Proposal for Energy Strategy Toward a Decarbonized Society

Achieving a Carbon-Neutral Japan by 2050

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Renewable Energy Institute

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About Renewable Energy Institute

Renewable Energy Institute is a non-profit think tank which aims to build a sustainable, rich society based on renewable energy. It was established in August 2011, in the aftermath of the Fukushima Daiichi Nuclear Power Plant accident, by its founder Mr. Son Masayoshi, Chairman & CEO of SoftBank Corp., with his own resources.

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Executive Summary

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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°C 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.

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%.

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.

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.

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.

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.

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.

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.

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%).

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.

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.

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.

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 change.

Chapter 1: Develop a Future for Japan Through Decarbonization

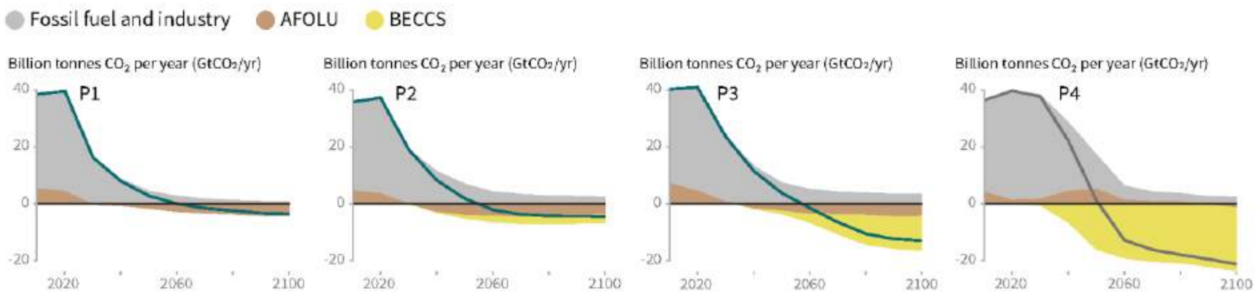
Japan is currently working to draft a long-term GHG reduction strategy for 2050, as required under the Paris Agreement, and plans to announce this policy prior to the G20 Meeting in Osaka in June 2019. The Roundtable for Long-Term Strategy under the Paris Agreement as Growth Strategy, which was established in August 2018 under the Prime Minister, announced its Roundtable proposal[1] on April 2 of this year. Based on this proposal, the Japanese government published the draft Long-Term Strategy on April 23[2]. This long-term strategy is a key plan that will map out the road Japan should take to realize a decarbonized society. 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 very little time left though until G20. Renewable Energy Institute seeks to contribute to constructive discussion on creating a decarbonized society by raising particularly critical issues that need to be discussed.

1.1 1.5°C Report proposes achieving net zero CO_2 emissions by 2050

The 1.5°C Report[3] issued by the Intergovernmental Panel on Climate Change (IPCC) in October 2018 makes it clear that the current target of less than 2°C above pre-industrial levels is inadequate for avoiding severe impacts like heatwaves and damage to ecosystems and that it is necessary to put the target at 1.5°C.

"The percentage of the global population that will be subjected to a severe heatwave at least once every five years" would be held to 14% with 1.5°C of global warming, compared to 37% with 2°C of warming. The decline in the global annual catch for marine fisheries would be 3.0 million tons with 2°C of warming, but half of that, 1.5 million tons, with 1.5°C of warming. The frequency of "summers without Arctic sea ice" would be at least once every 10 years with 2°C of warming, but once every 100 years with 1.5°C of warming.

The report lays out four scenarios for global CO_2 emissions and indicates that to achieve the 1.5°C target it will be necessary to achieve carbon neutrality by around 2050 and reduce emissions by approximately 45% against 2010 levels by 2030. (Figure 1-1).



Global indicators	P1	P2	P3	P4	Interquartile range
Pathway classification	No or limited overshoot	No or limited overshoot	No or limited overshoot	Higher overshoot	No or limited overshoot
CO_2 emission change in 2030 (% rel to 2010)	-58	-47	-41	4	(-58,-40)
↳in 2050 (% rel to 2010)	-93	-95	-91	-97	(-107,-94)
Renewable share in electricity in 2030 (%)	60	58	48	25	(47,65)
↳in 2050 (%)	77	81	63	70	(69,86)

Figure 1-1 1.5°C Report's Four Scenarios

Source: IPCC "Global Warming of 1.5℃ Summary for Policymakers" (October, 2018）
https://www.ipcc.ch/site/assets/uploads/sites/2/2018/07/SR15_SPM_version_stand_alone_LR.pdf

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[1] The Prime Minister's Office: Proposal of Roundtable for Long-Term Strategy under the Paris Agreement as Growth Strategy (April 2, 2019) https://www.kantei.go.jp/jp/singi/parikyoutei/siryou1.pdf

[2] "Long-Term Strategy under the Paris Agreement as Growth Strategy (Tentative proposal)" Document No.4, The 49th Joint Experts' Meeting of the Central Environmental Council and the Industrial Structure Council (April 23, 2019) https://www.meti.go.jp/shingikai/sankoshin/sangyo_gijutsu/chikyu_kankyo/chikyukankyo_godo/pdf/049_04_00.pdf[3] IPCC "Global Warming of 1.5°C Summary for Policymakers" (October 2018)

[3] IPCC "Global Warming of 1.5°C Summary for Policymakers" (October 2018)
https://www.ipcc.ch/site/assets/uploads/sites/2/2018/07/SR15_SPM_version_stand_alone_LR.pdf

The report indicates that the 2030 reduction targets submitted by countries under the Paris Agreement are inadequate for even achieving the 2°C target and that without further changes, temperatures will rise by 3°C. The targets diverge even more from the level called for in the 1.5°C Report. Nonetheless, at COP24 held in December 2018, the vast majority of countries indicated that they would accept the report's findings.

The background to this is that abnormal weather has been a frequent occurrence in many regions around the world and has deepened awareness of the severity of the crises being caused by climate change. In 2018, Australia was hit with record-setting floods after a severe draught that killed cattle by the hundreds of thousands and caused enormous damage. The media reported that one of Australia's main industries was on the verge of collapse[4]. In November 2018, wildfires broke out in California on an unprecedented scale, killing over 600 people and destroying more than 12,000 homes and buildings[5]. In March 2018, the World Meteorological Association issued a report that analyzed the frequency of abnormal weather around the world as related to long-term global warming trends caused by the increase in greenhouse gases[6].

The strategic long-term vision presented by the European Commission in November 2018 calls for a "Climate neutral Europe" of net zero greenhouse gas emissions by 2050[7]. The message of the 1.5°C Report regarding the urgency of measures has been widely noted by international society, and this target is becoming a new standard for pioneering climate action.

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

The Japanese government has previously indicated its intention to lead the world toward a decarbonized society (January 29, 2018, Budget Committee of the House of Representatives, answer of Prime Minister)[8]. With the 1.5°C Report presenting a challenging new target for climate change action, Japan needs to craft a long-term GHG reduction strategy aimed at carbon neutrality domestically by 2050 and to convey this plan to the global community.

The goal of zero emissions does not mean restricting economic growth or sacrificing the high standard of living. As indicated in this proposal, the transition to a decarbonized economy will itself cause the development of new decarbonized business and raise quality of life. As the Prime Minister Abe himself has acknowledged, "global warming measures are no longer a cost for companies."[9]

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[4] CNN, "Flooding in Queensland Australia, estimated 500,000 cattle dead, severe blow to cattle farmers" (February 13, 2019) https://www.cnn.co.jp/business/35132681.html

[5] BBC, "California wildfires, missing toll doubles to 631, death toll also rises" (November 16, 2018) https://www.bbc.com/japanese/46232160

[6] WMO Press Releases, "State of Climate in 2017 – Extreme weather and high impacts" (March 2, 2018) https://public.wmo.int/en/media/press-release/state-of-climate-2017-%E2%80%93-extreme-weather-and-high-impacts

[7] European Commission, "In-depth Analysis in Support of the Commission Communication COM (2018) 773" and" Fact Sheet: The Commission presents strategy for a climate neutral Europe by 2050 – Questions and answers" (November 28, 2018) https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf

http://europa.eu/rapid/press-release_MEMO-18-6545_en.htm

[8] Record of the Proceedings of the House of Representatives, "196th Diet Budget Committee No. 2" (January 29, 2018)

http://www.shugiin.go.jp/internet/itdb_kaigiroku.nsf/html/kaigiroku/001819620180129002.htm

[9] Prime Minister's Office website, Summary of Proceedings of 1st Roundtable for Long-Term Strategy under the Paris Agreement as Growth Strategy (August 3, 2018)

http://www.kantei.go.jp/jp/singi/parikyoutei/dai1/gijiyousi.pdf

The Japan Climate Initiative (JCI)[10], a network of corporations, local governments and other non-state actors established in July 2018, clearly expresses an awareness in its founding declaration of the fact that "the transition to a decarbonized society agreed under the Paris Agreement will generate new opportunities for growth and development" and "expanding and accelerating efforts toward a decarbonized society and setting an example for international society will bring significant benefits to Japan itself." 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[11].

Propelling efforts to reduce domestic GHG emissions would enable Japanese companies to quickly establish business models for a decarbonized economy and bolster their influence globally.

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

What is most important in realizing a decarbonization strategy is increasing the efficiency of available energy sources and fully utilizing existing renewable energy technologies. The important message of the 1.5°C Report is that to achieve carbon neutrality by 2050, large reductions of approximately 45% need to be made promptly by 2030.

New technology development needs to take place to completely achieve carbon neutrality, but there is no time to postpone large reductions until more innovative technologies from "disruptive innovation" can be utilized, nor is it necessary.

The International Renewable Energy Agency (IRENA) reports that 94% of the carbon reductions needed to keep global warming below 2°C can be achieved through greater energy efficiency and use of renewable energy. The International Energy Agency (IEA) has published similar projections (Figure 1-2, Figures 1-3).

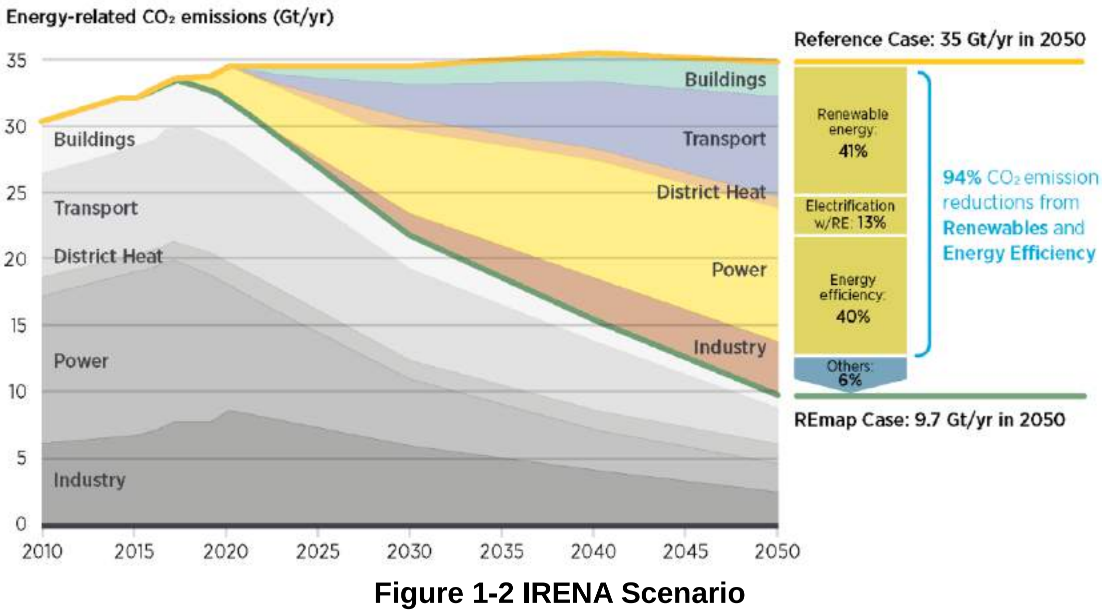

Figure 1-2 IRENA Scenario

Source: IRENA "Global Energy Transformation: A Roadmap to 2050" (April 2018)
https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Apr/IRENA_Report_GET_2018.pdf

10 Japan Climate Initiative (JCI) website https://japanclimate.org/english/

11 Breakdown: 39 companies have set targets, 33 companies have expressed their commitment (Science Based Targets website https://sciencebasedtargets.org/companies-taking-action/)

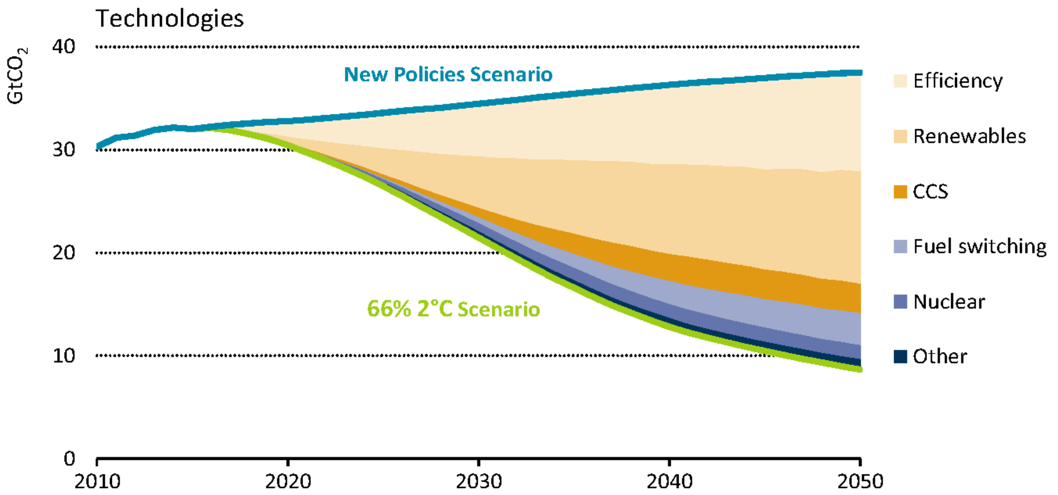

Figure 1-3 IEA Scenario

Note: "New Policies Scenario" is the scenario in which countries have implemented policies or will implement NDCs and other policies committed to under the Paris Agreement. The "66% 2°C Scenario" is a scenario for achieving the 2°C target with a 66% degree of reliability.

Source: OECD/IEA and IRENA "Perspectives for the Energy Transition Investment Needs for a Low-Carbon Energy System Executive Summary" (March 2017)
https://irena.org/-/media/Files/IRENA/Agency/Publication/2017/Mar/Perspectives_for_the_Energy_Transition_2017_Executive_Summary.pdf?la=en&hash=7FCE69C6C62EA63EBC400A85F1E0BEEBBC7A63E7

Further major reductions are needed to achieve the 1.5°C target, but common to strategies globally is that they put increasing energy efficiency and renewable energy for decarbonization at their core. As this proposal explains in the following chapter, however, Japan has been slow to immediately apply currently usable technologies in these two areas and now lags behind. Japan's awareness of itself as an advanced country in energy saving is now just an outdated belief. The energy efficiency of Japan's manufacturing sector has not improved over the past 30 years. Furthermore, the renewable energy deployment rate lags at around half the level or less of countries and regions that have promoted expansion in this area.

To seriously aspire to decarbonization, as a first step, Japan needs to promote innovation in its systems and regulations in order to allow full-scale utilization of existing technologies in energy efficiency and renewable energy. 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, the first step is to make it possible to produce renewable energy in large amounts at low prices. It is not convincing in the least to trumpet a hydrogen society without even raising the low goal of 22-24% renewable electricity for 2030.

In discussions in Japan, the opinion has been expressed that overseas contributions are more important than reductions domestically on the grounds that Japan's carbon emissions are around 4% of the world's total. This 4% figure, however, makes Japan the fifth highest carbon emitter in the world. Unless Japan actively works to reduce its own emissions, it will be in no position to ask the overwhelming majority of countries that emit less than Japan to make reductions.

The carbon emissions of Costa Rica in Central America, a country with a population of 4.8 million people, is miniscule compared to Japan. Costa Rica, however, in February 2019, set a goal of complete decarbonization by 2050. “If Costa Rica can break free of fossil fuels, it will show the world that even a small country can be a leader on a vitally important issue.” As a small country, this is Costa Rica’s message to the world[12]. Japan, one of the world’s economic superpowers, needs to serve as a model for the world and implement progressive measures to reduce emissions domestically.

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

The proposal announced recently by the Roundtable for Long-Term Strategy[13] includes a proactive contents toward realizing a decarbonized society as compared to the government’s past plans and strategies like the Strategic Energy Plan. The proposal refers to the IPCC’s 1.5°C Report at the start and expresses an awareness of the global community’s widespread acknowledgement of the need to strengthen measures as called for in the report. The proposal does state that Japan should "ambitiously aim to realize (a decarbonized society) as early in the latter half of the century as possible.” Though it stops short of targeting carbon neutrality by 2050 like the European Commission’s strategic long-term vision, and instead proposes a reduction of 80% from baseline levels. It also clearly states that Japan will not rely on reductions overseas and will commit to large-scale domestic reductions.

It points out that business and finance sectors have reoriented to “zero emissions” in which greenhouse gases are eliminated, and concludes that climate change measures are already a source of competitiveness for companies more than they are a cost. Further, the proposal indicates that energy efficiency improvements (energy savings) and shifts to renewable energy, whose costs are coming down worldwide, will be the centerpiece of cost efficiency initiatives for decarbonization in the government’s future energy policy.

On the other hand, the Roundtable proposal does not mention bolstering measures to 2030 as called for in the 1.5°C Report nor does it mention the need to raise renewable energy adoption targets, which are low by international standards. Regarding Japan’s policy of promoting coal-fired power, which has drawn international criticism, the proposal states that the country will work to reduce CO_2 emissions from coal-fired power, etc. in coordination with the long-term targets of the Paris Agreement to achieve a decarbonized society, and to accomplish this, the government will lower the country’s dependence on coal-fired power, etc. to the extent possible. This is a positive step compared to the Strategic Energy Plan, which clearly stated that Japan would promote coal-fired power designated “high efficiency,” but it is wholly inadequate compared to the global move to phase out coal-fired power completely. The proposal makes no mention of reconsidering the government’s support for the export of coal-fired power facilities and does not renounce the promotion of CCS technology for extending the life of these facilities.

By contrast, it repeatedly asserts that “disruptive innovation” is indispensable to solving the problem of climate change. As is pointed out here in REI’s proposal, emphasizing “disruptive innovation” tends to be used as a pretext for not implementing reduction measures with technologies that are readily available. If Japan preserves coal-fired power and does not update its renewable energy targets, even if it emphasizes technology developments related to hydrogen and CCUS, etc., it will not be viewed by the global community as seriously engaged in climate action.

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[12] The New York Times “Tiny Costa Rica Has a Green New Deal, Too. It Matters for the Whole Planet.” (March 12, 2019) https://www.nytimes.com/2019/03/12/climate/costa-rica-climate-change.html

[13] The Prime Minister’s Office: Proposal of Roundtable for Long-Term Strategy under the Paris Agreement as Growth Strategy (April 2, 2019) https://www.kantei.go.jp/jp/singi/parikyoutei/siryou1.pdf

Although reflections of efforts to make an ambitious long-term strategy in response to the message issued by the IPCC appear in several places, it is unclear if the strategy formulated will be ambitious enough toward the realization of a carbon neutral society. In addition, since the fourth round of the Roundtable was held last December, any review situation has been disclosed, and the proposal was suddenly released on 2nd April. In terms of the formulation process of the long-term strategy, the lack of transparency could cause a serious problem in the future.

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

The government's long-term strategy should draw on the forward-looking parts of the Roundtable proposal to push for a significant reduction in domestic GHG emissions by 2030 primarily through energy efficiency improvements and expansion of renewable energy, and then further develop measures to forge a path to carbon neutrality by 2050.

However, the government's long-term strategy proposal announced in April 23[14] takes a further step back from the Roundtable proposal on the matter of defining a clear path to a decarbonized society. The statement on increasing energy efficiency and transitioning to renewable energy as the central axis of decarbonization initiatives that was included in the Roundtable proposal has been removed, and the policy on lowering dependence on coal-fired power, etc. to the extent possible has also disappeared. It has been replaced with a statement "inefficient coal-fired power plants fade-out", 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.

Also, the proposal makes more detailed statements on nuclear power than the Roundtable proposal, such as when it gives small modular reactors as an example of innovative nuclear reactor development.

The emphasis on "disruptive innovation", which is also in the Roundtable proposal, is pushed even further, with the government insisting on the necessity of developing technologies like CCS, CCU, carbon cycle and hydrogen. Increasing energy efficiency and expanding renewable energy, which should be given highest priority to achieve major GHG reductions between now and 2030, is relegated to the background, and there is only cursory mention of regulatory system innovation like carbon pricing that is needed to take maximum advantage of these technologies.

The government's long-term strategy proposal is not at all in line with the current call to strengthen climate change measures based on the recent 1.5°C Report. 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.

The Renewable Energy Institute's proposal presents key debate points with supporting data on the substantial potential of renewable energy and energy efficiency and on assessments of coal-fired power, CCS and hydrogen, and it provides the basic form for the long-term reduction strategy that Japan should adopt.

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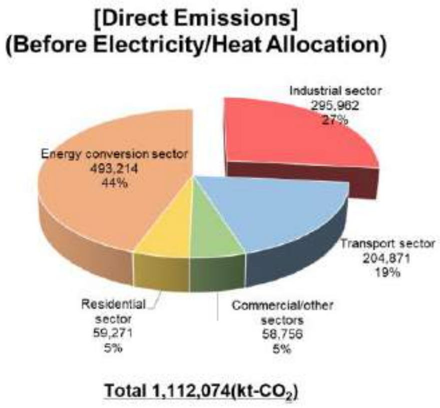
[14] "Long-Term Strategy under the Paris Agreement as Growth Strategy (Tentative proposal)" Document No.4, The 49th Joint Experts' Meeting of the Central Environmental Council and the Industrial Structure Council (April 23, 2019) https://www.meti.go.jp/shingikai/sankoshin/sangyo_gijutsu/chikyu_kankyo/chikyukankyo_godo/pdf/049_04_00.pdf[15] FY2017 percentages calculated based on The Electric Power Council for a Low Carbon Society's "Measures to Address Global Warming in the Electric Power Industry" (December 2018) (http://www.meti.go.jp/shingikai/sankoshin/sangyo_gijutsu/chikyu_kankyo/shigen_wg/pdf/h30_001_04_01.pdf) and Greenhouse Gas Inventory Office of Japan's "The GHG Emissions Data of Japan (FY1990-2017) (preliminary figures)" (November 30, 2018).

1.6 Five strategies toward a decarbonized society

It goes without saying that achieving a decarbonized society will require emission reduction measures to be strengthened in every sector of society. At the same time, in order to make major reductions quickly, it will be necessary to strategically develop measures for sectors and companies with particularly high emissions.

As shown in Figure 1-4, over 40% of Japan's CO_2 emissions are emitted by the energy conversion sector. A majority of these emissions are from thermal power plants. The next biggest emitter is the industrial sector at 27%, with basic material industries (steel, chemicals, etc.) in particular accounting for 22%.



Industrial sector breakdown (FY2017 preliminary figures)

Sector/energy-derived CO_2	kt-CO_2	Share of industrial sector	Share of all sectors	
Agriculture, fisheries, mining and construction	21,788	7%	2%	
Manufacturing total	**274,174**	**93%**	**25%**	
Food and beverages	8,843	3%	1%	
Textiles	5,991	2%	1%	
Pulp, paper and paper products	18,340	6%	2%	**4 industry total 22%**
Chemicals (incl. oil and coal products)	59,743	20%	5%	
Ceramic, stone and clay products	25,351	9%	2%	
Iron and Steel	**139,055**	**47%**	**13%**	
Non-ferrous metals	3,562	1%	0%	
Machinery (incl. fabricated metal products)	9,775	3%	1%	
Other manufacturing (other than the above)	3,514	1%	0%	
Industrial sector total	**295,962**	**100%**	**27%**	
All sector total	**1,112,074**	–	**100%**	

Figure 1-4 Japan's CO_2 Emissions by Sector and Industrial Sector Breakdown (FY2017, direct emissions)

Source: Created based on the Greenhouse Gas Inventory Office of Japan's "The GHG Emissions Data of Japan (FY1990-FY2017)" (preliminary figures) (November 30, 2018); CO_2 derived from energy use
http://www-gio.nies.go.jp/aboutghg/nir/nir-j.html

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 at thermal power plants such as coal-fired power, as well as in the industrial sector, mainly in basic material industries such as steel industry.

Based on this awareness, this proposal takes up strategies for decarbonization in the power sector, the heart of the energy conversion sector, in Part 1 (expanding renewable energy) and Part 2 (phasing out coal-fired power) of Chapter 2, and discusses decarbonization of the industrial sector, including basic material industries, in Part 3. The commercial and residential sectors, where the potential is great for both increasing energy efficiency and utilizing renewable energy, are discussed in Part 4 from the standpoint of greening buildings. Finally, the transport sector, where growth in electric vehicles has drawn attention, is taken up in Part 5.

The percentages for CO_2 emissions by sector released by the government often use indirect emissions. The biggest difference from direct emissions is whether CO_2 emissions from power generation are included in the energy conversion sector as belonging to coal-fired power plants or included in power consumption sectors like manufacturing and commercial/residential buildings. When figures for sector emissions use indirect emissions, even if power consumption is reduced by buildings and houses through energy savings, if the power sector increases use of fuels like coal with much higher CO_2 emissions, emissions by commercial and residential buildings, etc. will be counted as not decreasing or possibly even increasing. Actually, this phenomenon occurred when coal-fired power increased after nuclear power went offline following the Great East Japan Earthquake. At the same time, using figures for direct emissions alone de-emphasizes the significance of measures taken by residential and commercial buildings because how much power they use is not factored in. To compensate for this, trends in energy consumption need to be considered, not just CO_2 emissions. In light of this, the analyses in this proposal primarily use direct emissions, but in certain cases energy consumption is also taken into account.

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

Approximately 37% of Japan's CO_2 emissions come from the power sector[15], and reduction measures in this sector occupy the most important position in decarbonization strategy. The primary measure being taken globally to reduce CO_2 emissions in the power sector is transitioning to power systems centered on renewable energy. In Japan, renewable energy in many cases is still labeled as expensive and unstable due to its dependence on weather conditions. Globally, however, renewable is the most economical source of energy, and technologies have been developed for stably integrating variable renewables like solar and wind power into the power grid in large quantities.

To successfully transition to a decarbonized society, Japan first needs to set a clear target, like other progressive countries and regions, of supplying renewable energy for 40-50% of its power by 2030 and promote measures to achieve it. As the country works toward the 2030 target, the prospects for achieving 100% renewables as early as possible before 2050 could be presented in a way that would be instantly comprehendible for anyone.

Part 1 first discusses the key role played by renewable energy in global decarbonization strategies. Next, based on projections for renewable energy growth released by various research institutes in Japan and overseas, it shows supplying 40-50% of power as renewables well beyond the government's 2030 target is a realistic possibility, and then, finally, it discusses the prospects for 100% renewables by 2050.

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

Ambitious target for adoption of renewable energy by 2030

The IPCC's 1.5°C Report presents three scenarios (P1, P2, P3) for realizing significant emission reductions by 2050, but as of 2030, the scenarios are premised on supplying between 48% and 60% of the world's power with renewable energy (Figure 1-1). In 2017, renewables accounted for 26.5% of the power supply[16], so the 1.5°C target has been set extremely high. Looking globally, however, progressive countries and regions have emerged that have already pledged this ambitious target (Table 2-1).

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15 FY2017 percentages calculated based on The Electric Power Council for a Low Carbon Society's "Measures to Address Global Warming in the Electric Power Industry" (December 2018) (http://www.meti.go.jp/shingikai/sankoshin/sangyo_gijutsu/chikyu_kankyo/shigen_wg/pdf/h30_001_04_01.pdf) and Greenhouse Gas Inventory Office of Japan's "The GHG Emissions Data of Japan (FY1990-2017) (preliminary figures)" (November 30, 2018).

16 REN21 "Renewables 2018 Global Status Report" (P.40-41) (June 2018) http://www.ren21.net/wp-content/uploads/2018/06/17-8652_GSR2018_FullReport_web_final_.pdf

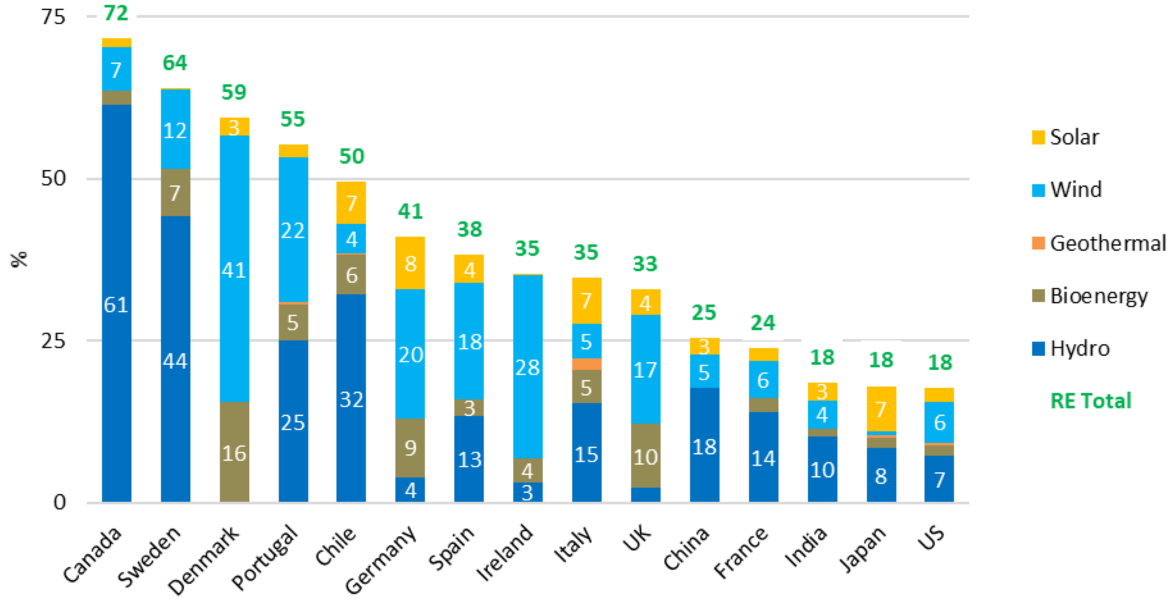

Figure 2-1 Ratio of Renewables to Total Power Consumption in 2018

Note: Individual country power consumption = (Domestic power generation) + (Imports from other countries) - (Exports to other countries). China and India percentages are calculated with power generation instead of power consumption. Both countries' power imports and exports volume are negligible. China's bioenergy data is unknown.

Source: Created by REI based on data from the International Energy Agency, China Electricity Council and Central Electricity Authority (India).

As shown in Figure 2-1, Sweden already supplies 64% of its power with renewables as of 2018. It benefits from its plentiful hydropower resources, and it has also focused on expanding wind power and bioenergy. Based on this, it has set a target of 100% renewables by 2040[17]. Denmark also already supplies 59% of its power with renewables, primarily wind power, and has set a target of 100% renewables by 2030[18.] Germany's 2030 target is 65% and it has already reached 41% as of 2018. The EU overall decided in June 2018 to raise its renewables target to 32% of final energy consumption by 2030[19]. This includes heat usage, vehicle fuel, etc., so based on electric power alone, it's at least equivalent to a target of over 50%.

In the U.S., while the Trump administration turning its back on climate action, many state governments are developing proactive renewable energy policies. California, the largest state in the U.S. by population (approx. 39.5 million), has set a target of 60% renewables for its power supply by 2030, and 100% net by 2045[20]. New York, the fourth most populous state (approx. 19.5 million) has also set a target of 50% by

[17] Swedish Institute website, "Energy Use in Sweden" (February 28, 2019) https://sweden.se/society/energy-use-in-sweden/

[18] Danish Ministry of Energy, Utilities and Climate, "Energy Agreement" (June 29, 2018) https://en.efkm.dk/media/12307/energy-agreement-2018.pdf

[19] European Commission website, "A new target for 2030" https://ec.europa.eu/energy/en/topics/renewable-energy

[20] The target of 100% by 2045 includes large-scale hydropower and nuclear power, which is not included in the 2030 60% target. However, Diablo Canyon Power Plant, the only remaining nuclear power plant in California, is scheduled to be decommissioned by 2025, so in fact power will be supplied with 100% renewables.

California Energy Commission (CEC)" California Renewable Energy Overview and Programs"

https://www.energy.ca.gov/renewables/

2030[21][22]. Also, Hawaii is topographically similar to a so-called island nation, but it is aiming for 100% renewables by 2045 (Table 2-1).

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.

China is the world's leading producer of renewable energy with approximately 175 GW and 184 GW of solar power and wind power, respectively, as of the end of 2018[23]. Its official national target is the target for 2020 established in the country's 13th Five-Year Plan for Energy Development (2020 target for solar power is 105 GW, so it has already achieved it by a large margin as of 2018, as shown above)[24]. China has not established official targets for 2030 or 2050, but the China National Renewable Energy Center (CNREC), which assists the National Development and Reform Commission (NDRC), announced in October 2018 the China Renewable Outlook 2018, which covers to 2050[25]. The outlook presents a scenario based on existing government policy and a scenario for achieving the Paris Agreement target of less than 2°C of warming. The renewable power percentage for 2035 is 60% even in the existing policy scenario, and the under 2°C scenario assumes the high percentage of 72% (Figure 2-2)[26].

[21] New York state government "Achieving NY Energy Goals"

https://www.nyserda.ny.gov/All-Programs/Programs/Energy-Storage/Achieving-NY-Energy-Goals

[22] Populations and rankings are based on estimates as of July 2018. Source: U.S. Census Bureau "Quick Facts United States"

https://www.census.gov/quickfacts/geo/chart/US/PST045218

[23] National Energy Administration, "2018 National Power Industry Statistics" () (January 18, 2019) http://www.nea.gov.cn/2019-01/18/c_137754977.htm

National Development and Reform Commission, National Energy Administration, "能源发展"十三五"规划（公开发布稿）" (December 2016)

http://www.ndrc.gov.cn/zcfb/zcfbghwb/201701/W020170117350627940556.pdf

[25] China National Renewable Energy Centre" China Renewable Energy Outlook 2018" (October 2018) http://boostre.cnrec.org.cn/wp-content/uploads/2018/11/CREO2018-EN-final-1.pdf

[26] China National Renewable Energy Centre " China Renewable Energy Outlook 2018 - Time for a new era in the Chinese energy transition -" (October 2018) http://boostre.cnrec.org.cn/wp-content/uploads/2018/11/China-Renewable-Energy-Outlook-2018-Folder_ENG.pdf

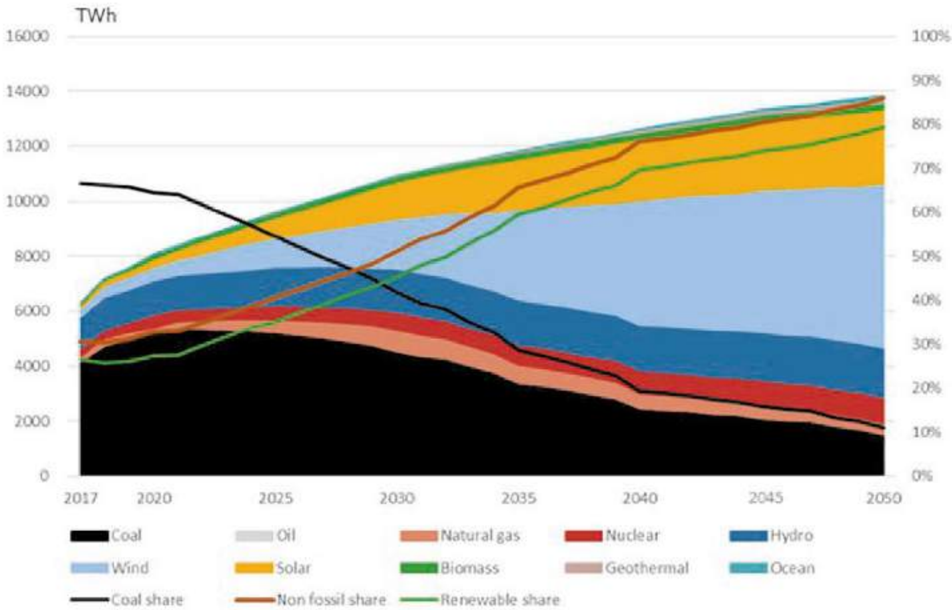

Figure 2-2 China's Power Generation Projections by Power Source in the Stated Policies Scenario

Source: China National Renewable Energy Centre（国家再生可能能源中心）"China Renewable Energy Outlook 2018" (October 2018) http://boostre.cnrec.org.cn/wp-content/uploads/2018/11/CREO2018-EN-final-1.pdf

Renewable power costs decreasing worldwide

The primary reason that increasing renewable power has been positioned at the heart of decarbonization strategy by the IPCC, EU and individual European countries and U.S. states is the broader awareness of the fact that energy costs decreasing over the past several years has made renewable energy the most realistic option for achieving a decarbonized society. Globally, solar and wind power have become cheaper power sources than thermal and nuclear power.

Figure 2-3 shows trends in levelized cost of electricity (LCOE) by power source, figures released by Lazard, a prominent German investment bank, in November 2018. 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.

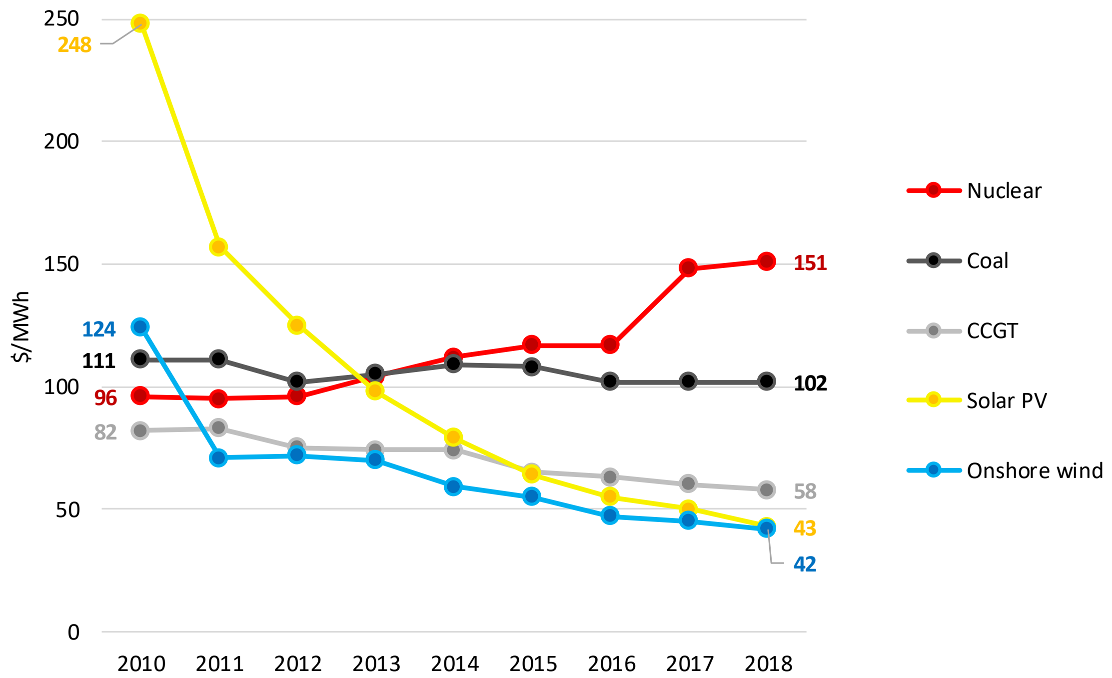

Figure 2-3 Trends in Generation Costs by Power Source (Global, New Plants, 2010-2018, LCOE w/o Subsidies)

Note: Does not include costs for decommissioning and waste disposal.

Source: Created by REI based on Lazard "Levelized Cost of Energy Analysis – Version 12.0" (November 2018) https://www.lazard.com/media/450773/lazards-levelized-cost-of-energy-version-120-vfinal.pdf

As this shows, renewables have become economical, and compared to a strategy with renewables as the primary source of decarbonized energy, nuclear power is becoming increasingly expensive and cannot be expected to play a major role in emission reduction measures going forward. The International Energy Agency (IEA)'s 2018 World Energy Outlook in its central case scenario (New Policies Scenario) projects that by 2040 the percentage of electricity supplied annually by nuclear power will fall to 9%, while renewable energy will grow to 41% (Figure 2-4). Even the IEA's projections have renewable energy playing the lead role in decarbonization.

Carbon capture and storage (CCS), in which carbon dioxide is captured from gases emitted by thermal power plants, has been trumpeted alongside nuclear power as a means of reducing the power sector's CO_2 emissions. In Japan recently, there has been momentum toward strengthening CCS-related R&D, but even globally there has been only minimal practical application of this approach, and even as a reduction measure for the power sector, it is far from being a realistic policy. This will be taken up in Part 2.

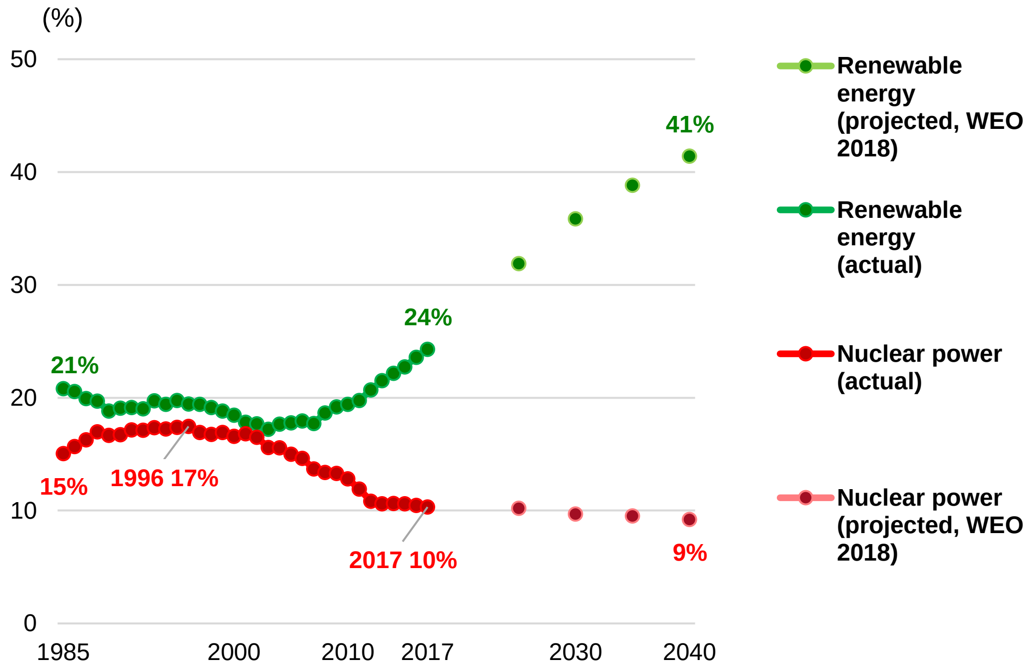

Figure 2-4 Ratio of Low Carbon Power Sources in Total Global Power Output and Future Projections

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 government's Strategic Energy Plan, which was revised in 2018, used phrasing that indicated its intention to make renewable energy the primary power source. The government should be lauded for setting this proactive goal in comparison to its previous plan, but its main 2030 power source targets were unchanged from the previous version, with renewables at just 22-24% of supply. This is less than half of the level set by progressive countries and regions.

In its recommendation "For Energy Shift in Japan"[27] published in February 2015, REI projected that it would be possible for renewable energy to handle 45% of the power supply in 2030 by raising energy efficiency and expanding solar and wind power. Trends over the four years since have provided evidence that this projection is realistic.

Trends in solar and wind power

Solar power and wind power are driving growth in renewable energy around the world. Even in Japan, solar power has grown substantially since 2012 when the feed-in tariff scheme was instituted. According to RTS Corporation, Japan's leading solar power consultant, cumulative solar power capacity in Japan reached 55.5 GW as of the end of 2018. The government's projection for solar capacity in 2030 is 64 GW. Annual capacity added recently has been lower than the 10.4 GW added in 2014 and 2015, but new plants are

[27] Renewable Energy Institute, (Recommendation) "For Energy Shift in Japan: Onward to a Rich and Safe Nation" (February 18, 2015) https://www.renewable-ei.org/activities/reports_20150218.php

expected to continue to go online at a pace of around 6 GW per year. At this rate, it is likely that the 2030 target will be reached in 2020. RTS released a projection in February 2018 indicating the potential for capacity of approximately 150 GW by 2030[28].

Rooftop solar on houses, buildings, warehouses and other structures is expected to play a central role going forward. In addition, it will also be possible to establish large-scale solar power plants on unused former factory sites and on abandoned farmland, which amounts to 10% of Japan's farmland by area. There is also sufficient potential for installing a substantial quantity of solar power plants in forested areas while preventing environmental damage[29].

At the same time, growth in wind power in Japan has lagged behind, with capacity at just 3.65 GW as of the end of 2018[30]. This is just over one-third of the 10 GW projection for 2030 in the Strategic Energy Plan. At nearly the same time the feed-in tariff scheme commenced, wind power became subject to the Environmental Impact Assessment Act and interconnections with the power grid are limited in Hokkaido and Tohoku where wind conditions are favorable, so it has not been possible in Japan to realize growth in wind power as has been done globally. However, projects with a total capacity of approximately 26 GW (as of March 2018) have already undergone environmental impact assessments[31], and with these facilities steadily going online, the government's 2030 target is projected to be reached ahead of schedule in the early 2020's.

With establishment of the Japan Wind Power Association, "What's New: Installed capacity of wind power generation at the end of 2018: 3,653 MW, 2,310 units (revised)" (January 16, 2019) in Development of Power Generation Facilities Using Maritime Renewable Energy Resources (Renewable Marine Resources Act)[32] in November 2018, momentum is building toward development of offshore wind farms. TEPCO Holdings, Chubu Electric, ORIX, Tokyo Gas and other companies have already expressed their intention to enter the market, and Akita Prefecture, Niigata Prefecture and other local governments are also promoting installation plans. A common opinion is that Japan has minimal shallow waters and it would be difficult to install fixed-bottom wind turbines like Europe where offshore wind installations are accelerating. According to estimates[33] from the Japan Wind Power Association, however, there is clearly the potential even in Japan for 91 GW of fixed-bottom wind turbines. Based on this, the association has set a target for realizing 10 GW of offshore wind power by 2030.

The association's overall onshore/offshore target for 2030 of 36 GW has not been updated since its "Wind Power Energy Resources and Mid/Long Term Target (V4.3)," which was released in 2014[34]. Installation of new onshore wind farms has lagged somewhat behind the vision's projections, but even since the vision was crafted, wind power facilities have gotten larger and capacity utilization is also generally higher, plus the regulatory environment has improved with the new Renewable Marine Resources Act, so meeting the vision's supply target is still certainly possible.

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[28] RTS Corporation, "Action Plan Proposal for 150 GW Domestic Solar Capacity by 2030: Solar Power as Key Power Source: The Coming of the Solar Society" Executive Summary (February 2019) https://www.rts-pv.com/uploads/2019/02/rts_PV150_action_plan_summary.pdf

[29] Renewable Energy Institute, "For Expansion of Sustainable Solar Power" (January 7, 2019) https://www.renewable-ei.org/en/activities/reports/20190130.php

[30] Japan Wind Power Association, "What's New: Installed capacity of wind power generation at the end of 2018: 3,653 MW, 2,310 units (revised)" (January 16, 2019) http://log.jwpa.jp/content/0000289646.html

[31] Ministry of the Environment's Environmental Impact Assessment Network, "Environmental assessment cases being processed"

[32] On the act's provisions: METI press release, "Cabinet Decision on the Bill for the Act of Promoting Utilization of Sea Areas in Development of Power Generation Facilities Using Maritime Renewable Energy Resources" (November 6, 2018) https://www.meti.go.jp/english/press/2018/1106_002.html

[33] Japan Wind Power Association, "For promotion of offshore wind power: Specific issues and prospects related to new offshore wind power law" (March 16, 2018) http://jwpa.jp/k5u8z6e6/gfisf4vk/180316_offshore_request_r.pdf

[34] Japan Wind Power Association, "Wind Power Energy Resources and Mid/Long Term Target (V4.3)" (May 2014) http://jwpa.jp/pdf/2014June25_WindEnergyResourcesandMidLongTermTarget_Ver43.pdf

Fixing Japan's high cost structure

Renewable energy costs in Japan have been coming down in recent years. This is particularly the case with solar power. Looking at large solar power facilities of at least 1,000 kW, power was 33.6 yen/kWh in fiscal 2012, but this has decreased by 40% to 19.8 yen/kWh as of fiscal 2018. At the government's solar power auction in December 2018, prices for the seven winning bids had fallen to 14.25-15.45 yen/kWh (Figure 2-5)[35].

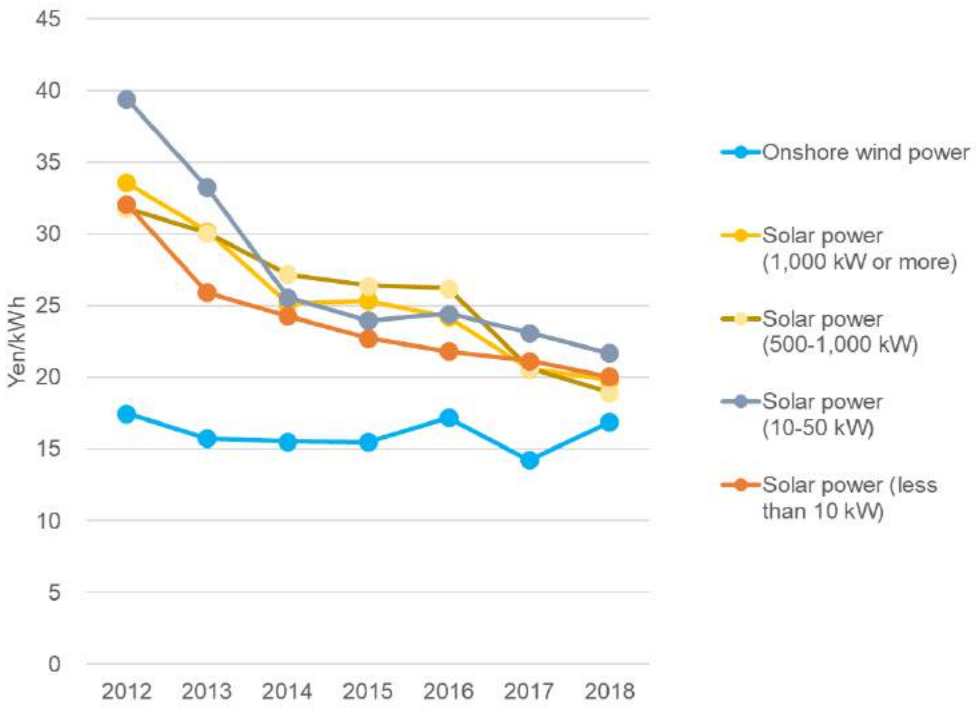

Figure 2-5 Solar and Wind Power Costs (2012-2018)

Source: Created by REI based on fiscal year figures from the Procurement Price Calculation Committee's "Opinion on Procurement Prices"

As this shows, solar power costs are coming down even in Japan, but they remain high by international standards. Fixing the high cost structure of solar power in Japan is the most important issue for realizing rapid growth. Table 2-2 compares solar power unit prices and costs for Japan, Germany, the U.K. and the U.S. using 2018 H2 data.

[35] Green Investment Promotion Organization, "Results of Third Solar Auction (FY18 H2)" (updated January 21, 2019) https://nyusatsu.teitanso.or.jp/servlet/servlet.FileDownload?file=00P7F00000CaI1X

Table 2-2 International Comparison of Solar Power Costs

	Germany	U.K.	U.S.	Japan
Unit price (yen/kWh)	7.3	9.8	6.2	13.6
Capital costs (10,000 yen/kW)	9.1	9.7	11.2	22.7
Operating costs (10,000 yen/kW/year)	0.20	0.20	0.15	0.30
Capacity utilization (%)	11	11	18	15
Capital procurement costs (%)	2.6	2.6	5.6	2.5

Source: Created by REI based on Bloomberg NEF's "Prices, Tariffs & Auctions"

What should first be noted is capacity utilization. Solar power has higher capacity utilization the longer the annual sunshine duration and the higher the intensity of solar radiation. Japan's capacity utilization is 15%, which is lower than the U.S.'s 18%, but four percentage points higher than Germany and the U.K. Sunshine duration is better than the U.K. or Germany, but Japan's unit price is 1.4-1.9 times higher.

It is clear from this comparison that the relatively high cost of solar power in Japan is not due to natural factors like differences in sunlight. Looking at costs, Japan's capital costs and operation costs are especially high compared to the other three countries. According to studies done by REI, there are no major differences in the cost of the equipment itself (solar modules, inverters, etc.), but engineering and electrical work costs, financing costs and margins for developers and installers are extremely high compared to Europe.

Even comparing projects within Japan, it is clear that differences in ordering and installation methods are responsible for large differences in energy costs. According to the BloombergNEF data used here, the average cost is 13.6 yen/kWh, but the minimum is 7.4 yen/kWh. This is by no means inferior to prices in the U.K. and Germany. Improving ordering and construction methods in Japan can certainly be expected to reduce costs significantly. The feed-in tariff scheme could also be improved.

RTS Corporation has also made projections for solar power costs going forward (Figure 2-6)[36]. According to these projections, equipment costs (modules, etc.) will continue to decline and eventually converge with international prices. Combined with reductions in operating and maintenance costs, etc. at large systems of 1 MW or more, energy costs are estimated to decline to 6.4 yen/1 kWh by 2025 and to 5.3 yen by 2030. Residential solar system costs are also projected at 8.0 yen/kWh by 2025 and 5.4 yen/kWh by 2030 (both based on accelerating installation and technology development).

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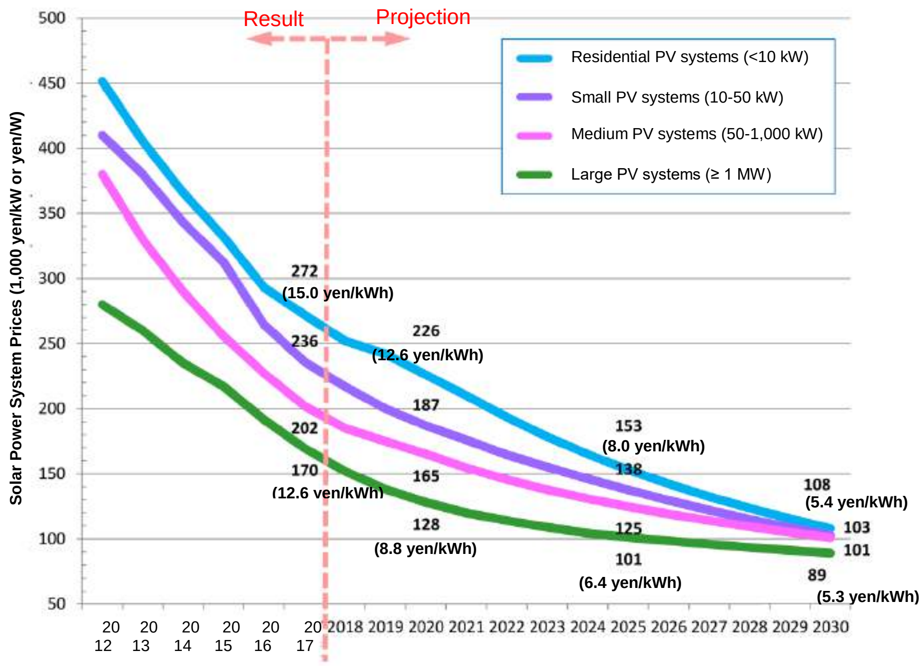
[36] RTS Corporation "Solar Power Capacity Estimates for 2030 in Japanese Market (2018-19)", p. 20 (September 2018)



(1) Solar power system prices (currently 170-272 yen/W) projected to decline to 89-108 yen/W by 2030)
(2) Energy costs (LCOE) will be 5.3-5.4 yen/kWh, declining to a point close to avoidable costs and lower than electricity rates on the receiving end

- Solar power cost estimates use "NEDO PV Challenges" (September 30, 2014) published by the New Energy and Industrial Technology Development Organization (NEDO)
- The lifespan of solar power systems is currently 20 years, but it is expected to lengthen to 25 years by 2025 and 30 years by 2030.

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RTS Corporation

Figure 2-6 Solar Power System Price Projections (to 2030, by system size)

Source: RTS Corporation, "Solar Power Capacity Estimates for 2030 in Japanese Market (2018-19)," p. 20 (September 2018)

At the same time, with new installations stagnating, there has been no marked downtrend in energy costs for wind power like there has been for solar. One reason costs remain high is the relatively limited opportunities for developers in Japan to gain experience and learn in order to reduce development costs due to the lack of major growth in the wind power market. It is also the case that development costs are relatively high due to restrictions on grid connection and irrational land use restrictions. The "Cost Competitiveness Task Force Report"[37] released in January 2019 by the Japan Wind Power Association (JWPA) puts current generation costs (LCOE) overall at generally around 14-15 yen/kWh.

The government has set a target for wind power costs of 8-9 yen/kWh by 2030, and the JWPA has the same target. The above Task Force Report presents a roadmap for making improvements by the mid-2020's in order to meet the 8-9 yen/kWh target, including design and maintenance improvements like larger swept areas, longer lifespans, and lighter weight nacelles, and by increasing capacity utilization with condition monitoring systems (CMS). According to data from regular reports submitted to the government based on the feed-in tariff scheme, six (9%) out of 64 onshore wind power operators already have power projects at less than 10 yen/kWh.

[37] Japan Wind Power Association Cost Competitiveness Enhancement Task Force, "JWPA Cost Competitiveness Enhancement Task Force Report: Toward Grid Parity" (January 2019)http://jwpa.jp/jwpa_report/JWPAcostTF_report_jan.2019.pdf

BloombergNEF has published forecasts for energy costs in Japan (Figure 2-7). According to these forecasts, solar power will become cheaper than natural gas in the early 2020's and coal-fired power in the mid-2020's. The report also predicts that onshore wind power will be cheaper than natural gas by the first half of 2020's.

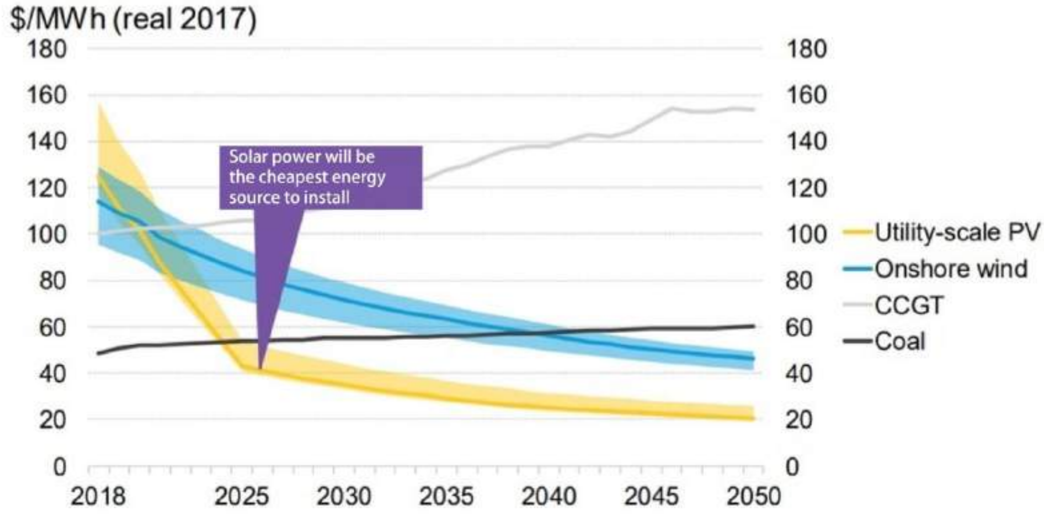

Figure 2-7 BloombergNEF Energy Cost Forecasts (to 2050)

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

For many years Japan has not enjoyed the benefits of inexpensive renewable energy like other countries, but it now looks probable that in the 2020's the high cost structure will be remedied and both solar and wind power will become more economical than nuclear and even coal-fired power.

Power system stability

Along with high costs, another problem often pointed to in connection with utilizing renewable energy in Japan is how to add large amounts of renewable energy to the power system without disrupting grid stability. On this point, however, various methods are already being used on the supply and demand sides in progressive countries and regions to integrate variable renewables into the power grid with stability at much higher percentages than Japan.

Output predictions based on weather forecasts, flexible operation of coal-fired power with highly adjustable output and use of demand management are some of the methods already established at present. Integrating these into power market operations makes it possible to create a mechanism by which the market autonomously prioritizes transactions with variable renewables. Variable renewables like solar and wind lend flexibility to the grid and can therefore also provide the grid with greater capacity.

Spain has a low capacity international power grid compared to other countries, and it uses these methods to stably integrate various renewables into its grid at rates of over 20%. By contrast, Denmark draws on its dense international grid to utilize variable renewables at rates of 40% or higher. Similarly, Ireland utilizes its international grid connections with the U.K. to successfully integrate wind power on a large scale.

In connection with these international grid examples, some argue that Japan presently does not share an international grid with any other country, so it cannot easily add renewables at high percentages. However, Japan's population and power demand are as large as several European countries. Japan's total population, as shown in the diagram, is equivalent to six European countries combined, including Germany and Sweden (Figure 2-8)[38]. Also, in terms of power demand, total power demand in Japan is equivalent to three times the U.K.

In Japan, there were previously nine general electricity utilities that each separately conducted operations in their respective service areas from Hokkaido to Kyushu. If Japan's power grid were managed as a single entity, it would be possible to add in large quantities of renewable energy like the international grids in Europe.

Country	Population (2016-2017 Estimates)
Denmark	5,760,694
Finland	5,508,214
Germany	82,657,002
Netherlands	17,099,796
Norway	5,276,968
Sweden	10,057,698
Total of 6 countries	126,360,372
Japan	126,786,000

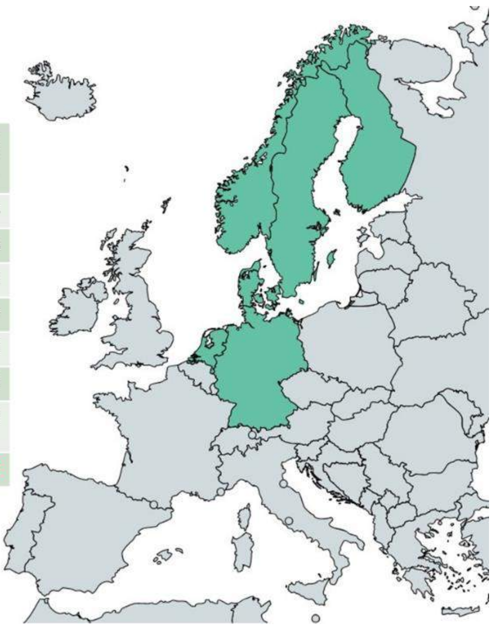

Figure 2-8 Population of Japan and Six European Countries
(2016-2017 estimates from the UN's "Population and Vital Statistics Report")

Based on a case study analysis that included Japan, the International Energy Agency (IEA) in its "The Power of Transformation" report[39] released in 2014 also states that it would be technically feasible to increase the share of variable energy from 25% to 40% even assuming current levels of power system flexibility.

REI conducted a study in 2018 with Agora Energiewende, a German think tank, and Elia Grid International (EGI), a European grid operator, on integrating variable renewables in large amounts into Japan's grid while maintaining power system stability[40]. The study made clear that Japan's power system can readily integrate renewables at a rate of 33% or more of annual power consumption (22% for variable renewables) while maintaining system stability, and even if the renewables share is as high as 40% (30% for variable renewables), it could be incorporated while keeping output restrictions low. This joint REI study with Agora Energiewende and EGI reached the same conclusion as the analysis in the abovementioned IEA report.

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[38] Calculated based on the UN's "Population and Vital Statistics Report" https://unstats.un.org/unsd/demographic-social/products/vitstats/seratab2.pdf

[39] OECD/IEA, "The Power of Transformation - Wind, Sun and the Economics of Flexible Power Systems" (2014) https://www.nedo.go.jp/content/100643823.pdf

[40] REI and Agora Energiewende, "Integrating Renewables into the Japanese Power Grid by 2030 - A frequency stability and load flow analysis of the Japanese system in response to high renewables penetration level" (December 2018) https://www.renewable-ei.org/en/activities/reports/20181217.php

3. Selecting power sources for 2030 and 2050

Power supply prospects for 2030

Power source shares in 2030 as listed in the government's Strategic Energy Plan (Figure 2-9 right) have renewable energy at 22-24%, nuclear at 20-22%, and thermal power at 44%. Figure 2-9 The figures on the left show the power supply as of fiscal 2017. Renewables have increased to 16.1%, while nuclear power is still only 3.1% of the power supply despite government and power company efforts to resume operations.

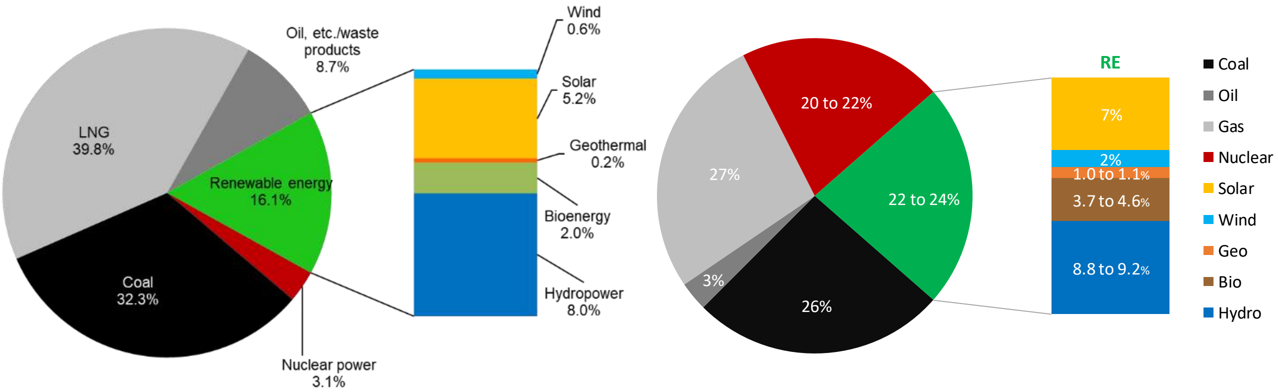

Figure 2-9 Japan's Power Mix, FY2017 results (left), FY2030 (long-term energy supply-demand projections) (right)

Source: Created by REI based on METI Agency for Natural Resources and Energy, "Comprehensive Energy Statistics" (referenced 11/22/2018) (left); METI, "Long-term Energy Supply and Demand Outlook for FY2030" (July 2015) (right).

Twenty-one of the 54 nuclear reactors operating before the Fukushima nuclear accident have been slated for decommissioning, or the decision on them is pending, so 33 reactors remain (one at Tokai and one or two at Hamaoka were slated for decommissioning prior to the accident). A total of nine reactors at Oi, Takahama, Genkai, Sendai and Ikata have resumed operations, but eight reactors have not even initiated the review process. To achieve the nuclear supply target in the Strategic Energy Plan will require operating reactors with a total capacity of around 35 GW, assuming capacity utilization of 70% (it was 67.2% in 2010), and this is just to meet the lower-end target of 20%. To create this much capacity, the following three hurdles will have to be overcome.

(1) Resuming operations at all 33 remaining reactors.

(2) Approving a 60-year operating timespan for all reactors that will reach their 40-year limit by 2030.

(3) Completing construction before 2030 on two reactors (Oma, Shimane 3) where construction has been stopped.

Due to significant safety concerns, it will not be easy for many of the nuclear plants that have not resumed operations to pass the Nuclear Regulation Authority's review process or obtain consensus locally. Prolonging operations at older reactors to 60 years is not only encountering vocal dissent, in some cases like with Tokai Unit 2, securing funding for the repairs required to extend operations is proving difficult. If the operating period remains at the original 40 years, a majority of the reactors will be shut down starting from the first half of the 2020's. 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 GHG emission reduction target of a 26% decrease from 2013 levels. This target itself has been criticized internationally as wholly insufficient and further improvements would be needed to meet even the 2°C target, let alone the 1.5°C target.

Given this, Japan has no choice but to increase renewable energy's share of supply to well beyond the current target of 22-24%.

Japan's solar power capacity can be realistically forecast to increase to over double the level assumed in the Strategic Energy Plan, and wind power, to over triple the level. Adding hydroelectric, geothermal, and bioenergy capacity at the levels assumed in the Strategic Energy Plan puts total renewable power supply at close to 400 TWh (Figure 2-10).

With total power 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 10% reduction in total power demand from current levels can be achieved, Japan would be able to supply 50% of its electricity with renewable energy.

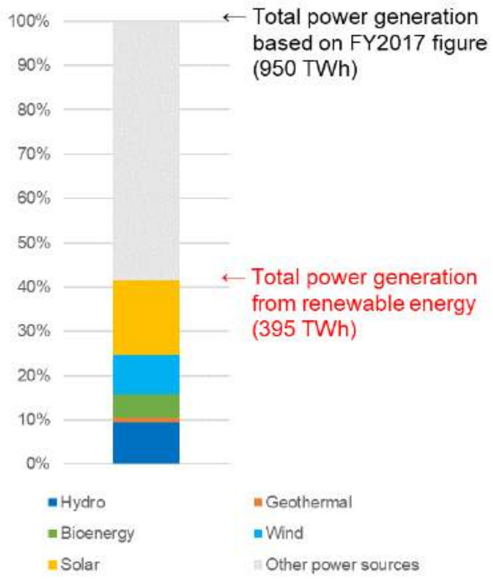

Figure 2-10 Sustainable Power Mix in 2030(based on REI's assumptions)

Source: Created by REI

Those critical of increasing renewables cite the increase in surcharges under the feed-in tariff scheme. An analysis of electricity prices since 2011, however, shows that changes in thermal power fuel prices has a bigger impact than changes in the surcharge.

REI has estimated how electricity prices will change in the case over 40% of Japan's electricity is supplied with renewables by 2030 as is assumed here (REI scenario), and in the case the percentage is at 22-24% as forecasted in the Strategic Energy Plan (government scenario) ([41]). Figure 2-11 shows the results. The REI scenario has higher surcharges than the government scenario, but wholesale power unit prices are lower, so when both factors are combined, electricity prices are lower. The wholesale power unit price is lower in the REI scenario because renewables is supplied in larger amounts, which makes it possible to eliminate thermal power sources with high fuel prices. This is called the merit order effect.

The estimates show that increasing renewable energy is an effective way of stabilizing electricity prices.

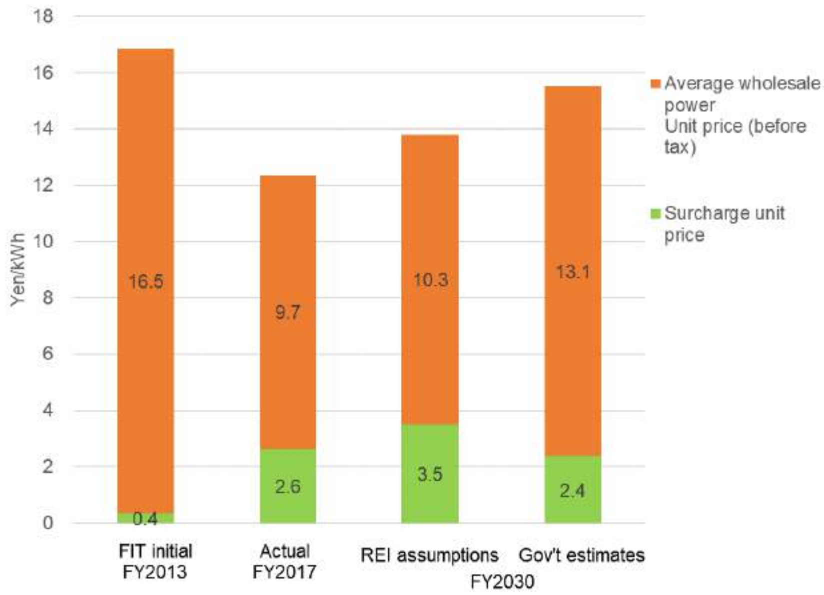

Figure 2-11 FY2030 Electricity Price Estimates (REI and government scenarios)

Source: Created by REI

From 40-50% in 2030 to 100% by 2050

A very different picture of Japan's power supply emerges from this. By the mid-2020's, solar power will be the cheapest source of energy, and wind power will be competitive enough to compete with thermal power. With companies required to disclose the impact of their corporate activities on climate change (carbon risk), more and more companies will procure renewable power as it becomes more economical. If over 40% of Japan's electricity is supplied with inexpensive renewable energy in 2030, the possibility of achieving 100% renewables by 2050 will likely be accepted as realistic by a majority of people.

Solar power will become cheaper and more efficient before 2050 and will be installed on the walls of buildings and municipal facilities, inside buildings and various other places it has not yet been installed.

[41] Details on how the estimates are calculated reference "Feed-in Tariffs in Japan: Five Years of Achievements and Future Challenges" (first version published August 10, 2017). The estimates' assumptions (renewable energy capacity, purchase prices, fossil fuel prices, etc.) are updated based on the most recent conditions. https://www.renewable-ei.org/en/activities/reports/img/pdf/20170810/REI_Report_20170908_FIT5years_Web_EN.pdf

A 2015 study conducted by the Ministry of the Environment[42] estimated that Japan has the potential for onshore/offshore wind power capacity of 608 GW, taking into account wind speeds, land use restrictions, ecosystem impact, and other factors. Considering that solar, hydro, geothermal, and bioenergy resources will also be utilized, realizing even a fraction of this potential would be sufficient to meet Japan's current electricity demand.

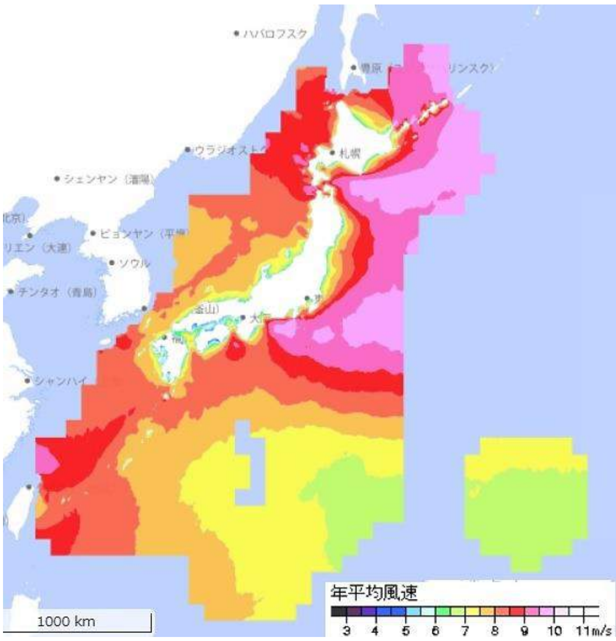

Figure 2-12 Japan Offshore Wind Condition Map

Source: New Energy and Industrial Technology Development Organization (NEDO), "NeoWins (Offshore Wind Condition Map)" (Accessed March 12, 2019) http://app10.infoc.nedo.go.jp/Nedo_Webgis/index.html

Further, establishing an international grid needs to be a full-fledged initiative to make this possible. It was generally thought in Japan that it would be difficult for an island nation to create an international power grid that crosses the ocean.

The Strategic Energy Plan states that Japan's energy environment is less like Germany, which has domestic coal reserves but also an international grid that makes it relatively easy to increase renewable energy, than it is like the U.K., which is dealing with declining production from North Sea oil fields and which as an island nation possesses limited international grid capacity. Though an island nation, however, the U.K. currently has four international grid connections totaling 4 GW that connect the U.K. with France, Ireland and the Netherlands. Four additional connections are under construction, another six projects have been approved, and one other is pending approval. The capacity of existing connections and those under construction totals 17.9 GW. This amounts to one-third of the U.K.'s maximum electricity demand. The Strategic Energy Plan's position lags behind the current reality of international grid reinforcements taking place in Europe.

[42] ITOCHU Techno-Solutions Corporation, "Report of Studies Commissioned on Grid Development in FY2013 for Increasing Renewable Energy Capacity" (January 2015) https://www.env.go.jp/earth/report/h27-02/mat01_zentai.pdf

The Asia International Grid Connection Study Group established by REI considers international grid connection routes between Japan, Korea and Russia (Figure 2-13, Figure 2-14), and released its second report[43] in June 2018. The conclusions of the report are as follows.

The report states that "it is physically and technically possible for Japan to construct interconnectors without any major problem in terms of connection to the onshore domestic network. Also, the construction costs of 2 GW interconnectors were found to be well recoverable, ranging from a little more than 200 billion yen (Japan–South Korea) to a little less than 600 billion yen (Japan–Russia) including the costs to reinforce Japan's domestic grids. "

International grid projects are being promoted by the government, power utilities and other actors even in countries like China, South Korea and Russia. Establishing an international grid in East Asia would create the infrastructure to make it possible to fully utilize the renewable energy sources in each country toward decarbonization of the entire region.

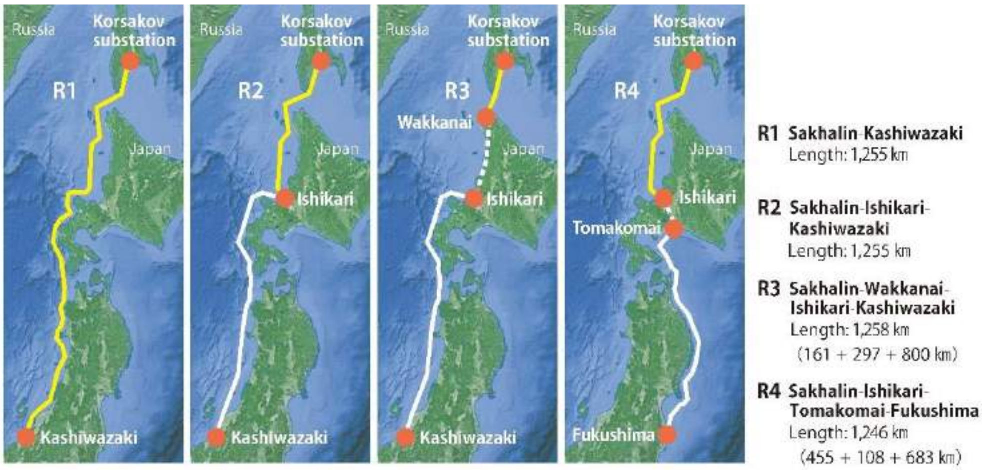

Figure 2-13 Asia International Grid (Japan-Russia Route)

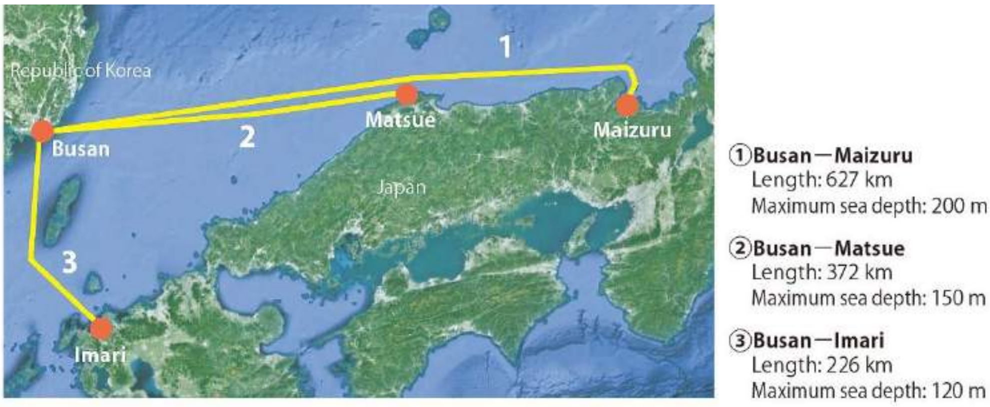

Figure 2-14 Asia International Grid (Japan-South Korea Route)

Source for Figure 2-13 and 14: REI "Asia International Grid Connection Study Group Second Report" (June 2018)
https://www.renewable-ei.org/pdfdownload/activities/REI_ASG_SecondReport_EN.pdf
https://www.renewable-ei.org/activities/reports/img/20180614/20180614_ASG_SecondReport_JP.pdf

[43] REI, "Asia International Grid Connection Study Group Second Report" (June 2018)
https://www.renewable-ei.org/pdfdownload/activities/REI_ASG_SecondReport_EN.pdf

The extreme difficulty of meeting the 2030 supply target for nuclear power established in the Strategic Energy Plan has already been discussed above and supplying nuclear power will become even more difficult moving toward 2050. Even if all existing nuclear reactors were to resume operations, in light of the 40-year operating rule (the four reactors with operating periods extended to 60 years calculated at 60 years), capacity as of 2050 will only be 2.8 GW (Figure 2-15). However, this 2.8 GW is the capacity of two reactors whose construction was discontinued after the earthquake, and without these, capacity is zero.

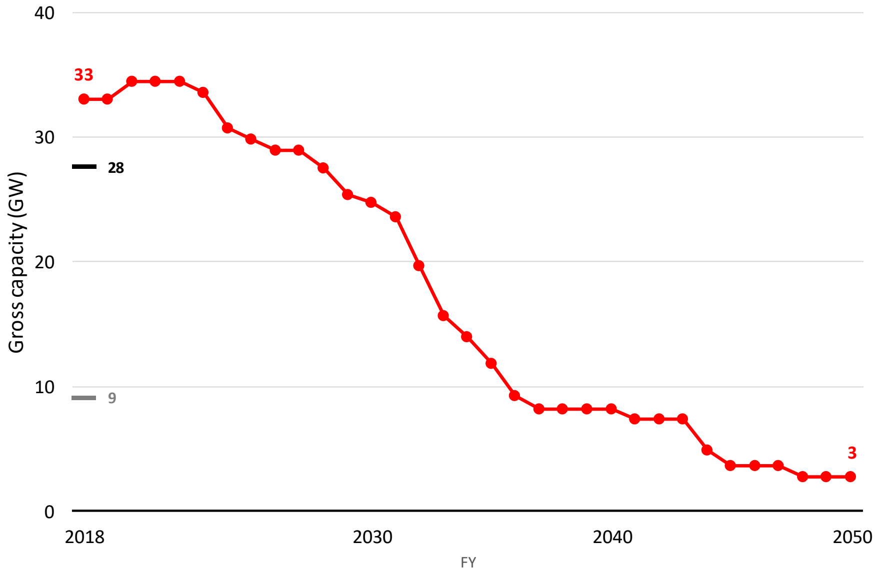

Figure 2-15 Nuclear Reactor Capacity Projection to 2050

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."

Building one new reactor costs approximately 1.5 trillion yen, and it is clear from cases of nuclear export projects to Turkey and the U.K. that had to be cancelled, they are not at all profitable. Having already experienced the Fukushima nuclear disaster, gaining the agreement of local residents on new reactor construction is pretty much an impossibility.

Given this state of affairs, the government has begun trumpeting the development of "next-generation nuclear power" like small modular reactors (SMR), tying the initiative to discussions of long-term reduction strategy. SMR development is taking place in China, the U.S. and Russia, but it is still in the development phase and energy costs are expected to be even higher than existing nuclear power. Renewable power is becoming more and more economical and is capable of being supplied in large amounts, so it is difficult to find the rationality in pursuing the development of high-cost "next-generation nuclear power" whose safety has also not been verified.

A number of existing nuclear reactors may be granted operating life extensions, but nuclear power cannot be considered a realistic power source for a decarbonized society in 2050 or thereafter.

Currently, virtually all of the coal, natural gas, and oil used as fuel for thermal power in Japan is imported, costing as much as approximately 16 trillion yen (for all fuel usage, including other than power generation)[44]. Japan has almost no fossil fuel resources or nuclear fuels, so even compared to the U.S. and countries in Europe, it would be highly rational to free itself of fossil fuels and nuclear power.

Japan has diverse renewable phenomena throughout the year, and when it comes to renewable energies like solar, wind, hydro, geothermal, and biomass, it is by no means a resource-poor nation; it is rich in sustainable energy. Utilizing the potential of renewable energy is the optimal means for Japan to break from its reliance on energy imports and achieve energy security, as well as the most certain path forward to decarbonization.

[44] Ministry of the Environment, “Annual Report on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan 2018”
http://www.env.go.jp/policy/hakusyo/h30/html/hj18010102.html

Part 2 Phase Out Coal-fired Power Before 2030

To decarbonize the power sector, countries around the world are increasing use of renewable energy while at the same time phasing out coal-fired power, the most carbon intensive power sources. Many countries will eliminate coal-fired power by 2030, financial institutions are withdrawing investment and financing from the coal business, and insurance companies are beginning to declare they will stop underwriting the industry.

Contrary to this global trend, Japan still continues a policy of promoting coal-fired power. New construction projects are being conducted domestically and support continues to be given for coal-fired power equipment exports overseas. Japan's coal policy is roundly criticized internationally and is damaging overall image of Japanese companies, which includes companies in other industries not involved in the power business. Products with lower CO_2 emissions are in demand globally, and if this coal-fired power promotion policy continues unchanged, Japan's international competitiveness could be affected as Japanese manufacturers and service industry companies are removed from international supply chains. It is also clear that the global market for coal-fired power facilities will continue to contract. A government policy promoting a certain coal-fired power is not only mistaken as a climate change measure, it is also seriously misguided as a growth strategy and economic policy.

In accordance with the Paris Agreement, Japan needs to immediately discontinue plans to build new coal-fired plants domestically and stop providing public subsidies for overseas exports and to phase out existing coal-fired plants as well before 2030. Whether or not Japan moves away from its coal-fired power promotion policy in its long-term reduction strategy will be a litmus test for whether Japan is truly serious about tackling climate change.

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

Targeting 2030, Powering Past Coal Alliance Launched and Growing

The Powering Past Coal Alliance[45] was launched at COP23 in 2017 under the leadership of the Canadian and British governments. The foundation of this initiative is a report[46] stating that to achieve the targets of the Paris Agreement, EU and OECD countries must end coal-fired power by 2030. A cabinet-level meeting of the alliance was held at COP24, and it was announced that 80 governments, local governments and businesses had joined as members and that it had partnered with the World Bank.

At least 20 out of the 35 OECD nations are either considering reducing coal-fired power or have already announced phase-out deadlines (Table 2-3). At present, 12 member countries of the alliance have phase-out deadlines of before 2030. The alliance's membership is not limited to national governments. South Chungcheong Province[47], whose coal-fired power capacity is twice that of Canada, also participates and has announced it plans to decommission 14 of its 30 coal-fired power plants currently in operation (18 GW) by 2026.

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[45] The Powering Past Coal Alliance is an international alliance aimed at phasing out coal-fired power that was established at COP23 at the end of 2017. https://poweringpastcoal.org/

[46] Climate Analytics, "Implications of the Paris Agreement for Coal Use in the Power Sector" (November 2016)

https://climateanalytics.org/media/climateanalytics-coalreport_nov2016_1.pdf

[47] Powering Past Coal Alliance, News, "South Chungcheong Province, home to half of South Korea's coal power generation, joins PPCA" (2 October 2018) https://poweringpastcoal.org/news/member-news/South-Chungcheong-Province-South-Korea-coal-Powering-Past-Coal-Alliance

With many European governments having announced coal-fired phase out plans, even Germany, which had prioritized ending nuclear power, announced in late January 2019 through its Commission on Growth, Structural Change and Employment (commonly called the Coal Commission) that it would be phasing out coal-fired power by 2038. Germany has 42.66 GW of coal-fired power capacity, roughly equivalent to Japan, and as a coal-producing country, has employment issues on mine workers. Its hurdles to phasing out coal are higher than Japan's. Germany plans to reduce coal-fired power by 30% (-12.6 GW) by 2022, 60% (-25.6 GW) by 2030, and its remaining 17 GW by 2038.

By contrast, under the Trump administration, the U.S. has attempted to gut the climate change policies instituted during the Obama presidency and has returned to a policy of defending coal-fired power. However, owing to lower prices for natural gas and renewable energy, the activities of NGOs dedicated to eliminating coal, the policies of state governments more actively promoting renewable energy growth, and other initiatives, coal-fired power is being phased out at a pace exceeding that of the Obama administration. According to the U.S. Environmental Protection Agency, coal use in 2018 shrank to its lowest level in 39 years[48].

Table 2-3 Coal-Fired Power Phase-Out Schedules by Country

Country	Coal-fired phase-out schedule	PPCA
Belgium	2016; Achieved 0% coal-fired power, the first country in EU	Member
France	0% by 2021; declaration by President Macron	Member
Sweden	0% by 2022; to be first in EU at 0% fossil fuels	Member
U.K.	0% by 2025; first to declare coal phase-out	Founded
Austria	0% by 2025; only two plants remain	Member
Italy	0% by 2025; part of national energy strategy	Member
Finland	0% by 2029; legislated in 2018	Member
Netherlands	0% by 2030; including 3 plants completed in recent years	Member
Canada	0% by 2030	Founded
Denmark	0% by 2030	Member
Portugal	0% by 2030	Member
Mexico	Plan to reduce to 4 GW by 2029	Member
Germany	Considering phase out by 2038 Reduce 13 GW by 2022, 26 GW by 2030 Berlin to 0% by 2030	–
Chile	Declared coal-fired power phase-out; cancelled all new projects	–

Source: Created by REI based on documents from the PPCA and each country.

48 USA EIA, "U.S. coal consumption in 2018 expected to be the lowest in 39 years" (December 4, 2018) https://www.eia.gov/todayinenergy/detail.php?id=37692 (URL viewed March 20, 2019)

IPCC 1.5°C Report calls for quick withdrawal from coal-fired power

The IPCC 1.5°C Report has made it clear that there is virtually no room for new coal-fired power plants to be built anywhere in the world. Most of the various CO_2 reduction scenarios in the report are united in requiring the quick phase-out of coal-fired power given coal's status as the most carbon-intensive fossil fuel. Coal-fired power currently accounts for approximately 38% of overall generation[49], but the report is emphatic on the need to reduce this to 0% by 2050. In addition, to achieve 0% by 2050 will require reducing coal-fired power's share of the power sector from the current 38% to 10% or less and its output to around one-third of current levels by 2030[50].

Coal phase-out policy

Both regulatory and economic levers are being utilized in countries committed to phasing out coal. The U.K. and Canada first set strict emissions standards for new coal-fired power plants that cannot be met with existing technologies. The U.K.'s emission standard is 450 gCO_2/kWh[51], and Canada's is 420 gCO_2/kWh[52]. These emission standards were then applied to existing power plants, and all plants that have not met the standard by the phase-out deadline will be shut down. At the same time, as an economic lever, the EU introduced a feed-in tariff scheme with unified carbon pricing in 2005. Transaction prices, however, stagnated and the scheme did not produce adequate results, so the U.K., which plans to phase out coal by 2025, instituted a carbon price floor (18 GBP/t-CO_2 in 2018) for coal-fired power plants in 2013[53].

As a result of this policy, the U.K. reduced coal-fired power's share of total supply from 42% in 2006 to 7% in 2017[54].

2. Japan's persistent reliance on coal

Emissions from power plants, including commercial plants and onsite generators, accounted for approximately 44% (preliminary figure) of CO_2 emissions from energy sources as of 2017. Over half of this total is emissions from coal-fired power. Compared to 1990 levels, CO_2 emissions from energy sources have been reduced by 160 million tons overall, but emissions from coal-fired power have risen nearly threefold, from 100 million to 280 million tons.

Consumption of coal for power generation has also increased dramatically. The amount increased more than threefold, from 26 million tons in 1990 to 83 million in 2015 (Figure 2-16). Major reductions to emissions can be made by transitioning away from coal-fired power.

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[49] IEA" Coal-fired power" (May 24, 2019) https://www.iea.org/tcep/power/coal/

[50] Paths to reducing coal-fired power emissions are analyzed by the German think tank Climate Analytics and other organizations in line with the IPCC's 1.5°C Report.

[51] UK Department for Business and, Energy and Industrial Strategy "IMPLEMENTING THE END OF UNABATED COAL BY 2025 Government response to unabated coal closure consultation" (January 2018) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/672137/Government_Response_to_unabated_coal_consultation_and_statement_of_policy.pdf

[52] Government of Canada "Proposed amendments to coal-fired electricity regulations and proposed natural-gas-fired electricity regulations" Date modified: February 16, 2018 (website viewed March 24, 2019)

[53] House of Commons Library "Carbon Price Floor (CPF) and the price support mechanism" (January 8, 2018)

[54] Calculated based on IEA, "Electricity Information" (2009 edition, 2018 edition)

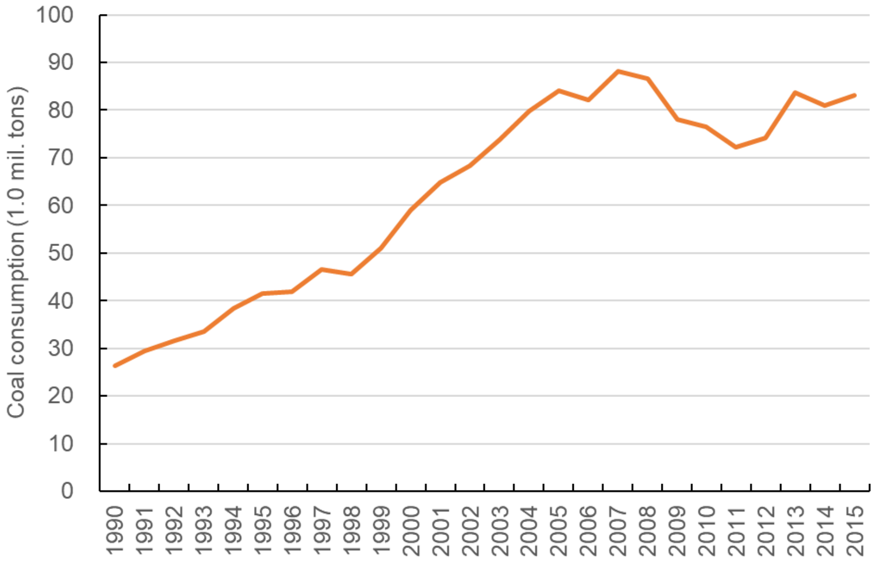

Figure 2-16 Coal Consumption by Japan's Power Industry

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

Japan's power industry promoted nuclear power under the pretext of climate change policy, but it also continued to bolster coal-fired power despite it having the highest emissions factor among all thermal power sources. Depending its climate change policy on nuclear power, the government did not introduce CO_2 reduction measures carried out in the U.S. and Europe, like setting coal-fired emission standards and introducing carbon pricing. New coal-fired power plants continued to be built, while increasing renewable energy has not been seriously taken up.

The Great East Japan Earthquake and Fukushima nuclear accident immediately caused nuclear reactors to be shut down throughout the country and exposed the weakness in a climate change policy long reliant on nuclear power. As of 2011, just 0.02% of Japan's total energy supply was provided by solar and wind power[55]. To make up for the lost nuclear power, power utilities restarted older oil- and coal-fired plants, and this immediately raised the emissions factor of the power supply. After the earthquake, the government took measures such as expediting environmental impact assessments for replacement coal-fired power plants and establishing an auction mechanism for new coal-fired power, and in 2013 it accelerated new coal-fired plant construction projects. The government's Strategic Energy Plan, revised in 2014 for the first time after the Fukushima nuclear disaster, positioned coal-fired power as an important "base-load power source" along with nuclear power, and this positioning was not changed when the plan was revised in 2018.

After the earthquake, plans were announced for new coal-fired plants with a capacity of 21 GW. Although 7 GW plans were eventually scrapped due to worsening profitability caused by changes in market conditions and to criticism at home and abroad, 1.3 GW has already begun operating and construction on another 8.6 GW is underway. Additionally, 4.4 GW is either currently in the environmental assessment phase or has completed the assessment and is awaiting the start of construction (Figure 2-17, as of February 28, 2019). This will come in addition to the 43.4 GW of coal-fired power already operating in Japan since before the earthquake. Subcritical (Sub-C) and supercritical (SC), whose efficiency is particularly poor, accounts for 58% (25 GW) of this total, and 6.9 GW (32 plants) has been operating for over 40 years. Only 0.6 GW, however, has been officially slated for decommissioning, and even including plants scheduled to be shut down temporarily, the figure is still less than 1 GW.

[55] Calculated based on IEA, "Electricity Information" (2014 edition)

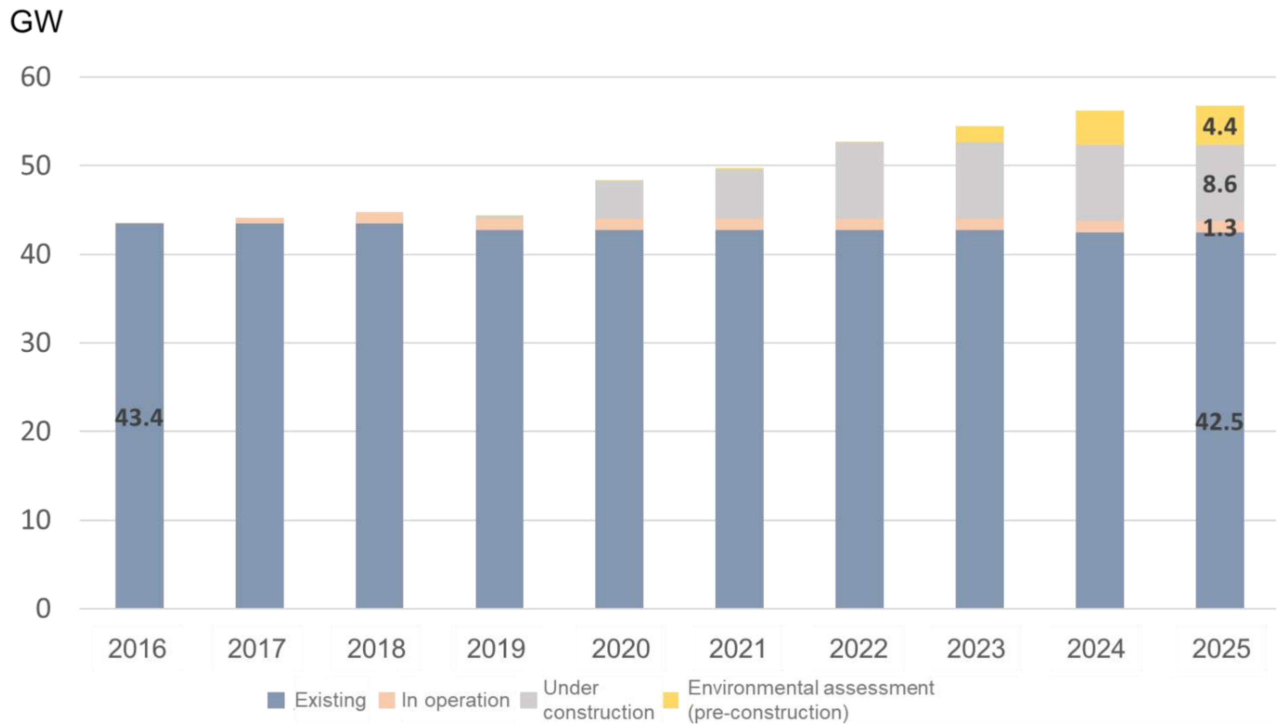

Figure 2-17 Total Capacity of Existing and Planned Coal-Fired Plants, Development Status, and Operation Start/End/Suspend Plans

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

In the government's 2030 power mix plan, coal-fired power is set at 26% of the total. With OECD countries planning to phase out coal-fired power by 2030, Japan's current plan to use coal for 26% of its power supply is highly problematic, and because new coal-fired plants continue to be built, even this percentage may be exceeded unless existing plants are phased out. If this happens, Japan may not even be able to meet its low target of 26% GHG reductions by 2030, compared to 2013 levels, which is in the Plan for Global Warming Countermeasures (2016).

The measures the government has taken thus far to reduce emissions from coal-fired power include an efficiency standard (42%) for new coal-fired plants based on the Act on the Rational Use of Energy (Energy Conservation Act), an efficiency standard (44.3%) for overall thermal power in 2030, and a 44% supply standard of non-fossil fuel power sources to retailers by 2030 based on the so-called Act on Sophisticated Methods of Energy Supply Structures (Sophisticated Methods Act). Judging by the many new plant construction projects that got underway in 2018, these standards are not currently playing an inhibitory role for most providers.

In the current Strategic Energy Plan, revised in 2018, the notion of phasing out inefficient coal-fired power makes an appearance as the plan calls for a mechanism to promote the phase out of inefficient coal-fired plants (supercritical and lower), which includes restrictions on new plants. This call seems to address the increasing international criticism of Japan's coal-fired power, but the government still plans to continue its policy of promoting what is called "high-efficiency" coal-fired power. The Japanese government defines high efficiency as coal-fired power that is ultra-supercritical (USC) or higher, but the emissions factor of USC is not that much different from standard coal-fired power. Even with technologies like integrated gasification combined cycle (IGCC), whose implementation has yet to start on a full-fledged basis, and integrated gasification fuel cell cycle (IGFC), whose technology is targeted for viability by around 2025, there is no change to the fact that CO_2 emissions are around two times that of the commonly used gas turbine combined cycle (GTCC) (Figure 2-18)[56]. The global push to phase out coal seeks to completely eliminate coal-fired power, including plants referred to as "high-efficiency;" the government's policy in this regard is completely inadequate.

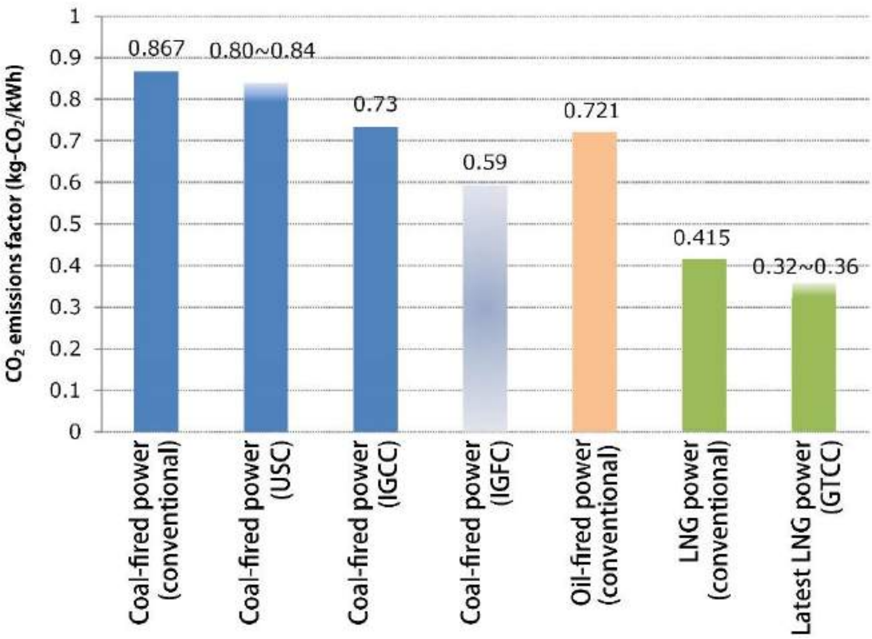

Figure 2-18 Comparison of Fossil Fuel-Fired Power Plant Emission Factors (By Fuel Type)

Source: Document 5, "Significance of Carbon Pricing" from the first meeting of the Ministry of the Environment's Carbon Pricing Subcommittee (June 2017) https://www.env.go.jp/earth/ondanka/cp/arikata/conf01/cp01_mat5.pdf

3. Internationally criticized coal-fired power export policies

Strong international criticism has been directed not only at Japan's policy of promoting coal-fired power but also at its policy of promoting the export of coal-fired power facilities. Japan is a major financer of coal-related projects and the country's megabanks are among the world-leaders in funding and investment for fossil fuel resources. With adoption of the Paris Agreement, the flow of funds being invested in energy in particular needs to be changed.

[56] Document 5, "Significance of Carbon Pricing" from the first meeting of the Ministry of the Environment's Carbon Pricing Subcommittee (June 2017) https://www.env.go.jp/earth/ondanka/cp/arikata/conf01/cp01_mat5.pdf

During the 10 years from 2009 to 2018, the Japan Bank for International Cooperation (JBIC), Nippon Export and Investment Insurance (NEXI), and Japan International Cooperation Agency (JICA) provided at least 16.1 billion U.S. dollars in overseas funding and insurance for 25 GW of coal-fired power facilities. The majority of this went to Indonesia (7 GW), India (6.4 GW) and Vietnam (6.7 GW). Along with these coal-fired power facilities, support is also provided for coal mining and power grid development in connection with coal-fired power. Along with public funding involving the JBIC or JICA, in the private sector, Japanese megabanks are involved in many projects.

This support has been promoted under the banner of emissions reduction, electrification, and anti-poverty measures through utilization of advanced coal-fired power technology. However, the dramatic decline in renewable energy prices and changes in demand for energy that have also taken place in developing countries mean that the original grounds for providing this support are disappearing. In parts of India and Indonesia, there are concerns about overcapacity from power surpluses. India is planning to end new construction of coal-fired plants by 2027 and is projected to close 22.7 GW of the coal-fired plants over five years from 2017 under more stringent environmental standards. Its 2018 National Electricity Plan indicates that power demand would be met even if these coal-fired plants were closed. Since 2016, in terms of capacity, new renewable energy plants have exceeded coal-fired power, and LCOE costs for solar power are lower than coal-fired power using domestic coal.

Further, according to the Japan Center for a Sustainable Environment and Society (JACSES), coal-fired boilers receiving support and in operation, under construction or being planned in South and Southeast Asia that are ultra-supercritical (USC) boilers, positioned by the government as “the latest technology,” account for just 2 GW of the 12.09 GW total; standard supercritical (SC) boilers make up the remaining 10 GW. USC boilers are also provided by China and South Korea, so it is not the case that Japan is exporting plants with especially high energy efficiency. Actually, USC-level plants do not even account for half of the projects supported by the JBIC and JICA over the past five years. More recently, in 2018, support was provided for low-efficiency SC boilers in Vietnam.

Given this state of affairs, if Japanese companies continue their coal-fired power businesses with public and private funding, coal power usage and CO_2 emissions in countries receiving support will solidify, and this will delay the countries’ transition to cheaper, minimally polluting renewables. Moreover, it will not only worsen the impact of climate change on an already vulnerable region, but also adversely affect the environment there. There is also the potential in the near future for the plants to become stranded assets.

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

The development and use of carbon capture and storage (CCS) technology provides a rationale for thinking Japanese coal-fired power is high efficiency and serves as grounds for the government’s coal promotion policy. The method called CCS of separating out and collecting carbon dioxide that is emitted and storing it in the ground or elsewhere has been trumpeted since the 1970’s as a technology for reducing carbon dioxide emissions. As stated in the Strategic Energy Plan, the purpose of CCS is to promote coal-fired power with reduced environmental impact. In the Strategic Energy Plan, there is mention of increasing coal power exports with CCS in stages based on the technology’s viability in practical application[57], so the intention is to export the technology overseas and not just use it to reduce CO_2 emissions at home.

[57] Strategic Energy Plan (Cabinet decision July 3, 2018) https://www.meti.go.jp/english/press/2018/0703_002.html

Research and development on CCS, however, has gone on in Japan and other countries since the end of the 1980's, but though 30 years have passed, it is not being utilized as a practical measure for CO_2 reduction. With the Paris Agreement target of less than 2°C warming and with the 1.5°C target in place as well, there is certainly a push to continue considering the possibilities of CCS technology, even internationally. However, as the dramatic fall in renewable power costs has given renewable energy an increasingly advantageous position as a decarbonization technology, it is becoming more and more difficult to justify CCS as a countermeasure for the power sector.

The decarbonization strategy to 2050 released by the European Commission in November 2018[58] acknowledges the need to consider CCS as a means of reducing the final remaining carbon dioxide after thoroughgoing reductions have been made by increasing energy efficiency and utilizing renewable energy and other technologies. The EU's strategy contains no plans to utilize CCS technology as a CO_2 reduction measure in the power sector.

Actually, according the global project list[59] released by the Global CCS Institute, which promotes CCS, there have only been two cases of the technology being applied to coal-fired power plants, one in the U.S. and one in Canada. The Canada plant's capacity is 110 MW[60] and the U.S. plant's is 240 MW[61], so they are by no means large thermal power plants. In addition, both plants are enhanced oil recovery (EOR) projects aimed at increasing oil production by injecting the recovered carbon dioxide into oil fields; CCS is not being conducted as an emissions reduction measure.

There was a time when Europe was actively working to make CCS viable as an emissions reduction measure for thermal power. The European Council in 2008 set a policy of supporting CCS demonstration projects and sought to conduct 12 commercial-scale projects by 2015. Two types of funding programs were started in 2009, but ultimately, as of today, with the exception of one small-scale pilot project, not a single project has been conducted.

The report released by the European Court of Auditors in October 2018[62] came to the conclusion that CCS support programs ran by the European Commission from 2008 to 2017 produced almost no beneficial results. The European Court of Auditors report cites stagnating carbon prices as one reason for the failure, but an offshore wind power project targeted at the same time by the same support programs grew substantially and has been considered a success.

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[58] European Commission "A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy COM (2018) 773 final"(November 28, 2018) https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_en.pdf

[59] Global CCS Institute "Facilities Database" https://co2re.co/FacilityData(Accessed March 7, 2019)

[60] SaskPower "Boundary Dam Carbon Capture Project" https://www.saskpower.com/our-power-future/infrastructure-projects/carbon-capture-and-storage/boundary-dam-carbon-capture-project

[61] NRG Energy "PETRA NOVA Carbon capture and the future of coal power" https://www.nrg.com/case-studies/petra-nova.html

[62] European Court of Auditors "Special Report Demonstrating carbon capture and storage and innovative renewables at commercial scale in the EU: intended progress not achieved in the past decade" (October 23, 2018) https://www.eca.europa.eu/Lists/ECADocuments/SR18_24/SR_CCS_EN.pdf

No real prospects for Japan's CCS projects

Japan's Strategic Energy Plan sets the goal of viable CCS technology by around 2020, and the Ministry of Economy, Trade and Industry and Ministry of the Environment are separately and jointly promoting multiple projects. Viable CCS requires technology to capture carbon dioxide from emission gases, technology to transport it to the storage site and technology to store it permanently. The transport and storage technologies depend on the existence of suitable storage sites in Japan in terms of both location and capacity. Most CCS projects conducted globally to date (16 out of 18) have stored the carbon dioxide at onshore oil drilling sites, etc.[63], but Japan has only very minimal suitable sites onshore. Japanese projects therefore mainly seek to store the carbon dioxide under the seafloor.

At the CCUS Early Adoption Conference held by the Ministry of the Environment in March 2019[64], a report was given on the current state of the technology's development. A document submitted to the conference[65] contained the statement, "Japan's storage potential seems substantial [...] but it is not known how much can be stored...." Actually, a specific suitable storage site has not yet been found. What is clear from this conference is how far the technology is from the target of practical viability by around 2020, and that CCS technology development is at the stage of basic concept construction and risk assessment methodology design for underground storage.

Coal-fired power with CCS not cost competitive

Initial calculations in the report[66] of the Expert Study Group on Ideal Approaches to CCS Demonstration and Research Projects published in August 2018 by the Ministry of Economy, Trade and Industry put the cost for carbon dioxide reduction via CCS, assuming a 20-km pipeline as the means of transport, at approximately 6.3 yen/kWh, and at approximately 9.8 yen/kWh when including maritime transport.

The report adds these CCS costs to the cost of coal-fired power in the government's 2015 report on power cost verification, which is 8.9 yen/kWh (deducting CO_2 measures), to estimate coal-fired power costs with CCS at 15.2-18.7 yen/kWh. Moreover, compared to renewable energy estimates in the same power cost verification report, solar (megasolar) is 12.7-15.6 yen/kWh, wind power (onshore), 13.6-21.5 yen/kWh, and biomass (mono-fuel combustion), 29.7 yen/kWh, and the report concludes that under certain conditions, CCS is expected to be cost competitive as a low carbon technology.

As shown in Part 1, projects at the 14-yen level have already appeared at solar power auctions held in 2018, even in Japan. BloombergNEF data for the second half of 2018 reports cases as low as the 7-yen level. It is estimated that by 2030 the cost of solar power will fall to the 5-yen level, and wind power generation to the 8-9-yen level. Assuming the estimates of the verification working group from 2015, asserting the cost competitiveness of coal-fired thermal with CCS is not persuasive.

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63 Global CCS Institute "Facilities Database" https://co2re.co/FacilityData(Accessed March 7, 2019)

64 "CCUS Early Adoption Conference: Demonstration Project Terminus and the Road Ahead" (March 5, 2019), held by the Ministry of the Environment
http://www.env.go.jp/earth/ccs/ccus-kaigi/post_50.html

65 Document 2-1," CCUS Early Adoption Conference: Demonstration Project Terminus and the Road Ahead" (March 5, 2019), held by the Ministry of the Environmenthttp://www.env.go.jp/earth/ccs/ccus-kaigi/2-1_CCUS_storage.pdf

66 Ministry of Economy, Trade and Industry, "Report of the Expert Study Group on Ideal Approaches to CCS Demonstration and Research Projects" (August 2018)
http://www.meti.go.jp/shingikai/energy_environment/ccs_jissho/pdf/20180822_01.pdf

CCS Ready policy behind the times

As can be seen from this, CCS technology development in Japan is still at the foundational stage with no prospects for viability in sight. It is difficult to imagine that the technology will be cost competitive after 2030. The government is considering introducing a policy called "CCS Ready" in connection with the development of CCS technologies[67]. The policy generally makes it mandatory during the approval process for new coal-fired power plants with high emissions to stipulate in advance that CO_2 reductions will be made through the use of CCS technology when it becomes available in the future.

Even in the European cases discussed above, CCS Ready policies have been implemented alongside support projects. However, with the support projects failing, the policy is becoming increasingly unrealistic as a CO_2 reduction measure. The U.K., which promoted a CCS Ready policy more robustly than any European country, has since decided to eliminate coal-fired power by 2025, instituting even stronger policies like a climate change tax, and has already significantly reduced coal-fired power in the country.

Planning for a CCS future despite no prospects for viability and a lack of cost competitiveness even in Japan and continuing to build new coal-fired plants and operate existing plants is completely unreasonable. CCS Ready is a policy that is already behind the times.

Despite no realistic prospects, a policy that aims to prolong the life of coal-fired power while discussing the possibilities of CCS Ready is bound to draw criticism internationally. The CO_2 emissions of CCS are not zero to begin with. The International Energy Agency estimates that emissions from coal-fired power would remain at approximately 100-140 g/kWh of CO_2 even with CCS[68]. The technology is hardly suited to achieving a decarbonized society.

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

Even in Japan, private-sector financial institutions, which are finally becoming concerned about stranded assets, have begun to announce they are ending funding and investment for new coal-fired power projects in Japan and abroad, though their announcements have been shaded in various ways. The megabanks, which have invested substantial funds in fossil fuels, are continuing their policies of supporting coal-fired power projects in the ultra-supercritical (USC) class. No insurance companies in Japan have declared they will stop underwriting coal-fired projects, but major insurers like France's Axa and Germany's Allianz have a policy of not investing in, financing or insuring coal-fired power or coal mining. If insurers offering insurance decrease in number, it could impact coal prices in the future. Additionally, in 2018, reinsurance companies like Swiss Re and Munich Re have tightened their policies on financing and underwriting coal-fired power and coal mining. According to Munich Re[69], damage caused by natural disasters in 2018 amounted to 16 trillion yen (160.0 billion US dollars), and there is a strong sense of crisis with respect to the increasing severity. Even so, the Japanese government has not altered its promotion policy, and as a result domestic trends clearly lag behind the rest of the world.

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[67] Ministry of the Environment, "CCS Ready Initiatives in Japan and Abroad" (February 2017) https://www.env.go.jp/press/files/jp/105492.pdf

[68] IEA "Energy Technology Perspectives 2017"（6 June 2017） pg. 366http://www.acs-giz.si/resources/files/Energy_technology_perspectives.pdf

[69] 8 January 2019, Munich Re Press release: Extreme storms, wildfires and droughts cause heavy nat cat losses in 2018

With the publication of the IPCC's 1.5°C Report and CO_2 reduction policies being strengthened globally, the outlook for coal-fired power is clear. Most advanced countries have announced a phase out before 2030, and coal-fired power, from which banks, insurers and pension funds are beginning to withdraw, is a technology that will eventually disappear no matter how efficient. Given these circumstances, there is no time to subsidize a technology with no future prospects. The Japanese government needs to announce in its long-term reduction strategy that it will transition to a policy of funding technologies with future potential ahead of 2050 in order to help ensure the long-term global competitiveness of Japanese companies.

What is needed now is a fundamental, strategic transition to phasing out coal-fired power to decarbonize the power sector, not shortsighted policy. The government needs to set a phase-out deadline of before 2030 and consider a concrete phase-out plan. It should begin to formulate a specific phase-out schedule and process, which could include, for example, first shutting down the 35 total subcritical (sub-C) and supercritical (SC) plants that have operated for over 40 years (approx. 8 GW) before the end of 2019, then shutting down the remaining 56 sub-C and SC plants (18GW), and finally stopping ultra-supercritical (USC) plants (refer to Figure 2-19). The longer a policy signal is delayed, the greater the stranded assets and the cost of future measures, while the impact of climate change and the task of countering it are left to future generations.

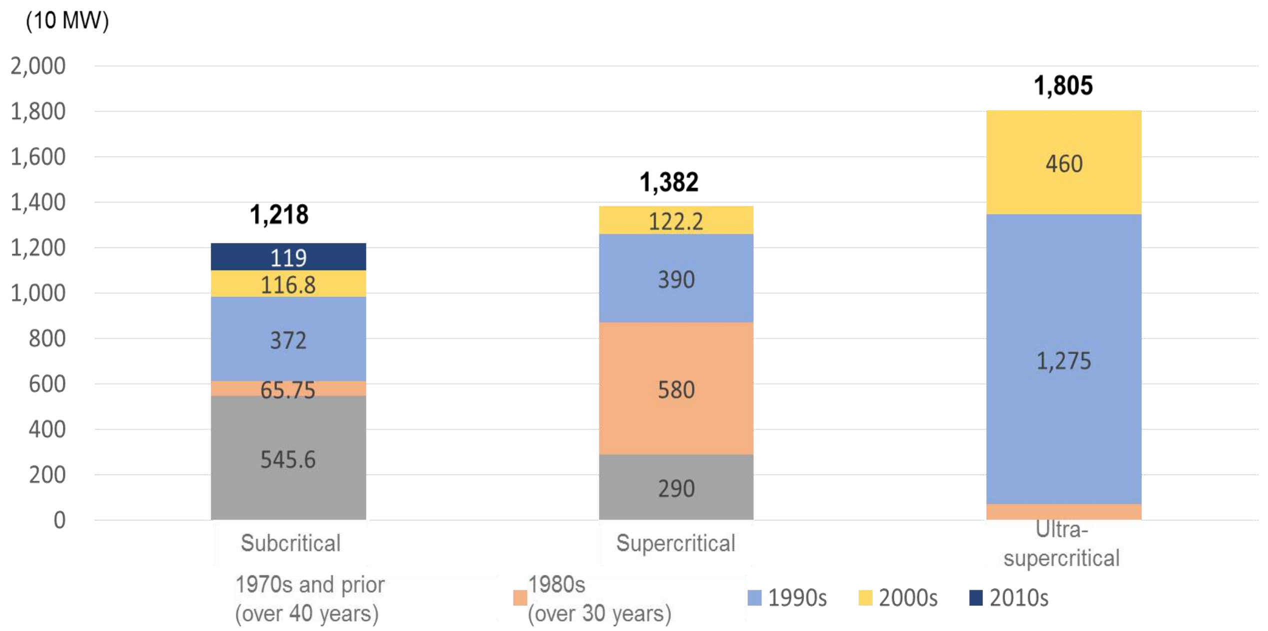

Figure 2-19 Coal-Fired Power Plants by Technology Type and Years in Operation

Note: Excludes other technologies like IGCC. Six smaller plants totaling 112 MW with unknown technologies are assumed as subcritical.

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

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

The industrial sector's share of CO_2 emissions (approx. 19%) is the second largest after the energy conversion sector, even globally, so reduction measures for this sector are highly important. Japan, which has prided itself on being a manufacturing superpower, has an even higher percentage, with the industrial sector accounting for 27% of emissions in fiscal 2017.

In light of its importance, countries have set high reduction targets for the industrial sector. For example, Germany is making reductions of 49-51% by 2030 (compared to 1990 levels), and France, of 24% by 2030 and 75% by 2050 (compared to 2013 levels); both countries are working toward lofty goals. By contrast, Japan's 2030 reduction target for the industrial sector is just 6.5% (compared to 2013 levels), well below other countries. Even compared to the reduction targets of other sectors in Japan like commercial (40%), residential (39%) and transport (28%), the meagerness of the industrial sector's target is striking[70].

Lurking in the background of this low reduction target for the industrial sector in Japan is the widespread but mistaken belief in Japan that because the country is an energy efficiency superpower there is no room to reduce emissions in the power sector; it would be like wringing out a dry rag. Actually, there is still a great deal of room for emissions reductions in the industrial sector. Furthermore, transitioning to the newly developing circular economy and bio economy has the potential to generate new business models for a decarbonized society.

CO_2 emissions from Japan's industrial sector are especially high in four basic material industries, steel, chemicals, cement and paper, accounting for around 80% of the sector's overall total. Reduction measures for basic material industries do have inherent difficulties, but they cannot progress while avoiding the transition to a decarbonized society. Starting with basic material industries, Japan's industrial sector needs to quickly transition away from dependence on fossil fuels and lead the world in developing new decarbonized business models.

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

Greater energy efficiency in Japan's stagnant manufacturing sector

The belief that Japanese industry has no more room to increase its energy efficiency has its origins in the experience of making major efficiency gains from the oil crisis of 1973 to the early 1980's. While it is true that since the Energy Conservation Act was enacted in 1979, efficiency measures have been conducted under the act, and from the 1970's to the first half of the 1980's modernizing facilities also had a major effect, as energy efficiency in Japan overall was improved by around 35%. However, as is shown in the government's Energy White Paper, for the past 30 years since the second half of the 1980's, the efficiency of the manufacturing industries has been at a standstill (Figure 2-20).

[70] The German and French targets are based on direct emissions; Japan's targets for each sector are based on indirect emissions.

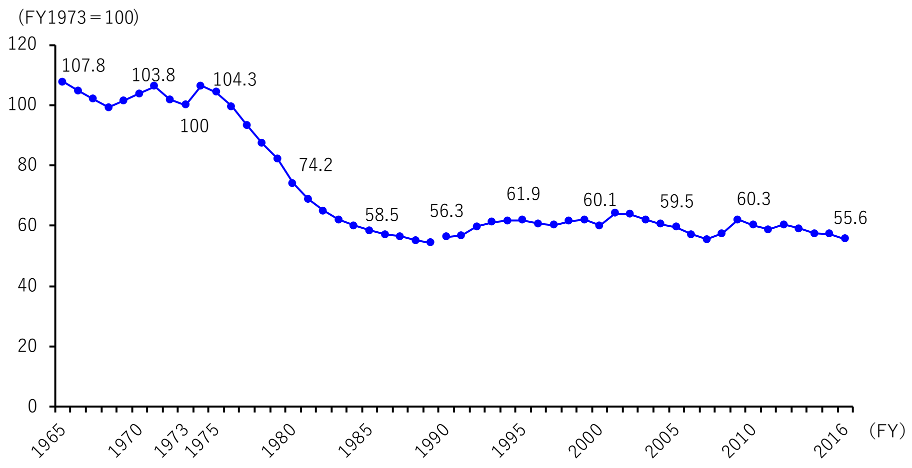

Figure 2-20 Energy Consumption Factor for Japan's Manufacturing Industries

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

The fact that efficiency is not improving does not mean that there is no room for further measures. One pointed example of potential improvement has been noted by the Energy Efficiency and Conservation Subcommittee set by METI: deterioration in the insulation for boiler pipes and other fittings is costing Japan's manufacturing industry more than 10% in unneeded energy consumption, a significant loss[71]. There has been no tangible improvement in CO_2 emissions factors in the four basic material industries discussed except for pulp and paper, and in some cases it has actually been increasing (Figure 2-21).

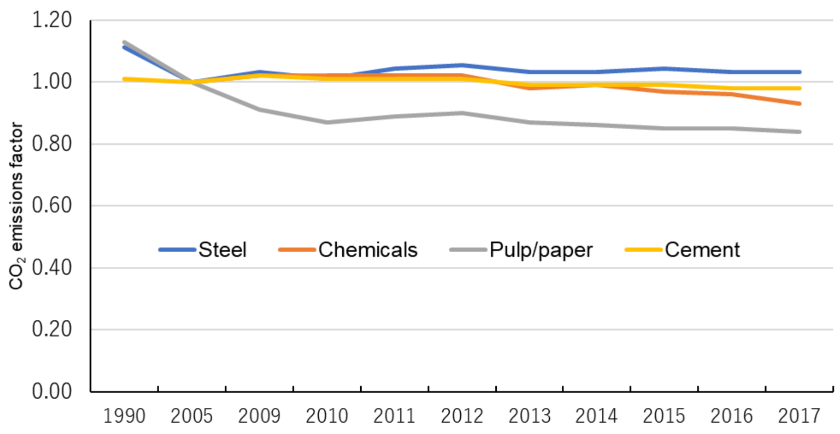

Figure 2-21 CO_2 Emissions Factor in Japan's Four Basic material industries

Note: The industries use different baseline years, so the figures presented are adjusted with 2005 set to 1.

Source: Created by REI based on Keidanren, FY2018 "The Commitment to a Low Carbon Society" and FY2017 "Follow-up Results - Summary"

[71] The Energy Conservation Center, Japan (2014), "Future Direction of Energy Efficiency Promotion in Industrial Sectors" https://www.meti.go.jp/shingikai/enecho/shoene_shinene/sho_energy/pdf/003_02_00.pdf

The Energy Conservation Act mandates efforts to improve the energy factor by at least 1% each year on average. In addition, under the benchmarking scheme[72] started in 2009, it is stipulated that all companies must aim for the level achieved by the top 10-20% of companies. However, even in the fiscal 2017 report, the percentage of companies achieving the benchmark is not at all high. For some industries, this is why major reductions of 30-50% for the industry overall can be expected just by all companies meeting the standard (Figure 2-22).

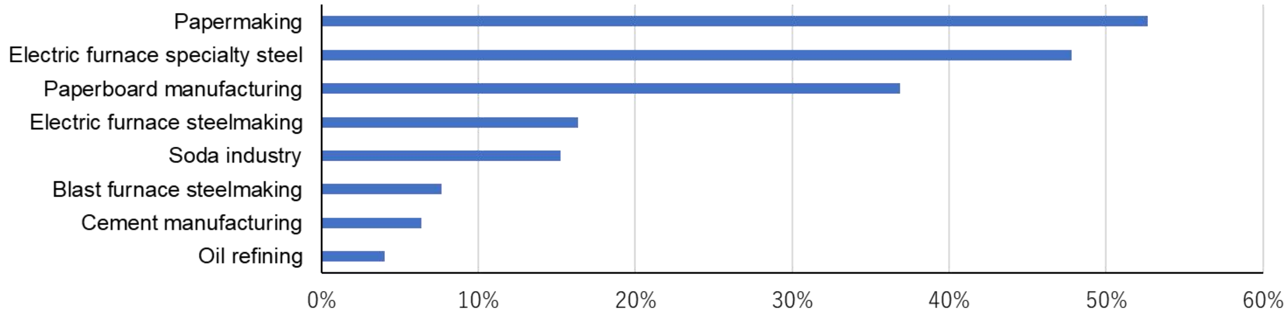

Figure 2-22 Reduction Rate When All Companies Achieved Benchmark

Source: Created by REI based on Agency for Natural Resources and Energy, "Achievements of Benchmarks Based on the Act on the Rational Use of Energy (FY2017 Periodic report)" (June 20, 2018)
(https://www.enecho.meti.go.jp/category/saving_and_new/benchmark/2017/benchmark29.pdf)

Transitioning from coal

Switching from coal to other fuel sources also has major potential for reducing CO_2 emissions in the industrial sector. Coal consumption has been increasing even in general industry (excluding the power sector), rising approximately twofold from a little less than 13.0 million tons in 1995 to 25.0 million tons (Figure 2-23). Coal's emissions factor is 1.8 times that of natural gas, so it is possible to make major reductions just by switching the fuel used from coal to natural gas.

[72] The Energy Conservation Act stipulated annual average improvement in energy consumption efficiency at least 1%, but this put a major burden on companies already promoting energy efficiency measures, so indicators for energy consumption efficiency (benchmarks) were set for individual sectors and areas as a means of promoting energy conservation through comparison with other companies.

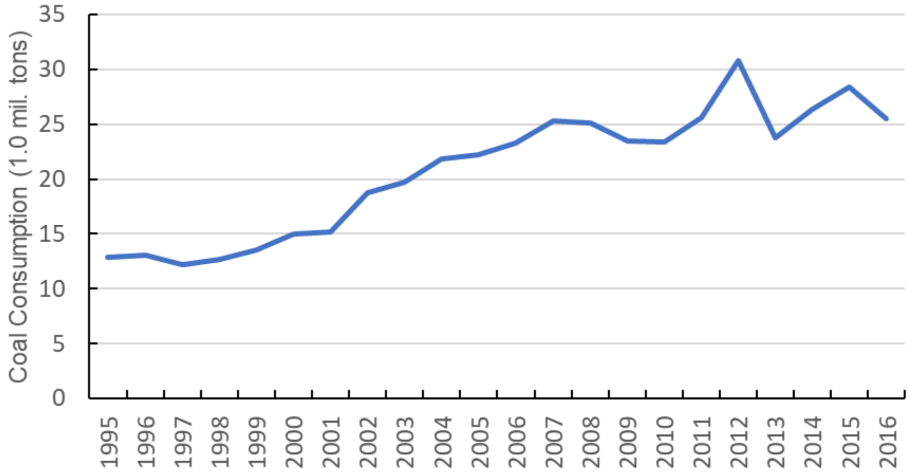

Figure 2-23 Coal Consumption in Japan's General Industry Sector

Note: Industries include food products, textiles, pulp and paper, chemicals, petroleum products, ceramic products, steel and coke, transport machinery, IPP/PPS, and others.

Source: Created by REI based on Japan Coal Energy Center, "Nationwide Coal Ash Fact-Finding Survey Report (FY2017 Results)" (February 2018) http://www.jcoal.or.jp/ashdb/ashstatistics/upload/H29_ashstatistics.pdf

Figure 2-24 compares the steel industry's fuel mix among advanced countries that are major steel producers, Japan, the U.K. and Germany (and OECD overall), and it shows that coal constitutes a large proportion of Japan's fuel mix. One reason for this is that coal is less expensive in Japan than other fuels, but another factor is that the tax rate is low even compared to other energy taxes.

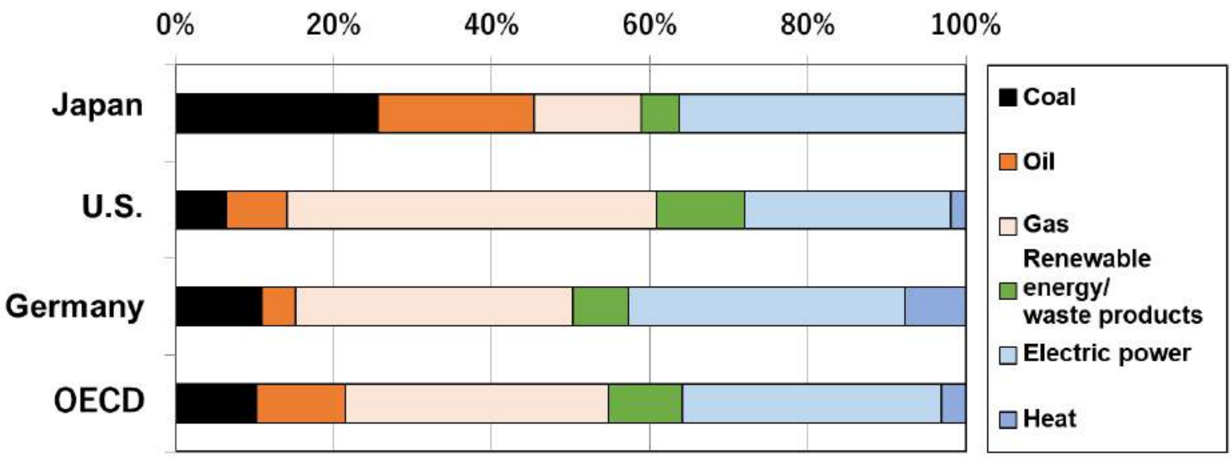

Figure 2-24 Steel Industry Fuel Mix (2016, Japan, U.S., Germany, OECD)

Source: Created by REI based on IEA, "World Energy Balances 2018"

Switching from blast to electric furnaces in steel industry

CO_2 emissions by the steel industry were 47% of the overall industrial sector in fiscal 2017 and 13% of all sectors, so reducing its emissions is of special importance. Broadly speaking, steel is produced using either blast furnaces or electric furnaces, CO_2 emissions per ton are three to four times that of electric furnaces. A feature of Japan's steel industry is that a high percentage, around 80%, of crude steel is produced with blast furnaces. This is substantially higher than the U.S. (33%) or Europe (60%) (Figure 2-25).

According to a report by the German Steel Federation[73], from 1990 to 2010, CO_2 emissions from steel production in the 27 member countries of the EU (at the time) decreased by approximately 25%. Along with reduced production volume and other factors, shifting from blast furnaces to electric furnaces is also cited as a factor (electric furnace share rose from 28% to 41%). A decarbonization target has been announced for Japan's steel industry, but with countries working to decarbonize by 2050, the target should not be an ultra-long-term goal for the end of the 21st century; it needs to be further accelerated.

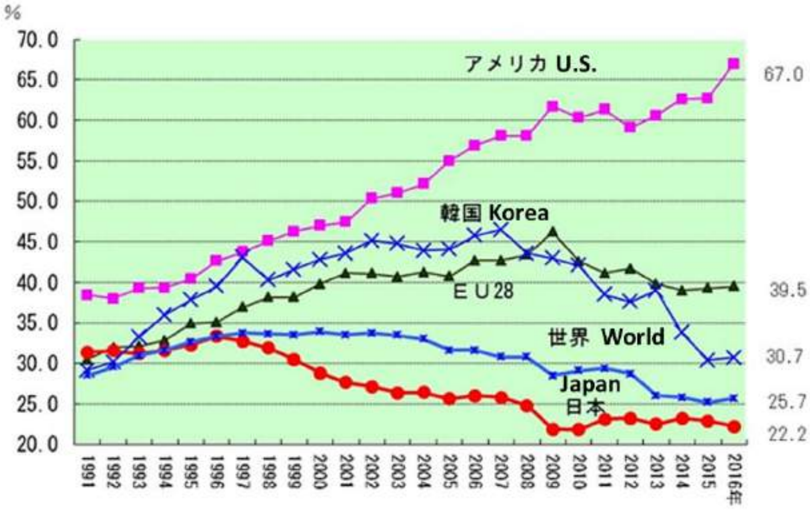

Figure 2-25 Electric Furnace Share in Major Countries

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

It is true that reducing CO_2 emissions is difficult in basic material industries due to their nature. Manufacturing processes require the use of high temperature heat, and until recently there were few energy sources that could be used other than fossil fuels. Moreover, in the production processes for steel (iron ore reduction) and cement (limestone calcination), carbon molecules in the raw materials are released as carbon dioxide. However, as discussed above, Japan's basic material industries still have room to increase energy efficiency and they are still not adequately promoting reduction measures that other countries have used, including switching from coal to other fuels and increasing relative use of electric furnaces.

[73] BCG, Steel Institute VDEh (German Steel and Iron Association's research institute), "Steel's Contribution to a Low-Carbon Europe 2050" (June 2013) https://www.bcg.com/ja-jp/publications/2013/metals-mining-environment-steels-contribution-low-carbon-europe-2050.aspx

Further reduction measures in global industry sector

The world moves quickly. Various considerations are taking place in the industrial sector, and there is starting to be evidence that through a combination of measures including increased energy efficiency, use of renewables, and improved resource efficiency, it will be possible to achieve carbon neutrality by 2050[74].

Even in the general industrial sector, which includes basic material industries, what is most important is promoting further energy efficiency improvements[75]. Significant energy demand in the industrial sector comes from the electric power consumed by motors used to drive pumps and other equipment. Making these motors smaller and higher performance goes without saying, while inverter control could also be introduced to operate motors with the necessary output at the necessary times. It has been reported that these measures would reduce power consumption by around half[76].

In addition, in the industrial sector, around half the energy consumed is used in the form of heat, but maximizing use of waste heat, which is called cascade use of heat, or the use of heat for multiple purposes, helps increase energy efficiency. To effectively reuse waste heat, heating pipes can be laid to utilize the waste heat to nearby factories, or, in some cases, the heat can be conducted to the commercial and residential sectors. Further, like surplus gas in the chemical industry and black liquor in the pulp and paper industry, it is possible to recover byproducts and use the energy.

In addition, lowering the resistance of the wire and pipe needed to supply factory power and steam through innovative use of materials and layouts is also expected to significantly improve energy efficiency[77]. Measures for factory and office air conditioning (conversion to heat pumps) and lighting (conversion to LED) are also important.

Dr. Amory B. Lovins of the U.S.'s Rocky Mountain Institute, a world leader in energy efficiency policy since the 1970's, in his paper "How Big Is the Energy Efficiency Resource," published in 2018, points out that the common assumption that energy efficiency is a dwindling resource is mistaken and that by making appropriate use of the efficiency resource with a view to the whole, it is a resource that will continue to expand. Japan's industrial sector, including basic material industries, has by no means depleted the resource of energy efficiency. What is lacking are appropriate policies to draw out this potential.

[74] Energy Transitions Commission, "Mission Possible: Reaching net-zero carbon emissions from harder-to-abate sectors by mid-century" (November 2019) http://www.energy-transitions.org/sites/default/files/ETC_MissionPossible_FullReport.pdf

[75] Amory B. Lovins, Rocky Mountain Institute (2012), "Reinventing Fire"

[76] In Japan, the biggest consumer of electric power at factories is use of 3-phase induction motors, which accounts for around 70% of power consumed by industry and 55% of Japan's total power consumption (Tsuchiya 2019).

[77] Amory B. Lovins (2018), Rocky Mountain Institute, "How Big Is the Energy Efficiency Resource" Environ. Res. Lett. 13 090401 https://iopscience.iop.org/article/10.1088/1748-9326/aad965/pdf[78] The Platform for Accelerating the Circular Economy: PACE (2019), The Circular Gap Report 2019

2. The rise of a circular economy that will transform the basic material industries

Along with energy efficiency improvements and other reduction measures conducted thus far, the rise of a circular economy has the potential to greatly alter basic material industries to achieve a decarbonized society.

Circular economy as climate change measure

Energy consumption has increased rapidly ever since the Industrial Revolution, but resources like metal, sands and stones, and fossil fuels have been consumed on nearly the same upward trajectory. Total global resource consumption in 2017 is estimated at 92.1 Gt, which is around four times higher than 1970. Resource consumption is projected to increase further to 177 Gt by 2050[78]. The environmental impact of extracting and processing these resources in such large quantities is enormous. The rapid increase in waste products that need to be processed is also a serious problem. At present, only around 10% of total resources are recycled.

Moving from the current linear economy to a circular economy where resources produced are semi-permanently circulated as social stock has been thought for some time to be essential to creating a sustainable society. In addition, it has become clear in recent years that shifting to a circular economy will also play a critical role in climate action, so there is renewed focus on it. Specifically, the following three initiatives for shifting to a circular economy will help reduce greenhouse gases.

The first pillar is promoting resource and material recycling by raising recycling rates and thereby increasing use of secondary materials. Most of the major basic material industries like steel, aluminum, plastic, paper and cement are highly conducive to recycling, and through reuse of recycled resources, it will be possible to dramatically reduce CO_2 emissions (Table 2-4)[79]. Compared to manufacturing aluminum from bauxite, a primary material, creating it with recycled materials would reduce energy use by as much as 97%.

As discussed above, CO_2 emissions from steelmaking with scrap steel as the primary material is significantly lower with electric furnaces than with blast furnaces. The amount of available scrap steel is growing globally and is estimated to reach 1.3 billion tons by 2050. This would be a large share of total demand given that actual demand in 2017 was approximately 1.6 billion tons and demand in 2050 is projected to be around 2.0-2.5 billion tons[80]. Advanced countries have already produced and accumulated a substantial amount of iron, and the scrap steel usage rate is expected to increase further. In the EU, the rate is projected to be around 80% from around 2030[81]. Likewise, even in Japan, with natural and artificial minerals reaching saturation, a shift is likely toward a circular economy that utilizes “urban mines”[82].

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78 The Platform for Accelerating the Circular Economy: PACE (2019), The Circular Gap Report 2019

79 Kawase and Matsuoka (2014), in a study of Japan, puts the reduction at 2.31 tons-CO_2/ton-crude steel with blast furnaces (converters) and 0.58 tons-CO_2/ton-crude steel with electric furnaces.

80 Baris Bekir Çiftçi “The future of global scrap availability” World Steel Association Blog (May 2, 2018) https://www.worldsteel.org/media-centre/blog/2018/future-of-global-scrap-availability.html, (Accessed March 20, 2019)

81 Material Economics “The Circular Economy - A Powerful Force for Climate Mitigation -"(2018) https://media.sitra.fi/2018/06/12132041/the-circular-economy-a-powerful-force-for-climate-mitigation.pdf

82 Hiroshi Komiyama and Koichi Yamada, “New Vision 2050” (2016)

Table 2-4 Comparison of CO_2 Emissions with Primary Materials and Recycled Materials (tons-CO_2/material tons)

Material	Current		2050	
	Primary material	Recycled material	Primary material	Recycled material
Steel	2.3	0.4	1.9	0.1
Aluminum	13.5	0.3	9.7	0.2
Plastic	2.4	0.4	2.2	0.3
Cement	0.7	0.3	0.6	0.1

Source: Material Economics" The Circular Economy - A Powerful Force for Climate Mitigation -"(2018)
https://media.sitra.fi/2018/06/12132041/the-circular-economy-a-powerful-force-for-climate-mitigation.pdf

The second important pillar for shifting to a circular economy is decreasing the amount of resources and materials used. It is possible to reduce usage amounts by making products lighter through improved design and increased strength and by improving production processes, specifically by switching from the conventional cutting process to lamination using 3D printing. Further, the materials themselves can be switched to materials with lower environmental impact. For example, it is becoming possible to use wood instead of steel-reinforced concrete and bio-materials instead of plastic.

The third initiative is developing innovative business models. As digitalization progresses, utilization and sharing of idle assets, platform as a service (PaaS) (services purchased rather than goods), and other models are rapidly expanding, and it is becoming possible to provide the high value-added services that are needed with fewer resources.

Major CO_2 reductions can be expected by shifting to the circular economy. For example, calculations for Europe 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 reduction in CO_2 emissions of 296 million tons-CO_2/year (Table 2-5). This corresponds to another 56% reduction in emissions (530 million tons) after energy efficiency improvements and utilization of renewable energy. On a global scale, the reduction potential is estimated at 3.6 billion tons-CO_2/year by 2050.

Table 2-5
CO_2 Reduction Potential of Four Basic Material Industries from Circular Economy Measures in Europe

Assumed scenario	Emissions (100 million tons-CO_2/year)	Notes
Reference case	5.30	Demand increases, but energy efficiency raised (Includes use of renewable energy, but not CCS)
Material recirculation	▲ 1.78	Recycling rate increases and use of secondary materials increase
Product material efficiency	▲ 0.56	Reduction in amount of materials used in products
Circular business model	▲ 0.62	Spread of new business models, including sharing models
Circular measures total	▲ 2.96	
After circular measures	2.34	

Source: Material Economics" The Circular Economy - A Powerful Force for Climate Mitigation -"(2018)
https://media.sitra.fi/2018/06/12132041/the-circular-economy-a-powerful-force-for-climate-mitigation.pdf

This transition to a circular economy has major significance as a climate change measure, so even among UN initiatives based on the United Nations Framework Convention on Climate Change (UNFCCC), it has been the subject of increasing attention at 2018 technical expert meetings[83].

The circular economy is now mentioned in the long-term reduction strategies of the EU and individual countries. For example, the EU's strategic long-term vision ("A Clean Planet for All") considers incorporating the transition to a circular economy in all scenarios. In addition, innovation for a competitive industry is cited as one of the seven shared components of the path to carbon neutrality. It particularly specifies reuse/recycling and alternatives to carbon-intensive materials.

Germany's Climate Action Plan 2050 requires efficiency strategies not only for the energy needed for production activities but for the resources as well and calls for digitalization and Industry 4.0 to contribute. France's National Low-Carbon Strategy also cites optimization of consumption through material reuse and recycling and increasing recycling rates for various materials.

Business sector driving the circular economy

The global business sector has been quick to understand the importance of the circular economy. To put it another way, the global business sector views these major changes in the business environment as an opportunity and is itself beginning to innovate. Table 2-6 shows major examples of companies engaged in the circular economy. It is clear that companies with substantial global influence regardless of the sector, including companies like Toyota, Apple and Coca-Cola, are broadly taking on this challenge.

The concept of the circular economy helps raise the profitability of business. That is, promoting resource efficiency, reuse and recycling can reduce risks and costs associated with resource procurement. In addition, it is recognized that servicing (converting things sold as products to selling them as services) and

[83] UNFCCC "Technical Expert Meetings in 2018" https://unfccc.int/topics/mitigation/workstreams/technical-expert-meetings#eq-2

establishing recycling sites also works to strengthen customer loyalty. Forming a circular economy may reduce the size of the basic material industry, but growth in the recycling industry is said to be a more effective means of economic growth at the macro level[84].

Table 2-6 Major Companies Engaged in the Circular Economy

Industry	Company	Targets, main initiatives
Automobiles	Renault (France)	· Possible to recycle 100% of plastic by 2025. 85% recycling possible even including other materials.
	Toyota Motors (Japan)	· Toyota Environmental Challenge 2050 indicates goals to develop low-carbon materials, expand recycled materials and develop appropriate processing methods, etc.
Electronics	Apple (U.S.)	· Announced plan in 2017 to use only recycled or recyclable materials in manufacturing
	Philips (Netherlands)	· To establish system for collecting all large devices by 2025. · Allocating half of profits to circular economy initiatives.
	Ricoh (Japan)	· Reducing new resource input 50% by 2030 and 93% by 2050
Food products/ health	Coca-Cola (U.S.)	· To make all packaging recyclable by 2025. · Use reused materials for half of packaging by 2030. · Thoroughly collect and recycle bottles and cans by 2030.
	Unilever (Netherlands)	· Will make it possible to reuse, recycle or compost all plastic packaging by 2025
Apparel Furniture Toys	H&M (Sweden)	· To create 100% circular, renewable business by 2030
	Ikea (Sweden)	· To eliminate all landfill waste from Ikea operations by 2020
	Lego (Denmark)	· To ban use of plastic from fossil fuels by 2030

Source: Created by REI based on the corporate websites, etc.

In Japan, initiatives to create a recycling-based society have been conducted for some time under the Basic Act on Establishing a Recycling based Society (2000) and individual recycling-related laws (for packaging, consumer electronics, small appliances, construction, food products, automobiles, and computers). However, though this initiative has involved related ministries and agencies, it has centered on the so-called "venous industry," in part because it has been promoted primarily by the Ministry of the Environment, which is responsible for waste stream administration.

By contrast, the circular economy, which has drawn global attention in recent years, is marked by initiatives by "arterial industry" companies that provide products and services to make their own corporate activities sustainable[85]. To realize this circular economy, companies involved in promoting it have launched the CE100 initiative and are driving reform (BOX).

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[84] Ellen Macarthur Foundation "Towards a circular economy: business rationale for an accelerated transition" (December 2, 2015) https://www.ellenmacarthurfoundation.org/publications/towards-a-circular-economy-business-rationale-for-an-accelerated-transition

[85] However, according to the definition by the Ellen MacArthur Foundation, the circular economy eliminates the concept of waste itself and generates the cascading use of everything as effective resources.

■**BOX: CE100**

CE100 is an initiative launched by the Ellen MacArthur Foundation. As of the end of February 2019, a total of 143 companies, governments, research institutes and other organizations participate in the initiative. From Japan, Bridgestone is a member.

CE100's activities include collaboration, capacity building, networking and research. Members plan and execute collaborative projects to realize the circular economy and also provide educational materials.

The Ellen MacArthur Foundation was established in 2010 to promote the transition to the circular economy in coordination with corporations, governments and research institutes. It has focused on collaborations with corporations and its list of global partners includes Danone, Google, H&M, Intesa Sanpaolo, Nike, Philips, Renault, SC Johnson, Solvay and Unilever.

Source: Ellen MacArthur Foundation website https://www.ellenmacarthurfoundation.org/

The movement is taking place across industries and includes automobiles, electronic devices, construction and food products, the important customers of basic material industries. Product design concepts and procurement policies will change as the transition is made to the circular economy, and this is expected to force basic material industries to make dramatic changes to their business approach going forward. For example, in Europe, the automotive and construction industries alone consume approximately 50% of four primary material resources, steel, aluminum, plastic, and cement, so the impact of changes in these industries would be enormous. It is the same mechanism as in the energy sector, where energy-using companies like the RE100 are procuring renewables and forcing the suppliers, the power industry, to change.

In fact, in response to this movement, the basic material industry globally is changing substantially. For example, some steelmakers are now working toward decarbonization. Previously, it had not been thought possible from a quality standpoint to use steel produced in electric furnaces with scrap steel in office equipment and other such applications. In Japan, however, Tokyo Steel, partnering with Ricoh, a major office equipment manufacturer, has succeeded in developing and utilizing electric furnace steel made with 100% scrap steel[86].

[86] Ricoh Company, Ltd. press release, "Ricoh begins using steel made of 100% steel scrap; Develops steel sheets for office equipment use with Tokyo Steel (March 27, 2012) https://jp.ricoh.com/release/2012/0327_1.html (accessed February 25, 2019)

Bioeconomy driving transition to renewable resources

Materials that meet contemporary needs and functionality requirements while being made from biomass materials are expected to play a major role in the future, rather than iron, concrete (cement) and other fossil fuel-based materials. This change is being promoted as another paradigm shift, a transition from a fossil-based economy to a bioeconomy. In recent years in particular, ecosystem pollution from plastics, including of the ocean, has reached the human body and there is a real sense of crisis. This is part of the reason for the increased focus on biomass materials, which are biodegradable.

Viewing this trend as an opportunity to supply various materials using bio-resources, the paper and wood products industries are beginning to produce a variety of renewable materials. For example, Stora Enso, a global major paper and wood products company besed in Finland, has redefined itself as a "renewable material company" and has started supplying various renewable fibers, resins and containers made from wood.

At the same time, the petrochemical industry is even beginning to incorporate bio-materials. DSM of the Netherlands was established in 1902 and used to be a government-run oil refinery, but it subsequently transformed itself into a petrochemicals company and is currently working to supply biofuels and develop microorganisms needed to refine bio-resources as a bio-refinery. The Finnish company Neste also was a government-run oil refinery, and it has already transformed into the world's largest biofuel producer. It is now also collaborating with Ikea to develop bio-plastics.

Even in Japan, wood construction on a medium to large scale has been increasing. Sumitomo Forestry has a vision of the "timber-utilizing cities" and has started a project of building a 350-meter ultra high-rise building made of wood by 2041. Shimizu Corporation has begun R&D on bioplastic manufacturing from lignophenol, which is contained in wood products[87]. Nippon Paper Industries has developed a material called cellulose nanofiber that is one-fifth the weight of steel but more than five times stronger and has already established a mass production line for it. Various applications are anticipated, one of which is used in automotive parts, and R&D is being conducted by a consortium from industry, academia and government, including Kyoto University, Toyota Motors and the Ministry of the Environment.

[87] Shimizu Corporation press release, "Construction of Research Facility for Bioplastic Materials in Okinoshima" (December 17, 2018) https://www.shimz.co.jp/company/about/news-release/2018/2018037.html

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

Lastly, the following lays out the general direction of a strategy for major CO_2 reductions in Japan's basic material industries.

The first premise is that there is still potential for reducing CO_2 emissions by switching from coal to other fuels and raising the benchmark achievement rate, as discussed above. Japan's energy efficiency measures in the industrial sector have thus far centered on the two main pillars of the Energy Conservation Act and voluntary initiatives by major industry associations (voluntary environmental action plans and the Commitment to a Low Carbon Society), the latter of which has been led by the Japan Business Federation (Keidanren). However, actual CO_2 reductions have stagnated, and initiatives will have to be accelerated in order to achieve the major reductions required by 2050. Bolder policy steps are needed, such as a regulatory framework that governs not only improvements on a per-unit basis but also total emission reductions and economic mechanisms like carbon pricing.

Japan's population is declining, and it may be possible to painlessly reduce total domestic demand while maintaining or raising living standards. Japan's CO_2 reduction scenarios to date have been premised on continued high activity and have not incorporated this major demographic change. With regard to changes in production volume from 2015 to 2030, the government's Long-term Energy Supply and Demand Outlook for FY2030 projects increases in crude steel of 15% and paper and paperboard of 3%. It also projects limited declines in cement of 10% and ethylene of 16%. Policy going forward should reduce production volume projections to realistic figures and facilitate the pursuit of high added value.

The need for disruptive technology development is often emphasized in connection with decarbonization of the industrial sector. Achieving carbon neutrality in the industry sector by 2050 will naturally require a number of new technologies. For example, in the medium temperature zone and above, technologies for electrification with renewable electricity need to be developed. In addition, utilization of renewable energy-derived hydrogen and bioenergy needs to be considered while performing lifecycle assessments with production and transport processes and verifying sustainability.

However, what is most lacking in this sector is a systematic social framework for fully utilizing the existing technologies of energy efficiency and renewable energy. Executing innovations in the true sense, innovations like carbon pricing, is what will enable Japan's industrial sector to accelerate its transition to decarbonization.

It is also important that the world's business sector, which includes Japanese companies, commits to the circular economy and strives to make major changes to the format of supply chains themselves, which include basic material industries. By actively working to 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 (Column)

Japan's climate change measures are characterized by an emphasis on utilizing hydrogen, with many statements to the effect that Japan is a world-leader in hydrogen technology and that this will drive decarbonization at the global level.

The government's Basic Hydrogen Strategy was released in December 2017 and states: "Based on the basic strategy, Japan will resolve energy security and GHG emission reduction challenges simultaneously, make national efforts to use hydrogen, and become the first country in the world to realize a hydrogen-based society in order to lead the world in using hydrogen." In addition, the government revised its Strategic Roadmap for Hydrogen and Fuel Cells in March 2019, which lays out future prospects for the technologies and an action plan.

Internationally, hydrogen is being promoted as a necessary option for building a carbon-neutral society by 2050. What underlies this is the mounting expectation that hydrogen will be produced from electrolysis using cheap electricity from renewables like solar and wind power in large amounts. It is assumed that hydrogen will be manufactured and supplied using large amounts of inexpensive renewable energy.

Hydrogen's role is to reduce the GHG emissions that remain after major reductions of 90% or more are made with energy efficiency improvements and increased use of renewable energy[88]. Specifically, while it is assumed that hydrogen will be used in some applications in the industrial and transport sectors for which electrification is especially difficult, its role is still under consideration in various respects. For example, in the U.K., a comprehensive review of future hydrogen use was conducted in 2018, and it indicates the importance of the government identifying development opportunities it will not later regret[89].

By contrast, Japan's hydrogen promotion policy is not generally clear on how hydrogen should be created or used and appears to be based on the call to realize a "hydrogen-based society." With Japan's 2030 target for renewable power, the major premise of hydrogen use, set at 22-24%, an extremely low level by international standards, it is difficult to class the government's advocacy of a hydrogen society as rational policymaking. The following issues can be pointed out with respect to hydrogen creation and use.

[88] IRENA (2018), "Hydrogen from Renewable Power: Technology Outlook for the Energy Transition" Committee on Climate Change, UK (2018) Hydrogen in a low-carbon economy, Fuel Cells and Hydrogen 2 Joint Undertaking (2019) Hydrogen Roadmap Europe

[89] Committee on Climate Change, UK (2018), ibid.

Problems related to hydrogen creation

First, how hydrogen is manufactured is extremely important. As hydrogen is virtually non-existent as a molecule in the natural world, it has to be manufactured by artificial means. That is to say, hydrogen is a secondary energy, and if hydrogen is produced with renewable power, as the energy carrier, it could enable large amounts of renewable energy to be supplied and decarbonization to be achieved[90]. From the standpoint of renewable energy, this also potentially provides the benefit of absorbing surplus power[91].

Conversely, while hydrogen production from fossil fuels like natural gas or coal is an established technology, it simply converts the energy in fossil fuels to hydrogen. Japan currently envisions hydrogen production along these lines, as being produced from fossil fuels, and specifically from brown coal, an inexpensive fossil fuel resource overseas, but such a method of production cannot serve as a means to decarbonization.

The reason is that ultimately CO_2 molecules are emitted in numbers equal to the number of carbon molecules in the fossil fuel used to make the hydrogen, making it impossible to avoid substantial CO_2 emissions[92]. In addition, the hydrogen production process requires enormous energy input[93]. Steam reforming of natural gas is performed in a reforming furnace at temperatures from 500°C to 1,000°C, and even when coal is used, the coal must initially be heated to 800-1,000°C to create coal gas. Fossil fuels are used for this currently.

For this reason, hydrogen production from fossil fuels is premised on being combined with CCS, but as discussed in Chapter 2, Part 2 of this proposal, there is no clear path to CCS viability and commercialization, so achieving the government's goal of viability by the first half of the 2020's seems unlikely. Particularly because Japan has so few sites suitable for carbon storage, at the very least, for a considerable time going forward, it will have to depend on overseas production, which means no change in an overseas-reliant energy mix.

Further, because hydrogen is extremely light and low density, to transport it efficiently requires compression under high pressure (700 atm) or liquification at -253°C or lower (around -160°C for LNG). In this case, the energy efficiency is 54.5% with high pressure gas and 55.7% with LNG, meaning around half of the hydrogen's energy is lost[94].

Given this, it is only when electricity from renewable energy becomes available in large amounts that CO_2-free hydrogen can be used on a large scale, which would then help bolster climate change measures and raise the country's primary energy self-sufficiency[95].

[90] On this point, the 5th Strategic Energy Plan states that hydrogen should be a new energy option alongside renewable energy, which is problematic in that it treats hydrogen, a secondary energy, the same as renewables, which are primary.

[91] IRENA (2018), ibid., Agora Verkehrswende, Agora Energiewende and Frontier Economics (2018): The Future Cost of Electricity-Based Synthetic Fuels

[92] For example, the overall chemical formula for manufacturing hydrogen from natural gas (methane) is $CH_4+2H_2O \rightarrow 4H_2+CO_2$.

[93] Instead of fossil fuels, hydrogen can also be created from biomass resources. However, even in this case, the issue is the same because the carbon dioxide that is generated when gasifying biomass and conducting hydrogen reforming has to be captured.

[94] NEDO (2010), "Feasibility Study in Response to Hydrogen Carriers"

[95] The EU defines low-carbon hydrogen as hydrogen that reduces CO_2 by 60% or more compared to manufacturing hydrogen by the steam reforming of natural gas.

Problems related to hydrogen use

As stated above, hydrogen is an energy carrier that must be produced artificially. Accordingly, considering the manufacturing costs and transport costs, thinking that hydrogen should only be utilized in sectors where renewable power use is exceedingly difficult would serve to lower social costs.

Specifically, in order to decarbonize the industrial sector, it is assumed that various chemical products will be manufactured with hydrogen[96], or that the high temperatures needed in the industrial process will be produced. Also, decarbonization of heat usage in the commercial and residential sectors has not progressed adequately, so it has been suggested that the existing gas infrastructure be used to add hydrogen to the mix with the aim of swiftly decarbonizing these sectors.

At the same time, in Japan, measures are being promoted without an overarching strategy. For example, in Japan, fuel-cell vehicles are being promoted by both the public and private sectors, but for compact vehicles that make short trips, the widespread availability of electric vehicles allows for electricity to be supplied from renewable energy, making fuel-cell vehicles that run on hydrogen of only limited benefit.

Further, Japan's Basic Hydrogen Strategy lays out a scenario in which hydrogen is used on a large scale in the power sector as an alternative to natural gas. It positions hydrogen power that stably consumes large quantities of hydrogen as the most important application that needs to be promoted in combination with construction of an international supply chain, adding the note that when the LNG supply chain was built in the 1960’s, natural gas was purchased at a long-term fixed price under the fully distributed cost method and consumed in electric power and city gas applications.

At the stage in which 100% of power is supplied with 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 surplus electricity, while hydrogen could conversely be used to generate electricity. However, Japan already has massive pump-storage hydropower capacity of 27.5 GW. It is therefore difficult to envision hydrogen power playing a major role as an adjusting power. In addition, the fact that the Basic Hydrogen Strategy mentions the LNG supply chain as an example can be interpreted as the government trying to position hydrogen power as a primary source of electricity. It is difficult to find any economic rationality in using hydrogen in this way.

[96] It is assumed that various chemical products like ammonia will be manufactured using hydrogen.

Part 4 Strategy for Zero-Emission Buildings

CO_2 emissions from the commercial and residential sectors are almost entirely from energy consumed by houses, office buildings and other structures. For this reason, the two sectors together can be taken as the building sector, and initiatives for this sector's decarbonization are presented in this proposal as zero-emission building strategy.

As was seen in Chapter 1, CO_2 emissions from the commercial and residential sectors only account for 10% of Japan's total based on direct emissions data. However, in terms of energy consumption, the two sectors' share is 31%. In addition, around half of the energy used in the building sector is electric power. For this reason, the amount of the sectors' emissions will be greatly affected by whether or not steady progress is made in power decarbonization. If electric power is completely decarbonized, emissions will automatically be reduced by half.

Looking at energy consumption trends to date, the commercial sector (non-residential buildings) has been consuming less energy after peaking in the mid-2000's (Figure 2-26). The commercial sector's total floor area and the scale of its economic activities have increased during this time. The fact that it has reduced energy consumption amid such growth could be positively evaluated for the commercial sector's energy efficiency improvements.

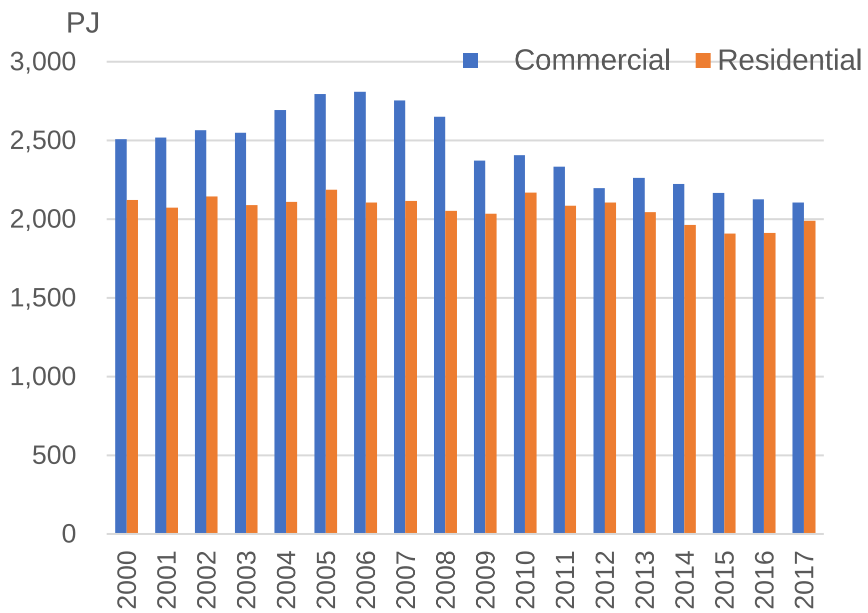

Figure 2-26 Final Energy Consumption in Building Sector (Commercial/Residential) and Targets (PJ)

Source: Created by REI based on the Agency for Natural Resources and Energy, "Comprehensive Energy Statistics", etc.

On the other hand, the household (residential) sector's energy consumption had been edging down since 2011, but increased slightly in 2016 and 2017, as the overall margin of decrease has been smaller than the commercial sector. During this time, it is thought that increases in personal consumption, the number of households and new construction starts have offset the effects of energy efficiency improvements.

There is therefore a difference in degree between the commercial sector and residential sector, but taken as a whole the building sector's energy efficiency has been improving. Also, in recent years, zero-energy buildings (ZEB) and zero-energy houses (ZEH)[97] have been increasing in number, and in the building sector, decarbonization technologies have already entered the popularization phase.

The problem is, however, that the progress made may not be enough to reduce the building sector's overall emissions to zero and achieve carbon neutrality by 2050. Buildings once they are built stay in use for a long period of time. 2050 is the near-future, around 30 years away. New buildings built now will still be very usable even in 2050. Looking toward 2050, carbon neutrality needs to be quickly achieved for new buildings. At the same time, the huge stock of existing buildings also needs to be updated for energy efficiency and converted to use renewable power and heat for the remaining portion.

Strong policy leadership is needed for the extremely large number of new and existing buildings in order to raise the awareness of everyone involved - owners, occupants, designers, construction companies, the financial sector, etc. - and promote collaboration for zero emissions. Many national and regional governments around the world are currently crafting new policies for the decarbonization of houses and buildings. Developing building renovations aimed at zero emissions into a new business field is also effective as a long-term growth strategy. For Japan to decarbonize by 2050, it needs to initiate effective policies at an early stage.

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

Energy consumption by the overall building sector has been decreasing, but what about the energy performance of individual buildings?

Japanese houses poorly insulated

Insulation (thermal) performance accounts for a large proportion of the energy conservation performance of houses, so it serves as an indicator of their energy performance. As can be seen in Figure 2-27[98], according to a 2015 survey, only a small fraction of Japan's residence stock (8%) meet the current insulation standards. Furthermore, 35% of houses - an extremely high rate - are completely uninsulated, with no insulative material in the walls, floors, or ceilings.

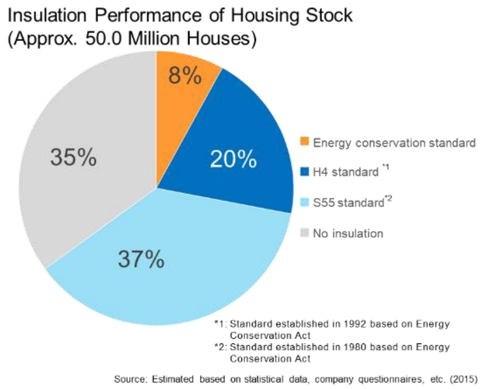

Figure 2-27 Insulation Performance of Housing Stock

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

97 Houses (ZEH) and non-residential buildings (ZEB) with annual net primary energy consumption of zero due to raising energy efficiency in the design and utilizing renewable energy. These definitions for building design have been set by the Roadmap Examination Committee, and in 2016 nationwide there were around 34,000 newly constructed ZEH and 141 ZEB.

98 Energy conservation standards for houses were instituted in 1980 under the Energy Conservation Act in the form of residential thermal performance standards and were further strengthened in 1992 and 1999. In 2013, revisions were made to add primary energy standards including for facilities to thermal performance standards for the building skin (walls, windows, ceilings, floors), but skin performance was set at the same level as the 1999 standards. The current 2016 standards were created under the Building Energy Efficiency Act established in 2015, but the standards from 1999 were used for thermal performance.

However, while insulation performance is low, the energy consumption of Japanese houses is also low. As shown in Figure 2-28, compared to the U.S., Europe and South Korea, the amount of energy consumed by Japanese houses for heating is low. This is said to be due to the way to heat in Japanese homes. Unlike in Europe and other regions where the entire house is heated 24 hours a day, in Japan, it is common to only heat rooms that are currently occupied and to turn off the heat in the middle of the night.

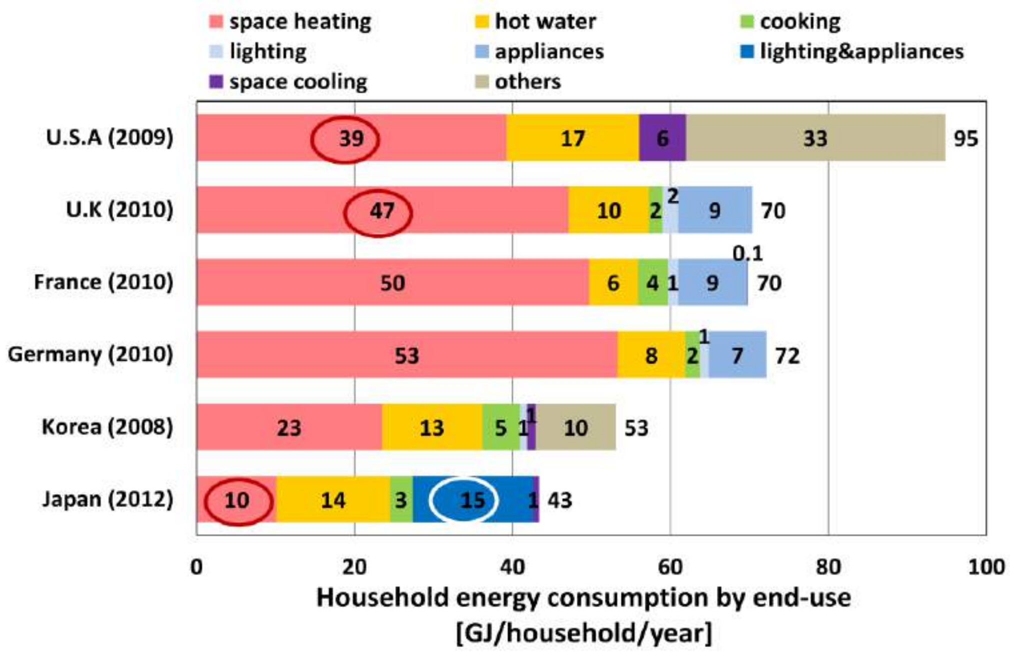

Figure 2-28 International Comparison of Residential per-Unit Energy Consumption by Application

Source: Ministry of Land, Infrastructure, Transport and Tourism, "Report of Study Group on Current State of House/Building Energy Consumption Performance" (reference document) P.47 Prepared by Dr. Nakagami, Chief Executive Officer of Jyukankyo Research Institute Inc. (March 2018) http://www.mlit.go.jp/common/001229009.pdf

At the same time, in Japan, many elderly people die each year at home from heat shock, the causes of which are cited as taking a hot bath in a house with low room temperatures (4,866 people drowned in the bath in 2016) and the decline in room temperatures during the winter. In Japanese houses, many of which are uninsulated, heating only occupied rooms means not only that temperatures drop at night and in the early morning, temperature differences between the rooms undeniably have a major effect on health. A recent study[99] shows that raising room temperatures by adding insulation has a positive effect on blood pressure and bath habits and clarifies the importance of home energy performance.

Energy performance of non-residential buildings still insufficient

Looking at the conformance of non-residential buildings (when initially built) with energy efficiency standards, as shown in Figure 2-29, as of 2017, 98% of large buildings with floor space of 2,000 m^2 or more meet the energy efficiency standard. In addition, 91% of medium-sized buildings (300-2,000 m^2) conform as well. The current energy efficiency standard, however, is at the same level for thermal performance as the

[99] The Study on the Impact of Insulative Renovation, etc. on House Occupants' Health FY2014 – FY2018 (Japan Sustainable Building Consortium, Smart Wellness Housing Committee) is an ongoing comparative study of the health status of house occupants before and after renovations to add insulation.

standard from 20 years ago; it is fairly easy to meet. Despite this, only 75% of small buildings of less than 300 m^2 conform with it (2018).

Energy consumption 20% lower than the energy efficiency standard is set as an "incentive standard", but as of 2015, this standard is only met by 59% of large buildings and 54% of medium-sized buildings[100]. This means that approximately half of buildings are between the current energy efficiency standard and the incentive standard. The zero-energy building (ZEB) level, which will be required of almost all buildings in 2050, requires that buildings consume 50% less energy than under the current standard[101], but buildings presently are still far from this level.

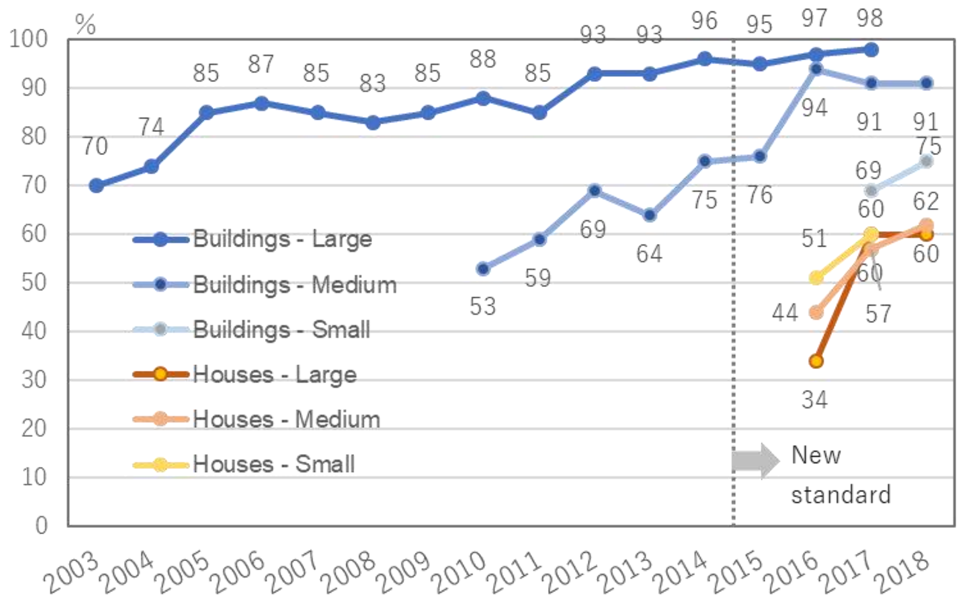

Figure 2-29 Energy Conservation Standard and Conformance Rates

Source: Created by REI based on MLIT, "Approach to Future Energy Efficiency Measures for Houses and Buildings (secondary proposal) (reference document)," January 2019, and "Report of Study Group on Current State of House/Building Energy Consumption Performance (reference document)," March 2018. Figures from 2015 based on the new standard.

The potential for adequate energy efficiency in existing non-residential buildings can be seen in the initiatives of the Tokyo Metropolitan Government in Tokyo, where 19% of the country's commercial buildings are located. The Tokyo Metropolitan Government is promoting proactive energy reduction policies that go beyond the national government, including a cap-and-trade program that requires large facilities to reduce their total CO_2 emissions. The energy consumption per square meters and other data for large buildings are published as a part of this program, and the data shows that reductions have made progress over the past eight years, led by offices that occupy a large proportion of their buildings[102].

[100] Ministry of Land, Infrastructure, Transport and Tourism, "Report of Study Group on Current State of House/Building Energy Consumption Performance" (reference material) (March 2018)

[101] According to the definition of ZEB established in 2015 by the ZEB Roadmap Committee.

[102] Documents from the first meeting of the Tokyo Metropolitan Government's Specialist Review Committee for Implementing Mandatory Reduction Schemes http://www.kankyo.metro.tokyo.jp/climate/large_scale/overview/after2020/kentokai/ and "TMG Energy Conservation Record (FY2016 Result) (Class I)" http://www.kankyo.metro.tokyo.jp/climate/large_scale/data/karte.html

The cap-and-trade program also requires that facilities covered by it submit the checklist along with energy consumption and CO_2 emissions data. It ensures that buildings check over 200 measures related to promote energy efficiency and their levels of implementation, and the results show there is still a great deal of room for further measures. Japan's buildings have significant potential for further energy reductions.

As discussed in Part 3 as well, Dr. Amory B. Lovins of Rocky Mountain Institute, in his "How Big Is the Energy Efficiency Resource"[103], points out that energy efficiency is an expanding resource. How much energy can be generated from this resource by creating and implementing policies for energy reduction is currently an important issue for Japan.

2. Policy direction in realizing zero-emission buildings

From energy efficiency to carbon neutrality

New buildings going forward need to have energy performance suitable for 2050. The performance of the building frame in particular (insulation, solar shading, etc.), which is difficult to renovate after construction, needs to be adequate from the start. When a new building is being constructed, high energy performance can be achieved while keeping additional costs low, so measures for new buildings need to be strengthened as quickly as possible.

To raise the performance of new buildings, comprehensive initiatives need to be conducted, including raising minimum energy conservation standards, expanding best practices and providing mechanisms for securing financing. It is important to collaborate with many stakeholders and professionals in the field in order to make major energy reductions, and a strong, clear signal needs to be sent in order to guide the market.

The basic policy globally for raising the performance of new buildings is setting energy efficiency standards and requiring conformance with them. For many years in Japan the energy efficiency standard was indicated as "for the decision-making of the building owner," and there was no mandatory system that would prevent construction if a standard was not met. At long last, in 2015, it became mandatory for non-residential buildings with total floor space of 2,000 m^2 or more to conform with an energy efficiency standard.

The Strategic Energy Plan of 2018 calls for making conformance with an energy efficiency standard mandatory in phases for new houses and buildings by 2020, and it was expected that the scope of the requirement would further expand to include houses. However, in January 2019, the government announced a policy of making conformance mandatory for medium-sized buildings (non-residential), but for medium-sized and large residential buildings it only plans to strengthen the notification system and for small houses and buildings require accountability not conformance. The reason given was that since the conformance rate is currently low (60% for large residential buildings and 75% for small buildings), making conformance mandatory would lead to market turmoil. The energy efficiency target of 2030 required for the building sector based on the Long-Term Supply-Demand Projections set by METI is considered achievable through the Housing Top-Runner Program and increased popularity of ZEH houses.

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[103] Lovins points out that the commonly held belief that as reduction measures are taken and energy conserved, the potential for further efficiency improvements dissipates and costs go up is mistaken. Energy efficiency, when viewed as a whole, is a resource that when practiced with appropriate methods generates increasing benefits. He explains with extensive examples from construction, general industry, automakers and others that it is possible to reduce more energy at lower costs. "How Big Is the Energy Efficiency Resource" https://iopscience.iop.org/article/10.1088/1748-9326/aad965/pdf

Putting off mandatory conformance for houses and small buildings is in line with the conventional policy approach of perfect enforcement without too much difficulties. However, given the existence of a target for major energy reduction that must be met by 2050, the government should now play a role for energy efficiency standard that goes beyond its conventional approach of ensuring enforcement for the last 10% or smaller.

Future energy efficiency standards and compliance systems for buildings need to consider the steps that must be taken to realize zero emissions for the building sector as a whole by 2050. It would have major significance to plan to make zero emissions as the minimum standard in the final stage and present a schedule for regulatory reform to that end with stages and years clearly defined. To set a deadline for introduction of a zero-emission standard for new construction as early as possible before 2050 and use backcasting to set a schedule for steadily strengthening the standard over time would send an important signal to the many companies and organizations involved in building construction.

If the steps used to gradually bolster the standard are easy at first, they would have to be difficult later. If the steps are few in number, then each step would have to be challenging. As the final deadline is set, then postponing any step would mean subsequent steps would have to be even more difficult. Setting an easy initial goal without indicating the difficulty of the final goal or its deadline is by no means fair to stakeholders in the building sector. A clear roadmap to zero emissions is needed.

There are currently ZEB and ZEH roadmaps for new buildings that are playing an important role as there is no clear regulatory schedule for ZEH and ZEB. The Strategic Energy Plan of 2014 established ZEB and ZEH targets for 2020 and 2030[104], consistent definitions for ZEB and ZEH were then set, and in 2015 roadmaps were created for achieving the targets. With ratification of the Paris Agreement, and based on the progress of initiatives, follow-up was conducted and the current roadmaps to 2030 were established. This cycle of considering the issues based on progress made and making revisions toward the next target, and, as shown in Figure 2-30, the fact that measures have been comprehensively considered over an unprecedentedly broad range before being taken up are both highly laudable.

[104] In the Strategic Energy Plan, for ZEB and ZEH targets, the government aims "to achieve ZEB on average with regard to newly constructed buildings, by 2020 for public buildings and by 2030 for non-residential buildings nationwide," and "to achieve ZEH [...] for standard newly constructed houses by 2020 and for all newly constructed houses on average by 2030."

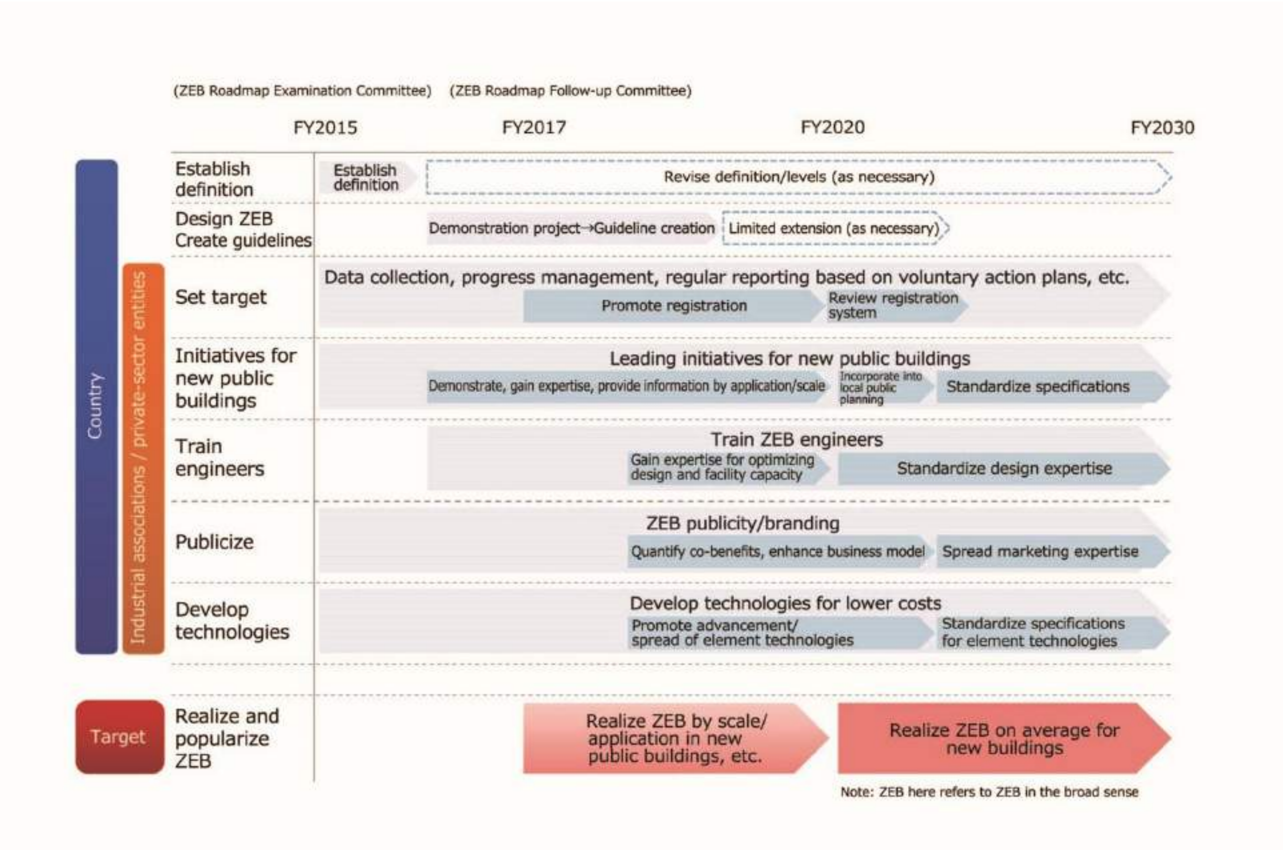

Figure 2-30 Roadmap to ZEB Achievement and Proliferation (updated after follow-up; summary version)

Source: "ZEB Roadmap Follow-up Committee Summary" (May 2018)
http://search.e-gov.go.jp/servlet/PcmFileDownload?seqNo=0000174301

The issue with this roadmap is that no final targets are indicated for 2050 and it is not a plan for achieving the target of zero with 2050 stock. For this reason, there is little mention on coordination with energy efficiency standards and renovating existing buildings to ZEB/ZEH status. Premised on extending the range of the roadmap to 2050 and ultimately making ZEB/ZEH (or, at least, the energy efficiency standards of ZEB/ZEH) the minimum standard, the government needs to integrate energy efficiency standards, ZEB/ZEH standards and the roadmap.

Progressive countries and regions around the globe are transitioning to the zero net energy standard with a view to 2050. Table 2-7 show examples of energy standards for new construction created or revised in 2017 and 2018. There are examples like Germany of steadily continuing to strengthen insulation standards, and those like Canada and California which have set the clear goal of net zero energy. Japan should also draw up a roadmap as soon as possible for energy efficiency standards leading to zero emissions by 2050 with initiatives laid out in steps over the next 30 years.

Table 2-7 Building Energy Standards and Recent Trends (New Construction)

Country/Region	Building energy standards and other recent trends
Germany	The Energy Conservation Ordinance has been in effect since 2016 and requires new buildings to achieve a reduction of primary energy consumption by 25% and an improvement in building insulation by 20% The insulation improvement is a continuation of significant improvements in Germany through a series of policies that have achieved more than 75% heating energy savings since 1975
Canada	Continuous improvement process and is guided by the target of achieving net - zero energy ready buildings by 2030. The National Energy Code of Canada for Buildings 2017 pushes towards that target with a 10% energy savings compared to the 2011 version
British Columbia, Canada	Commit to taking steps to increase energy efficiency requirements to make buildings net - zero energy ready by 2032
California, U.S.	California 2019 Building Energy Efficiency Standards is the first code in the United States to require solar PV systems on new homes. In addition, the code also targeted energy efficiency, including 30% reduction in energy use for non - residential buildings
New York City, U.S.	Developed an energy code revision handbook, which includes the goals of the 2019 code to incorporate the latest version of the NYStretch Code – Energy based on Local Law 32 of 2018

Source: Created by REI based on Global Alliance for Buildings and Construction "2018 Global Status Report" https://worldgbc.org/news-media/2018-global-status-report-towards-zero-emission-efficient-and-resilient-buildings-and

Renovating existing houses and buildings

Except for some ZEB and ZEH built in recent years, most existing buildings will not meet 2050 performance requirements for energy efficiency as they stand now. Though some of these buildings will likely be eliminated for reconstruction after considering overall performance, including seismic capacity, compared to new construction, an extremely large amount of building stock will have to be steadily renovated up to 2050.

A comprehensive policy package is needed, including standards, labeling, inspections and consulting, and financing programs, but as of the present Japan's policies targeting renovations to existing buildings at the national level consist only of a modest subsidy program[105]. This needs to be expanded as soon as possible.

In Europe, there is also the approach of setting energy standards for existing buildings like the EU's EPBD directive[106] and then strengthening the standards in stages all the way to net zero. France requires the actual amount of energy consumed to be reduced (Table 2-8).

[105] The Tokyo Metropolitan Government's Total Emissions Reduction and Trading Scheme (Tokyo cap-and-trade program) is proving to be highly effective as a measure for existing buildings. Extending policies that draw on the experience of this program to other regions is another important option.

[106] Energy Performance Building Directive

Table 2-8 Building Energy Standards and Recent Trends (Existing Buildings)

Country/Region	Energy standards, etc. for existing buildings
EU	An amendment(2018/844/EU) to the Energy Performance of Buildings Directive (EPBD) was published on 19 June 2018. This amendment introduces revisions to the EPBD to accelerate renovation of existing buildings. The aim is for a buildings stock that is highly energy efficient and decarbonized by 2050 in a cost - effective transformation to nearly zero energy buildings. Member states have until March 2020 to transpose provisions into national law
France	Decree No. 2017 - 919 (2017) sets a requirement to undertake energy performance improvements when a major renovation occurs. This requires increased insulation when renovating 50% of an exterior surface (e.g. façade renovation, roof replacement or transformation of a non - heated space into housing) with the aim for a “no - regret” approach through optimized cost during an existing renovation process. The French Energy Transition Law also sets a requirement on users and owners of tertiary buildings to reduce their final energy consumption, as compared to 2010, by 40% in 2030, 50% in 2040 and 60% in 2050, either through improved building operations or physical building and system improvements.
Bern, Switzerland	For building refurbishment, Switzerland applies a target value for deep refurbishment of 75 kilowatt hours (kWh) per m2, which is about double the value of the mandatory standard for new buildings. For non - residential buildings, the code limits electricity use in buildings with floor areas over 500 square meters and requires improvements every five years. A building refurbishment programme will subsidize building insulation and the integration of renewables.

Source: Created by REI based on Global Alliance for Buildings and Construction “2018 Global Status Report”
https://worldgbc.org/news-media/2018-global-status-report-towards-zero-emission-efficient-and-resilient-buildings-and

In addition, various measures for existing buildings are being developed not only by the Tokyo Metropolitan Government but local and city governments around the world (Table 2-9). Residences and buildings have local characteristics related to climate, design traditions, living patterns and the like, therefore, local government policies have advantages to take these local characteristics into account. The scale of stakeholders is smaller than with national-level policies, which makes it possible to take a highly practical approach.

Vancouver City mandates energy performance upgrades when renovations are made, Singapore mandates improvements through refrigerator efficiency standards, and New York City is said that currently they are in the final stage of the process to set the standard for energy intensity. Various measures connected with renovations to existing buildings are being conducted and they will be very useful as reference when national-level considerations take place. It is expected that such cities will continue to play an active role in driving energy performance measures globally.

Table 2-9 City and Local Government Measures for Existing Buildings

Category	Building energy policy	City/region
Mandatory energy renovations	○ Energy efficiency renovations and mandatory upgrades	Vancouver
	○ Mandatory tuning, Retro commissioning	NYC, Seattle
	○ Mandatory conformance with chiller performance standards	Singapore
Strengthening of energy standards	○ Application of building energy code to existing buildings	NYC, etc.
Visualization of energy performance	○ Benchmark system	NYC, etc.
	○ Energy performance labeling/performance certification, green building ratings	Singapore EU, etc.
	○ Reporting system related to energy performance	Tokyo Metro
	○ Strengthening of visualization Open data, visualization	NYC, etc.
Energy audits Energy efficiency diagnosis	○ Mandatory energy audits	Singapore San Francisco
	○ Provision of energy efficiency diagnosis	Tokyo Metro
Carbon pricing	○ Cap-and-trade program	Tokyo Metro

Source: Created by REI

Instituting mandatory labeling program

Another policy being overlooked is mandatory labeling of building energy performance. The Building-Housing Energy-Efficiency Labeling Program (BELS) is a best-effort labeling program for new houses and buildings. Various labeling programs are already in use, including House Performance Labeling Program, CASBEE, and Tokyo Metropolitan Government's Green Building Program, and it would be possible to immediately make them mandatory for large buildings in particular. A unified, nationwide energy performance labeling program should be made mandatory and be implemented as soon as possible.

Energy performance labeling is also important for existing buildings, not just new construction. Opportunities should be created to confirm house/building performance and consider improvements when they are bought and sold or leased, by adding it, for example, to the important items explained in real estate transactions. Europe's EPC program is already in place in multiple countries and should be referenced.

Figure 2-31 BELS Label (for illustrative purposes only)

Source:
Jutaku Seino Hyoka Hyoji Kyokai
"ZEH Labeling Begins"
pamphlethttps://www.hyoukakyoukai.or.jp/bels/pdf/bels_leaflet02.pdf

In addition, for large buildings, implementing a benchmark program like those of U.S. cities would also be effective. The energy performance assessments conducted in Japan are based on building designs, and there are discrepancies with actual figures. As long as energy consumption is largely determined by the devices and consumption patterns of users, it is crucial that building stakeholders (owners, tenants, managers, etc.) grasp the actual figures and have opportunities to compare them with other buildings. A benchmark program makes it mandatory to report actual consumption data to all buildings of a similar size, which allows benchmark indicators like average energy consumption and deviation to be calculated and fed back into assessments. This would serve as the perfect opportunity for building owners to grasp the energy consumption level of their own buildings and make renovations for greater energy efficiency.

In progressive cities like New York, the actual energy consumption data of individual buildings and deviation values, etc. are subject to disclosure (Figure 2-32).

In Japan, such figures are often not disclosed for reasons of privacy and the like, but massive energy consumption by large buildings has an enormous impact on the decarbonization efforts of entire cities and regions as well. Policies in places like New York are based on the idea that information related to the energy efficiency of large buildings has public relevance and should be publicly disclosed. The data is used not only by building owners and government officials but by third-party researchers and consultants as well for considering energy renovation methods for existing buildings and their future potential.

The fact that performance labeling for existing building lags behind in Japan could actually be drawn on to create an ideal policy that combines performance labeling and benchmarking, a hybrid of the European and American approaches. It would also have significance in that it would help in the accumulation and transparency of property information in order to facilitate the further development and maturation of Japan's used house and building markets.

Figure 2-32 Benchmarking Visualization: New York City Energy & Water Performance Map

Note: The data is not only disclosed but rendered visually. With the help of New York University, the benchmarks are mapped onto a GIS map and individual building evaluations are shown visually. Individual building performance is color-coded, and more detailed data can be displayed by clicking on one of the buildings.

Source: New York City Energy & Water Performance Map
https://serv.cusp.nyu.edu/projects/evt/(Accessed March 27, 2019)

Coordination with renewable energy policy

In California, under 2019 Energy Standards enacted the previous year, it will be mandatory from 2020 for new houses to have solar power systems. In Switzerland (Bern) as well, it will be mandatory in 2020 to use renewable heat and power. For new construction, there is now a movement to make zero emissions, including energy generation, the standard starting with houses, for which it is relatively easy to accomplish.

By contrast, the solar power systems that have actually been installed on ZEH houses in Japan have capacity of around 4-5 kW, and solar heat and geothermal heat are hardly being used. Also, high rise buildings, which have limited space for solar panels compared to the level of their energy demand are frequently classified as "ZEB Ready" or "Nearly ZEB[107]"; there are few cases of buildings achieving the ZEB standard with onsite renewable energy.

However, according to RTS Corporation's long-term projection for solar system installation, which was discussed in Part 1, rooftop supply is expected to grow significantly going forward, and developing incentives and rules to maximize solar system installation timed to building construction and renovation is important as a renewable energy policy as well.

California recommends, as "smart ready," installing demand response systems on buildings to make it possible to shift energy consumption to off-peak hours. It is an attempt to create next-generation zero-energy houses that use renewable energy more flexibly. Electric power is priced differently by the power utilities depending on the time slot, which serves as a climate change measure for the state while reducing electricity bills for consumers.

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

House/building renovation as pillar of long-term investment strategy

There are projected to be below 50 million households in 2050. Most houses today would not pass the performance test as of 2050, so the majority will need to be either renovated and rebuilt completely. In considering measures for the next 30 years, this means that over a million houses will need to be renovated or rebuilt each year. Currently, around 900 thousand houses are built every year. Going forward, given that it will also be necessary to reduce lifecycle carbon emissions (embodied carbon), initiatives to prolong service lives will need to be seriously considered, and policy should be directed toward reducing new construction and promoting renovation. Energy efficiency renovations currently number around 400 thousand annually. In order to realize the needed 1 million plus renovations and rebuilds each year until 2050, energy efficiency renovations will need to increase to around double the current level.

At the same time, the current stock of non-residential buildings is 2.62 billion square meters[108], and new construction takes place at a rate of around 50 million square meters per year[109]. However, considering that

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[107] ZEB Ready is energy efficiency of at least 50% of the energy standard, and Nearly ZEB is reduction of 75% or more (with the requirement of at least 50% of the energy efficiency standard). Buildings that do not meet ZEB's 100% reduction requirement are still assessed as in the ZEB family.

[108] Total of corporate, etc. and public non-residential buildings from MLIT's "Building Stock Statistics" (2017) http://www.mlit.go.jp/common/001198960.pdf

[109] Total of non-residential buildings from MLIT's "Building Starts Statistics" (2018) http://www.mlit.go.jp/common/001271052.xls

the pace of new construction will slow going forward, renovations will also have to take place on a scale equivalent to new construction at present. The scale is considerable, but various programs would generate major co-benefits and create economic added value. Houses and buildings construction projects have long supported Japan's economy.

Investment in residential and non-residential buildings in fiscal 2018 is estimated at 31 trillion yen[110]. The total investment is equivalent to approximately one-fourth of Japan's GDP. The majority of this investment at present is for new construction, but given the declining population, and considering lifecycle CO_2 as well, the major pillar of construction investment should be switched from new rebuilds to converting existing buildings to high-quality buildings through renovation. There needs to be a strategy, therefore, for developing building renovation into a major industry.

However, it will be difficult to scale up the current small-scale, one-off renovation projects for energy efficiency into a full-fledged industry. Keeping the good characteristics that contribute to local economies by utilizing local SME business and resources and creating job, at the same time, the scale of the industry needs to be further expanded. This is because reducing renovation project costs and speeding up the process could generate a positive cycle of promotion and expansion. Even overseas, many businesses and local governments develop and support diverse business models and best practices have emerged, including examples of success with financing schemes that do not rely on subsidies[111]. Japan should also work to develop the energy efficiency renovation business with reference to these practices.

Comfortable, healthy living and work spaces

As discussed at the start, the energy performance of Japanese houses is low. Energy consumption per household is lower than the U.S. or Europe, but, at present, this low level of consumption is not preferable from a health or comfort standpoint. Unless changes are made, it will be difficult to make large steady energy reductions. The opportunity is here now to transform Japanese homes into comfortable, healthy living environments. Improving the insulation performance of Japan's housing stock is essential to providing a comfortable living environment for everyone living in Japan, one with stable room temperatures and no mold or condensation concerns, all while not significantly increasing energy consumption but actually reducing it.

Regarding the required level of insulation performance, an important standard should probably be the level that ensures rooms are warm enough not to negatively affect people's health, whether heating rooms intermittently only while they are occupied[112]. As climate change progresses, there is a strong possibility that extreme weather in the form of frigid winters and heat waves will increase. Given this, insulation performance is all the more necessary as a means of not increasing energy consumption in response to rising heating and cooling demand. A resilience perspective is also important, which means whether the living environment can be maintained when the energy supply from outside is cut off during floods and other natural disasters, which are predicted to occur more frequently.

In the area of energy efficiency performance, there are already products and technologies existing in the market, so we do not need to wait for additional innovative products to be developed and commercialized. With demand increasing for houses with high insulation performance, the cost of building materials and the houses themselves will come down to be within the reach of greater numbers of people. The increasing quality and lower cost of energy efficient building materials like window sashes in recent years is proof of this.

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[110] MLIT, "Summary of Fiscal 2018 Estimate of Construction Investment" (August 2018) http://www.mlit.go.jp/common/001240810.pdf

[111] Energiesprong is one example that began in the Netherlands and has expanded to the U.K., France, the U.S. and Canada.

[112] Approach used by the G1/G2 standards of the Investigation Committee of Hyper Enhanced Insulation and Advanced Technique for 2020 Houses (HEAT20)

The comfort of the workplace environment is also a matter of interest to many people. Building facilities designed for increased work productivity are in demand around the world, and evaluation systems are also starting to be used to rate offices for health.[113] As health and productivity, factors related to workers and occupants, become important in deciding building value, renovation demand for existing buildings will eventually increase, and this could lead to energy performance renovations. Overseas, upgrading energy performance is starting to be made mandatory when various types of renovation projects are conducted (Table 2-7, Table 2-8).

In conjunction with decarbonization, buildings that offer a pleasant environment will increase the attractiveness of cities and help build urban centers that are competitive on a global level. The world's metropolises are competing to implement zero-emission building strategies. Now is the time for Japan as a whole to broadly implement a strategy that also includes existing buildings. Commercial buildings regularly replace their facilities and conduct renovations, and major renovations need to take place every 15 to 20 years. Japan must not miss this opportunity to implement highly cost effective measures. It is up to the government to send a strong signal by providing targets, standards and a roadmap for achieving zero emissions in all existing buildings.

Toward zero emissions in the building sector by 2050

Lastly, the following organizes measures and scenarios in the residential and commercial sectors for 2050 from the perspective laid out above. The important point is that achieving significant additional energy efficiency in the building sector is possible by utilizing technologies that are already widespread. The main measures are shown in Table 2-10. The technologies are not novel, but the reduction benefits are substantial.

At the same time, overall activity in the building sector is greatly affected by trends in household numbers and commercial floor space, and because the population is decreasing, both residentials and operating floor space are expected to decline. Given these circumstances, it will be possible by 2050 to reduce energy consumption in the building sector by half compared to 2016, both in the residential and commercial sectors.

The remaining energy demand, with the exception of renewable energy used for heat like solar heat and biomass, will be entirely covered by electric power. Realizing 100% renewable power by this time would allow the overall building sector to decarbonize and achieve zero emissions. The scope covered by electric power will expand greatly, but by improving energy efficiency through strengthening insulation performance, etc., it will be possible to either not increase or actually reduce the amount of electric power consumed compared to current levels.

Decarbonization of the building sector in this way is possible through energy efficiency improvements and 100% renewable power, but whether this can be implemented in a way that minimizes economic and social costs depends on policy. The longer energy efficiency, energy-demand reduction, and energy transition are delayed saying they would be too difficult at present, the greater the measures required in the future, the greater the cost, and the greater the impact on the economy and society will likely be. Whether transition policies can be quickly implemented going forward is the key test for a long-term reduction strategy.

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[113] Programs include the WELL Building Standard (evaluation system for creating better living environments that adds the perspective of "human health" to space design, construction and operation; developed in the U.S. and started in 2014), and CASBEE SMO (evaluation program for office "smart wellness" in the CASBEE series; preliminary version has been released).

Table 2-10 List of Measures in Building Sector (Residential/Commercial Sectors)

Main measures (residential)	Main measures (commercial)
・ Use of heat pump air conditioning for heating/cooling ・ Use of heat pumps for hot water (electrification), use of solar heat ・ Higher insulation performance ・ Use of LED lighting ・ Electrification of kitchen appliances ・ Increase energy efficiency of appliances; etc.	・ Use of heat pumps for heating/cooling ・ Higher insulation performance ・ Use of pump inverters, pipe insulation ・ Use of heat pumps for hot water (electrification) ・ Use of LED lighting ・ Electrification of kitchen appliances ・ Other drive efficiency improvements; etc.

Source: Created by REI

Part 5 Pursuing Decarbonization in the Transport Sector

The transport sector accounts for 23% of Japan's final energy consumption and 19% of its CO_2 emissions (fiscal 2017). These figures have been trending down since 2000 due to the lack of growth, contrary to GDP, in freight and passenger demand and increasing energy efficiency (Figure 2-33).

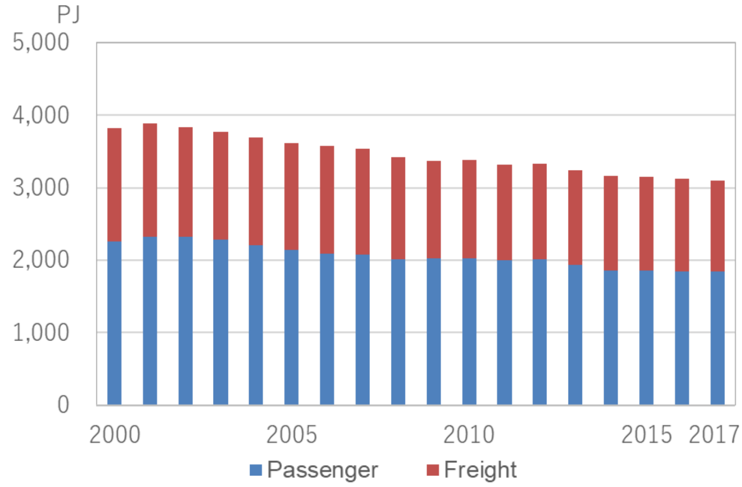

Figure 2-33 Final Energy Consumption in Transport Sector

Source: Created by REI based on the Agency for Natural Resources and Energy, "Comprehensive Energy Statistics," etc.

The technologies needed to decarbonize the transport sector differ with the sub-sector, whether passenger vehicles, trucks, rail, ships or airplanes. Decarbonizing private passenger vehicles, motorcycles and scooters, taxicabs, light-duty trucks and buses can be accomplished by switching to electric vehicles (EV)[114], which are already commercialized, and converting to 100% renewable electric power. In contrast with this, for heavy-duty trucks, airplanes and ships, etc., decarbonization technologies are not at the stage of full commercialization, so efforts aimed at developing and commercializing such technologies need to be accelerated going forward.

Further, regardless of whether a sub-sector can already use electric vehicles or whether it will require technologies to be developed going forward, energy efficiency is needed to improve and reduce energy consumption. The important message shared with other sectors is the need to move forward with reductions to 2030 through maximum use of technologies available now and not wait for new technologies to be developed.

[114] This proposal mainly discusses electric vehicles (EV) as battery electric vehicles (BEV) in particular, but also takes up plug-in hybrids (PHV) in the context of EVexpansion.

1. Decarbonization in passenger vehicles through adoption of EV technology

Developing EV technologies and decreasing costs

Electric vehicles are the decarbonization technology for which transport sector expectations are highest.

Table 2-11 is a comparison of electric vehicles and gasoline vehicles, etc. from the standpoint of energy efficiency and CO_2 emissions. Electric vehicles are the most energy efficient transport option (energy consumed per kilometer traveled is the lowest). Regarding CO_2 emissions from fuel manufacture to operation as well, while figures are not fixed because they are determined by the emission factor of the power used, as of the present, electric vehicle emissions are the lowest. As electric power becomes low-carbon going forward, CO_2 emissions will decrease further.

Table 2-11 Energy Consumption and CO_2 Emissions per Kilometer Traveled by Vehicles in Japan

	Electric vehicles (BEV)	Gasoline vehicles (Vehicles with internal combustion engines)	Hybrid vehicles (HEV)	Fuel cell vehicles (FCV)
Energy efficiency in operation (MJ/km)	0.36	1.69	1.09	0.73
CO_2 emissions (g-CO_2/km) including operation and fuel manufacture	55(59)	147(132)	95(69)	78-132

Source: Created by REI based on Japan Automobile Research Institute, "Analysis of Overall Efficiency and GHG Emissions" (JC08 Mode), 2011, and documents from METI's Strategic Commission for the New Automotive Era (first meeting). CO_2 emissions are based on electric power emission factors from fiscal 2009. Figures in parentheses are based on emission factors from fiscal 2015 (METI document).

Electric vehicles have overcome their technical problem of short driving distances and long charging times to a certain extent, and passenger vehicles can now travel 400 km on a single charge and receive an 80% charge in 30 minutes to an hour. Costs, the issue that remains, are expected to continue to come down as battery prices decrease. The International Council on Clean Transportation (ICCT), a research institute dedicated to environmental policy in the transport sector, gives the prediction that by around 2025, electric vehicle prices will be equivalent to or lower than internal combustion engine (ICE) vehicles that use gasoline or diesel (Figure 2-34)[115].

[115] Other sources include BloombergNEF, "2018 Long-Term Electric Vehicle Outlook 2018," etc.

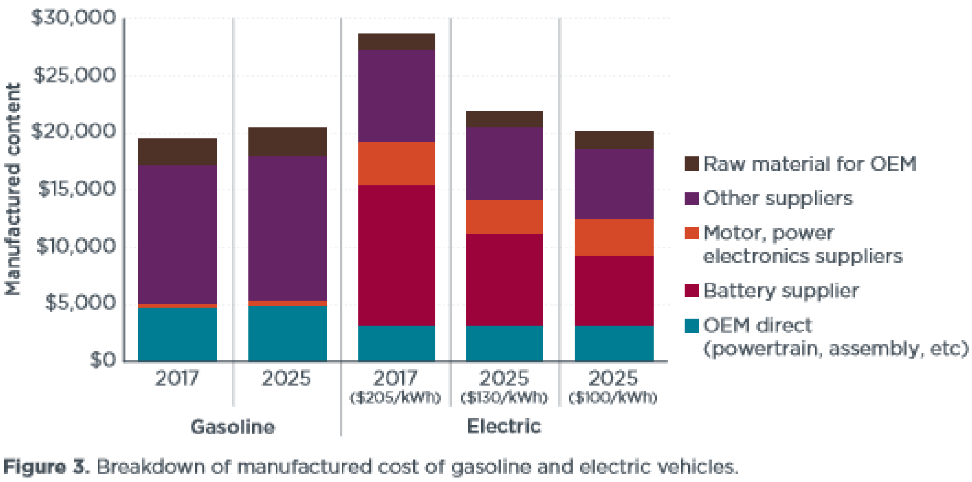

Figure 2-34 Price Projections for Electric Vehicles (Battery) and Gasoline Vehicles

Note: The value listed below the battery vehicle year is the cost of the battery pack. 2025 is estimated with two costs ($130/kWh and $100/kWh).

Source: ICCT "Power play: how governments are spurring the electric vehicle industry" (May 2018)
https://www.theicct.org/publications/global-electric-vehicle-industry

Reflecting these trends, sales of electric vehicles are growing worldwide. Vehicle stock has risen sharply over the past several years, reaching 3 million vehicles in 2017 (Figure 2-35). Along with their high level of decarbonization performance, electric vehicles also have the advantage of zero air pollution, quiet operation, and ease of driving, among others, and as the difference in price with internal combustion engine vehicles continues to shrink, electric vehicles are expected to enter the phase of autonomous growth in sales and ownership even without the kind of policy support that is offered now.

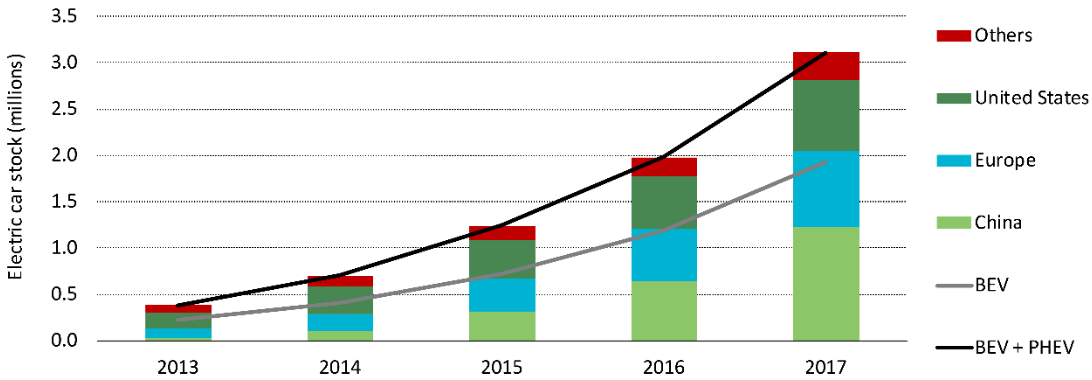

Figure 2-35 Sharp Rise in Worldwide EV Ownership (2013-17)

Note: Stock is estimated based on cumulative sales since 2005. Official statistics from each country are used (if consistent with increasing sales volume and the data is usable) and supplemented with ACEA and EFAO documents.

Source: IEA "Global EV Outlook 2018" (May 2018)
http://centrodeinnovacion.uc.cl/assets/uploads/2018/12/global_ev_outlook_2018.pdf

Electric vehicle policy in other countries

Countries around the world have implemented various policies to support the spread of electric vehicles. Target years have been announced for when sales of new vehicles with internal combustion engines (ICE) will be prohibited in Norway (the earliest at 2025), France, the U.K., India, the Netherlands and elsewhere. Along with helping to address climate change, regional governments are also implementing policies to reduce air pollution from gasoline and diesel vehicles.

Further, regulations on fuel economy and carbon emissions for individual vehicles are becoming more stringent each year in various countries, which is further promoting the shift to electric vehicles. California's ZEV regulation, which makes it mandatory for automakers to sell zero-emission vehicles has been implemented in the U.S. by ten states total and has been highly effective. Beginning in 2018, in terms of allocation requirements, hybrid vehicles (except PHEV) will not be counted as ZEV. There are also subsidies and tax incentives provided in various forms in each region, and these are expected to further stimulate the switch to electric vehicles.

The electric vehicle policy drive is especially strong in China. The subsidy program began in 2015 has had a major impact, and in 2017 the Chinese market became the largest in the world with 780 thousand electric vehicles sold. Further, in 2019, the New Energy Vehicle (NEV) regulation, similar to California's ZEV, will go into effect. Manufacturers are moving to introduce electric vehicles to comply with fuel economy requirements. Major cities with pollution problems have implemented policies requiring lotteries or auctions, etc. to register new internal combustion engine vehicles, and this has had a major impact. Six major cities (Beijing, Shanghai, Shenzhen, Tianjin, Hangzhou, and Guangzhou) in 2017 accounted for half of China's electric vehicle sales. China's automakers have also responded; there are now companies with policies of selling only electric vehicles starting in 2025. The Chinese government strongly intends to develop globally competitive automobile and battery industries as a part of its industrial policy and not only for the environmental goals of addressing climate change and reducing pollution. Japanese automakers also cannot afford to ignore the shift to electric vehicles in China as the China market accounts for 28% of Honda's global car sales by volume, 16% of Renault-Nissan's, and 12% of Toyota's.

Figure 2-36 shows projections for electric vehicles in the IEA's scenario for global warming of less than 2°C; 14% of global vehicles owned are electric vehicles in 2030 and 84% in 2060 (includes both battery vehicles and plug-in hybrid vehicles). Developments beyond this would be needed to achieve the 1.5°C target.

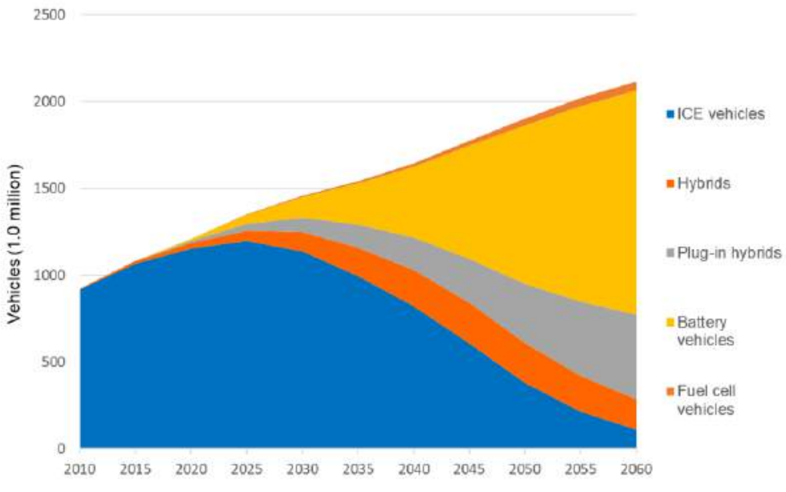

Figure 2-36 Projections for Vehicle Ownership by Type in "Below 2 degrees Scenario"

Source: IEA "Energy technology perspectives 2017" (June 2017)

Clarifying EV strategy in Japan

The government convened the Strategic Commission for the New Automotive Era in April 2018 and released its interim report in August. The report sets a goal for Japanese vehicles supplied globally of reducing GHG emissions per vehicle by approximately 80% of 2010 levels by 2050. On a per-passenger vehicle basis, the goal is reduction of around 90%, so the assumption is that achieving this level will require the rate of xEV passenger vehicles to be 100%. xEV in this context includes battery electric vehicles (BEV), hybrid vehicles (HEV), plug-in hybrid vehicles (PHEV) and fuel-cell vehicles (FCV). What is distinctive about this is that there are no goals for individual types of electric drive.

In addition, the target for the domestic Japanese market remains the target in the Next-Generation Vehicle Strategy 2010 formulated in 2010. Which is next-generation vehicles as 50-70% of new passenger vehicles sold by 2030. The target for electric vehicles is 20-30% of next-generation vehicles sold by volume, but it also includes a 5-10% target for clean diesel vehicles, a sector from which global automakers are withdrawing in quick succession. The strategy also sets a 3% target for fuel cell vehicles.

Compared with the policies of other countries which narrow the focus to electric vehicles among the types of electric drive and prioritize their growth, Japan’s policy is unclear on the direction for passenger vehicles going forward, and makes no mention of gasoline or diesel vehicle sales.

Two major automakers, Toyota and Honda, continue large-scale investment in the development of fuel-cell vehicle technologies and both already have commercialized models on the market. However, prices are still high and the cost of establishing a hydrogen station network will be enormous; plus, compared to electric vehicles, fuel costs are high and becoming CO_2-free is premised on growth in renewable power, so there are a number of major issues to overcome. Given the trend toward electric vehicles globally and in the China market specifically, Toyota and Honda have both begun to move strategically into electric vehicles.

The EV lineup in the Japanese market is limited compared to Europe and other regions, but it is expected that by 2025 new models from domestic automakers will arrive to the market, the sales environment for electric vehicles will improve, and sales will increase. Major changes are anticipated in mobility services, starting with self-driving vehicles and IoT applications, and automakers are currently focusing their R&D and investment in these areas. It will be necessary to further accelerate decarbonization. With the global market for passenger vehicles shifting rapidly to electric vehicles, Japan will need to more clearly define its strategy.

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

Figure 2-37 shows each mode of transport’s share of CO_2 emissions in the transport sector. It also shows the areas with the greatest prospects for electrification. Passenger vehicles, which can be decarbonized with existing EV technologies, have the largest share of emissions at 49%. Next, almost half of trucks, which account for a large 37% share, are light-duty trucks, which travel relatively short distances and generally have local routes, so using EV trucks would be relatively easy. Driving in urban areas in particular involves the problems of pollution and noise, etc., so electric vehicles have advantages in this regard as well, and this is why they are already starting to be deployed. Japan's three truck manufacturers have already developed commercial light-duty EV trucks, and these models are currently being used by courier companies, convenience stores and other companies. Mitsubishi Fuso Truck and Bus Corporation announced that it had established a mass production system for electric trucks for the global market and would begin supplying EV trucks to the U.S. major courier company UPS.

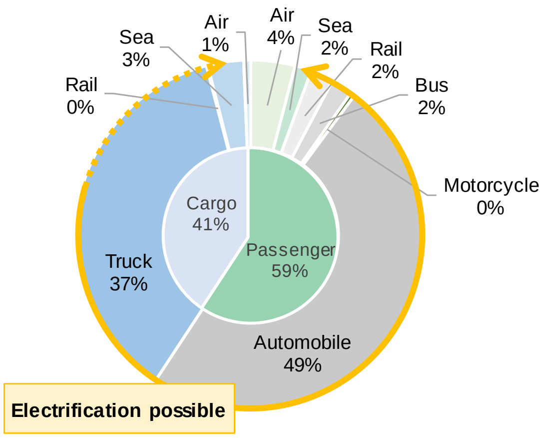

Figure 2-37 Emissions Share and Electrification Prospects by Mode

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

Progress is also being made in EV technology for heavy-duty trucks, with range, which had long been a sticking point, beginning to increase and test runs being conducted. Semi, Tesla's heavy-duty electric tractor-trailer announced in November 2017, can travel 300 miles (480 kilometers) or 500 miles (805 kilometers) on one charge, pull around 36 tons and is priced at $150,000 (approx. 16 million yen) or more, a difference in price of around 10% compared to diesel trucks, its competitor. Operating costs are 20% less, so the additional cost can be recovered in just a few years. The company is testing Semi on runs with cargo from its Nevada factory to its assembly plant in California and plans to begin selling the truck in 2019. Ford also unveiled its concept for electric heavy-duty trucks at a motor show in 2018.

Unlike passenger cars and light-duty trucks, heavy-duty trucks can potentially be combined with fuel cell-hydrogen because the fuel station network does not need to be extensive. However, in light of current trends in heavy-duty electric trucks just before their commercialization, the schedule for development, application and infrastructure will need to move forward at a very quick pace.

As for buses, routes are generally fixed and buses travel relatively short distances; plus, ownership costs, which include the vehicle price and running costs, are potentially less for electric buses than diesel or CNG buses even now because of their inexpensive fuel and maintenance costs. Accordingly, they are starting to be used in cities as a way to combat air pollution and noise. In China in particular, which accounts for over half the world's electric bus market with over 100,000 of the buses sold, the city of Shenzhen, with a population of over 13 million, has used electric buses for all its 16,359 city buses since 2017. Cities in China and Europe will no doubt continue to deploy electric buses while taking advantage of government and EU support. C40, a climate change action network made up of major cities, is also carrying out an electric bus initiative.

In Japan, electric buses are being used in very limited areas in cities like Yokohama and Gifu, but it is still on a very small scale. There is a plan to put 100 or more fuel-cell buses into operation for the Tokyo Olympics, but given the cost of hydrogen fuel, which will likely be high for the immediate future, and the need to establish hydrogen stations, and other factors, whether this is an economically sustainable option over medium/long term needs to be reassessed.

3. Decarbonization in shipping and aviation

Along with aviation, maritime shipping is the sector where decarbonization lags the furthest behind. That said, an emissions mechanism for international maritime shipping, which is not directly included in the Paris Agreement, was decided by the International Maritime Organization (IMO) in 2018. Steps toward decarbonization are still behind, but the OECD's International Transport Forum has stated a goal of decarbonization by 2035 and has proposed measures to achieve it[116]. Domestic maritime shipping should implement measures ahead of international shipping, but the decarbonization measures in the report are the same for both international and domestic (Table 2-12).

Table 2-12 Decarbonization in Maritime Shipping

Type of Measures	Main Measures
Technological	Light materials, slender design, less friction, propulsion improvement devices, waste heat recovery
Operational	Lower speeds, ship size, ship-port interface, onshore power, smart shipping
Alternative fuels/energy	Advanced biofuel, LNG, Hydrogen, Ammonia, Fuel cells, Electricity, Wind, Solar

Source: Created by REI based on International Transport Forum, OECD 2018, "Decarbonising Maritime Transport- Pathways to zero-carbon shipping by2035" (March 2018) https://www.itf-oecd.org/sites/default/files/docs/decarbonising-maritime-transport.pdf

Achieving decarbonization in the maritime shipping industry will require not only the development of 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.

Working toward decarbonization also means the creation of new business opportunities. In 2018, Nippon Yusen (NYK Line) announced its concept ship of Super Eco Ship 2050 for zero CO_2 emissions. Overseas, since 2017, electric ferries have operated between Sweden and Denmark, carrying over 1,000 passengers and 240 cars on the four-kilometer voyage. A corporate group in Norway led by Yara is developing a self-navigating electric freighter and has announced it will begin operating in 2019. Competition related to decarbonization has already begun. In Japan, many ships still use Bunker C diesel, and more stringent international sulfur oxide regulations will also be a good opportunity to bolster initiatives for decarbonization.

Current emissions from the aviation sector, including both passenger and cargo flights, account for 5% of the transport sector, which is not a large share, but air demand is expected to increase going forward, so measures will need to be strengthened. The International Civil Aviation Organization (ICAO) is establishing fuel economy regulations for new aircraft and preparing to launch a carbon offset program in 2020 called Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to address CO_2 emissions from international flights. However, future demand is expected to center on international routes, and this, along with the difficulty in shifting to electric technology, makes the sector one of the most difficult to decarbonize.

[116] International Transport Forum, OECD, "Decarbonising Maritime Transport- Pathways to zero-carbon shipping by2035" (March 2018) https://www.oecd-ilibrary.org/docserver/b1a7632c-en.pdf?expires=1556089098&id=id&accname=guest&checksum=A64F85E69AB28BE510D773E0A03C7BAE

For this reason, there are high expectations for bio jet fuel, which is made from biomass. Six airports around the world, including Los Angeles International and Oslo Airport, have already begun supplying jet fuel mixed with bio fuel, and bio fuel has been used on over 150,000 flights operated by such airlines as KLM Royal Dutch Airlines, Scandinavian Airlines and Lufthansa[117]. At present, however, bio fuel production capacity is equivalent to a mere 0.1% of global demand. If this technology is to make a significant contribution to CO_2 reduction, international cooperation to achieve major advances in technology and production capacity are essential.

The premise here, which is the same as for bioenergy as a whole, is securing sustainability while considering lifecycle assessments, etc. of the supply chain, from production region environment to production and transport. On this point, expectations are mounting for next-generation bio fuels, not making food as its materials (both second-generation fuels made from waste and cellulose and third-generation fuels produced from algae, etc.).[118]

Even in Japan, a project to develop bio jet fuel has been conducted since fiscal 2017[119]. Japan should lead the international decarbonization effort in the aviation industry, and like with the maritime shipping industry, navigate toward increasing energy efficiency through technology innovation, including in operations, and use of bio fuels and other renewable energy sources.

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

As shown in Table 2-13, various technologies exist for decarbonization of the transport sector. As shown in Figure 2-37, there is the potential for approximately 70% of emissions in the transport sector overall to be decarbonized using electric vehicles for passenger cars, trucks, buses, etc. This means, accordingly, that thoroughgoing policies should be implemented to promote the conversion to electric vehicles. If 100% renewable power is realized, it will be possible to not only decarbonize the electricity used as fuel but also the power consumed in battery manufacturing. From the standpoint of lifecycle CO_2 reduction as well, using 100% renewable power and electrification are the key.

What is important for the decarbonization of the transport sector is, like with other sectors, the fact that activities have already begun on the demand side. EV100[120], which was born out of Climate Week in New York in 2017, is an international initiative in which progressive companies unite to promote use of electric vehicles and make their use the standard practice by 2030. At present, 35 companies have signed on to the initiative, including Ikea, Bank of America, and Deutsche Post DHL Group, and the Japanese companies Aeon Mall, Askul and NTT. Participating companies have committed to doing at least one of the following by 2030.

- Integrating electric vehicles into directly owned or leased corporate fleets
- Placing requirements in service contracts for electric vehicle usage
- Supporting staff to use electric vehicles by installing charging infrastructure at all premises
- Supporting electric vehicle uptake by customers by installing charging infrastructure at all premises

[117] ICAO "Global Framework for Aviation Alternative Fuels" https://www.icao.int/environmental-protection/GFAAF/Pages/default.aspxx

[118] IRENA "Biofuels for aviation" (January 2017) https://www.irena.org/documentdownloads/publications/irena_biofuels_for_aviation_2017.pdf

[119] In NEDO's "Production technology development project for bio jet fuel (FY2017-FY2020)," technologies are being developed to produce fuel from micro-algae and wood chips.

[120] "The Climate Group EV100" Website https://www.theclimategroup.org/project/ev100

In addition, the Fossil Free Streets Declaration[121], an initiative of C40, a climate action network of major cities, declares the commitment to purchase only zero-emission buses by 2025 and create zero-emission zones in key areas by 2030. Currently, 27 cities are participating and collaborating to fulfill this commitment, including Paris, London, Los Angeles, Copenhagen and Tokyo.

For freight transport as well, promoting carbon-free logistics under the leadership of freight owners will be the key to decarbonization. The Energy Conservation Act is currently being strengthened with respect to freight owners in the direction of promoting collaboration, including coordination among ownwers and between owners and transport companies, but the scope needs to be further expanded and measures on the demand side as well, including broad consideration of the responsibilities of freight owners, including individuals, should be enhanced.

As stated at the start as well, what is most important for 2050 is generating major reductions to energy consumption as quickly as possible and taking effective measures to boost energy efficiency at the same time to convert to EVs. To achieve this, accelerating fuel economy regulations, instituting CO_2 standards to make fuel economy regulations possible, including electric vehicles, and implementing ZEV quota rules like those instituted in California and China.

With its society in the maturation phase, Japan would be able to painlessly reduce passenger transport volume as its population declines. In addition to conventional modes of public transport, it is also possible that new community-level mobility services will lead people to stop using their own personal vehicles and further raise transport efficiency. Demographic aging will also likely spur such developments. Policy should be oriented not only to raising the energy efficiency of modes of transport and promoting the energy transition as an extension of policies implemented to date, but also use the opportunity of decarbonization to comprehensively promote community development, energy, welfare and medical policies with the goal of clean, safe, flexible and efficient carbon-free mobility for all.

[121] "C40 Cities" Website https://www.c40.org/other/fossil-fuel-free-streets-declaration

Table 2-13 Decarbonization Technologies for the Transport Sector

Category	Type	Decarbonization technology	Technical evaluation	Economy Evaluation	Benefits and issues
Passenger transport	Passenger vehicles Motorcycles/scooters Taxis Compact buses	Electric vehicles + 100% renewable power	Commercialization	Around 2025 Equivalent to gasoline vehicles	Usable as storage Battery; high lifecycle CO_2
	Large buses	Electric vehicles + 100% renewable power Or, fuel-cell vehicles	Electric vehicles close to commercialization	Electric route buses can pay off quickly	Overseas, route buses viable Issues with long-distance buses
Freight transport	Light-duty trucks	Electric vehicles + 100% renewable power	Partial commercialization	△	
	Heavy-duty trucks	Electric vehicles + 100% renewable power Or, fuel-cell vehicles	Electric vehicles at testing stage		Issues with EVs; range and charging time
Rail, ship, air	Rail (non-electric)	Battery drive, etc.			
	Ships	Electric drive, bio fuel, hydrogen	Commercialization still in the future (large)		Fuel oil regulations
	Aircraft	Electric drive, bio fuel, hydrogen	Commercialization still in the future		Alternative bio fuels being developed

Source: Created by REI

Chapter 3: Social and Regulatory Innovation for a Decarbonized Society

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

In Chapter 2, five particularly important strategies were proposed for realizing a decarbonized society in Japan. Strategies are presented for each emissions sector, but a long-term reduction strategy needs to have clear targets and strategies for the entirety. The following three components are essential.

- Clearly state the goal of carbon neutrality domestically by 2050
- Accelerate emission reductions to 2030
- Implement social and regulatory innovations for full utilization of available energy efficiency and renewable energy technologies

Clearly stating the goal of domestic carbon neutrality by 2050 would clarify Japan’s intended direction. It would also allow corporations and local governments to broadly define the direction of their own activities.

In addition, Japan’s long-term reduction strategy will be the first such strategy among advanced countries to be formulated since release of the 1.5°C Report by IPCC. Stating the goal of carbon neutrality by 2050 would make it possible to clarify Japan’s position as a global leader in climate action.

Clarifying a 2050 target in this way is important, but this alone is not enough. Achieving carbon neutrality by 2050 will only be possible if Japan accelerates its efforts to reduce emissions to 2030. As discussed in Chapter 2, making a major transition to decarbonization in all areas between now and 2030, in the form of expanded use of renewable energy, increased energy efficiency, reductions in the industrial and transport sector and the like, is the key to defining a clear path to achieving the 2050 target.

Early action is needed also to actually limit the progression of climate change. The degree of warming will be determined by cumulative GHG emissions. Strengthening reduction measures as 2050 draws near will be too little too late.

Of course, achieving carbon neutrality will be no easy task, but the world already has energy efficiency and renewable energy technologies that can be used immediately to reduce emissions. As evidenced in the strategies of international institutions and countries/regions engaged in progressive measures, almost all the reductions needed for carbon neutrality can be achieved through full application of these two technologies. Global climate change initiatives that have been underway for a long time are serving as a powerful, usable weapon both technologically and economically.

As shown in this proposal with supporting data, prices for solar and wind power, etc. are coming down dramatically, and it is now possible to supply large amounts at a low price. The impact of decarbonization with renewable power extends to other sectors as well. By switching most vehicle fuels, which have been reliant on fossil fuels, to electric vehicles, progress in decarbonization can be made with renewable power. Even low-temperature heat, which accounts for a large proportion of energy consumption in the commercial and residential sectors, can be provided with renewable power through the use of heat pumps. Electrification is also possible in many areas of the industrial sector, such as with use of electric furnaces in steel production. Rapid growth in renewable energy in the power sector first would make it possible to decarbonize the transport, industrial, commercial and residential sectors through further electrification.

As stated in this proposal for zero-emission strategy and decarbonization of basic material industries, the potential for energy efficiency improvements is clearly well beyond what has been thought the case thus far.

Japan's long-term reduction strategy should clearly communicate that it plans to implement social and regulatory innovations to apply currently available emission reduction technologies to every aspect of the economy and society.

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

In connection with the government crafting a 2050 reduction strategy, it has communicated the message since the Strategic Energy Plan was revised in 2018 that renewable energy will be used as the main source of electric power and that global warming measures will come at no cost to corporations; rather, they will be a source of competitiveness. These statements have been progressive and in line with global trends aimed at a decarbonized society.

On the other hand, it must be pointed out that the government has also made statements that could hinder the progress of climate change measures.

In its discussion of the strategy to 2050, the Strategic Energy Plan resolutely emphasizes the uncertainty of the future. "[R]egarding the long-term outlook for 2050, a forecast with a high level of probability is difficult because it involves the potential and uncertainty of technological innovation, etc. and the lack of transparency regarding changes in conditions"[122].

Based on this understanding, the government has set forth an "omni-directional, multiple track scenario." "..., at the current time perfect energy technologies that are economic and decarbonized and can satisfy fluctuating energy demand alone have not been realized," so the government will develop a strategy of adopting 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 no doubt the case that any a plan which runs to 2050 will have a level of uncertainty. However, it is a mistake to obfuscate the increasingly obvious options among global energy sources by emphasizing "uncertainty."

It is not, as the government suggests, difficult to choose from among the energy technologies of renewable power, hydrogen/CCS and nuclear. As already discussed, supplying 100% renewable power is a practical, achievable goal. By contrast, nuclear power is no longer an economically feasible option due to the lack of prospects for processing radioactive waste and the increasing costs involved. It has also already been pointed out that CCS is not a realistic option as a measure for reducing coal-fired power emissions.

This emphasis on "uncertainty" and "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, which should be done quickly by focusing government and private-sector resources. Corporations would be able to make major investments in this area if targets and strategies were presented for the long-term, stable utilization of renewable energy in large amounts. There are clear examples in European countries of off-shore wind power rapidly expanding and prices coming down. An emphasis on "uncertainty" that is not based in reality is a mistake that will inhibit private-sector investment.

Secondly, on the flip side, it serves as an excuse to maintain coal-fired power and nuclear power-energy sources even though they should be phased out as quickly as possible. Japan's financial institutions are also beginning to move in the direction of not investing in new coal-fired power plants, but their keeping "high-efficiency" coal-fired power as an option and otherwise remaining somewhat vague compared to the stance taken by overseas financial institutions is because the government is maintaining a policy of retaining coal-fired power.

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[122] Strategic Energy Plan, pg. 13 (Cabinet decision July 3, 2018) https://www.meti.go.jp/english/press/2018/pdf/0703_002c.pdf

Thirdly, it emphasizes the need for "development of disruptive technology" to achieve the multiple track scenario and encourages the focused deployment of resources to this end. The direction indicated in the Strategic Energy Plan is: "The 2050 energy scenario will have a response through non-continuous innovative technology in mind[123]."

Of course in the process of achieving zero GHG emissions, there could be some areas that cannot be handled with existing technologies. The "development of disruptive technology" itself is certainly necessary as a policy for reducing the remaining emissions after thoroughly utilizing currently available technologies. However, a distinguishing feature of the government's scenario is that it lacks initiatives to thoroughly utilize existing technologies related to renewable energy and energy efficiency, while emphasizing the "development of disruptive technology" like hydrogen, carbon cycle and CCS.

The government should adopt the scenario that promotes full utilization of renewable energy and energy efficiency for the realization of a decarbonized society. Specifically, the government needs to first significantly raise its 2030 emission reduction and renewable energy targets. The government's current plan, which neglects to thoroughly utilize available technology while it maintains coal-fired power and emphasizes the necessity of "development of disruptive technology" to achieve decarbonization, is wholly unpersuasive.

3.3 Introducing basic rules for a decarbonized society to Japan

A decarbonized society, which the world has set as its goal, requires different principles for action than those employed thus far in the society developed on the mass consumption of fossil fuels. Even if the intention is economic growth and raising the standard of living, the amount of greenhouse gases allowed to be emitted into the air must be strictly limited and net carbon emissions reduced to zero by 2050. The remaining carbon budget, meaning the quantity of greenhouse gases the world can emit while still avoiding a climate catastrophe, is miniscule.

Different rules are now needed for corporate activity and the way social life is structured. However, the rules required in a decarbonized society do not entail prosperity being sacrificed. 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.

The recommendation of the Advisory Panel of Experts on Climate Change, established under the Minister of Foreign Affairs, calls for energy efficiency and renewable energy to be at the center of decarbonization efforts. It also refers to rulemaking on decarbonization taking place globally and sounds the alarm stating, "Setting rules of the decarbonized economy without Japan will have a negative impact on global Japanese industries[124]."

[123] Strategic Energy Plan, pg. 130 (Cabinet decision July 3, 2018)
https://www.meti.go.jp/english/press/2018/pdf/0703_002c.pdf

[124] Recommendations on Energy of the Ministry of Foreign Affairs' Advisory Panel of Experts on Climate Change, "Promote new diplomacy on energy through leading global efforts against climate change" (February 19, 2018)
https://www.mofa.go.jp/files/000335212.pdf

Recommendations on Climate Change of the Ministry of Foreign Affairs' Advisory Panel of Experts on Climate Change, "Climate Change as the Main Mission of Japan's Diplomacy to Transform Japan into a Decarbonized Nation" (April 19, 2018)
https://www.mofa.go.jp/files/000356250.pdf

To realize a decarbonized society, social and regulatory innovations are needed to change the form of corporate activities and living patterns. In the area of finance, said to be the lifeblood of the economy, ESG financing, which requires climate change risk and other aspects of sustainability to be considered when making financing and investment decisions, is rapidly expanding. The recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), which call for financial institutions and regular corporations to disclose risks and opportunities related to climate change, are beginning to be broadly accepted. There are already 76 Japanese companies and institutions that have signed on to the TCFD recommendations. This amounts to over 10% of the global total (626 companies and institutions) (as of April 9, 2019)[125].

Basic rules for a decarbonized society like ESG financing and the TCFD recommendations are beginning to take root in Japan, too. At the same time, however, there are other rules gaining traction globally that Japan has been slow to adopt. The representative example is carbon pricing.

Carbon pricing assigns uniform prices to GHG emissions and makes “transparent” the cost of greenhouse gases that previously could be emitted for free. Specifically, the schemes used are a carbon tax and emissions trading. Its significance is also pointed out in the report of the Investigative Commission on Carbon Pricing[126].

“Under carbon pricing, the cost of emitting greenhouse gases is fairly made “transparent,” so it becomes possible to reduce emissions while comparing the cost of emission reduction measures and the burden from carbon pricing.” “When each entity selects and executes inexpensive emission reduction measures, that is, in the order of measures with the highest cost performance, the overall cost of reductions to society is minimized, which means explicit carbon pricing is the most cost effective means of achieving reduction targets.”

Carbon pricing is also significant in that the polluter pays principle, which is that the polluter is responsible for the cost of anti-pollution measures and regulatory requirements, is applied to climate change measures. The polluter pays principles is applied to emission of pollutants that cause air and water pollution, so there is no rational reason not to apply the principle to the emission of substances that are causing climate change and putting humanity itself at risk.

Carbon pricing is already in effect in 44 countries and 27 regions around the world (Figure 3-1)[127]. Looking only at Asia, South Korea instituted an emissions trading scheme (ETS) in 2015, China ran a pilot program in two provinces and five cities, including Beijing and Shanghai, from June 2013 to June 2014, and then in December 2017, announced that it would start a nationwide emissions trading scheme (ETS) for the power sector[128].

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125 METI website, “Trends in Climate Change-related Disclosures” http://www.meti.go.jp/policy/energy_environment/global_warming/disclosure.html

126 Summary report of the Investigative Commission of Carbon Pricing, “Toward a Smooth Transition to the Decarbonized Society and Simultaneous Solutions to Economic and Social Issues” (March 2018) https://www.env.go.jp/earth/cp_report.pdf

127 World Bank “Carbon Pricing Dashboard Map & Data” (Accessed March 15, 2019) https://carbonpricingdashboard.worldbank.org/map_data

128 Ministry of the Environment, Central Environment Council, second meeting of Subcommittee on Utilization of Carbon Pricing (August 27, 2018) Document 2, “Carbon Pricing Significance, Effects and Issues, etc.” https://www.env.go.jp/council/06earth/y0619-02/mat02.pdf

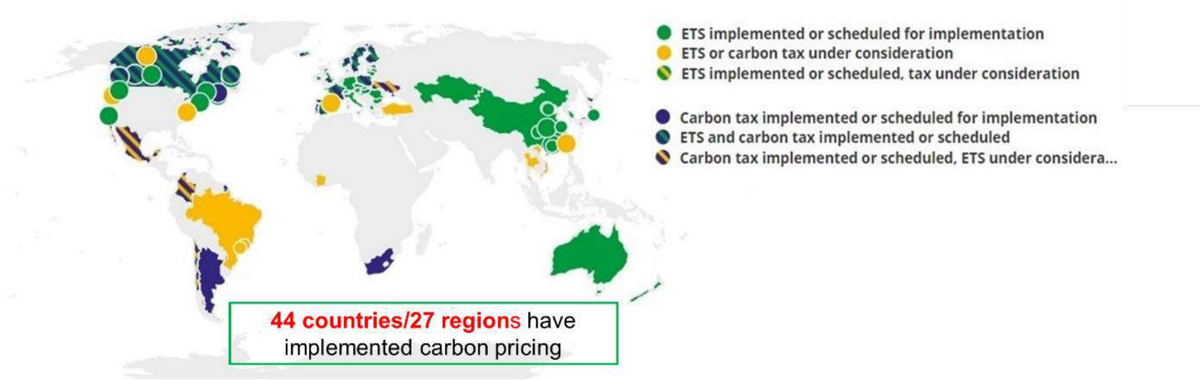

Figure 3-1 Carbon Pricing Implementation and Consideration in Various Countries and Regions

Source: World Bank "Carbon Pricing Dashboard Map & Data" (Accessed March 15, 2019)
https://carbonpricingdashboard.worldbank.org/map_data

Japan has also discussed instituting carbon pricing since 2000, meaning the debate has been drawn out for almost 20 years[129]. With the central government not taking action, the Tokyo Metropolitan Government enacted "Total CO_2 Emission Reduction and Emission Trading Program (Tokyo Cap-and-Trade Program)" by ordinance in 2008 and put it into force in 2010. Tokyo's scheme was strongly and repeatedly opposed by the Japan Business Federation (Keidanren) and Federation of Electric Power Companies, Japan Iron and Steel Federation and other organizations, but the metropolitan government's Bureau of Environment stated that there is no basis for opposing the scheme, designed the scheme based on opinions from companies in the city to which it would apply, and established it with the unanimous assent of the Tokyo Metropolitan Assembly. Since the scheme has been instituted, it has been stably implemented with the active participation of the city's companies up to the present. According to the metropolitan government, in fiscal 2017, the scheme was effective in generating a 27% reduction in emissions among the major businesses subject to it[130].

The government instituted Tax for Climate Change Mitigation in October 2012. It is a type of carbon tax, but the tax rate is extremely low, just 289 yen per ton[131]. 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)[132]. Japan's tax rate is equivalent to one-fiftieth of this (Figure 3-2).

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[129] In 2000, the Ministry of the Environment established the Investigative Commission on Emissions Trading Schemes. Ministry of the Environment, Central Environment Council, "On the Form of a Domestic Emissions Trading Scheme in Japan (Interim Summary)" (December 2010) https://www.env.go.jp/council/06earth/r0610-01.pdf

[130] Tokyo Metropolitan Government Bureau of Environment, "Tokyo Cap-and-Trade Scheme, Second Planning Phase Year 3 Results (February 19, 2019) http://www.kankyo.metro.tokyo.jp/climate/large_scale/data/index.files/CapandTrade2017result_J_.pdf
Note: Emissions against baseline emissions. Baseline emissions is average emissions for three consecutive fiscal years from fiscal 2002 to fiscal 2007 as selected by the business entity.

[131] Ministry of the Environment, "Adoption of Tax for Climate Change Mitigation" https://www.env.go.jp/policy/tax/about.html

[132] Ministry of the Environment, Central Environment Council, second meeting of Subcommittee on Utilization of Carbon Pricing (August 27, 2018), Document 2 (pg. 46), "Carbon Pricing Significance, Effects and Issues, etc." https://www.env.go.jp/council/06earth/y0619-02/mat02.pdf

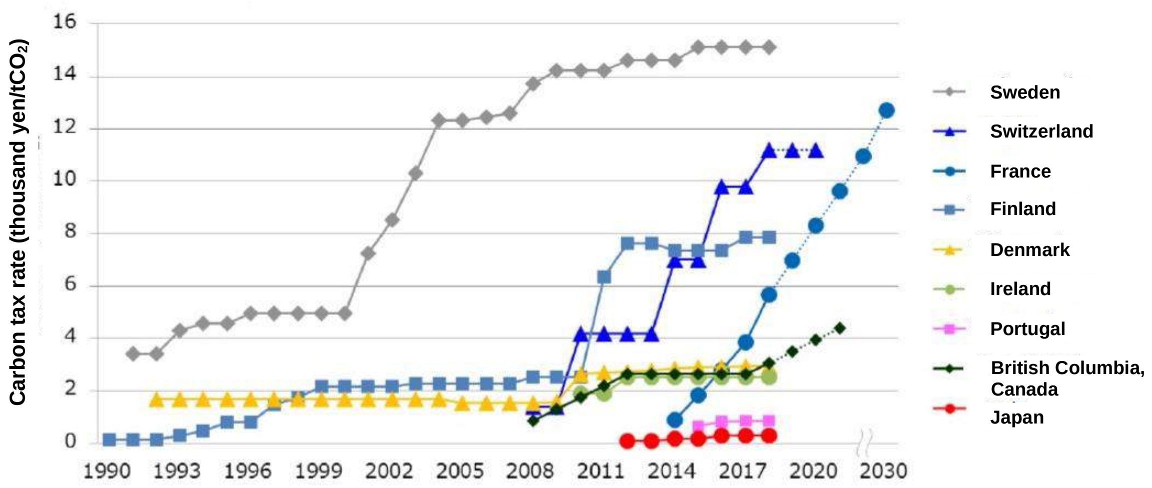

Figure 3-2 Carbon Tax Rate Comparison

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

The Carbon Pricing Subcommittee[133], established under the Central Environment Council, has been considering the matter since 2018, but it is no longer the time for repeated discussions.

Internationally, many major companies, including in the oil industry, support carbon pricing. If carbon pricing is further delayed, Japan will undoubtedly face the criticism that it is not prepared to seriously tackle the threat of climate change.

Among the basic rules needed for a decarbonized society, another major area in which Japan lags behind is full-fledged power system reform. Creating a fair, competitive power system has been carried out in Europe and the U.S. in the context of economic liberalization long before the transition to a decarbonized society became an area of focus. Utilizing large amounts of renewable energy is the most important issue in realizing a decarbonized society. As Japan's power system has long been based on regional monopolies, full-fledged power system reform is among the social and regulatory innovations that are essential to creating a decarbonized society. (REI will separately make a proposal on this issue.)

[133] Ministry of the Environment, "Global Warming Measures" https://www.env.go.jp/earth/ondanka/cp/index.html

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

On August 20, 2018, Greta Thunberg, a 15-year-old high school student, initiated a school strike to call for stronger climate action, and her protests outside the Swedish parliament have spread throughout the world. On March 15, 2019, strikes took place in over 120 countries, as over 1.6 million young people walked out on their classes and participated in the protests[134]. "If the world is going to fall apart in 50 years, why should I go to school?" These young people talk of the importance of climate action while also offering scathing criticism of the current generation, which has failed to enact the measures that are needed.

In her speech at the World Economic Forum in Davos on January 25, 2019, Greta spoke of the importance of the carbon budget in particular[135].

"And since the climate crisis is a crisis that has never once been treated as a crisis, people are simply not aware of the full consequences of our everyday life. People are not aware that there is such a thing as a carbon budget, and just how incredibly small that remaining carbon budget is. And that needs to change today.

No other current challenge can match the importance of establishing a wide public awareness and understanding of our rapidly disappearing carbon budgets that should and must become a new global currency in the very heart of future and present economics. "

The crisis of climate change is becoming a reality. The task of the current generation is not to fulfill its responsibility to some far off future generation but to the very next generation.

Whether listing the uncertainty surrounding climate change forecasts or the uncertainty surrounding the technologies used to combat global warming, 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, there are many non-governmental actors that have begun to take action to fulfill their responsibilities to the next generation, including the over 70 companies that have committed to formulating Science Based Targets (SBT) consistent with the Paris Agreement for emission reduction, as well as local governments that have set the target of zero emissions.

For the longest time, Japan has put off introducing the measures necessary to shift to a decarbonized society employing a variety of excuses to justify that. Time is running out. The long-term 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 change.

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134 TIME "'It's Literally Our Future.' Here's What Youth Climate Strikers Around the World Are Planning Next" (March 20, 2019) http://time.com/5554775/youth-school-climate-change-strike-action/

135 The Guardian "'Our house is on fire': Greta Thunberg, 16, urges leaders to act on climate
Greta Thunberg" (January 25, 2019)
https://www.theguardian.com/environment/2019/jan/25/our-house-is-on-fire-greta-thunberg16-urges-leaders-to-act-on-climate

Proposal for Energy Strategy Toward a Decarbonized Society

Achieving a Carbon-Neutral Japan by 2050

31 May 2019

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