

Outlook and Challenges for Electric Utility Industry

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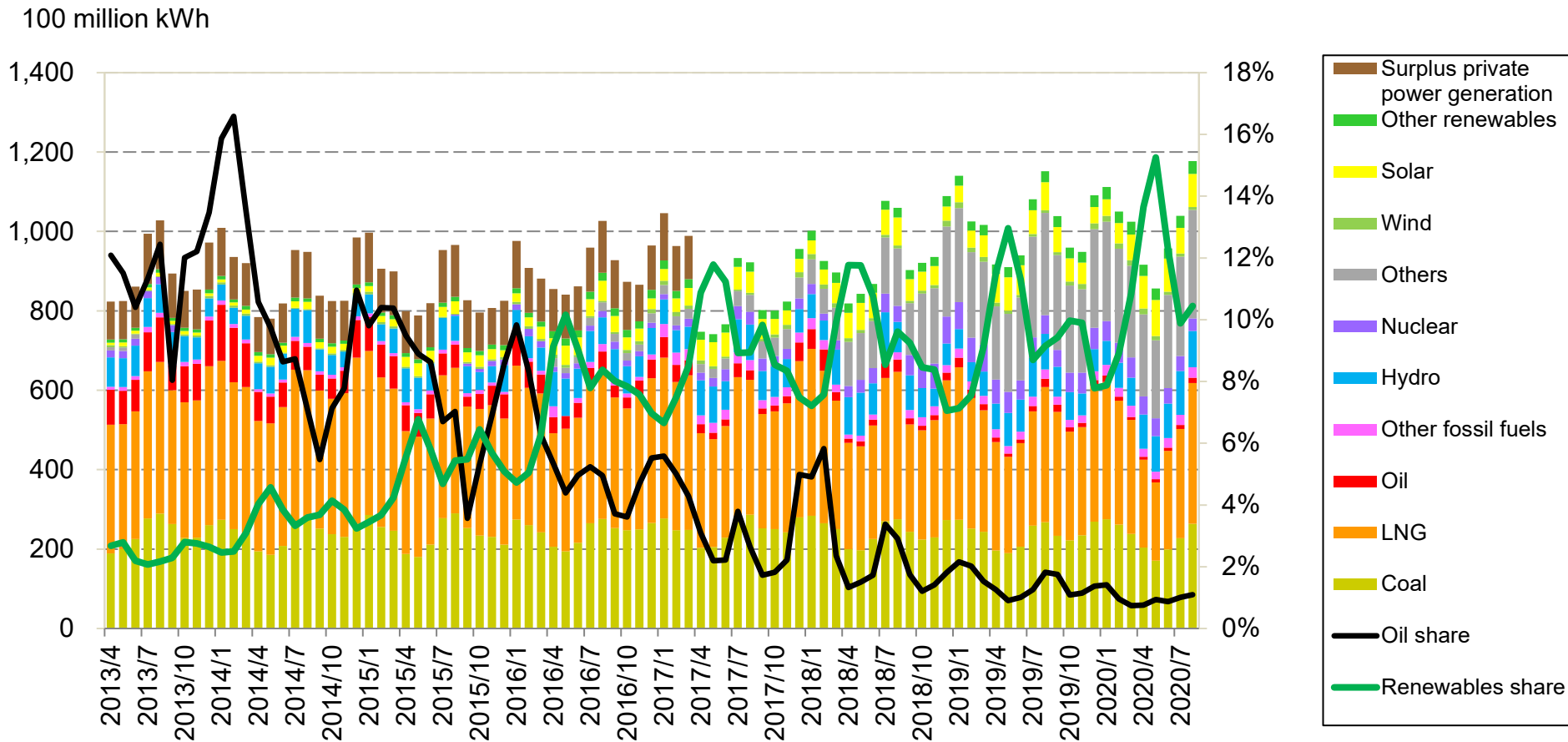
Key Points

- ✓ Day-ahead spot trading now accounts for 30% of total electricity sales in Japan, indicating that day-ahead spot prices have significant impacts on the profitability of power generation facilities and competition for retail sales. In central and western Japan, day-ahead spot prices have come closer to fuel costs for coal-fired power plants, affecting the maintenance of LNG-fired power plants. Power producer-supplier companies have taken advantage of retail sales based on such low day-ahead spot prices to expand their power market shares in many regions.
- ✓ Successful bid prices reached the ceiling in auctions for delivery in the capacity market in 2024, becoming a big topic. The average successful bid price, though higher than prices in the U.S. PJM capacity market, is close to levels that have been seen in New York City and new ISO New England capacity markets, indicating that the successful bid prices in Japan were adequate for a tight supply-demand balance.
- ✓ In an increasing number of countries or regions, conventional power generation capacity has declined due to the expansion of renewable power generation capacity, leading to concern that the power supply-demand balance could tighten on a decline in renewable power output. In Japan as well, the supply-demand balance has tightened frequently to the extent where instructions for improvement measures are issued, though with rotating outages avoided. The viewpoint of how best to secure stable power supply is important.
- ✓ As constraints on the grid through renewable power generation expansion and the need for investment in power facilities are expected to be highlighted in 2021, Japan will be required to consider grid management measures as well as equipment-related measures.

1. Competition in the Japanese Electricity Market

(1) Trends in Power Generation by Source

- As oil began to see its share of Japan's total power generation slipping below 10% in an increasing number of months from around 2015 after the share's expansion since the Great East Japan Earthquake, renewable energy raised its share above 5%. Since 2017, renewables' share has remained around 10%.



(Note) Statistics have changed since April 2017.

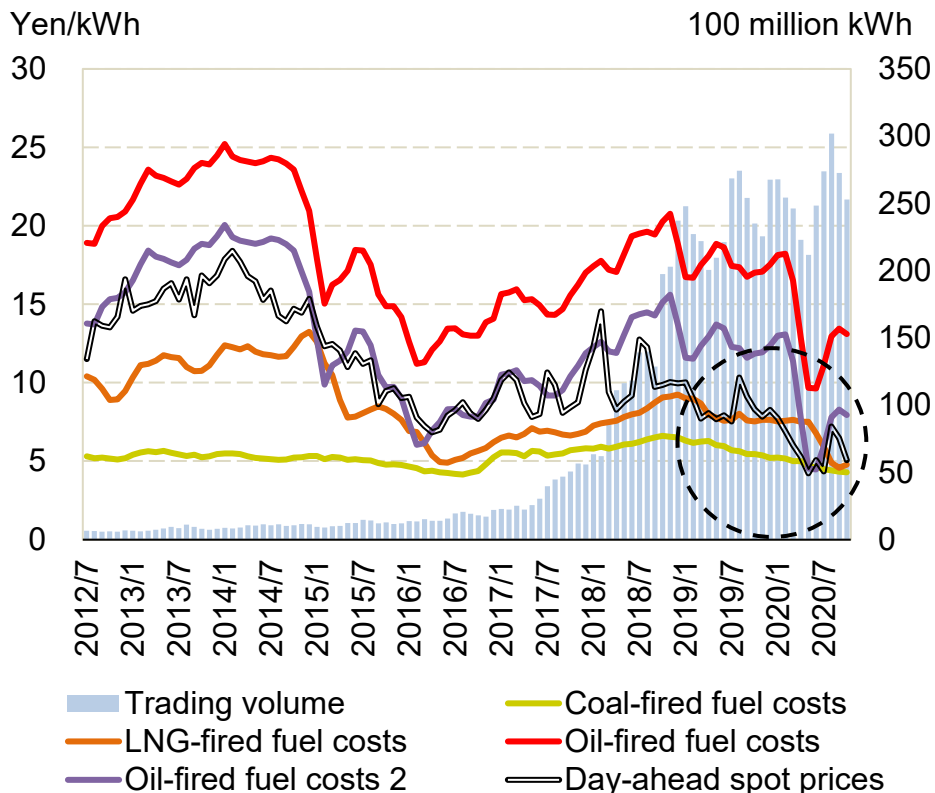
(Source) Prepared from Agency for Natural Resources and Energy "Survey of Electric Power Statistics"

1. Competition in the Japanese Electricity Market

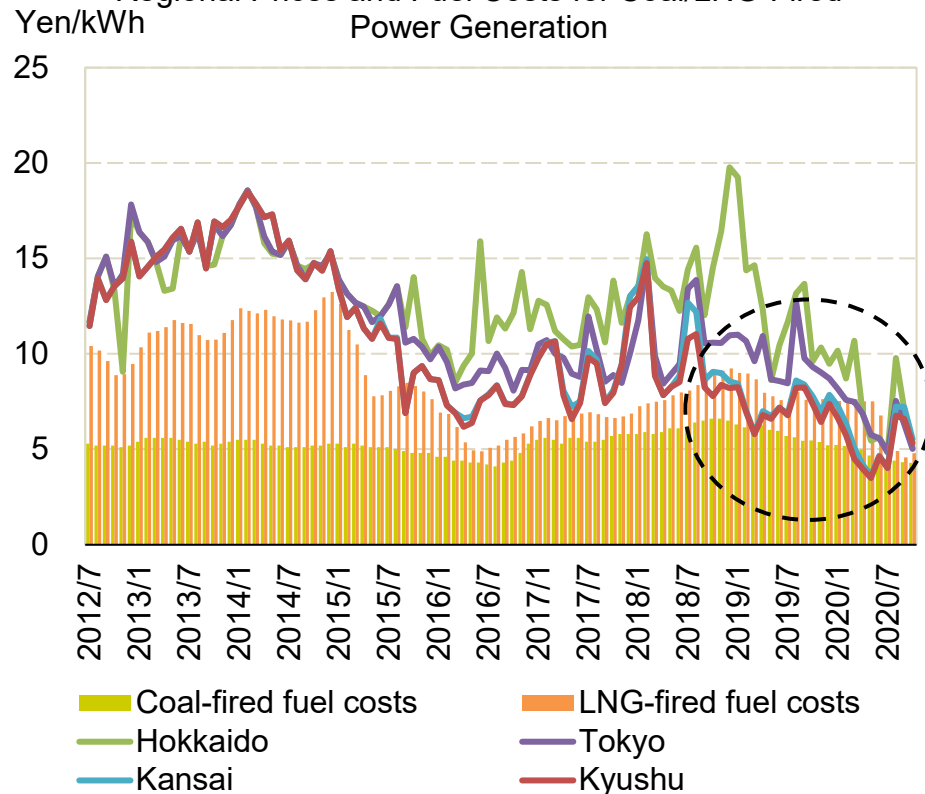
(2) Day-Ahead Spot Prices and Fuel Costs

- Day-ahead spot system prices had been strongly linked to fuel costs for oil-fired power plants until around February 2017 but have come closer to fuel costs for LNG-fired plants since then in line with a decline in oil-fired power generation. Renewable power generation growth has caused a further division between eastern and western markets since around 2015, with the western market featuring cheaper costs.
- Since Kyushu Electric Power Co. began to suppress electrical output from FIT power sources in October 2018, spot electricity prices have declined below fuel costs for LNG-fired power generation mainly in central and western Japan. Spot electricity prices are expected to remain stagnant in 2021.

Day-Ahead Spot Prices and Fuel Costs



Regional Prices and Fuel Costs for Coal/LNG-Fired Power Generation

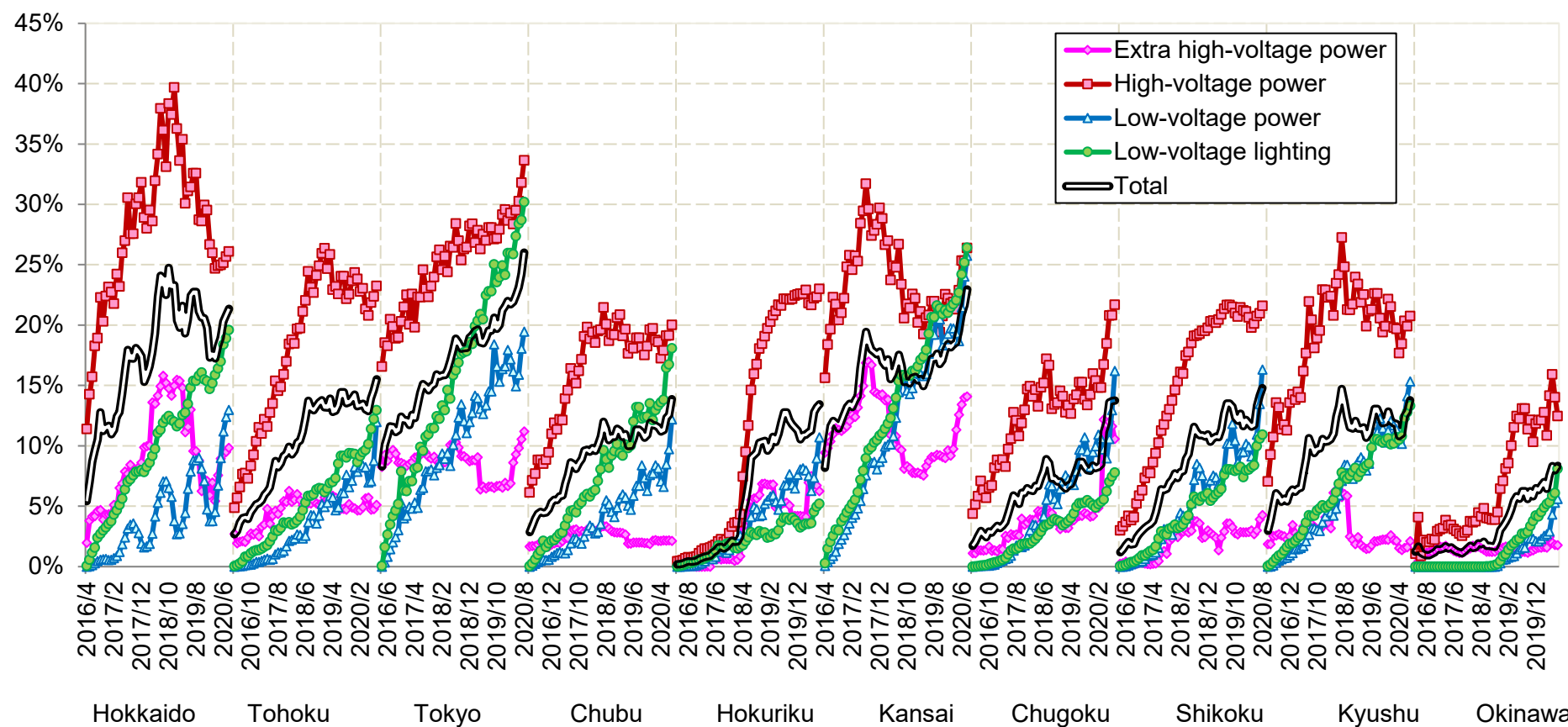


(Note) Fuel cost (power generation efficiency at 40%) + Operation/maintenance cost at JPY1.7/kWh for coal-fired power generation,
 Fuel cost (power generation efficiency at 50%) + Operation/maintenance cost at JPY0.6/kWh for LNG-fired power generation,
 Fuel cost (power generation efficiency at 35%) + Operation/maintenance cost at JPY5.15/kWh for oil-fired power generation (oil-fired fuel costs 2 cover fuel cost alone)
 (Sources) Fuel prices have been computed by the IEEJ Energy Data and Modelling Center. Spot prices are from the Japan Electric Power Exchange.

1. Competition in the Japanese Electricity Market

(3) Competition among Electricity Retailers (from April 2016)

- As of July 2020, 19.7% of households in Japan had switched from traditional electric utilities on average. The switching rate remains higher for high-voltage power service users and for the Hokkaido, Tokyo, and Kansai regions. Switching rates for low-voltage power service users are higher in the Tokyo, Chubu, and Kansai regions. In central and western Japan, day-ahead spot prices are indicating a variable cost market. Until delivery begins in the capacity market, power producer-supplier companies that procure electricity in the spot market may increase their competitiveness.

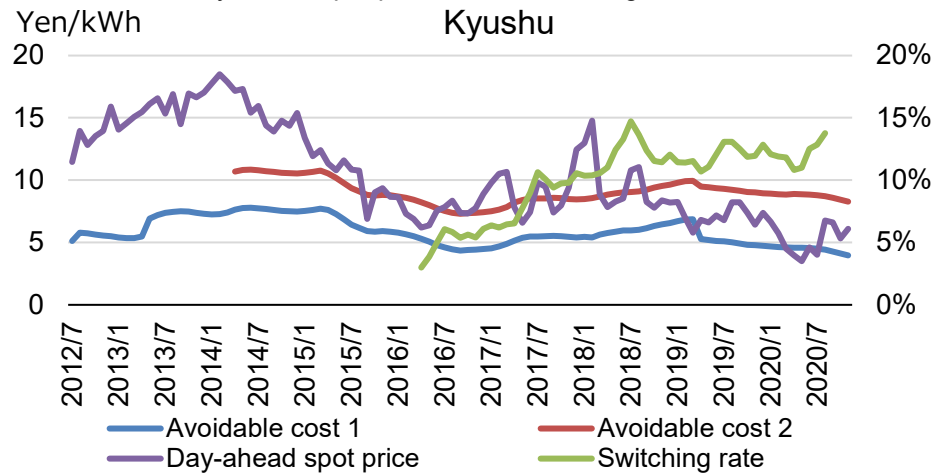
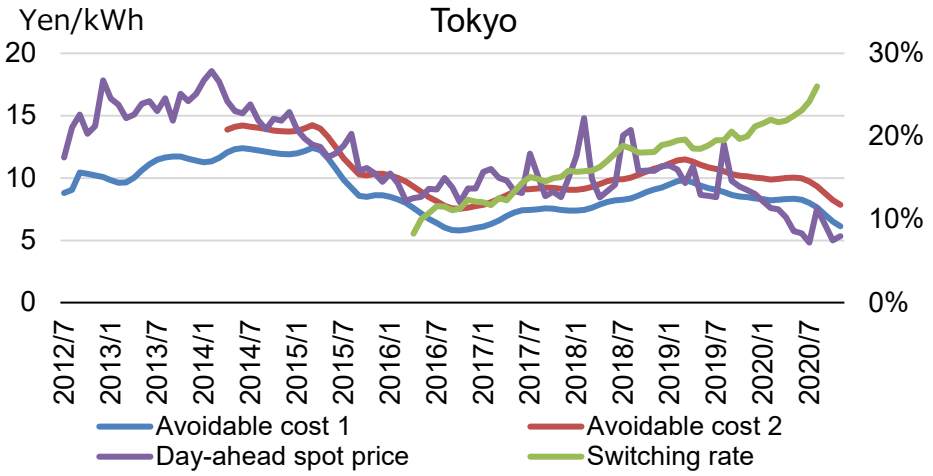
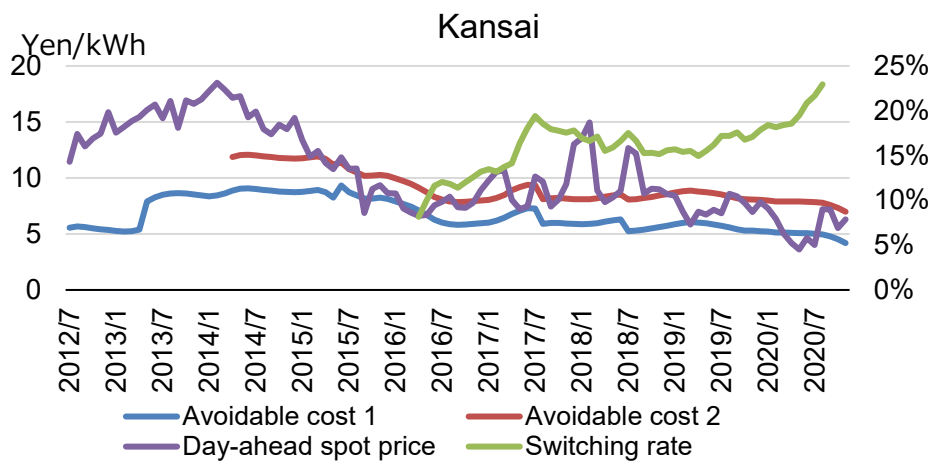
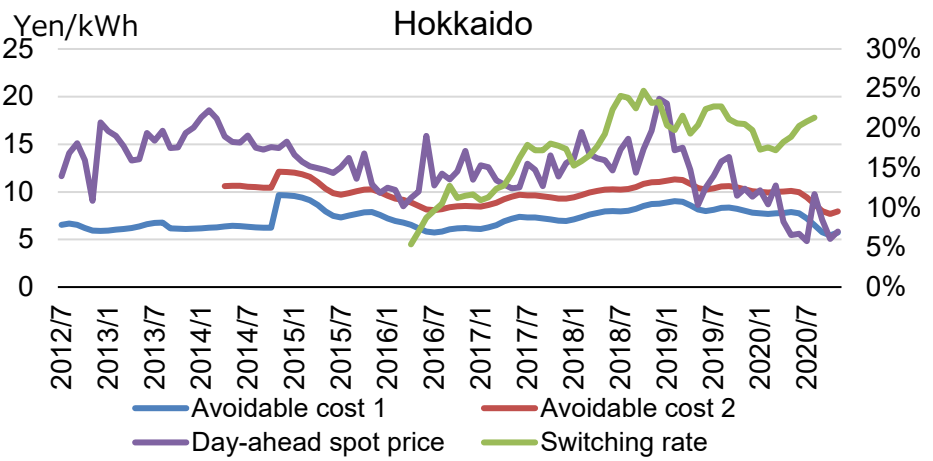


(Source) Prepared from Electricity and Gas Market Surveillance Commission "Electricity Trading Report Aggregation"

1. Competition in the Japanese Electricity Market

(4) Avoidable Cost and Competition

- The monthly average day-ahead spot price for some months has slipped below the avoidable cost 2 (including fixed costs) published for feed-in-tariff adjustment, indicating that it has become difficult to recover fixed costs for electricity sources. In the Tokyo area, the price slipped even below variable costs for all electricity sources.

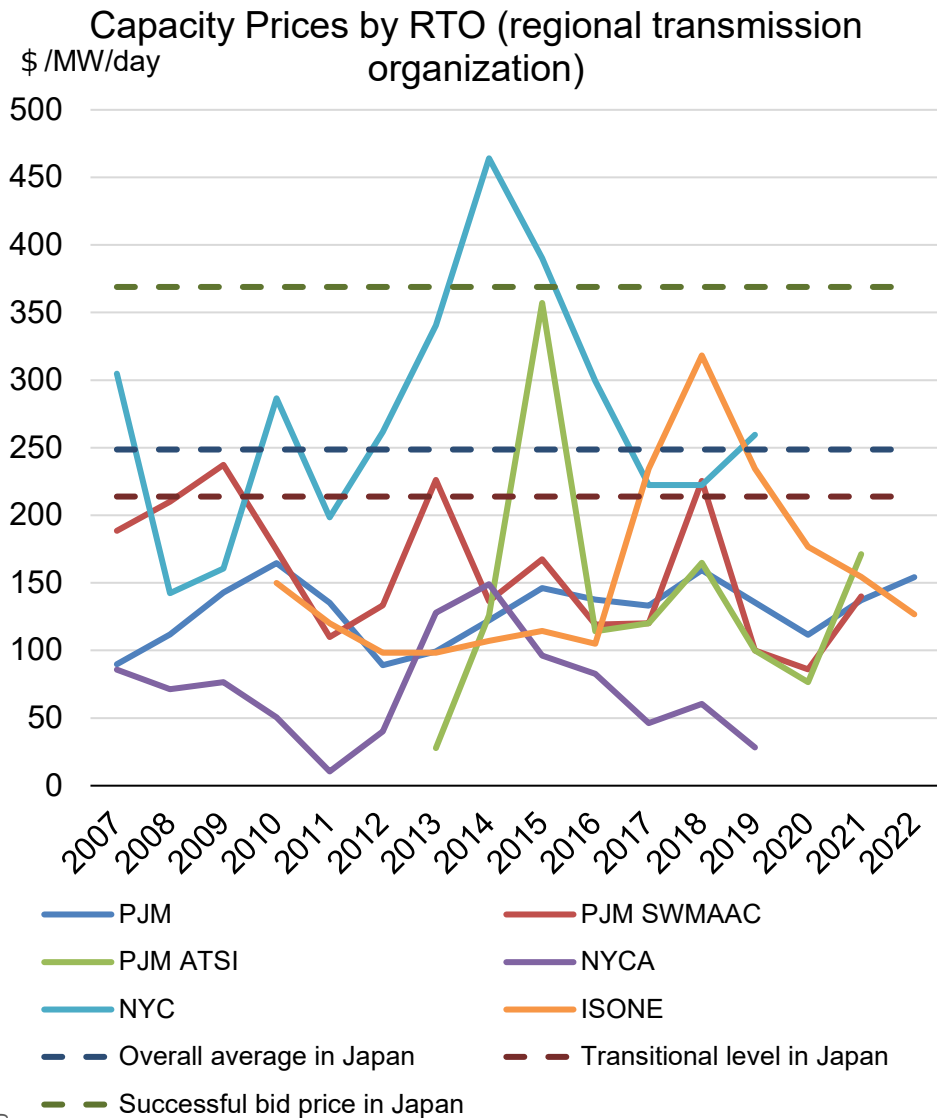


(Note) Avoidable cost 1 is based on the power generation cost of average variable costs for all power sources for long-term adjustment. Avoidable cost 2 covers variable and fixed costs with consideration given to the assessment of supply capacity by renewable energy source.

(Source) Avoidable cost data are from the Green Investment Promotion Organization, day-ahead spot electricity price data from the Japan Electric Power Exchange, and switching rate data from the Electricity and Gas Market Surveillance Commission.

1. Competition in the Japanese Electricity Market

(5) Capacity Market Transactions



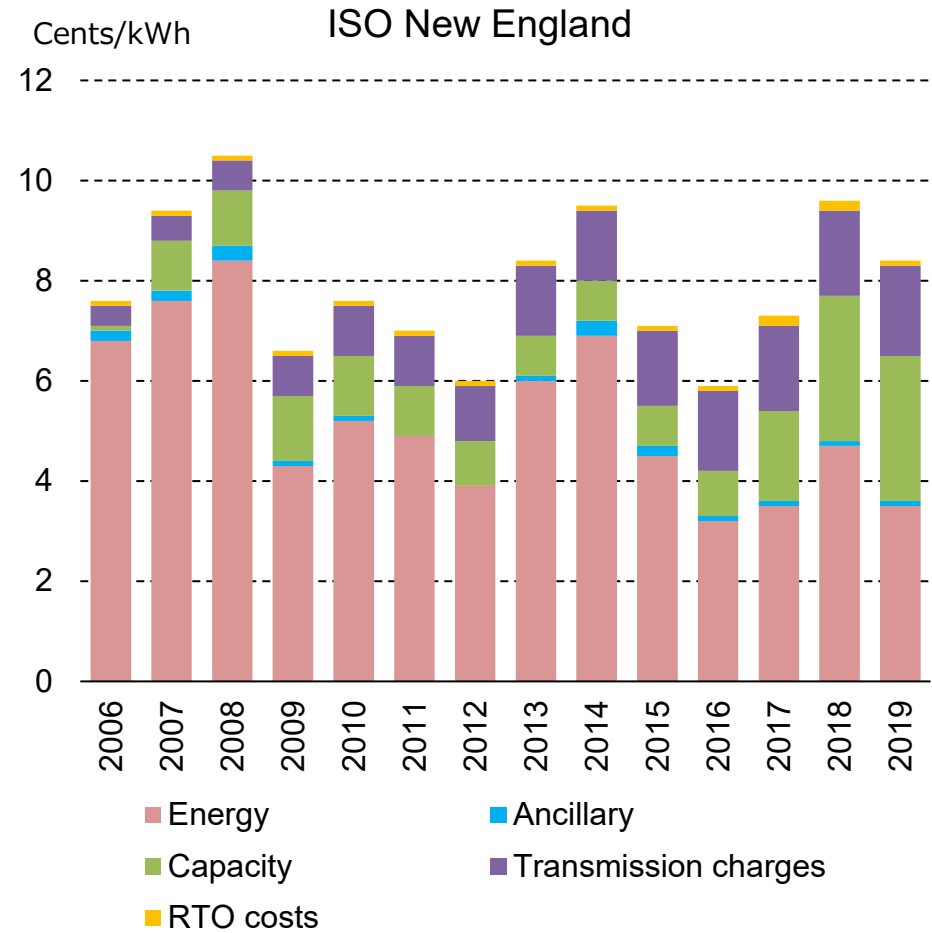
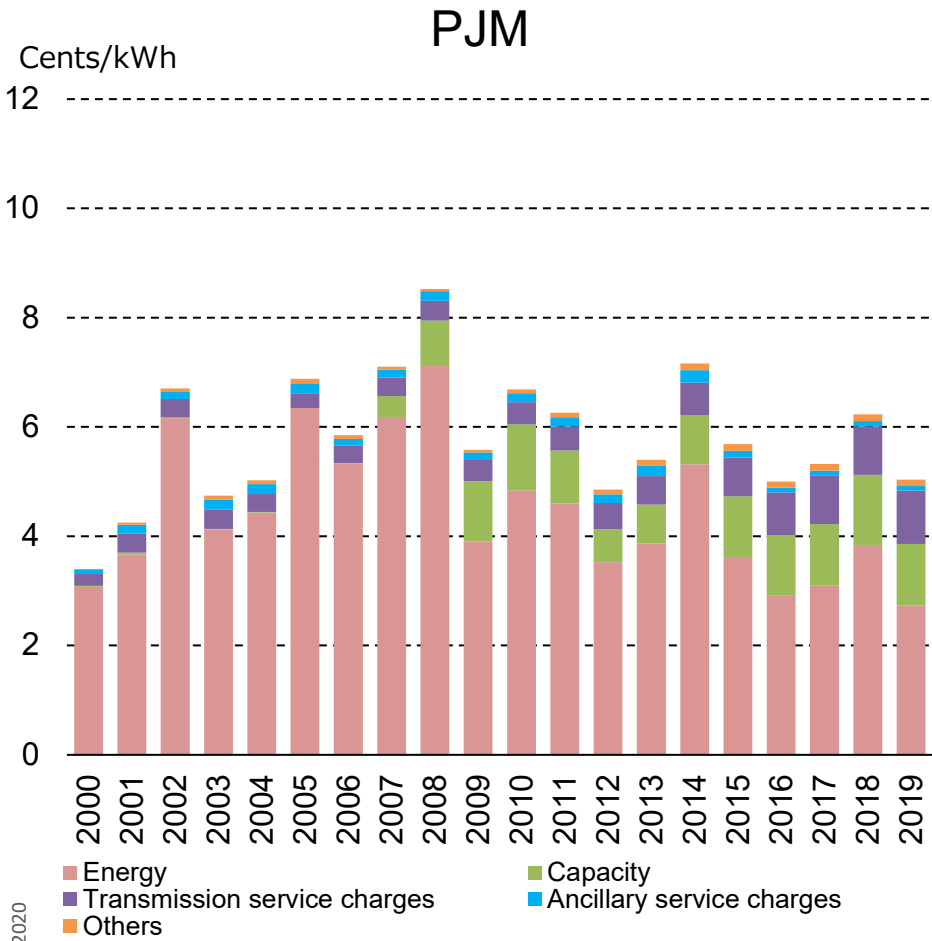
- Successful bid prices for the capacity market reached the ceiling of JPY14,137/kW per year, becoming a big topic. They are higher than capacity prices for the PJM regional transmission organization but close to levels seen for New York City, new ISO (Independent System Operator) New England, PJM Southwest SWMAAC (Mid-Atlantic Area Council), and PJM ATSI (American Transmission Systems, Inc.) markets. They thus may be viewed as adequate under a tight supply-demand balance.
- The problem is whether successful bid prices rightly reflected the supply-demand balance. Penalties may have to be reviewed. Japan may learn something from a PJM system for transferring successful bidders' supply capacity commitments.
- ※ Although there is an idea for using the capacity market mechanism for phasing out coal-fired power plants, the idea has been adopted rarely in Europe and should be considered prudently. (The idea has been adopted for Italy's reliability option capacity market.)

(Note) Based on the exchange rate of \$1 for JPY105.

(Source) Prepared from RTO/ISO websites

【Reference】 Breakdown of Wholesale Supply Costs in U.S. Northeast

- Wholesale supply costs for PJM and ISO New England are broken down in the following figure. Of wholesale supply costs for PJM in 2019, capacity market costs stood at 1.13 cents/kWh, lower than the estimated Japanese level of slightly less than JPY2/kWh and the ISO New England level of 2.9 cents/kWh.

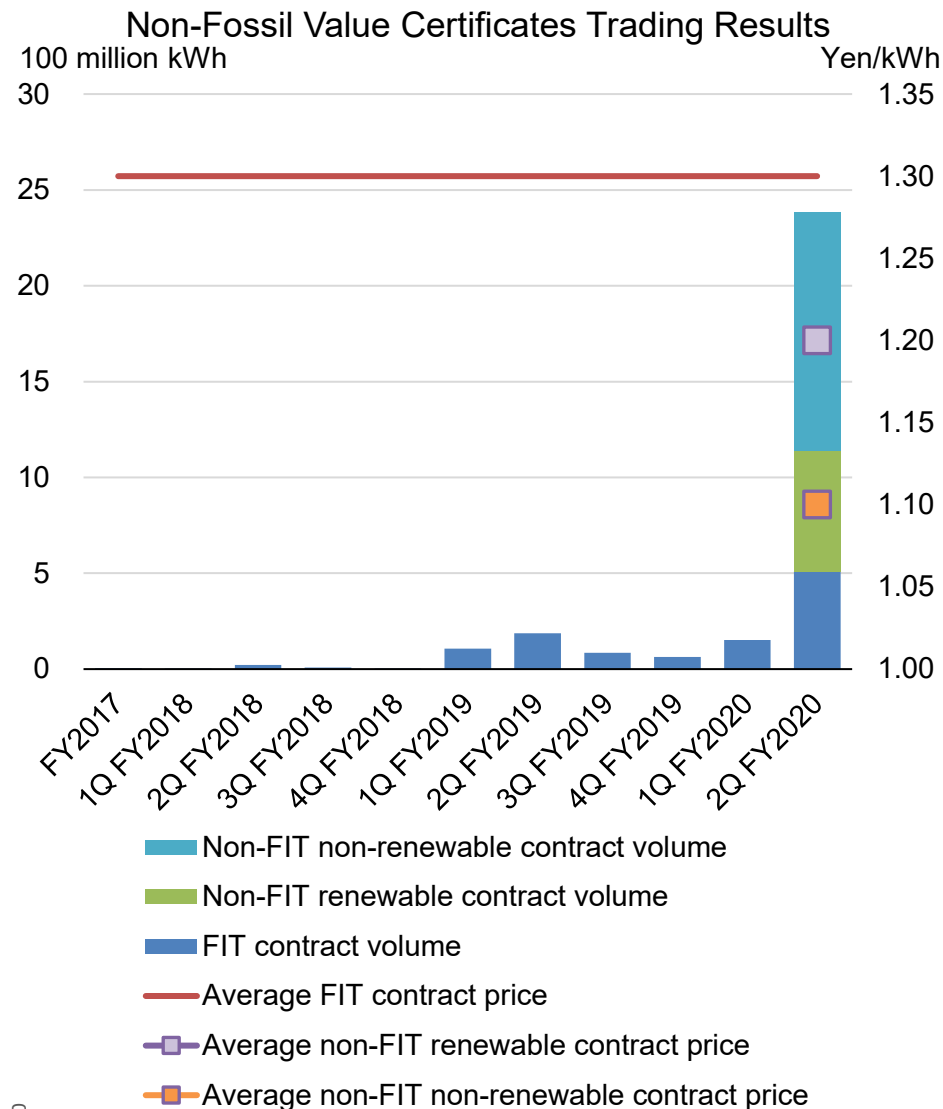


(Source) Monitoring Analytics, "State of the Market Report for PJM"

(Source) ISO New England, "Annual Markets Report"

1. Competition in the Japanese Electricity Market

(6) Non-fossil value certificates trading



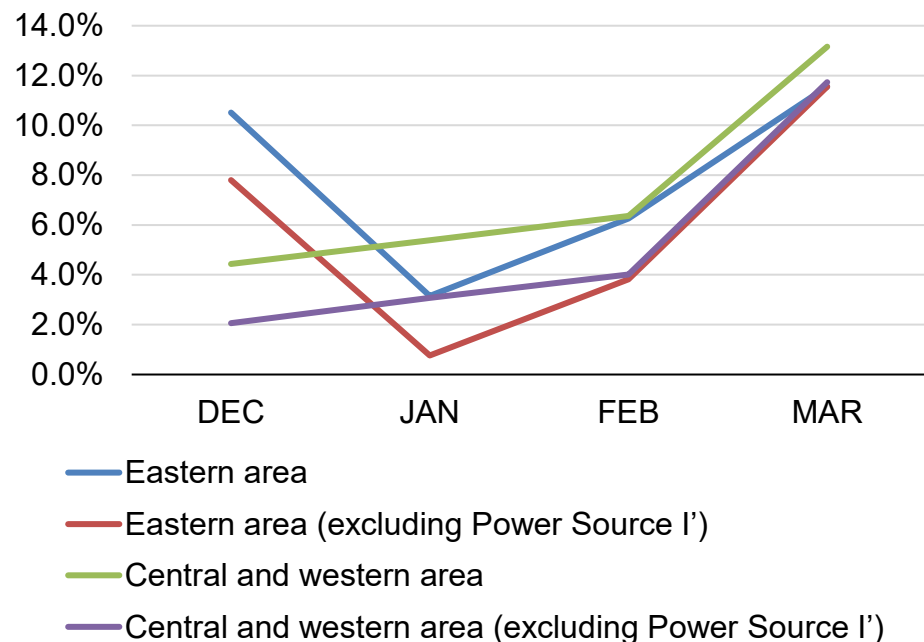
- FIT non-fossil value certificate trading volume increased from 150 million kWh in the first auction for FY2020 to 510 million kWh in the second. The first auction volume accounted for 5.2% of FIT purchases. In the second auction, certificate trading volume might have increased in tandem with FIT purchases.
- Trading started in non-FIT non-fossil value certificates on November 11, 2020. No lower limit price is set for non-FIT non-fossil value certificate trading. Prices came at 1.2 yen/kWh for non-FIT renewable contracts and 1.1 yen/kWh for non-FIT non-renewable contracts.
- Given that renewable credit prices in the United States range from 0.8 cents/kWh to 1.5 cents/kWh and that a green charge stood at around 1.0 cents/kWh in a past U.S. survey, a non-fossil premium might have been recognized at around JPY1/kWh.

1. Competition in the Japanese Electricity Market

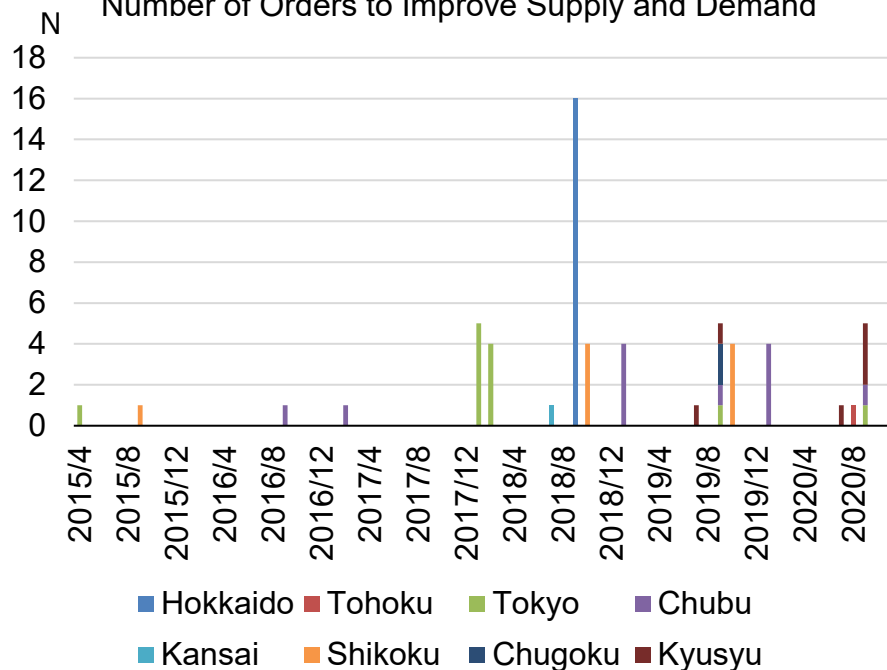
(7) Japan's Winter Supply/Demand Outlook

- The minimum supply margin of 3% for a cold winter is secured for this winter. If a cold winter is accompanied by additional factors, the supply-demand balance may tighten. The Hokuriku, Kansai, and Kyushu areas could see supply shortages on a single-handed basis. Supply reserve margins cover Power Source I' that is secured for the severest weather in a decade. If no such power source is considered, the supply margin is expected to slip below 3% in the eastern area.
- Orders from the Organization for Cross-regional Coordination of Transmission Operators for improving the power supply-demand balance have increased since around winter 2017. Even excluding special orders that accompanied the Hokkaido earthquake in September 2018, such orders responding to demand hikes caused by weather factors have risen. Some of such orders have originated from solar PV power generation forecast errors. Given that such situation is not known well, how best to share information should be considered.

FY2020 Supply Reserve Margin Outlook



Number of Orders to Improve Supply and Demand



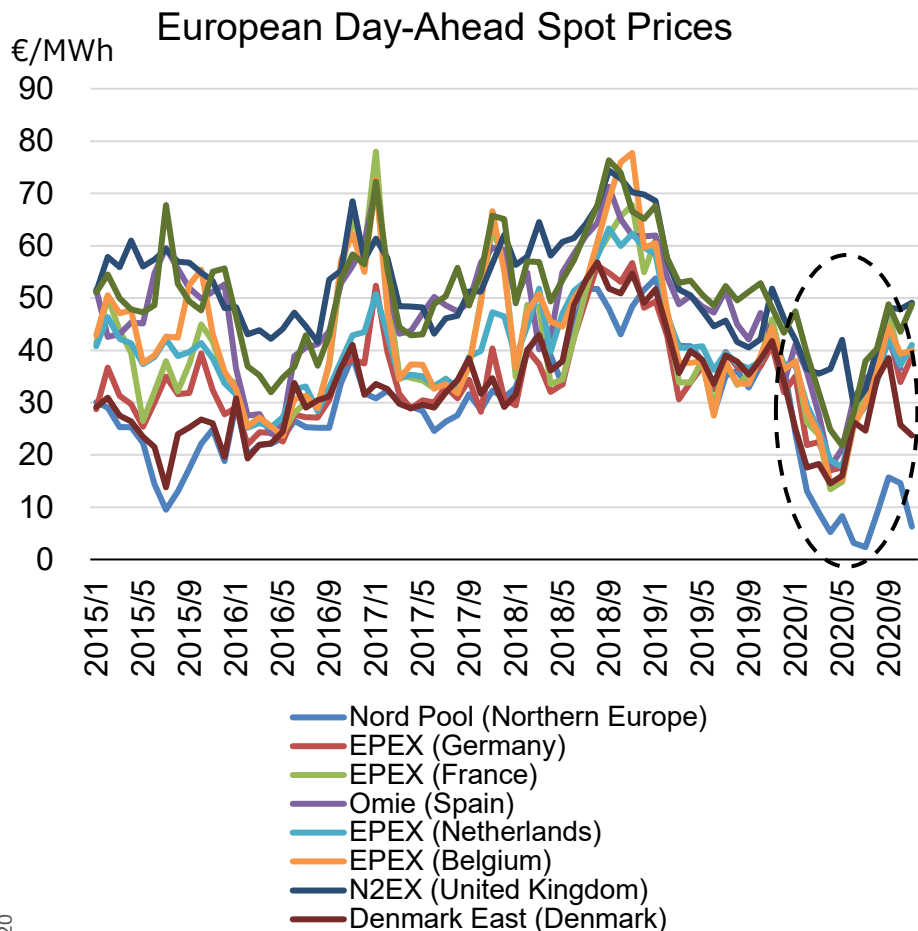
(Source) Prepared from Organization for Cross-Regional Coordination of Transmission Operators "Electricity Supply and Demand Verification Report" October 2020

(Source) Prepared from Organization for Cross-Regional Coordination of Transmission Operators "Responses to Supply-Demand Balance Deterioration"

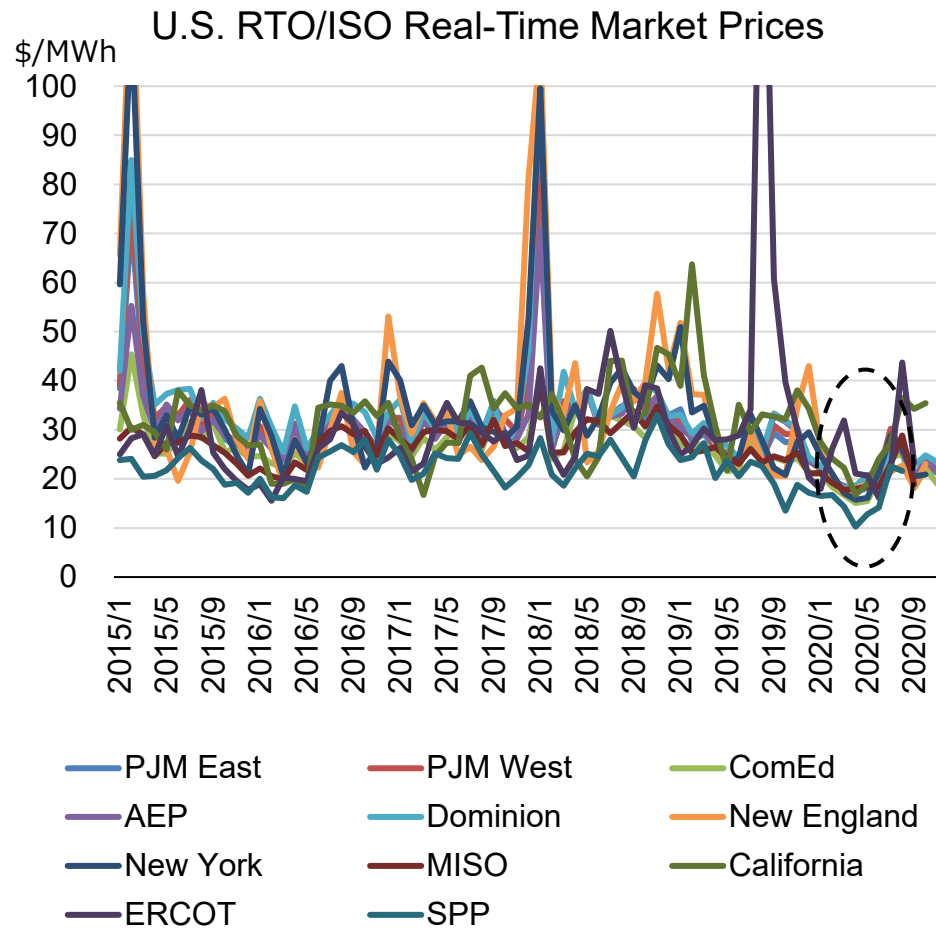
2. Western Situation

(1) Western Wholesale Electricity Market Price Trends

- In Western countries as well, wholesale power market prices have weakened due to falls in electricity demand and in primary energy prices under the COVID-19 pandemic. Although there is concern that electric utilities' earnings could decline, they might have been affected less than other energy companies.



(Sources) Prepared from each exchange's websites

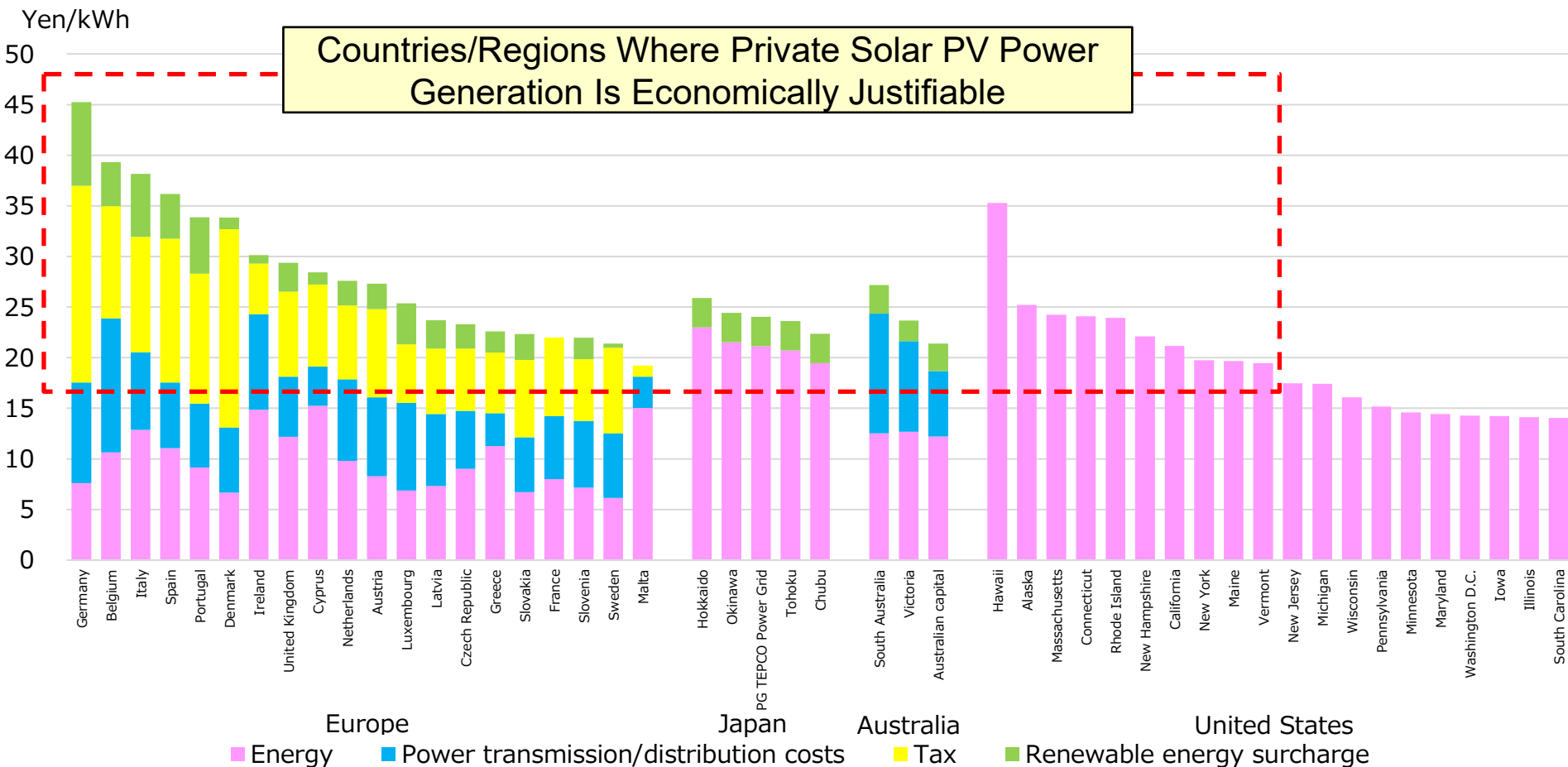


(Sources) Prepared from each RTO/ISO website

2. Western Situation

(2) International Comparison of Electricity Rates

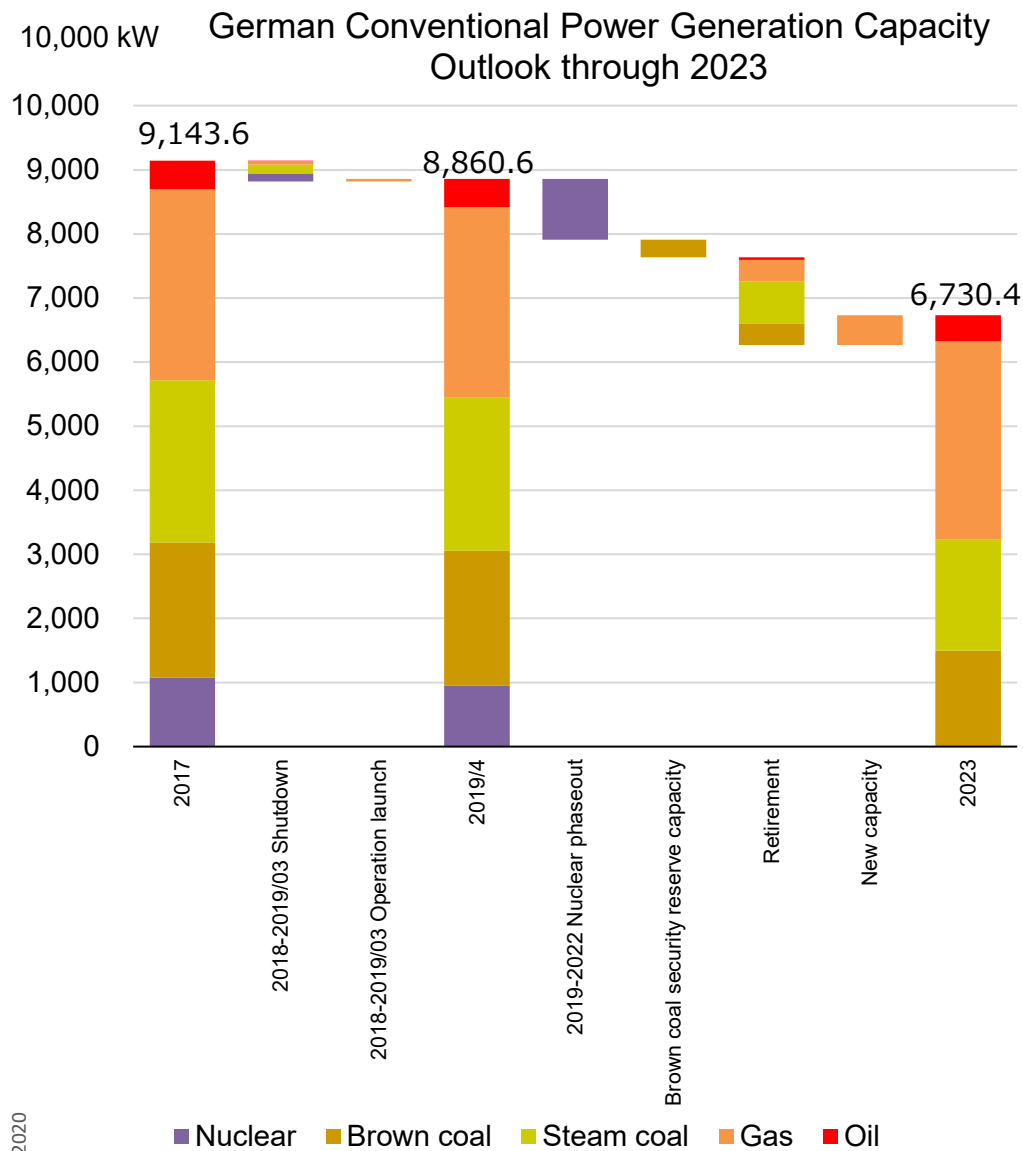
- In an increasing number of countries, growth in renewable power generation capacity has caused higher surcharges and power transmission/distribution costs, leading to higher power bills. In a rising number of countries or regions, it has become economically justifiable to have private solar photovoltaics capacity. In some cases, the combination of private solar PV capacity and storage batteries has been favorable.



(Note) The 2019 average exchange rates of JPY123.6 to the euro and JPY110.1 to the dollar are used, based on the NEDO "Foreign Exchange Rate Table."
 (Sources) Eurostat (for users consuming 1,000-2,500 kWh annually) is used for Europe. The average lighting service price and the surcharge of JPY2.90/kWh in the Electricity and Gas Market Surveillance Commission's "Electricity Trading Report Aggregation" are used for Japan. The EIA's "Electricity Annual" is used for the United States.

2. Western Situation

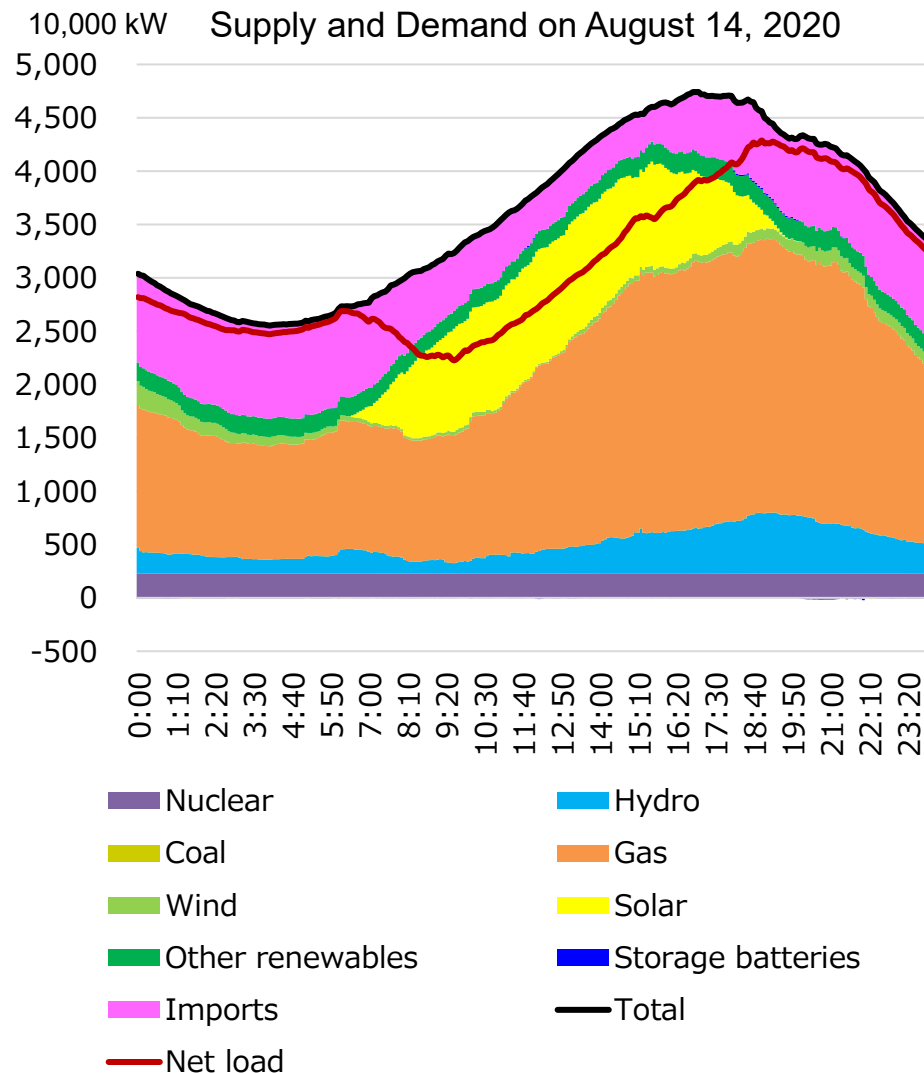
(3) German Conventional Power Generation Capacity Outlook



- Germany has decided to phase out coal-fired power generation in addition to nuclear generation. However, non-renewable energy power generation capacity has not increased. RWE predicts that conventional power generation capacity will decrease by 26.4% from 91.436 million kW in 2017 to 67.304 million kW in 2023. The predicted capacity in 2023 is even smaller than 75.4 million kW forecast one year ago for 2020-2023.
- Germany's maximum power output in 2019 was 76.535 million kW, indicating that Germany would have to depend heavily on electricity imports if power output from renewables declines.
- In France, Belgium, and the Netherlands near Germany, load-following generation capacity has continued to decrease. As more nuclear generation capacity is shut down in France this winter under the impact of the COVID-19 pandemic, abnormally cold weather could lead the power supply-demand balance to tighten.

2. Western Situation

(4) Tight Supply-Demand Balance for California ISO

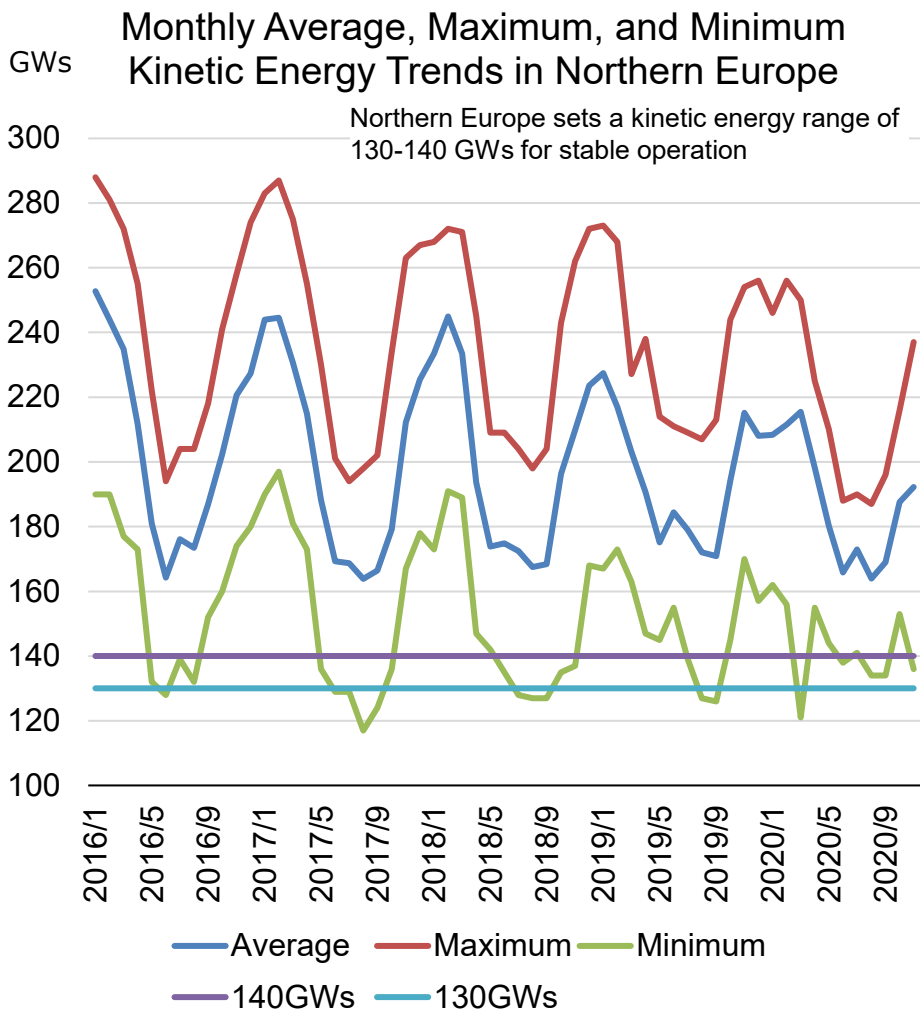


- California ISO triggered a rotating outage for up to 1 million kW on August 14, 2020, and another for up to 470,000 kW on the next day as the evening power supply-demand balance tightened.
- Power demand growth under a heat wave caused the tighter supply-demand balance. The demand peak of 46.78 million kW on August 14 was higher than 44.3 million kW in 2019 but not so unusual compared with 50.12 million kW in 2017 or 46.43 million kW in 2018, slipping below the peak of 47.76 million kW coming every five years.
- California ISO, which depends heavily on imports from other states amid widespread demand expansion under heat waves, failed to cover demand due to a decline in imports, leading to the rotating outages.
- California ISO had installed storage batteries with total capacity of 4.721 million kW as of August 2020. However, most of them were designed for secondary adjustment, failing to be used for supplying electricity for peak demand. This may be one of the reasons for its failure to avoid rotating outages (the peak electrical output on August 14 stood at 147,000 kW). California ISO is considering launching a new system to use the batteries for energy trading in the autumn of 2021.

(Source) Prepared from California ISO, "Today's Outlook"

2. Western Situation

(5) Inertia Decline and Countermeasures



- The Electric Reliability Council of Texas, Ireland, the United Kingdom, and Northern Europe are taking additional measures as synchronized power generations that have rotational energy called kinetic force to stabilize frequency have decreased due to growth in non-synchronized generations (including wind and solar PV power plants).
- Given that strict conditions, including surplus capacity for a grid, are imposed on the suppression of renewable power generation, it is not easy to suppress renewable energy power generation for the reason of a decline in kinetic energy.
- Therefore, the abovementioned regions have taken additional measures to deploy fast frequency response (FFR) capacity that can respond to frequency drops more quickly than primary adjustment capacity. Northern Europe began to procure FFR capacity in 2020 in consideration of an increase in time zones where kinetic energy slips below the standard range for stable operation. FFR capacity is planned to total 300,000 kW for the whole of Northern Europe. The United Kingdom plans to procure dynamic control capacity totaling 1 million kW in 2021. Such additional measures can work to push up power generation costs.
- In Japan, the Organization for Cross-regional Coordination of Transmission Operators has begun to consider how best to respond to kinetic force and other technical problems under the expansion of renewable power generation capacity. Various viewpoints are required for responding to these challenges.

(Note) Kinetic energy value represents spacing value per minute.

(Source) Prepared from Fingrid, "Kinetic energy of the Nordic power system - real time data"

3 . Electric Utility Industry Challenges for 2021

- The supply and demand adjustment market is planned to launch the wider operation of replacement reserve (online, response time within 15 minutes, continued operation for 3 hours) and replacement reserve-for FIT (online, response time within 45 minutes, continued operation for 3 hours) in FY2021. They have already been operated for five regions – Chubu, Hokuriku, Kansai, Chugoku, and Kyushu. From April, they will be operated for all regions. The consideration of details for frequency contentment reserve, synchronized frequency restoration reserve, and frequency restoration reserve is planned to be completed within FY2021.
- In response to high successful bid prices in an auction for delivery in the capacity market in 2024, potential revisions to the capacity market system have been considered. Fundamental revisions may be difficult. Revisions may be limited to a change in how to count supply capacity subject to unsuccessful bids.
- The Organization for Cross-regional Coordination of Transmission Operators has begun to consider how best to respond to kinetic force and other technical problems under the expansion of renewable power generation capacity, planning to publish a conclusion in May 2021. Given that it is not easy to suppress renewable energy power generation for the reason of a decline in kinetic energy as indicated by overseas cases, the organization should check overseas cases in considering the matter.
- Mainly in advanced economies, electricity demand falls and weak wholesale electricity prices under the COVID-19 pandemic have discouraged investment in power facilities. As growth in investment in power transmission/distribution facilities is increasingly criticized in some countries, needs are growing for power source management rather than equipment investment. Japan as well may be increasingly required to adopt power source management measures to hold down electricity rate hikes through investment expansion.