自然エネルギー財団
RENEWABLE ENERGY INSTITUTE

31 May 2019
(Japanese version released on 26 April 2019)

Executive Summary

Proposal for Energy Strategy Toward a Decarbonized Society
—Achieving a Carbon-Neutral Japan by 2050

Japan is currently working to formulate its long-term GHG reduction strategy for 2050, as required under the Paris Agreement, and is aiming to announce this policy prior to the G20 Meeting. This Long-Term Strategy is a key plan that will map out the road Japan should take to realize a decarbonized society. Normally, such a strategy should be created based on input from a broad range of voices, such as citizens, businesses, local governments, and NGOs. However, there is little time remaining before the G20. This proposal aims to contribute to a constructive dialogue on the realization of a decarbonized society by raising particularly critical issues that require discussion.

Chapter 1: Develop a Future for Japan Through Decarbonization

1.1 1.5℃ Report proposes achieving net zero CO_2 emissions by 2050

The Special Report on Global Warming of 1.5℃ issued by the Intergovernmental Panel on Climate Change (IPCC) revealed that the target of limiting global warming to less than 2℃ above pre-industrial levels is insufficient to avoid the severe impact of climate change, and that 1.5℃ should instead be targeted. Additionally, in order to achieve this target, the IPCC concluded that it is necessary to achieve net zero CO_2 emissions by 2050, and a 45% reduction against 2010 levels by 2030.
The message of the 1.5℃ Report regarding the urgency of measures has been widely noted by international society, and this target is becoming a new standard for pioneering climate actions.

1.2 Reducing domestic emissions and pioneering a new Japan-led business model for a decarbonized economy

The task for Japan is to formulate and present international community a long-term reduction strategy that aims for net zero domestic CO_2 emissions by 2050. As of February 2019, 72 Japanese companies have already pledged their commitment to the formulation of Science Based Targets (SBT), which are designed to achieve Paris Agreement targets. By propelling efforts to reduce domestic CO_2 emissions, Japanese companies can rapidly establish business models for a decarbonized economy, creating the potential to further increase their global presence.

1.3 Energy efficiency and renewable energy should be central to decarbonization strategy

The International Renewable Energy Agency (IRENA) reports that it is possible to achieve 94% of the CO_2 reductions required to keep global warming below 2℃ through energy efficiency and utilization of renewable energy. However, the energy efficiency of Japan's manufacturing sector has not improved over the past 30 years. Furthermore, the renewable energy deployment rate for electricity lags at around half the level of countries and regions that are leading in this area. As a first step, Japan needs to promote regulatory and institutional innovation in order to allow full-scale utilization of existing energy efficiency and renewable energy technologies. The need for “disruptive innovation” must not be used as an excuse for not fully applying the technologies that are currently available. In order to make the use of hydrogen truly effective for decarbonization, we must first be able to produce large amounts of renewable energy economically. It is totally unconvincing to advocate for a hydrogen society without raising the low renewable energy target of 22-24% in 2030.

1.4 Positives and shortcomings of proposal by Roundtable for Long-Term Strategy under the Paris Agreement as Growth Strategy

The released proposal by “the Roundtable for Long-Term Strategy under the Paris Agreement as Growth Strategy” established under the Prime Minister and its Cabinet contains some more forward-looking content than previous government plans. Although the 2050 target is limited to an 80% reduction from the baseline level, the report states that Japan should "ambitiously aim to realize (a decarbonized society) as early in the latter half of the century as possible," as well as "aim for a significant reduction in domestic emissions."

On the other hand, the Roundtable proposal does not mention strengthening climate measures through to 2030, raising renewable energy targets, or reviewing support for overseas export of coal-fired power plants. In addition, it repeatedly emphasizes "disruptive innovation" as a pretext to avoiding implementation of mitigation measures that can be enacted immediately using existing technology.

The Long-Term Strategy to be formulated by the government should utilize the forward-looking areas of the Roundtable proposal while incorporating further ambitious measures, including pushing for a significant reduction in domestic CO2 emissions through to 2030 and forging a path to zero net emissions by 2050.

1.5 Evaluation of the Government’s Long-Term Strategy Proposal

The government’s long-term strategy proposal announced April 23 and based on the Roundtable proposal takes a further step back from the Roundtable proposal on the matter of defining a clear path to a decarbonized society. The statement in the Roundtable proposal on reducing dependence on coal-fired power to the extent possible has been eliminated and replaced with mention of phasing out (“fade out”) inefficient coal-fired power, etc. This expression is used together in the Strategic Energy Plan with promotion of ultra-super critical coal-fired power, which the government calls “high-efficiency,” and it means something entirely different than the “phase out” of coal-fired power being pursued in most advanced countries.

The government maintains its commitment to coal-fired power, does not raise its target for adoption of renewable energy and still trumpets the realization of a hydrogen society, which make it all but impossible for Japan to show the world it is serious about climate action.

1.6 Five strategies toward a decarbonized society

The combined emissions of the energy conversion sector and the industrial sector account for more than two thirds of Japan's total emissions. A decarbonized society will therefore not be realizable without implementing focused reduction efforts in thermal power plants such as coal-fired power, as well as in the industrial sector - mainly in primary materials industries such as steelmaking.

Chapter 2: Five Strategies Toward Net Zero CO_2 Emissions in 2050

Part 1: Supply 40-50% of Japan's Electricity with Renewable Energy by 2030

1. Electricity generated from renewable energy will drive conversion to a decarbonized society

The IPCC Special Report forecasts that in a scenario in which the 1.5℃ target is achieved, 48% to 60% of the world's electricity will be supplied by renewable energy by 2030. Looking globally, some nations and regions have already begun setting ambitious targets that aim to achieve this level.

Table 2-1 2030/2050 Targets by Country

Country/ Region	GHG Reduction Targets			Renewable Energy (Power Share) Target
	2030	2050	Baseline year	
Germany	▲55% (Interim target)	▲80-95%	1990	• 65% by 2030 • 80% or more by 2050
France	▲40%	▲75%	1990	• 40% by 2030
EU	▲40%	▲80-95%	1990	• 32% of final energy consumption by 2030 (Power 50% or more)
US	▲26-28% (2025)	▲80% or more	2005	• California 60% by 2030 100% by 2045 • New York 50% by 2030 • Hawaii 100% by 2045
Japan	▲26%	▲80%	FY2013	• 22-24% in FY2030

Note: The European Commission (EU) in November 2018 announced its long-term vision aimed at climate neutrality by 2050.

Source: Created by REI based on the long-term strategies of each country (for Japan, Plan for Global Warming Countermeasures) and government agency websites.

Sweden has set the goal of achieving 100% renewables by 2040, while Denmark aims to reach this target by 2030. Germany aims to achieve 65% by 2030. As a whole, the EU has set the target of 32% renewable energy by 2030, including heating and fuel, which equates to more than 50% of electricity at a minimum. In the US, California, the nation's largest state by population, has set a target of 60% renewable energy in its electricity supply by 2030, and a net rate of 100% by 2045. The state of New York has also set a target of 50% by 2030. Although China has not officially announced its 2030 target, the China National Renewable Energy Center (CNREC), which serves as an advisor to the National Development and Reform Commission, has set high renewable energy ratios in its 2035 electricity supply forecasts, at 60% under the existing policy scenario, and 72% under a "less than 2℃" scenario.

The primary reason why renewable energy has been positioned at the core of decarbonization strategy in many countries is that electricity generation costs have fallen dramatically over the past few years, making renewable energy the most realistic option for realizing a decarbonized society. On a worldwide scale, solar and wind power generation have become competitive against thermal and nuclear power generation. The cost per kilowatt hour of electricity generated by solar and wind power has fallen to 4.2-4.3 cents as of 2018. At 15.1 cents per kilowatt hour, nuclear power is almost quadruple the cost, while at 10.2 cents coal-fired power is more than double. The International Energy Agency (IEA) forecasts that by 2040 the ratio of electricity supplied by nuclear power annually will have fallen to 9%, while renewable energy will grow to 41%.

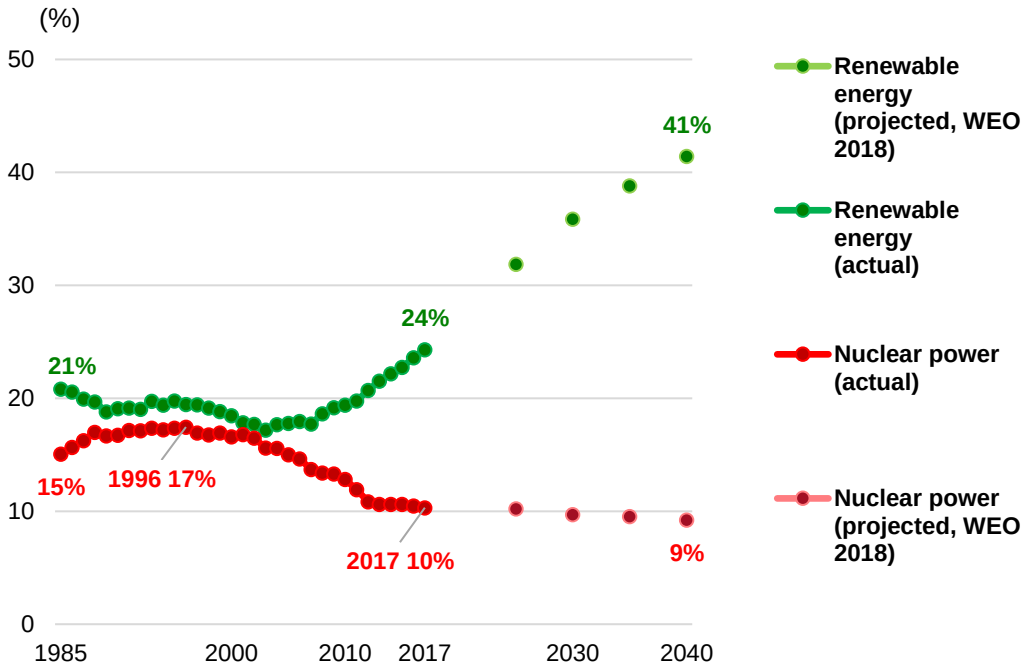

Figure 2-4 Ratio of Low Carbon Power Sources in Total Global Power Output and Future Projections

Source: Created by REI based on BP "Statistical Review of World Energy 2018" (June 2018) https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html, and IEA's "World Energy Outlook 2018" (November 2018) https://www.iea.org/weo2018/

2. Outlook for solar and wind power generation in Japan

The cumulative capacity of solar PV equipment installed in Japan reached 55.5GW as of the end of 2018. At this rate, it is likely that the 2030 target of 64GW set by the government will be reached in 2020. RTS Corporation, one of Japan's largest solar power generation consultants, has published forecasts stating that it will be possible to install approximately 150GW by 2030.

The total capacity of wind power generation equipment installed in Japan is only 3.65GW as of the end of 2018. However, projects with a total capacity of approximately 26GW have already undergone environmental impact assessments, and with these facilities gradually commencing operation, it is forecast that Japan will achieve its government-set 2030 target of 10GW ahead of schedule in the early 2020s. Additionally, the November 2018 passing of a law promoting the installation of offshore wind power generation facilities has given momentum to development efforts. According to calculations by the Japan Wind Power Association (JWPA), Japan has the potential to generate 91GW of electricity via wind power if bottom-mounted turbines such as those used in Europe are introduced. Given these circumstances, it is feasible that that the JWPA 2030 target of 36GW may indeed be achieved.

The cost of renewable energy in Japan has trended downward in recent years, as far as 14.25-15.45 yen per kilowatt hour in government solar power generation bidding conducted in December 2018. Bloomberg NEF data for the second half of 2018 indicates that although the average per-unit generation cost was 13.6 yen per kilowatt hour, the minimum was 7.4 yen per kilowatt hour.

RTS Corporation estimates that for a large-scale system generating above 1MW, costs will fall to 6.4 yen per kilowatt hour in 2025 and 5.3 yen in 2030. Bloomberg NEF forecasts for Japan also show that solar power will become more economical than natural gas power in the early 2020s, and coal-fired power in the mid-2020s. The same report also forecasts that onshore wind power generation will also become cheaper than gas in the first half of 2020s.

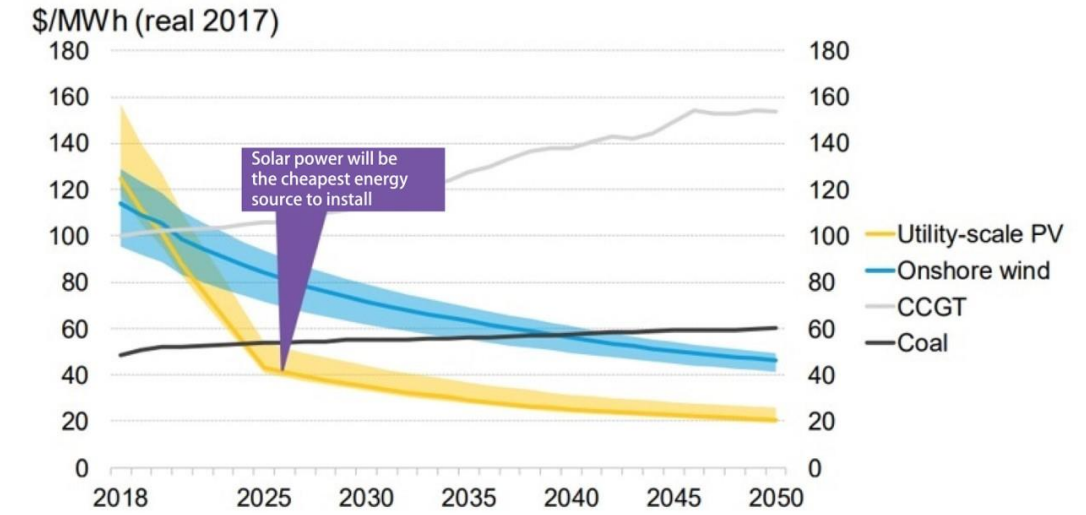

Figure 2-7 BloombergNEF Energy Cost Forecasts (to 2050)

Source: “Renewable Energy Procurement, Options in Japan” (February 1, 2019) by Miho Kurosaki, Head of Japan and Korea research, BloombergNEF, presented at RE-Users Summit 2019 held by REI on February 1, 2019 https://www.renewable-ei.org/pdfdownload/activities/4-1_Kurosaki_RE-Users%20Summit%202019_JP.pdf

3. Selecting power sources for 2030 and 2050

The share of respective power sources in 2030 outlined in the governmental Strategic Energy Plan sets renewable energy at 22-24%, nuclear at 20-22%, and thermal power at 44%. In fiscal 2017, although the share of renewable energy grew to 16.1%, nuclear energy accounted for a mere 3.1%.

Of the 54 reactors operating prior to the Fukushima nuclear accident, 21 have either already been decided to decommission or their decommission is being considered. Although nine reactors have recommenced operation, 8 have not even applied for the screening process required to restart. Given these circumstances, the target of 20-22% appears infeasible, and realizing a level even half this will be difficult.

If, hypothetically, the share of electricity supplied by nuclear power was 10%, and this shortfall was met by thermal power, it would be impossible for Japan to meet its greenhouse gas reduction target of a 26% decrease from 2013 levels. This target itself has been criticized internationally as "highly insufficient," and would require further improvements to meet even the 2°C target, not to mention a target of 1.5°C.

What Japan should aim for is to increase its renewable energy supply to a level that far exceeds its current target of 22-24%. Japan's solar power generation capacity is realistically forecast to be more than double and wind power generation capacity more than triple the levels assumed in the Strategic Energy Plan. Adding hydro, geothermal, and bioenergy power generation capacity at the levels assumed in the Basic Energy Plan gives a total renewable energy electricity supply of close to 400TWh. With total electricity demand in fiscal 2017 at 950 TWh, this would allow more than 40% of Japan's electricity supply to be generated by renewable energy sources. Furthermore, if energy efficiency improves and an approximate 15% reduction in total electricity demand from current levels can be achieved, this would make it possible for Japan to supply 50% of its electricity with renewable energy.

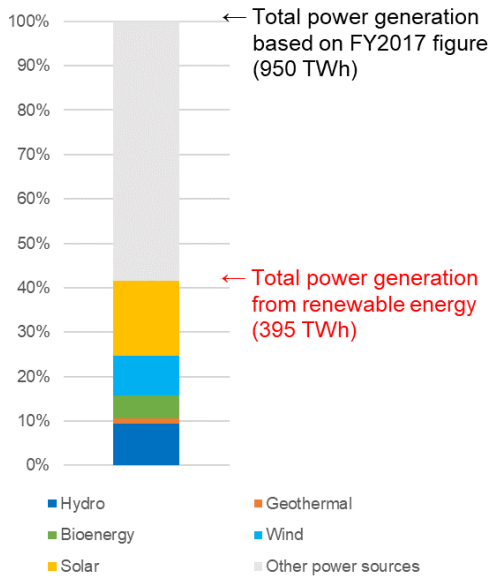

Figure 2-10 Sustainable Power Mix in 2030(based on REI's assumptions)

Source: Created by REI

A 2015 study conducted by the Ministry of the Environment estimated that Japan has a wind power generation potential of 608GW if all possible onshore and offshore generation facilities were installed. Considering that solar, hydro, geothermal, and bioenergy resources will also be utilized, realization of even a fraction of this potential would be sufficient to meet Japan's current electricity demand.

In addition, the development of international electricity supply grids should be pursued in earnest. Studies by the Asia International Grid Connection Study Group into developing an international Japan-South Korea and Japan-Russia power grid estimate that the construction is physically and technologically possible, with construction costs ranging from just over 200 billion yen (Japan-South Korea) to just under 600 billion yen (Japan-Russia) - an investment that can realistically be recouped.

Even if all Japan's current nuclear reactors were to recommence operation, in the case that the principle of a 40-year operating life is adhered to, only 2.8GW of generation capacity would remain in 2050 (furthermore, this calculation assumes that the two reactors whose construction was halted following the Great East Japan Earthquake will be completed and commence operation). Even if, in the future, several existing nuclear reactors were to be granted extensions to their operating life, nuclear power cannot be considered a realistic power source for supporting a decarbonized society in 2050 and beyond.

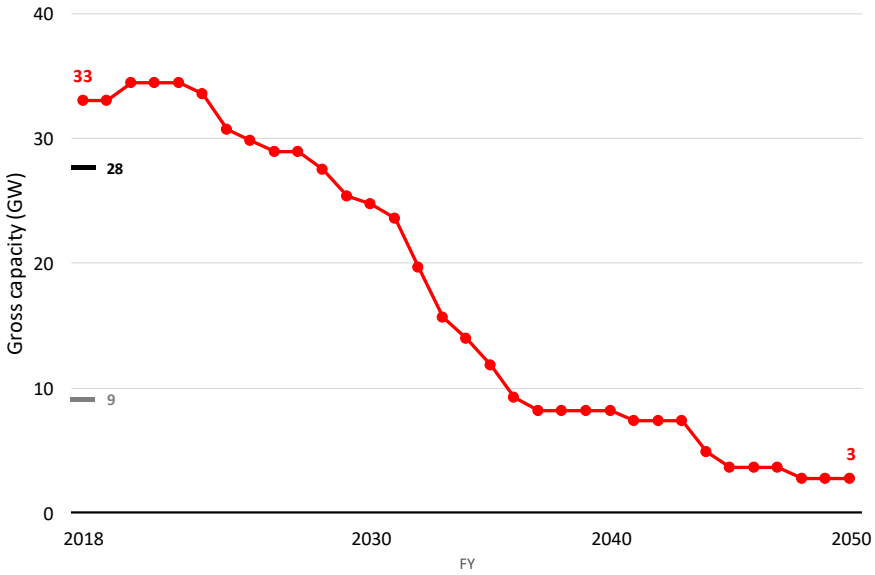

Figure 2-15 Nuclear Reactor Capacity Projection to 2050

Note: - Full restart of all remaining 33 existing nuclear reactors from the end of FY2018, and supposing the announced permanent shutdown plans of Fukushima Daini 1, 2, 3 & 4, Genkai 2, and Onagawa 1 at the end of FY2018,

- Operation starts of Shimane 3 in 2020, and of Ohma in 2026, based on World Nuclear Association, "Plans for New Reactors Worldwide – updated, February 2019" (accessed March 12, 2019), and

- Lifetime operations; 40 years for all nuclear reactors, except for Mihama 3, Takahama 1 & 2, and Tokai 2; 60 years as already granted.

Source: Created by REI based on IAEA website, “Power Reactor Information System - Japan,” Japan Atomic Industrial Forum, “Current Status of Nuclear Power Plants in Japan” (March 4, 2019), and World Nuclear Association website, “Nuclear Power in Japan – updated February 2019.”

Currently, virtually all of the coal, natural gas, and oil used as fuel for Japan's thermal power generation is imported from overseas, with total costs running to approximately 16 trillion yen per year (for all fuel usage, including other than power generation). Japan enjoys a diverse range of renewable phenomena across each of its four seasons, and considering renewable energy sources such as solar, wind, hydroelectric, geothermal, and biomass power generation, it is by no means a resource-deprived nation, but a country rich in sustainable renewable energy resources. Utilizing the potential of renewable energy presents the optimum path for Japan to break free of its reliance on energy imports and achieve energy security, as well as the most assured path toward decarbonization.

Part 2: Phase Out Coal-fired Power Before 2030

1. Coal-fired power is being phased out around the world

With the Powering Past Coal Alliance (PPCA) led by the UK and Canada, at least 20 out of the 35 OECD nations are either studying reducing their coal-fired power generation, or have already announced schedule for phasing out this power source completely. The 1.5°C Special Report has identified that there is virtually no space for construction of new coal-fired power plants in any global region.

2. Japan's persistent reliance on coal

From 1990 to 2017, the amount of CO_2 emitted from Japan's coal-fired power plants almost tripled, from 100 million tons to 280 million tons. The amount of coal consumed for power generation purposes also increased more than threefold, from 26 million tons in 1990 to 83 million tons in 2015.

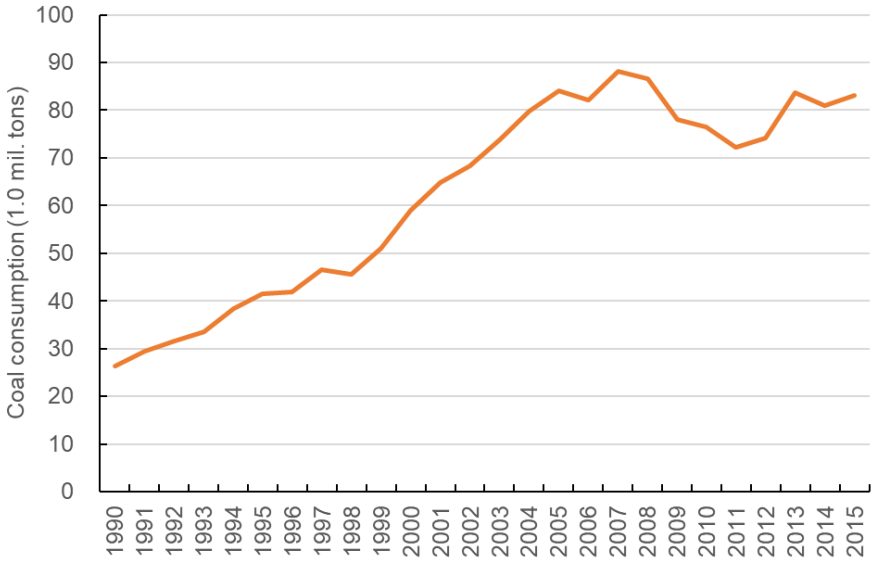

Figure 2-16 Coal Consumption by Japan's Power Industry

Source: Created by REI based on METI, "Energy White Paper 2018" (June 2018)
https://www.enecho.meti.go.jp/about/whitepaper/2018html/2-1-3.html

While Japan's electricity industry has promoted nuclear power as a climate change measure, at the same time it has continued to increase its coal-fired power generation. The Japanese government's climate change measures also rely on the promotion of nuclear energy, and the nation has not introduced measures taken in Europe and the US, such as setting emissions standards for coal power or adopting carbon pricing. Furthermore, it has not worked in earnest to expand electricity generation via renewable energy sources.

The Great East Japan Earthquake and Fukushima nuclear accident quickly exposed the weakness in Japan's nuclear-reliant emissions reduction measures. Electricity companies restarted aged oil-fired power plants to make up for the shortfall, rapidly pushing up the nation's emissions factor.

Following the earthquake, there are plans to add an additional 21GW of coal-fired power generation capacity in Japan. Although 7GW of this plan was eventually scrapped due to worsening profitability brought about by changes in the market environment as well as criticism at home and abroad, 1.3GW has already commenced operation and construction of a further 8.6GW is underway. A further 4.4GW is either currently in the environmental assessment phase or awaiting the start of construction after assessment has been completed. These capacities will come in addition to the 43.3GW of coal-fired power have been already operating before the earthquake in 2011.

In its 2030 plan, the Japanese government has set coal-fired power at 26% of the total power. While Japan's plan itself is severely problematic at a time when nations around the world are setting targets to phase out coal power by 2030, new construction projects are continuing as planned, and decommissioning of existing plants will not proceed, Japan is in danger of exceeding even this forecast.

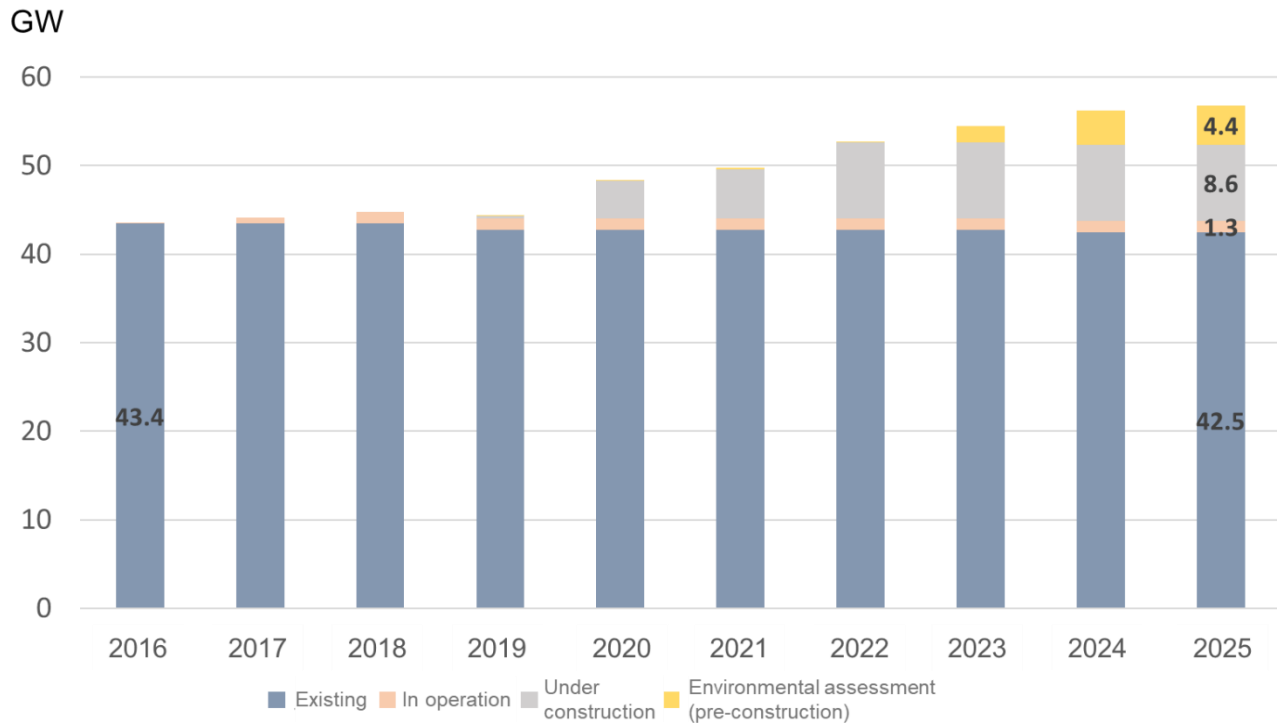

Figure 2-17 Total Capacity of Existing and Planned Coal-Fired Plants, Development Status, and Operation Start/End/Suspend Plans

Source: Created by REI based on “Thermal and Nuclear Power Plant Handbook (2017 revised edition)” and power company disclosures, etc.

Although the Japanese government is embarking on a coal power policy of "ultra-supercritical" (USC) plants that meet defined high-efficiency standards, the improvement in emissions factor of such plants when measured against conventional ones are not significant. The worldwide movement to phase out coal aims for complete cessation, including those facilities classed as "high-efficiency," and in this regard the Japanese government's policies are completely insufficient.

3. Internationally criticized coal-fired power export policies

During the 10-year period from 2009 to 2018, the Japan Bank for International Cooperation (JBIC), Nippon Export and Investment Insurance (NEXI), and Japan International Cooperation Agency (JICA) provided overseas funding and insurance for coal-fired power plants to the value of at least 16.1 billion US dollars. Japanese megabanks are also among the world's leading investors in and funders of fossil fuel resources by monetary amount.

This investment and funding have until now been promoted under the banner of CO_2 emissions reduction, electrification, and poverty elimination measures by using coal-fired power technology. However, the dramatic decline in renewable energy prices and change in demand for energy that have also taken place in developing countries mean that the original grounds for providing support are disappearing. If Japanese companies continue their coal-fired power businesses, coal power usage and CO_2 emissions in the countries receiving support will become ingrained, delaying the shift to renewable energy sources that are ultimately more economical and generate less pollution.

4. Prolonging life of coal-fired power plants using CCS technology

Japan has worked to develop carbon capture and storage (CCS) technology with the aim of promoting the installation of coal-fired power generation facilities. However, with the dramatic fall in the cost of electricity generation with renewable energy sources, placing renewable energy in an increasingly advantageous position as a decarbonization technology, it is becoming increasingly difficult to justify CCS as a countermeasure in the electricity generation sector. The European Commission's decarbonization strategy through to 2050 contains no plans to utilize CCS technology as a CO_2 reduction measure in the electricity sector.

Materials from meetings held by the government to promote CCS technology show that the target of practical application by around 2020 set out in the Basic Energy Plan is far from being realized, and that development of CCS technology remains stuck in the "construction of a basic concept" and "development of risk assessment measures related to underground storage" phases.

Additionally, a 2018 report by the Ministry of Economy, Trade and Industry (METI) estimates the generation cost for coal-fired power generation including CCS at 15.2-18.7 yen per kilowatt hour. Japan has already seen bidding for solar power generation projects at the 14-yen level in 2018. In addition, it is estimated that by 2030 the cost of solar power generation will fall to the five-yen level, and wind power generation to the 8 to 9-yen level. The premise that coal-fired power plant in conjunction with CCS can be cost-competitive is unconvincing.

5. Japan must clearly communicate a shift away from coal-fired power

Even in Japan, some private sector financial institutions have begun to announce that they will cease investing in or funding new coal-fired power projects in Japan and overseas. However, megabanks continue to maintain their policy of supporting USC-level coal power businesses. The domestic response has been slow compared to global trends due to the fact the Japanese government has not changed its promotion stance. The government should set a limit for phasing out coal power before 2030, and begin formulating a concrete schedule and processes for doing so. The longer the sending of a policy signal is delayed, the greater the amount of stranded assets and the cost of future countermeasures, in addition to leaving future generations with the impact of climate change and the task of implementing countermeasures.

Part 3: Japan Should Develop a New Decarbonized Business Model for the Basic Material Industries

1. The industrial sector has the potential to significantly reduce its emissions

The 2030 CO_2 reduction targets for Japan's industrial sector are only 6.5%. This low figure stands out compared to the targets for commercial (40%), residential (39%) and transport (28%). Although Japan's industry achieved an approximate 35% improvement in energy efficiency from the 1970s through to the mid-1980s, improvements in manufacturing efficiency have stalled during the 30-year period from the latter 1980s. One pointed example of the room for improvement is that noted by the METI committee - that degradation of the insulation used with boiler pipes and other fittings is costing Japan's manufacturing industry more than 10% in unneeded energy consumption - a significant loss.

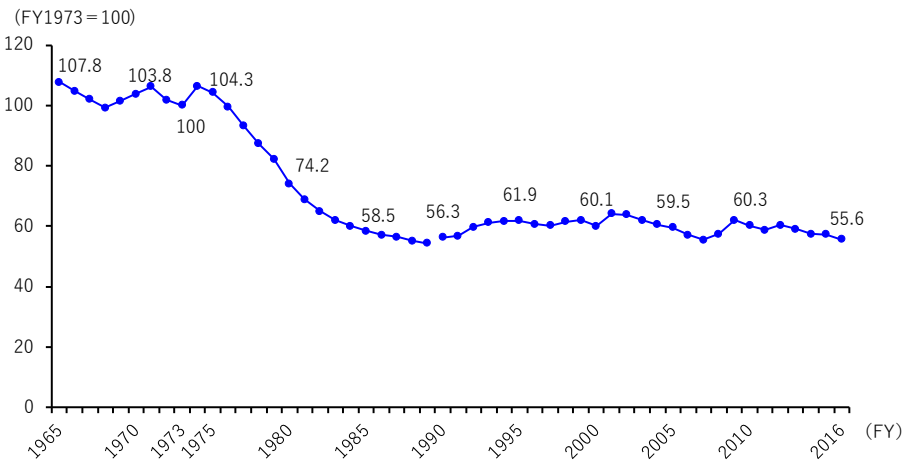

Figure 2-20 Energy Consumption Factor for Japan's Manufacturing Industries

Source: Agency for Natural Resources and Energy, "Energy White Paper 2018"

Another opportunity for significant CO_2 emissions reductions in the industrial sector is a switch from coal to other fuel sources. Japan's coal consumption has approximately doubled from just under 13 million tons in 1995 to 25 million tons in 2016. Simply switching the fuel used from coal to natural gas would achieve a significant reduction in emissions.

Comparison of the fuel mix used in the steel industries of Japan, the US, Germany, and the OECD as a whole finds that coal comprises a comparatively high ratio in Japan. A characteristic of Japan's steel industry is that crude steel production using blast furnaces, which generate three to four times the emissions per ton of electric furnaces, accounts for approximately 80% of production - an extremely high ratio compared to the US (33%) and Europe (60%).

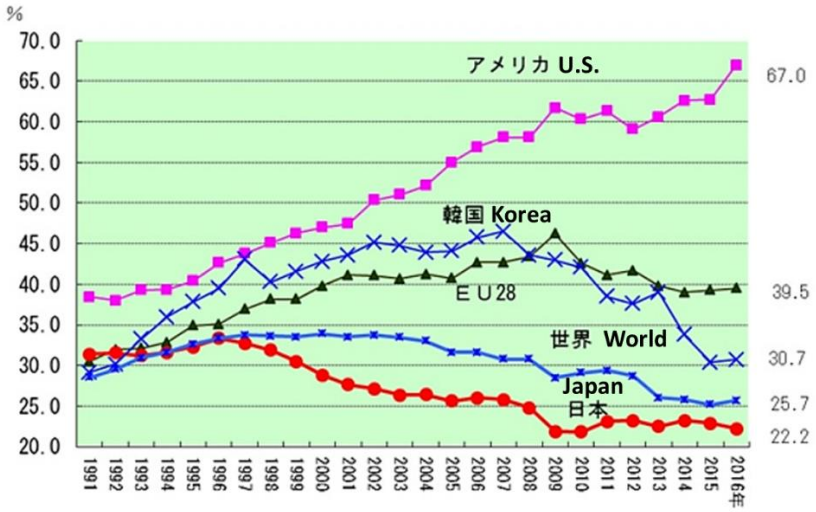

Figure 2-25 Electric Furnace Share in Major Countries

Source: Non-Integrated Steel Producers' Association, "Electric Furnace Share in Crude Steel Production Worldwide and Major Countries" (Accessed March 28, 2019) http://www.fudenkou.jp/about_03.html

2. The rise of a circular economy that will transform the basic materials industry

It has become clear that the shift to a circular economy will also play a critical role in climate change countermeasures, and growing focus is being placed on this area. Calculations based on the EU area indicate that in the four main basic material industries of steel, aluminum, plastic, and cement, the shift to a circular economy in addition to energy efficiency initiatives and use of renewable energy would result in a further 56% reduction in CO_2 emissions. Global businesses have already embarked on reforms aimed at achieving a shift to a circular economy, including the creation of the "CE100" initiative comprised of companies working to promote a circular economy.

It is expected that the shift to a circular economy will force the basic materials industry to make dramatic changes to its business approach in the future. In Europe, the automotive and construction industries alone consume approximately 50% of the four main basic material resources - steel, aluminum, plastic, and cement. Certain steelmakers are beginning to work toward decarbonization. One area for which particularly high future expectations are held is a shift in materials used to include not only steel, concrete (cement), and fossil fuel - based materials, but also a range of biomass-based materials that fulfill modern needs and functions - in other words, the shift to a bioeconomy.

3. Japan as a new manufacturing power in the decarbonized era

Thus far, Japan's energy efficiency measures in the industrial sector have centered on two main pillars: the Energy Conservation Act, and voluntary actions by major industry association, primarily driven by the Japan Business Federation (Keidanren). However, reduction results have stagnated, plus initiatives must be accelerated in order to realize the large-scale reductions required by 2050. Bolder policy steps are needed, such as the introduction of a regulatory framework that governs not only improvements on a per-unit basis but also a reduction in the total volume of emissions, as well as economic methods such as carbon pricing.

Another important factor is that global business sectors, including Japanese companies, are committing to the realization of a circular economy, and that major changes are occurring to the state of the supply chain itself, including the basic materials industry. By proactively working to achieve a shift to a circular economy and bioeconomy, Japan has the opportunity to reinvent itself as a new manufacturing power in the decarbonized era.

The correct way to manufacture and use hydrogen

Under the banner "realization of a hydrogen society," Japan has promoted policies toward this end. With the 22-24% renewable energy target in 2030 - an extremely low level by international standards - the government's advocation of a hydrogen society cannot be considered as a rational policy.

Hydrogen must be manufactured by artificial means. If hydrogen is produced with electricity derived from renewable energy, as an energy carrier it can supply large amounts of renewable energy, contributing to the realization of decarbonization. Conversely, producing hydrogen from other energy sources such as natural gas or coal simply converts the energy stored in fossil fuels to hydrogen for subsequent use.

The current plan for hydrogen production in Japan is precisely the latter model: it is envisioned that fossil fuels, specifically lignite - a cheap fossil fuel from overseas - will be used to produce hydrogen. As the fossil fuels that are used as raw materials ultimately emit CO_2 molecules equal to the number of carbon atoms, major CO_2 emissions are unavoidable. Due to this, it is assumed that production of hydrogen from fossil fuels will take place in conjunction with CCS. However, there is no roadmap for the practicalization and commercialization of this technology. Furthermore, in order to transport hydrogen efficiently, it is either compressed to high pressures or converted to liquid at a temperature of minus 253℃ or lower. However, in this case approximately half of the energy stored by the hydrogen is lost.

Japan's Basic Hydrogen Strategy draws a scenario in which hydrogen is to be used on a large-scale basis, serving as a replacement to natural gas in the electricity generation sector. At a stage in which 100% of electricity is supplied using renewable energy, in addition to measures such as efficient grid operation, bolstering of interconnections, and utilization of storage batteries, the manufacture of hydrogen could potentially be used as a way to absorb excess electricity, while hydrogen could conversely be used to generate electricity. However, Japan already has a massive pump-storage hydropower generation with a capacity of 27.5GW. It is therefore difficult to envision hydrogen electricity generation playing a major role as an adjusting power. In addition, the Basic Hydrogen Strategy uses the LNG supply chain as an illustrative example, which appears to show that the aim is to position hydrogen electricity generation as a primary electricity supply source. It is difficult find any economic rationality in such a usage method.

Part 4: Strategy for Zero-Emission Buildings

1. Current state of Japan's buildings and need for improvement

In the 2015 survey, only 8% of Japan's residences meet the current energy conservation standards. Furthermore, 35% - an extremely high rate - are uninsulated, with no insulative material utilized in the walls, floors, or ceilings. For non-residential buildings more than 90% of large and mid-sized buildings meet the current energy standards when they are newly built. However, the standards in question are equivalent to those set 20 years ago, and target figures are considerably lenient.

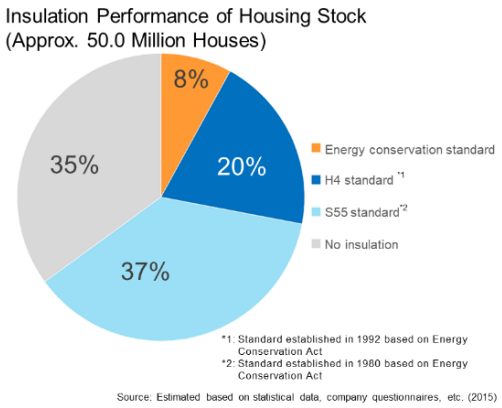

Figure 2-27 Insulation Performance of Housing Stock

Source: Ministry of Land, Infrastructure, Transport and Tourism, “Approach to Future Energy Efficiency Measures for Houses and Buildings” (secondary proposal) (reference document), January 2019

2. Policy direction in realizing zero-emission buildings

Future energy conservation standards and their compliance systems for buildings need to consider the steps required in order to realize zero emissions across the building sector as a whole by 2050. In their present state, most current buildings will not satisfy energy efficiency level required in 2050. Renovations must be steadily implemented on an extremely large volume of building stock with poor energy performance by 2050. Mandate disclosure of building energy performance should also be implemented, including for existing buildings.

3. Creating an attractive urban environment and society through zero-emission building strategy

Combined investment in residential and non-residential buildings in Japan is estimated to reach 31 trillion yen in fiscal 2018. Although at present the bulk of this investment is directed towards new builds, investment in renovations to transform existing buildings into high-quality stock should be positioned as a major pillar of construction investment going forward. To this end, a strategy for developing building renovation into a key industry is needed.

Now is the perfect opportunity to transform Japanese residents into comfortable, healthy living environments. Improving the insulation performance of Japan's housing stock is essential in order to provide a comfortable living environment to everyone living in Japan - one with stable room temperature and free of mold and condensation worries - all without a significant increase in or even a reduction in energy consumption.

Interest in workplace environment and comfort is heightening, and evaluation systems are starting to be introduced to evaluate healthy offices. In conjunction with decarbonization, buildings that offer a pleasant environment will increase the attractiveness of Japan's cities and help build urban centers that are internationally competitive on a global level. The world’s metropolises are competing to implement zero-emission building strategies. It is up to the Japanese government to send a strong signal by unveiling targets, standards and a roadmap for achieving zero emissions in all existing buildings.

It is possible to achieve further significant energy efficiencies in the building sector by utilizing technologies that are already used widely. With the decline in Japan's population, the number of households and commercial building space required are expected to decrease. Taking into account these factors, a 50% reduction of energy consumption in the building sector from 2016 levels should be achievable in 2050, in both the residential and commercial sector.

Regarding remaining energy demand, in addition to utilization of renewable energy heat sources such as solar thermal and biomass energy, if the remainder is covered by electricity generated from renewable energy, the building sector as a whole can achieve decarbonization and zero emissions. In order to implement this with minimal economic and social costs, a transition policy should be implemented swiftly, without putting off implementation of necessary measures.

Part 5: Pursuing Decarbonization in the Transport Sector

1. Decarbonization in passenger vehicles through adoption of EV technology

In August 2018, the Japanese government released the Interim Report by the Strategic Commission for the New Era of Automobiles. The 2030 targets outlined in this document were unchanged from those formulated in 2010. The report forecasts that 50-70% of new domestic passenger vehicle sales will be next-generation automobiles and 20-30% will be EVs, however, it also includes a 5-10% target for clean diesel automobiles - a sector from which global automakers are withdrawing in quick succession. The report also sets a 3% target for fuel cell EVs. It does not identify the future direction Japan should aim for with regard to automobiles.

2. Decarbonization in trucks and buses - the outlook for a shift to EV technology

Small trucks are comparatively simple to shift to EV technology as they typically travel a shorter distance, within a certain territory. Japan's three truck manufacturers have each released commercial compact EV truck models, which have been adopted by courier companies and other businesses. Headway is also being made with regard to EV technology in heavy duty trucks, with range - which had long been a sticking point - beginning to expand, and progress being made in test runs.

Fixed-route buses operate on a predetermined course and run a comparatively short distance. In terms of the total cost of bus ownership, which includes the vehicle price and running costs, EV buses can potentially be more cost-efficient than diesel or CNG buses, even at present, due to their fuel efficiency and low maintenance costs. Accordingly, they are starting to be introduced in urban centers with a pressing need for measures against environmental issues such as air pollution and noise. In particular, China comprises the majority of the global e-bus market, with sales of more than 100,000 vehicles. In Japan, although e-buses have been introduced in limited areas including the cities of Yokohama and Gifu, the scale of implementation is still small.

3. Decarbonization in shipping and aviation

Achieving decarbonization in the shipping industry will require not only new energy sources and new, highly fuel-efficient vessel technologies which utilize these sources, but measures across the entire spectrum, including energy efficiency technology and initiatives on the operating and port sides. To realize this, fuel regulations must be strengthened, and incentives are needed to ensure fuel-efficient designs in new vessel builds.

Demand in the aviation sector is forecast to increase in future, primarily on international routes. In addition, the difficulty in shifting to electric technology makes this sector one of the most difficult in which to achieve decarbonization. Due to this reason, high hopes are being placed on bio jet fuel, which uses biomass as its raw material. However, at present the production capacity for bio fuel is equivalent to only 0.1% of global demand. International cooperation to achieve major advances in technology and production capacity will be essential for this technology to make a significant contribution to the CO_2 reduction

4. Aiming for decarbonization in the transport sector with a shift to EV technology and energy efficiency

As more than 70% of the emissions in the transport sector as a whole can be reduced with the introduction of EV technology, comprehensive efforts to promote this technology are needed. Having reached a maturation phase in its economy, Japan will be able to reduce its volume of transport without much burden as its population declines. There is also a possibility that in addition to traditional means of public transport, the appearance of new mobility services that can be operated at the community level will drive a breakaway from individual use of household vehicles, further improving transport efficiency. In aiming to achieve a shift to a decarbonized society, comprehensive policies that encompass city planning, energy, welfare, and healthcare should be created with the target of delivering clean, safe, liberating, and efficient decarbonized mobility to all citizens.

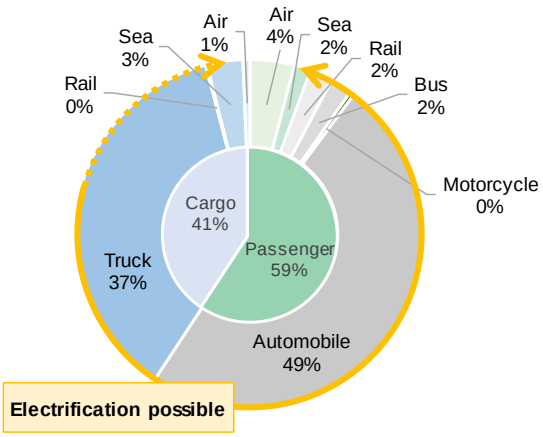

Figure 2-37 Emissions Share and Electrification Prospects by Mode

Source: Created by REI based on the Agency for Natural Resources and Energy, “Energy White Paper 2018”

Chapter 3: Social and Regulatory Innovation for a Decarbonized Society

3.1 Components essential in Japan's Long-Term GHG Reduction Strategy

Japan's long-term reduction strategy requires clear targets and strategies for each of the three underlying points.

- Clarify that Japan will work to achieve net zero domestic CO2 emissions by 2050

  Setting a clear target of zero net domestic emissions by 2050 will encourage businesses and local governments to set a broad direction for their initiatives on their own accord. Additionally, this will allow Japan to clarify its intention to serve as a world leader in global climate actions.

- Accelerate emissions reductions through to 2030

  Achieving zero net CO2 emissions in 2050 will only be possible if Japan accelerates its efforts to reduce emissions through to 2030. Additionally, the extent of the rise in temperature will be impacted by the cumulative amount of greenhouse gases emitted. Moves to enhance GHG emission reduction measures when it is already close to 2050 will come too late.

- Implement social, regulatory and institutional innovations to fully utilize the energy efficiency and renewable energy technologies already available

  Although realizing zero net CO_2 emissions will be no easy task, the world already possesses energy efficiency and renewable energy technologies that can be put to use immediately to reduce emissions. Japan's long-term reduction strategy should clearly communicate the message that it will implement social and regulatory innovations to apply currently available CO_2 reduction technology to all corners of the economy and society.

3.2 The harmful effects of the government's emphasis on uncertainty

The government's Strategic Energy Plan emphasizes future "uncertainty," and presents a strategy in which the government adopts an "omni-directional, multiple track scenario approach that aims at energy transitions and decarbonization" that pursues all options including renewable energy, hydrogen and CCS, and nuclear power.

It is only natural that a plan which runs through to 2050 will have a level of uncertainty associated with it. However, it is a mistake to cloud the increasingly obvious conclusion regarding selection of the world's energy sources by emphasizing "uncertainty." While achieving 100% electricity supply powered with low-cost renewable energy is becoming a practical, achievable target, nuclear power and CCS-equipped thermal power are becoming infeasible as options, including from an economic perspective.

This emphasis on "uncertainty" and "a multiple track scenario" will hinder Japan's efforts to achieve decarbonization in the following three regards.

Firstly, it downplays the importance of expanding renewable energy, a task which should be tackled rapidly by focusing government and private sector resources. Secondly, it serves as an excuse to keep coal-fired power and nuclear power, energy sources which should be phased out as quickly as possible in the picture. Thirdly, it emphasizes the necessity of "disruptive technology innovation" as a pretext to realizing a multiple track scenario, encouraging the focused deployment of resources in this area.

"Disruptive technology innovation" itself is certainly necessary. However, a distinguishing feature of the scenario drawn by the government is that it lacks efforts to thoroughly utilize existing technologies related to renewable energy and energy efficiency, while emphasizing "disruptive innovation. "The government's current plan, which neglects to thoroughly utilize the existing technology available while maintaining coal-fired power and emphasizing the necessity of innovation to achieve decarbonization, is completely lacking in credibility.

3.3 Introducing basic rules for a decarbonized society to Japan

A decarbonized society will require a different set of behavioral principles from society thus far, which has been developed based on the large-scale consumption of fossil fuels. Our carbon budget is rapidly shrinking. However, the rules required in a decarbonized society are not regulations that force us to sacrifice prosperity. The utilization of low-cost renewable energy and improved energy efficiency have made it possible to realize growth and prosperity in a sustainable manner as a decarbonized society.

Even in Japan, some basic rules necessary for a decarbonized society are beginning to take root, such as the Task Force on Climate-Related Financial Disclosures (TCFD). At the same time, however, Japan has been slow to adopt some other rules that have otherwise spread globally. The representative example is carbon pricing.

Japan, too, has discussed the introduction of carbon-pricing system since the year 2000, drawing out debate on the issue for almost 20 years. While the central government dragged its feet, the Tokyo Metropolitan Government has enacted "Mandatory Reduction of Total CO_2 Emission and Emission Trade System (Tokyo Cap-and-Trade Program)" by its ordinance in 2008, subsequently enforcing in 2010. According to the metropolitan government, in fiscal 2017 the Tokyo Cap-and-Trade Program was effective in realizing a 27% reduction in emissions volume among the large-scale commercial facilities covered under its scope. On the national level, although the government introduced the Anti-Global Warming Tax in October 2012, at only 289 yen per ton the taxation rate is extremely low. Sweden, an early adopter of carbon pricing which has achieved significant results through its program, set its carbon price at approximately 15,000 yen per ton of CO_2 (2018). Japan's tax rate is equivalent to one-fiftieth of this.

If the introduction of carbon pricing is further delayed, Japan will undoubtedly face criticism that it is not prepared to seriously tackle the threat of climate change.

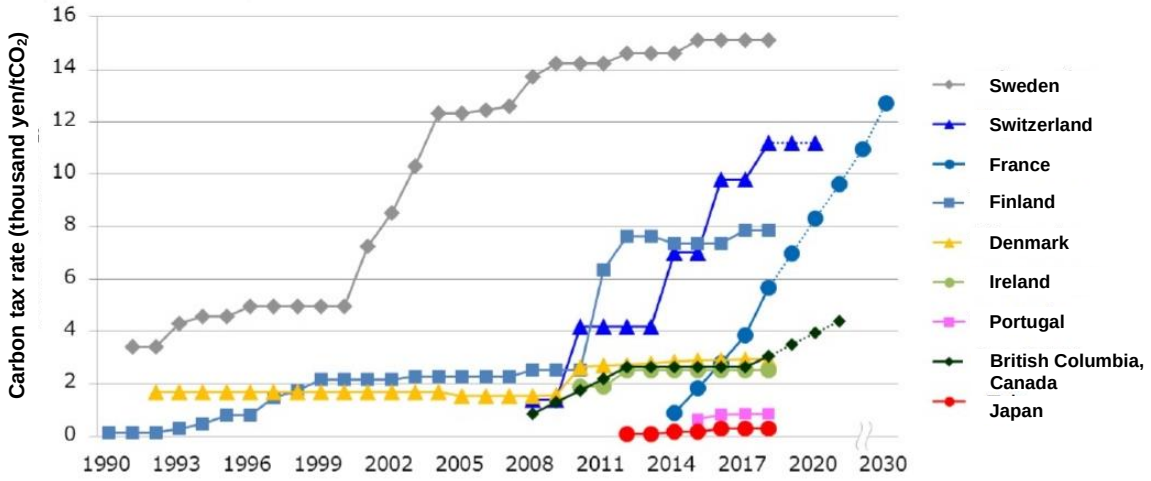

Figure 3-2 Carbon Tax Rate Comparison

Source: Ministry of the Environment, Subcommittee on Utilization of Carbon Pricing (Fourth Meeting), Document 2 (November 2018)
https://www.env.go.jp/council/06earth/post_71.html

3.4 Japan must act now to fulfill its responsibility to the next generation

The threat of climate change is becoming a reality as we speak. The task required of the current generation is not to fulfill our responsibility to future generations, but to fulfill our responsibility to the next generation - that which directly follows us.

Whether listing the uncertainty surrounding climate change forecasts or the uncertainty surrounding the technologies used to combat climate change or claiming that "overseas contribution is more important than reducing emissions in Japan," there is no justification for delaying necessary efforts to achieve large-scale reductions in domestic emissions.

Even in Japan, many non-state actors have begun to act to fulfill their responsibilities to the next generation. More than 70 companies have pledged Science Based Targets (SBT), aligned with the Paris Agreement and there are local authorities that have zero emission target.

For the longest time, the Japanese government has used a variety of excuses to justify putting off introducing the measures necessary to shift to a decarbonized society. Time is running out. The long-term emission reduction strategy that will be formulated in 2019 must be the first step Japan takes to show the world that it, too, has begun working to deliver truly effective measures to combat climate chang.