# THE 2035 JAPAN REPORT

## Plummeting costs of solar, wind, and batteries can accelerate Japan's clean and independent electricity future

BERKELEY LAB

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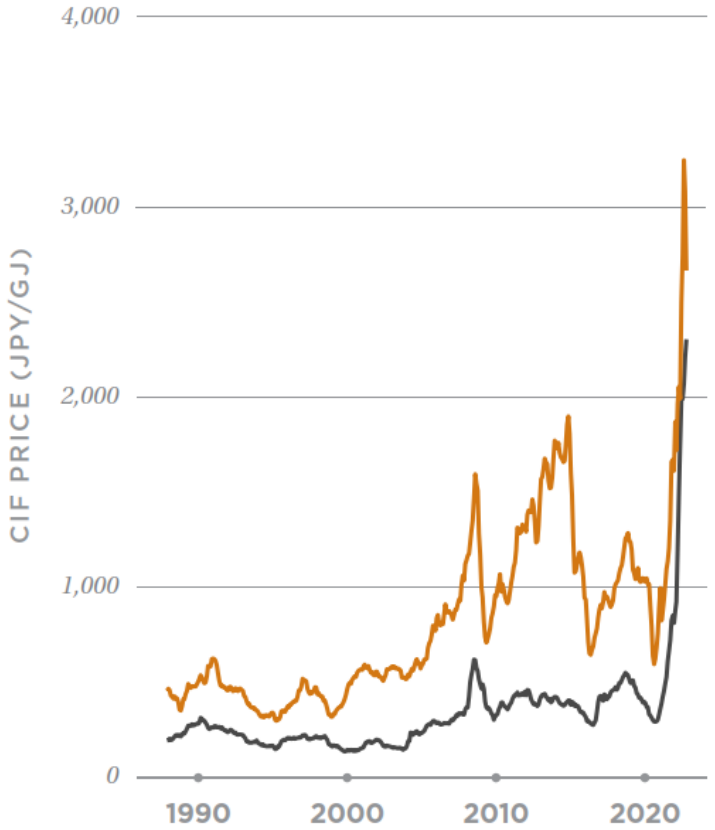
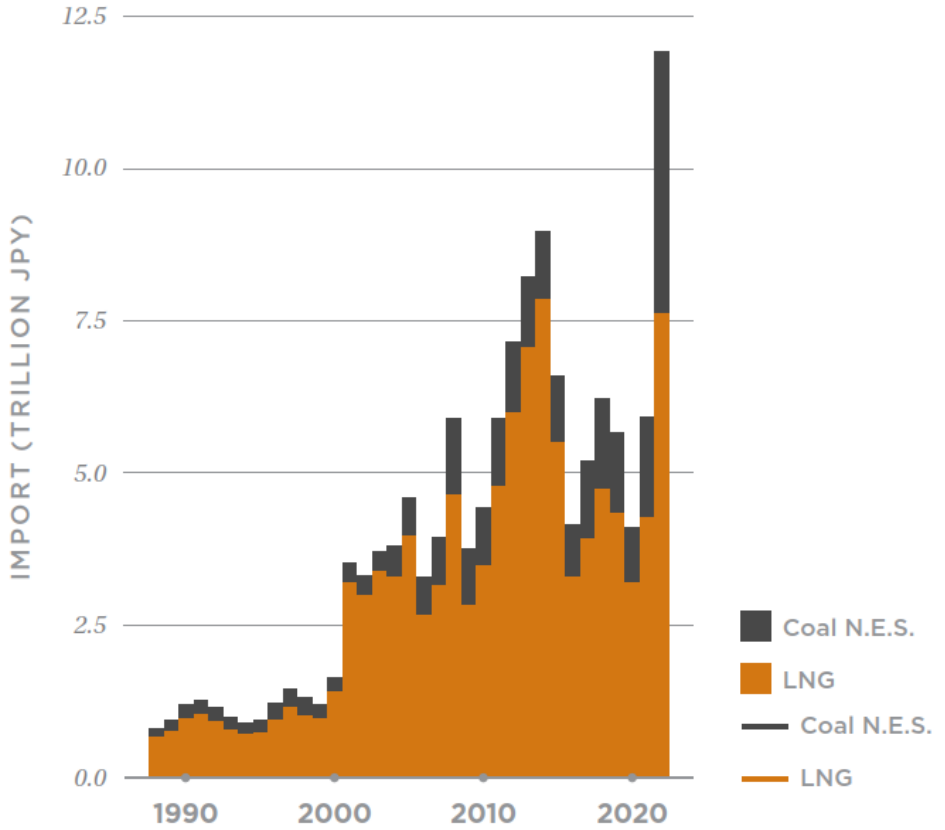
# Global Energy Crisis Poses Security Challenges and Clean Energy Opportunities for Japan

- Japan depends on foreign fossil fuel imports for 90% of its primary energy consumption
- Technological advancements and a drastic reduction in solar, wind, and battery storage costs present new opportunities to make clean electricity generation more affordable while reducing emissions

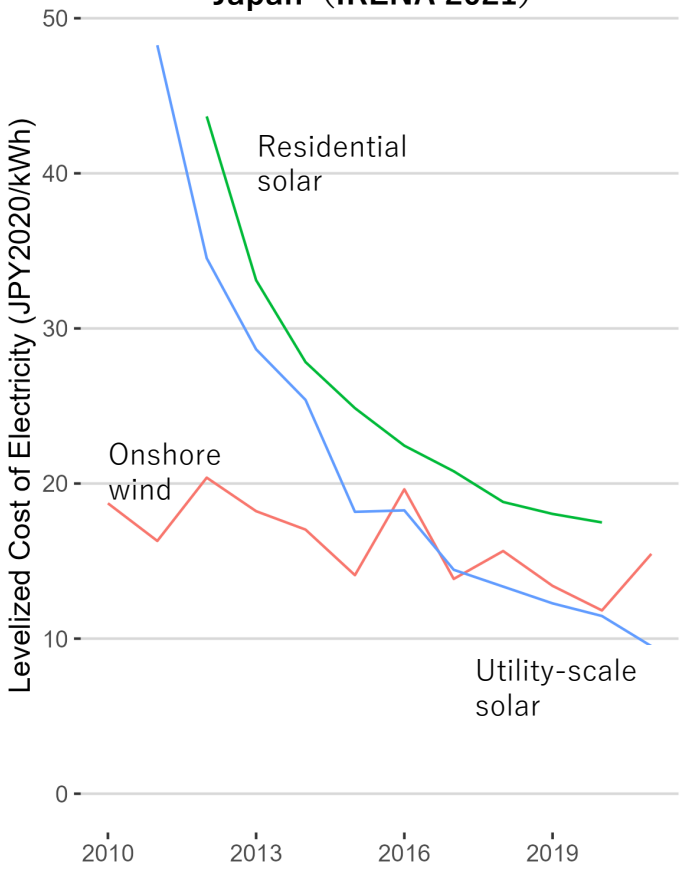
**CIF Price of Coal and LNG in Japan (Trade statistics of Japan 2022)**




**Coal and LNG Import in Japan (Trade statistics of Japan 2022)**




**LCOE of wind and solar in Japan（IRENA 2021）**



# Research Questions

- What effect will recent declines in wind, solar, and battery storage costs have on the pace and scale of renewable resource development?
- What clean energy goals are technically and economically feasible, given the inherent uncertainties including in electricity demand growth, fossil fuel prices, and RE and energy storage costs?
- How can a faster transition to clean energy deliver not only environmental and economic benefits, but also reduce security risks related to dependence on imported fossil fuels?

# Methods

- This study analyzed optimal (least-cost) investment and hourly operation of Japan's power system from 2020 through 2035
- The model meets the 2030 targets of the 6th Strategic Energy Plan and 90% clean energy by 2035.
- Generation from any resource that does not produce direct CO2 emissions is considered to be clean energy in this analysis, including generation from renewables, hydrogen, and nuclear sources.

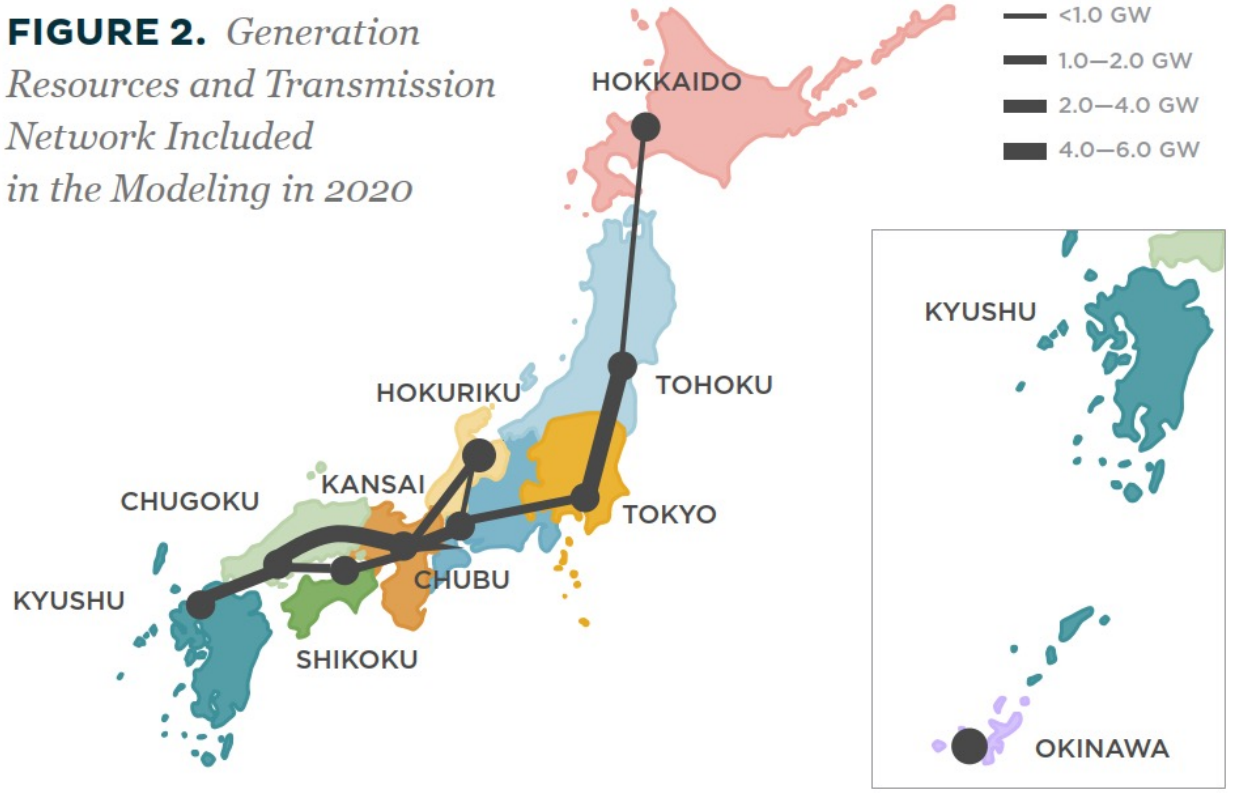


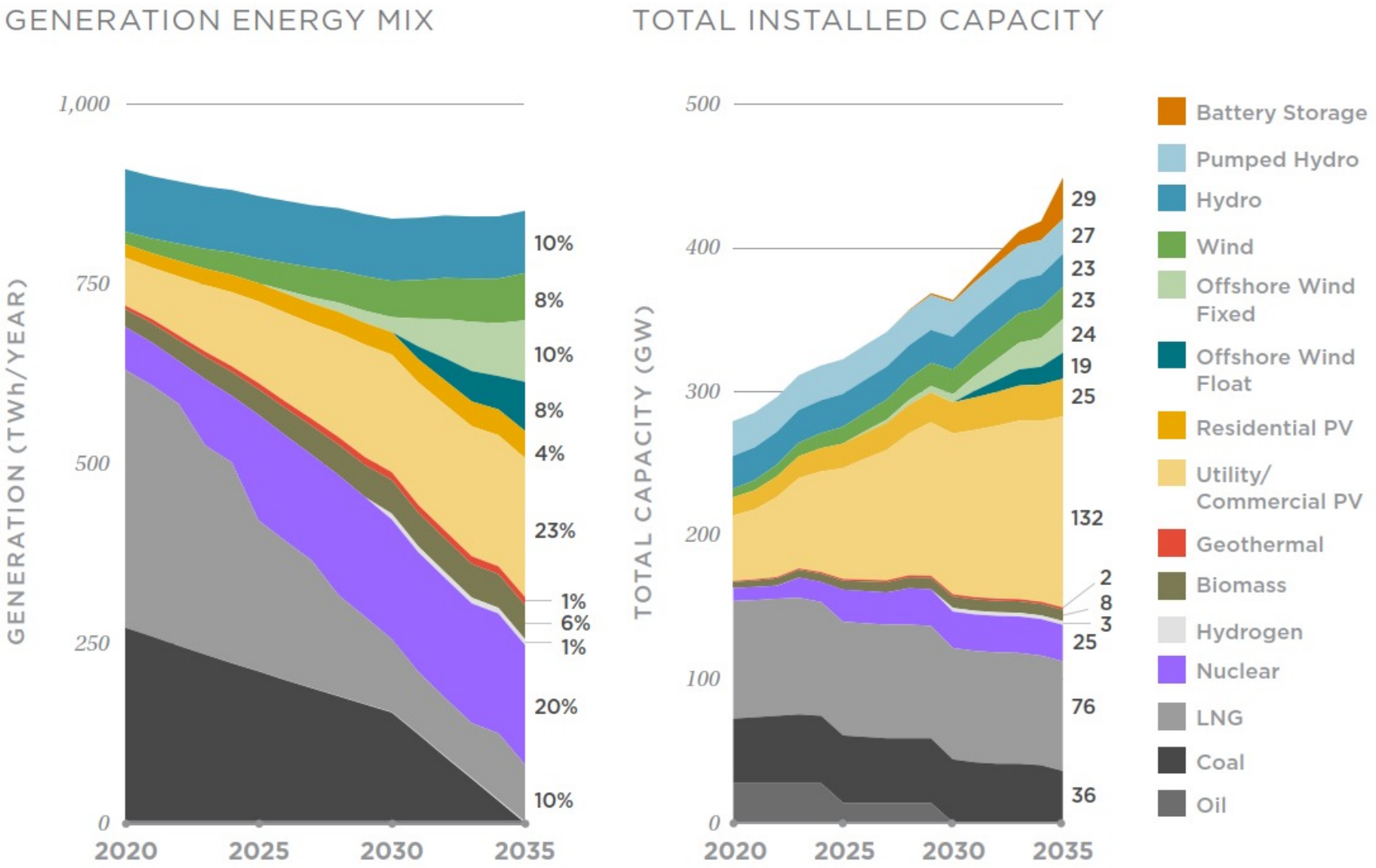

**FIGURE 2.** *Generation Resources and Transmission Network Included in the Modeling in 2020*

# Assumptions in Clean Energy Scenario and Sensitivity Analysis

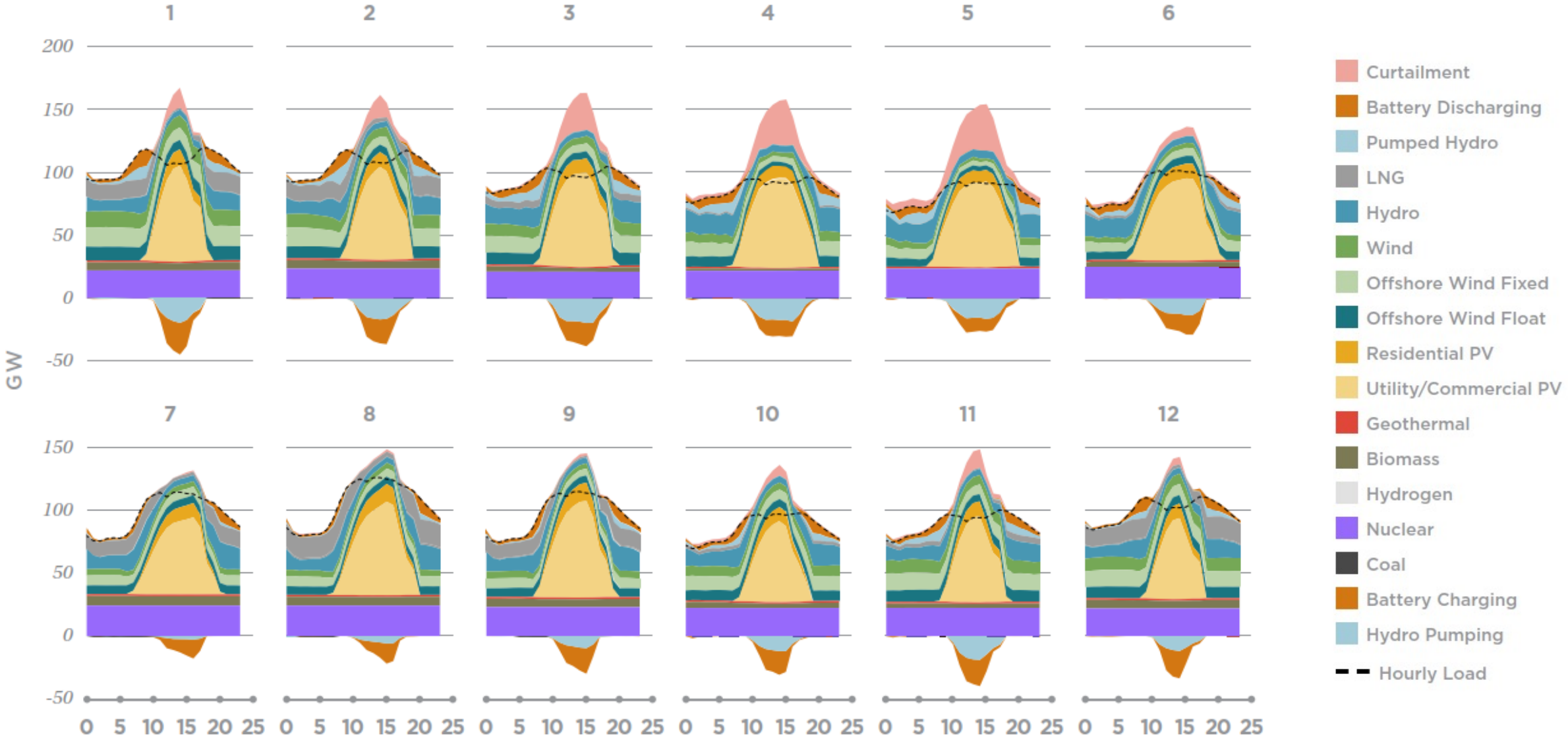
- Renewables in 2030 must exceed the targets in the 6th Strategic Energy Plan
- Coal and LNG cannot exceed the targets in the 6th Strategic Energy Plan
- 90% clean energy and coal phaseout by 2035
- Fossil fuel prices stays constant at the level before the Russian invasion of Ukraine invasion (2012-2021 average)
- Lifetime of coal and LNG is 50 years.
- All existing nuclear restarts and are granted 20-year lifetime extension (60-year lifetime).
- Costs are taken from Japan's data, while solar, wind and batteries are based on NREL ATB moderate with Japan specific adjustment.
- Sensitivity analysis includes the costs of RE and batteries, fuel costs (2022 levels), electricity demand, and no nuclear lifetime extension

# Key Findings

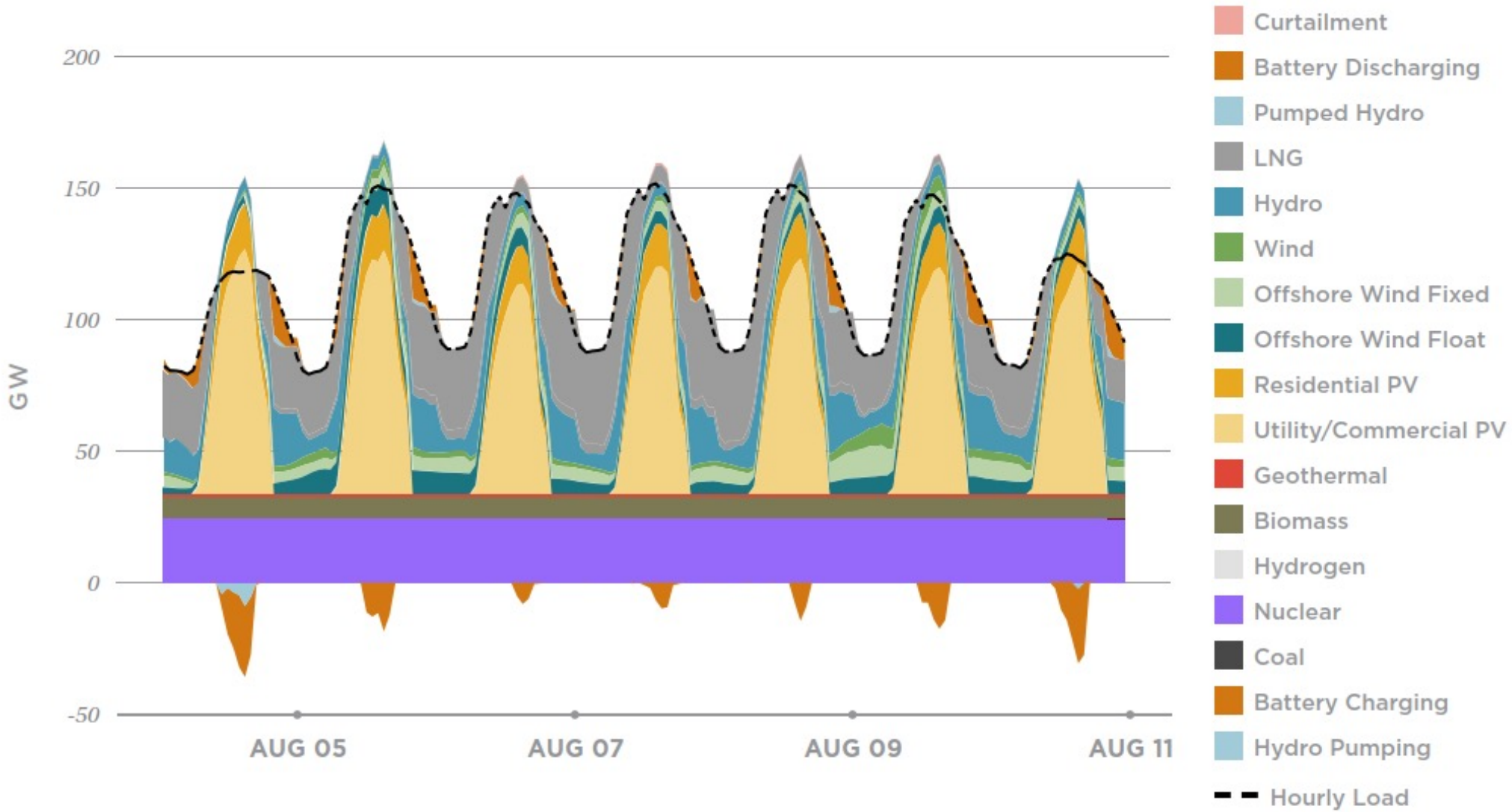
# Japan’s 90% Clean Grid Is Dependable Without Coal Generation Or New Natural Gas Plants



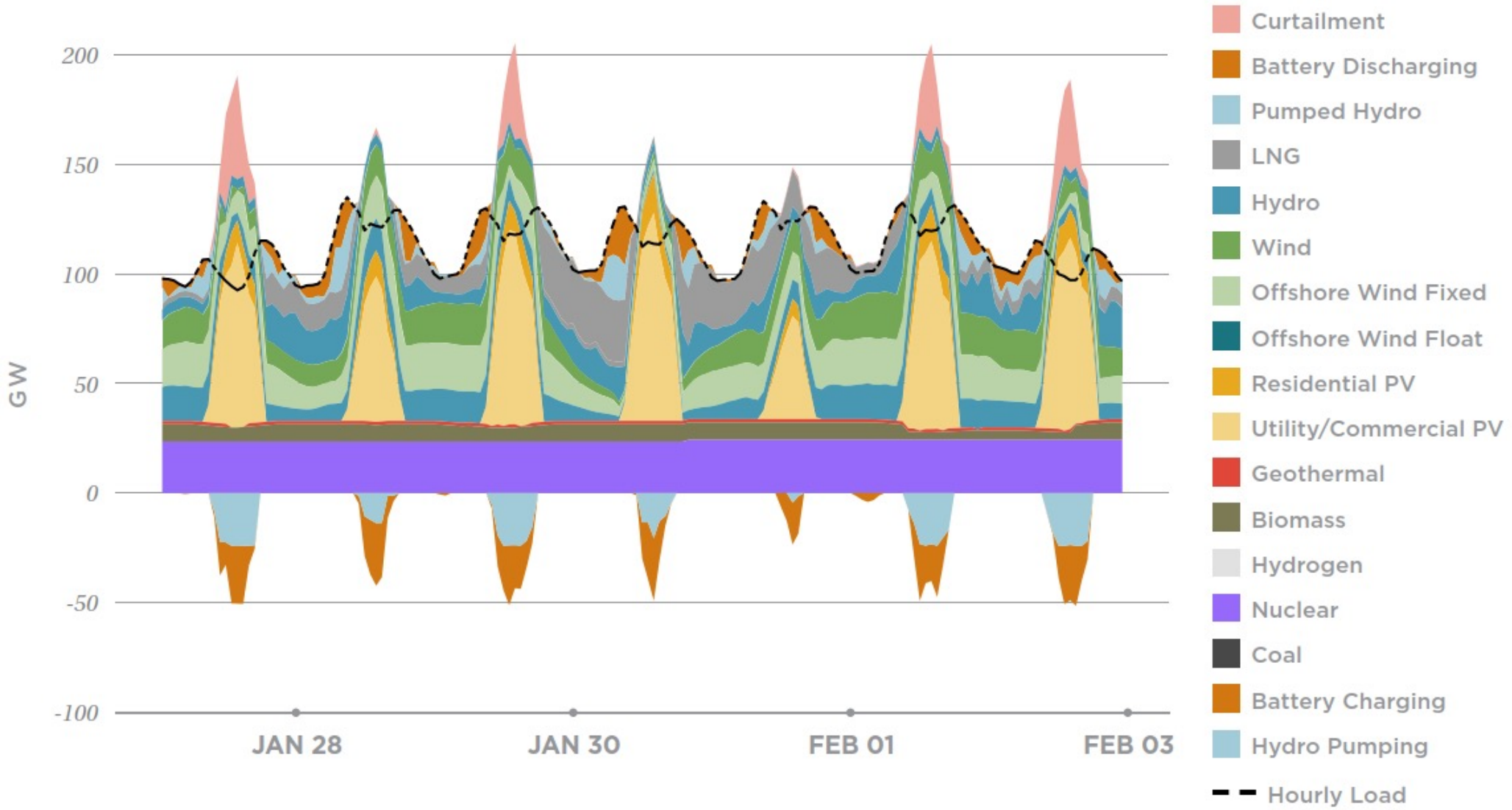
# National System Average Hourly Dispatch in 2035 for 12 Months



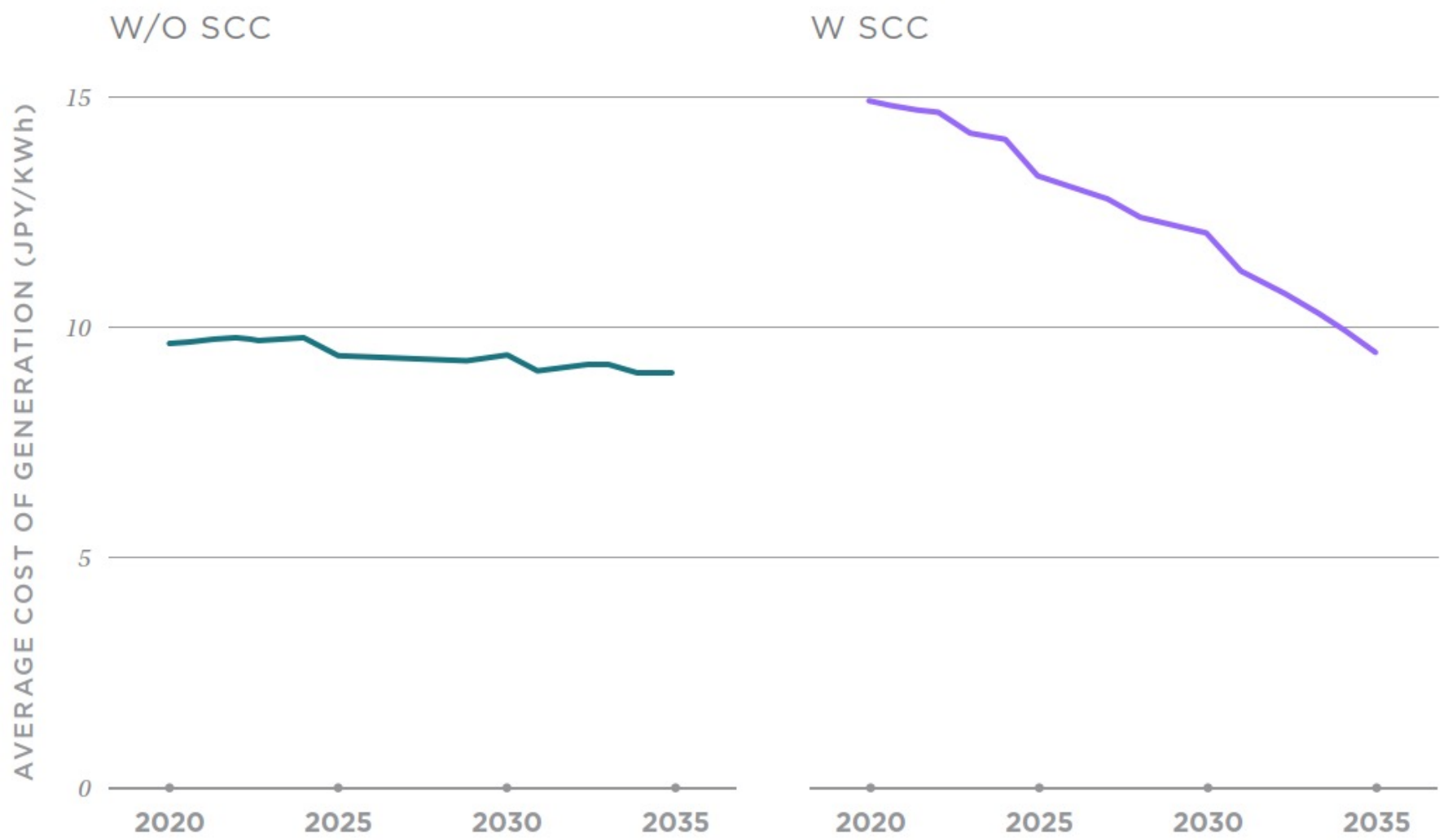
# National System Dispatch in the Highest Net Load Week of Summer 2035



# National System Dispatch in the Highest Net Load Week of Winter 2035



# Electricity Costs From The 90% Clean Grid Are Lower Than Today's Costs



# The Results Are Robust Across All Sensitivity Scenarios

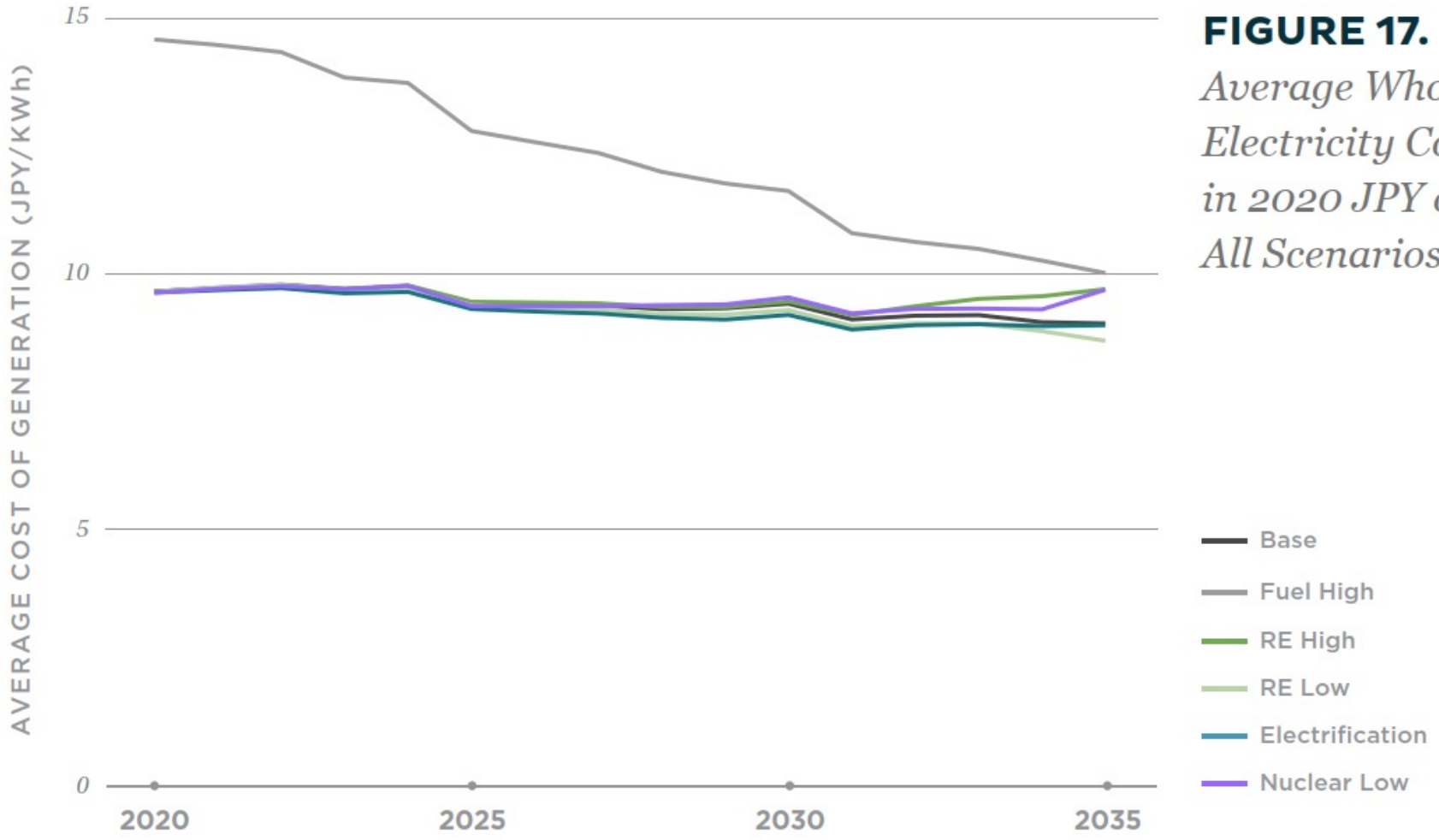
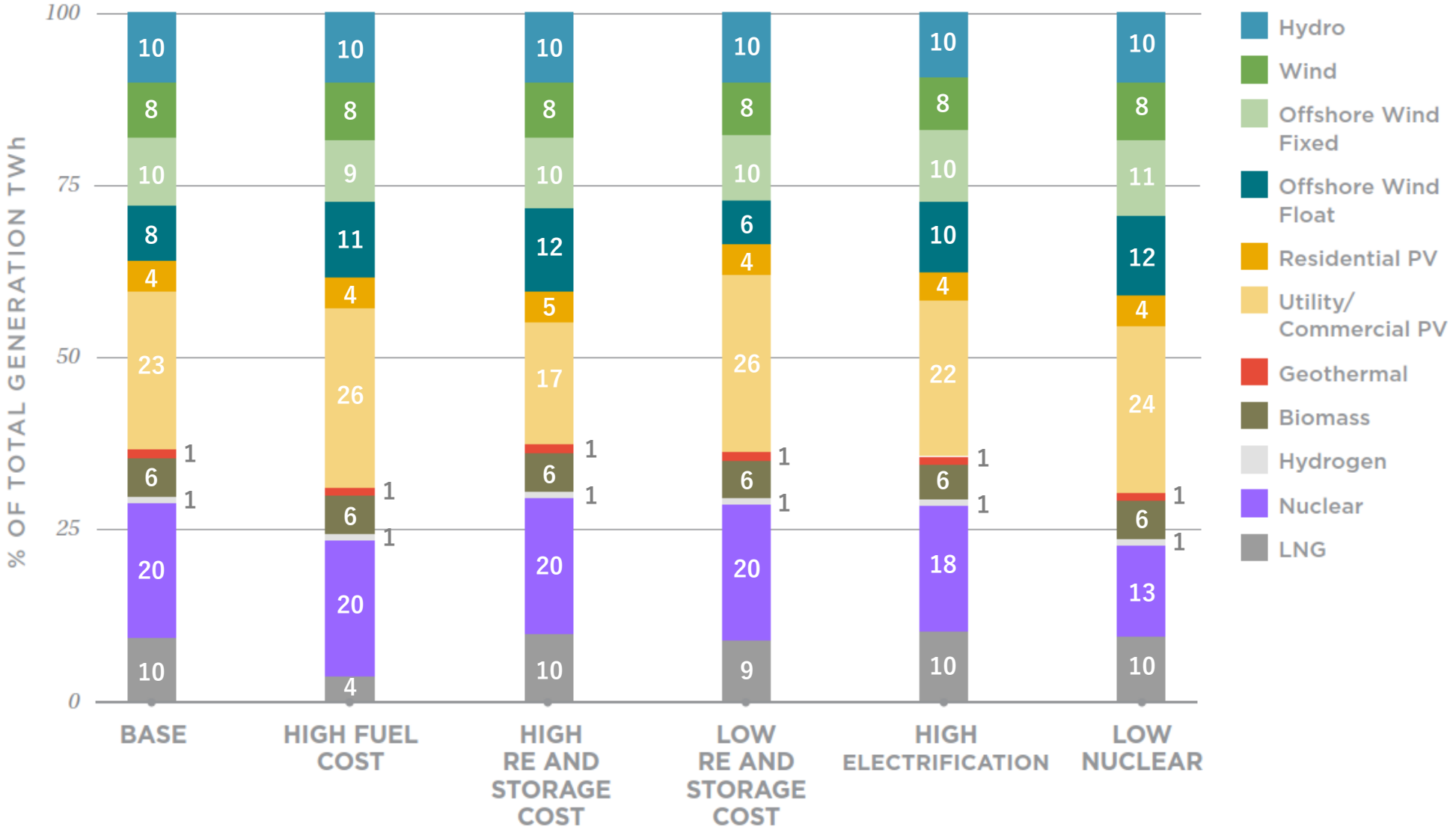
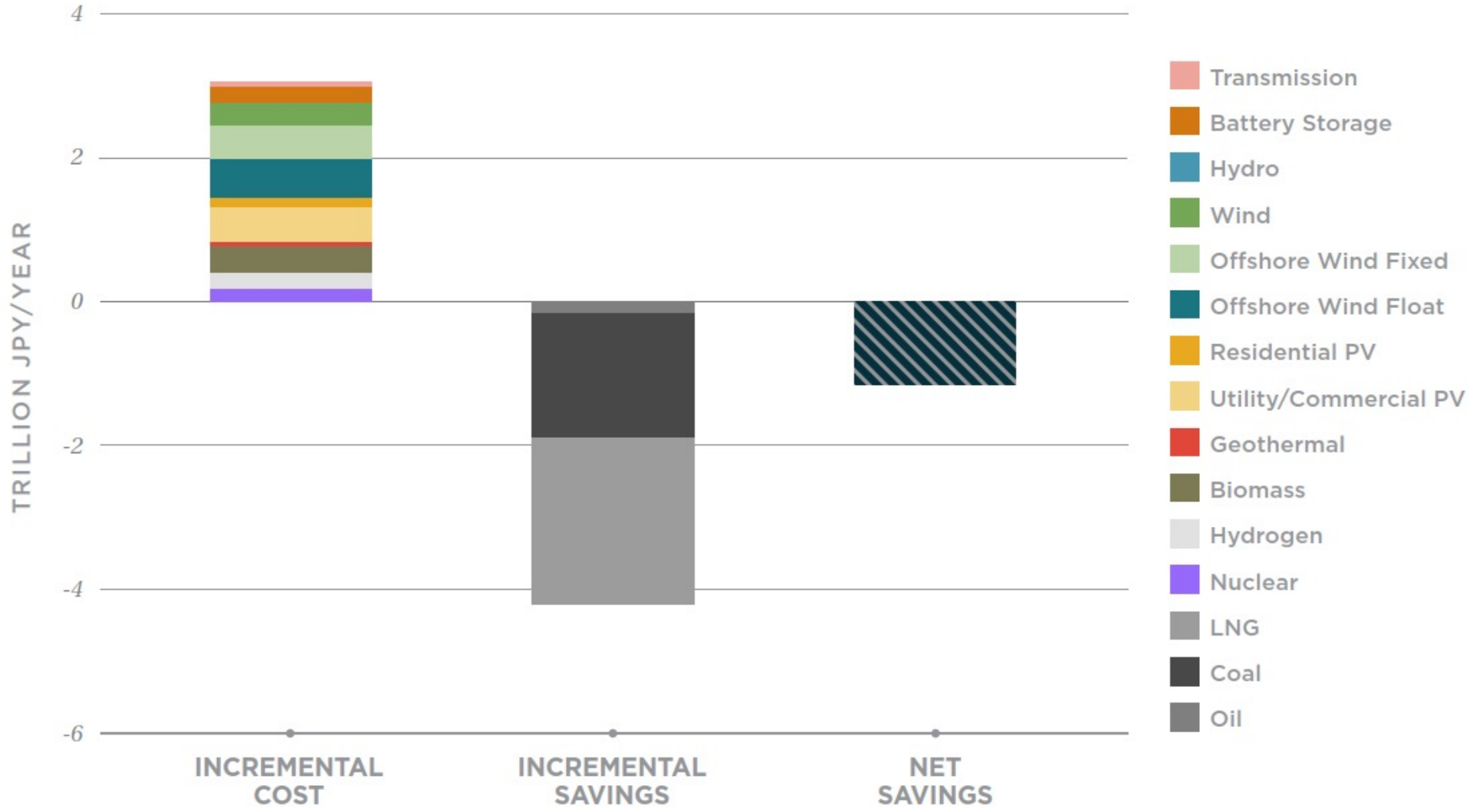



**FIGURE 17.**
*Average Wholesale Electricity Costs in 2020 JPY of All Scenarios*

# Generation mix in 2035 under six scenarios



# Incremental Costs Of New Generation, Storage, And Transmission Is Smaller Than The Fossil Fuel Costs



# 85% Reduced Fossil Fuel Imports And A 90% Clean Energy Grid Can Significantly Bolster Japan's Energy Security

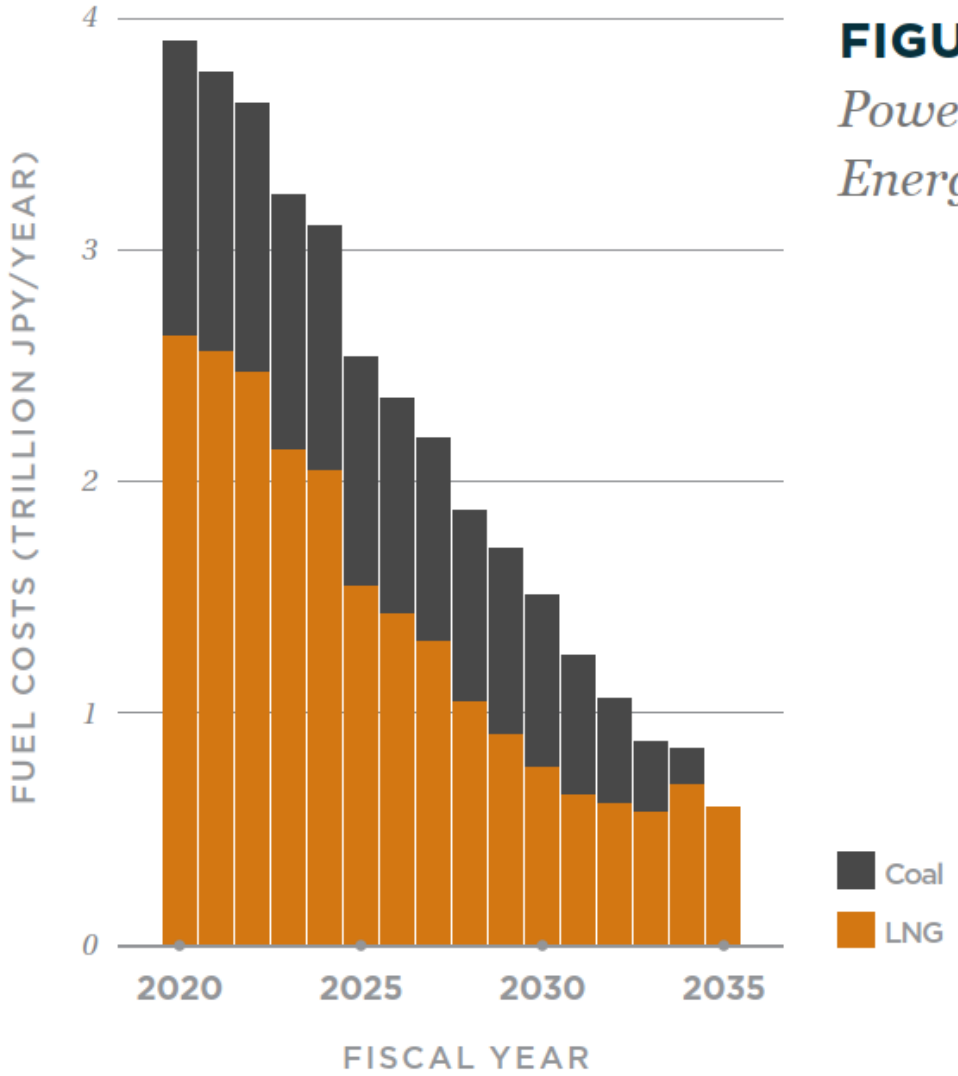



**FIGURE 18.** *Imported Fuel Costs for Power Generation Under the Clean Energy Scenario in 2020 JPY*

# Scaling-up Renewables To Achieve The 90% Clean Energy Grid Is Feasible

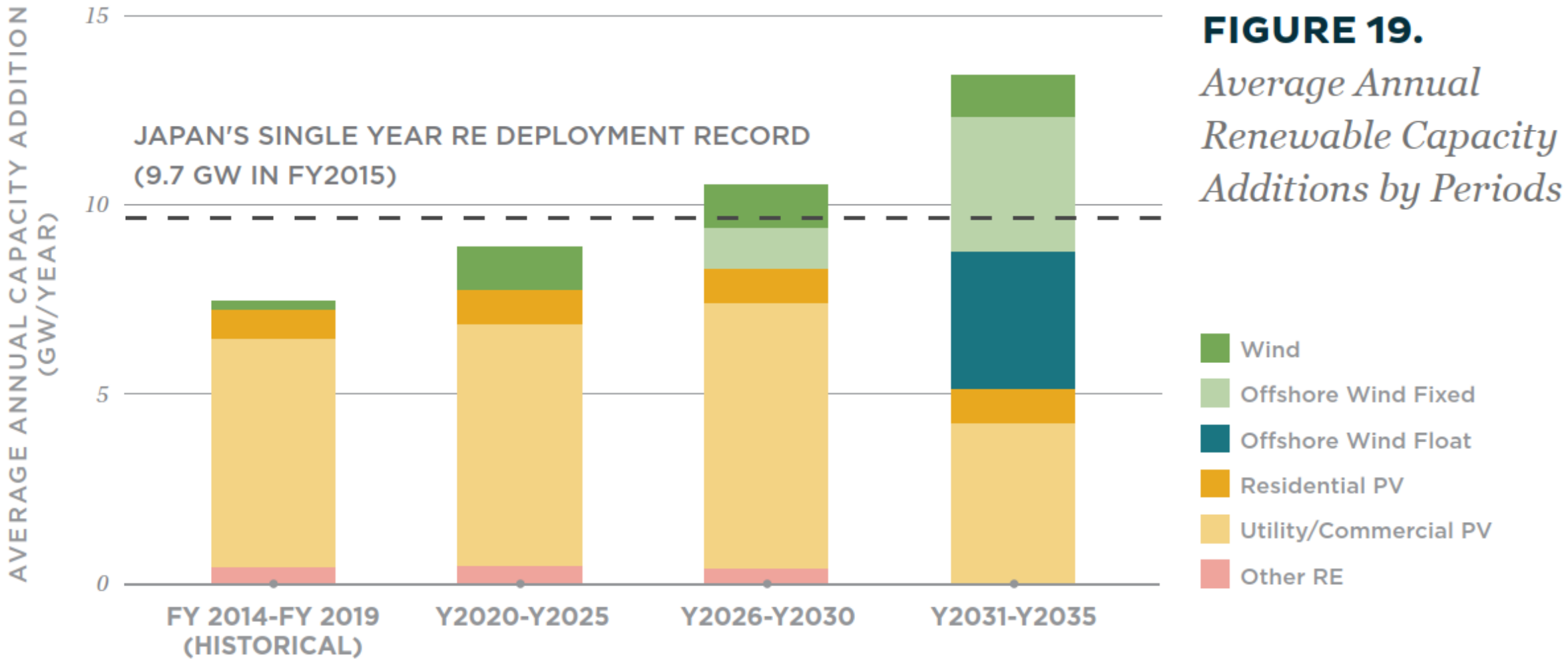



**FIGURE 19.**
*Average Annual Renewable Capacity Additions by Periods*

# Cumulative New Capital Investment reaches 38 trillion JPY (JPY 2020)

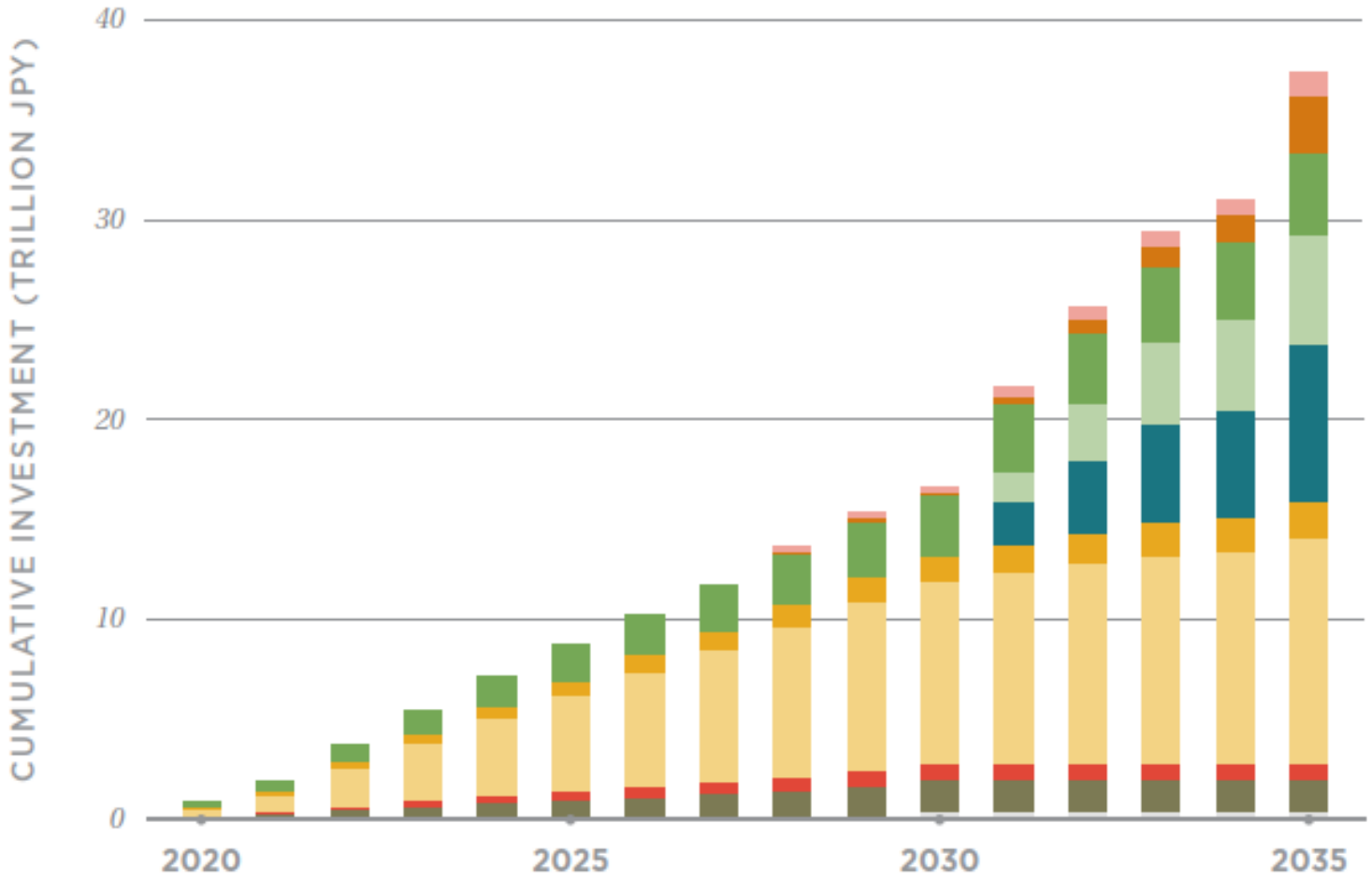



**FIGURE 21.** *Cumulative New Capital Investment for Generation and Transmission, 2020–2035*

- 地域間送電線
- 蓄電池
- 陸上風力
- 洋上風力着床式
- 洋上風力浮体式
- 住宅向け太陽光
- 非住宅向け太陽光
- 地熱
- バイオマス
- 水素

# Clean Energy Can Cut Electricity Sector CO2 Emissions By 92%

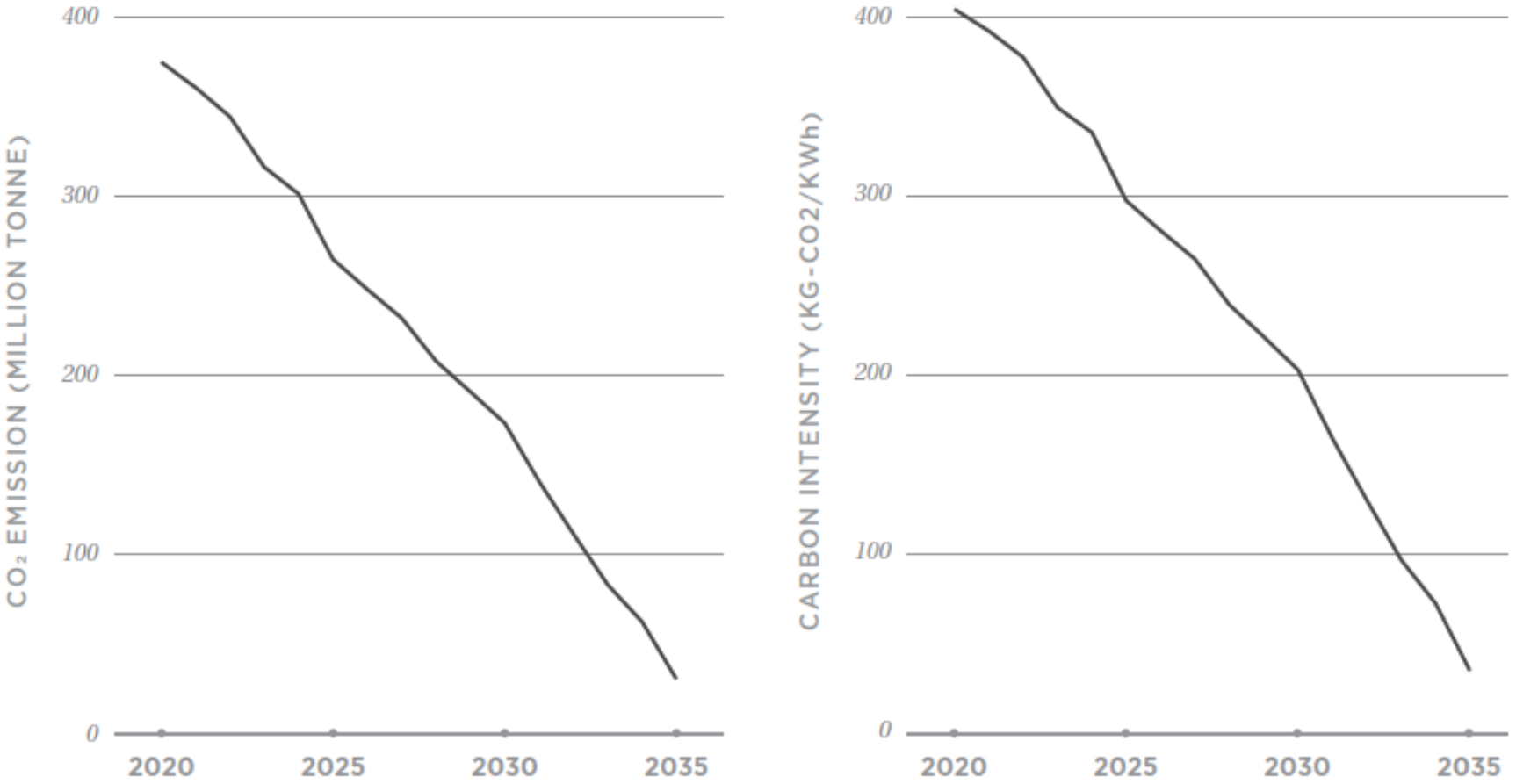



**FIGURE 22.** *$CO_2$ Emissions and Carbon Intensity*

# Reaching Cost-effective Levels Of Clean Energy Generation Will Require Overcoming Policy, Market, And Land-use Barriers

***Establishing Medium-Term Policy Targets (Beyond 2030)***

- Set medium-term targets for renewable generation and coal phaseout in 2035 and beyond to reduce policy and market uncertainties
- Create coherent policy packages to enable the medium-term policy targets including research, development, and demonstration (RD&D)

***Accelerating RE Deployment and Coal-Fired Power Phaseout By Mitigating Environmental Externalities***

- Consolidate feed-in tariffs, including feed-in premiums and reverse auctions, to accelerate renewable deployment
- Increase the price of carbon to accelerate coal-fired power phaseout
- Invest part of the carbon revenues in RD&D related to innovations needed to create a zero-carbon grid

# Reaching Cost-effective Levels Of Clean Energy Generation Will Require Overcoming Policy, Market, And Land-use Barriers

***Lowering Institutional and Societal Barriers to Rapid RE Deployment***

- Establish qualified renewable energy zones (REZs) with suitable topography and land-use designations to avoid delays in permitting and deployment
- Integrate the zoning process in transmission planning
- Involve stakeholders at early stages of planning to cultivate public input and acceptance

***Pursuing a Just Energy Transition through Targeted Assistance Policies***

- Mitigate the societal and economic impacts of coal phaseout with transition assistance programs for communities and businesses
- Use carbon revenues to reimburse households and businesses for part of their utility expenditures, reducing the tax burden

# Reaching Cost-effective Levels Of Clean Energy Generation Will Require Overcoming Policy, Market, And Land-use Barriers

***Ensuring System Dependability, Enhancing Operational Flexibility, and Boosting Energy Efficiency***

- Create markets and profitable business models for flexible resources including energy storage, demand-side management and measures, and flexible generation
- Drive investments in cost-effective energy efficiency improvement through standard setting or adoption of fiscal incentives

# Next Steps

- This report primarily focuses on renewable-specific technology pathways rather than explore the full portfolio of clean energy technologies. Other technology could contribute to lowering the system costs.
- Issues such as LOLP, system inertia, alternating-current (AC) transmission flow of both intra- and inter- regional transmission lines, and issues in AC power system such as reactive power compensation need further assessment.
- The operational impacts of day-ahead / intra-day forecast errors in RE and load

# Strong policies are required to take advantage of multiple benefits of 90% clean energy grid

| | CURRENT GRID (2023) | 90% CLEAN (2035) |
|---|---|---|
| Highly Decarbonized Grid | | ○ |
| Dependable Grid | ○ | ○ |
| Electricity Cost Reductions | | ○ |
| Feasible Scale-Up | | ○ |
| Environmental Savings | | ○ |
| Energy Independence | | ○ |

Questions?

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