METI
Ministry of Economy, Trade and Industry

(Provisional translation)

Energy White Paper 2025（Summary）

(FY2024 Annual Report on Energy)

June 2025

Agency for Natural Resources and Energy

Chapter 1. Progress in Reconstruction of Fukushima

1. Efforts toward decommissioning of Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company Holdings（TEPCO）

- **The retrieval of the fuel debris from TEPCO's Fukushima Daiichi Nuclear Power Station** is **a task of unprecedented technical difficulty worldwide.** It is important to proceed steadily and step by step. **A first trial retrieval was completed at Unit 2 in November 2024**. The retrieved fuel debris is being analyzed at analysis facilities such as Japan Atomic Energy Agency(JAEA). **The second trial retrieval was completed in April 2025**, and it will also be analyzed in the same manner.
  * In September 2024, a trial retrieval of the fuel debris from Unit 2 using a telescopic device began, shifting to the Phase 3 of the Mid-and-Long-Term Roadmap, which sets out the decommissioning process.
- Monitoring results and reviews by the IAEA have **confirmed that the discharge of ALPS treated water has been conducted safely.** On February 14, 2025, dismantling work began on the tanks from which ALPS treated water had been discharged. **Facilities related to fuel debris retrieval are planned to be constructed** on the site.
- As of April 2025, the **additional measures on monitoring under the IAEA framework have been conducted three times with the participation of experts from third-party analytical laboratories, including those from China**. In March 2025, Japan and China **concurred on promoting relevant consultations towards the resumption of imports of Japanese aquatic products, on the premise that no abnormalities are seen in the results of the analysis**.

Fuel debris trial retrieval using telescopic device

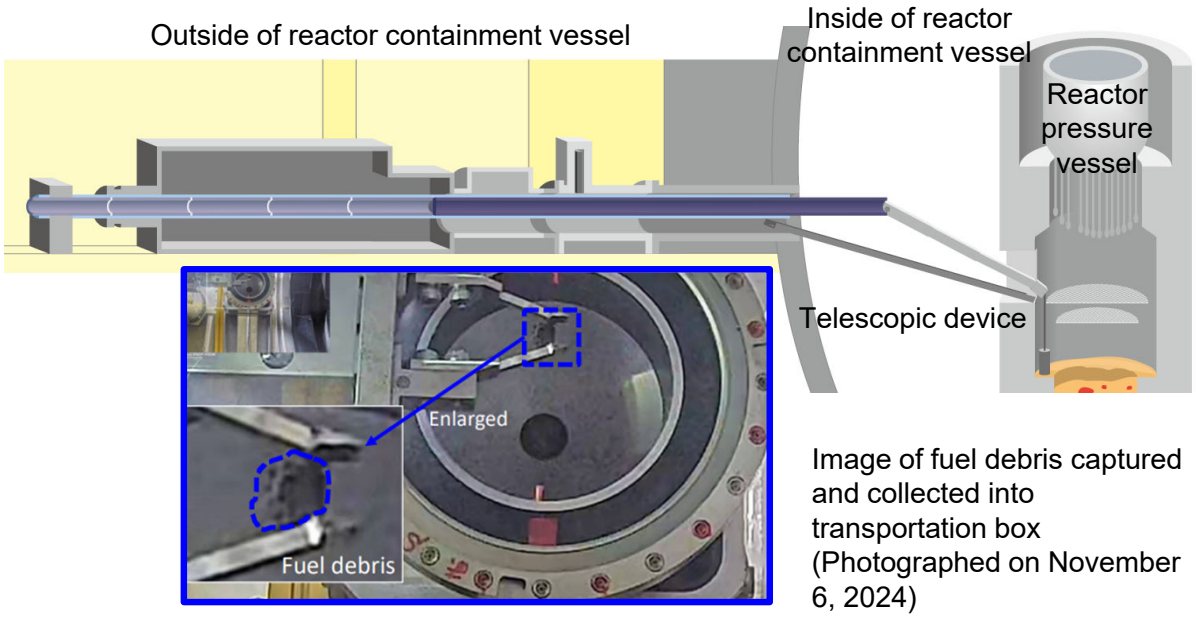


Image of fuel debris captured and collected into transportation box (Photographed on November 6, 2024)

Dismantling of tanks from which ALPS treated water has been discharged

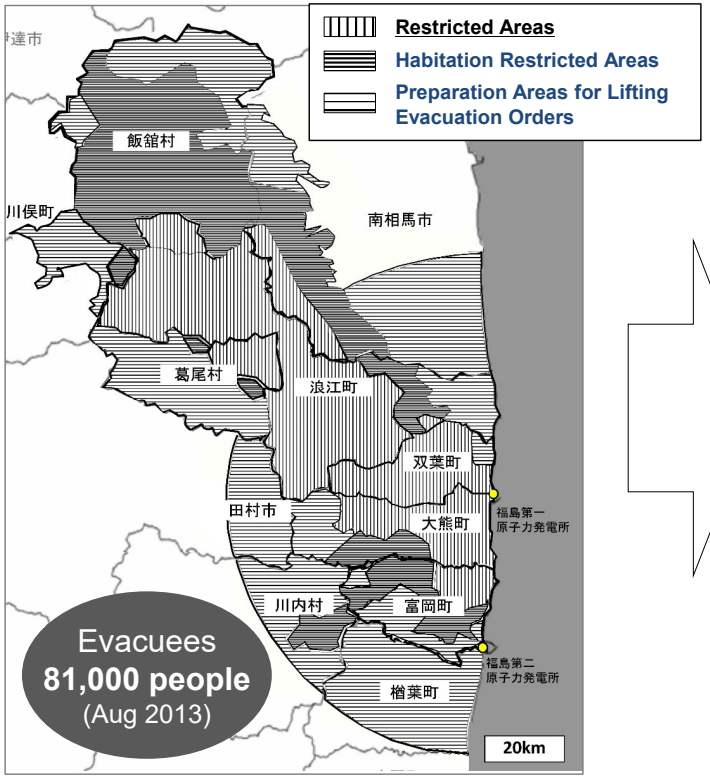
Image of top (roof) of tank being removed

2. Efforts for Lifting the Evacuation Orders Imposed on the Restricted Areas*

* Areas where residency has been restricted for the foreseeable future

- Based on the **"System of Specified Living Areas for Returners"** established in 2023 to enable all the residents who wish to return to do so, **reconstruction and revitalization plans for the towns of Okuma, Futaba, Namie, and Tomioka and Minamisoma City were approved** by March 2025. Decontamination, infrastructure development, and other efforts will continue.
- In March 2025, **evacuation orders were lifted in the villages of Iitate and Katsurao to allow to the use of land** necessary **for reconstruction using local resources such as compost production and wind power generation**.

<<Evacuation order zones: August 2013>>

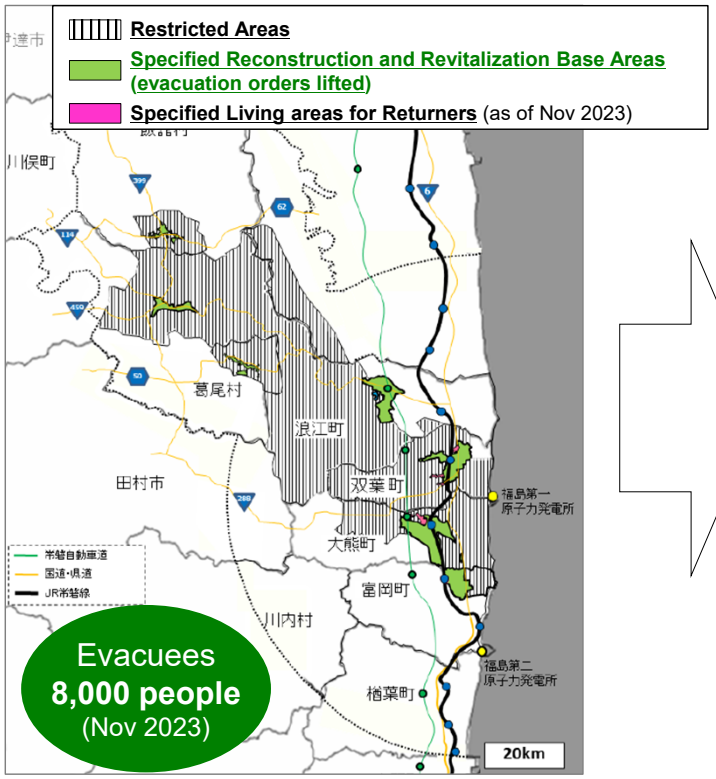


<<August 2013>>
A review of evacuation order zones was completed (Figure above)

⇩ Evacuation orders were lifted one by one from April 2014

<<By March 2020>>
Evacuation orders were lifted in all areas except difficult-to-return zones

<<November 2023>>

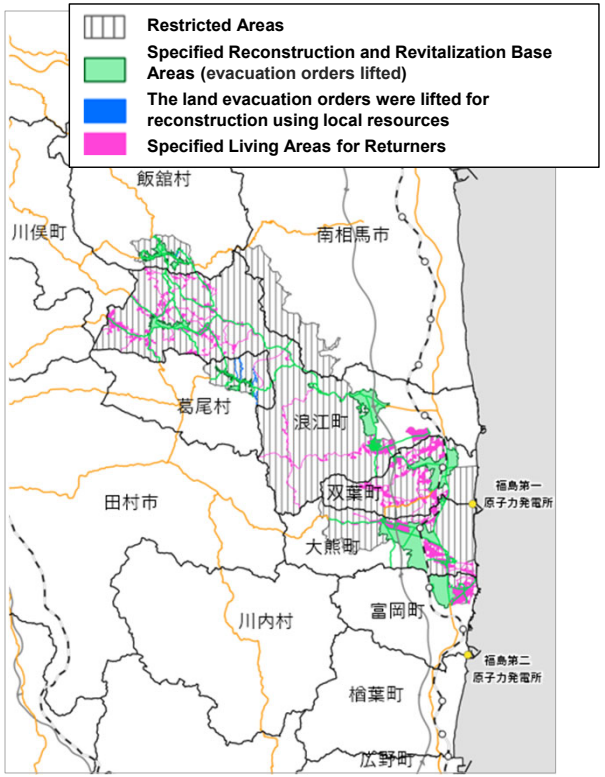


<<May 2017>>
From among the difficult-to-return zones, **specified reconstruction and revitalization base areas** were established aiming to lift evacuation orders and enable residents to return within five years

⇩ Evacuation orders were lifted one by one from March 2020

<<By November 2023>>
Evacuation orders were lifted in all specified reconstruction and revitalization base areas

<<April 2025>>



<<June 2023>>
The **System of Specified Living Areas for Returnees** was established to make efforts to lift evacuation orders to enable all residents who wish to return to do so over the 2020s

<<By March 2025>>
For the towns of Okuma, Futaba, Namie, and Tomioka and Minamisoma City, **the plans for reconstruction and revitalization of specified living areas for returnees were approved**

↳ **Decontamination, infrastructure development**, and other efforts will continue **to lift evacuation orders**

3. Efforts to create new industries (Fukushima Innovation Coast Framework)

- The Fukushima Innovation Coast Framework is **an initiative aiming to create new industries in Hamadori and other areas** through various subsidy programs and the development of business environments, including the establishment of the Fukushima Robot Test Field, in order to **revive industries in the area**. "Blueprint for Industrial Development Based on the Fukushima Innovation Coast Framework" was revised this fiscal year.
- In September 2024, **"Acceleration Plan 2.0"** of **"The Fukushima Plan for a New Energy Society"** was adopted.**It will expand the introduction of renewable energy in Fukushima and accelerate the social implementation of hydrogen**.

Six Key Fields of Fukushima Innovation Coast Framework

Decommissioning

Technical development with domestic and international wisdom

"The Naraha Center for Remote Control Technology Development" conducts verification tests necessary for decommissioning work and other tasks.

Robotics and Drones

Forming a robotics industry cluster around the Fukushima Robot Test Field

"The Fukushima Robot Test Field" provides demonstration environments for field robots on land, at sea, and in the air.

Energy, Environment and Recycling

Establishing advanced renewable energy and recycling technologies

"The Fukushima Hydrogen Energy Research Field" produces hydrogen from renewable energy

Agriculture, Forestry and Fisheries

Revitalizing the agriculture, forestry, and fisheries industries by utilizing ICT and robotics

Establishing an agricultural model that utilizes ICT "Demonstration of unmanned tractor operation"

Medical and Health Care

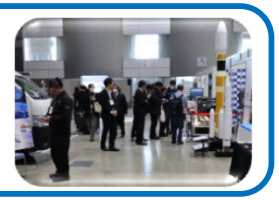
Developing sales channels for companies through technical development support

"The Fukushima Medical Device Development Support Centre" provides comprehensive support from development to commercialization

Aerospace

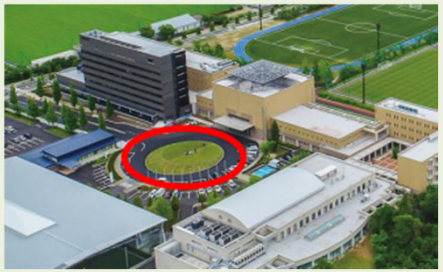
Demonstrating "Flying Car" and attracting related companies

"Robot & Aerospace Festa Fukushima" allows technological exchanges in the aerospace industry



The Fukushima Plan for a New Energy Society

- In 2016, **"The Fukushima Plan for a New Energy Society"** was formulated, aiming to **make the entire Fukushima Prefecture a hub for creating a model that will be a pioneer of the new future energy society**.
- The **"Acceleration Plan 2.0"** adopted in September 2024 advances **further expansion of the introduction of renewable energy through the completed shared power transmission lines** and **the acceleration of the social implementation of hydrogen** in collaboration with the Fukushima Hydrogen Energy Research Field (FH2R).



(J-VILLAGE)

J-VILLAGE has exploited the flexibility of **perovskite solar cells by installing them on the lawn on the cone-shaped slope** of its training center. The feasibility of introducing the solar cells will be examined in the future, including compatibility with ground surfaces and curved shapes.

Fukushima Institute for Research, Education and Innovation (F-REI)

- Aiming to become **a world-eminent core center for creative reconstruction, the institute** engages in **research, development, industrialization, and human resource development in five fields.**
- In the energy field, it is carrying out **technological demonstrations and other projects to make Fukushima a pioneering carbon-neutral site in the world**.

[(1) Robotics]

Research and development of robots, drones, and performance evaluation methods for them

[(2) Agriculture, forestry, and fishery industries]

Demonstrative research and studies aiming to realize a local circular economy model

[(3) Energy]

Technological demonstrations and so forth aiming to achieve carbon neutrality

[(4) Radiation science, drug discovery and medical treatment, industrial use of radiation]

Studying in the use of radiation and radioisotopes

[(5) Collection and dissemination of data and knowledge of nuclear accidents]

Research, development, and information dissemination that contribute to environmental recovery from a nuclear accident, dispelling of false rumors ,and so forth

1. Changes in environment surrounding Japan's energy (1)

◆ The global energy environment has dramatically changed since the start of Russia's aggression against Ukraine in February 2022, with heightened tensions in the Middle East and the Trump administration's announcement of its withdrawal from the Paris Agreement. Japan also needs to take all possible measures to ensure its energy security.

Increased requirements for economic security due to Russia's aggression against Ukraine

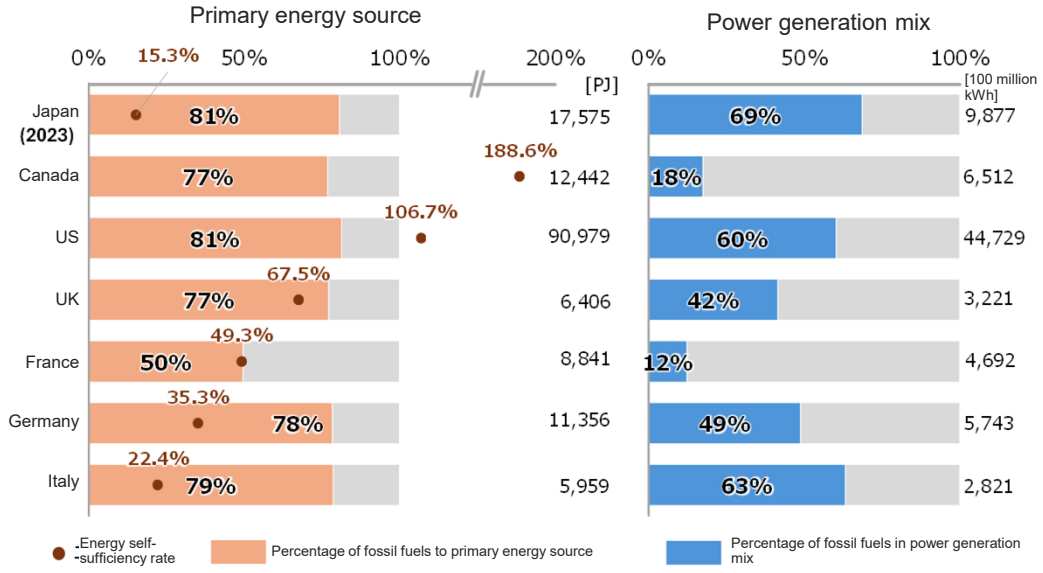
Russia and Ukraine	Israel and Palestine	US and EU
[Feb 2022] Russia`s aggression against Ukraine begins.	[Oct 2023] Palestinian militant groups, including the Islamic Resistance Movement (Hamas), launched attacks on Israel.	[Feb 2024] (EU) The European Commission proposed a 90% reduction in GHG emissions by 2040 compared to those in 1990. (Under discussion as of the end of March 2025)
	[Jan 2025] Temporary ceasefire agreement	[Jan 2025] (US) The Trump administration announced its withdrawal from the Paris Agreement.
[Since 2025] Ceasefire negotiations	[Mar 2025] Israel resumed military attacks.	[Since 2025] The US raised tariffs, and other countries responded to this action.

<<Examples of each country's measures for energy security>>

US	The former Biden administration promoted clean energy policies (such as the Inflation Reduction Act), but the Trump administration has changed the policies, including the announcement of its withdrawal from the Paris Agreement, and is promoting the development of domestic energy resources.
EU	The EU is accelerating its efforts to reduce its dependence on Russia for energy while strengthening support for clean energy industries in Europe.

- Japan's energy self-sufficiency rate is 15.3% (the lowest among the G7 countries). Approximately 70% of electricity generation is dependent on fossil fuels.
- Since Russia's aggression against Ukraine, the decreased supply of LNG and escalating prices have had a great impact on the trade balance.
- Increasing the share of carbon-free power sources is essential to maintain Japan's competitiveness as an industrial base among G7 countries.

Energy self-sufficiency rate and fossil fuel ratio of each country



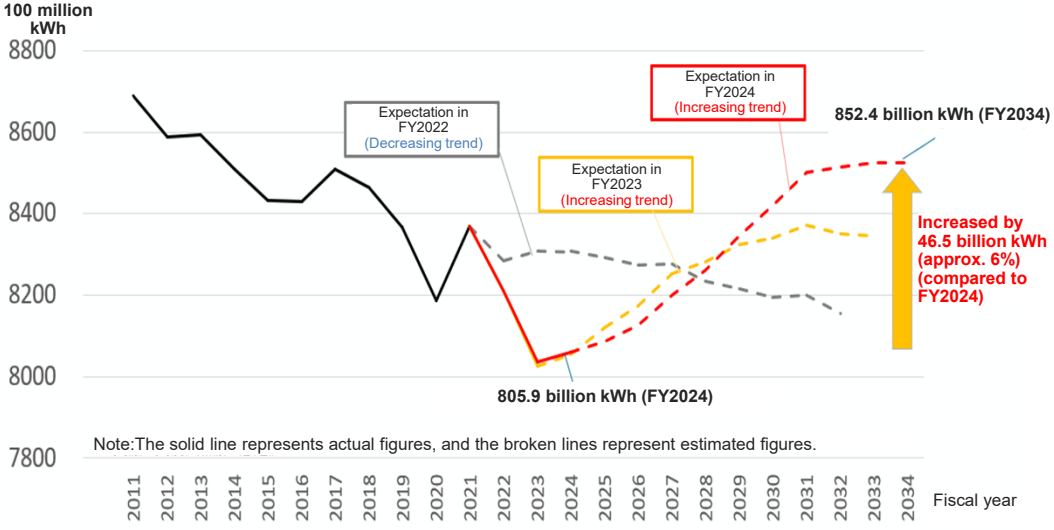
Sources: Japan's data was quoted from FY2023 Energy Supply and Demand Statistics (Final Report), other countries' data was 2022 data quoted from "World Energy Balance 2024."

1. Changes in environment surrounding Japan's energy (2)

◆ In addition to energy security, it is necessary to take measures taking into account possible increases of electricity demand due to the progress of digital transformation (DX) and green transformation (GX), maintaining ambitious goals in measures against climate changes implementing realistic and diverse responses, and strengthening industrial policies through GX.

<<Potential increase in electricity demand due to progress in DX and GX >>

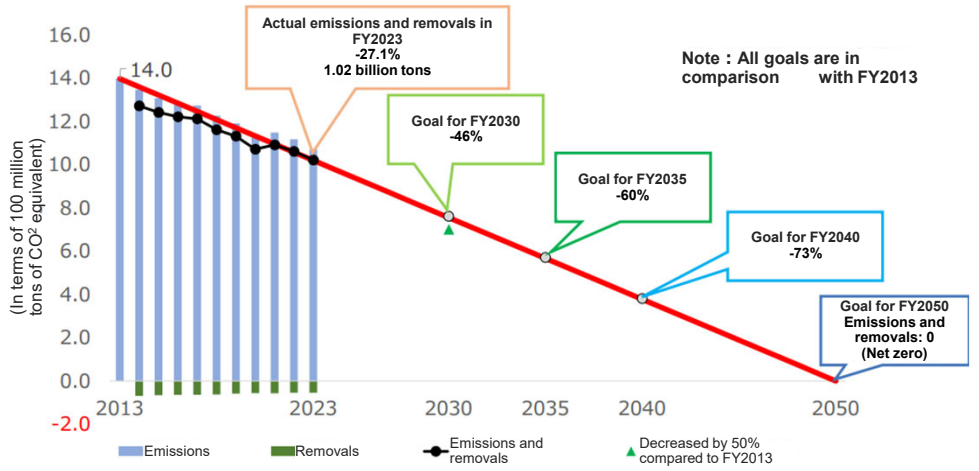
- Even with energy conservation efforts taken into account, electricity demands in Japan is expected to increase due to the construction of new data centers and semiconductor fabs.



Source: Organization for Cross-regional Coordination of Transmission Operators "Expected Demands in Whole Japan and in Each Supply Area" (FY2025) was referenced to draw the chart

<<Maintaining ambitious goals against climate change and realistic and diverse measures >>

- Countries including Japan are firmly maintaining ambitious goals that are consistent with the 1.5°C target and aim to achieve carbon neutrality by 2050. At the same time, there is also a transition to a more realistic stance to attain a balance between cost efficiency and a stable supply.



Source: "Japan's Nationally Determined Contribution (NDC)"

<<Integration of energy policy and industrial policy>>

Japan	Since defining "The Basic Policy for Realization of GX," the government has implemented measures for supporting anticipatory investments worth 20 trillion yen over 10 years and a growth-oriented carbon pricing scheme, and in February 2025, it established the "GX2040 Vision" with a long-term perspective.
EU	The EU is strengthening support for the clean energy industry through measures such as the Net-Zero Industry Act (February 2024), which includes supportive measures for increasing the production of clean energy technologies within the EU area.

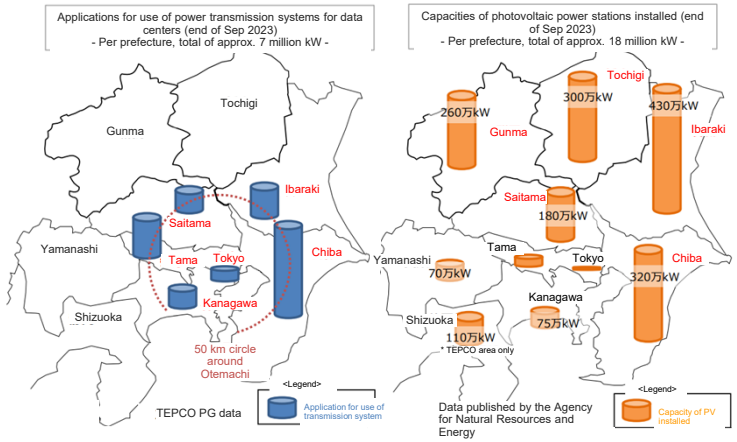
Chapter 2. Japan's Efforts to Achieve GX and 2050 Carbon Neutrality

2. Accelerating the development of domestic locations for data centers through collaboration between

- To accelerate DX using AI and achieve both economic growth and decarbonization at the same time, we will promote **effective collaboration between electricity and telecommunications (watt-bit collaboration)** through the **development of efficient electricity and telecommunications infrastructures**, taking into account the uneven distribution of electricity demand and carbon-free power sources, lead times, and so forth.
- It is likely that we will enter an era in which products and services, including data centers, will create added value utilizing clean energy such as carbon-free electricity, and **consumers themselves will need to accelerate their efforts to utilize and secure carbon-free electricity**.

Background (1) Uneven distribution of large-scale electricity demand of data centers

- Data center locations are concentrated in the suburbs of urban areas where data is consumed, far away from carbon-free power source locations.



Source: TEPCO Power Grid "Roles and Issues of Electric Power System to Achieve Both GX and DX Simultaneously"

Background (2) Difference in lead times between data center construction and carbon-free power source establishment

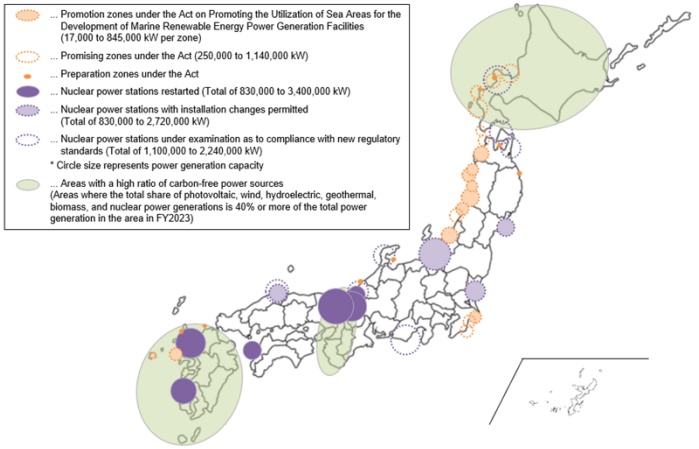
- The construction lead time of a data center is shorter than that of a carbon-free power source. A carbon-free power source sometimes requires the development of large-scale power transmission systems.

Power source	Construction time
Data center	1 to 2 years
Photovoltaics power station	1 to 4 years
Onshore wind turbine	2 to 5 years
Offshore wind turbine	3 to 7 years
Hydroelectric power station	5 to 15 years
Geothermal power generation (conventional)	3 to 8 years
Nuclear power station	5 to 15 years

Source: IEA "Energy and AI" (2025) was referenced to draw up the table

Background (3) Uneven distribution of carbon-free power sources

- The supply capacity of carbon-free power sources is also unevenly distributed across areas.



Source: 11th GX Implementation Council meeting "Toward Acceleration of Japan's Green Transformation" was referenced to draw the map

Watt-bit collaboration

We will **promote the watt-bit collaboration to effectively link electricity and telecommunications** to efficiently develop electricity and telecommunications infrastructures so that the electricity infrastructures, data center locations, and telecommunications infrastructures are totally optimized.

After the concept was proposed in the "GX2040 Vision" (Cabinet Decision in February 2025), the **" Public-Private Advisory Council on Watt-Bit Collaboration"** was established in March 2025 as a forum for collaboration and cooperation among stakeholders in the public and private sectors. The forum studied **effective measures for linking electricity and telecommunications** for the efficient development of data centers and compiled a plan for future studies in June of this year.

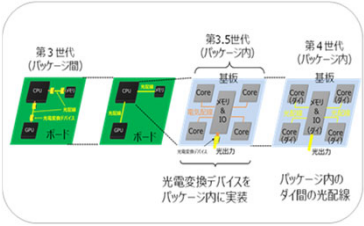
3. Next-generation energy innovative technologies (1)

◆ To simultaneously achieve a stable energy supply, economic growth, and decarbonization and aim for carbon neutrality by 2050, it is essential that Japanese companies undertake disruptive innovation in their next-generation energy innovative technologies and apply them to business.

Electro-optical integration

Action on increasing data volumes and power demand with large capacity, low latency, and low power consumption

- The use of optical signals instead of electrical signals for data processing and communication enables large capacity, low latency, and low power consumption.
- Amid intensifying international competition in the development of electro-optical integration devices, Japan is leading the world in terms of high-temperature operation and long-term reliability.
- It is expected that Japan will capture the market at an early stage through further differentiation in conjunction with the IOWN initiative and the establishment of a mass production system ahead of the rest of the world.



Development of electro-optical integration technologies

Perovskite solar cells

Next-generation solar cells characterized by being lightweight and flexible.

- They are expected to be installed on roofs and walls with low load-bearing capacity, where it was conventionally difficult to install solar cells.
- As the international competition in development intensifies, Japan leads the world in terms of durability and upsizing, which are key factors for commercialization.
- It is necessary to develop technologies for further improving the durability and power generation efficiency, and to establish a mass production system that is globally competitive.

Perovskite solar cells

Floating wind turbines

Floating wind turbines can generate electricity even in deep offshore waters

- The wind turbines are not fixed to the seabed, but are installed on floating structures on the sea. They can be installed in sea areas where the fixed-foundation installation is not feasible.
- As the international competition in development intensifies, it is expected that Japan will begin mass production utilizing its strengths in the shipbuilding technology and similar areas.
- To begin mass production at low cost, it is necessary to develop optimum design methods and build supply chains through global collaboration.

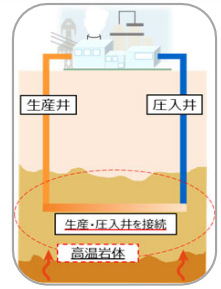
Floating wind turbine

3. Next-generation energy innovative technologies (2)

Next-generation geothermal power generation

Making maximum use of Japan's geothermal power potential through "closed-loop" and "supercritical geothermal power generation"

- "The closed-loop" method is expected to increase the number of candidate sites, and "the supercritical geothermal power generation" is expected to improve the power generation efficiency and upsize the scale.
- Some foreign companies are ahead of others in commercializing "the closed loop" method, while "the supercritical geothermal power generation" is still in the technological development stage in each country.
- For both technologies, we expect to collaborate with leading foreign companies to accelerate demonstration projects, including those in Japan, and establish commercialization know-how ahead of the rest of the world.

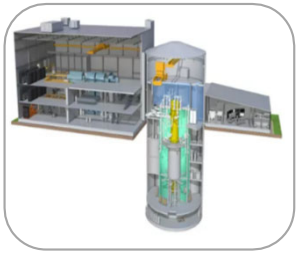


Closed-loop method

Next-generation advanced reactors

Next-generation advanced reactors with improved safety and energy efficiency (advanced light- water reactors, small modular reactors, fast reactors, high-temperature gas-cooled reactors, fusion energy)

- Regarding next-generation advanced reactors, in addition to improved safety, they have features providing a decarbonized power supply and distributed energy supply, waste volume reduction and hazard mitigation, and a carbon-free hydrogen and heat supply.
- For advanced light- water reactors, exchanges of opinions between business operators and regulatory authorities and technological development pertaining to new safety measures are underway. For small modular reactors, Japanese and American companies are conducting research and development aiming to demonstrate elemental technologies. For fast reactors and high-temperature gas-cooled reactors, demonstration reactors are being developed. For fusion energy, startups and other companies are carrying out technological development for a variety of reactor types. It is expected that these reactors will be put into practical application.


Small modular reactor

Hydrogen and its derivatives (hydrogen, ammonia, e-fuel, e-methane)

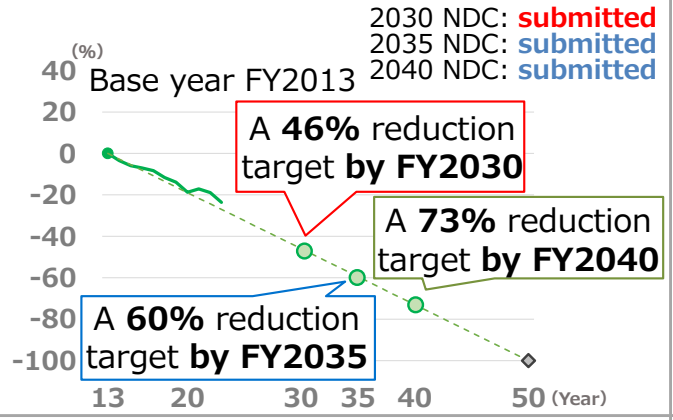
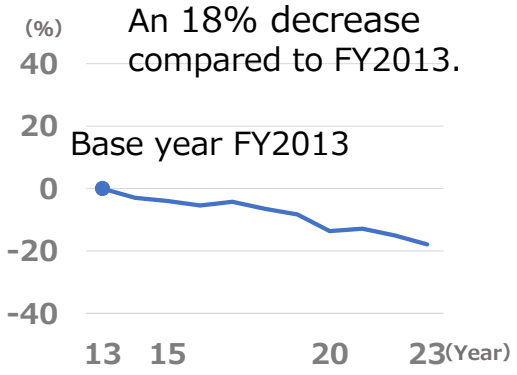
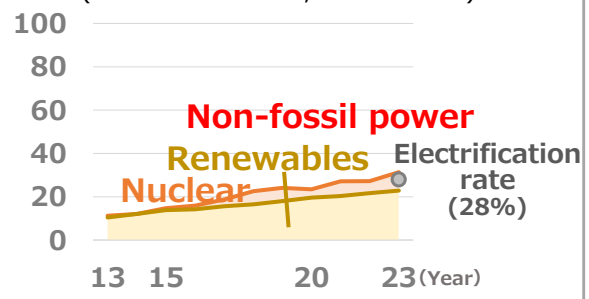
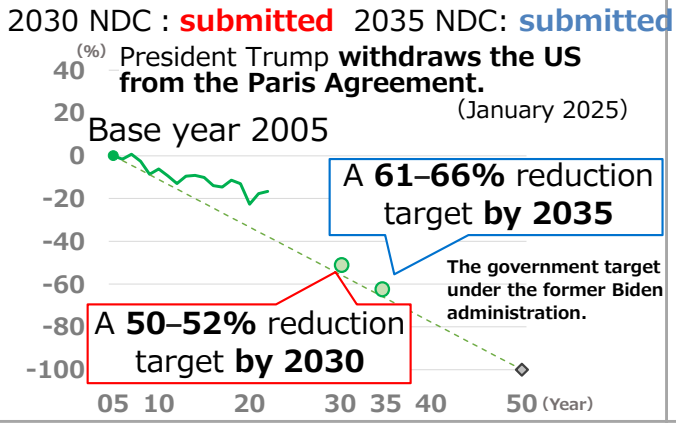
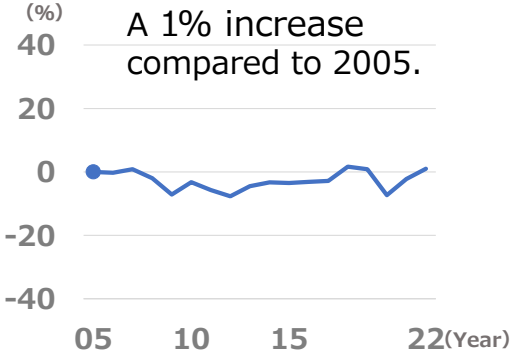
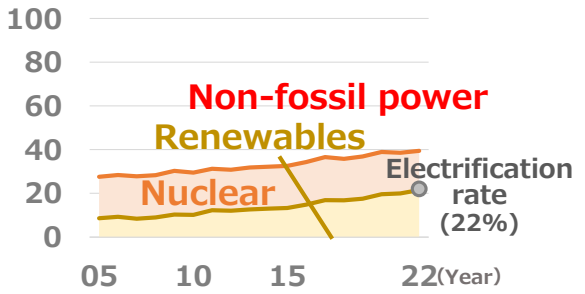
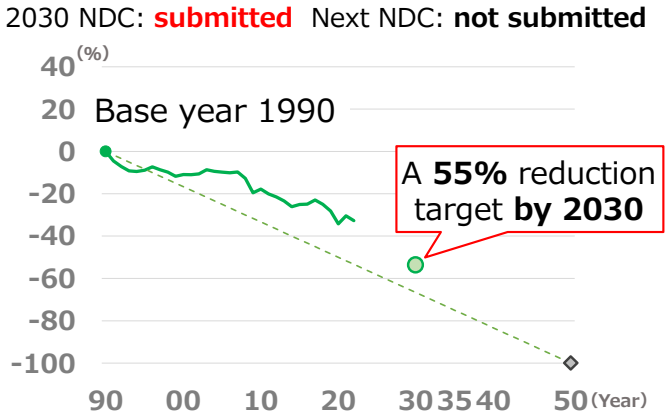
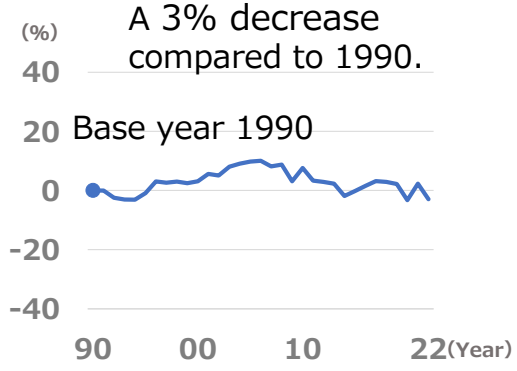
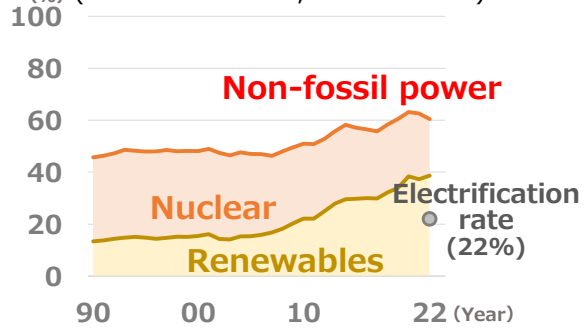
A next-generation fuel that will be the key to decarbonizing a wide range of fields, including steel, chemicals, mobility, industrial heat, and power generation.

- Japan is a global leader in fields such as the components for water electrolysis units that "produces" hydrogen, marine transportation technology that "transports" hydrogen, and power generation that "uses" hydrogen. Efforts are also underway to expand the utilization of e-fuels and e-methane.
- Such technologies will be commercialized as soon as possible and participation in both domestic and international markets where demand for hydrogen and its derivatives are expected to grow will happen at an early stage.


Liquefied hydrogen carrier

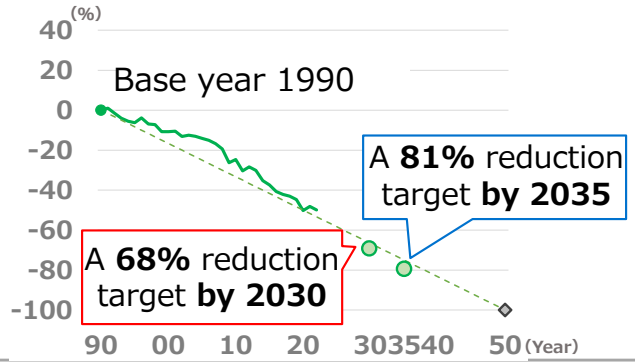
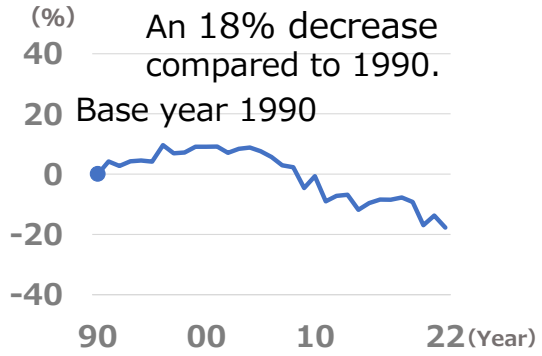
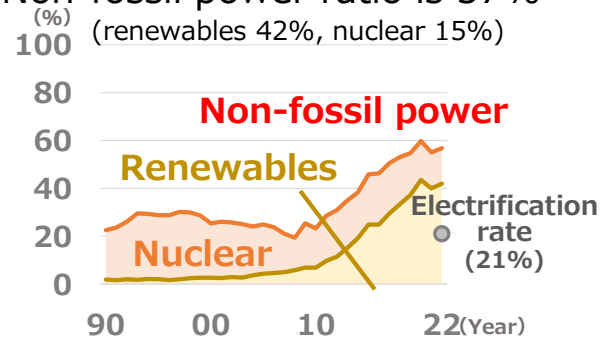
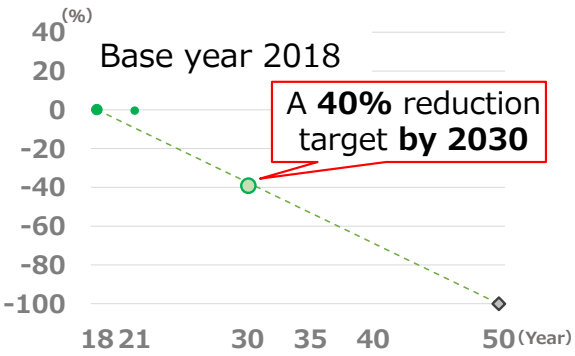
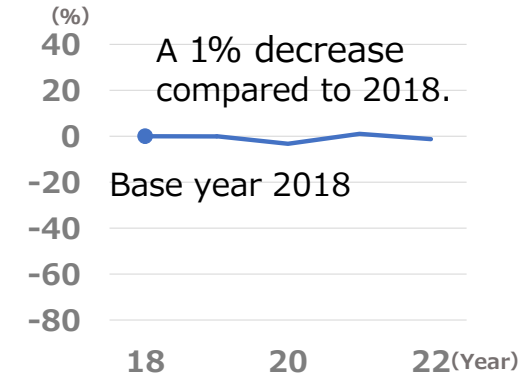
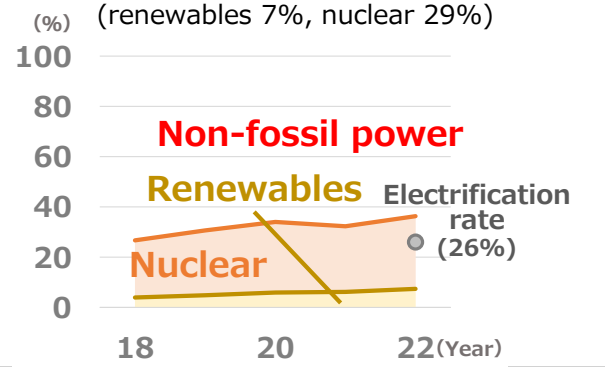
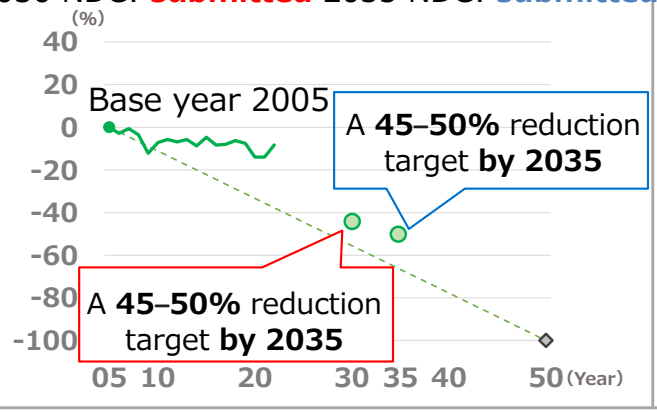
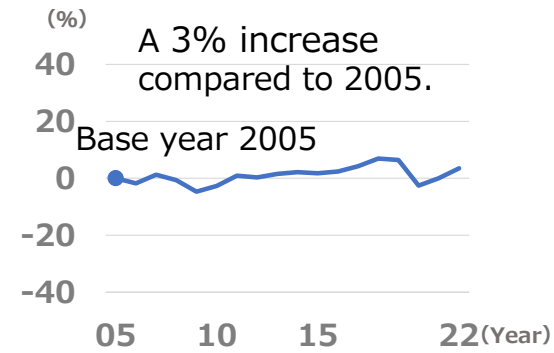
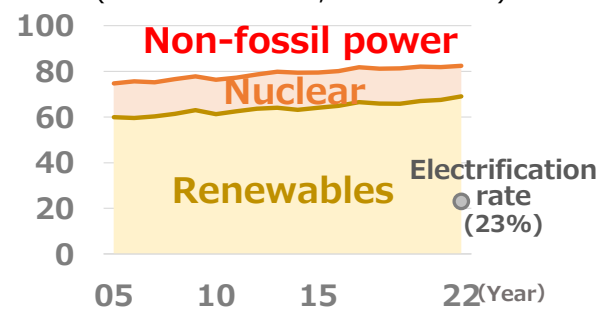
- Japan will also make efforts in the development of domestic resources such as methane hydrate, renewable heat sources such as solar and geothermal heat, marine energy such as wave and tidal power, and technologies such as demand response and carbon dioxide removal (CDR).

Trends and Background in Achieving Carbon Neutrality in 10 Major Countries/Regions (1)

2022	GHG emission reduction rate: targets and progress	Background (1): reduction rate of final energy consumption	Background (2): non-fossil power ratio (renewables+nuclear)
Japan (FY2023) 1 billion tons GHG 8.1 tons GHG per person			• Non-fossil power ratio is 31% (%) (renewables 23%, nuclear 9%) 
US 5.5 billion tons GHG 16.5 tons GHG per person			• Non-fossil power ratio is 39% (%) (renewables 21%, nuclear 18%) 
EU 3.1 billion tons GHG 7.0 tons GHG per person			• Non-fossil power ratio is 61% (%) (renewables 39%, nuclear 22%) 

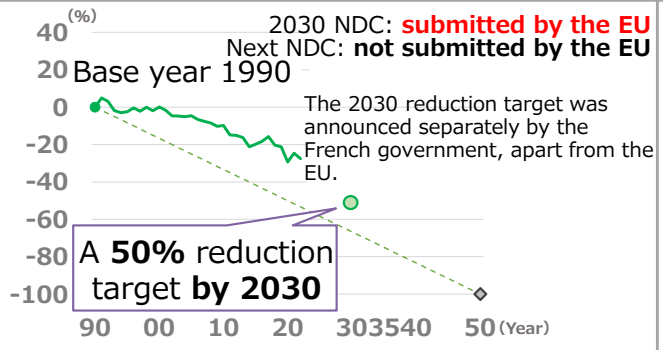
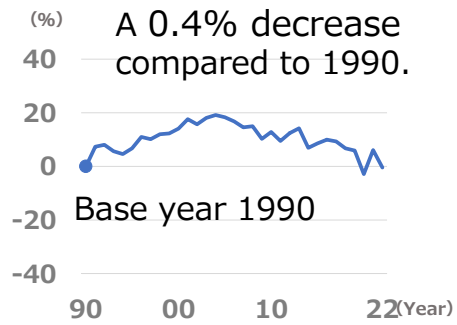
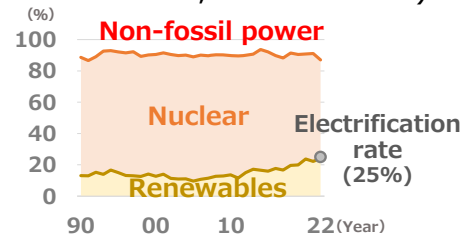
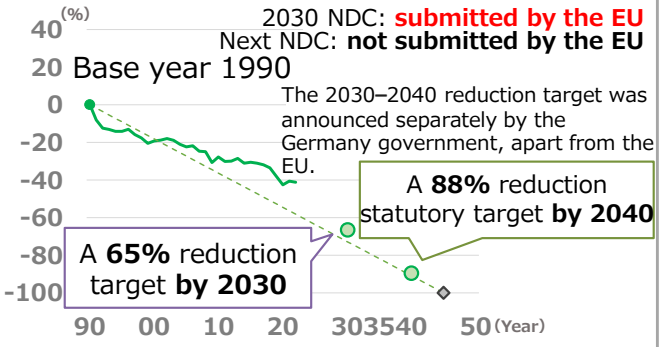
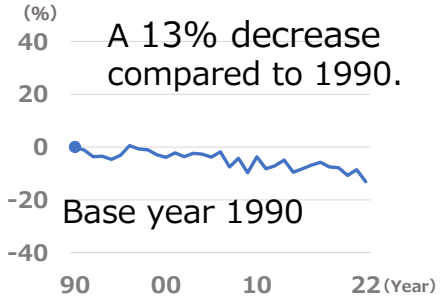
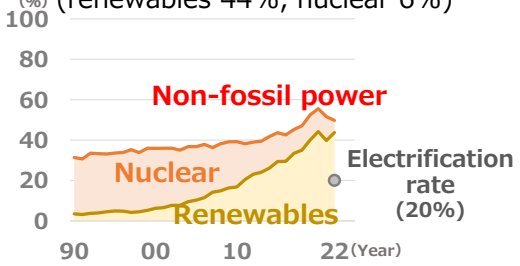
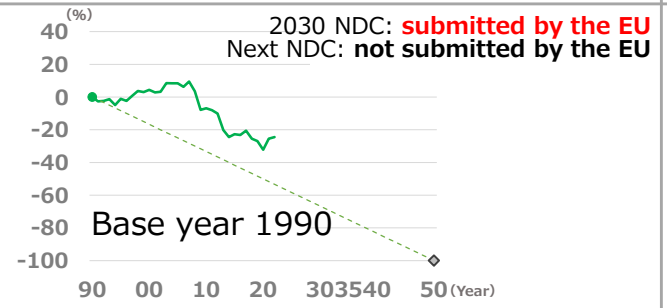
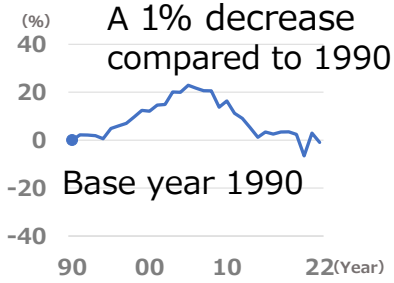
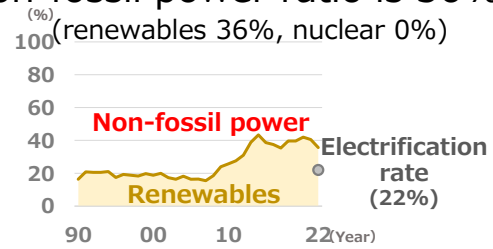
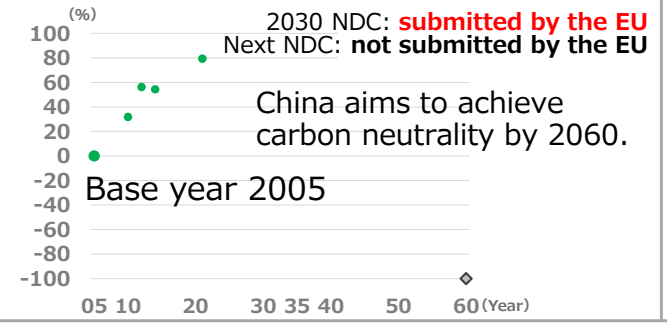
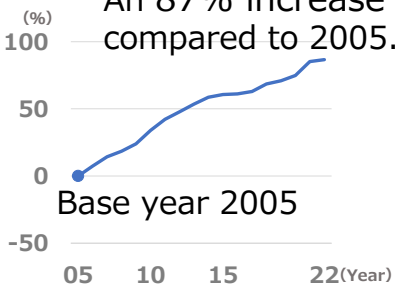
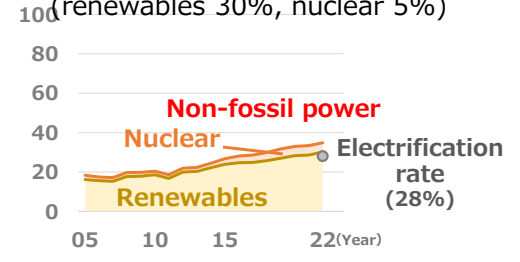
Note: The greenhouse gas (GHG) emission reduction targets and actual emissions of each country are calculated considering the emissions and absorption in the land use, land-use change, and forestry (LULUCF) sector. The base year and reference year for the reduction rate of final energy consumption are aligned with the base year and reference year of each country's Nationally Determined Contributions (NDCs). For Japan's fiscal year 2023, the data is based on comprehensive energy statistics and information published by the Ministry of the Environment. The electrification rate differs due to varying assumptions in energy conversion standards between the IEA and comprehensive energy statistics.

Trends and Background in Achieving Carbon Neutrality in 10 Major Countries/Regions (2)

2022	GHG emission reduction rate: targets and progress	Background (1): reduction rate of final energy consumption	Background (2): non-fossil power ratio (renewables+nuclear)
UK **400 million tons GHG** **6.0 tons GHG per person**	2030 NDC: **submitted** 2035 NDC: **submitted** 		• Non-fossil power ratio is 57% (renewables 42%, nuclear 15%) 
Korea **700 million tons GHG** **13.2 tons GHG per person**	2030 NDC: **submitted** Next NDC: **not submitted** 		• Non-fossil power ratio is 36% (renewables 7%, nuclear 29%) 
Canada **800 million tons GHG** **19.5 tons GHG per person**	2030 NDC: **submitted** 2035 NDC: **submitted** 		• Non-fossil power ratio is 82% (renewables 69%, nuclear 13%) 

Note: The greenhouse gas (GHG) emission reduction targets and actual emissions of each country are calculated considering the emissions and absorption in the land use, land-use change, and forestry (LULUCF) sector. For Korea, the latest data on GHG emissions submitted to the UNFCCC is from 2021, so the GHG emission reduction rate is reported up to 2021. For years prior to 2021, only the years in which GHG emissions were submitted to the UNFCCC are listed. The base year and reference year for the reduction rate of final energy consumption are aligned with the base year and reference year of each country's Nationally Determined Contributions (NDCs).

Trends and Background in Achieving Carbon Neutrality in 10 Major Countries/Regions (3)

2022	GHG emission reduction rate: targets and progress	Background (1): reduction rate of final energy consumption	Background (2): non-fossil power ratio (renewables+nuclear)
France 400 million tons GHG 5.5 tons GHG per person			• Non-fossil power ratio is 87% (renewables 24%, nuclear 63%) 
Germany 800 million tons GHG 9.0 tons GHG per person			• Non-fossil power ratio is 50% (renewables 44%, nuclear 6%) 
Italy 400 million tons GHG 6.6 tons GHG per person			• Non-fossil power ratio is 36% (renewables 36%, nuclear 0%) 
China 13 billion tons GHG 9.2 tons GHG per person			• Non-fossil power ratio is 35% (renewables 30%, nuclear 5%) 

Note: The greenhouse gas (GHG) emission reduction targets and actual emissions of each country are calculated considering the emissions and absorption in the land use, land-use change, and forestry (LULUCF) sector. For China, the latest data on GHG emissions submitted to the UNFCCC is from 2021, so the GHG emission reduction rate is reported up to 2021. For years prior to 2021, only the years in which GHG emissions were submitted to the UNFCCC are listed. The base year and reference year for the reduction rate of final energy consumption are aligned with the base year and reference year of each country's Nationally Determined Contributions (NDCs).