Climate Integrate

Decarbonizing Japan's Electricity System

Policy Change to Trigger a Shift

2035年電力システム

脱炭素化への政策転換

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JRE Sakata wind power station (Sakata city, Yamagata)

About this report

In this report, Climate Integrate proposes policy measures that would be needed to decarbonize Japan's power sector by 2035, based on a scenario developed by Lawrence Berkeley National Laboratory. Through our partnership with Berkeley Lab, Climate Integrate gained valuable insights. We express our deepest gratitude to the authors of the scenario, including Kenji Shiraishi, Won Young Park, Nikit Abhyankar, Umed Paliwal, Nina Khanna, Jiang Lin, and Amol Phadke, all at Berkeley Lab, and Toru Morotomi at Kyoto University. We are also grateful for insightful comments by Kenji Shiraishi (Berkeley Lab), Yoh Yasuda (Kyoto University) and Hajime Matsukubo (Citizen's Nuclear Information Center) following their review of our report.

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Introduction

– Key takeaways from the 2035 Japan Report by Lawrence Berkeley National Laboratory

The 2035 Japan Report: Plummeting costs of solar, wind, and batteries can accelerate Japan's clean and independent electricity future,[1] published by Lawrence Berkeley National Laboratory (Berkeley Lab), concludes that decarbonization of Japan's power sector is achievable based on the Clean Energy scenario.

The Clean Energy scenario

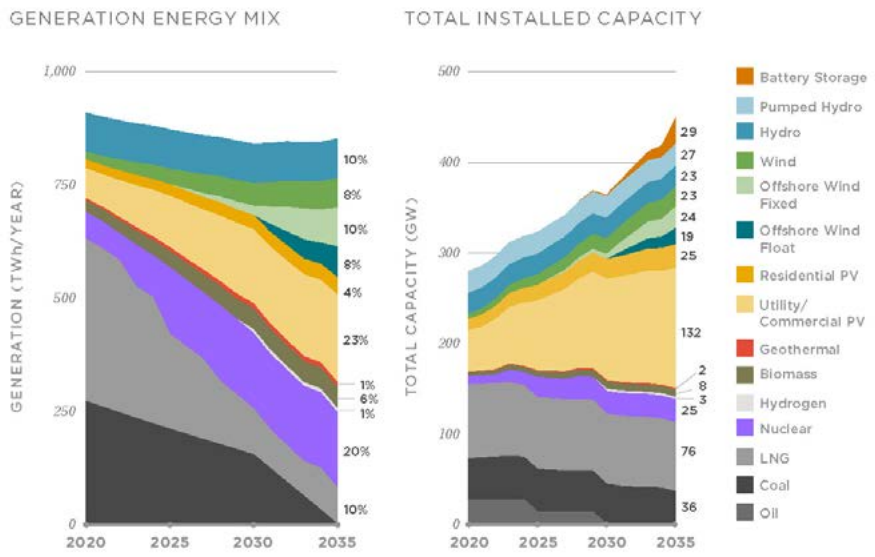


FIGURE ES1. *Generation Energy Mix and Total Installed Capacity between 2020 and 2035, Clean Energy Scenario*

Capacities of offshore wind (24 GW for bottom-fixed and 19 GW for floating types) and storage batteries (29 GW) will increase significantly toward 2035

Source: Berkeley Lab

Conclusions

The 2035 Japan Report by Berkeley Lab concludes that the Clean Energy scenario is achievable by 2035 with a shift to a 90% clean energy system, and that it would be dependable.

Key findings:

- Strong policies are required to create a 90% clean grid by 2035
- Japan's 90% Clean Grid is dependable without coal generation or new natural gas

1 The 2035 Japan Report: Plummeting Costs of Solar, Wind, and Batteries Can Accelerate Japan' s Clean and Independent Electricity Future

plants
- Electricity costs from the 90% Clean Grid are lower than today's costs
- 85% reduced fossil fuel imports and a 90% clean energy grid can significantly bolster Japan's energy security
- Scaling-up renewables to achieve the 90% clean energy grid is feasible
- Clean energy can cut electricity sector CO_2 emissions by 92% (from 2020 levels)
- Reaching cost-effective levels of clean energy generation will require overcoming policy, market, and land-use barriers

Berkeley Lab's report also proposes policies for the following:
- Establishing medium-term policy targets (beyond 2030)
- Accelerating renewable energy deployment and coal-fired power phaseout
- Lowering institutional and societal barriers to rapid renewable energy deployment
- Pursuing a just energy transition through targeted assistance policies
- Ensuring dependability, enhancing operational flexibility, and boosting energy efficiency

A 90% decarbonization of Japan's power sector by 2035 is possible

The Clean Energy scenario by Berkeley Lab shows that Japan can decarbonize 90% of its power sector by 2035, and that the key will be the rapid and extensive deployment of renewable energy, as their costs drop significantly. The scenario emphasizes that Japan can take full advantage of its abundant solar and wind resources to increase the share of renewables to 70% of power generation while maintaining a stable power supply and reducing electricity costs. Berkeley Lab has conducted similar analyses of power sectors in the United States, India, and China. The scenario for Japan is also aligned with the G7 Leaders' Communique announced in Elmau, Germany in June 2022,[2] in which the leaders committed to achieving a fully or predominantly decarbonized power sector by 2035.

With limited fossil fuel resources at home, Japan relies heavily on imported fuels, which account for about 85% of the primary energy supply,[3] and this is why the country's energy self-sufficiency rate remains extremely low. Against this background, this Clean Energy scenario envisioning a significantly reduced share of fossil fuels by 2035 - just 10% of Japan's total power generation (gas-fired power only, no coal) - may sound ambitious. However, Berkeley Lab's conclusion that it is indeed feasible is momentous.

2 G7 Leaders' Communique, June 28, 2022

3 Ministry of Economy, Trade and Industry Energy demand and supply for fiscal year 2021 (preliminary), November 22, 2022 (in Japanese).

Benefits of decarbonizing 90% of Japan's power sector by 2035

Japan would enjoy many benefits and it would be very significant if Japan were to make the scenario a reality. First of all, Japan would be able to break free of its dependence on fossil fuels, which are a massive source of CO_2 emissions. Damage from climate disasters is being witnessed all over the world. Under guidance from the United Nations, countries are aiming to limit the global temperature increase to 1.5℃ below pre-industrial levels to avoid further loss and damage from climate change.[4] The Earth's temperature is rising with cumulative CO_2 emissions in the atmosphere, which means the remaining carbon budget is limited and there are concerns we could exceed that limit within a matter of years. In order to stabilize the climate, global greenhouse gas (GHG) emissions must be cut by more than half by 2030, the emissions need to reach net zero by 2050, and short- and mid-term measures need to be strengthened.[5]

Achieving this scenario would also help reduce electricity costs and improve Japan's energy self-sufficiency. Fuel costs around the world jumped recently, pushing electricity bills up, as a result of efforts to wean off Russian sources after Russia's invasion of Ukraine in Feb. 2022.[6] Japan's excessive reliance on fossil fuels poses a major threat to the stability of its energy supply and economy. It will continue to be exposed to geopolitical risks and saddled with concerns about supplies and risks of rising energy prices. In contrast, renewable energy has advantages; it can be produced using domestic resources and incurs no fuel costs.

The scenario presented by Berkeley Lab underscores the significance of shifting to a decarbonized power system centered on renewables, to ensure energy security, avoid cost increases, and protect our industries and civic life.

A shift to renewables is key: Nuclear and co-firing of hydrogen and fuel ammonia are costly

The scenario shows that costs of solar and wind power decline, while adding new nuclear capacity and co-firing with hydrogen and ammonia at thermal power plants are not viable options for 2035 due to their high costs.

As a result, for Japan to decarbonize its power sector, an economically and environmentally sound and entirely viable option is to implement a steady but rapid expansion of wind, solar and other forms of renewable energy while pursuing a swift phase-out of coal-fired power and a reduction of gas-fired electricity generation.

Policy change is crucial for a speedy shift to renewables

4 United Nations Framework Convention on Climate Change (UNFCCC), Sharm el-Sheikh Implementation Plan, November 2, 2022 Para 8.

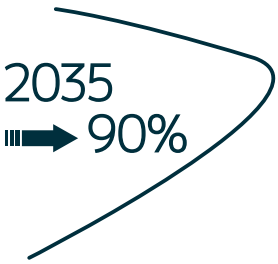
5 Intergovernmental Panel on Climate Change (IPCC), Summary for Policymakers (SPM), 2021 (P.13, 27-29).

6 Electricity and Gas Market Surveillance Commission (EGC), Document on fuel costs, submitted to a METI taskforce, January 11, 2023 (in Japanese).

Under the 90% Clean Energy scenario by 2035, the capacity of renewable energy needs to increase from 188 to 254 GW between 2030 and 2035 and the capacity of storage batteries needs to expand from 1.5 to 29 GW. To achieve such expansion, the government needs to adopt national policies to shift to renewables and move away from fossil fuels. Therefore, it is crucial to make policy changes to achieve the three following objectives through consensus building among stakeholders, through democratic processes:

1. On the supply side, move away from fossil fuels and accelerate the deployment of renewables
2. On the demand side, achieve higher energy efficiency and energy conservation
3. Develop a more flexible power system and upgrade infrastructure

The following is a set of policy proposals and accompanying recommendations to decarbonize Japan's power sector, based on Climate Integrate's analysis of the Berkeley Lab scenario.



Executive Summary

To achieve net-zero emissions by 2050, it is essential to strengthen measures to tackle climate change, ensure a stable supply of energy, and realize a just transition. Decarbonization of the power sector is especially crucial. It is a sector that can accommodate a rapid shift thanks to falling costs of solar and wind power, and decarbonization of the power sector can have ripple effects on other sectors.

The Clean Energy scenario developed by Lawrence Berkeley National Lab shows that it is possible for Japan to decarbonize 90% of its power sector and reduce electricity costs by 2035, through a massive shift to solar and wind. To realize this shift, the government would need to overhaul its energy policies and significantly strengthen and/or change policy measures. In this report, we present three key elements for a national vision and seven policy measures that are essential if Japan is to achieve the Clean Energy scenario.

National vision

1. A grand design centered on a shift to renewables

To align Japan's climate change policy with the 1.5℃ goal of the Paris Agreement and the 2050 net-zero emissions target and make the policy cost-effective, Japan needs to develop a grand design and a roadmap to supply the electricity sector with 100% renewable energy, then devise industrial policies and select technologies accordingly. Formulation of such a grand design should be coordinated by the Cabinet Office with the aim of policy integration among the many government ministries and agencies, while ensuring citizen participation in decision-making processes.

2. Ambitious targets and policy review

Given that the United Nations is calling for more ambitious targets for 2030 and that Japan has great wind and solar potential, Japan needs to strengthen its 2030 targets for GHG emission reductions and share of renewable energy. It should aim to increase the share of renewable electricity in the power generation mix to 50% or higher by 2030, and 85% or higher by 2040, with a lofty goal of 100% renewables by 2040. Policy targets should include a phase out of coal-fired power. Such a phase out is essential to realize the Clean Energy scenario. There also needs to be a staged reduction of gas-fired power generation, and a ban on new construction of gas-fired power plants. As they are not aligned with the Paris Agreement and are not economically justifiable, hydrogen and ammonia co-firing should not be promoted, and existing nuclear power should not be replaced. Instead, the government should aim to achieve 100% renewables.

3. National strategies for a just transition

A dramatic shift to renewables in the electricity system would mean the downsizing of the fossil fuel and nuclear power industries and a massive expansion of renewables-related industries. In formulating national strategies, the government needs to place an emphasis on policies for a just transition for workers and a transformation of industrial structure. The government should support consensus-building with stakeholders to assess impacts on the local economy and employment, formulate support measures, and create new industries in affected regions, and should also provide fiscal measures for a just transition.

Policy measures

1. Making carbon pricing more effective

Japan's Tax for Climate Change Mitigation has been set at low levels. The government plans to introduce full-scale emissions trading in fiscal year (FY) 2026, auctioning of emissions from power plants in FY2033, and carbon emissions surcharges in FY2028, and plans to use revenues from these measures for the redemption of "GX Economy Transition Bonds." We recommend that the government set the target price of at least 6,000 yen/ton (CO_2 equivalent), and accelerate plans for staged increases to reach that level, which is necessary to achieve the Clean Energy scenario. When introducing carbon pricing policies, Japan should implement a carbon tax, rather than surcharges (which lack public oversight through deliberation in parliament). Revenues from carbon pricing need to be decided in a fair, transparent way, and the majority should be redistributed through measures such as direct dividend and reductions in social security taxes.

2. Expanding renewable energy in ways that benefit communities

Renewables are a distributed energy source that can be developed and utilized by regional communities. However, many local governments in Japan have introduced ordinances to rein in solar and wind developments, in response to opposition to inappropriate projects. It is important to notify and engage in dialogue with local residents at an early stage of proposed renewables projects, in order to build consensus and facilitate the massive expansion

of renewable energy. The government should ensure that full information is available to the public and that local residents are part of the development process. It should also build frameworks for central-government-led zoning to promote renewables, and schemes for circulating benefits and revenues within the community, and support community-led power generation projects.

3. Enhancing flexibility in Japan's power system

Due to the variability of solar and wind output, a flexible electricity system is a prerequisite for a massive expansion in renewable energy. To better manage electricity supply and demand, the government needs to update its current curtailment rules to a new framework that prioritizes electricity sources that make economic sense. Japan's power grid needs physical upgrades, and there is a need to improve the management of existing transmission lines with rule changes and technologies. Japan should also improve the ability to further control demand and supply by integrating measures and technologies such as output adjustment, cross-region transmission, demand response, power storage and sector coupling.

4. Redesigning power markets to encourage fair competition

Japan has several electricity markets, and their increasing complexity calls for a better environment for new entrants to trade electricity under fair conditions. The types of "long-term decarbonized electricity" to be auctioned on the capacity market include co-firing with fossil-fuel-derived hydrogen and ammonia, as well as liquefied natural gas (LNG) power (newly built). The government should reconsider its plan to introduce a long-term decarbonized electricity auction, and instead redesign the mechanism to secure capacity. It should redesign the power market to be fairer by starting discussions about unbundling the sales and generation units of Japan's ten major utilities, increasing trading volumes on the spot market, and introducing negative pricing.

5. Boosting offshore wind development

Offshore wind power generation must expand if Japan is to shift to renewables. To do so, Japan needs to set ambitious targets for floating offshore wind, accelerate grid development to connect regions that have abundant wind resources with areas that have high electricity demand, and adopt a centralized approach as soon as possible for government engagement with local communities. The country also needs to develop domestic supply chains and offshore wind ports, and attract energy-intensive industries to offshore wind power producing regions. Policy work across multiple ministries should be better consolidated in order to expedite procedures and boost efficiency.

6. Improving energy efficiency

Energy saving and efficiency are as important as production, and they both contribute to decarbonization. The Energy Efficiency Act and the Building Energy Efficiency Act were enacted to reduce users' energy intensity, with a focus on mandatory reporting, but more effective measures are needed. Carbon pricing is an effective way to boost energy efficiency in society and the economy as a whole. Additional measures and better implementation are needed to improve energy efficiency in the industrial, building, and transportation sectors.

7. Using fiscal measures to support the energy shift

Multiple government ministries and agencies have budgets relating to decarbonization, and subsidies are available for technology development through the Green Innovation Fund. Based on estimates that Japan's decarbonization efforts will require 150 trillion yen in public and private investment over the next decade, the government plans to issue 20 trillion yen in "GX Economy Transition Bonds." All these measures should be cost effective and aligned with the Paris Agreement. The government should take both of those criteria into account to assess each budget request and fiscal expenditure. Fiscal support for a just transition and climate tech should also be provided.

To realize the Clean Energy scenario presented by Berkeley Lab, Japan would need to swiftly implement the policy measures summarized above. It is our hope that this report will contribute to the implementation of policy changes by policymakers and civil society.

Decarbonizing Japan's Electricity System Policy Change to Trigger a Shift

Climate Integrate

10 Recommendations

Vision 1 Grand Design

Grand Design
- 1.5℃ aligned design
- Industrial policies
- Cost-effective technologies

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Measures
- Intra-agency coordination
- Citizen-participation
- Clear roles for national, subnational governments
- Budget and fiscal measures

Vision 2 Ambitious Targets

Ambitious Targets
- GHG reductions & renewables targets
- 5-year target cycle
- Sectoral targets

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Policy Review
- Coal-fired power: phaseout
- Gas-fired power: ban on new construction
- Hydrogen & ammonia: reconsideration of policies
- Nuclear: ban on new construction

Vision 3 Just Transition Strategies

National Strategies
- Impact analysis
- Support for affected areas and workers
- Creation of green industries

Dialogue
- Consensus building among stakeholders

Financial Support

Proposal 1 Effective Carbon Pricing

Implementing Carbon Pricing Schemes → **Incentives for Energy Efficiency, Renewables**

- Higher prices
- Fair and transparent use of revenues
- Carbon dividends, support for just transition

Proposal 2 Renewables for Communities

Utility-scale Solar, Wind Power × **Rooftop Solar, Micro Hydro**

- Information disclosure, community participation
- Zoning
- Community-led power projects

Proposal 3 Flexibility in Power System

- Market Mechanism
- Grid Management
- Grid Flexibility
- Sector Coupling

Proposal 4 Redesigning Power Market

- Capacity Market Reform
- Separation of Generation and Retail Units
- Fair Burden Sharing
- Trading on the Spot Market
- Negative Pricing

Proposal 5 Boosting Offshore Wind

- Floating Offshore Wind Target
- Transmission Lines
- Centralized System
- Domestic Procurement
- Port Development
- Local Electricity Consumption
- Centralized Tasks and Duties

Proposal 6 Energy Efficiency

Industries
- Review of energy efficiency standards
- Emissions trading scheme and carbon tax
- Energy saving consultants

Buildings
- Tougher standards
- Mandatory PV for new buildings
- PV, insulation for existing buildings

Transportation
- 2035: new gasoline-powered car sales end
- Bikeable, walkable communities
- Efficient freight transport

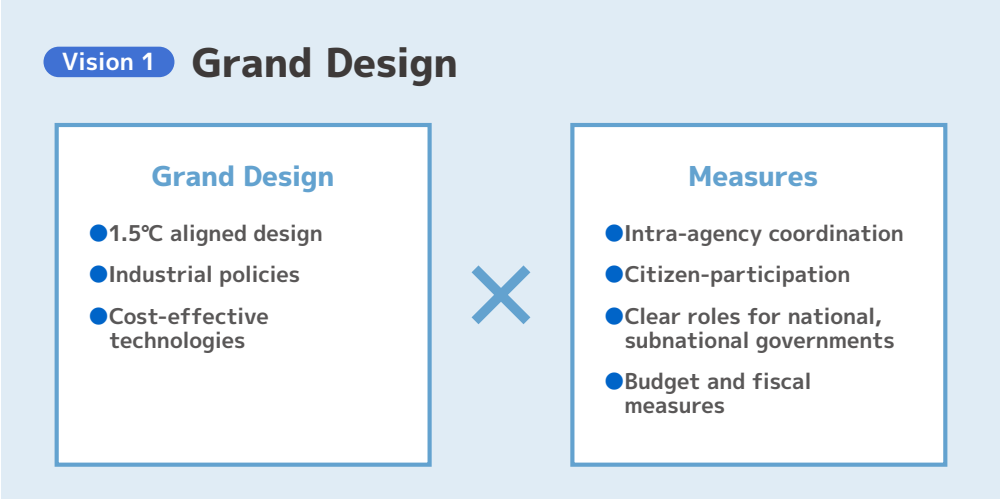
Proposal 7 Fiscal Measures

- Paris-aligned, Cost-benefit Analysis
- Just Transition Support
- Investment in Climate Tech

Hakuba village, Nagano

1. National vision

1-1. A grand design centered on a shift to renewables



To achieve net-zero emissions by 2050, Japan would need to further strengthen its climate change measures, ensure a stable supply of energy, and realize a just transition, and the key to all of that would be to prioritize the decarbonization of the power sector over other sectors. This is a sector that can accommodate a rapid shift thanks to falling costs of solar and wind power. Decarbonization of the power sector can have ripple effects on other sectors. The Japanese government needs to declare that it will undertake a bold shift to create a power system centered on renewables in order to achieve carbon neutrality, and then present a grand design and industrial policy to achieve the energy shift.

Current status

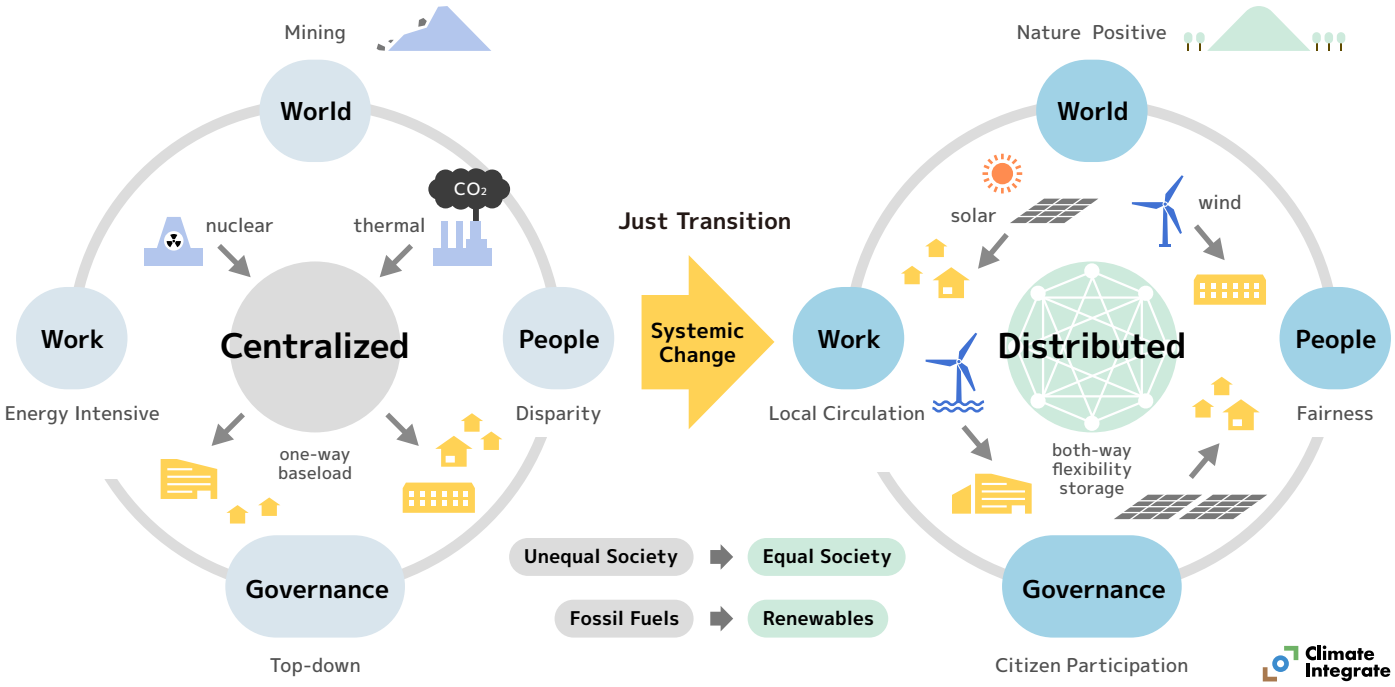
The government has compiled several long-term strategies and roadmaps in line with its target to achieve carbon neutrality by 2050. It has set emission reduction targets and a power generation mix for 2030 and policies for each sector. Japan has declared a target of reducing GHG emissions by 46% by 2030 from 2013 levels, and that it would make an effort to achieve 50%. By 2030, renewables are to account for 36% to 38% of Japan's power generation mix, according to the government outlook. The government says that to the extent possible it will prioritize and expand the use of renewable energy as a main power source.[7] But it has yet to indicate a pathway for the power generation mix beyond 2030.[8]

The Green Growth Strategy, announced in 2021, identified 14 priority areas. Although renewable energy is included, the others are heavy in technologies that still have little

7 METI, Sixth Strategic Energy Plan, Oct. 22, 2021

8 In December 2020, a government taskforce (in Japanese) presented "reference" values for the power generation mix in 2050, with renewable electricity accounting for about 50 to 60%, hydrogen and ammonia about 10%, and the remaining 30% to 40% from nuclear and fossil fuels (combined with CCUS and carbon recycling). The Sixth Strategic Energy Plan, published later, mentioned these "reference" values, saying that any electricity source obviously has issues, so multiple scenarios are needed for 2050.

Chart.1 National policy and a grand design



prospect of commercial viability in the foreseeable future, such as carbon capture, utilization and storage (CCUS), nuclear fusion, and next-generation nuclear reactors.[9]

As for the Green Transformation (GX), the cabinet approved the GX Basic Policy"[10] in February 2023, along with a companion roadmap[11] for the next decade, with the goal of achieving a "green transformation" in Japan. The government said that it will expand renewable energy and install more storage batteries. However, it also said that the service life of nuclear reactors could be extended by not counting the periods they are offline, and to develop and construct next-generation nuclear reactors. The roadmap makes no mention of the power generation mix beyond 2030 and no detailed emissions targets for each sector. Essentially, Japan has not yet presented a pathway to achieve carbon neutrality by 2050 in any of its strategies and plans.

Proposals

Japan's economy and society will be hard hit and our national security shaken if climate change continues to worsen. The government needs to prioritize decarbonization, end its reliance on fossil fuels - the biggest contributor to global warming - to help achieve global goals to keep the temperature rise under 1.5℃ and focus on making Japan's economy and society sustainable and prosperous while utilizing domestic natural capital.

A priority should be placed on decarbonization of the power sector, as that is crucial to decarbonize other sectors as well. A government roadmap is needed to improve energy

9 METI, Green Growth Strategy, June 18, 2021

10 Government of Japan, GX Basic Policy, February 10, 2023 (in Japanese).

11 Government of Japan, Roadmap for GX Basic Policy, February 10, 2023 (in Japanese).

efficiency and reduce energy consumption, making full use of domestic renewable resources to supply 100% of the electricity needed in Japan by 2040, and ensuring that energy-related policies are integrated across the board.

A national grand design for a shift to renewables would include:

- An energy shift aligned with the 1.5℃ goal, incorporating greater energy efficiency, massive deployment of renewables, and a move away from fossil fuels
- Industrial policies for an energy transition (to foster new industries, develop domestic supply chains and markets)
- Selection of technologies that are effective in reducing emissions and cost-effective

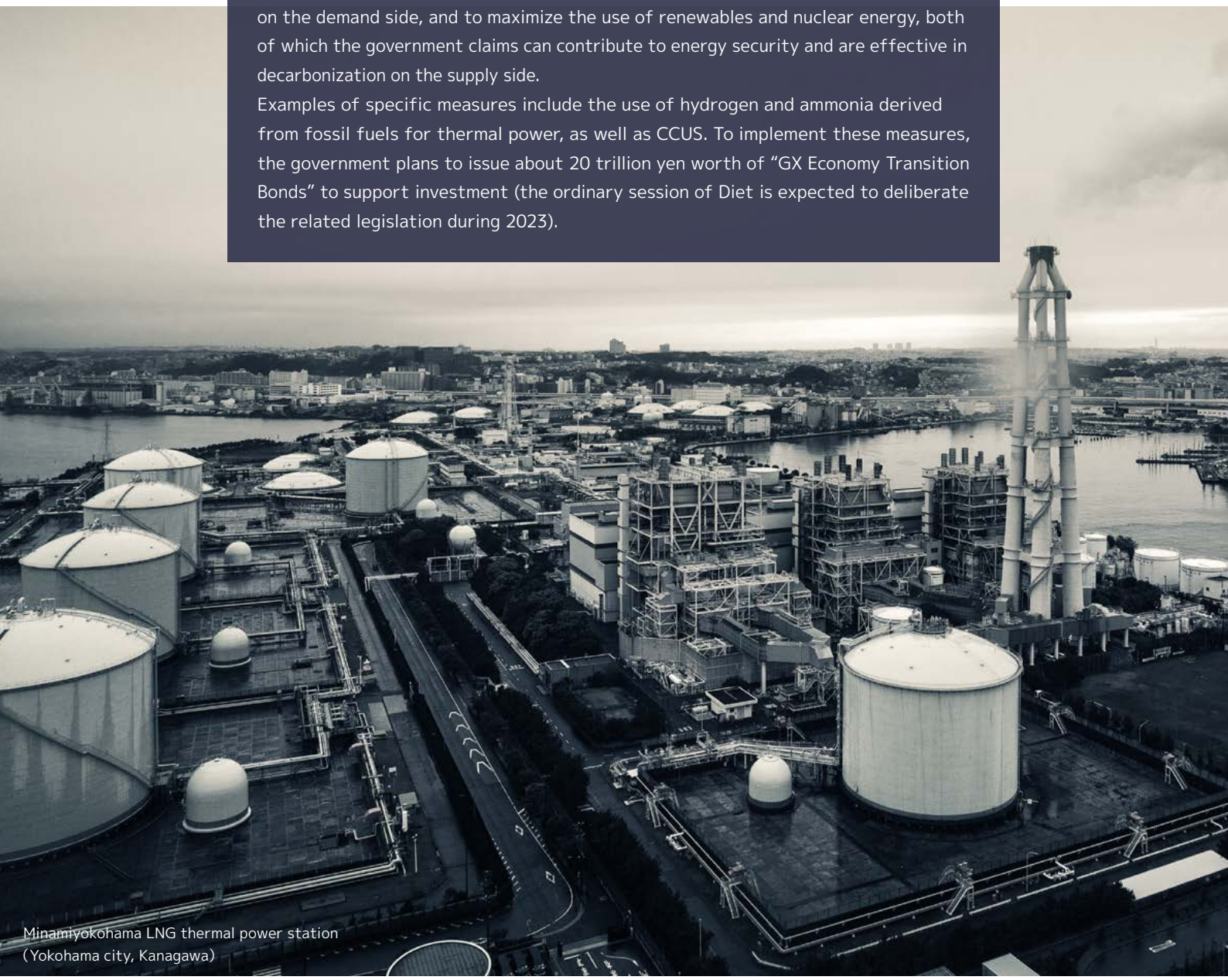
A structure to implement the grand design would include:

- Improved coordination under the Cabinet Office, and policy integration among all government agencies
- Participatory and democratic decision-making processes for policy formulation
- Clarification of roles for national and subnational governments
- Budget allocations and fiscal measures aligned with the 1.5℃ goal

What is a Green Transformation (GX)?

Japan defines Green Transformation (GX) as an overarching system reform of Japan's economy and society to achieve emission reductions and enhance its industrial competitiveness.[12] GX is one of the key investment areas in the government's "Grand Design and Action Plan for a New Form of Capitalism" (Cabinet Decision, June 2022) and through it the government aims to mobilize about 150 trillion yen in GX investments from public and private sources. In February 2023, the cabinet approved the GX Basic Policy[13] for green transformation aiming to break away from an excessive reliance on fossil energy, promote energy efficiency measures and the energy shift in industries on the demand side, and to maximize the use of renewables and nuclear energy, both of which the government claims can contribute to energy security and are effective in decarbonization on the supply side.

Examples of specific measures include the use of hydrogen and ammonia derived from fossil fuels for thermal power, as well as CCUS. To implement these measures, the government plans to issue about 20 trillion yen worth of "GX Economy Transition Bonds" to support investment (the ordinary session of Diet is expected to deliberate the related legislation during 2023).

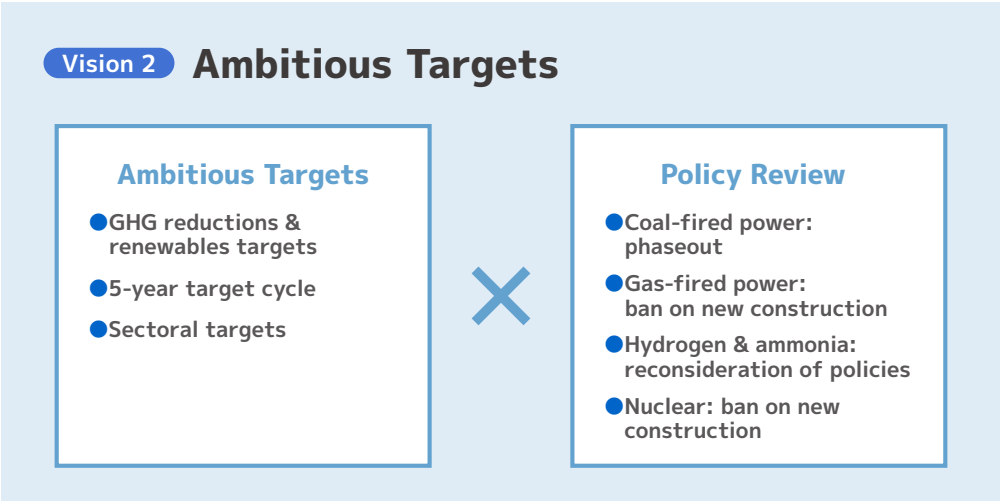


Minamiyokohama LNG thermal power station
(Yokohama city, Kanagawa)

12 METI GX League Basic Concepts, February 1, 2022 (in Japanese).

13 Government of Japan, GX Basic Policy, February 10, 2023 (in Japanese).

1-2. Ambitious targets and policy review



Numerical targets would be a key element for any grand design. Japan has abundant renewable resources, such as wind and solar. According to estimates by the Ministry of the Environment (MOE), Japan's potential for commercially viable wind and solar power is more than double the country's current annual power generation. That abundance should allow Japan to set ambitious targets for renewables.[14]

Current status

Japan's national target for GHG emission reduction is a 46% to 50% cut by 2030 from 2013 levels. Under the Sixth Strategic Energy Plan to achieve the reduction target, Japan's outlook for the renewable energy share in the power generation mix is 36% to 38% by 2030. The outlook for the share of renewables are low compared with global outlooks presented by international organizations. [15] Japan has yet to set any target or outlook beyond 2030 and this results in a lack of incentive to scale up renewables.

Coal- and gas-fired power are to account for 19% and 20%, respectively, in Japan's power generation mix in 2030, according to the Sixth Strategic Energy Plan. Under current policy, coal-fired power generators are required to achieve a generation efficiency of 43% or higher as a measure for Japan to "fade out" inefficient plants by 2030.[16] But separate policies allow coal-fired power plants to mix coal with fuels that have lower emissions, such as biomass, hydrogen and ammonia, to achieve the 43% efficiency target. Furthermore, hydrogen and ammonia are categorized as non-fossil energy, even though in practice they are derived from

14 MOE, Japan's potential for renewables, April 2022 (in Japanese).

15 For example, a report by the International Energy Agency(IEA) Net Zero by 2050 A Roadmap for the Global Energy Sector presented a global scenario of 60% renewables in 2030, October 2021 (P.115).

16 METI Working Group on coal-fired power, Advisory committee for natural resources and energy Interim report, April 23, 2021 (in Japanese).

fossil fuels.[17] Several studies have found that any reductions of CO_2 emissions achieved through co-firing of hydrogen and ammonia would be extremely limited and costly.[18, 19, 20]

These conflicting policies add uncertainty prospects for the overall reduction of coal power in Japan. The government also plans to promote the construction of new gas-fired power plants based on the assumption that they will later co-fire with hydrogen or fire hydrogen alone to supply power.[21] The push for co-firing with hydrogen and ammonia at thermal power plants and CCUS technologies was also evident in the GX Basic Policy, making Japan one of few developed nations without a coal phase out plan.[22]

As for nuclear power generation, in the GX Basic Policy the Kishida administration unveiled its intentions to extend the service life of currently operating units, restart reactors that have been halted, and develop and construct next-generation reactors. This revelation indicates a move away from policies to reduce the country's nuclear reliance that were introduced following the 2011 Fukushima nuclear disaster.

Proposals

Setting ambitious targets for emission reductions and renewables

The U.N. has been calling on governments to strengthen emission reduction targets for 2030 to close the gap between anticipated emission levels in 2030 and levels consistent with a 1.5 ℃ goal.[23] Taking into account the feasibility of a decarbonized power sector as presented in the Clean Energy scenario, Japan should strengthen its targets for GHG emission reductions and increase the share of renewable electricity for 2030, and set targets for every five years through 2050. Reduction targets also need to be set for the electricity/heat, industry, transportation, commercial and residential sectors.

Reconsidering policies for hydrogen and ammonia co-firing, CCUS and nuclear power

Coal-fired power: Phase out. Make the decision to phase out coal by 2030 and develop a plan to do so.

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17 With a revision in May 2022, the government set a policy of promoting the use of hydrogen and ammonia as "non-fossil energy source" under the Act on Sophisticated Methods of Energy Supply Structures.

18 TransitionZero, Coal-de-sac: Advanced Coal in Japan, February 14, 2022

19 Climate Integrate, Getting Lost on the Road to Decarbonization: Japan's Big Plans for Ammonia, June 30, 2022

20 BloombergNEF, Japan's Ammonia-Coal Co-Firing Strategy a Costly Approach to Decarbonization, Renewables Present More Economic Alternative, September 28, 2022

21 Agency for Natural Resources and Energy (ANRE), Auctions of long-term decarbonized power sources, November 30, 2022 (P.7) (in Japanese).

22 E3G Coal Transition Progress Tracker, OECD & EU Countries

23 UNFCCC Sharm el-Sheikh Implementation Plan, November 2, 2022, Para 20, 23, 29.

Table 1. Reduction target proposals

Year	2030	2035	2040	2045	2050
GHG emission reductions	At least - 60%	-70%	-80%	-90%	Net zero
Share of renewable electricity in generation mix	At least 50%	At least 85%	Nearly 100%		

Prepared by Climate Integrate

Gas-fired (LNG) power: Gradually reduce existing capacity, ban new construction. Power generated from gas-fired plants should be reduced significantly and the use of gas-fired power needs to be limited to dispatchable power sources to address supply fluctuations. Construction of new plants should be banned, as there is no need for new capacity. Existing plants should be gradually phased out.

Hydrogen and ammonia co-firing: Reconsider. Fundamentally reconsider policies for co-firing with hydrogen and ammonia at thermal power plants. They are high-cost options, whereas the costs of solar and wind power are falling and economically viable options.

Nuclear power: Ban new construction, phase out existing plants. There is no economic rationale for massive spending on new nuclear capacity instead of solar and wind, which are low-cost and have vast potential. There are safety issues with restarting old nuclear reactors, and building new capacity presents challenges such as high costs and long planning horizons, so new construction is a highly unlikely option. Instead of replacing old nuclear plants with new ones or add new capacity, Japan should phase out nuclear and increase the share of decarbonized electricity by promoting energy efficiency and renewables.

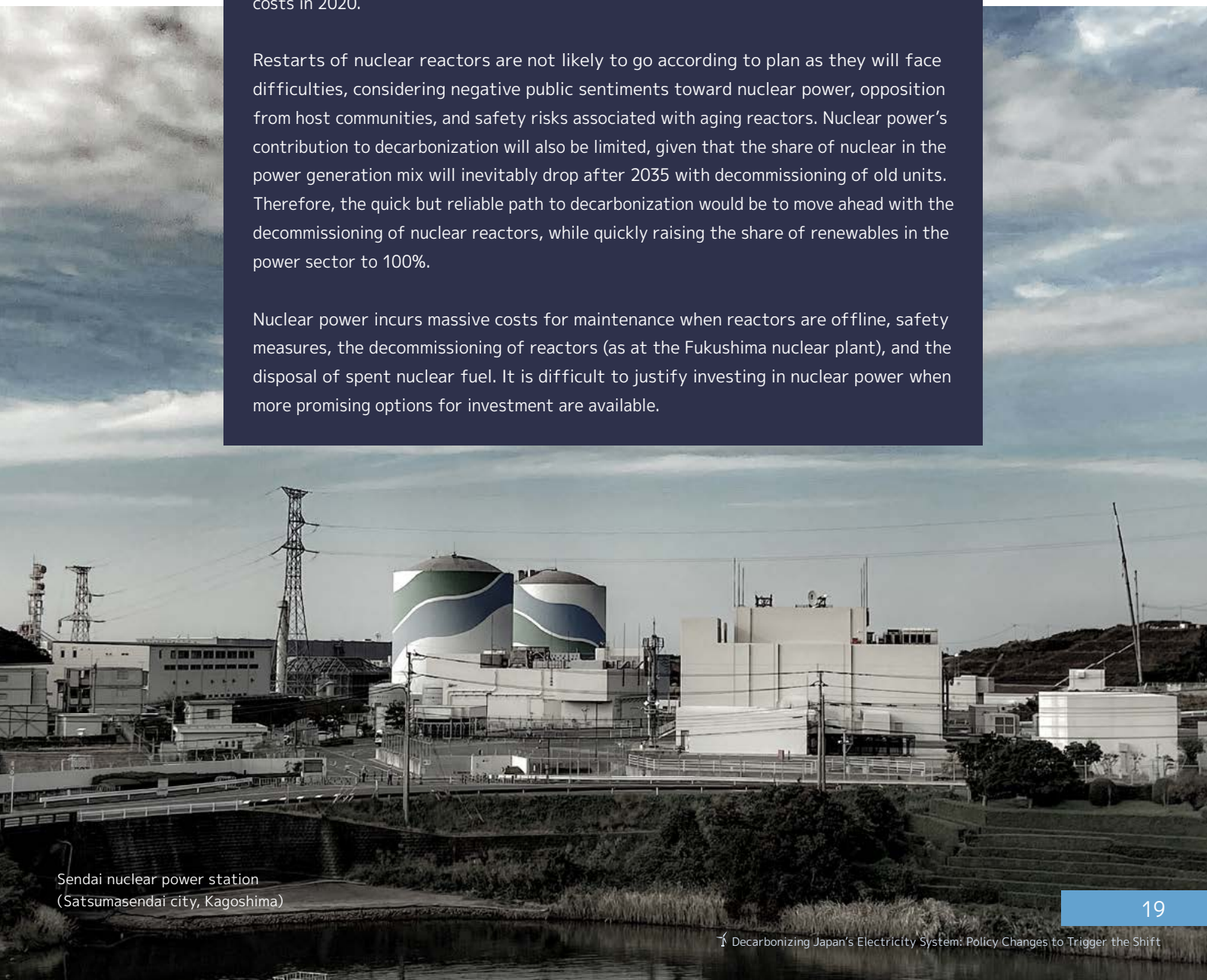
Nuclear power in Japan

Berkeley Lab's Clean Energy scenario does not count any new nuclear construction or replacement, as they are not considered to be economically viable options due to challenges such as obtaining permits and local acceptance, long construction periods, and high generation costs compared with solar and wind power. The scenario assumes, however, that nuclear power will still account for approx. 20% of Japan's power generation mix in 2035, based on the assumption that under current policy the government will maintain a portion of nuclear capacity by restarting idled reactors and extending their operating lives.

The Low Nuclear scenario assumes that reactors will be decommissioned at 40 years of service, leading to a decrease of 8 GW of nuclear capacity and an increase in the capacities of offshore wind and battery storage, without impacting the reliability of supply. Costs may be marginally higher than the Clean Energy scenario, but still lower than costs in 2020.

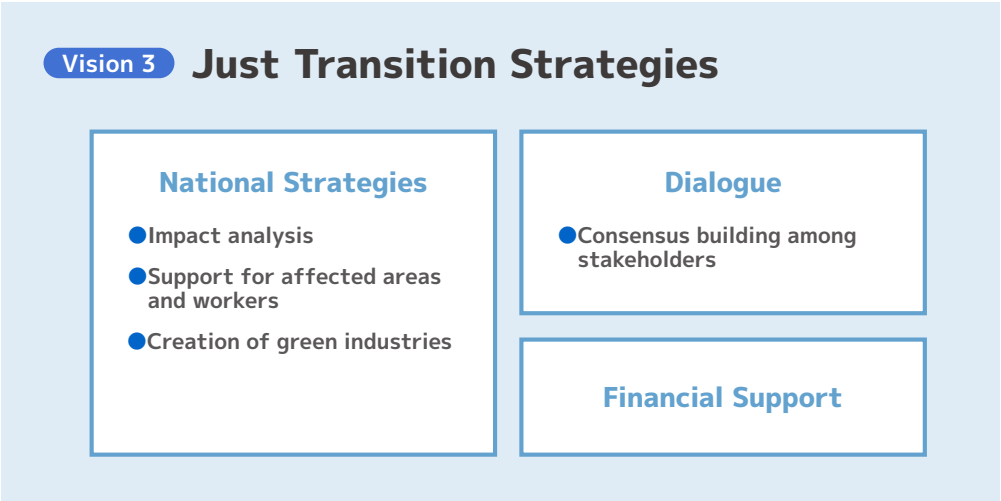
Restarts of nuclear reactors are not likely to go according to plan as they will face difficulties, considering negative public sentiments toward nuclear power, opposition from host communities, and safety risks associated with aging reactors. Nuclear power's contribution to decarbonization will also be limited, given that the share of nuclear in the power generation mix will inevitably drop after 2035 with decommissioning of old units. Therefore, the quick but reliable path to decarbonization would be to move ahead with the decommissioning of nuclear reactors, while quickly raising the share of renewables in the power sector to 100%.

Nuclear power incurs massive costs for maintenance when reactors are offline, safety measures, the decommissioning of reactors (as at the Fukushima nuclear plant), and the disposal of spent nuclear fuel. It is difficult to justify investing in nuclear power when more promising options for investment are available.



Sendai nuclear power station
(Satsumasendai city, Kagoshima)

1-3. National strategies for a just transition



A dramatic shift to renewable power would lead inevitably to the downsizing of the thermal and nuclear power industries and an expansion of renewables-related industries. A just transition[24] for structural changes in industries and supply chains as well as employment is a key focus for achieving decarbonization globally,[25] and Japan also needs to address these issues. Strategies for a just transition would serve as an important employment policy.

Current status

Japan's Long-Term Strategy under the Paris Agreement, released in October 2021, refers to a just transition in this way: "The Government, local authorities and companies as well as financial institutions will work together to provide vocational training to the workforce, support for diversification and shifts in business operations, support for inviting new business and replacement of the labor force, in order to achieve the transition of the workforce to a decarbonized society smoothly and without delay. Such efforts also include support to local societies and economies for their smooth transitions," [26]

Meanwhile, the government's Green Growth Strategy and GX Basic Policy detail support for hydrogen and ammonia co-firing in thermal power generation as well as CCUS pilot projects.

24 A just transition is possible through participation by all stakeholders in dialogue, by giving people in communities a say in choices and ensuring that workers have meaningful jobs and stable incomes, in order to leave no one behind in the transition to a decarbonized society. It is also crucial to promote the diversification of a sustainable economy at local, regional and national levels, and to strengthen the resilience of communities. The preamble to the Paris Agreement acknowledges "the imperatives of a just transition of the workforce and the creation of decent work and quality jobs."

25 For example, Canada and Spain have strategies for a just transition while the European Union has set up a fund for a just transition to provide support measures for regions that rely heavily on fossil fuels. References: Kiko Network "Just transition" (2021, in Japanese), and World Resources Institute "Just Transition and Equitable Climate Action Resource Center."

26 Government of Japan The Long-Term Strategy under the Paris Agreement, October 2021.

However, they fail to provide specific measures needed for a just transition that would be made necessary by the energy shift, which would include closures of thermal power plants. Local governments in communities that currently host thermal and nuclear power plants have yet to get a grasp on how the transition will impact their local industries and employment.

Proposals

A just transition would involve recognizing the importance of establishing measures and building sustainable communities by implementing the following policy measures.

A national strategy for a just transition: A national just transition strategy for industries and workers should be established to avoid adverse effects of the shift to renewable power and to revitalize local economies. Such strategy would include the following actions.

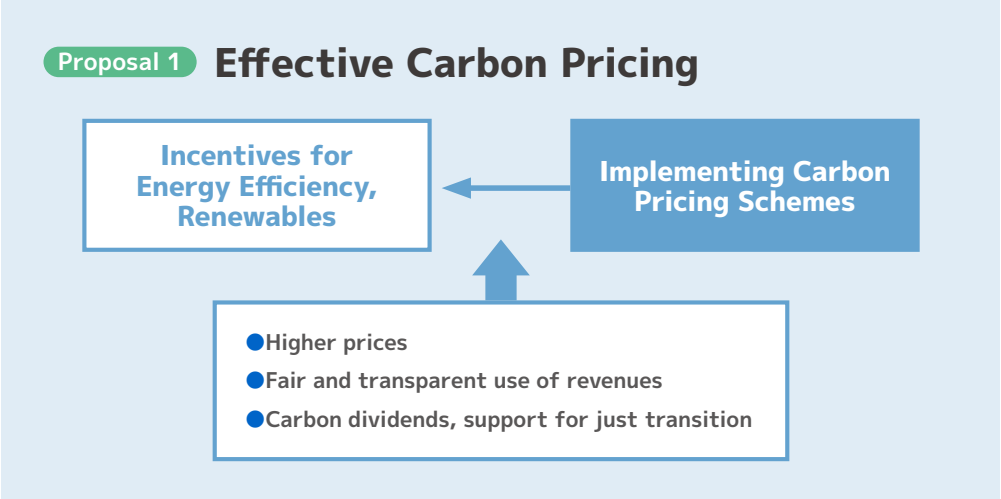
- Conducting a nationwide survey on impacts on host communities, economies, and employment from the decommissioning of power plants and related facilities
- Establishing support measures such as job training, career change assistance, and unemployment compensation, in the most affected areas and for workers at risk of losing jobs
- Fostering decarbonization industries in impacted areas, such as infrastructure development and manufacturing in solar, offshore wind, batteries, and EVs, as well as human resources training

Opportunities for dialogue: Consultations for consensus-building need to take place between national and local governments, businesses, factories, labor unions, citizens and NGOs.

Financial support: The national and local governments should provide financial support to implement policies associated with just transition strategies.

2. Policy measures

2-1. Making carbon pricing more effective



Current status

In October 2012, Japan introduced the Tax for Climate Change Mitigation, equivalent to a carbon tax, on top of the existing Petroleum and Coal Tax. The rate of this tax is still currently 289 yen/t-CO_2, which is low compared with other countries (Chart 2). As for emissions trading, Japan has no nationwide program, but the Tokyo Metropolitan Government and Saitama Prefecture have launched their own emissions trading schemes.

Following instructions from then-Prime Minister Yoshihide Suga in December 2020,[27] the Ministry of Economy, Trade and Industry (METI) and Ministry of the Environment (MOE) separately started discussions on carbon pricing schemes, such as carbon tax and emissions trading.[28, 29] Through that process, METI launched the Green Transformation (GX) League, a forum of hundreds of companies, and started a pilot for voluntary emissions trading in September 2022.[30] According to the GX Basic Policy approved by the cabinet in February 2023, the government plans to start full-scale emissions trading in FY2026, to introduce the auctioning of emissions from power generation companies in FY2033, and carbon emissions surcharges in lieu of carbon taxes in FY2028.

The government plans to issue "GX Economy Transition Bonds" of about 20 trillion yen over the next ten years and use revenues from carbon pricing schemes such as emissions trading and surcharges for the redemption of the bonds. It intends to issue the bonds to raise funds for investments in large-scale projects for the development of technologies promoted by the GX Basic Policy. There are concerns that this scheme would benefit only the companies involved in those projects, and that it would not pass on revenues from

27 METI Summary of a press conference by minister Kajiyama, December 21, 2020 (in Japanese).

28 METI Study group on financial means to achieve carbon neutrality (in Japanese).

29 MOE Subcommittee on the utilization of carbon pricing (in Japanese).

30 Japan Exchange Group (JPX) News Release JPX commences carbon credit market demonstration, September 22, 2022.

carbon pricing to Japanese society as a whole.

Proposals

Carbon pricing is a financial scheme to reduce CO_2 emissions by putting a price on emissions and using the economic effects of price incentives. The concept has gained support as a means of achieving decarbonization targets, and a quick implementation of carbon pricing policies with appropriate design is needed. In order to reduce CO_2 emissions by promoting energy efficiency measures and expanding renewables, the government needs to provide price incentives at appropriate levels to rein in overall emissions. Revenues generated from carbon pricing policies such as taxes and cap-and-trade can be given back to society and used to pay for decarbonization efforts.

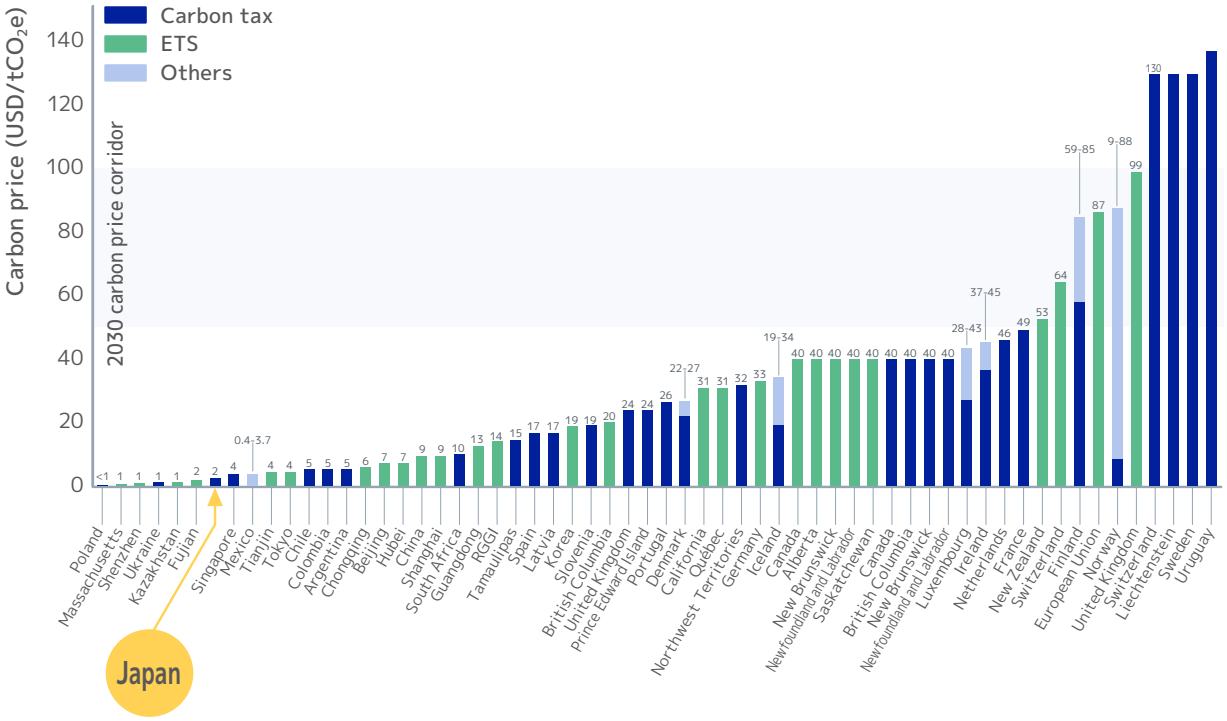
- **Prompt carbon pricing schemes:** The government should start emissions trading earlier than the planned year of 2026. Instead of the surcharges the government is considering to introduce in FY2028, legislation should be prepared and passed by Diet to introduce a carbon tax sooner in order to put an appropriate price on emissions and decide on fair usage of revenues.

- **Setting higher prices on emissions:** Following the Clean Energy scenario, through a combination of raising the rates of existing tax schemes, introducing emissions trading ("cap and trade"), and implementing a full-fledged carbon tax, the price on carbon should be raised to the equivalent of 6,000 yen/t-CO_2 by 2035 or higher.

- **Fair and transparent use of revenues:** The use of revenues from carbon pricing instruments should align with the grand design, be deliberated by Diet, and decided in fair and transparent processes.

- **Revenue redistribution and support for a just transition:** Higher carbon prices would have a regressive effect in terms of a greater burden on lower income earners. Revenues from carbon pricing schemes should be redistributed to the Japanese people through measures such as carbon dividend and reduction in social security taxes. A priority should be given to providing support for a just transition for regions and workers impacted by decarbonization. If revenues are to be used for the redemption of "GX Economy Transition Bonds," their use should be limited to measures that are cost-effective and expected to have a real effect in reducing emissions by 2035.

Chart 2. Carbon prices as of April 1, 2022

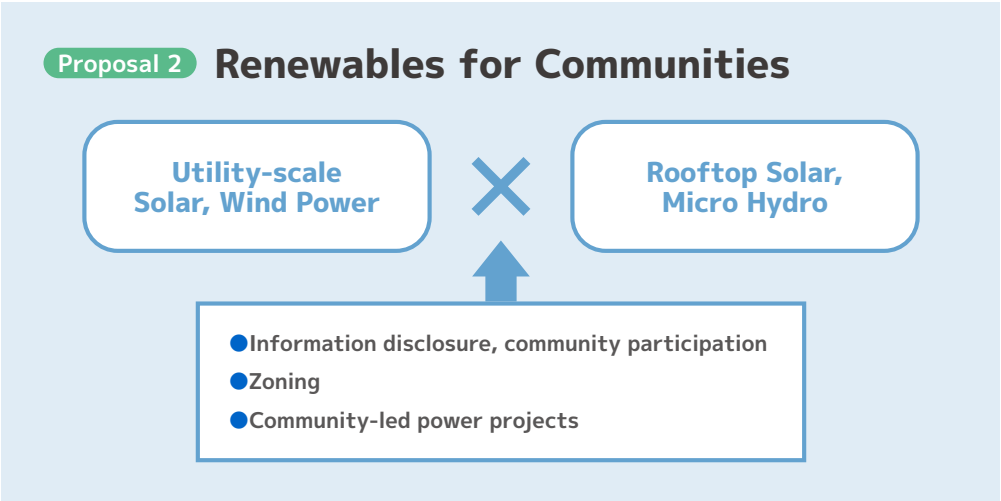


Prepared by Climate Integrate from World Bank materials[31]

Kaya wetland (Toyooka city, Hyogo)

31 World Bank State and Trends of Carbon Pricing, May 24, 2022.

2-2. Expanding renewable energy in ways that benefit communities



Current status

Renewables are a distributed energy source that can be developed and utilized through local initiatives. However, 224 local governments (about 13% of Japan's local governments) have introduced ordinances to rein in renewable energy developments in the face of some solar and wind projects that were not implemented appropriately.[32] In some regions with plans and potential for offshore wind farms, local residents have expressed concern and opposition.

Information on individual renewables projects that have received government approval to sell electricity under the feed-in tariff (FIT) program is publicly available on METI's website.[33] However, information on applications for renewables projects is only made available to the local governments concerned. Government policies require developers to "make an effort" to notify local residents about their projects at an early stage of planning.[34] Such requirements are not legally binding, and residents sometimes learn about a new project only when construction is about to begin. In October 2022, a METI taskforce on the proper installation and management of renewable energy projects compiled a set of proposals and urged the government to consider making it mandatory for proponents to notify residents of renewable energy projects of a certain size by certain measures, including holding information sessions for residents.

In June 2021, the government compiled a "roadmap for regional decarbonization," presenting steps and measures to be taken for regional development by local communitiesup to 2030.

32 Research Institute for Local Government Local ordinances regarding solar power generation equipment, accessed January 13, 2023 (in Japanese).

33 ANRE Application site for feed-in tariff programs (in Japanese).

34 METI Taskforce proposals on appropriate installations and management of renewable energy equipment October 2022 (in Japanese).

It also plans to designate at least 100 "Decarbonization Leading Areas"[35] across Japan, with 46 of them announced in 2022.

At the municipal level, a revision to the Act on Promotion of Global Warming Countermeasures in 2021 allows cities, towns and villages to designate "promotion zones" for decarbonization projects. In these zones, developers of local renewable energy projects are eligible for preferential measures to streamline the development process.[36] Japan currently has two promotion zones and more are under consideration by about 20 municipalities.[37] These measures are expected to contribute some progress being made. However, their impacts will likely be limited, as they are not based on any long-term plan beyond 2030.

Proposals

The shift to renewables requires not only building large-scale wind and solar farms in areas with vast potential, but also scaling up rooftop solar which can be installed nearly anywhere across Japan, as well as small hydropower and biomass electricity generation to take advantage of local resources. Regardless of the size of project, there should be systems to notify local residents about renewables projects and facilitate dialogue from an early stage of planning, in order to build consensus and facilitate a rapid energy shift to renewables.

- **Full information disclosure and community participation:** The government should develop mechanisms that allow local residents to obtain information and provide their comments on renewables projects from early stages of planning, hold consultations, and resolve disputes.

- **Central government-led zoning for renewable energy, and sharing benefits with communities:** The central government should develop a mechanism to take the lead in designating areas to promote renewable energy across the country through coordination with local governments.[38] Once the mechanism is in place, the selection of "Decarbonization Leading Areas" by MOE and designation of "Promotion Zones" for renewables by municipal governments can be done more efficiently to deploy renewables. When selecting such leading areas for renewable energy, upgrade plans for local grids should be taken into account in order to ensure the renewable electricity generated is used efficiently. Systems should also be established to redistribute some of the revenues from renewables projects back to these designated zones.

- **Support for community-led projects:** Obstacles need to be removed for power

35 Decarbonization Leading Areas, according to MOE, are intended to achieve net-zero CO_2 emissions from electricity consumption in residential and business sectors by FY2030. They are also to make efforts to achieve reductions in other GHG emissions such as from transportation and heat use at levels that are aligned with Japan's FY2030 reductions target and local characteristics.

36 MOE Measures for renewable projects that can benefit communities, April 2022(P.6) (in Japanese). Preferential measures include a streamlined process to receive approval and a shortened environmental impact assessment process at early stages of planning.

37 MOE Toward 2050 carbon neutrality, November 9, 2022 (P.30) (in Japanese).

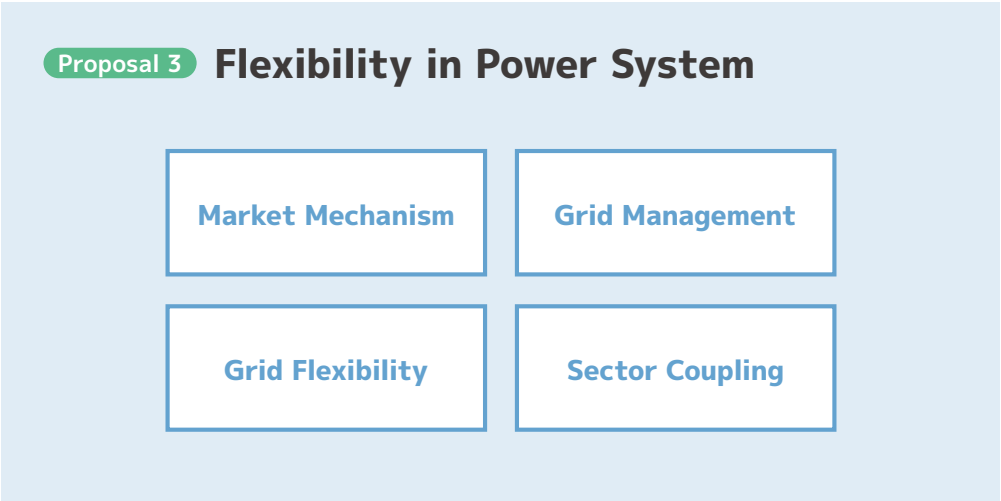
38 MOE has published a manual on zoning for wind power (in Japanese), but not yet for solar.

projects developed by communities and municipal governments, to ensure fair competition for their entry, continuation, and expansion in electricity markets.

- **Speedy introduction of a centralized system for offshore wind development (See 2-5)**

Solar Sharing (Toyooka city, Hyogo)

2-3. Enhancing flexibility in Japan's power system



Current status

Since the start of the feed-in tariff program in July 2012, Japan's renewable energy development has been led largely by solar power. To expand variable power sources such as solar and wind, there is a need for measures to maintain balance between electricity demand and supply. Japan has introduced curtailment, which requires power producers to reduce or halt electricity production, in accordance with priority dispatching rules. Under curtailment rules, power production is reduced in this sequence: (1) thermal power, pumped hydro → (2) biomass → (3) solar, wind → (4) nuclear, hydro, geothermal.

In 2018, the main island of Kyushu had the first case of curtailment of variable renewable power (item (3) solar, wind). Since then, curtailment has also been carried out in Hokkaido, Tohoku, Chugoku, and Shikoku regions, though less frequently.[39] Although such measures are necessary for the stability of the power supply, excessive curtailment could directly impact the bottom line of power producers. The government is considering ways to tackle the situation, such as implementing measures on the demand side and strengthening the grid. As for storage batteries, which contribute to stabilizing the grid by charging and discharging surplus electricity, the government plans to set a target for 2030 for stationary batteries, and to expand the national battery manufacturing capacity to 150 GWh by then.[40] It also will develop a market mechanism to allow for distributed power sources—such as residential storage batteries—to trade electricity, and adjust grid access rules for storage batteries.

Proposals

Below are several recommendations for Japan to improve its electricity supply and demand management in anticipation of a massive deployment of renewables.

39 ANRE Report on curtailment (in Japanese).

40 Government of Japan GX Basic Policy, February 10, 2023 (in Japanese).

- **Prioritization of power sources based on market principles:** Under Japan's curtailment rules, renewable energy producers are required to reduce or halt power production before hydropower, nuclear, and geothermal power producers. In order to deploy the more variable energy sources, however, the country needs to break away from the long-held concept of "baseload power sources," and review the curtailment rules that favor nuclear. A smart approach would be to choose electricity sources that make the best economic sense, by curtailing electricity in order from high to low marginal cost.[41]

- **Grid upgrades and better grid management:** Japan's grid system needs to be upgraded to accommodate the more variable renewable power sources such as solar and wind in accordance with a "master plan" for cross-region transmission lines being compiled by the Organization for Cross-regional Coordination of Transmission Operations, Japan (OCCTO). Currently "non-firm" access to the grid is provided to power producers at main grid levels.[42] The government plans to expand this to local grid levels and start accepting applications in April 2023. It is crucial for this to actually be done. At the same time, adopting new technologies such as dynamic line rating (a technology to enhance connectivity to the grid with sensors giving real-time information on weather conditions) could also help reduce the frequency of curtailment and enhance grid management.[43]

- **A more flexible power system:** In promoting renewables as a main source of electricity, it is crucial to maintain supply and demand balance and improve the flexibility of the grid. Balancing capability is one aspect of flexibility which can be provided by controlling output from plants - including thermal, hydro and biomass power generators - as well as interregional transmission, demand response, and energy storage. An optimal combination of these technologies would provide flexibility in managing the variability of the power system. In particular, the expansion of wind capacity, combined with accelerated development of cross-region power transmission, would be key to supplement solar power at night and on cloudy days.

  Japan can create new business opportunities using the latest technologies and digitization. One example would be demand response based on electric vehicle batteries - an option that has considerable potential. Setting a target for battery deployment could increase Japan's balancing capability and accelerate decarbonization. According to the International Energy Agency (IEA), the share of renewable energy in Japan's total power generation is still low, and the impact from variable energy sources on the power system is still limited,[44] so the current system allows some leeway to adopt these measures in stages, to improve flexibility of the grid.

- **Sector coupling:** The volume of excess renewable power is expected to increase as renewable installations expand. Such excess electricity should be utilized by promoting

41 Cabinet Office's taskforce on renewable energy regulations made similar proposals, June 3, 2021(in Japanese).

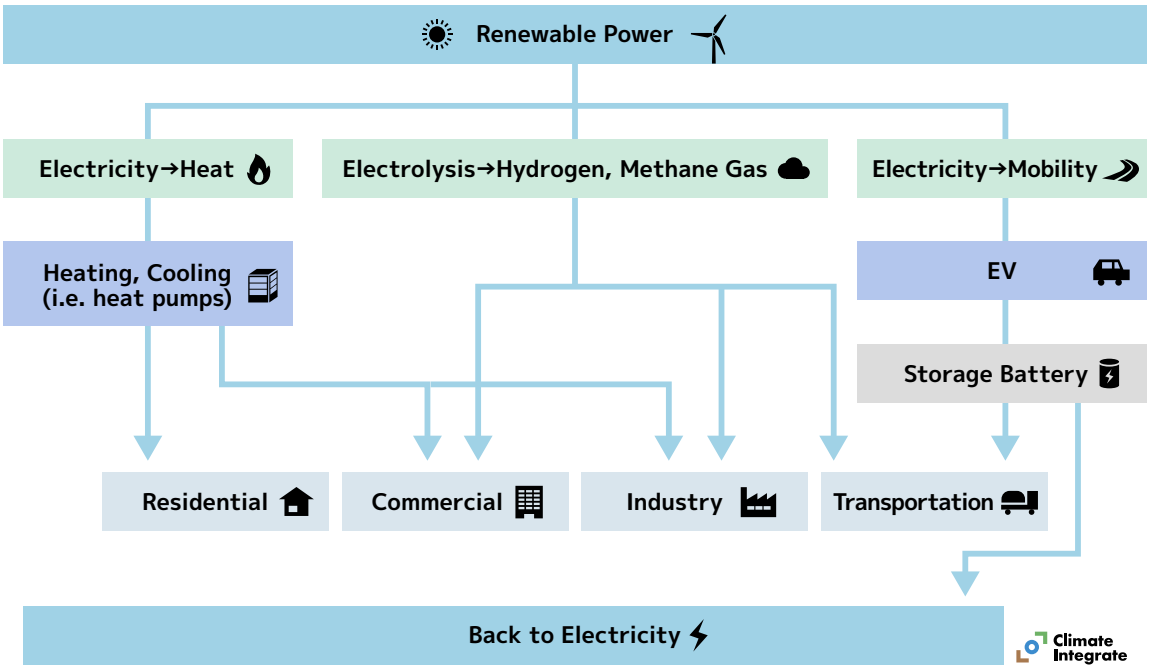
42 ANRE How to connect to the grid to increase renewables March 25, 2021 (in Japanese).

43 ANRE Next generation grid, March 12, 2021 (P.46) (in Japanese).

44 IEA Status of Power System Transformation 2019, May 2019

electrification and sector coupling (integration of sectors such as manufacturing, heat, residential and commercial, transportation and agriculture, as shown in Chart 3). Sector coupling means transferring energy between sectors. In the power sector, in particular, rapid deployment of renewable energy from wind and solar power can accelerate electrification of sectors, especially heat and transport,[45] which can help reduce CO_2 emissions through the indirect use of renewable energy. Sector coupling also allows for the use of new sources of flexibility such as thermal energy storage and electricity storage using EV batteries, contributing to improving the flexibility of the overall power system.

Chart 3. Concept of sector coupling

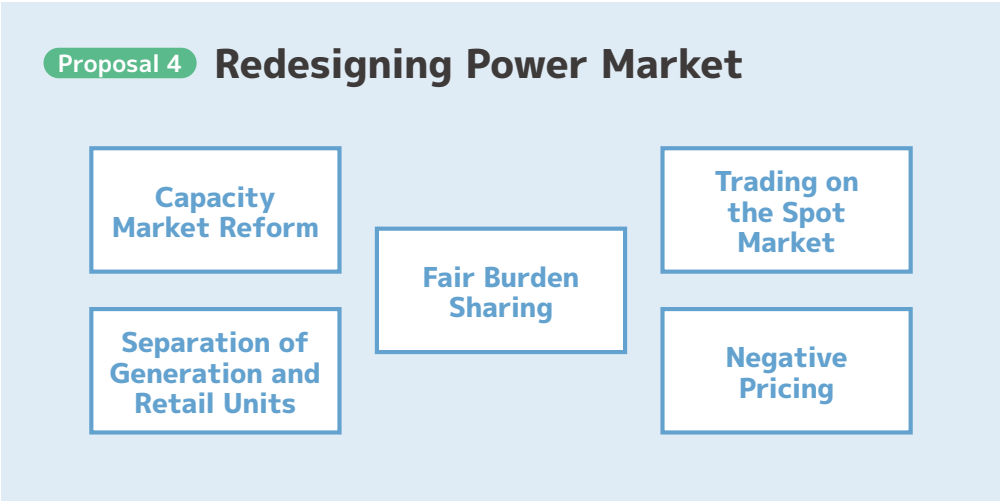


Prepared by Climate Integrate based on International Energy Association (IEA) materials[46] and cleanenergywire.com.

45 IEA Wind TCP Task25 Electrification, August 2020.

46 IEA Status of Power System Transformation 2019, May 2019

2-4. Redesigning power markets to encourage fair competition



Current status

For decades, ten regional utilities in Japan were in charge of electricity generation, transmission/distribution, and retail. The liberalization of retail electricity began in March 2000, first targeting extra-high-voltage customers (large factories, department stores, office buildings) and allowing them to source electricity from other power producers. The scope of liberalization was later expanded to high voltage consumers (small- and mid-size buildings and factories), and the process was completed in April 2016 with low-voltage customers (homes and small retail stores). In the course of market reforms, the electricity generation and retail sectors were both liberalized, which prompted the emergence of the wholesale market. Meanwhile, the transmission/distribution sector was legally separated from other sectors.

Japan subsequently created more markets besides the wholesale market and the situation became increasingly complex (Chart 4).[47] One of them, the "capacity market," is drawing criticism for functioning as a de-facto mechanism that provides incentives to prolong the use of existing facilities such as nuclear and aging coal power plants.[48] The government plans to add a new mechanism to the capacity market to auction "long-term decarbonized electricity." The auction would incentivize multi-year investments in decarbonized power sources (unlike the capacity market, which covers only one year). The government's choice of power sources eligible to take part in the auction lacks some logic, as it includes not only hydrogen and ammonia co-firing in thermal power plants (despite their poor prospects for return on capital investment), but also thermal power with CCUS, and under certain conditions, new gas-fired

47 Venues for electricity trading in Japan include the Tokyo Commodity Exchange (electricity futures), the Japan Electric Power Exchange (spot, hour-ahead, forward, financial transmission rights, baseload, non-fossil fuel certificates), OCCTO (capacity, long-term decarbonized electricity auctions) and the Electric Power Reserve Exchange (balancing). Individual spot contract and one-on-one futures contracts are also done outside these markets.

48 Cabinet Office's taskforce on renewable energy regulations Views on the capacity market, December 1, 2020 (in Japanese).

power generation.[49]

Meanwhile, despite market liberalization attempts, the original ten regional utilities continue to generate much of the electricity produced in Japan.[50, 51] The newer, smaller electricity retailers source their electricity as follows:

(1) One-on-one contracts with power producers
(2) Transactions on the wholesale market
(3) Ownership of power plants
(4) Transactions on the baseload market

However, the current situation has its flaws. For one-on-one contracts, most of the power supplied by the ten regional utilities still goes to their own retail units or to retailers of group companies.[52] As for the wholesale market, where the spot (day-ahead) market accounts for the majority of transactions, there are fewer "sell" offers from the ten regional utilities than from newer, smaller electricity retailers,[53] possibly indicating a lack of fair competition.

Some measures to ensure fair practices in electricity wholesale were implemented in FY2021 to prevent the ten regional utilities from selling electricity under preferential conditions to their own retail units.[54] More needs to be done.

Furthermore, the spot (day-ahead) market has not been serving as a practical venue for power retailers to source electricity and avoid imbalance settlement fees. That is because trading volume on the spot market is low (about 0.7% of all electricity sold in Japan) as bidding is closed an hour before the delivery.[55]

49 ANRE Auctions of long-term decarbonization electricity sources, October 3, 2022 (P.4) (in Japanese).

50 ANRE Active trading on wholesale market, May, 25, 2016 (P.2) (in Japanese).

51 ANRE Baseload electricity, April 7, 2020 (in Japanese).

52 EGC FY2022 update on trading submitted to the 73rd working group, May 31, 2022 (P.4) (in Japanese).

53 Climate Integrate data compiled from ANRE statistics (in Japanese).

54 EGC Press release on commitment to fair wholesale of electricity by 10 major utilities, September 9, 2020 (in Japanese).

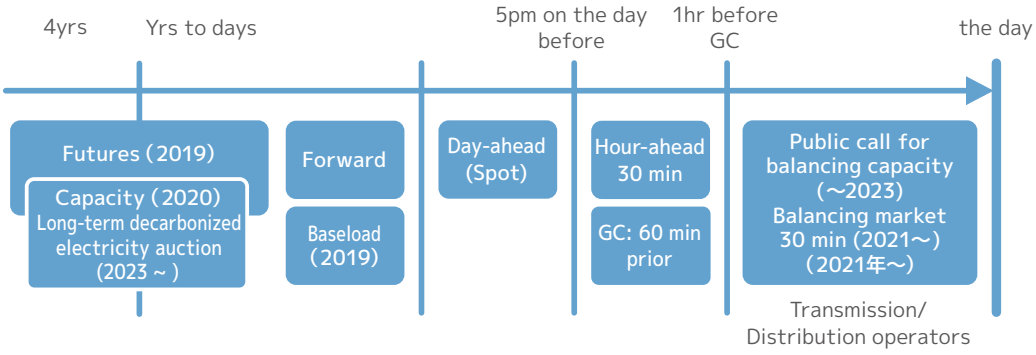
55 EGC Monitoring report for July-September 2022, December 22, 2022 (P.2) (in Japanese).

Table 2. Types of electricity markets in Japan

Types	Transactions	Markets	Buyers
Electricity (kWh)	Generated power	Wholesale market ・Spot (Day-ahead) ・Hour-ahead ・Forward ・Baseload	Power retailers
Capacity (kW value)	Ability to generate power	Capacity market	Power retailers
Balancing (Δ kW value)	Ability to adjust demand and supply in a short term	In transition from ancillary service public offering to balancing market	Transmission and distribution operators

Prepared by Climate Integrate from materials from ANRE taskforce on sustainable electricity system[56]

Chart 4. Timeline for power market functions



Prepared by Climate Integrate from materials by Kimio Yamaka[57]

Proposals

The following measures, if introduced, would structure power markets in Japan to offer transparency and fair competition.

- **Review the capacity market:** The auction for "long-term decarbonized electricity" that the government is planning to introduce needs a thorough review, as the scheme provides long-term incentives for investing in and keeping fossil fuel power plants running, including plants co-firing with hydrogen and ammonia, as well as nuclear power plants. Capacity mechanisms (such as strategic reserves) need to be redesigned in order to

56 ANRE taskforce on sustainable electricity system Ensuring investment in power sources, October 16, 2020 (in Japanese).

57 Kimio Yamaka, Graduate School of Economics, Kyoto University, Research Project on Renewable Energy Economics, Column No. 334 Reasons behind tight supply and demand of electricity, September 9, 2022 (in Japanese).

ensure adequacy.

- **Unbundle generation and retail units:** The government and the ten regional utilities should start looking into legally unbundling the utilities' generation and retail operations into two entities, in order to prevent power sales within each utility under preferential conditions, and to thoroughly liberalize the power market.

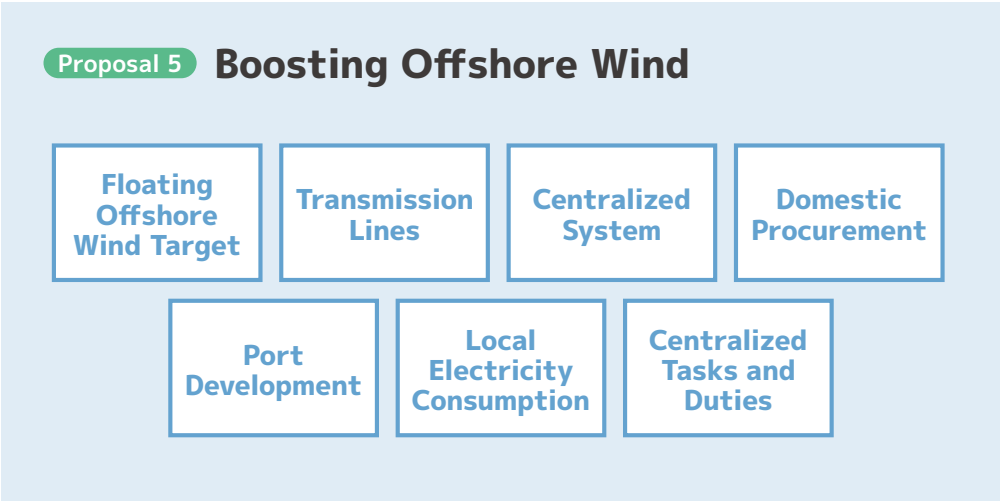
- **Increase trading volume on the spot market:** In April 2022, Japan began a gradual shift from the feed-in tariff scheme (FIT) to the feed-in premium scheme (FIP). The switch requires renewable energy producers to sell electricity on the wholesale market, rather than receiving a pre-set tariff, and they will be subject to imbalance settlement fees for any difference between the planned versus delivered power generation amounts. The government should start discussions on shortening the gate closure from the current close of one-hour before delivery to shorter times such as 5 and 15 minutes to allow for more flexible supply and demand adjustments.[58]

- **Start discussions on negative pricing:** The minimum bidding price is currently 0.01 yen/kWh on the spot market of the Japan Electric Power Exchange (JEPX). However, such an artificially set price could distort market mechanisms. One way to help balance the grid would be to introduce negative pricing, which would require power generators to pay for excess electricity. That, in turn, could prompt them to reduce or shut down renewable power generation when supply exceeds demand.

- **Ensure fair cost sharing:** Costs to strengthen and connect to the grid should not be borne unfairly by renewable power producers or hinder the accelerated development of renewables.

58 Some countries in Europe set the gate closure at 5 minutes or 15 minutes. Mitsubishi UFJ Research and Consulting Report on overseas electricity markets, March 26, 2021 (in Japanese).

2-5. Boosting Offshore Wind Development



Current status

In 2020, a private-public council set up to strengthen Japan's competitiveness in the offshore wind industry set a target of adding 30 to 45 GW in offshore wind projects by 2040.[59] While the target is ambitious, it is also far below the country's offshore wind potential of 552 GW (128 GW of bottom-fixed and 424 GW of floating), according to figures by the Japan Wind Power Association (JWPA).[60] Floating offshore wind is an important technology to utilize wind potential, and the government plans to start discussions to set a target.[61]

In recent years, the government has enacted legislation and revised existing laws to deploy more offshore wind.[62] For example, the Port and Harbor Act has been revised to promote offshore wind projects near ports. The Act on Promoting the Utilization of Sea Areas for the Development of Marine Renewable Energy Power Generation Facilities was enacted for the development of wind farms further into the ocean. The government is compiling a master plan for cross-region transmission lines, a blueprint for the expansion of main grids to connect regions that have abundant offshore wind resources (such as Hokkaido and Tohoku) with areas that have high electricity demand, including Tokyo.

The government plans to introduce a Japanese version of a more centralized system modeled after European schemes for offshore wind development, putting the government in charge of activities such as research required for offshore wind development. According to the roadmap of the GX Basic Policy, research will start in FY2023, with bidding beginning in FY2025.[63]

59 The public-private council on offshore wind industry Summary of the visions for the offshore wind industry (1st edition), December 15, 2020 (P.6) (in Japanese).

60 The Japan Wind Power Association document submitted to the public-private council on offshore wind industry, July 17, 2020 (P.14) (in Japanese).

61 Green Transformation Implementation Council GX Basic Policy (draft), December 22, 2022 (in Japanese).

62 ANRE Offshore wind policies, October 6, 2022 (P.5) (in Japanese).

63 Government of Japan Roadmap for GX Basic Policy, February 10, 2023 (in Japanese).

The challenge for Japan's offshore wind industry is to build a domestic supply chain without the presence of a major wind turbine maker. The pace of onshore wind development did not pick up even after the FIT program started in 2012, as wind projects with a capacity of 10 MW or larger became subject to environmental impact assessments soon after the FIT was introduced.[64] The slow uptake in wind development has led major domestic makers (Hitachi, Mitsubishi Heavy Industry, Japan Steel Works) to cease wind turbine production.

Another issue is the inefficient engagement process at prospective offshore wind farm sites, as individual developers themselves are dealing with local communities and fisheries stakeholders.[65] According to a draft plan for a centralized system presented by the government in January 2023,[66] local governments will be in charge of coordinating with local communities to develop projects, and the central government will be in charge of providing support for local governments.

Proposals

Offshore wind will play a crucial role in the shift to renewables in Japan. The following measures are recommended in order to accelerate developments beyond JWPA targets.

- **Set ambitious targets for floating offshore wind:** For the full deployment of the potential for floating offshore wind, Japan should aim to install 2 to 3 GW by 2030, 20 GW by 2035 and set an ambitious target for 2050. Japan also needs to set industry policies for floating offshore wind soon in order to be able to compete with countries aiming to build gigawatts of capacity each by 2030.[67] A delay in setting goals and policies could slow the development of related industries and infrastructure, and prevent Japan from gaining market share in Asia.

- **Accelerate grid development:** To expand offshore wind, there is a need for further development of transmission lines and other infrastructure for the efficient use of wind power. A pilot project is underway for undersea high-voltage cables between Hokkaido and Tokyo. Such installations need to advance quickly, and feasible grid projects under the master plan should also proceed.

- **Introduce a centralized system for local engagement:** In the centralized system the government is planning, it is laudable that the scope is expected to include local

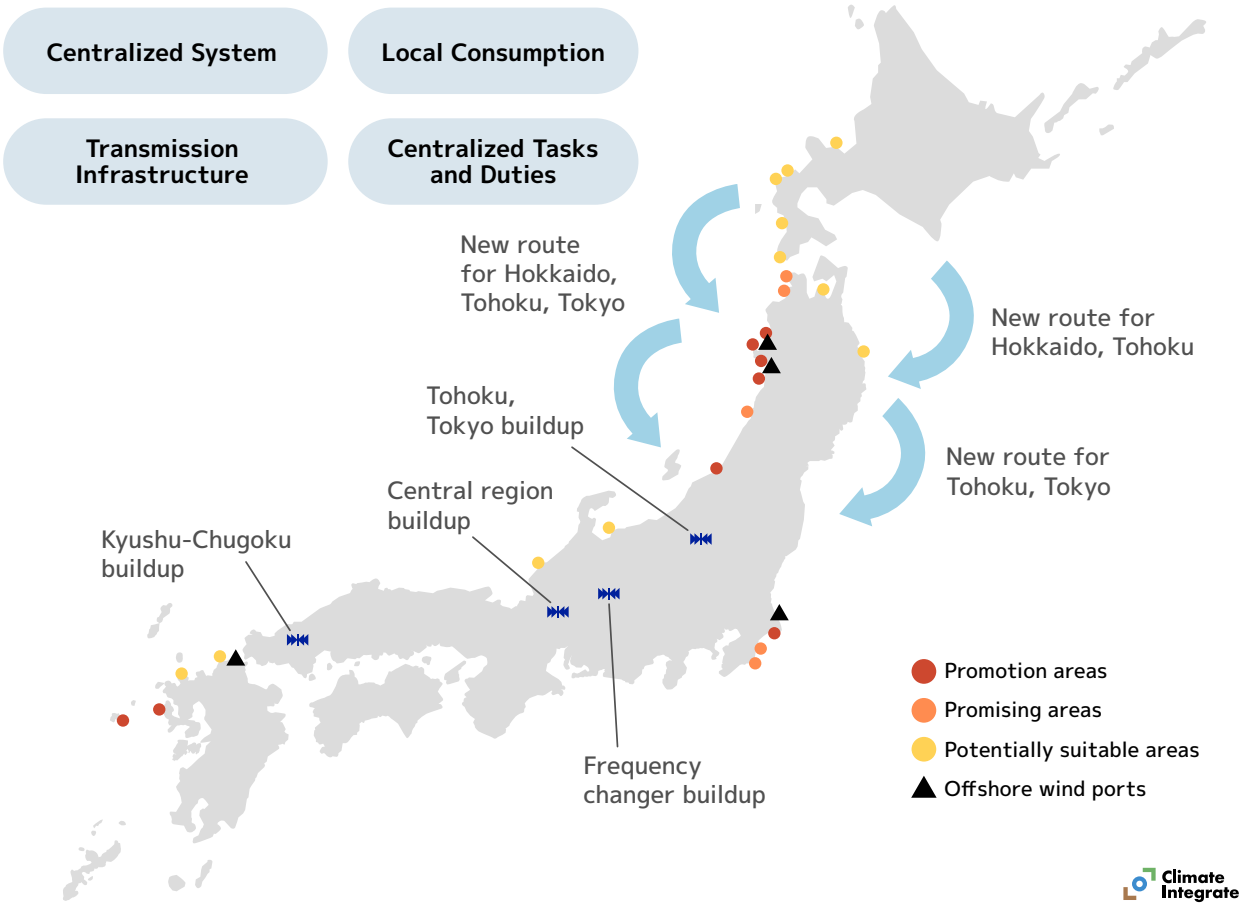
64 The Japan Wind Power Association Japan's wind installation data as of the end of 2018, January 16, 2019 (in Japanese).

65 Renewable Energy Institute Proposals for the Coexistence of Offshore Wind with Local Communities and the Fishing Industry, July 29, 2022 (P5) (The original Japanese report was published in June 2022)

66 METI, MLIT 18th joint taskforce meeting Draft of a centralized system mechanism, January 30, 2023 (in Japanese).

67 Japan's Floating Offshore Wind Group Outlook on floating offshore wind power in Japan, September 2021 (P.2) (in Japanese).

Chart 5. Grid development for offshore wind expansion



Prepared by Climate Integrate from METI materials[68, 69, 70]

coordination for dialogue to achieve consensus building among local stakeholders. The current plan is for local governments to be in charge of local coordination at candidate sites, but the central government should also be involved in the process for the time being, to set useful precedents and accelerate the full-scale deployment of offshore wind.[71]

- **Develop industry to increase domestic procurement:** The private-public council on offshore wind has set a target rate of 60% for domestic procurement by 2040. Wind turbine manufacturing accounts for 23.8% of the offshore wind supply chain, while the costs of research, installation, operation, maintenance, and dismantling account for more

68 METI Transmission and distribution business, November 24, 2022 (P.11) (in Japanese).

69 METI Systems related to offshore wind power (in Japanese).

70 MLIT Summary of offshore wind port system (in Japanese).

71 Renewable Energy Institute Proposals for the Coexistence of Offshore Wind with Local Communities and the Fishing Industry, July 29, 2022 (P.15).

than 60%.[72] Japan has no domestic manufacturing capacity for the actual wind turbines at the moment, but the domestic share of other parts could be increased. Related businesses should be encouraged to develop in order to ensure a stable supply of key parts and components.

- **Develop offshore wind ports:** The government is developing offshore wind ports across the country, to be used as hubs for the construction and maintenance of wind farms at sea. It is also aiming to develop so-called "carbon neutral ports" (CNP) featuring facilities designed to help decarbonize port activities. Some ports could potentially serve dual functions as both an offshore wind port and a carbon neutral port. Possible functions being considered for CNPs include providing storage space for imported hydrogen and ammonia, but expectations for the scale of such storage tend to be overestimated. Port development requires a long-term perspective. Investments need to be well considered, taking into account the potential for expansion of offshore wind ports as related industries grow, while any investments in infrastructure for hydrogen and ammonia must be planned carefully as their demand is hard to forecast.

- **Promote local consumption of electricity:** Along with grid development for long-distance power transmission, Japan should create local demand for offshore wind power in industries with high electricity demand, such as data centers. According to policies on digital technology use,[73] approved in 2022, the government plans to build more than ten data centers over the next five years across Japan to use locally produced renewable electricity. The government should jumpstart efforts for local consumption of renewable energy by building data centers at sites with offshore wind resources, and use excess electricity, for example, to produce green hydrogen.

- **Centralize tasks and duties:** Policies related to offshore wind span several ministries, including METI, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), MOE and the Fisheries Agency. This calls for a centralization of contact points to expedite the process of building offshore wind farms. Government responsibilities—at national, regional and municipal levels—also need to be clarified to ensure more efficient operations.[74]

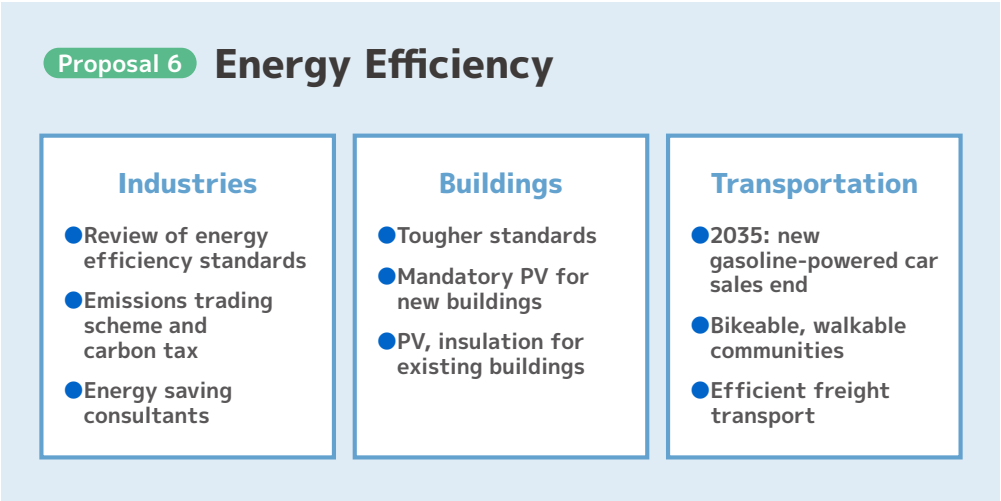
72 The public-private council on offshore wind industry Summary of the visions for the offshore wind industry (1st edition), December 15, 2020 (P.12) (in Japanese).

73 Government of Japan Basic policy for digital garden city, June 2022 (in Japanese).

74 Renewable Energy Institute Proposals for the Coexistence of Offshore Wind with Local Communities and the Fishing Industry, July 29, 2022

Wind turbines farm in Baltic Sea, Denmark

2-6. Improving energy efficiency



Current status

Each sector on the demand side (industries, transportation, commercial and residential) has the potential to reduce emissions by improving energy efficiency. Japan has two laws related to energy efficiency: the Act on Rationalizing Energy Use (Energy Efficiency Act) and the Act on Improvement of Energy Consumption Performance of Buildings (Building Energy Efficiency Act).

Under the Energy Efficiency Act, businesses are required to make plans to achieve their energy efficiency goals and report on their energy use. Standards are set by the government for the improvement of energy efficiency of factories (1% a year), and for energy efficiency for each type of industry and equipment. However, they are not regulatory standards, no advisory or order has ever been issued, and no public announcement has ever been made concerning businesses failing to meet standards. In addition, these standards are for energy intensity (per unit of activity), so they are not effective in reining in a rise in total CO_2 emissions when production volumes increase. Much of the corporate effort on energy efficiency is voluntary, in line with Voluntary Action Plan the Japan Business Federation (Keidanren) introduced in 1997.

With a 2022 amendment to the Building Energy Efficiency Act, it will become mandatory for all new residential and other buildings to meet energy efficiency standards starting in 2025.[75] However, the current standards (e.g., residential buildings require Class 4 insulation) are below the levels required for net-zero energy houses (ZEH) and net-zero energy buildings (ZEB). Furthermore, many existing residential and other buildings have no insulation, despite subsidies and incentive programs being available, so there is room for improvement.

75 MLIT Building Energy Efficiency Act, (in Japanese).

Proposals

Saving energy by improving energy efficiency on the demand side is as important as producing energy on the supply side, and contributes to decarbonization. Policy measures should be strengthened in order to improve energy efficiency in each of the following three categories, combined with energy management, the use of renewables, and electrification.

① Buildings
② Systems, facilities
③ Transportation

Introduction of carbon pricing: Japan should set a carbon price of 6,000 yen/t-CO_2 or higher to promote energy efficiency across society and the economy.

Strengthening policy measures:

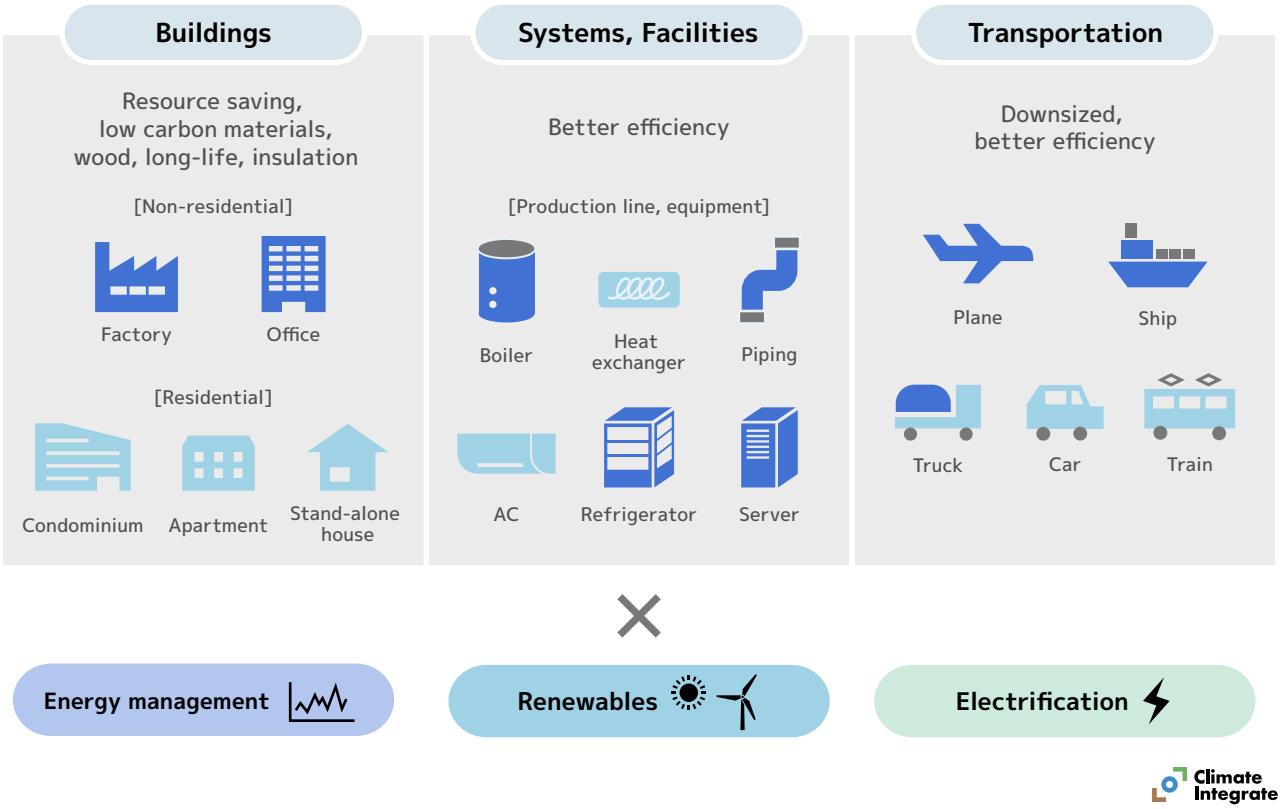
- **Industries**
  - A review needs to be conducted to assess the effectiveness of the standard requiring factories to improve energy efficiency 1% every year, which is a non-binding standard under the Energy Efficiency Act. Based on the results of the review, the government should set an emission reduction target for the industry sector and introduce a scheme combining emissions trading and carbon tax.
  - The government should institutionalize the practice of using energy-saving consultants who provide reviews of energy efficiency plans and advice to emitters. It should be mandatory for large emitters to receive such outside reviews and counseling, and smaller emitters should be encouraged to do so as well.

- **Buildings**
  - Tougher energy efficiency standards for new buildings should be introduced. The government should make it mandatory for buildings to meet requirements that are more ambitious than the existing ones for ZEB and ZEH and implement measures to put in place even more ambitious standards earlier than 2030.
  - It should be made mandatory for builders to install equipment to use renewable energy such as solar panels when they construct new buildings.
  - More support measures should be introduced to install solar panels and add insulation for existing buildings. Priorities should be given to insulate public facilities ahead of private buildings.

- **Transportation**
  - Sales of new internal combustion engine (ICE) vehicles (including hybrid and plug-in hybrid) should end by 2035.
  - Urban planning should focus on building bikeable and walkable communities and implementing measures to improve public transportation systems.
  - Cargo transport needs to be made more efficient.

- **Information sharing**
  - Appeals for energy saving actions will only start to be effective after putting the above-mentioned policy measures in place. To raise awareness among businesses and citizens, easy access to detailed information about energy efficiency measures and policies should be provided.

Chart 6. Improve energy efficiency



2-7. Using fiscal measures to support the energy shift

Proposal 7 **Fiscal Measures**

- Paris-aligned, Cost-benefit Analysis
- Just Transition Support
- Investment in Climate Tech

Current status

In METI and MOE energy special account budget requests for FY2023, funds related to fossil fuels, CCUS, hydrogen, and ammonia continue to account for more than 30% of the total energy-related budget, and the share rises to 50% if allocations for nuclear are added (Chart 7). In other words, allocations have been made for all types of power sources, from renewables to fossil fuels and nuclear. Most of MOE's budget request is allocated for the energy efficiency and renewables sectors, while the largest share of METI's request is for fossil fuels.

The government's two trillion yen Green Innovation Fund provides subsidies through the New Energy and Industrial Technology Development Organization (NEDO) for the development of innovative technologies, but much of the funding is allocated for fossil fuel-related projects, including CCUS and hydrogen and ammonia technologies.

Moreover, co-firing with hydrogen and ammonia is among the technologies in the power sector eligible for public funds for transition finance, according to METI, and the government is urging the private sector to invest in them as well.[76] Little financial support has been provided, however, for a just transition away from the fossil fuel industry. The government estimates that Japan's decarbonization efforts will require 150 trillion yen in public and private investment in the next decade, and plans to issue 20 trillion yen in "GX Economy Transition Bonds."

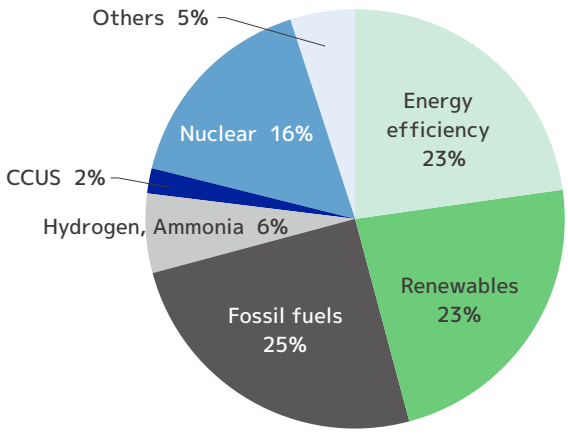
Japan lags behind in the climate tech sector, technologies focused on reducing GHG emissions and adapting to the impacts of climate change. The government has set aside 100 billion yen from the Green Innovation Fund to provide support for novel technologies and startups,[77]

76 The government revised in May 2022 the Act on Advancement of Energy Supply to define hydrogen and ammonia as non-fossil energy sources to promote the use of such fuels as decarbonized sources.

77 METI Allocation policy for Green Innovation Fund, revised March 18, 2022 (in Japanese).

only a few Japanese companies have a global presence in climate tech, and they rarely get mentioned in industry reports published overseas.[78, 79]

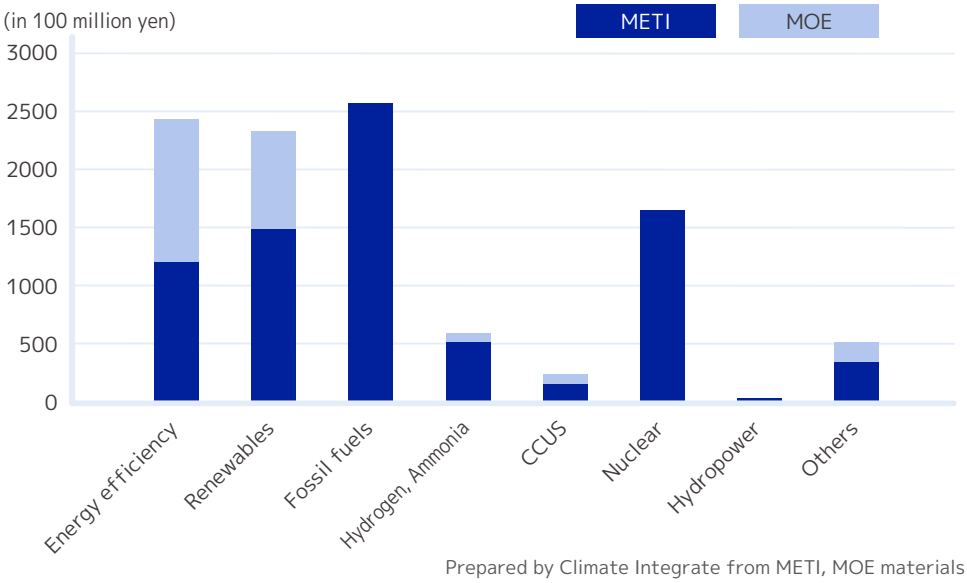
Chart 7. Budget requests for FY2023
(METI's energy budget and MOE's Special Account Budget for Energy)



A budget item with multiple purposes is categorized into the most suitable purpose. "Others" includes projects with no specific category, contributions to international organizations.

Prepared by Climate Integrate from materials by METI[80] and MOE[81] (energy-related special account budget documents)

Chart 8. Breakdown of MOE, METI budgets Prepared by Climate Integrate



Prepared by Climate Integrate from METI, MOE materials

78 PwC State of Climate Tech 2021.

79 Holon IQ Global Climate Tech Unicorns.

80 METI Documents for special account for energy measures (FY2023), August 31, 2022 (in Japanese).

81 MOE Documents for special account for energy measures (FY2023), (in Japanese).

Proposals

- **Review of CO_2 emission reductions and cost benefit analysis in budget requests and expenditures:** The government should closely examine its public spending in deciding whether the use of each electricity source and new technology is cost-effective and aligned with the Paris Agreement. Hydrogen and ammonia co-firing are still high cost and should be implemented only if a project featuring those technologies is found to be more cost-effective than other options in reducing CO_2 emissions.

- **Support for a just transition:** Budgets should be allocated to support workers in areas heavily impacted by the energy transition, and be aligned with strategies for a just transition (Section 1-3).

- **Promotion of investment in climate tech:** Financial support should be provided for startups and technologies in financial and other sectors that are not typically within the scope of technology development support from NEDO but still have the potential to become key players.

Capitol Building (Chiyoda ward, Tokyo)

Conclusion

The Clean Energy scenario presented by Lawrence Berkeley National Laboratory shows that decarbonizing Japan's power sector while reducing electricity costs is not impossible. It is doable. But for this to happen, Japan must make policy shifts as presented in this report. To decarbonize the power sector, it is essential for the government to send out a clear signal that it is championing the energy transition, and committed to providing the required incentives and support to make it a reality.

In policy discussions in Japan, there tends to be an emphasis on why an energy shift is not possible. But it has to happen if we are to overcome the many challenges associated with climate change. At the same time, this shift will bring many benefits, such as improved energy security and reduced health risks. Now is the time for policymakers and civil society to bring forward a swift policy shift and implement changes, to create a better future. It is our hope that this report will help Japan make the shift.

Sakatakyoudou Thermal Power Station (Sakata city, Yamagata)

Climate Integrate
March 1, 2023
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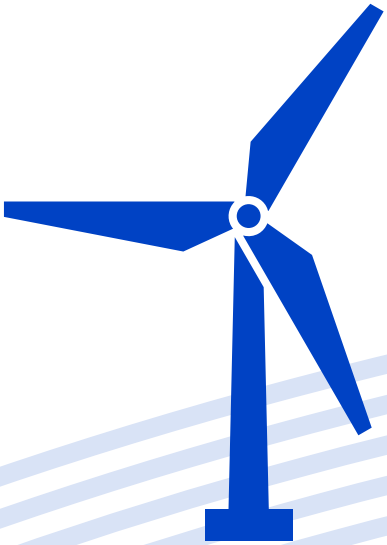

Climate Integrate

Climate Integrate is an independent think tank based in Japan.

We aim for the realization of a just, sustainable, and peaceful society with our work focused on research, engagement, and communication. Through integrated approaches to connect scientific, political, and social dimensions, we support actions for decarbonization by civil society, business and the public sector.

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