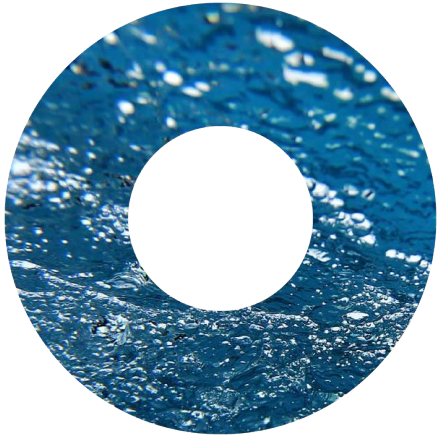
Climate Integrate

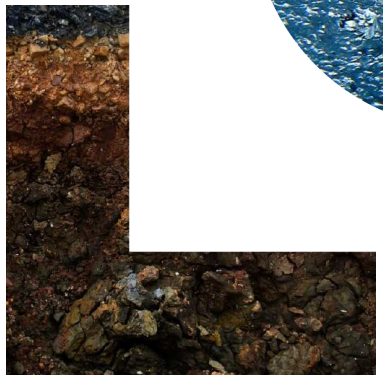
Fact Sheet

Japan’s climate and energy policies



This report summarizes key facts to help clarify the current status, issues, and policy directions regarding the development of the following plans during fiscal 2024.

- Strategic Energy Plan
- Plan for Global Warming Countermeasures
- GX 2040 Vision
- Nationally Determined Contribution (NDC)



July 25, 2024

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1. Climate crisis Stronger measures are critically needed to close gap with 1.5°C goal

Current status

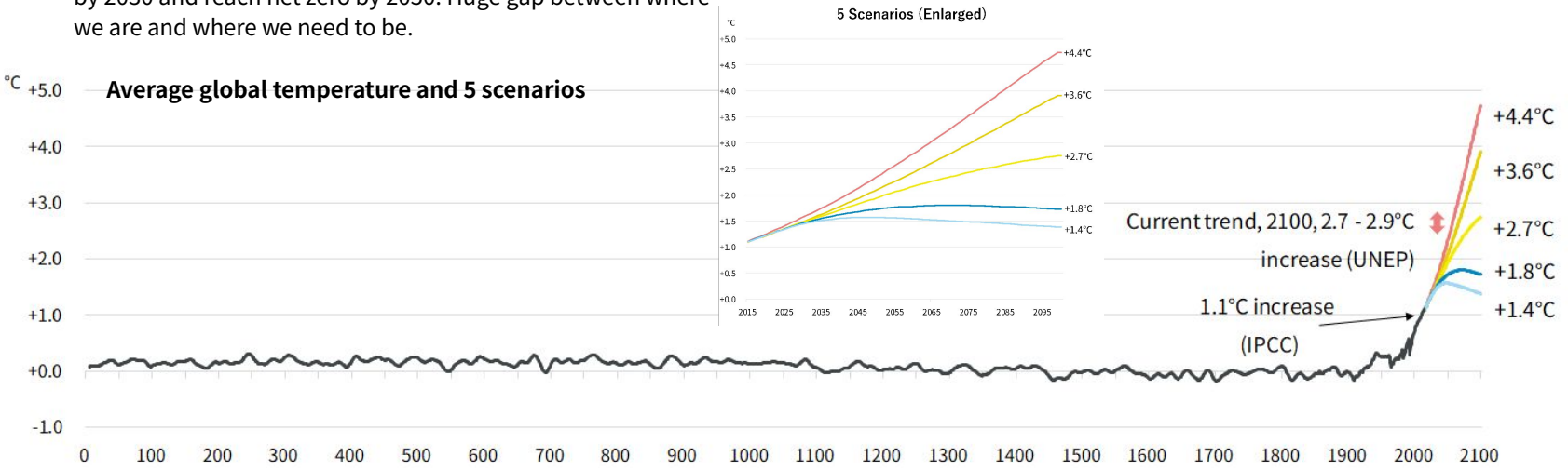
- Global temperature is 1.1°C above pre-industrial levels.
- Global temperature is on track to rise 2.5-2.9°C by 2100.
- Under the Paris, UN aims to limit temperature rise to 1.5°C.

Issues

- Climate change results in extreme weather events, causing health and economic impacts, disaster-related deaths.
- To achieve 1.5°C goal, global GHG emissions must be halved b. by 2030 and reach net zero by 2050. Huge gap between where we are and where we need to be.

Policy directions

- To align with international agreements, close the gap versus goal.
- At COP28, govts agreed to strengthen measures to achieve the 1.5° C goal, transition away from fossil fuels, 3X renewable energy and 2X energy efficiency improvement rate by 2030. G7 leaders agreed to achieve a fully or predominantly decarbonized power sector by 2035 and phase out coal power by the early 2030s.



Source: Prepared by Climate Integrate based on IPCC “6th Assessment Report” WG1, SPM1, SPM8

2. GHG emissions and targets Emissions declined in recent years, but future is uncertain

Current status

- Japan's GHG emissions in FY2022 were 1,135 Mt (-19.3% from FY2013, -2.5% from FY2021). After deducting removals, 1,085 Mt (-2.9%, -2.3%, respectively).
- Emissions peaked in FY2013, have trended down since.
- Japan targets -46% by 2030, with aspirational goal of -50%. Govt says it is "on-track" toward net zero goal.

Issues

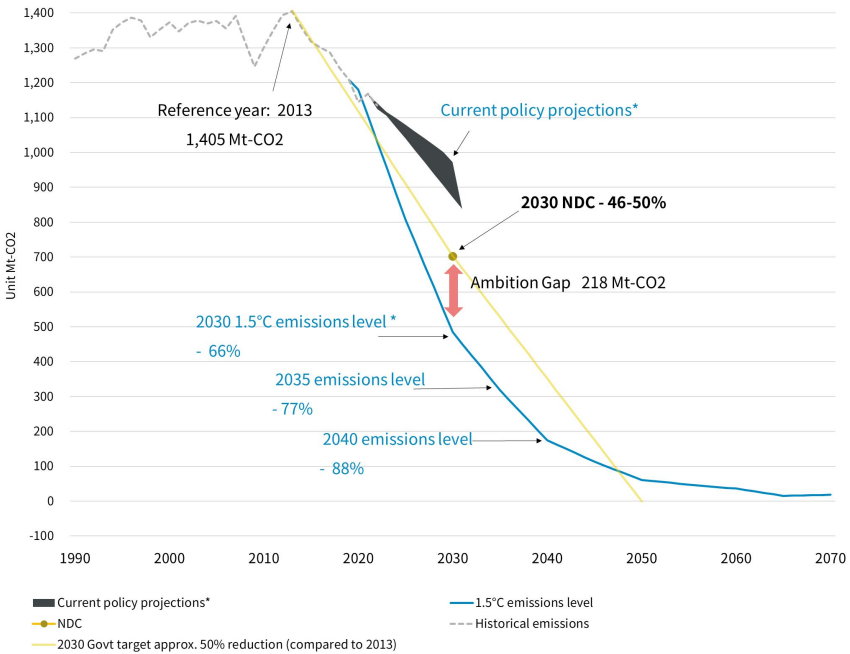
- Under current policy, 2030 target is difficult to achieve.
- No path has yet been established for net zero by 2030-2050.

Policy directions

- Japan should fulfill its responsibilities, by achieving 2030 goal ahead of schedule and significantly reducing emissions, then support global -60% by 2035 and -69% by 2040 (relative to 2019) as in COP28 agreement.

Target	2030 (base Year)	2035 (base Year)	2040 (base Year)	2050 (base Year)
Global IPCC 1.5℃	-43% (2019)	-60% (2019)	-69% (2019)	-84% (2019)
1.5℃ Japan pathway (Climate Analytics)	-66% (2013)	-77% (2013)	-88% (2013)	-96% (2013)
Japan's target	-46 ―-50% (2013)	**TBD** IPCC level -66% (2013)	**TBD** IPCC level -73% (2013)	Net Zero

Japan's GHG emissions and pathway toward net zero (base year 2013)



*Climate Analytics

Source: Prepared by Climate Integrate based on Climate Analytics "1.5°C-consistent benchmarks for enhancing Japan's 2030 climate target", National Institute for Environmental Studies (NIES) "GHG Emissions Data of Japan"

3. GHG emissions breakdown 70% are from thermal power, transportation, steel, cement, chemicals

Current status

- Electricity generation was largest source of GHG emissions in FY2022 (38% of total).
- Coal power is largest emissions source within electricity generation (23%).
  LNG power 12%.
- Transportation 16%, of which about 80% is from automobile use.
- Steel industry 10%, followed by cement and chemical industries.

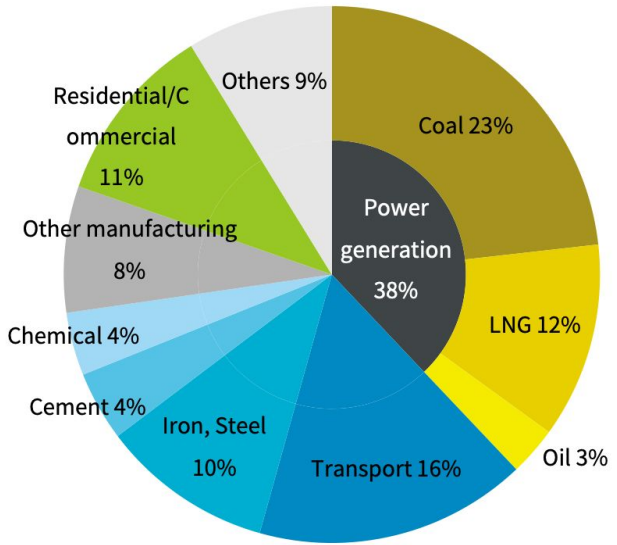
Issues

- Large emitters dominate in Japan, with >70% of emissions coming from thermal power, steel, cement, and petrochemical manufacturing.

Policy directions

- Transform infrastructure, business and industrial structure in high-emission sectors.
- Significantly reduce coal power generation.
- Prioritize transition away from fossil fuels in energy-intensive industries such as transportation and steelmaking.

GHG emissions breakdown in FY2022 (1,135 Mt- CO2e) / direct emissions



Source: Prepared by Climate Integrate based on Agency for Natural Resources and Energy (ANRE) "Comprehensive Energy Statistics", NIES "GHG Emissions Data of Japan"

4. Electricity mix High dependence on thermal power making 2030 target unachievable

Current status

- The electricity mix in FY2022 was 22% renewables, 31% coal, 34% natural gas, 8% oil, 6% nuclear (i.e., >70% reliant on thermal power).
- Renewables: 8% hydro, 9% solar, 4% biomass, 1% wind.
- Over the past 10 years, the share of coal power has remained almost flat, and the share of renewables has more than doubled. Increase in renewable energy accounts for part of nuclear decrease after the 2011 accident.
- Govt targets for FY2030 are 36-38% renewables, 19% coal, 20% natural gas, and 20-22% nuclear.

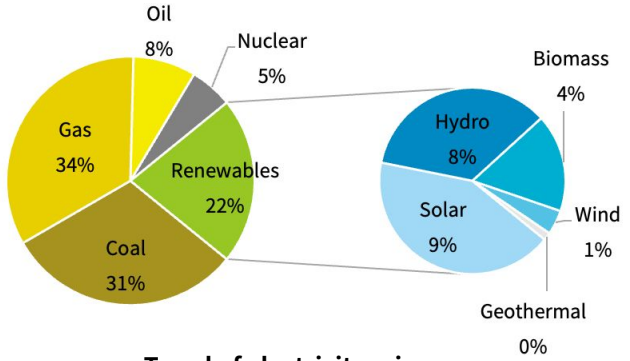
Issues

- Decarbonization of electricity system is slow due to high reliance on thermal power, uncertainty for nuclear, and slow deployment of renewables. Japan's CO_2 intensity is highest in G7. A large gap between the current path and 2030 target.
- Power utilities' supply plans for FY2033 fall far short of govt targets. Delays in improving CO_2 intensity may make it difficult to achieve GHG reduction targets.

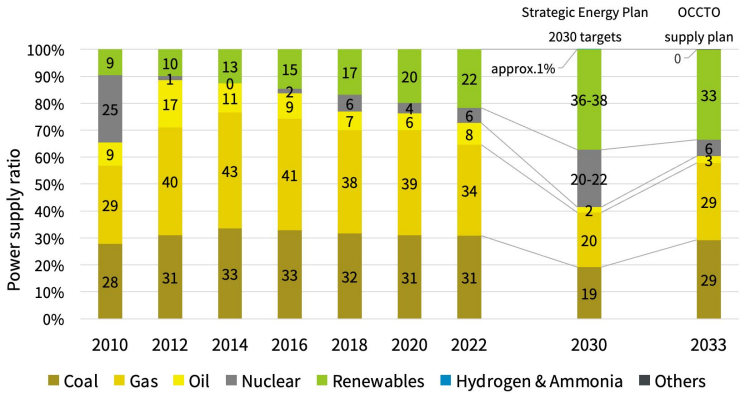
Policy directions

- Accelerate the shift away from thermal power and expand renewables to approach power system decarbonization by 2035.

Electricity mix and breakdown of renewables in FY2022



Trend of electricity mix



Source: Prepared by Climate Integrate based on ANRE "Comprehensive Energy Statistics"

5. Electricity demand AI and chip making increase demand, but they also boost energy efficiency

Current status

- Since Fukushima nuclear plant accident in 2011, electricity demand has been trending downward.
- The Organization for Cross-regional Coordination of Transmission Operators (OCCTO) has revised its demand forecast upward by 2% from last year's projection due to the impact of new data center and semiconductor plant construction. Demand in FY2033 will be back to about the same level as FY2019.
- More large corporate users are seeking renewable electricity sources.

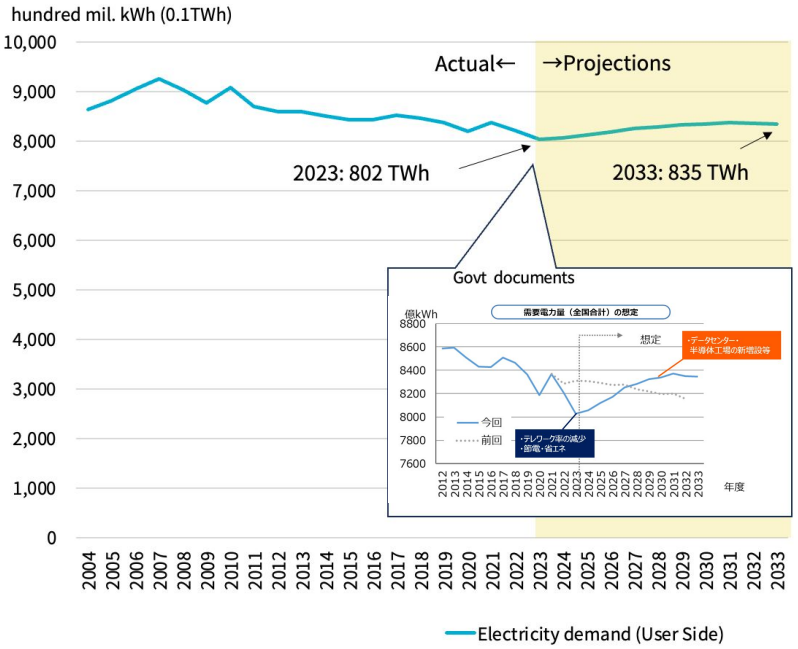
Issues

- Looking ahead to 2050, demand is expected to increase, but projections may be overstated due to the effects of improving energy efficiency through digital technologies.
- Measures to increase supply capacity through new construction of LNG power plants and continued use of coal power plants hurt decarbonization efforts.

Policy directions

- Accelerate the deployment of renewable energy and rapidly increase the share of decarbonized power sources.
- Build data centers and other facilities near renewable electricity sources such as offshore wind.
- Maximize the impacts of energy efficiency and effective use of electricity using digital and AI technologies.

Total national electricity demand



Source: Prepared by Climate Integrate based on OCCTO "National Electricity Demand"

6. Costs of fossil fuel imports Costs of fossil fuel imports can be greatly reduced through an energy transition

Current status

- Japan relies almost 100% on imports for oil, coal, and natural gas.
- Japan spends a huge amount to import fossil fuels, at 34 trillion yen in 2022 (of which, 12 trillion yen for electricity), and 27 trillion yen in 2023.
- Govt has no policy to transition away from fossil fuels. It is promoting LNG as “decarbonized” thermal power and developing LNG supply chains, including new developments.

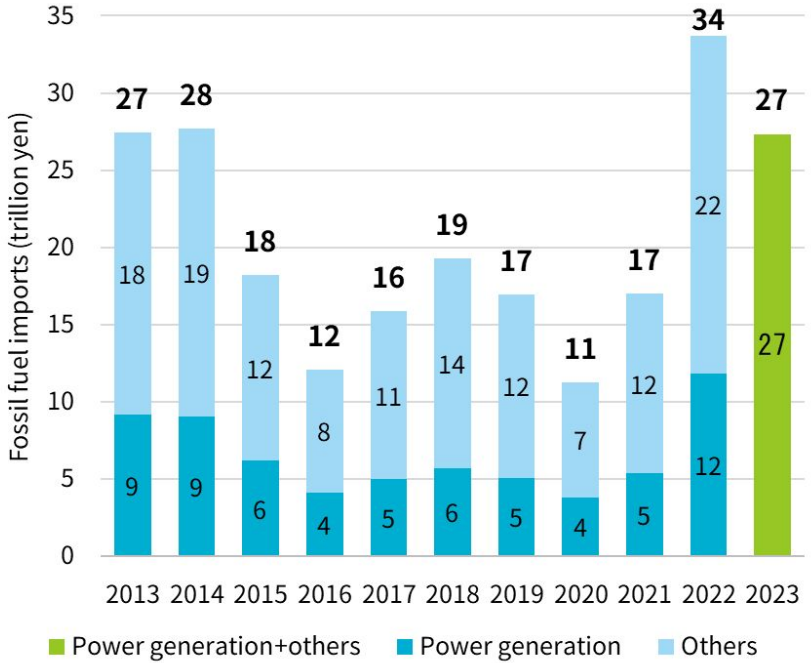
Issues

- Continuing to rely on fossil fuels forces Japan to keep sending vast sums of financial resources overseas.
- The introduction of carbon pricing internalizes external diseconomies, will further increase the cost burden going forward.
- Energy security risks remain high due to foreign resource dependency and low energy self-sufficiency.
- Japan faces risks of energy supply disruptions and price hikes in the event of an international situation or emergency.

Policy directions

- Japan should strengthen policies to expand renewable energy and improve energy efficiency in line with the COP28 agreement to transition away from fossil fuels.

Public spending for fossil fuel imports (calendar year)



* Oil includes those for materials

Source: Prepared by Climate Integrate based on Ministry of Finance “Trade Statistic", ANRE “Comprehensive Energy Statistics”

7. Costs of electricity generation Costs for renewables have dropped since govt estimates in 2020

Current status

- Comparisons of electricity generation costs (govt estimates in 2020 and our estimates for 2023) show increased costs for nuclear and thermal power, and decreases for solar, onshore & offshore wind. Economics of transitioning to renewables continue to improve.
- For thermal power, fuel costs and social costs have risen. For nuclear, capital costs & operating/maintenance costs have increased.

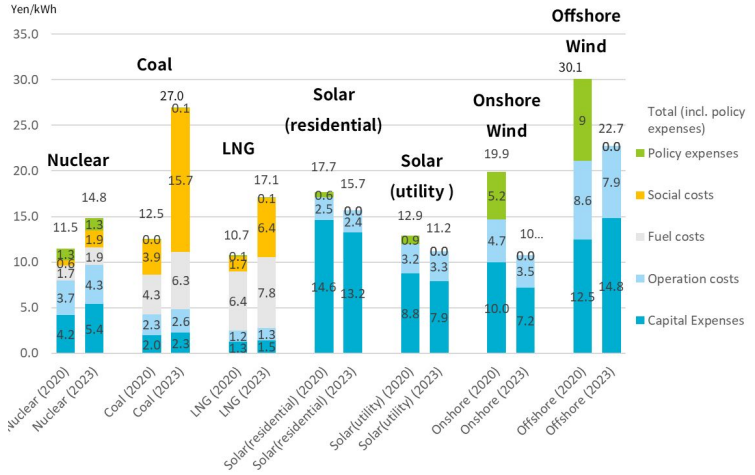
Issues

- Generation costs of thermal and nuclear power are increasing.

Policy directions

- Promote economically-viable renewables.
- Count integration costs (grid upgrades, etc.) needed for an energy transition as expenditures to transition away from fossil fuels.

Costs of electricity generation (by source)
(govt estimates for 2020 and Climate Integrate estimates for 2023)



Source: Generation Cost Verification WG “Report to Strategic Policy Committee” September, 2021 (Assumptions for 2023 by Climate Integrate)

Summary of cost assumptions

Nuclear

1) Construction costs: Use 2023 levels, applying the construction cost deflator (electricity). Use 2009 as the starting year for the most recent construction year of govt Cost Verification Working Group (2021).
2) Cost of 2011 nuclear accident: Updated to add increased cost of the accident (1.9 tril. yen based on Dec. 22, 2023 govt release) to costs indicated by Working Group (2021).
3) Nuclear fuel cycle costs: Add 240 billion yen to Working Group estimates (2021).
4) Additional cost of safety measures: Updated based on public announcements and press reports. Adjust by same ratio as Working Group (2021).

Coal and LNG

1) Construction costs: For coal power, use sampling of power plants operating in 2019 (one plant) and 2020 (two). Then adjust using construction cost deflator with 2020 as year one. For LNG power generation, use sampling of power plants operating in 2019 and 2018 (two plants each). Then adjust using construction cost deflator with 2019 as year one.
2) Fuel prices: Prices for 2023 are from trade statistics (2023 average). Prices for 2024 onward assumed to change from actual 2023 values based on trends in IEA's Stated Policies Scenario.
3) Social costs (CO_2 price): For 2023, EU-ETS average price for 2023 (83.66 Euros) is used. Future prices are assumed to follow price trends in IEA (2023), Global Energy and Climate Model Documentation 2023, and Stated Policies Scenario for CO_2 Price (EU) in IEA Paris.
4) Exchange rates: 2023 averages (trade statistics)

Renewables

1) Capital costs, operating/maintenance costs, capacity factor: Referred to figures from the 2023 Procurement Price Calculation Committee (for offshore wind, this study uses as a model plant the Akita-Noshiro Port Project by Akita Offshore Wind Corporation, which started operating in 2023.)
2) Policy costs: Govt's Cost Verification Working Group (2021) calculates it as additional internal rate of return (IRR) portion. However, since solar (for commercial use), onshore wind, and offshore wind have already shifted to a bidding system, the IRR surcharge is not guaranteed and is not actually paid, so in this study, it is not counted as policy costs. The feed-in tariff for solar (residential use) is still being implemented, and the IRR is deemed to be 3.2%, which is almost the same as the discount rate of 3%.

8. Solar Harnessing potential with deployment in the right places

Current status

- 73.8 GW installed (March 2024), versus target of 103.5 to 117.6 GW by 2030. 6.2 GW of FIT/FIP-certified capacity has yet to start operations.
- Some capacity is also being deployed outside the FIT/FIP system.
- The latest 5 GW/year of additional deployment is only about half what it was at the peak (9.4 GW/year, in 2014).

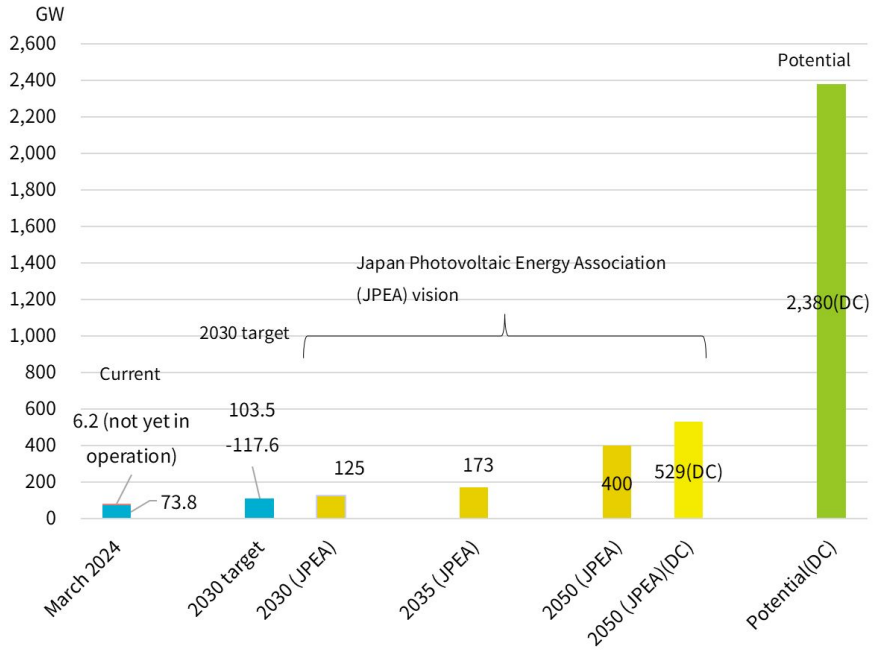
Issues

- Targets fall short of potential deployment. Pace of deployment is slowing.
- Problems have occurred due to projects causing negative environmental impacts, installation on slopes, insufficient communication with residents.
- Proper disposal/recycling of used panels needed in future (disposal expected to peak after mid-2030s).
- Lower revenues due to increased output curtailment.

Policy directions

- Set ambitious targets and expand where deployment potential is large – on agriculture-related sites, rooftops of buildings, etc.
- Achieve vision of Japan Photovoltaic Energy Association (JPEA).
- Enable flexible use by time-of-use pricing, market trading, storage, etc.
- Establish mass production technologies for lightweight and flexible perovskite solar cells.

Status of deployment and potential of solar power (GW)



* Potential is from JPEA.

Source: Prepared by Climate Integrate based on JPEA “PV Outlook 2050 (ver.1 for FY2024)”, ANRE “Decarbonized Power Sources” July 8, 2024 (p.13)

9. Wind Operate stalled onshore wind projects and expand into EEZ

Current status

- Onshore wind: 5.9 GW installed (March 2024), versus target of 17.9 GW by 2030. Due to local concerns, 9.9 GW not yet operating even though FIT/FIP-certified.
- Offshore wind: 0.15 GW installed (March 2024), versus target of 5.7 GW by 2030. 5.1 GW at project formation stage (bottom-fixed). Govt says it is “making steady progress” with many prospective zones and potentially suitable zones identified.

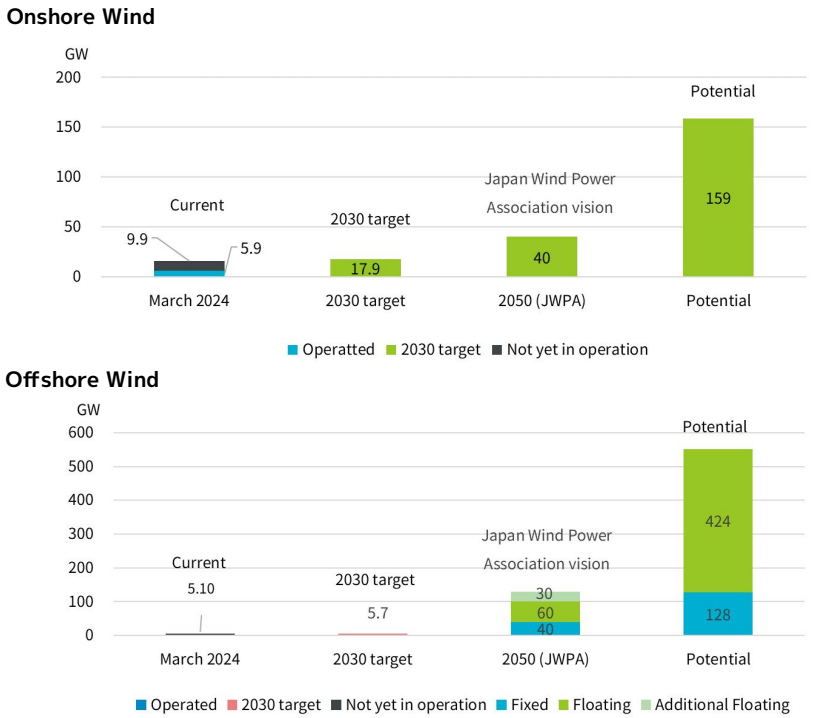
Issues

- 2030 targets are low. Delayed deployment of onshore wind is putting the targets in jeopardy.
- No roadmap for establishing supply chains to promote domestic industries and enter overseas markets.

Policy directions

- Aim to coexist with local communities, start onshore wind projects not yet operating, and deploy further.
- Set ambitious targets and swiftly pass a bill to amend the Act to expand offshore wind to EEZ.
- Establish supply chains and create a roadmap for project formation and expanded deployment of floating offshore wind.

Status of deployment and potential of wind power



Source: Prepared by Climate Integrate based on ANRE “Decarbonized Power Sources” July 8, 2024 (p.13), Japan Wind Power Association (JWPA) “Wind Vision 2023” (p.6). Potential estimates are from JWPA.

10. Offshore wind Establish supply chains and develop industries to expand in Asia-Pacific

Current status

- The govt is promoting offshore wind power.
- There are no domestic manufacturers of wind turbines, so they are being procured overseas.
- Some companies have begun businesses such as manufacturing foundations for bottom-fixed offshore wind turbines, and building specialized ships for offshore wind deployment.

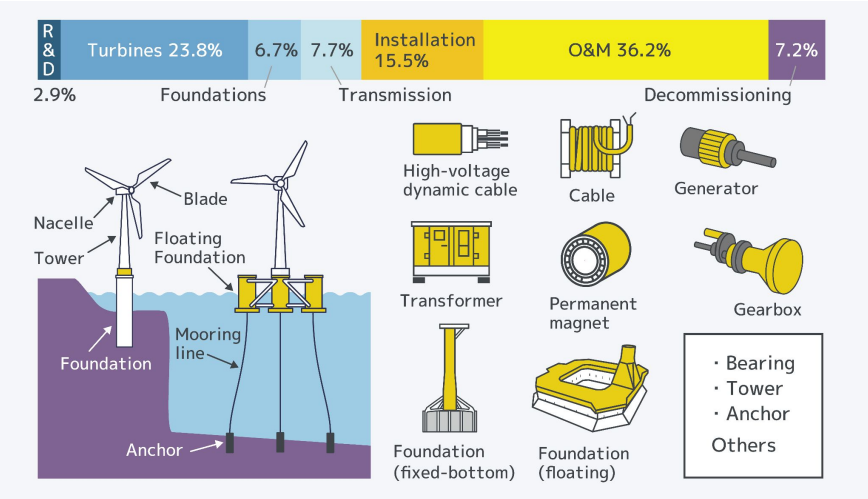
Issues

- Slow to establish supply chains, including parts procurement, ship and port construction, workforce development.
- Despite huge potential, no targets have been set for floating offshore wind deployment, so market size is difficult to predict.

Policy directions

- Increase the ratio of domestic procurement.
- Set ambitious targets for floating offshore wind deployment.
- Rapidly establish supply chains to deploy offshore wind in Japan and overseas (especially in Asia-Pacific).
- Develop a roadmap to establish supply chains to promote domestic industry and enter overseas markets.

Overview of offshore wind supply chain



Source: Prepared by Climate Integrate based on Cabinet Secretariat materials

11. Coal Weak coal policy making 2030 target unachievable

Current status

- Coal power is the largest source of GHG emissions (23%).
- Govt target is to reduce coal power to 19% of the electricity mix by FY2030. The current ratio is 31%.
- To “fade-out” inefficient coal power, govt requests companies to submit voluntary plans (not made public) to decarbonize thermal power.
- Despite G7 agreement to phase out unabated coal power in the early 2030s or a timeline consistent with 1.5°C goal, Japan has not yet indicated its coal end year.

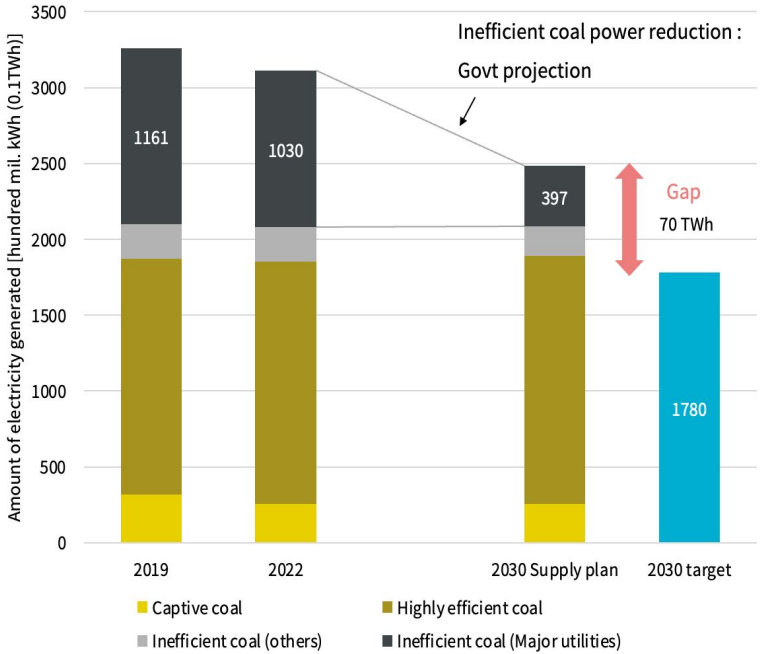
Issues

- Electric utilities’ supply plans show that coal power is projected at 29% in 2033, far above govt target of 19% in 2030.
- Utilities’ plans will result in exceeding govt 2030 target of 178 TWh by 70 TWh. CO_2 emissions to drop by only 20% relative to FY2022 (Climate Integrate estimates).

Policy directions

- Promote/accelerate phase-out of all inefficient coal power plants and reduction of power generation from high-efficient coal power plants and captive generators.
- Develop policies and legislation to phase out coal in line with G7 commitments.

Trends of coal power generation and its forcast



* “Inefficient coal (Major utilities)” is based on the government data in May 2024. The others are estimates by Climate Integrate based on FY2023 data.

Source: Prepared by Climate Integrate based on “Comprehensive Energy Statistics", ANRE materials, Press release, 6th Strategic Energy Plan

12. Nuclear Nuclear plays limited role for decarbonization

Current status

- The Fukushima nuclear plant accident in March 2011 resulted in shutdown of all 54 operating reactors in Japan.
- Currently, 24 reactors slated for decommissioning, 12 restarted, 5 approved for upgrades, 10 under review, and 9 have no submissions for review.
- Reactors are aging (of the remaining 36, 5 have operated for 40 yrs or more, 19 are 30 – 39 yrs, and 12 are 0 – 29 yrs).
- 5.5% of electricity supply mix, capacity factor 19.3% (FY 2022).

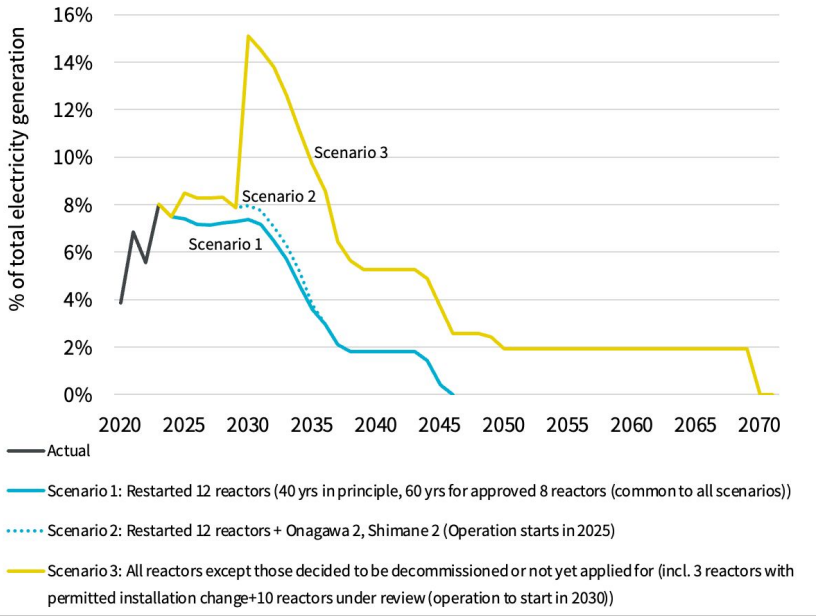
Issues

- Plans and restarts are delayed by reviews, consensus building, litigation, breakdowns, accidents, etc.
- Govt target for nuclear in 2030 (20 – 22% of electricity mix) is unrealistically high and will be difficult to achieve.
- Even if reactors are restarted or lifetimes extended, nuclear is still likely to peak at 7 – 15% of electricity mix, then decline rapidly.
- Replacement and new construction require about 10 years to plan and about 10 years to build.

Policy directions

- Avoid unrealistically high expectations that are unlikely to be met.
- Disclose information and decide carefully after public discussion, to enable rational choices relative to other electricity sources.

Share of nuclear in total electricity generation (Climate Integrate scenarios)



Scenarios by Climate Integrate
- Lifetime: 40 yrs, 8 reactors extended to 60 yrs
- Capacity factor: 75% by 40 yrs, 65% by 50 yrs, 55% by 60 yrs
- Generation: Linear reduction from 2022 to 2030. Stabilization after 2030.

Source: Prepared by Climate Integrate based on “Comprehensive Energy Statistics”, ANRE materials

13. Effective use of variable renewables Various ways to deal with short/mid/long-term fluctuations

Current status

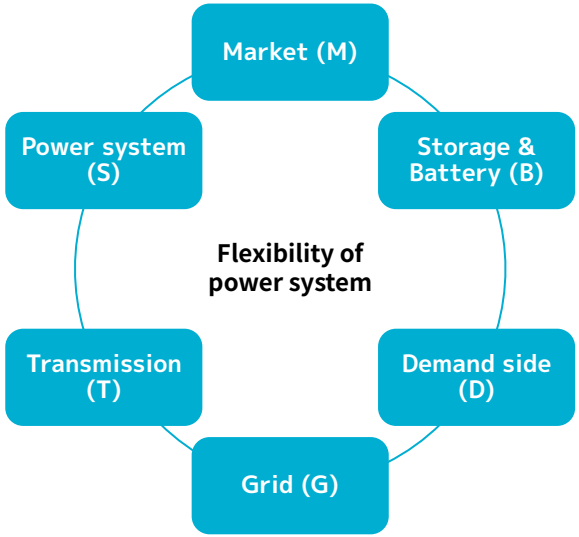
- Of renewable energy 22% share in the electricity mix in FY2022, variable renewables accounted for 10% (solar 9%, wind 1%).
- The Japanese “connect and manage” scheme of non-firm access connection has started functioning. Curtailment is conducted to balance supply and demand, eliminating grid congestion, etc.

Issues

- Amid concerns about variability with the expansion of fluctuating renewable energy sources, concept of flexibility is largely lacking from market and system design, limiting the supply capacity of renewable energy.
- Curtailment could be excessive.

Policy directions

- Implement various means to enhance flexibility in the electricity system, and accelerate the large-scale deployment of renewables.



Hourly basis
Times of day when demand is high or low

- (D) Dynamic pricing
- (M) Intraday market, negative pricing
- (B) Hot water storage, EV, batteries (sector coupling)
- (S) Flexibility of pumped storage power generation and conventional power sources
- (S) Curtailment

Daily basis
Cloudy/sunny days, windless/windy days

- (S) Prediction based on weather forecasts
- (S) Flexibility of pumped storage power generation and conventional power sources
- (T) Cross-regional interconnection
- (B) Hot water storage, EV, batteries (sector coupling)
- (S) Curtailment

Seasonal basis
Seasonal variation

- (S) Promote a balance between PV (mostly generate during the day in summer) and wind power (mostly generate at night in winter)
- (B) Hot water storage and hydrogen (sector coupling)
- (D) Flexible operation of data centers, etc.
- (D) Reduce demand for heating and cooling during peak hours by improving thermal insulation

Source: Climate Integrate

14. Renewables roadblocks (1/2) Review market systems/regulations, make steady progress

Topic	Issues	Policy directions
Scale/ pace of deployment	- Low targets, slow deployment due to delays in reviews and actual work for grid connections - Legislation delay (suspension of amending the Act on Promoting the Utilization of Sea Areas for the Development of Marine Renewable Energy Power Generation Facilities – to enable deployment of floating offshore wind in Japan's EEZ), delays in establishment of supply chains	- Establish ambitious deployment targets - Start operation ASAP of delayed solar and wind projects, and promote further deployment - Enact bill ASAP to amend the Act, and develop offshore wind projects in the EEZ
Fair, and open, competitive market	- Continued internal transactions/sales within utilities that dominated Japan's electricity market before market reforms. - Discriminatory environment, with entry barriers. Regional disparities in procurement, wheeling/transmission, and pricing	- Eliminate discriminatory practices, improve business viability of the FIP system - Cross-regional integration of transmission/distribution areas
Thermal / nuclear	- Incentives for thermal and nuclear power in capacity markets and "long-term decarbonized electricity auction system"	- Review/reform the "long-term decarbonized electricity auction system"
Acceptance	- Opposition by local communities - Provision of benefits to the community	- Ensure community acceptance through zoning and consensus building - Return profits to the community

Source: Climate Integrate

14. Renewables roadblocks (2/2) Review market systems/regulations, make steady progress

Topic	Issues	Policy directions
Cost burden for renewable energy companies	- Cost of wheeling charges (including nuclear power related, etc.) imposed on new entrants in electricity retail business - Cost of grid connections and core grid infrastructure being imposed on new entrants in electricity retail business - Unequal status for firm and non-firm contracts between conventional and new operators, and new entrants have to cover additional cost compared to utilities (which have both electricity generation and retail within the group)	- Remove barriers, in tariff systems on the electricity generation side, grid connection rules, non-firm contracts, and cost burdens for capacity market contributions
Grid connections	- Grid constraints - Delays in core and local grid improvements	- Fast-track or accelerate grid maintenance and upgrades
Supply-demand balancing, flexibility	-- Non-transparent, uncompensated curtailment, priority for electricity supply from nuclear power - Distortions caused by market price setting - Lack of flexibility	- Prioritize dispatch from renewable energy, disclose supply/demand information - Introduce negative pricing - Expand demand-response, sector coupling
Information disclosure, value and cost disclosure	- Lack of transparency for renewable energy surcharges, fuel adjustment costs, wheeling charges, cost burdens - Lack of options and information on renewable sources - No environmental value-added to FIT electricity supply - Renewable energy and nuclear/hydro lumped together	- Review electricity rates system - Expand the service menu for consumers - Increase information disclosure and transparency - Make clearer distinctions for renewable energy in environmental value and in non-fossil certificates

Source: Climate Integrate

Climate Integrate

“Fact Sheet: Japan’s climate and energy policies” July 25, 2024

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