled materials. One meeting was held to promote the concept of unwanted item circulation among schools, communities, organizations, and businesses.
- Enhancing Mattress Recycling: Two meetings were conducted to discuss policies, helping businesses understand policy directions and gather suggestions on technical improvements for processing efficiency and methods for reusing discarded mattresses.

(3) Extending Product Lifespans

Encouraging product-sharing economy services: Four meetings were held to help businesses understand policy directions and gather feedback on challenges in implementation. These efforts aimed to collaboratively promote the reduction of single-use beverage cups.

(4) Collaborative Actions

- 2023 Taiwan-Germany International Symposium on Net-Zero Life Transition: To align Taiwan's net-zero living transition policies with international standards, the Ministry of Environment partnered with the German Institute Taipei to host the seminar on October 25, 2023. Taiwanese and German experts, along with industry representatives, shared insights on improving public awareness of green living and fostering behavioral change. The seminar also highlighted experiences in promoting the shared economy within industries, offering strategic recommendations for advancing the transition to sustainable living.

- Carbon Reduction Through Behavioral Change International Workshop: The workshop invited the Jyukankyo Research Institute (JYURI) of Japan to present research on applying behavioral science (Nudge) to energy-saving and decarbonization measures. The event also featured the Singapore office of the UK Behavioral Insights Team (BIT), which shared experiences in using behavioral science concepts to address societal challenges and implement net-zero carbon reduction practices. Discussions with domestic experts and scholars facilitated knowledge exchange, supporting the effective implementation of net-zero green living measures in Taiwan.
- 2023 Behavioral Change Carbon Footprint Analysis Model International Seminar: The seminar invited Japan's National Institute for Environmental Studies (NIES) to share insights on the behavioral change carbon footprint analysis model. Discussions included five domestic experts and scholars from the economic sector to evaluate the feasibility of developing a localized net-zero green living carbon reduction model for Taiwan. The goal was to understand the diverse benefits of net-zero green living and implement effective measures in daily life.
- Achieving Zero Food Waste—Designing for Consumer Behavior Change Industry Communication Meeting: The meeting featured the Singapore office of UK-based company Winnow, which shared how AI can be utilized to achieve zero food waste. Presentations included methods for promoting zero food waste, business models that facilitate waste reduction, and case studies demonstrating behavior change designs for the public. The event also facilitated experience sharing with domestic enterprises and collected practical feedback from participating businesses to refine and review the execution of key strategies for net-zero green living.

11. Green Finance

(1) Organizing seminars and informational meetings to facilitate communication and exchange with stakeholders, including financial institutions, their investment and lending counterparts, and listed companies.

- The Financial Supervisory Commission (FSC) released the Sustainable Development Action Plan for Listed Companies on March 28, 2023. To refine the action plan, the FSC held an in-person seminar on March 14, 2023, inviting representatives from government agencies, NGOs, industry associations, securities-related organizations, banks, life insurance companies, securities and investment trusts, listed companies, accounting firms, and third-party verification institutions. A total of 53 organizations and approximately 100 participants attended. The FSC will review and revise the plan annually, considering international sustainability trends and domestic practices and leveraging public–private collaboration to support listed companies in achieving sustainable development and enhancing international competitiveness.
- In 2023, the first Sustainable Finance Evaluation process was conducted. The FSC, in cooperation with the Taiwan Financial Services Roundtable, related organizations, and external experts and scholars, established the Sustainable Finance Evaluation Committee. The evaluation process was carried out by a task force comprising the Taiwan Academy of Banking and Finance, the Securities and Futures Institute, and the Taiwan Insurance Institute. Results were announced on December 26, 2023. During the process, the task force held industry-specific informational meetings for banking, securities, and insurance sectors in March 2023, followed by the First Sustainable Finance Evaluation Online Seminar on April 28, 2023. This helped financial institutions understand the evaluation process and indicators, with approximately 480 participants attending.
- To implement the Enhancement of Taiwan's Sustainable Economic Activity Classification Reference Guidelines commissioned research project and collect practical feedback from relevant industries, the contracted research organization held eight industry public hearings in December 2023. From January to March 2024, eight industry workshops and one inter-ministerial consultation meeting were conducted, inviting relevant government agencies, industry associations, and businesses involved in the research project. Approximately 480 participants attended. The contracted research organization will incorporate feedback from industry

stakeholders to develop localized and operational classification standards. These standards will serve as reference directions for businesses in carbon reduction transitions and as evaluation references for financial institutions' investment and lending activities. The research report was completed in April 2024. The Financial Supervisory Commission is currently referencing the recommendations from the commissioned research report and planning discussions with relevant ministries to refine the content of the guidelines and promotional strategies. The guidelines are tentatively scheduled to be announced by the end of 2024.

(2) Facilitating communication and exchange with the general public through the planning and establishment of a sustainable finance website and the organization of domestic and international promotional activities.

The Financial Supervisory Commission (FSC), in collaboration with the Taiwan Financial Services Roundtable, established the Net-Zero Promotion Task Force for the Financial Industry. Members of the Sustainable Finance Pioneer Alliance, the Joint Credit Information Center, and the Securities and Futures Institute serve as conveners of the five working groups within the task force, working alongside affiliated organizations and financial industry associations to develop tools, guidelines, or databases. The Capital and Statistics working group within the platform collected member feedback to provide suggestions for the structure of the Sustainable Finance Website. In 2023, the FSC outsourced the establishment of the website, which provides information and data on sustainable financial products for investors, allowing stakeholders such as investors, businesses, and the general public to understand Taiwan's progress in sustainable finance. The website officially launched in January 2024.

The FSC also utilized the Domestic and International Promotion working group within the platform to incorporate sustainable finance knowledge and concepts into financial education and advocacy, promoting social dialogue on green and sustainable issues. In 2023, a total of 85 financial education and advocacy activities on the theme of Green and Sustainable Finance were held, with over 80,000 participants.

Additionally, in 2023, the FSC outsourced a study on the regulatory mechanisms of international sustainability rating agencies to inform the development of supervisory regulations. This initiative aims to enhance the transparency and standardization of ESG rating processes. The commissioned research was completed in November 2023.

(3) Communication with civic groups through participation in seminars or holding meetings.

On January 17, 2023, The FSC participated in the Ministry of Environment's Net Zero Transition Key Strategies Action Plan forum. It also promptly responded to the opinions on green finance issues raised by civic groups and other stakeholders.

Furthermore, in response to the letter to the President demanding "effective utilization of offshore wind power funds to give back to the ocean" penned by environmental groups at the conclusion of the 20th National NGOs Environmental Conference, the FSC immediately assembled relevant ministries to communicate with the aforementioned environmental groups and reach a consensus.

12. Just Transition

To strengthen public participation in net-zero just transition efforts, the National Development Council (NDC) held three expert consultation meetings on August 10, September 30, and October 5, 2022. These meetings invited 19, 11, and 9 scholars and experts, respectively, to engage in consultation and dialogue on topics such as an overview of net-zero just transition, wind and solar energy, and the transition to electric vehicles. The key points from the meetings are summarized as follows:

(1) Taiwan's context differs from the international context; just transition strategies must be tailored to Taiwan's socioeconomic background.

- Considering Taiwan's unique challenges, such

as its lack of fossil fuel resources and the need for high energy security and land-use constraints in renewable energy development, it is recommended that Taiwan identify societal needs within its specific context. This includes compiling ideas for job and community assessments, job transformation, and the creation of new job types, while exploring opportunities to address multiple local social needs during the transition process.

- While many international approaches to achieving net-zero just transition are being discussed, the key lies in how these ideas can be implemented in Taiwan. Special emphasis should be placed on respecting the democratic mechanisms of Indigenous communities, initiating early dialogues, and establishing participatory mechanisms to foster effective conversations and influence decision-making. Only through this process can real issues be identified, and viable solutions found.
- Taking environmental participation rights as an example, attention must be paid to the existing conditions for public participation in Taiwan. Internationally, Scotland's Just Transition Commission and related policy frameworks are often referenced. However, in Scotland's developmental context, the UK had already signed the Aarhus Convention, granting environmental participation rights, and established procedures for public access to information and participation. Such regulations ensure sufficient time for the public to review disclosed information. The UK also has numerous communication guidelines designed to implement environmental participation rights, which safeguards the public's rights. Ensuring that the public feels encouraged and accepted as participants in environmental decision-making is essential to establishing a foundation for discussions on just transition.

(2) To facilitate ministries' promotion of net-zero just transition and mitigate the impact on the labor market during the transition, it is recommended to strengthen the evidence base for just transition policy planning.

- In Taiwan, there are methodological or knowledge gaps in defining the scope of stakeholders and providing support in the context of net-zero just transition. It is recommended to reference international case studies and related research or consider piloting the just transition process or solutions for a specific issue. This could help establish a methodology, clarify stakeholder identification, the scope of issues to be addressed in the just transition, and its potential positive impacts.
- Whether in legislative or regional transition cases, a comprehensive knowledge base is essential. Countries use domestic case studies—such as those in mining, fossil fuels, energy-intensive industries, and agriculture—to gain deeper insights into domestic and international principles of just transition and dignified work. Through social dialogue processes, these studies can help define and guide priority areas for just transition efforts.
- The United States, the United Kingdom, and the European Union have already conducted simulations and assessments of the labor market impacts during the net-zero transition. If energy transition is combined with digital transformation in the future, the overall impact on jobs will become a critical concern for social and labor policies. It is recommended to anticipate and prepare for these potential impacts through early estimation and planning.

(3) Experts and scholars offered various suggestions on defining and identifying stakeholders and vulnerable groups.

- The shift in the just transition's focus from labor employment rights to the environmental justice movement reflects the historically unfair distribution of environmental costs caused by economic development. For example, waste has been unfairly allocated to Indigenous peoples, the working class, minority groups, and disadvantaged populations. Just transition advocates argue that these stakeholders should be recognized and included in decision-making processes related to environmental issues.
- From a sociological perspective, climate change is not merely a scientific or technical issue but fundamentally a problem of social inequality. This includes inequalities in carbon emissions between wealthy nations and individuals versus poorer nations and individuals, as well as other structural social inequalities. Discussions on just transition may inevitably challenge existing social structures.

(4) In light of other countries' emphasis on social dialogue and participation in promoting just transition, it is recommended that Taiwan strengthen mechanisms for civic engagement.

- Legal frameworks must emphasize public participation and grant it legal effect or actively introduce actionable guidelines to bring about meaningful improvements in stakeholder communication in practice.
- Mechanisms for civic engagement must be established to provide citizens with necessary resources and empower both civil servants and the public. This includes cultivating the skills needed for participation in discussions or providing assistance from professional deliberation or advisory teams to facilitate problem-solving and solution development within these mechanisms.
- Considering the practicality of implementation, it is suggested to divide platforms and groups based on topics, first defining the necessity and priority of different issues. One or two topics could be selected for pilot trials, enabling the accumulation of experience in promoting social dialogue.
- Diverse channels should be employed to collect public opinions both directly and indirectly, such as holding public hearings or gathering feedback through submissions, social media, and other platforms.

(5) The importance of developing resilient communities.

- The traditional reliance on external investment, large-scale ventures, and major entrepreneurship has not been conducive to building resilient economies in communities. It is recommended to inventory community resources and collaborate with local non-profit organizations, non-governmental organizations, and small and medium-sized business owners to uncover unique local characteristics and develop a resilient community economy.
- Consider local approaches by leveraging existing mechanisms in Taiwan, such as regional revitalization and area development, and integrating them with creative solutions from digital transformation, startups, or social enterprises. These efforts can provide innovative private-sector practices to support stakeholders and vulnerable groups.

II. Government Platforms Related to Climate Change

1. Climate Talks Platform

The Ministry of Environment established the Climate Talks Platform in 2020. Through a visualized and interactive interface, the platform presents greenhouse gas reduction data and the progress of mitigation measures implemented across various sectors. It also aggregates critical climate policy information from both domestic and international sources, along with links to relevant government agency websites, enabling users to quickly grasp the progress of Taiwan's climate policies. Additionally, the Climate Talks Platform serves as Taiwan's primary online channel for public dialogue on climate issues. For major climate policies such as the Greenhouse Gas Reduction Action Plan and the 2050 Net-Zero Pathway, the platform collects public opinions and publishes government responses indicating how those opinions were considered.

Figure 9.3.1-10. Visualized Policy Information on the Climate Talks Platform

Source: Climate Talks Platform, Ministry of Environment.

2. Climate Information Disclosure Platform

Recently, online search volumes for keywords such as "net-zero emissions" and "greenhouse gases" have surged domestically, highlighting the necessity of integrating and publicly disclosing climate information. To enhance public participation mechanisms under the *Climate Change Response Act*, the Climate Information Disclosure Platform was officially launched on Earth Day in 2024. This platform serves as the single, dedicated website for statutory climate change information disclosure by all levels of government agencies. Built on the concept of a Climate Info Hub, the platform promotes transparency in climate policy information and facilitates public engagement. It integrates external content websites, such as the Climate Talks Platform, and provides the public with the latest, most accurate climate information. Additionally, efforts are being made to ensure that the platform's content is bilingual, aligning Taiwan's climate governance achievements with international standards.

3. National Council for Sustainable Development, Executive Yuan – Taiwan 2050 Net-Zero Emissions Website

To enable the public to quickly access needed information, the National Council for Sustainable Development (NCSD), Executive Yuan, launched a dedicated Net-Zero website, which provides information related to Taiwan's 2050 Net-Zero Pathway. The website includes sections such as Understanding the Net-Zero Transition, Taiwan's 2050 Net-Zero Pathway, Latest Updates, and Related Links. It has also published updates regarding Taiwan's new carbon reduction targets and Taiwan's Comprehensive Carbon Reduction Action Plan, which were announced by the National Climate Change Committee on January 23, 2025, as well as carbon reduction action plans for the six major sectors. In the future, the website will continue to provide updates on the progress of net-zero policy implementation. Additionally, it will regularly update news and event information to keep users informed of the latest developments, thereby fostering public understanding and participation in achieving the 2050 net-zero emissions goal.

To implement President Lai's National Project of Hope, which outlines five key strategies for Green Growth and 2050 Net-Zero Transition, and to align with international standards for setting Nationally Determined Contributions (NDCs), Taiwan's Comprehensive Carbon Reduction Action Plan seeks to achieve the 2050 net-zero target in a steady and pragmatic manner. The Action Plan intensifies decarbonization efforts by adopting a top-down approach that focuses on the six major sectors through the Carbon Reduction Flagship Program; at the same time, it allows for the dynamic adjustment of implementation strategies through a bottom-up approach where ministries and agencies can propose Sectoral Voluntary Carbon Reduction Plans. The Action Plan is further supported by six key pillars—technological innovation, financial support, carbon pricing, regulatory adjustment, green collar talent, and community-driven initiatives—which systematically integrate sectoral carbon reduction efforts with comprehensive financial planning. The vision is to achieve a more diversified energy transition, a more innovative industrial transition, a lower-carbon lifestyle transition, and a more resilient social transition. Additionally, the Action Plan aims to reduce air pollution, enhance energy independence, stimulate private investment, and cultivate green collar talent, thereby driving green growth and improving societal well-being.

III. Green Collar Talent

As industries strive to achieve the 2050 net-zero transition, demand for green collar talent is growing rapidly. In December 2024, the Ministry of Environment and 104 Job Bank jointly released the Green Collar Employment Trends Report, which indicated that nearly 3,600 companies were recruiting for green positions in 2024, with an average monthly demand of 22,000 personnel—a 3.29-fold increase over an 8-year period, approaching the talent gap observed in the AI industry. Starting in 2025, publicly listed companies will be required to prepare sustainability reports, and in 2026, high carbon-emitting enterprises will begin paying carbon fees. This is expected to result in an additional 1- to 3-fold increase in the demand for green collar talent. The electronics, information technology, and semiconductor industries are experiencing the highest demand, particularly for positions in engineering R&D, environmental safety, and project management. There is also a rising demand for environmental professional certifications, and the restrictions on academic backgrounds are gradually being relaxed to attract interdisciplinary talent. The Ministry of Environment plans to establish the Net-Zero Green Collar Talent Training Alliance in 2025, aiming to train at least 3,500 individuals annually to address the shortage of green collar talent.

9.3.2 Civil Society Organizations Advancing Climate Empowerment

Taiwan boasts a vibrant non-governmental organization (NGO) sector. In addition to climate-focused organizations addressing climate change and sustainable development, a diverse array of environmental groups addressing broad environmental issues, local community groups focusing on regional concerns, and privately funded foundations also engage with and respond to climate change issues. The following sections introduce collaborative environmental protection initiatives between the government and civil society organizations in response to international actions, corporate sustainability initiatives led by civil society organizations, and youth climate empowerment activities promoted by the government and youth groups.

I. Earth Day

Earth Day, initiated in 1970 and held annually on April 22, aims to raise awareness about environmental protection. It has since expanded to 193 countries, attracting the participation of over 1 billion citizens worldwide. The theme for 2021 was "Restore Our Earth", calling on people to take concrete actions to demonstrate care for the planet, reduce their environmental impact, and improve and restore Earth's ecosystems to prevent disasters caused by environmental degradation.

On April 22, 2024, President Tsai Ing-wen, accompanied by Vice President Lai Ching-te, met with representatives from environmental groups attending the 21st National NGOs Environmental Conference. The President expressed gratitude to all environmental partners for their contributions to advancing government policies and their efforts toward environmental protection in Taiwan. President Tsai highlighted that since the establishment of a regulatory tracking system in 2019, approximately 70% of the proposals submitted by environmental groups over the past 5 years have been resolved and removed from the list. This success reflects the collaborative efforts of partners and government agencies in finding public-private solutions to Taiwan's environmental issues. She emphasized that the government and civil society have jointly addressed many complex and challenging issues in the past and expressed confidence that they can continue to work together to find the best solutions, paving the way for Taiwan's sustainable development.

Figure 9.3.2-1. The President and Vice President Meet with Representatives of Environmental Groups at the 21st National NGOs Environmental Conference on Earth Day 2024

Source: Office of the President Website.

II. Earth Hour

Earth Hour is an energy-saving initiative launched by the World Wide Fund for Nature (WWF). It invites organizations worldwide to turn off non-essential lights and energy-consuming devices for one hour from 8:30 p.m. to 9:30 p.m. on the last Saturday of March each year to raise awareness of energy conservation and global warming.

The first Earth Hour event was held in Sydney, Australia, in 2007. Since 2010, Taiwanese NGOs, businesses, and government agencies at all levels have actively participated. In 2021, over 1,178 businesses took part, including iconic buildings such as the Presidential Office Building, Taipei 101, and the Taiwan Power Company headquarters. According to publicly available data from Taiwan Power Company, Taiwan's participation in the event since 2010 has cumulatively saved nearly 900,000 kWh of electricity. This, combined with public education and advocacy efforts driven by public–private partnerships, has significantly contributed to advancing Taiwan's climate change policies. It also serves as a concrete example of Taiwan's government and civil society responding to international initiatives. On March 23, 2024, O'right's Zero Carbon Green Building served as the organizer of Earth Hour in Taiwan. The event saw enthusiastic participation across industries, government, academia, 572 companies, and 6,980 chain stores nationwide. This energy-saving effort resulted in approximately 289,000 kWh of electricity saved, equivalent to reducing about 143,055 kilograms of carbon dioxide emissions. The event aimed to raise public awareness about climate change and the importance of energy conservation and carbon reduction.

Left Image: Presidential Office Building. **Right Image: Taipei 101**

Figure 9.3.2-2. Iconic Buildings in Taiwan Responding to Earth Hour

Sources: *Yahoo! News*. "Taiwan's Earth Hour 2024 Achieves Record-Breaking Carbon Reduction". March 23, 2024. Vogue. "Earth Hour 2024! Responding to Earth Hour by Turning Off Lights for One Hour: Presidential Office Building, Taipei 101, the World Trade Center Collaborate to Showcase Environmental Awareness". March 22, 2024.

III. RE10x10

Greenpeace launched the RE10x10 corporate green electricity initiative at the end of 2020. To date, it has received enthusiastic support from 102 companies, including small and medium-sized enterprises, large electricity consumers, and publicly listed companies spanning various industries. If all participating companies achieve the initiative's goals, it is estimated that by 2025, they will collectively use at least 81.7 million kWh of green electricity, reducing carbon emissions by over 40,000 metric tons annually—equivalent to the annual carbon absorption capacity of 103 Da'an Forest Parks. Currently, 40 companies have started using green electricity, with 18 achieving the commitment to use 10% green electricity. Notably, 11 companies have exceeded 20% green electricity usage, setting a new benchmark for encouraging Taiwan's small and medium-sized enterprises to adopt green electricity.

Figure 9.3.2-3. RE10x10 Corporate Green Electricity Initiative 2023 Annual Report Press Conference and Networking Gathering

Source: Greenpeace Website

IV. World Seagrass Day

To highlight the global commitment to protecting seagrass beds, the United Nations incorporated seagrass ecosystems into the Global Biodiversity Framework and the Convention on Biological Diversity (CBD) in 2020. To ensure the persistence of biodiversity and prevent the degradation of the marine environment, March 1 was designated as World Seagrass Day. The event aims to raise awareness of the threats facing seagrass ecosystems, promote and facilitate seagrass restoration and conservation, and enhance the importance of ecological conservation. In response to World Seagrass Day and to align with international efforts, the Fisheries Research Institute, Ministry of Agriculture, extended its ongoing efforts in seagrass bed restoration and conservation. In 2024, it organized the 2nd World Seagrass Day – Penghu Declaration event, marking the first such event held in Taiwan.

V. Taiwan Alliance for Net-Zero Emission

To encourage the industrial sector to fulfill corporate social responsibility, promote sustainable development, advance global renewable energy development, and help businesses achieve global carbon reduction goals, the Taiwan Alliance for Net-Zero Emission (TANZE) raised an initiative and established the Alliance for Net-Zero Emission. The Alliance aims to establish a platform for sharing net-zero emissions information and resources, fostering collaboration among alliance members, government

agencies, industries, academia, research institutions, and non-profit organizations. Additionally, it engages in public signature campaigns and educational outreach to unite all sectors of the nation in achieving the goal of net-zero greenhouse gas emissions.

To encourage all sectors in Taiwan to fulfill their social responsibilities and pursue sustainable development, the Alliance promotes measures such as energy-saving practices, process improvements, energy substitution, forest management, carbon capture and storage, and carbon credit offsets to achieve Net Zero goals. The Alliance also promotes the Net-Zero Certification, which involves two stages: Commitment and Achievement. It calls on organizations to lead the way by achieving net-zero emissions at office sites by 2030 and at production and service sites by 2050. As of 2023, 23 companies have applied for the certification.

Figure 9.3.2-4. Inaugural Meeting of the Taiwan Alliance for Net-Zero Emission

Source: Taiwan Alliance for Net-Zero Emission Website.

VI. Sustainable Finance Pioneer Alliance

To align with the 2050 Net-Zero Emissions policy, address climate change, and promote sustainable development, the first Sustainable Finance Pioneer Alliance was established on September 5, 2022, by five financial holding companies: Yuanta Financial Holdings, CTBC Financial Holdings, E.SUN Financial Holdings, First Financial Holding, and Cathay Financial Holding. The alliance committed to taking more proactive actions on five major topics: green procurement, investment and financing with engagement, information disclosure, assistance and promotion, and international alignment, thereby enhancing the momentum for national and industrial net-zero transition.

The second cohort expanded to include six financial holding companies, with Mega Financial Holdings joining as a new member. The alliance continues to leverage the power of sustainable finance to drive Taiwan's net-zero development, beginning with internal efforts. Members take concrete actions to reduce carbon emissions while carefully managing the physical and transitional risks posed by climate change. They also guide their clients and harness peer influence to steer industries and society toward sustainable development goals.

Figure 9.3.2-5. Launch Press Conference for the Second Cohort of the Sustainable Finance Pioneer Alliance

Source: Economic Daily News. Sustainable Finance Pioneer Alliance Led by E.SUN.

VII. 2050 Net-Zero Cities Exhibition

The 2050 Net-Zero Cities Exhibition, guided by the NCSD and organized by the National Development Council, the Taipei Computer Association, and the Taiwan Smart City Industry Alliance, aims to connect domestic and international cities to share solutions for digital transformation and net-zero technologies. This initiative seeks to accelerate Taiwan's progress toward its net-zero goals and highlight its determination to work hand-in-hand with global cities to achieve digital and green transitions.

The event's overall design revolves around the 12 Key Strategies of the Executive Yuan's Net-Zero Emissions Plan: wind/solar PV, hydrogen, innovative energy, power systems and energy storage, energy saving and efficiency, carbon capture, utilization and storage, carbon-free and electric vehicles, resource recycling and zero waste, carbon sinks, green lifestyle, green finance, and just transition. Through exhibitions and forums, the event showcases Taiwan's commitment and achievements in achieving net-zero emissions

Additionally, the event features the Net-Zero Cities Forum Series, which includes the Net-Zero Cities International Summit, the Net-Zero Transition Forum, and the Global Carbon Market Forum. These forums invite representatives from domestic and international cities, along with experts from industry, government, and academia, to participate in keynote speeches and discussions. The forums focus on three major transformation priorities essential to achieving net-zero cities: energy transition, just transition, and lifestyle transformation. Participants exchange experiences and insights on the journey toward net-zero transitions.

1. Taiwan Net-Zero Vision Pavilion :

The Taiwan Net-Zero Vision Pavilion is a collaborative exhibition organized by the National Development Council (NDC) and the responsible ministries for the 12 Key Strategies. It showcases the achievements of each agency's net-zero emissions action plans. The pavilion features displays from eight major ministries: the NDC, Ministry of the Interior,

Ministry of Economic Affairs, Ministry of Environment, Ministry of Transportation and Communications, National Science and Technology Council, Financial Supervisory Commission, and Ministry of Finance. The exhibition highlights their phased accomplishments and future action plans toward achieving net-zero emissions.

2. City Net-Zero Vision Pavilion :

Local governments play a crucial role in advancing net-zero transitions. This year, Yunlin County, New Taipei City, and Chiayi City are among the exhibitors, presenting tailored net-zero action plans and sustainable development initiatives from a city perspective.

3. Net-Zero Industrial Transformation Zone :

To meet the carbon reduction demands of the four major supply chains, the exhibition adopts a large-first, small-later approach, where leading net-zero enterprises and state-owned companies present net-zero emissions solutions. Foxconn and Chengyun Motors will showcase new electric buses aligned with smart city and net-zero trends. Lotte Rail, a South Korean company, will exhibit rail-based smart solutions for the first time in Taiwan. Globally recognized ProLogium Technology will display solid-state batteries for electric vehicles, a safer alternative to current liquid batteries prone to fire risks. TECO and Tatung will present various electric energy solutions. Uwin Tech will showcase its energy management platform, while Delta Electronics will feature its smart park management platform.

4. Net-Zero Technology Thematic Zone :

This zone brings together research institutions affiliated with various ministries to showcase R&D projects and achievements related to the 2050 Net-Zero Emissions Plan. This year, the National Taiwan Ocean University, celebrating its 70th anniversary and positioning itself as a Global Leader in the Marine Industry, expanded its exhibition. The university presented marine technology R&D results in three key areas: marine energy, drones, and marine blue carbon. Additionally, it showcased industry-academia collaboration results in fields such as aquavoltaics and maritime port research.

5. Green Finance Zone :

Green finance is a critical driver for achieving net-zero emissions. The Ministry of Finance and the Financial Supervisory Commission led 20 public and private banks in showcasing green financial products needed for corporate green transitions. This substantial financial presence highlights the critical trend of No ESG, No Money.

6. Startup Thematic Zone (Smart Startup Program, SSP) :

The SSP brought together global innovation teams and accelerators. This year, 10 startup accelerators (including Qualcomm, Chunghwa Telecom, United Innovation, and New Taipei BaoGao Digital Base) participated, leading a total of 87 startups. Of these, 49 were international teams (56%), and 38 were domestic teams (44%). The exhibition highlighted the boundless potential for future industries in green transitions.

Figure 9.3.2-6. 2024 Net-Zero Cities Forum Series

Source: National Development Council

VIII. Industrial Carbon Neutrality Alliance

To unite the industrial sector's determination to reduce carbon emissions and respond to the Ministry of Economic Affairs' large-first, small later model for promoting net-zero transformation, the Ministry of Economic Affairs joined forces with the Chinese National Federation of Industries to establish the Industrial Carbon Neutrality Alliance in July 2022. The Alliance initially prioritized recruiting 30 industrial associations and their member companies, including those from the steel, petrochemical, cement, paper, and man-made fiber industries, aiming to pool resources from the Ministry of Economic Affairs and relevant government agencies. Through large enterprises leading small and medium-sized enterprises, the alliance seeks to share carbon

reduction technologies and experiences, striving together to achieve the 2050 Net-Zero Emissions Target. The alliance promotes industrial net-zero transformation through three key strategic approaches: enhancing industrial carbon management capabilities, establishing an industrial carbon reduction service platform, and promoting diversified large-first, small later practices. It has continuously encouraged industrial associations to join. By the end of June 2024, the alliance had grown to include over 100 industrial associations, representing more than 38,000 member companies.

Figure 9.3.2-7. Inaugural Meeting of the Industrial Carbon Neutrality Alliance

Source: Ministry of Economic Affairs website.

IX. Climate-Related Forums

Table 9.3.2-1. Climate-Related Forums

Date	Conference Name	Event Details
2023/4/13	Working Together for Net-Zero Transformation Climate Forum	Climate forums were convened to invite pioneers from Taiwan's industries, energy sector, residential and commercial transportation, resource recycling, green finance, and green living sectors, who are actively participating in and practicing the net-zero transformation. The forums aimed to facilitate interaction and exchange on Taiwan's current progress while encouraging collective efforts toward achieving the nation's net-zero emissions target.
2023/5/29	2023 Resource Recycling International Conference	Experts and representatives from Europe and Asia across industry, government, academia, and research were invited to discuss topics such as resource recycling policies, plastic resource recycling, sustainable product eco-design and business models, and waste-to-energy technologies. These discussions explored international resource recycling policies, industry developments, and innovative research outcomes, fostering global interaction and accelerating cross-sector communication. The goal was to provide a reference for countries formulating resource recycling policies, enhance visibility for emerging green industries on the international stage, and showcase Taiwan's efforts and achievements in resource recycling.
2023/6/30	Resource Transformation Towards Sustainability Resource Recycling Forum	The forum, themed Transforming Perceptions to Promote Resource Recycling invited leading enterprises from six key areas of resource recycling to share their experiences on turning waste into resources. Discussions focused on changing product and resource usage, establishing circular supply chains, and creating sustainable business models.
2023/7/20-2023/7/22	2023 Asia-Pacific Sustainability Forum	The second 2023 Asia-Pacific Sustainability Forum gathered leading domestic institutions from industry, government, academia, research, and civil society under the theme Road to Net Zero. The forum served as a hub connecting public and private sectors, industrial supply chains, academia, and the general public, collectively advancing sustainable transformation and exchanging the latest ESG and sustainability insights both domestically and internationally.

X. Promoting Sustainable Environmental Concepts to Civil Groups and Cooperatives

The Ministry of the Interior has promoted sustainable environmental concepts through large-scale educational training for cooperatives and civil groups. For example, in 2023, the Ministry organized national-level seminars on the management of social organizations, cooperative training sessions, and national liaison meetings for industrial, commercial, and freelance professional groups. These events collectively attracted approximately 1,308 participants:

1. National Seminar on the Management of Social Organizations:

Held on September 21 and September 22, 2023, at the Ministry of the Interior, this seminar focused on empowering organizations. The goal was to ensure that newly established organizations could smoothly advance their operations and fulfill their founding purposes and objectives, thereby contributing to social welfare. The seminar was open to officers and staff members of national social organizations newly registered within the past year. These participants often brought enthusiasm for their organizations' missions as well as adaptability to new educational concepts. During the sessions, the Ministry introduced the concept of sustainable environments, encouraging attendees to incorporate these principles into their future organizational operations and practices.

2. Cooperative Educational Training:

To enhance the understanding of cooperative organizations among members, directors, supervisors, and appointed staff, the Ministry of the Interior conducts annual educational training sessions. These aim to establish cooperative principles, improve professional knowledge and skills in cooperative management, and promote the sound development of cooperatives. Cooperatives are inherently local, sustainable enterprises focusing on production and consumption. During the seminars, the Ministry introduced sustainable environmental concepts to participants, encouraging cooperatives to incorporate these principles into their production processes.

3. National Liaison Meeting for Industrial, Commercial, and Freelance Professional Groups and Model Group Observations:

Held on September 12 and September 19, 2023, this event was an enhanced version of previous organizational seminars, expanded into a 1-day program featuring site visits, experience sharing, keynote speeches, and discussions. The goal was to strengthen communication and interaction among groups. The event was open to presidents, secretaries-general, and general managers of national-level industrial, commercial, and freelance professional organizations. Many of the visited and observed organizations were actively pursuing core sustainable development goals, such as circular economy, energy efficiency, carbon reduction, and sustainable production. The Ministry used this opportunity to promote sustainable environmental concepts and systems to participating members, encouraging them to further integrate these principles into the operations of their respective organizations.

XI. Low-Carbon Building Policy Exchange Forums

In recent years, the Ministry of the Interior has been actively promoting policies related to low-carbon buildings. To enhance communication and dialogue within the industry and gather feedback, the Ministry, in collaboration with the Ministry of Environment, held three Low-Carbon Building Policy Exchange Forums in Taipei, Taichung, and Kaohsiung on June 7, June 11, and June 14, 2024, respectively. These forums invited associations such as the Real Estate Development Association, the Architects Association, the Civil Engineers Association, and the Construction Association, for a total of 125 participants. Discussions centered on strategies for low-carbon buildings and issues related to construction costs. The forums provided an opportunity to listen to industry opinions and grassroots voices while fostering comprehensive two-way communication and interaction. The suggestions gathered will be incorporated into policy planning and implementation.

Figure 9.3.2-8. Three Low-Carbon Building Policy Exchange Forums

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Appendix: Chinese–English Glossary of Proper Nouns

Chapter	Chinese noun	English noun	English Abbreviation
Chapter 1	資源循環零廢棄	Resource Circulation and Zero Waste	-
	綠色設計	Green Design	-
	國際森林管理委員會	Forest Stewardship Council	FSC
	世界港口永續計畫	World Port Sustainability Program	WPSP
Chapter 2	二氧化碳移除	Carbon Dioxide Removal	CDR
Chapter 3	國家自定貢獻	Nationally Determined Contributions	NDC
	聯合國政府間氣候變化專門委員會	Intergovernmental Panel on Climate Change	IPCC
	負碳技術	Negative Emission Technologies	NETs
	碳捕捉利用與封存	Carbon Capture, Utilization and Storage	CCUS
	昆明 - 蒙特婁全球生物多樣性框架	Kunming-Montreal Global Biodiversity Framework	K-M GBF
	蒙地卡羅模型	Monte-Carlo Method	MCM
	排放基線	Business as usual	BAU
	循環採購	Circular Procurement	-
	溫室氣體低排放分析平台模型	Low Emission Analysis Platform	LEAP
Chapter 4	澳洲農業與資源經濟局	Australian Bureau of Agriculture and Resource Economics and Sciences	ABARES
	一般均衡	Computable General Equilibrium	CGE
	臺灣經濟與環境一般均衡模型	General Equilibrium Model for Taiwanese Economy and Environment	GEMTEE
	臺灣農業部門模型	Taiwan Agricultural Sectoral Model	TASM
	臺灣漁業部門模型	Taiwan Fishery Sectoral Model	TFSM
	溫室氣體低排放分析平台模型	Low Emission Analysis Platform	LEAP
	可計算一般均衡模型	Computable General Equilibrium Model	CGE模型

Chapter	Chinese noun	English noun	English Abbreviation
Chapter 5	聯合國政府間氣候變化專門委員會第六次評估報告	Intergovernmental Panel on Climate Change Sixth Assessment Report	IPCC AR6
	第六期耦合模式	Coupled Model Intercomparison Project Phase 6	CMIP6
	標準化降雨指數	Standardized Precipitation Index	SPI
	第六次評估報告	The Sixth Assessment Report	AR6
	連續不降雨日數	maximum number of Consecutive Dry Days	CDD
	全球暖化程度	Global Warming Level	GWL
	代表濃度途徑	Representative Concentration Pathways	RCPs
	共享社會經濟途徑	Shared Socioeconomic Pathways	SSPs
	溫濕度指數	Temperature-humidity index	THI
	國家海洋資料庫及共享平台	National Ocean Database And Sharing System	NODASS
Chapter 6	碳捕捉、（再）利用與封存	Carbon Capture, Utilization and Storage	CCUS
Chapter 7	固體回收燃料	Solid Recovered Fuel	SRF
Chapter 9	新世代環境教育發展	New-generation Environmental Education Development	NEED
	氣候變遷教育	Climate Change Education	CCE
	永續發展教育	Education for Sustainable Development	ESD
	永續發展目標	Sustainable Development Goals	SDGs
	生物多樣性公約	Convention on Biological Diversity	CBD

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