Systems Analysis Group

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Research Activities in Systems Analysis Group

The Systems Analysis Group aims to provide valuable information about response measures to global warming and energy issues through systematic approaches and analyses at both national and international levels.

The Government of Japan formulated the 7th Strategic Energy Plan[1)], the Plan for Global Warming Countermeasures[2)], and the GX2040 Vision[3)], and these were approved by the Cabinet in February 2025. Greenhouse gas (GHG) emissions reduction targets as Nationally Determined Contributions (NDCs) for 2035 and 2040 were set at reductions of 60% and 73%, respectively, compared to FY2013 levels, and were submitted to the UNFCCC Secretariat as Japan's NDC on February 18. Globally, many countries submitted their NDC3.0, which outlines emissions reduction targets for 2035 and 2040 around the time of COP30 in November 2025. The Systems Analysis Group conducted scenario analyses for the formulation of the 7th Strategic Energy Plan in FY2024, and carried out further expanded analyses in this fiscal year. In addition, while reviewing the status of emissions reduction targets in the latest NDCs, analyses and evaluations of emissions reduction efforts were conducted using multiple indicators. This report explains these scenario analyses and evaluations.

1. Sensitivity analysis of energy supply and demand scenarios for the 7th Strategic Energy Plan

The Government of Japan revised the Plan for Global Warming Countermeasures in February 2025 and set GHG emissions reduction targets as NDCs for 2035 and 2040 at reductions of 60% and 73%, respectively, compared to FY2013 levels, and also submitted them to the UNFCCC Secretariat on February 18. These targets correspond to a linear reduction path from the already submitted 46% reduction by 2030 to net-zero emissions (100% reduction) by 2050. While keeping exiting reduction targets and advancing responses to climate change, a pathway was selected that also responds to increasingly complex international circumstances. Furthermore, in the outlook of energy supply and demand in the 7th Strategic Energy Plan, a scenario in which emissions are higher was also presented as a response to economic risks. Meanwhile, global emissions continue to rise, and international conditions are becoming increasingly chaotic. The Russia–Ukraine war has prolonged, and in February 2026, the United States and Israel attacked Iran, intensifying tensions in the Middle East. The US Trump administration formally withdrew from the Paris Agreement in January 2026, and further declared withdrawal from the UNFCCC itself. Also, in February, it announced repeal of the GHG "endangerment finding", which had served as the legal basis for various emissions reduction policies.

Global climate change countermeasures are becoming increasingly fragmented. In aiming to achieve global carbon neutrality (CN), increasing differences in ambition and policy strength among countries make mitigation efforts more difficult. Climate change countermeasures are an urgent issue. However, in a situation without international cooperation on emissions reduction, even if domestic emissions reduction efforts are strengthened, reductions may be realized not through progress in climate policy but through declines in production activity and industrial leakage overseas. In such a case, even if domestic emissions decrease, global emissions will not decrease.

RITE conducted scenario analysis in FY2024, which was used as a major reference for the energy supply and demand outlook of the 7th Strategic Energy Plan[4),5)]. In that analysis, the "Risk Strategy Scenario" (regarded as the "Technology Improvement Scenario" by the government) was also adopted as a risk response scenario. However, under such international conditions, the importance of conducting broader scenario analysis has increased. Therefore, further expanded analysis was conducted based on the "Risk Strategy Scenario" presented for the formulation of the 7th Strategic Energy Plan.

1.1. Methodology

As in the analysis for the 7th Strategic Energy Plan, analysis was basically conducted using the DNE21+ model[6),7),8)]. Figure 1 shows the analysis flow.

The DNE21+ model is a partial equilibrium energy supply and demand model in which production volumes of energy-intensive industries (such as crude steel) and transport service demand are assumed exogenously. However, it has been observed that overseas relocation of energy-intensive industries has been progressing, and in future CO_2 emissions reductions, it is highly possible that production activity levels of energy-intensive industries themselves will change (decline in Japan) due to relative price changes with overseas markets induced by international differences in CO_2 emissions reduction stringency. Therefore, analysis was conducted incorporating the effect of reduced production volumes in energy-intensive industries that may be induced by international differences in CO_2 emissions reduction stringency. In this analysis, the global energy-economic model DEARS[9),10)] was basically used. On the other hand, there is a possibility that price elasticity has increased especially in developed countries, and therefore, analysis assuming higher price elasticity was also conducted for the "Low Growth Scenario". The calculations were performed again using DNE21+ with the updated prerequisites based on the estimated results of production declines.

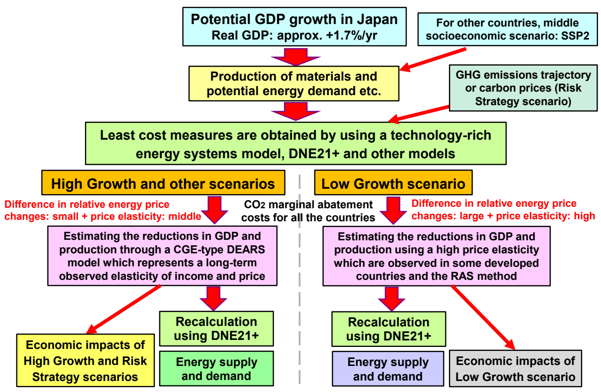

Figure 1 Estimation procedure for economic impacts and energy systems

1.2. Scenario assumption

Analysis was conducted for the seven scenarios shown in Table 1.

The "High Growth Scenario" assumes broad and significant technological progress. In contrast, scenarios in which only certain technologies progress successfully are the "Renewables," "Hydrogen," and "CCS" scenarios. All of these scenarios assume linear emissions reductions from a 46% reduction in 2030 to CN in 2050, and a 73% reduction in 2040. The targets of a 60% reduction in 2035 and a 73% reduction in 2040 (both compared to 2013 level) were submitted as Japan's NDC to the UNFCCC Secretariat in February 2025.

The "Low Growth Scenario" assumes that all technologies progress only along an extension of current trends. As can be understood from the analysis results described later, the impact on Japan's economy under this "Low Growth Scenario" is extremely large. Due to rising relative energy prices compared to overseas, energy-intensive industries may fall behind in international competition, and significant declines in production volumes may be expected. The government's GX policy aims to achieve a virtuous cycle between the environment and the economy, and a situation in which GHG emissions are significantly reduced but the economy is severely damaged must be avoided. Moreover, in such a case, even if domestic emissions are reduced, energy-intensive industries would increase their activities overseas, and global emissions would likely not decrease.

It should be noted that even in the "Low Growth Scenario," technological progress along the current trends is assumed, and given the recent economic downturn in Germany, for example, this scenario represents a sufficiently high risk of occurrence. Therefore, as a risk response strategy in the case where innovative technological progress does not occur, the "Risk Strategy Scenario" was also presented, in which strict achievement of domestic GHG emissions targets is not required so as to avoid excessively widen relative energy price differences. In this scenario, a carbon price level equivalent to that in a 1.5°C scenario is assumed, and Japan's emissions are calculated based on the model's economic calculation. As a result, in the "Risk Strategy Scenario," the targets of a 73% reduction in 2040 and CN in 2050 are not achieved; instead, emissions are reduced by 61% in 2040 and 79% in 2050.

Amid the increasing fragmentation of climate change countermeasures in recent years, relative energy price differences are more likely to widen further. Therefore, in FY2025, scenarios were analyzed assuming even lower carbon price levels than in the "Risk Strategy Scenario," namely the "High-risk Scenario" and the "Stated Policies Scenario." As will be described later in detail, the former adopts the carbon prices assumed in the International Energy Agency (IEA)'s Net Zero by 2050 (NZE) scenario, and the latter adopts the carbon prices assumed in the IEA's Stated Policies Scenario (STEPS).

The above scenarios are illustrated in Figure 2.

Table 1 Assumed scenarios

Emissions scenarios	Scenario name	Scenario descriptions
Emissions reduction scenarios: 2030: -46% 2040: -73% 2050: -100% [World] Below 1.5 °C	**High Growth** [Innovative technology expansion]	Broad mitigation technologies advance rapidly and expand internationally. Gaps between the relative prices of energy in Japan and other countries are moderate. A virtuous cycle between the economy and the environment.
	Renewables [Renewable expansion]	High social acceptance and rapid cost reduction of renewables
	Hydrogen [Hydrogen and new fuels deployment]	Rapid cost reductions in hydrogen, including ammonia, e-methane, and e-fuels
	CCS [CCS deployment]	Lower social barriers to geological CO_2 storage
	Low Growth [-]	Incremental technology improvements. The relative prices of energy in Japan will increase. Relocation of industries to abroad, an emerging risks for economic stagnation
Carbon price scenarios: Risk-responding scenario with a virtuous cycle between the economy and the environment under the uncertainties of technology improvements. -73% in 2040 and CN in 2050 as policy targets, but focused more on mitigation costs, leading to changes in the emissions under uncertainties	**Risk Strategy** [Technology Improvement]	Technology improvements are conservative, leading to the increase in relative energy prices in Japan. Restrictive carbon price policies are taken to maintain a virtuous cycle of the economy and the environment. Carbon prices are assumed based on the NGFS NZE2050 scenarios.
	High-risk Strategy [-]	Same as above, except for the assumption of the carbon price which refers to the IEA NZE
Carbon price scenario: Enhanced priority on the economy. Withdrawal from 1.5 °C and CN by 2050. Only pledged policies are implemented.	**Stated policies scenario** [-]	Same as above, except for the assumption of the carbon price which refers to the IEA STEPS

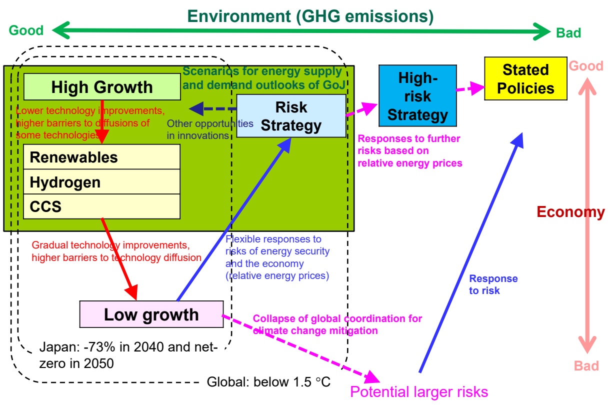

Figure 2 Map of the assumed scenarios

1.3. Assumption on technology scenarios and model preconditions

The assumptions for individual technologies in each scenario are as shown in Table 2, consistent with the scenario analysis conducted for the 7th Strategic Energy Plan. For details of the model preconditions and scenario assumptions, refer to References 4) and 11).

As mentioned earlier, except for the "Low Growth Scenario," reductions in production volumes of energy-intensive industries were, in principle, estimated using the global energy-economic model DEARS and then fed back into the DNE21+ model for calculation. On the other hand, for the "Low Growth Scenario," analysis was conducted assuming a relatively high long-term price elasticity value of −1.0.

Table 2 Scenario assumption for technologies

Scenarios	Potential economic growth	GHG emissions	Nuclear	Renewables		CCS／CDR	Hydrogen/ammonia	e-fuels/e-methane	IT electricity demands	Automobiles	Iron and steel	
	Income, population, and baseline industrial structure changes	Carbon prices due to emissions reduction	[Upper bound] Low: Existing 60 yrs operation reators only/ Mid: 20% in 2040; 10% in 2050/ High: 20%	[Upper potential considering social acceptance] Low: double of the current deployment level of solar PV, and three times for onshore wind power/ High: four times as the current deployment levels both of PV and onshore wind power	[Cost] Mid./ Rapid cost red.	[Upper bound] Annual potentials of geological storage (2050) Low: 0.12 Gt/ High: 0.24 Gt	[Cost] Mid./ Rapid cost red.	[Cost] Mid./ Rapid cost red.	Exogenous outlook	[EV cost] Mid./ Rapid cost red.	Diffusion constraints of hydrogen DRI	EITE and car production reductions due to energy price increase including relative prices
High growth	The official ambitious target by the GoJ	[World] 1.5℃ target [Japan] 2030: -46% 2040: -73% 2050: -100%	High	High (Economical potential: Mid)	Rapid cost red.	High	Rapid cost red.	Rapid cost red.	High	Rapid cost red.	High	Low (mid. price elasticity (CGE model: DEARS))
Renewables			Mid	High (Economical potential: Mid)	Rapid cost red.	Low	Mid	Mid	High	Rapid cost red.	High	
Hydrogen			Mid	High	Mid	Low	Rapid cost red.	Rapid cost red.	High	Mid	High	
CCS			Mid	High	Mid	High	Mid	Mid	High	Mid	High	
Low growth (Ref.)			Low	Low	Mid	Low	Mid	Mid	Mid	Mid	Mid	High (high price elasticity +RAS)
Risk strategy		Carbon price: NGFS NZ2050	Mid	High	Mid	Low	Mid	Mid	High	Mid	Mid	Low

1.4. Results of scenario analysis

(1) Global emissions and temperature rise

This section presents the model analysis results for the assumed scenarios.

First, Table 3 summarizes the emission reduction rates of global emissions in 2040, the timing of achieving net-zero CO_2 emissions globally, and temperature increases for the analyzed scenarios. The scenarios with a 73% reduction in 2040, including the "High Growth Scenario" adopted in the government's Strategic Energy Plan, as well as the "Risk Strategy Scenario," show a peak temperature increase of 1.7°C, which correspond to 1.5°C scenarios with temperature overshoot, and are consistent with the current recognition, such as statements by the UN Secretary-General António Guterres that temperature overshoot is unavoidable.

In the "High-risk Strategy Scenario," the temperature increase in 2100 is 2.4°C, while in the "Stated Policies Scenario," it is 3.2°C. Global emissions do not achieve net zero by 2100 in both scenarios. These levels are close to the UNEP estimate of 2.6°C (range: 1.9-3.6°C) under current policy continuation.

Table 3 Global emissions and temperature rise

		GHG emissions reduction in 2040 (relative to 2019)	Net-zero timing of CO2 emissions	Temperature rise compared with the pre-industrial level	
				Peak	2100
IPCC C1：1.5℃ with no or limited overshoot		69 [58–90] %	2050–55	1.6℃ [1.4–1.6]	1.3℃ [1.1–1.5]
IPCC C2：1.5℃ with high overshoot		55 [40–71] %	2055–60	1.7℃ [1.5–1.8]	1.4℃ [1.2–1.5]
Scenarios in this analysis	**-73% in 2040 and net-zero in 2050**	62 % (energy CO2：71–72%)	2050–55	1.7℃	1.4℃
	Carbon price scenario (Risk strategy)	52 % (energy CO2：54%)	2050–55	1.7℃	1.5℃
	Carbon price scenario (High-risk strategy)	24% (Energy CO2：8%)	— (2100-)	2.4℃	2.4℃
	Stated policies scenario	1% (Energy CO2：-28%)	— (2100-)	3.2℃	3.2℃

(2) Costs and economic impacts

Table 4 shows the marginal abatement costs of CO_2, and Table 5 shows the marginal costs of electricity.

Looking at the marginal abatement costs of CO_2, even under the "High Growth Scenario," it is analyzed that achieving a 73% reduction by 2040 and CN by 2050 would require considerably high costs. It is also considered that further innovation beyond what was assumed in this analysis would be necessary for realization.

In the "Low Growth Scenario," even greater increases in CO_2 marginal abatement costs and electricity costs are estimated. In addition, in comparison with other countries, it is confirmed that the electricity price gap widens in relative price terms. It should be noted that this analysis assumes achieving less than 1.5°C globally;

however, in reality, the world is heterogeneous, and some countries may implement only measures close to baseline levels. In such cases, the electricity price gaps between Japan and other countries under the “Low Growth Scenario” could widen even further. Therefore, it is important to consider flexible responses in emissions reductions to some extent.

The “Risk Strategy Scenario” is designed to respond to such situations. In this scenario, as described earlier, a carbon price equivalent to that in a 1.5°C scenario is assumed globally, resulting in uniform CO_2 marginal abatement costs (carbon prices) worldwide, which are slightly lower than those in the “High Growth Scenario.” In the “Risk Strategy Scenario,” which assumes continuing the current pace of technological progress, because the scenario assumes carbon prices rather than emission constraints, energy costs and electricity costs remain at levels comparable to the “High Growth Scenario.” In comparison with other countries, although electricity prices increase compared to current levels in all scenarios due to emissions reduction measures, the relative price gap with overseas does not widen significantly.

The “High-risk Strategy Scenario” and the “Stated Policies Scenario” refer to the carbon prices in IEA scenarios. Japan’s carbon prices in 2040 are estimated at 116 USD/tCO_2 and 41 USD/tCO_2, respectively (equivalent to 12,800 yen/tCO_2 and 4,500 yen/tCO_2 assuming an exchange rate of 1 USD = 110 yen). The upper and lower bounds of the GX-ETS carbon prices in 2026 are set at 1,700-4,300 yen/tCO_2 (with an annual increase of 3% in real terms), and the assumed carbon prices in these scenarios are considered to be close to these levels. The marginal electricity costs in 2040 is estimated to remain almost unchanged compared to 2020 in the “High-risk Strategy Scenario”, while they slightly decrease due to reductions in renewable energy costs in the “Stated Policies Scenario.”

Table 4 Marginal abatement costs of CO_2 emissions

		Emissions reduction scenario (-73% in 2040)					Carbon prices scenario		
		High growth	Renew ables	Hydrogen	CCS	Low growth	Risk strategy	High risk strategy	Stated policies
Japan	2040	301	369	467	396	538	257	116	41
	2050	578	716	742	892	951	500	141	50
US	2040	294	350	409	362	410	257	116	0
	2050	262	348	454	350	467	500	141	0
UK	2040	294	350	419	369	428	257	116	84
	2050	317	387	558	452	579	500	141	89
EU	2040	298	350	409	362	410	257	116	84
	2050	413	516	648	541	664	500	141	89
Others	2040	294	350	409	362	410	257	20～116	0～84
	2050	262	348	454	350	467	500	31～141	0～89

Unit: USD/tCO_2 (in 2000 price)

Table 5 Marginal costs of electricity in 2040

	2020	Base line	Emissions reduction scenario (-73% in 2040)					Carbon prices scenario		
			High growth	Renew ables	Hydro gen	CCS	Low growth	Risk strategy	High risk strategy	Stated policies
Japan	166	127	212	224	251	242	311	213	168	141
US	40	38	98	118	125	116	126	127	86	43
UK	114	135	180	195	223	203	222	201	168	158
Germany	114	119	175	191	202	198	204	194	158	148
France	114	113	171	165	172	173	173	174	170	160
Korea	103	103	174	173	194	195	194	184	145	123
China	61	66	143	152	213	192	213	173	103	71
India	105	121	187	190	236	239	237	223	165	121

Unit: USD/MWh (in 2000 price)
Note) The prices are the generation output terminal prices but including the grid integration costs.
The 2020 prices are also estimated using the model.

Table 6 shows the estimates of production volumes and GDP declines calculated using the global energy-economic model DEARS for the “High Growth Scenario,” “Low Growth Scenario,” and “Risk Strategy Scenario.” It also presents economic growth projections including the effects of overseas diffusions of mitigation technologies and products.

In the “High Growth Scenario,” rapid technological progress is assumed; however, due to the stringent emissions reduction targets of a 73% reduction by 2040 and CN by 2050, GDP is projected to decline by 4.1% in 2040 and 5.6% in 2050. In the iron and steel sector, production declines by 3.9% in 2040 and 11% in 2050 (for example, the potential crude steel production in 2050 is estimated at 90 million tons per year, but declines by 11% to 80 million tons per year). However, if the world moves toward the 1.5°C target, there is also the potential to capture overseas markets. Although there is significant uncertainty in the estimates, an increase of about 5 percentage points per year is projected. Therefore, this scenario could achieve economic growth roughly at the level of potential growth (slightly positive in 2040; the economic growth rate for 2023–2040 is estimated at 1.5% per year, incorporating population decline effects).

In the “Low Growth Scenario,” where technological progress remains gradual, it is possible that Japan is placed in a situation where access to relatively low-cost decarbonized energy is even more limited compared to overseas, resulting in wider relative energy price gaps with other countries and large-scale industrial relocation overseas. In the iron and steel and chemical industries, extremely large declines in production volumes of around 40% compared to the baseline are estimated. Similarly, in the automobile industry (transport equipment), similar level of production decline is estimated. Overall GDP is also projected to decline significantly by around 13–14%. If emissions reductions are pursued linearly toward CN by 2050 without substantial technological progress, a situation similar to that shown in the “Low Growth Scenario” could plausibly occur.

In the “Risk Strategy Scenario,” technological progress is assumed to be similar to that in the “Low Growth Scenario” rather than rapid as in the “High Growth Scenario,” and the economic impact is estimated to be not significantly different from that of the “High Growth Scenario” while emissions increase relative to targets. Avoiding major declines in economic activity and industrial relocation due to carbon constraints is important, and this scenario represents one that can respond to such risks.

In the “High-risk Strategy Scenario,” because carbon prices are low, negative impacts on the economy can be significantly suppressed compared to other scenarios. On the other hand, since emissions reductions abroad also do not progress, the effect of the international advantages of mitigation technologies in Japan is smaller than in other scenarios. As a result, when including overseas market acquisition effects, the overall economic impact will be at a level similar to that of the “Risk Strategy Scenario” and the “High Growth Scenario.”

Table 6 GDP and major manufacturing industries in Japan

Reduction ratios in productions/value added	High Growth (DEARS)		Low Growth (price elasticity: -1.0, income elasticity: +1.0, and RAS)		Risk Strategy (DEARS)		High-Risk Strategy (DEARS)	
	2040	**2050**	**2040**	**2050**	**2040**	**2050**	**2040**	**2050**
Iron and steel	-3.9%	-11.0%	-41%	-46%	-3.6%	-11.0%	-2.8%	-2.1%
(production [million ton/yr])	(0.86)	(0.80)	(0.53)	(0.49)	(0.86)	(0.80)	(0.87)	(0.88)
Chemical	-3.7%	-11.2%	-35%	-40%	-3.3%	-10.7%	-2.1%	-1.7%
Non-metal materials	-2.1%	-2.7%	-30%	-34%	-1.7%	-3.8%	-0.9%	-0.6%
Non-ferrous metals	-1.4%	-2.7%	-35%	-39%	-1.2%	-5.0%	-0.8%	-0.2%
Paper and pulp	-3.5%	-6.3%	-33%	-37%	-3.1%	-7.2%	-1.5%	-1.7%
Transport machinery	-4.1%	-6.9%	-42%	-47%	-4.7%	-8.2%	-1.6%	-2.0%
GDP (excluding the overseas diffusion effects)	-4.1%	-5.6%	-13%	-14%	-3.6%	-5.9%	-1.8%	-2.1%
GDP/GNI (including the overseas diffusions particularly of mitigation technologies/ products)	Approximately same of the potential economic growth (oversea effects:+4% to +5%)		Less expectation on the overseas additional effects of economic increase		Approximately same of the potential economic growth (oversea effects:+3% to +4%)		Approximately same of the potential economic growth (overseas effects:+1%)	
Annual growth in GDP/GNI since 2023 (including future population decrease)	+1.5%/yr	+1.2%/yr	+0.6%/yr	+0.7%/yr	+1.4%/yr	+1.2%/yr	+1.4%/yr	+1.2%/yr

(3) Japan’s emissions

Figure 3 shows GHG emissions by sector in Japan. As noted earlier, emissions are estimated to be reduced by 61% in 2040 and 79% in 2050 in the “Risk Strategy Scenario.” The reductions are 52% in 2040 and 63% in 2050 in the “High-risk Strategy Scenario,” while reductions remain at 41% in 2040 and 45% in 2050 in the “Stated Policies Scenario,”.

In the “High-risk Strategy Scenario” and the “Stated Policies Scenario,” hydrogen-based direct reduction steelmaking is not economically viable even in 2050, and the blast furnace–basic oxygen furnace method remains economically efficient. Consequently, a considerable amount of emissions remains in the iron and steel sector.

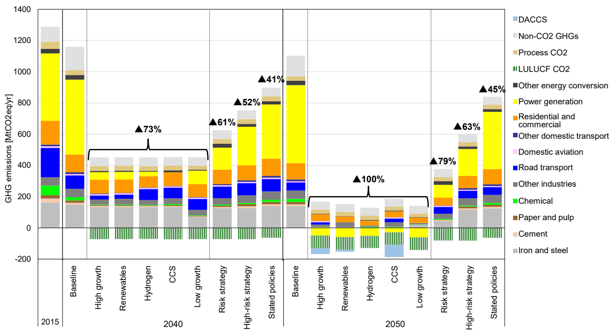

Figure 3 GHG emissions by sector

(4) Japan's energy supply and demand

Figure 4 shows electricity generation in Japan. Electricity generation increases in all scenarios except for the "Low Growth Scenario." Under the 73% reduction scenario for 2040, since non-CO_2 GHGs and other hard-to-abate industrial sectors remain, achieving near-zero emissions in the power generation sector is economical. A combination of renewable energy, nuclear power, and CCS is found to be economically optimal. The share of renewable energy in 2040 is estimated to be around 40–50%, and it is slightly lower at around 35% in the "Risk Strategy Scenario." In 2050, a notable increase in floating offshore wind power is observed.

Electricity demand is expected to essentially increase due to factors such as IT demand. However, if energy prices become relatively high, it becomes necessary to suppress energy consumption while production volumes decline, including through industrial relocation overseas. Investment in economically efficient power sources often requires long lead times. Therefore, in order to avoid tight electricity supply-demand conditions, it can be said that highly predictable energy and climate policies that prevent the realization of the "Low Growth Scenario" are important.

In the "Risk Strategy Scenario," the share of LNG-based power generation (including cogeneration and CCS-equipped systems) remains at approximately the current level until 2050 as an economically efficient outcome. In the "Stated Policies Scenario," coal-fired power generation remains economically viable, while the economic potential of renewable energy is significantly constrained.

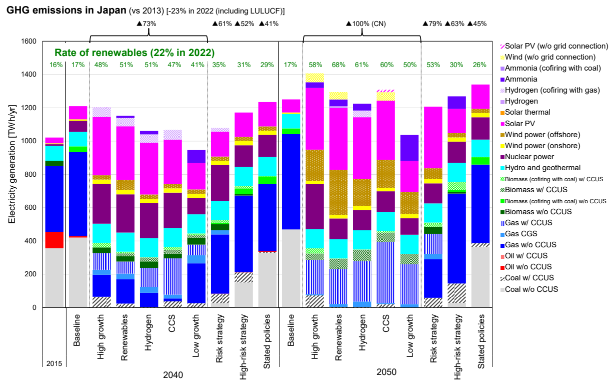

Figure 4 Electricity supply

Figure 5 shows final electricity consumption by sector. In the "High Growth Scenario," final electricity consumption is 1,081 TWh/year in 2040 and 1,210 TWh/year in 2050. The demand is expected to be significantly suppressed due to high energy prices in the "Low Growth Scenario." In the "High-risk Strategy Scenario" and the "Stated Policies Scenario," electrification is somewhat suppressed due to low level of carbon prices, however, energy-saving effects are also weaker, resulting in relatively high levels of final electricity consumption.

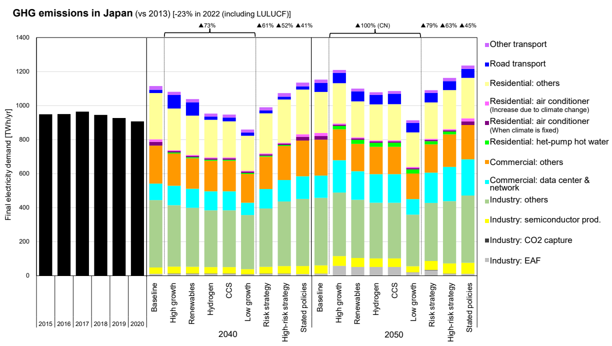

Figure 5 Final electricity demand by sector

Figure 6 shows total final energy consumption. Increasing the electrification rate is an economically efficient measure. However, complete electrification is not economical in any sector, and a combination of hydrogen, ammonia, synthetic methane (e-methane), synthetic fuels (e-fuels), and biofuels is considered economically optimal.

For total final energy consumption, the electrification rate in 2040 is estimated to be 38–44% under the 73% reduction scenarios, and 54–57% under CN in 2050. Total final energy consumption in 2040 is estimated to decrease by 26–28% compared to 2015 under the 73% reduction scenarios, and by 36–41% in 2050 under CN.

In the "High-risk Strategy Scenario" and the "Stated Policies Scenario," relatively high total final energy consumption is estimated as carbon price level is low.

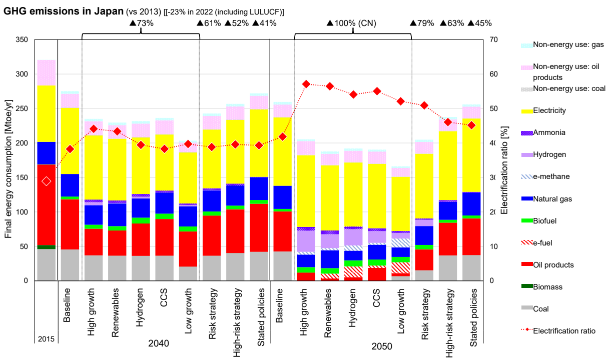

Figure 6 Final energy consumption by fuel type

2. Analysis and evaluation of 2035 emissions reduction targets (NDCs)

2.1. Status of emissions reduction targets in NDCs

A pledge-and-review mechanism was adopted in the Paris Agreement in order to encourage participation from many countries, which established a framework in which nearly all countries undertake emissions reduction efforts. Under the Paris Agreement, all countries determine their own targets and methods for achievement and submit them as Nationally Determined Contributions (NDCs) every five years (Article 4, paragraphs 2 and 9). When revising targets, countries are required to make progression beyond their previous targets (Article 4, paragraph 3). In addition, to promote effective implementation, all countries are required to report their implementation status and undergo review in a transparent manner using common and flexible methods (Article 13). For the Paris Agreement to effectively achieve emissions reductions, it is considered important how appropriately the review process can be implemented. However, as the appropriateness or inadequacy of each country' s NDC is not subject to review under the review procedures decided at COP24, evaluation outside the UNFCCC framework is considered important.

RITE previously analyzed emissions reduction efforts using various indicators for the Intended Nationally Determined Contributions (INDCs) submitted before the Paris Agreement in FY2015. Furthermore, in FY2021, a similar analysis was conducted for the NDCs submitted to the UN by November 11. Subsequently, around COP30 in November 2025, many countries submitted NDC3.0, including emissions reduction targets for 2035 (and for some countries and regions, including Japan, also for 2040). Based on this, in FY2025, analysis and evaluation of emissions reduction efforts focusing on NDC3.0 were conducted.

Table 7 shows the emissions reduction targets of NDC3.0 submitted to the UN by December 31, 2025, as well as the status of published NDCs and CN declarations (only selected countries are shown).

Developed countries, including Japan, present enhanced emissions reduction targets compared to their 2030 targets in NDC3.0. Meanwhile, China, which had previously set CO_2 intensity targets, has expanded the scope to GHGs and presented an absolute emissions reduction target of 7–10% below peak level.

Table 7 Emissions reduction targets in major countries' NDCs

	2030 NDC	2035 NDC	2040 NDC	2050 -
Japan	-46% (vs 2013)	-60%	-73%	CN by 2050
US※1	-50% to -52% (vs 2005)	-61% to -66%	—	CN by 2050
EU27	-55% (vs 1990)	-66.25% to -72.5%	-90%	CN by 2050
UK	-68% (vs 1990)	-81%	—	CN by 2050
Switzerland	-50% (vs 1990)	At least -65%	At least -75%	CN by 2050
Norway	-55% (vs 1990)	-70% to -75%	—	Low emission society by 2050
Australia	-43% (vs 2005)	-62% to -70%	—	CN by 2050
New Zealand	-50% (vs 2005)	-51% to -55%	—	CN by 2050 (w/o methane)
Canada	-40% to -45% (vs 2005)	-45% to -50%	—	CN by 2050
Russia	-30% (vs 1990)	-65% to -67%	—	CN by 2060
Korea	-40% (vs 2018)	-53% to -61%	—	CN by 2050
China※2	-65% CO_2 emissions per GDP (vs 2005)	-7% to -10% vs GHG emissions peak (peaking before 2030)	—	CN by 2060
India	-45% GHG emissions per GDP (vs 2005)	—	—	CN by 2070

※1 Submitted by the Biden administration. Withdrawn from the Paris agreement on Jan. 26, 2026.
※2 Evaluated with the 2030 baseline emission estimated by the DNE21+ as the peak.

2.2. Evaluation of emissions reduction efforts in NDCs

(1) Indicator and methodology for evaluation

It is important to properly review emissions reduction targets pledged by each country in their NDCs. Given differences in national circumstances, it is important to evaluate emissions reduction efforts in a way that ensures comparability while taking these differences into account, and therefore, it is necessary to select appropriate indicators and measure emissions reduction efforts accordingly. In this study, evaluation was conducted using the indicators described below based on previous research[12)].

Measuring emissions reduction efforts is considered important for establishing a PDCA (Plan–Do–Check–Act) cycle. The principles for comparability metrics are described in Reference 13) as below.

- Comprehensive: capturing efforts comprehensively
- Measurable: capable of being measured
- Replicable: reproducible and transparent
- Universal: applicable to as many countries as possible

Furthermore, since no single indicator can uniquely determine fairness or equity, it is necessary to conduct a multifaceted evaluation using multiple indicators.

In this study, the evaluation of "emissions reduction effort" in NDC targets adopts the same methodology as used in the 2015 evaluation, selecting indicators summarized in Table 8 so that efforts can be appropriately assessed despite differences in national capabilities and mitigation potentials. The methodology described here has also been adopted as a peer-reviewed literature in Reference 14), and in addition, indicators not explicitly included in that study (such as per capita emissions) are also adopted and evaluated here.

Table 8 Evaluation indexes adopted in this study

Indicators for emissions reduction efforts		Overview	Notes
Emissions reduction ratio from the base year	Relative to 1990, 2005, 2013, etc.	When baseline emissions are expected to stagnate, it is more relevant to simply compare the projected reduction rates, which makes it possible to avoid uncertainties in the estimation for baseline emissions.	Comparison based on each country's base year should be conducted.
	Relative to latest possible year, such as 2019		It is good as a measure for evaluating future reduction efforts since reduction ratios based on the most recent results are shown.
Emissions per capita	Absolute level	To show the level of GHG emissions per capita.	As this is highly dependent on the country's level of economic activity and situation in general, assessing emissions reduction efforts through this indicator can be difficult.
GHG emissions per unit of GDP (CO_2 intensity)	Absolute level	To show the level of GHG emissions considering a scale of economic activities.	Values tend to be higher for low-GDP countries, and highly dependent on industrial structure.
	Improvement rate (e.g. compared to 2019, etc.	Using the rate of change might be assessed as an aspect of the emissions reduction efforts, as the differences of economic growth rate can be removed.	Countries with low-GD tend to show better improvement rate of intensity due to high GDP growth rates.
Emissions reduction ratio compared to baseline emissions		Differences in economic growth can be taken into account.	It excludes past efforts in energy saving and the abatement potential of renewables.
CO_2 marginal abatement cost (carbon price)		This is highly relevant for assessing reduction efforts, as it reflects national differences in terms of economic growth, energy savings efforts and the abatement potential of renewables.	Existing measures such as energy taxes are considered out of scope (however, if energy saving effects have already been achieved, they may be taken into consideration as the MAC is estimated to be high).
Emission reduction costs per GDP		While marginal abatement costs do not take into account the economy's ability to bear the necessary burden, this indicator is sensitive to that.	Uncertainties are high as this is a model-based estimation.

Below are several points to note in evaluating emissions reduction efforts in NDCs.

- There is significant uncertainty in emissions projections and reductions related to Land Use, Land-Use Change, and Forestry (LULUCF), making evaluation difficult; therefore, this study basically does not address them.
- For countries that have submitted emissions reduction targets relative to a base year, the emissions for the target year are calculated based on actual emissions in the base year (excluding LULUCF).
- For countries that have submitted GDP intensity improvement targets, evaluation is conducted based on RITE's assumptions for future GDP.
- For countries that have submitted reduction targets relative to BAU (Business-As-Usual), when BAU emissions are specified in the NDC, total emissions for the

evaluation year are calculated based on those values.

(2) Results of analysis and evaluation of emissions reduction efforts

Figure 7 shows a comparison of the emissions reduction ratio in 2035 compared to the base year of 2013. Table 9 summarizes emissions reduction ratio in 2035 compared to 1990, 2005, 2013, and 2021 for major countries.

In terms of reductions relative to 2013, Norway shows the highest reduction rate, followed by the United Kingdom and Australia. On the other hand, countries expected to experience significant economic growth in the future may appear disadvantaged when evaluated based on reductions relative to a base year. Thus, while this indicator is very simple, it is considered inappropriate for evaluating emissions reduction efforts, especially when including developing countries.

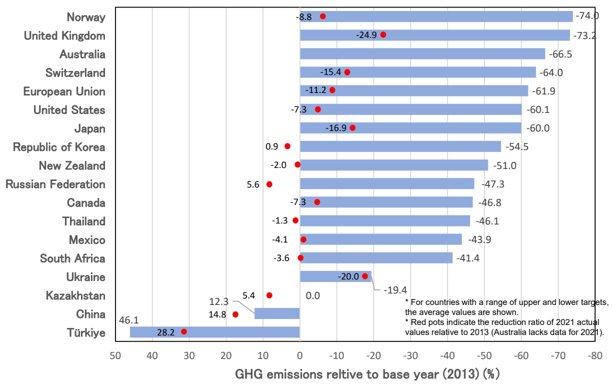

Figure 7 GHG emissions reduction ratio in 2035 relative to the base year of 2013

Table 9 GHG emissions reduction ratio in 2035 relative to the base year

	Emissions reduction ratio from the base year			
	1990	2005	2013	2021
Japan: -60% vs 2013 (-73% vs 2013 in 2040) *1	-56% (-70%)	-59% (-73%)	-60% (-73%)	-52% (-68%)
US: -61% to -66% vs 2005	-55% to -61%	-61% to -66%	-57% to -63%	-54% to -60%
EU27: -66.25% to -72.5% vs 1990 (-90% vs 1990 in 2040) *1	-66.25% to -72.5% (-90%)	-64% to -71% (-89%)	-58% to -66% (-88%)	-53% to -61% (-86%)
UK: -81% vs 1990	-81%	-78%	-73%	-64%
Switzerland: -65% vs 1990 (-75% vs 1990 in 2040) *1	-65% (-75%)	-66% (-76%)	-64% (-74%)	-57% (-70%)
Norway: -70% to -75% vs 1990	-70% to -75%	-72% to -77%	-72% to -76%	-69% to -74%
Australia: -62% to -70% vs 2005	-53% to -63%	-62% to -70%	-63% to -70%	n/a *2
New Zealand: -51% to -55% vs 2005	-38% to -43%	-51% to -55%	-49% to -53%	-48% to -52%
Canada: -45% to -50% vs 2005	-32% to -38%	-45% to -50%	-44% to -49%	-40% to -45%
Russia: -65% to -67% vs 1990	-65% to -67%	-44% to -47%	-46% to -49%	-49% to -52%
China: -7% to -10% vs GHG emissions peak *3	+298% to +285%	+85% to +79%	+14% to +10%	-1% to -4%
Korea: -53% to -61% vs 2018	+14% to -6%	-38% to -49%	-50% to -59%	-51% to -59%

*1 The values in parentheses are targets for 2040.
*2 Actual value for 2021 is lacking.
*3 Evaluated regarding the 2030 baseline emission estimated by DNE21+ as a peak.

Figure 8 shows GHG emissions per capita in 2035. The United Kingdom, Switzerland, and Norway have relatively low levels, while Turkey, Ukraine, and China are projected to have incremental per capita emissions.

Figure 9 shows GHG emissions per unit of GDP in 2035. Switzerland, Norway, and the United Kingdom are estimated to have low emissions per GDP. However, it should be noted that emissions per GDP are influenced by industrial structure - for example, countries with a larger tertiary sector tend to show better values, while those with a larger secondary sector tend to show worse values - independent of actual emissions reduction efforts.

Figure 10 shows emissions relative to baseline in 2035. In addition to Norway, which has a high reduction rate relative to its base year, Thailand is also evaluated as having a high reduction rate due to expected future economic growth.

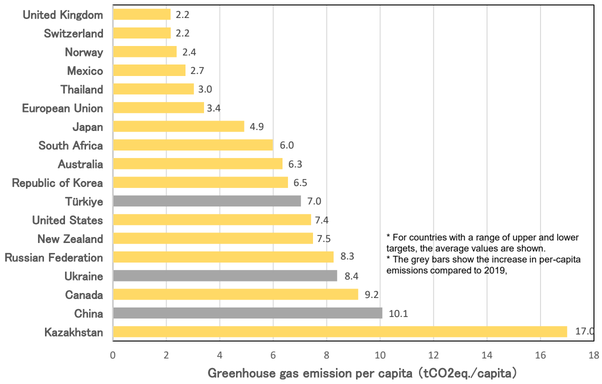

Figure 8 Per-capita GHG Emissions in 2035 for NDCs

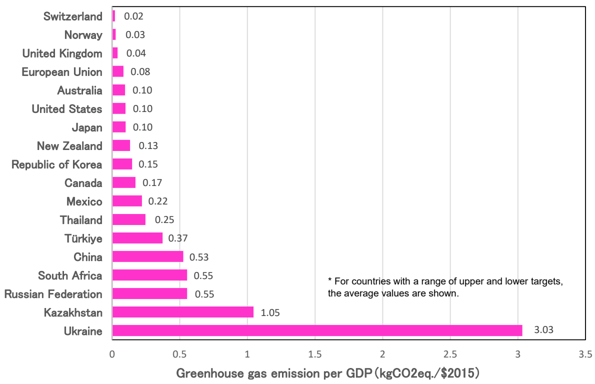

Figure 9 Per-GDP(MER) GHG Emissions in 2035 for NDCs

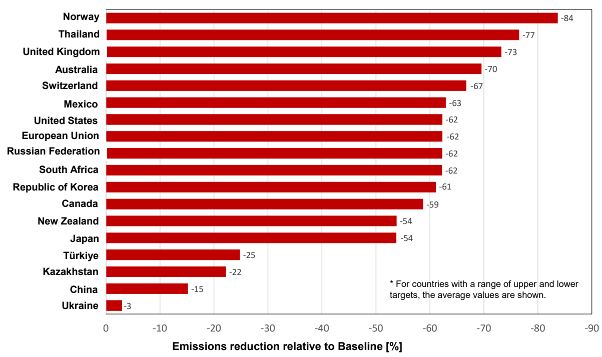

Figure 10 Emissions reduction ratio relative to baseline in 2035

Figure 11 shows marginal abatement costs of CO_2 in 2035. Thailand, the United Kingdom, and Russia are evaluated as having high marginal abatement costs. For countries and regions such as the EU27, Switzerland, and Japan, which also present 2040 targets, marginal abatement costs in 2040 are estimated to be 387, 318, and 368 USD/tCO_2, respectively. For China, since the timing and level of its emission peak are not clearly specified, the 2030 baseline emission estimated by the DNE21+ model was treated as the peak for evaluation, resulting in a marginal abatement cost of 38 USD/tCO_2.

Including non-Annex I countries, many submitted targets imply marginal abatement costs reaching hundreds of USD per tCO_2. While these are considered ambitious targets on one hand, their feasibility raises more questions than previous NDCs.

Figure 12 shows emissions reduction costs relative to GDP in 2035. Russia, Thailand, and Ukraine are evaluated as having high costs relative to GDP. These costs include the effect of net cost increases due to decrease in exports of oil and gas associated with emissions reductions. For example, Russia is evaluated as having a 16% increase in reduction cost relative to GDP due to decreased fossil fuel exports compared to baseline. Therefore, caution is required in interpretation.

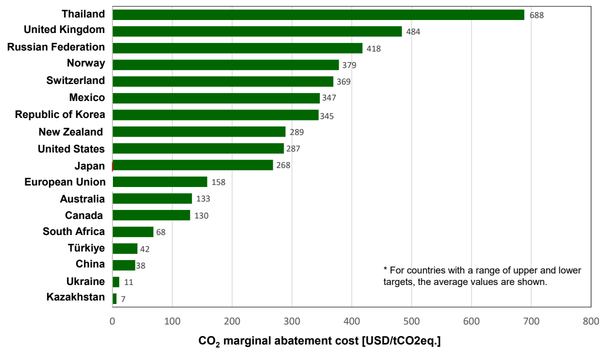

Figure 11 Marginal abatement costs of CO_2 in 2035

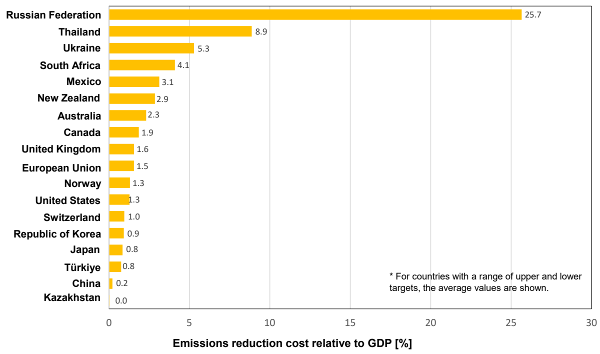

Figure 12 Per-GDP emissions reduction cost in 2035

2.3. Summary

Emissions reduction targets for 2035 NDCs of various countries were evaluated using multiple indicators for emissions reduction effort. Among these, emissions reduction costs were analyzed using the global energy and climate policy assessment model DNE21+.

Including non-Annex I countries, many submitted emissions reduction targets imply marginal abatement costs reaching hundreds of USD per tCO_2. While these indicate ambitious targets, their feasibility is even more questionable than previous NDCs. As noted earlier, this evaluation basically does not include LULUCF due to its high uncertainty. Some countries with high marginal abatement costs may be assuming significant reductions through LULUCF; however, even in such cases, their targets may deviate from actual emission reductions.

For China, since the emission peak is not clearly specified in its NDC, the 2030 baseline emission estimated by DNE21+ was treated as the peak, resulting in a marginal abatement cost of 38 USD/tCO_2.

The Paris Agreement's NDC framework is based on a pledge-and-review approach. Although differences exist among countries, striving for equitable emissions reduction efforts is important for maintaining the system and achieving global emissions reductions. However, the United States has withdrawn from the Paris Agreement, and some major emitting countries have not submitted NDC3.0, suggesting that significant disparities in emissions reduction efforts among major countries may remain.

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