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Electric Utility Industry and Renewable Energy Outlook and Challenges for 2019

The Institute of Energy Economics, Japan

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Points of the report

- ✓ Day-ahead spot electricity prices on the Japan Electric Power Exchange tend to be linked to fuel costs for oil-fired power generation positioned as marginal supply capacity. In line with oil price hikes in 2018, the average day-ahead spot electricity price remained around JPY10/kWh. As oil-fired power generation has shrunk, however, regions and time slots where spot electricity prices depend on variable costs for gas-fired and coal-fired power generation have been emerging. This trend is likely to be enhanced.
- ✓ As electricity retailers' profit margins have been shrinking on the intensification of competition, profitability has been deteriorating for new retailers called power producer and supplier companies. As a drastic-change alleviation measure for avoidable costs is set to expire on the introduction of the baseload power source market, PPS companies are required to reconsider their business models.
- ✓ As China accounts for half of the global renewable energy power generation growth, any FIT system revision that largely changes FIT electricity purchases in China can exert great influence on the global renewable energy market.
- ✓ Along with FIT electricity generation control, next-generation networks for the effective utilization of small-capacity renewable energy power generation facilities are under consideration. Japan is considering N-1 power control and non-firm connection systems to ease power transmission congestion. However, ideas about how to control and communicate substation capacity at voltage adjustment points vulnerable to congestion and about efficient output control may have to be put into order.

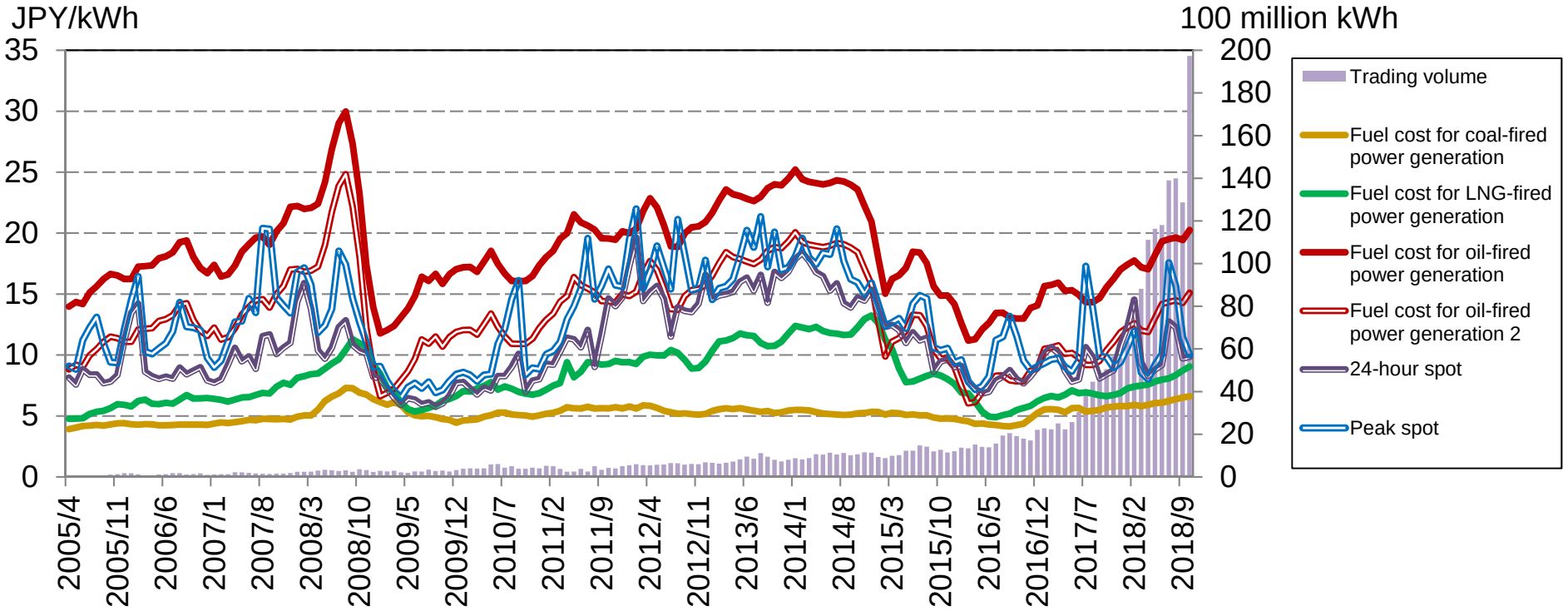
Progress in electricity system reform

- Detailed designs of new markets continue to be considered. On the other hand, (1) how to eliminate prediction errors for solar photovoltaics power generation and (2) how to use imbalance charges for providing incentives have become major challenges. Particularly, it is difficult to make the first challenge consistent with the real-time market, indicating that the wholesale power trading process would have to be modified.

	Outline	Plan	Challenges
Baseload power market	Baseload power generation capacity such as nuclear, coal and hydro plants are sold through forward auctions (annual trading for the immediate future)	● Trading will be launched in FY 2019. ● Delivery will be launched in FY2020.	● A complicated market and possible verification
Rules for utilization of interconnection lines	Interconnection reservations secured over a long term are subjected to day-ahead spot trading to sell indirect transmission rights for risk-hedging purposes.	● In FY2018, indirect auctions (grid utilization subjected to trading at an exchange) were introduced. ● In FY2019, indirect transmission rights will be introduced.	● Accounting for indirect transmission rights
Capacity market	Conventional capacity for which fixed costs are difficult to recover due to wholesale market vitalization is bought by the network sector with costs shouldered by retailers.	● In FY2020, trading will be launched. ● In FY2024, capacity will begin to be delivered.	● How to treat existing capacity ● Rising costs for retailers
Non-fossil value trading market	Certificates for all non-fossil power sources are issued for purchases by retailers to help achieve the non-fossil power generation capacity target.	● In FY2018, certificates for FIT power sources began to be sold through auctions. ● In FY2019, full non-fossil value trading will be launched.	● Validation of non-FIT non-fossil value certificates
Other markets	Gross bidding: Traditional electric utilities place bids and offers simultaneously on a marginal cost basis on an exchange. Supply-demand adjustment market: The market allows participants to flexibly trade in and procure adjustment capacity (wider area).	● In FY2017, gross bidding was launched. ● In FY2021, a supply-demand adjustment market will be created. ● In FY2020 or later, a wider-area supply-demand adjustment market will be created.	● How to secure retailers' reserve capacity ● Solar PV power generation prediction errors ● Imbalance charges

Day-ahead spot price trends

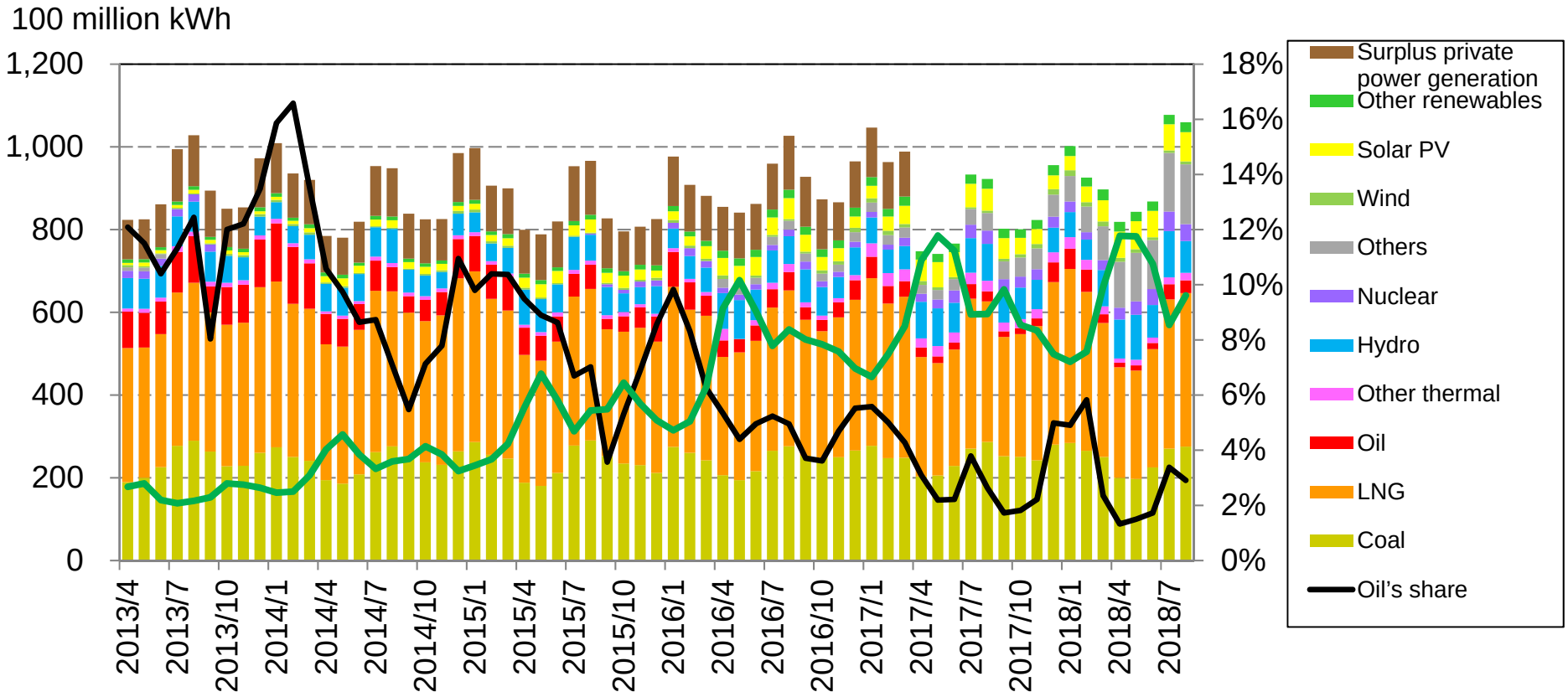
Day-ahead spot electricity prices on the Japan Electric Power Exchange tend to be linked to fuel costs for oil-fired power generation positioned as marginal supply capacity. In line with oil price hikes in 2018, the average day-ahead spot electricity price remained around JPY10/kWh. As oil-fired power generation has shrunk, however, regions and time slots where spot electricity prices depend on variable costs for gas-fired and coal-fired power generation have been emerging. This trend is likely to be enhanced. As gross bidding in which traditional electric utilities release some electricity for intragroup transactions to the market has been introduced along with indirect auctioning that subjects bilateral trading through grid interconnection lines to trading via the exchange, electricity trading volume has been increasing rapidly (accounting for 17% of total electricity sales as of August 2018).



(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. Fuel cost for oil power generation 2 covers 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.

[Reference] Monthly power generation by source

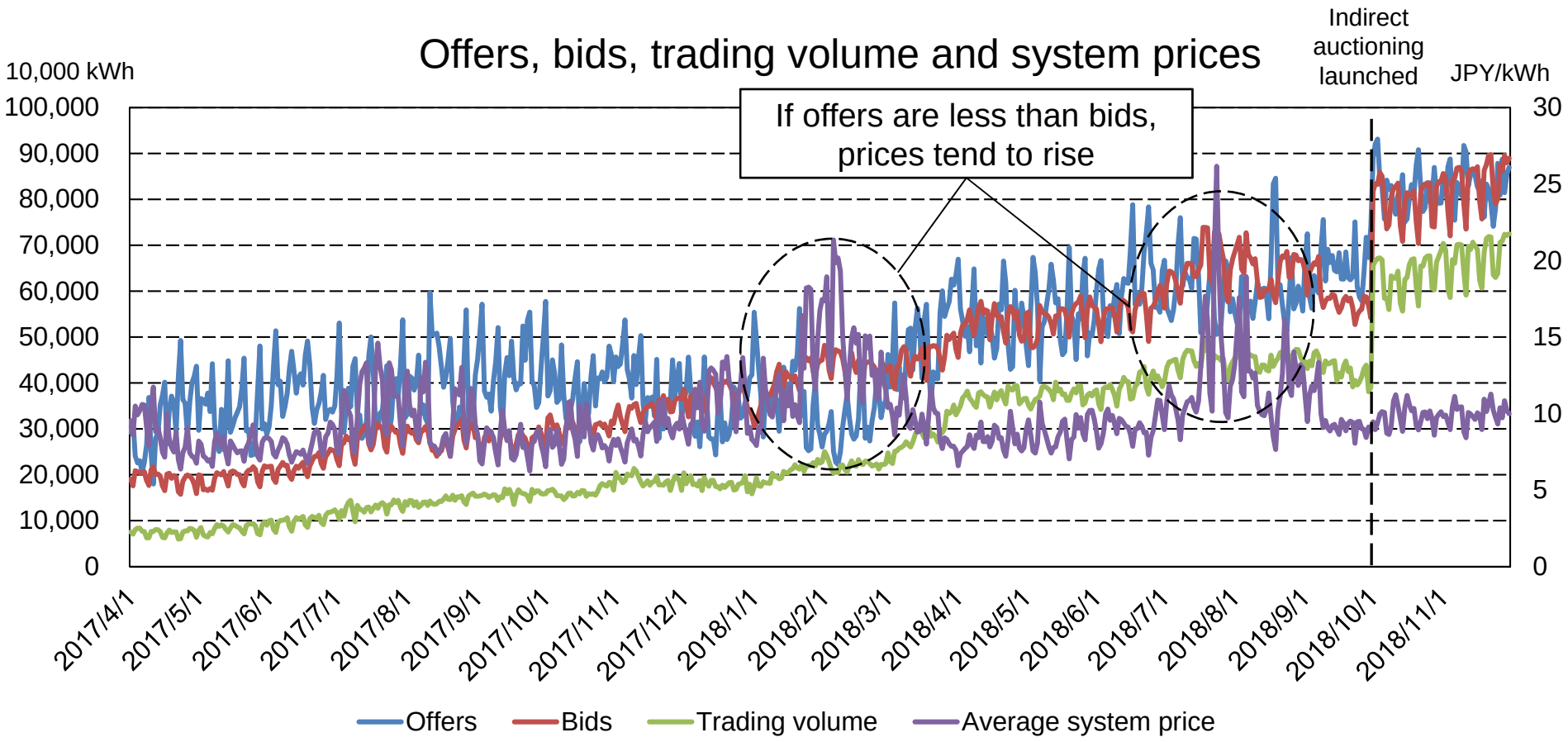
Oil's share of the power mix had been kept at a certain level until 2013 but has remained below 5% since 2017.
In contrast, renewable energy's share has followed an uptrend, standing at around 10% since FY2017.



(Note) Statistics have changed since April 2017.
(Sources) Prepared from Agency for Natural Resources and Energy "Survey of Electric Power Statistics"

Effects of exchange-based trading policy

As gross bidding has been launched since FY2017, day-ahead spot trading volume on the Japan Electric Power Exchange has been gradually increasing. Since the market shifted to an indirect auctioning system in October 2018, trading volume has grown further. Although the baseload power market will be launched in FY2019, it will have no effect on exchange-based trading in the year, with delivery planned to start in FY2020.



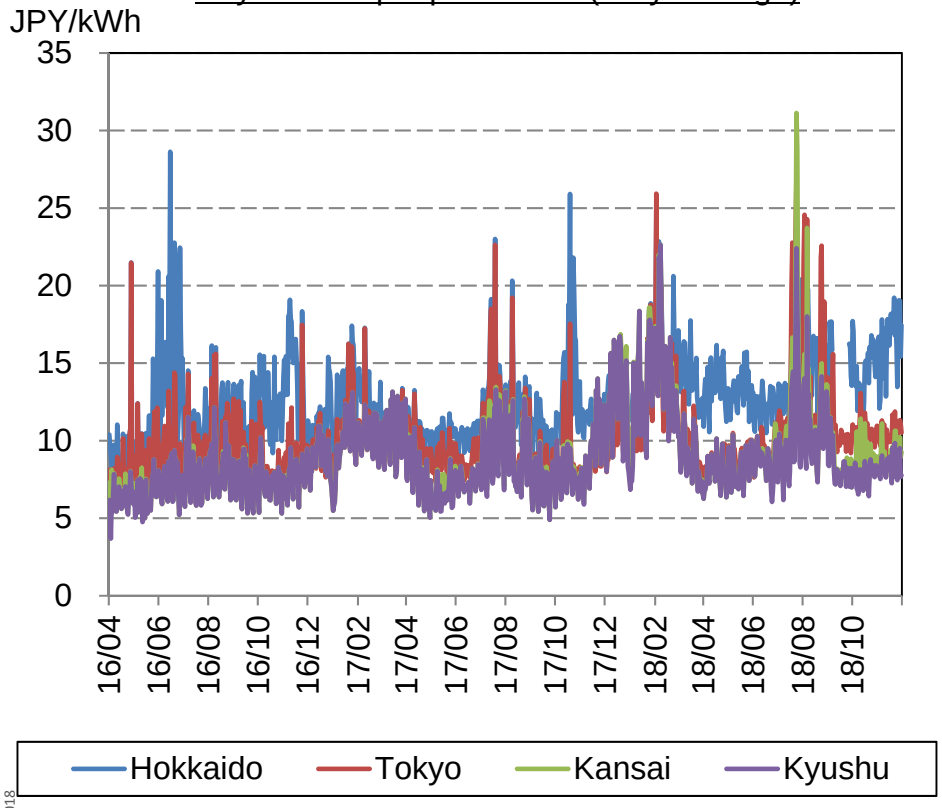
(Source) Japan Electric Power Exchange

Interregional day-ahead spot price gaps

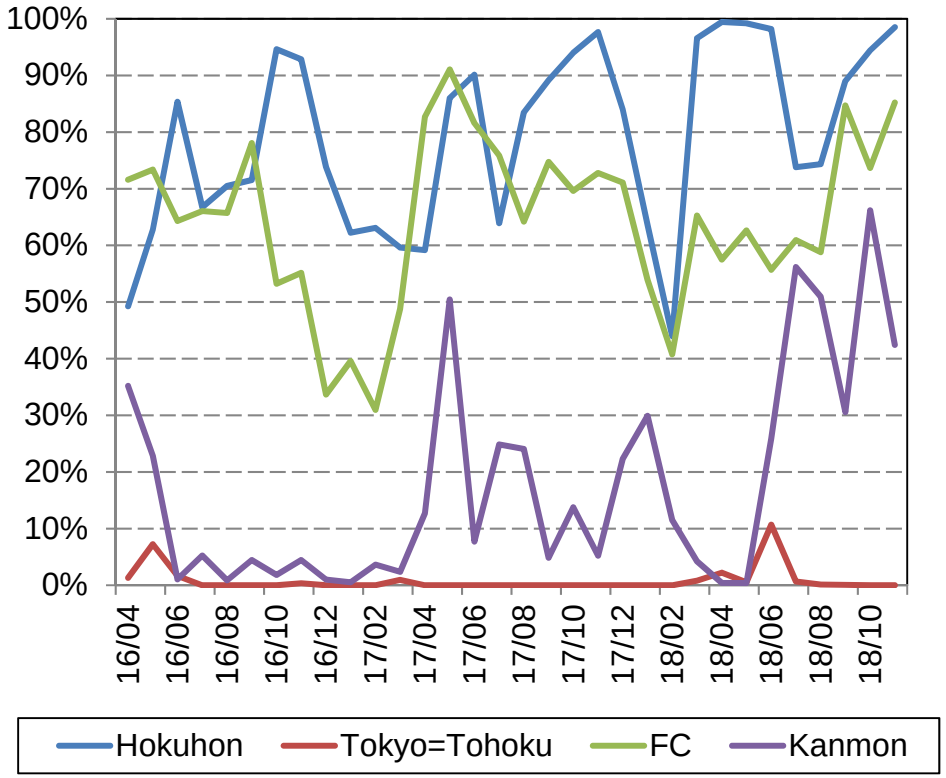
Market splitting(Note) is frequently seen for electricity trading between areas divided by the Hokuhon (Hokkaido-Honshu) interconnection line, the FC (frequency converter) and the Kanmon interconnection line, resulting in consistent price gaps between Hokkaido, Honshu and Kyushu and between eastern and western Japan. Indirect auctioning has so far had no impact on market splitting. As delivery starts on the baseload power market in FY2020, however, market splitting may increase.

(Note) Market splitting means that when nationwide transactions are established to cause transmission congestion on interconnection lines, the market may be segmented into areas for area-by-area transactions at different prices.

Day-ahead spot price trend (daily average)



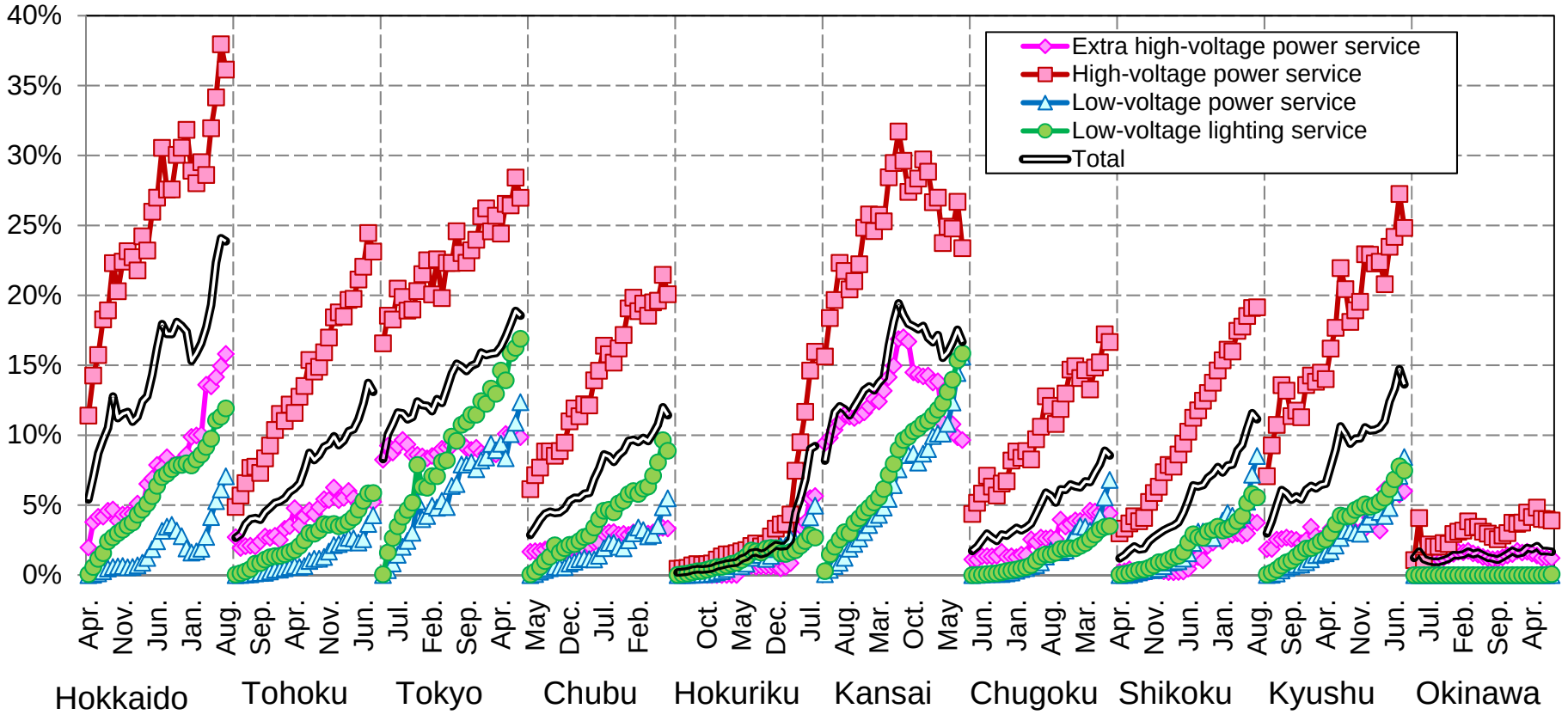
Market splitting rate (monthly splitting rate)



(Source) Japan Electric Power Exchange

Trends of regional rates of switching from traditional electric utilities

The rate of switching from traditional electric utilities to new retailers called power producer and supplier companies has increased in Hokkaido, Tokyo and Kansai. Particularly, the rate exceeded 20% in Hokkaido. As the average electricity rate has become invulnerable to fuel cost fluctuations, electricity rates have apparently tended to depend on wholesale power market and competition conditions.

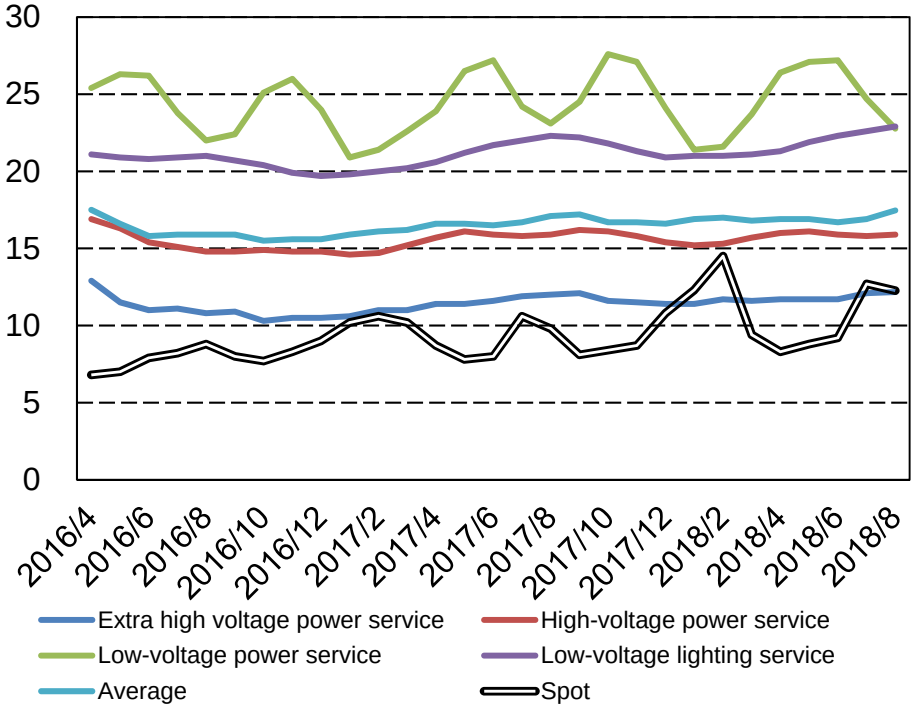


(Source) Prepared from Electricity and Gas Market Surveillance Commission “Electricity Trading Report Aggregation”

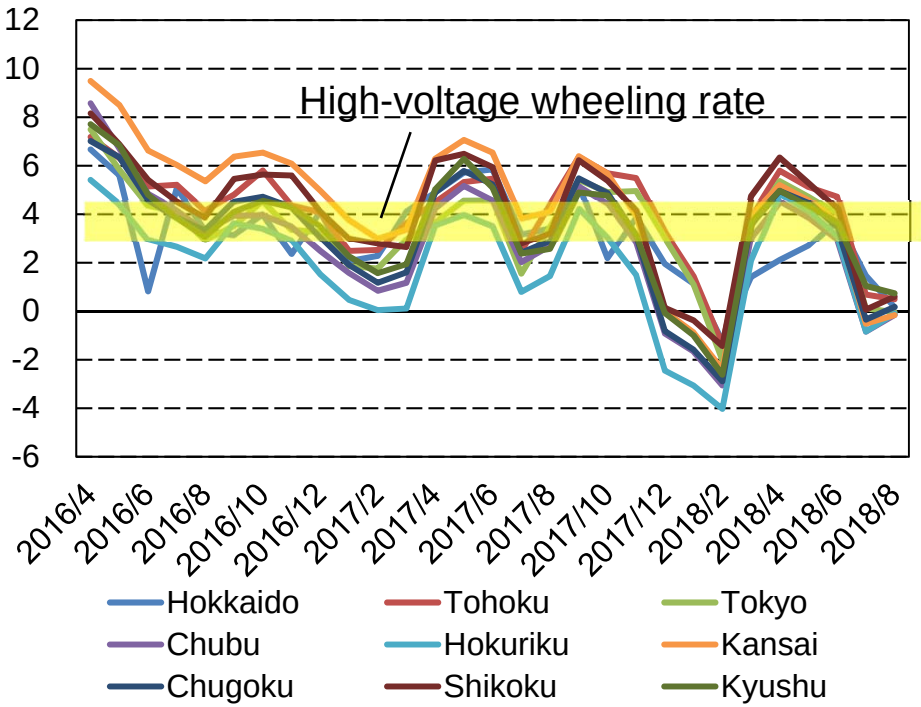
Average unit electricity price and profitability (1)

While day-ahead spot electricity prices have been rising due to increasing prices of imported fuels, with FIT surcharges expanding, electricity retail prices have not risen enough to reflect these hikes amid fierce competition, indicating that retailers' profit margins have continued shrinking. In the high-voltage power service, profit margins might have become negative for the procurement of FIT electricity at avoidable costs linked to the market.

JPY/kWh Nationwide average unit electricity price and spot price



JPY/kWh High-voltage average unit price – Surcharge – Avoidable costs linked to market

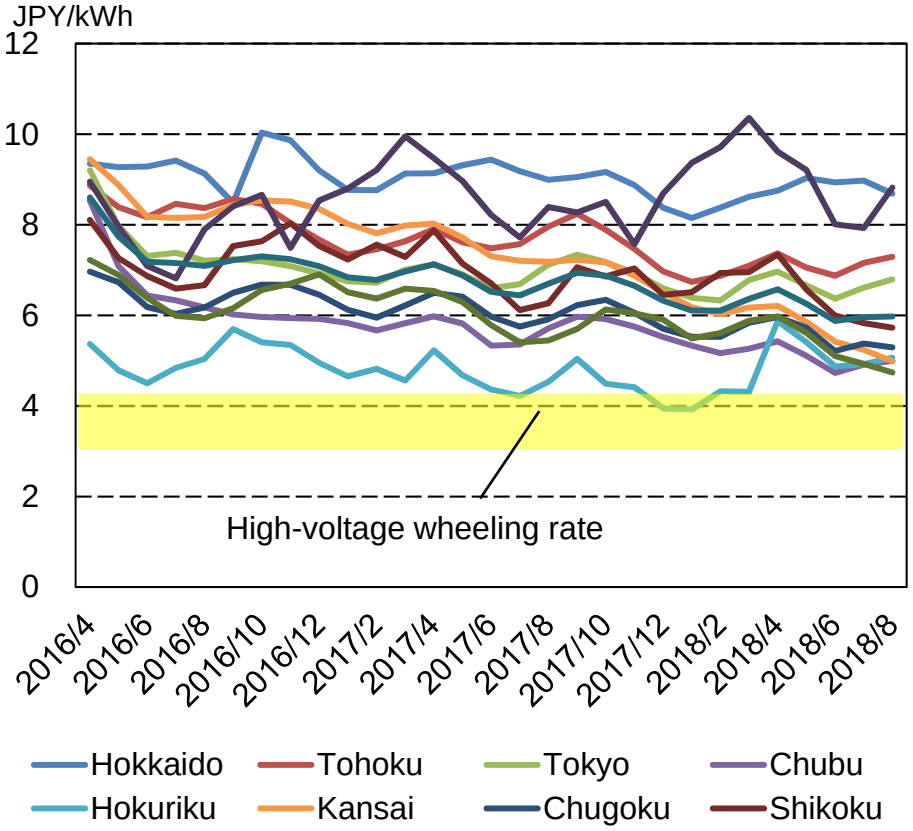


(Source) Electricity and Gas Market Surveillance Commission

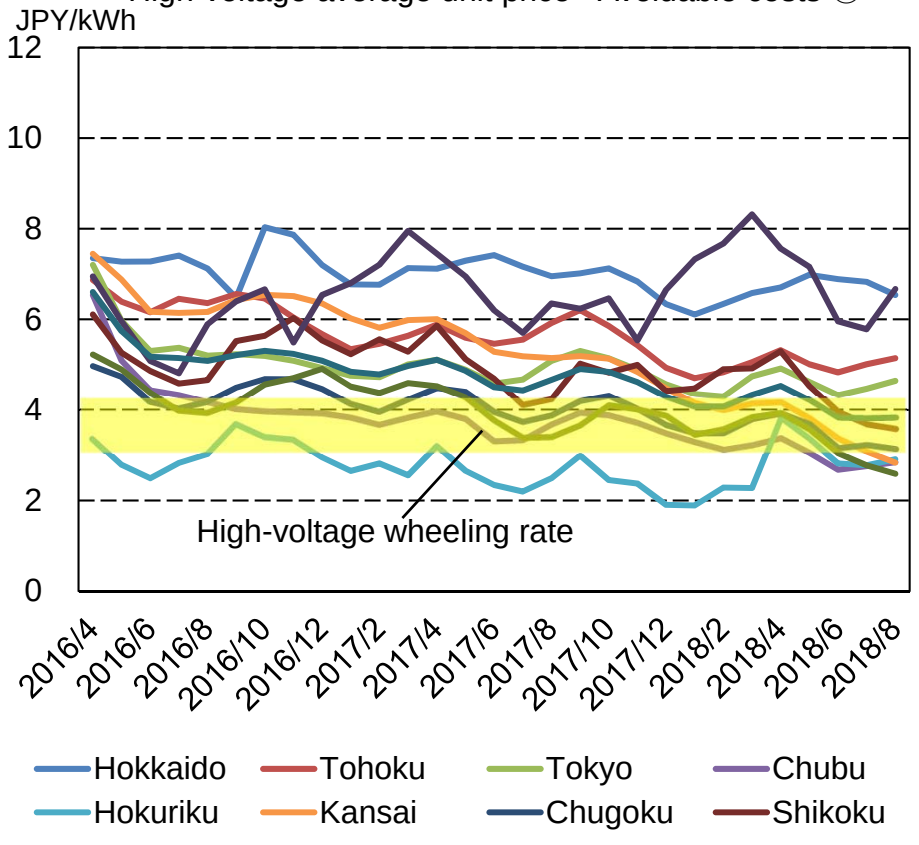
Average unit electricity price and profitability (2)

Even since avoidable costs for FIT electricity were linked to the market in April 2016, profitability has been secured for facilities approved in or before 2014 that are subjected to the market-linked avoidable costs calculated with a method under a drastic-change alleviation measure (Graph ①). In an increasing number of regions, however, profitability might have been lost for facilities approved in or after March 2014 that are subjected to the costs calculated with another method under the measure (Graph ②).

High-voltage average unit price - Avoidable costs ①

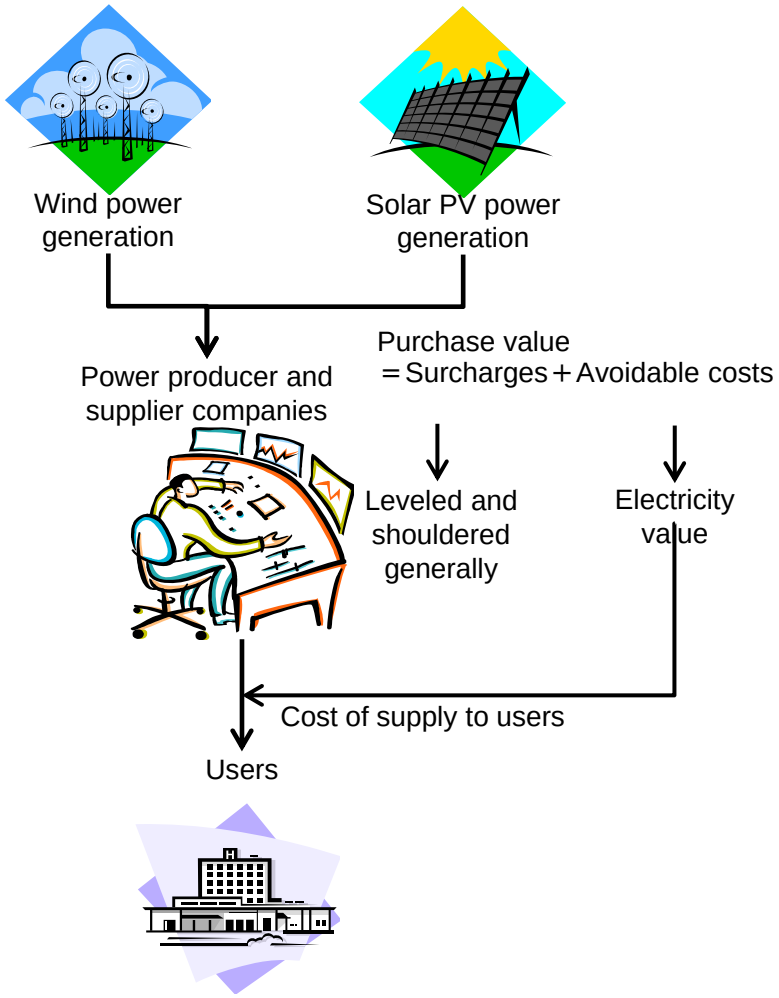


High-voltage average unit price - Avoidable costs ②



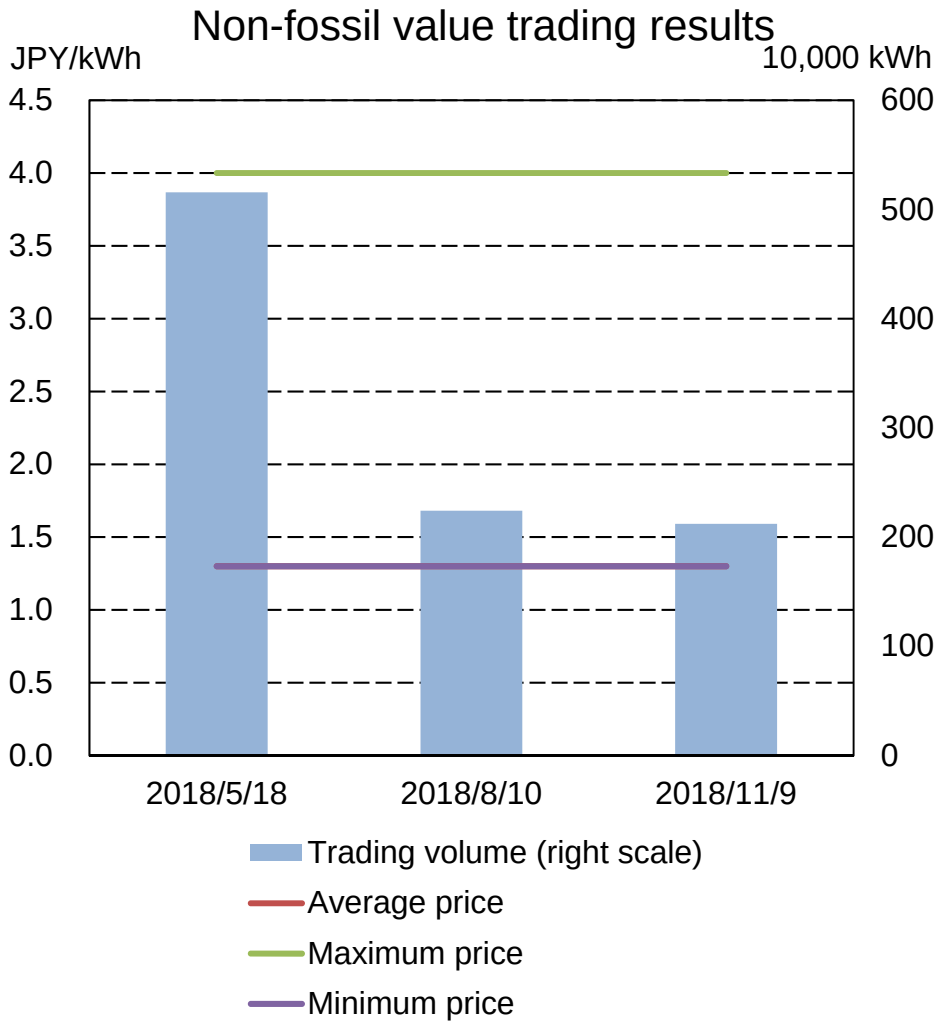
(Source) Electricity and Gas Market Surveillance Commission

【Reference】 Avoidable costs



- Until March 2016, contracts had been admitted for electricity retailers to purchase FIT electricity for supply to users. At present, however, electricity transmission and distribution utilities purchase FIT electricity, with retailers continuing to purchase FIT electricity under contracts existing since before March 2016.
- The value of FIT electricity purchased by retailers is called avoidable costs. Until March 2016, the avoidable costs for new retailers called PPS (Power Producer and Supplier) companies had been based on the average of avoidable costs for traditional electric utilities, resulting in cheap electricity supply in some regions. While the avoidable costs are linked to the market at present, a drastic-change alleviation measure has been introduced to calculate the avoidable costs with the abovementioned method for five years.
- There are two types of avoidable costs applied under the drastic-change alleviation measure – one for facilities approved in or before March 2014 and another for those approved in or after April 2014. The former type is based on the power generation costs for the average variable costs for all electricity sources giving priority to long-term adjustment. The latter type gives consideration to electricity supply capacity assessment by renewable energy source and adds fixed costs to the avoidable costs. The present avoidable costs are based on day-ahead and real time market spot prices for short-term adjustment.

Non-fossil value certificates



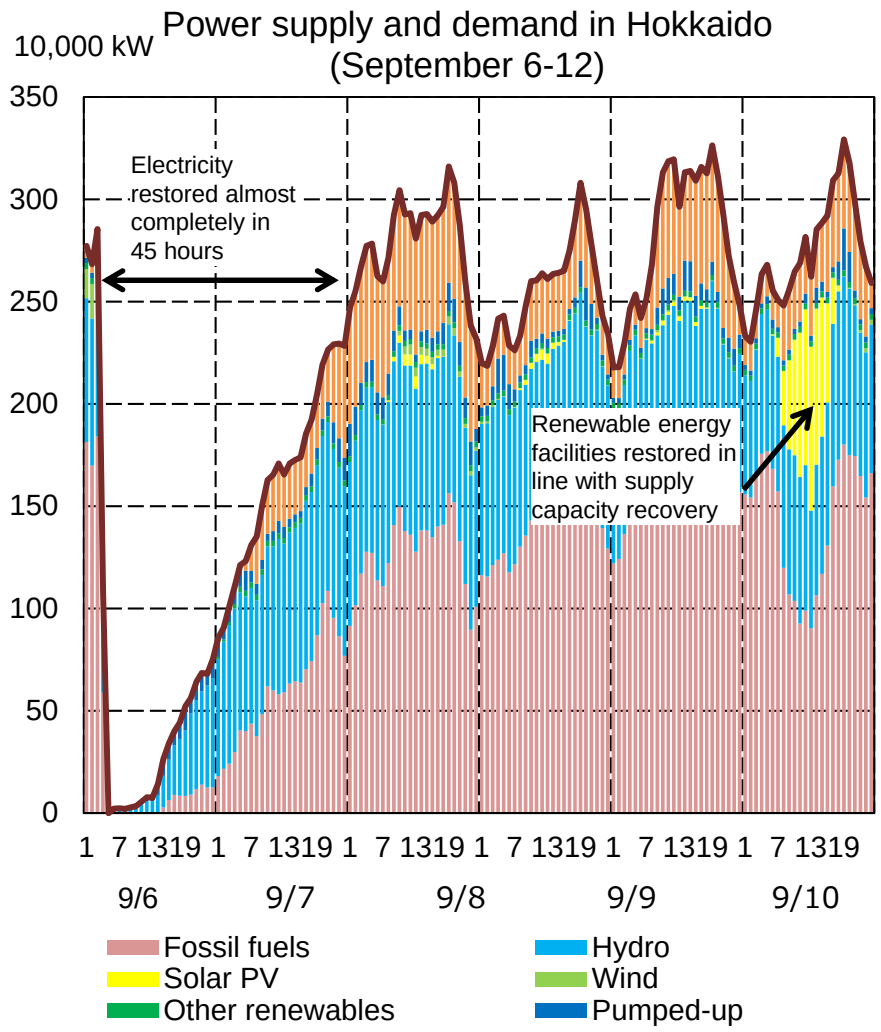
(Note) May transactions were for FY2017 and later transactions for FY2018.

(Source) Japan Electric Power Exchange

- Although trading in non-fossil value certificates started in May 2018, trading volume has been very limited, resulting in about JPY12.37 million in cumulative surcharge savings.
- The average price stood at the same level as the minimum price of JPY1.3/kWh indicating market participants' low appetite to buy non-fossil value certificates. The number of auction participants declined from the initial level of 26 to only nine in November.
- As retailers' profit margins are apparently shrinking, whether non-fossil value can be accepted by users may have to be examined.
- An initiative to conduct tracking for utilizing FIT electricity for the RE100 (Renewable Energy 100%) initiative for stimulating users' appetite for non-fossil value certificates has been suggested along with a policy of designing non-fossil value certificates for non-FIT electricity.

(Note) Tracking manages information on electricity sources, electricity generation locations, generation capacity, generation periods and control that would be linked to non-fossil value certificates to prevent the double use of certificates.

Verifying resilience based on Hokkaido Blackout



- When the Hokkaido Eastern Iburi earthquake occurred on September 6, 2018, a blackout came for the whole of Hokkaido. According to the government's Electricity Resilience Working Group, the blackout was attributable to multiple factors – the shutdown of the Tomato Atsuma power station near the epicenter and that of hydropower generation accompanying accidents involving four transmission lines. Constraints will be imposed on operational conditions to prevent the recurrence of such blackout.
- The following points were confirmed in a general electricity resilience review conducted from the viewpoint of whether a similar event could come in any other region:

✓ It was confirmed that the loss of the largest power generation site in eastern Japan, central/western Japan, or the Shikoku or Kyushu regions would not lead to a blackout through a frequency decline.

✓ In the Okinawa region, it was confirmed that conditions would become severe in the minimum demand section as well as the daytime section when solar PV power generation peaks, leading operational conditions to be revised.

✓ It was confirmed that an N-4 (Note 1) transmission line accident would not lead to a blackout in any region.

- It was decided that the Organization for Cross-regional Coordination of Transmission Operators, Japan, will (1) further reinforce the Hokuhon (Hokkaido-Honshu) interconnection line, (2) take measures such as supply capacity expansion to secure responses, (3) reinforce and expand the utilization of interregional connection lines contributing to harmonizing resilience with renewable energy expansion, (4) revise a frequency level set for disconnection (Note 2) accompanying solar PV and wind power generators' frequency fluctuations and (5) conduct the technical examination of blackout costs.

(Note 1) "N-4" means the simultaneous failure of four grid facilities and is a technical term used for a stable supply analysis.
(Note 2) When the frequency remains below a certain set level for a certain period of time, an under-frequency relay works to shut down a power generator to prevent its failure.

(Source) Prepared from Hokkaido Electric Power Co. "Supply and Demand Results in Hokkaido"

This winter's supply-demand balance

- In its outlook for this winter released on November 28, the European Network of Transmission System Operators for Electricity (ENTSO-E) pointed out that some countries could see electricity supply capacity shortages if renewable energy power generation facilities operate below their capacity. Supply capacity shortage risks are higher for countries that heavily depend on gas-fired power generation. Germany and Italy are expected to have to curtail renewable energy power generation if their respective domestic surplus supply exceeds interconnection line capacity.
- As Japan has revised demand assumptions for an abnormally cold winter in consideration of such winter seen in the previous fiscal year, there is a larger number of regions that fail to have regional capacity to secure capacity required for stable supply. Each region is expected to take advantage of Power Source I (Note), fossil-fired power generation expansion and interconnection lines to secure the electricity reserve margin of 3%. A U.S. winter reliability assessment concludes that the risk of tight supply is small.

(Note) Power supply adjustment capacity to respond to the hottest or coldest weather in a decade.

This winter's supply-demand balance outlook for major countries

	Normal	Severe winter	Daytime oversupply risk	Night-time oversupply risk
Austria	Required to import	Required to import	Absent	Absent
Belgium	Required to import	Shortage risk	Prone to export	Prone to export
Finland	Required to import	Shortage risk	Absent	Prone to export
Hungary	Required to import	Required to import	Absent	Absent
Italy	Required to import	Shortage risk	Present	Present
U.K.	Self-sufficient	Self-sufficient	Absent	Prone to export
Germany	Self-sufficient	Required to import	Present	Present
France	Self-sufficient	Required to import	Absent	Absent

(Note) "Required to import" here means a country that has smaller supply capacity than peak demand but can cover a shortage with imports. "Shortage risk" means a country that has smaller supply capacity than peak demand and cannot cover a shortage with import capacity.
(Source) ENTSO-E, "Winter Outlook 2018/2019," November 2018

This winter's supply-demand balance by region

	Severe winter	Interconnection line utilization
Hokkaido	○	○
Tohoku	Reserve capacity shortage	○
Tokyo	Reserve capacity shortage	○
Chubu	○	○
Hokuriku	Supply capacity shortage	○
Kansai	○	○
Chugoku	Supply capacity shortage	○
Shikoku	Supply capacity shortage	○
Kyushu	Supply capacity shortage	○
Okinawa	○	○

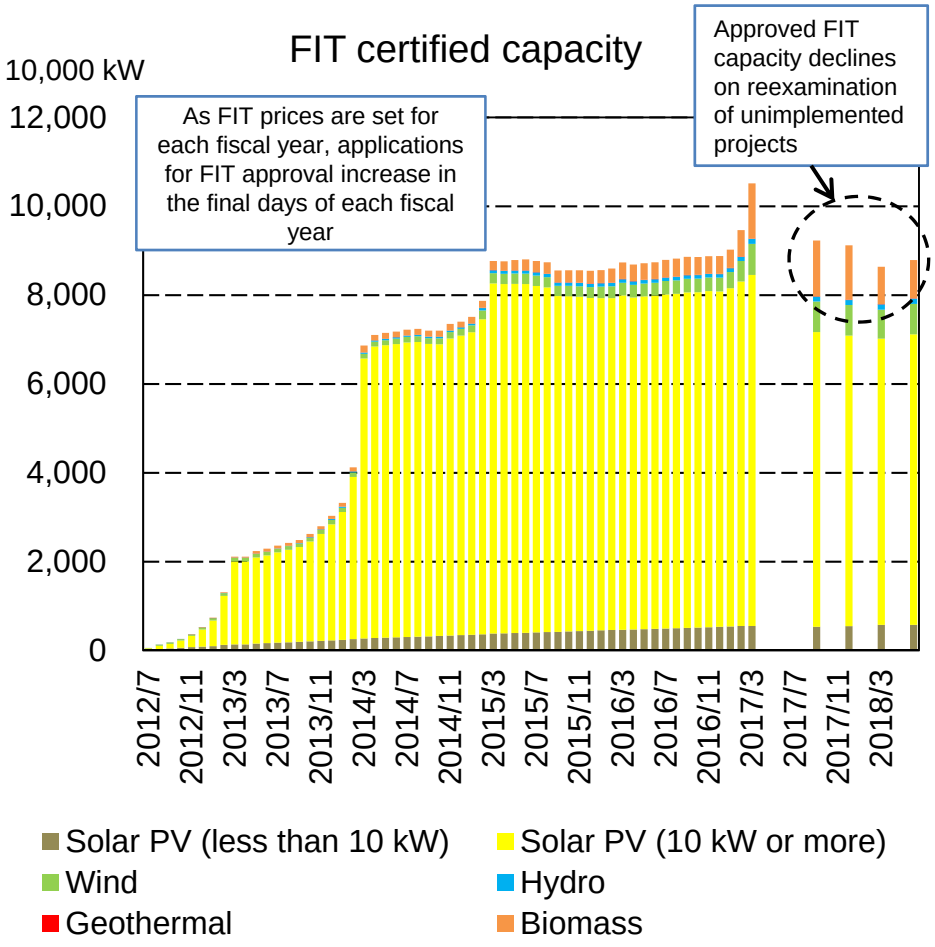
(Note) ″Reserve capacity shortage" here means that supply capacity is larger than peak demand, with reserve capacity being short. Supply capacity shortage means that supply capacity is smaller than peak demand.
(Source) Organization for Cross-regional Coordination of Transmission Operators, Japan, "Electricity Supply and Demand Verification Report," November 2018

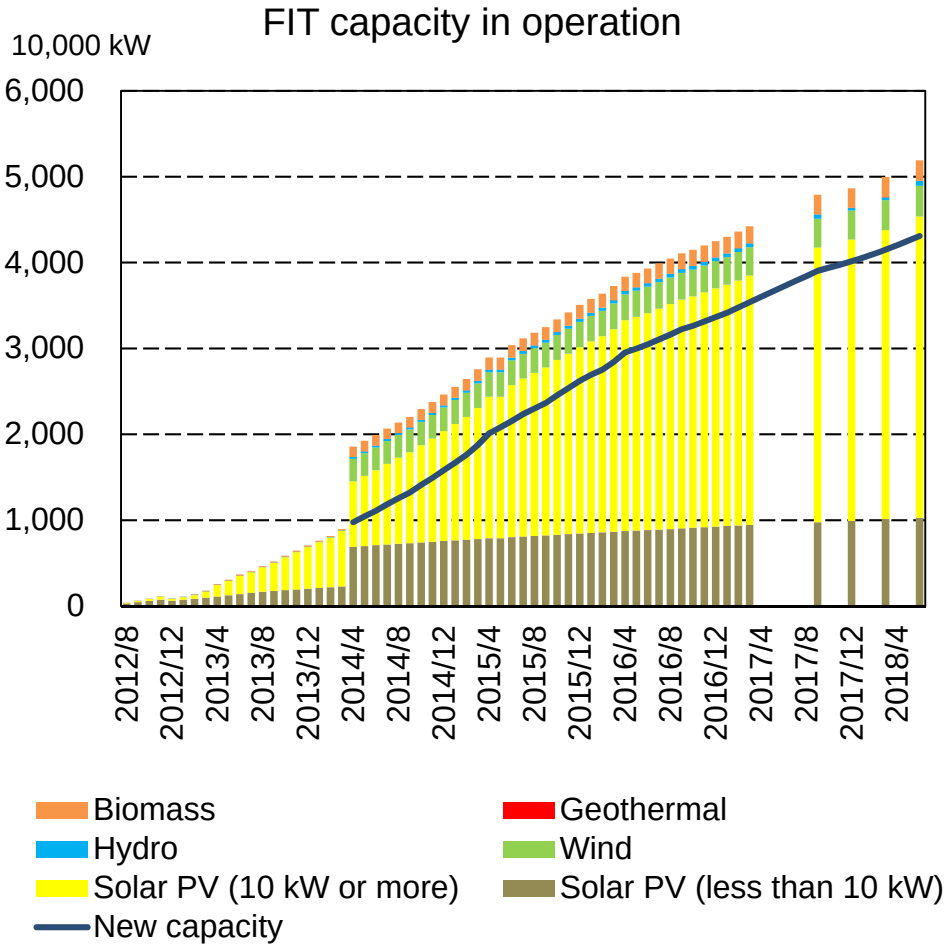
Short-term challenges for electric power industry

- In FY2019, trading is set to start in baseload power generation capacity and indirect transmission rights. Trading in baseload power generation capacity will have no impact within FY2019 as delivery is scheduled for FY2020. As daytime oversupply increases in line with the expansion of renewable energy power generation under the FIT scheme, Market splitting for spot wholesale power prices is prone to increase.
- As electricity retailers' profit margins are shrinking on fierce competition, it is becoming difficult for them to secure competitiveness through market-based electricity procurement. It has become difficult to consider non-fossil value certificate and capacity markets that could exert additional burden on PPS companies.
- The drastic-change alleviation measure for linking avoidable costs for FIT electricity to the market is set to expire in five years from April 2016. Business models are required to be reconsidered toward the launching of the baseload power market as an alternative option to secure cheap supply capacity.
- The Hokkaido blackout has prompted the government to verify the resilience of power systems. It has been concluded that any disaster similar to the earthquake that led to the Hokkaido blackout would fall short of triggering a blackout in any regions other than Hokkaido and Okinawa where operational conditions would be revised to avoid any similar blackout.
- In its outlook for this winter's electricity supply-demand balance, the European Network of Transmission System Operators for Electricity (ENTSO-E) pointed out that some countries could see electricity supply capacity shortages if renewable energy power generation facilities operate below their capacity. This is attributable to the continuous retirement of fossil-fired power plants that has come on slack wholesale power prices amid the expansion of renewable energy power generation. Japan will have to confirm whether stable electricity supply would be secured before delivery on the capacity market starts.

Renewable energy power generation under FIT scheme

- While renewable energy power generation capacity certified under the FIT scheme has declined due to measures taken to address projects that have been left unimplemented for a long time after FIT certification, FIT capacity in operation has continued increasing.



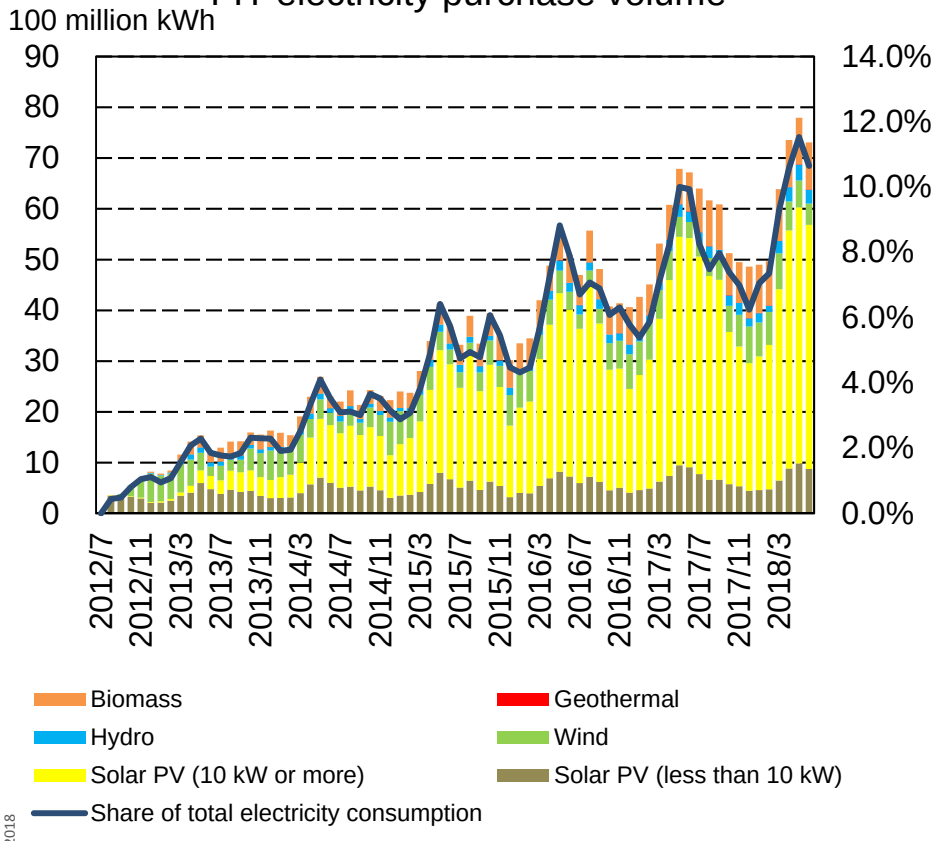


(Source) Agency for Natural Resources and Energy “Information Disclosure Website”

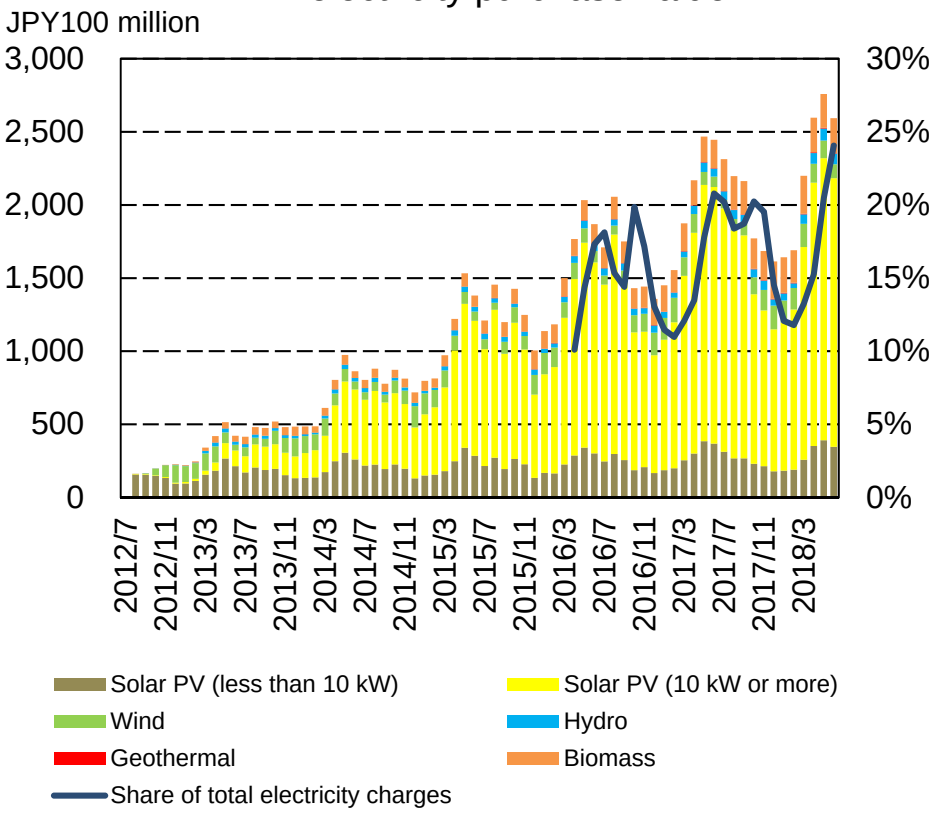
FIT electricity purchase volume and value

- FIT electricity purchases have been increasing, accounting for 10% of total electricity consumption or 20% of total electricity charges in some months. How to suppress rapid growth in the purchase value is a challenge.
- While how to suppress renewable energy power generation costs to cut burdens on consumers is attracting attention, consideration should be given to how to nurture business operators that can implement stable solar PV or wind power generation at lower cost.

FIT electricity purchase volume



FIT electricity purchase value

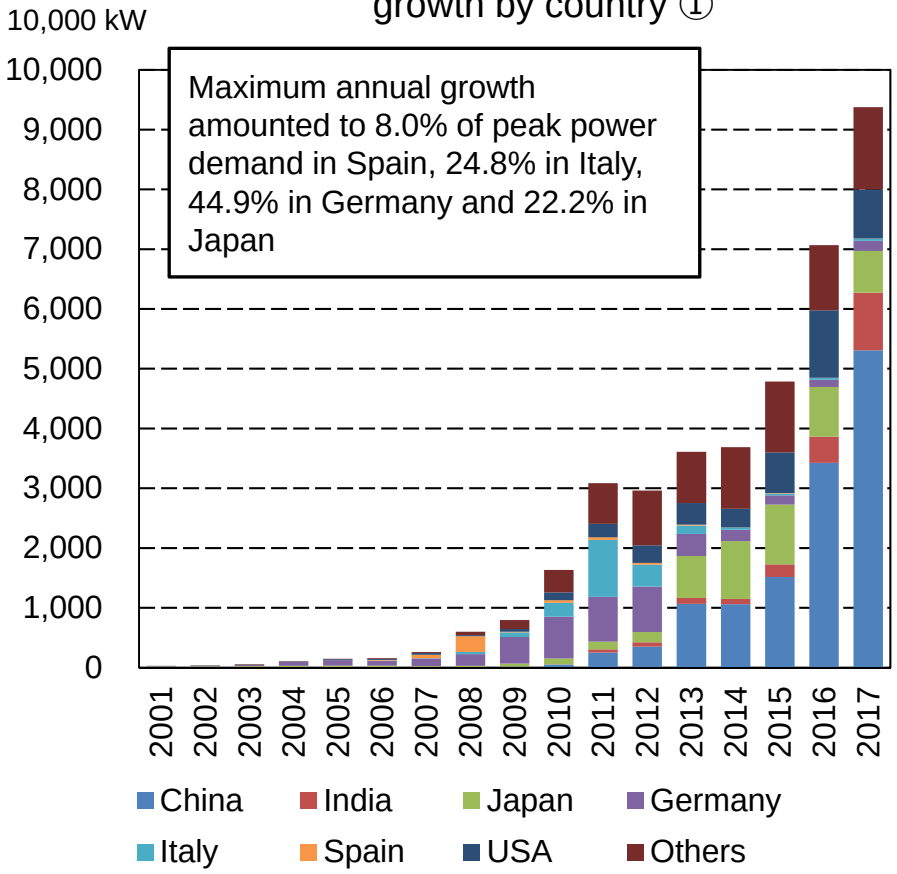


(Source) Agency for Natural Resources and Energy “Information Disclosure Website”

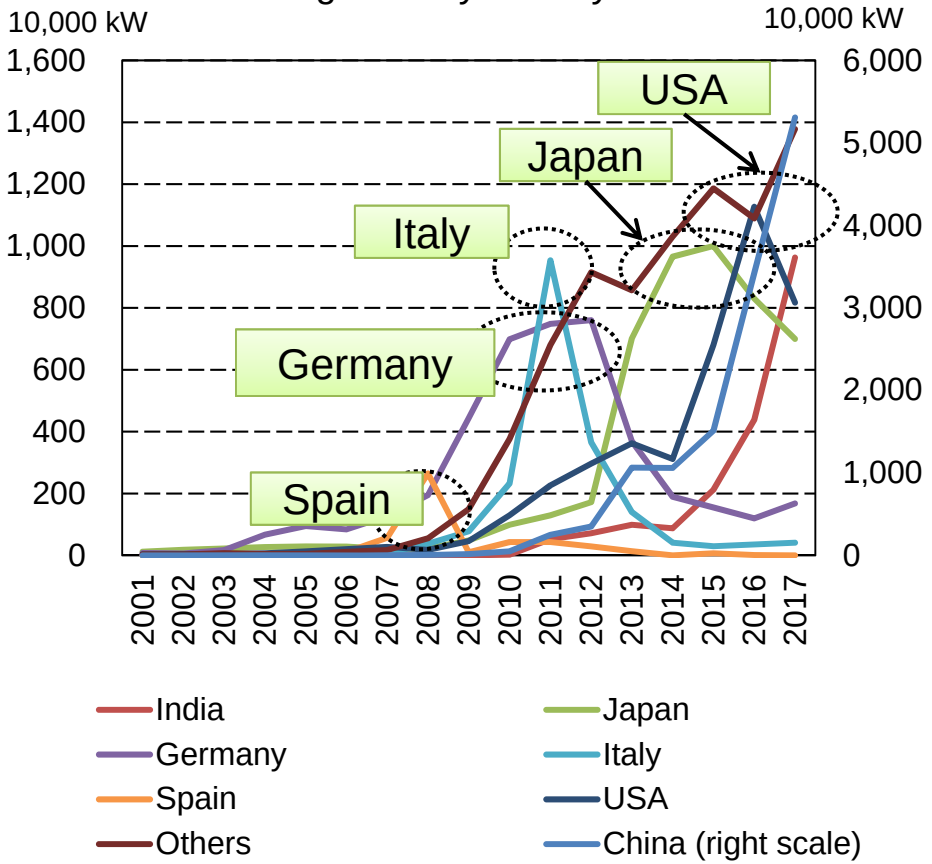
Solar PV power generation capacity growth

- Solar PV power generation is prone to an investment boom, expanding rapidly before decelerating growth. At present, solar PV power generation is expanding rapidly in the United States and China.

Annual solar PV power generation capacity growth by country ①



Annual solar PV power generation capacity growth by country ②

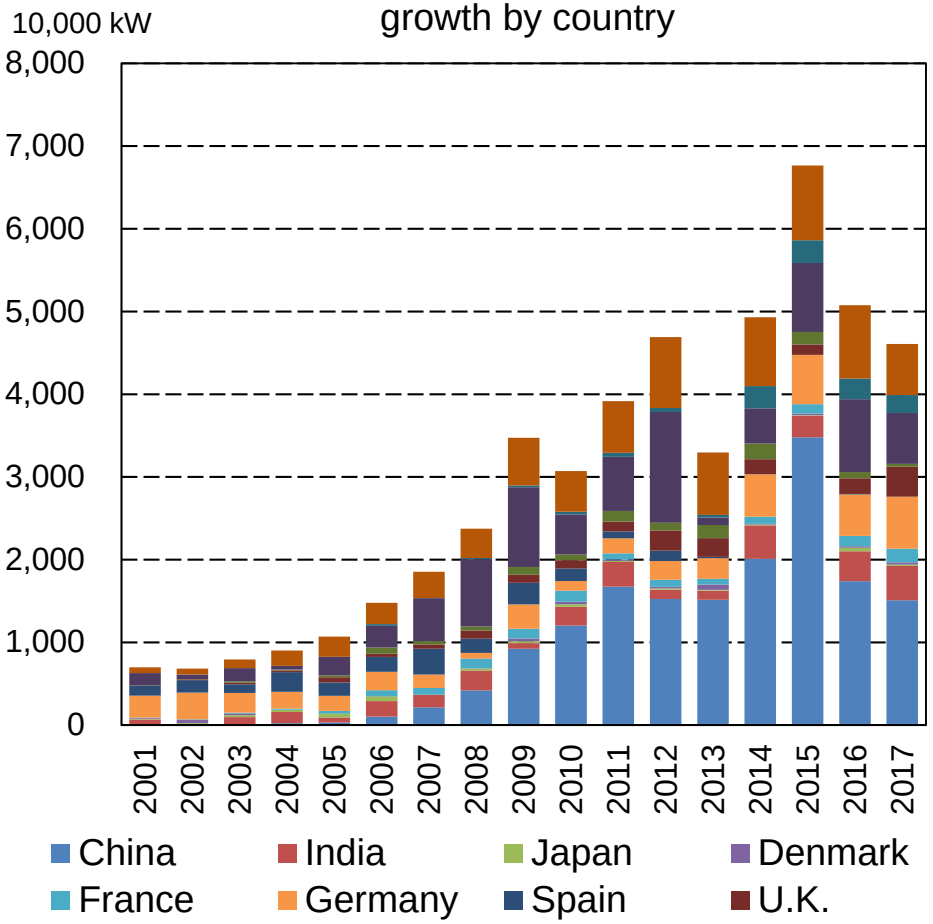


(Source) IRENA

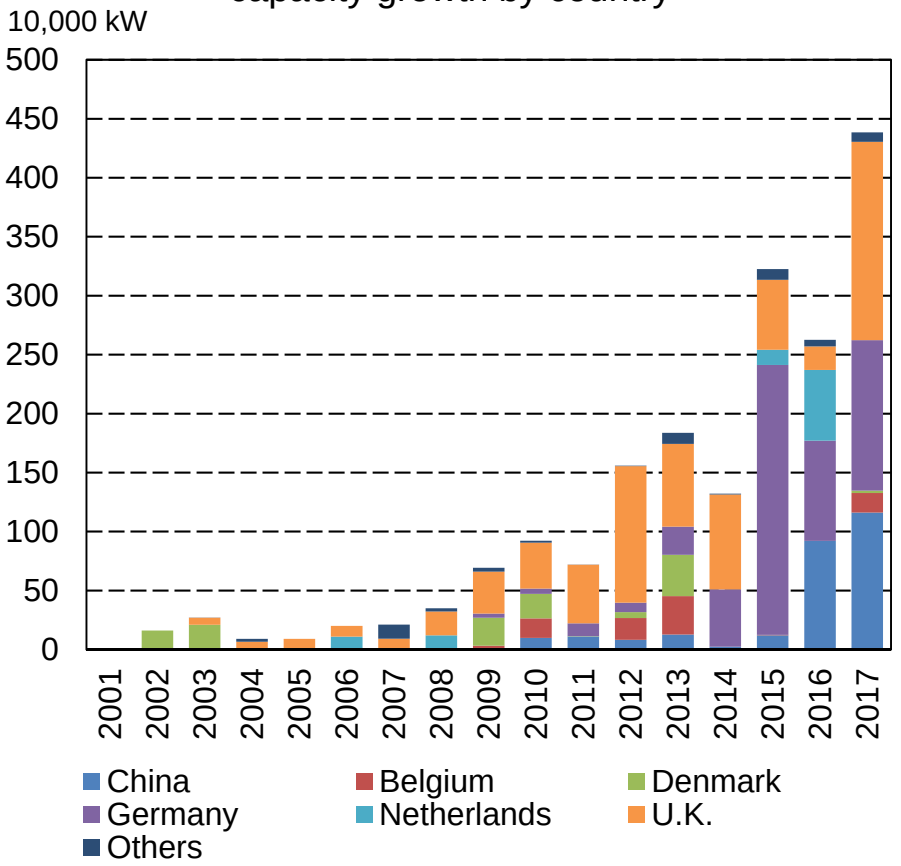
Wind power generation capacity growth

- Wind power generation capacity growth in China has remained rapid. Offshore wind power generation capacity is expanding in China as well as in Europe's North Sea.

Annual wind power generation capacity growth by country



Annual offshore wind power generation capacity growth by country

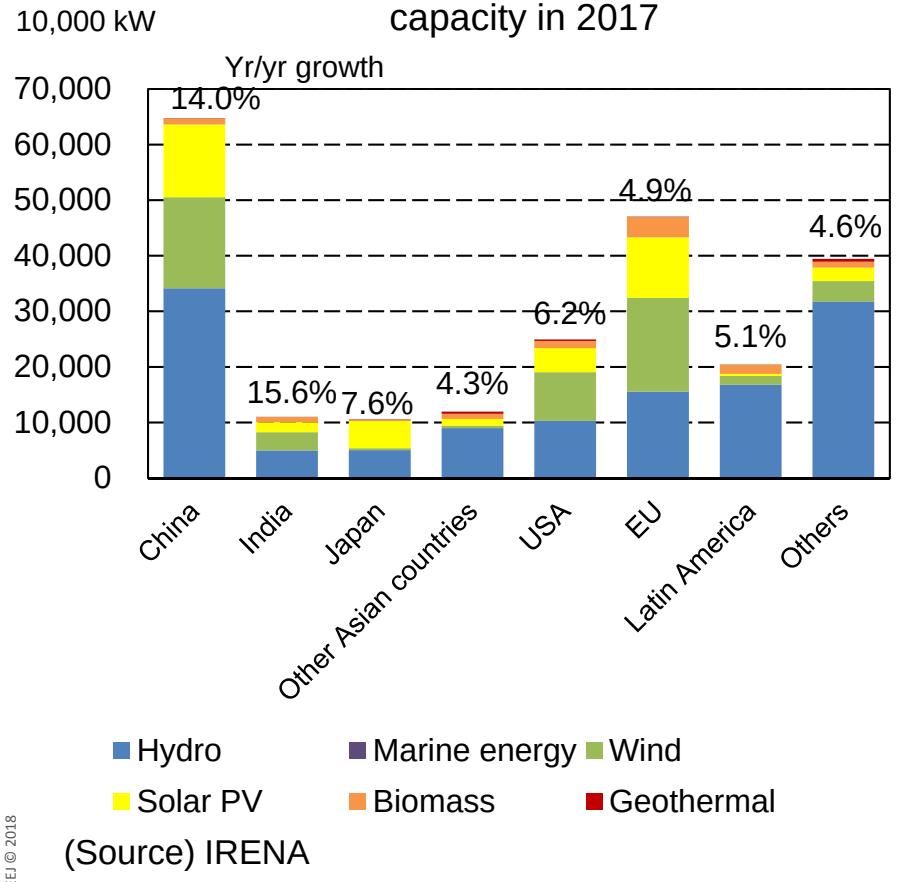


(Source) IRENA

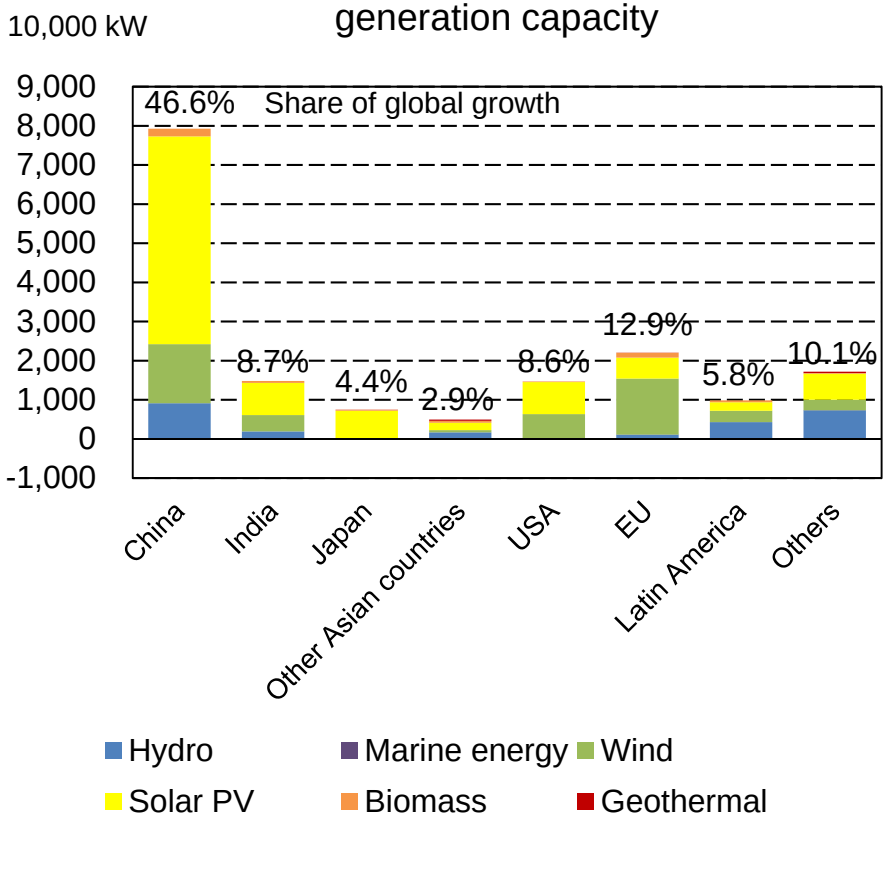
Renewable energy power generation capacity growth trends

- China accounts for 46.6% of annual growth in global renewable energy power generation capacity. A large change in FIT electricity purchases resulting from the modification of the FIT system for renewable energy power generation in China exerts influence on the global renewable energy market. As China announced a plan to suppress solar PV electricity purchase in May 2018, for example, solar PV panels came into oversupply with prices declining.

Renewable energy power generation capacity in 2017



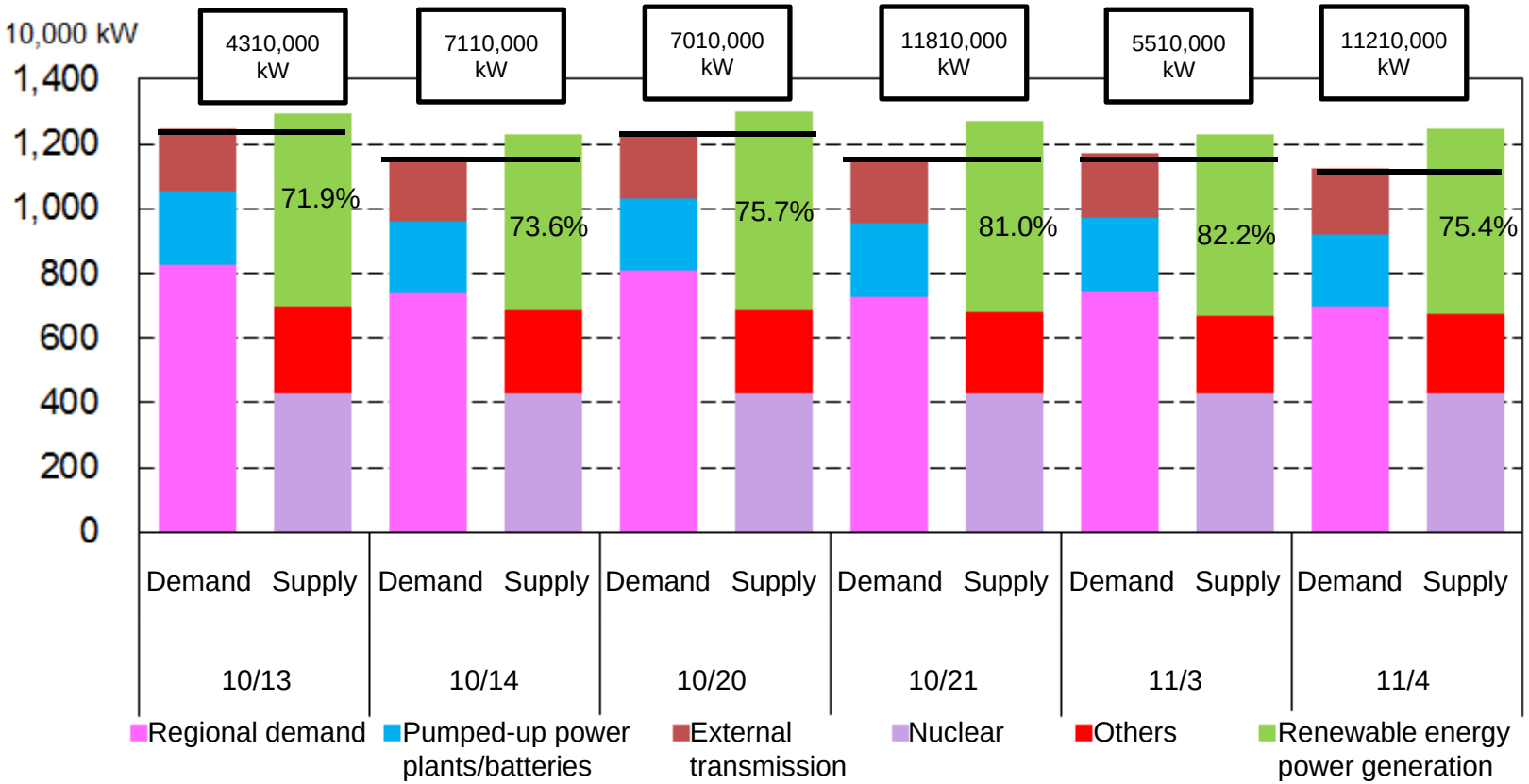
Yr/yr growth in renewable energy power generation capacity



(Source) IRENA

Kyushu Electric Power's FIT power generation curtailment

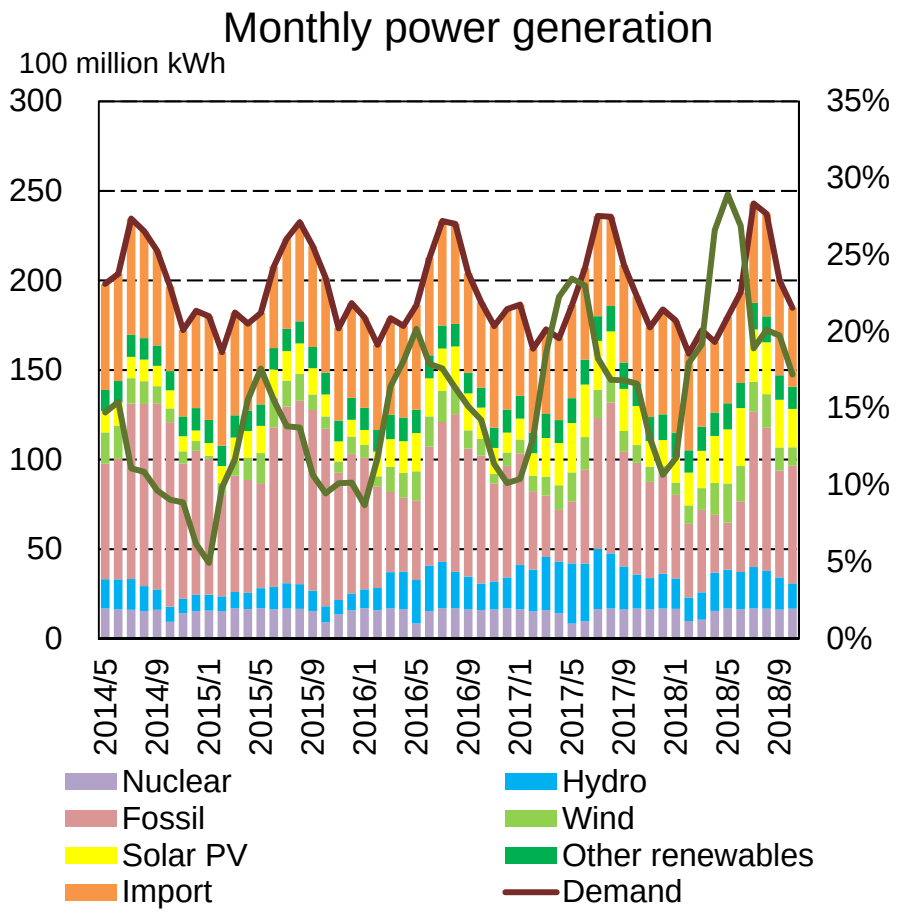
- Kyushu Electric Power Co. implemented FIT power generation curtailment on Saturday and Sunday in the middle of October. The curtailment came as the utility failed to avoid oversupply even by taking full advantage of interconnection lines, pumped-up power plants and storage batteries. As FIT power generation capacity connected to the grid network increases, the frequency of FIT power generation curtailment is expected to increase.

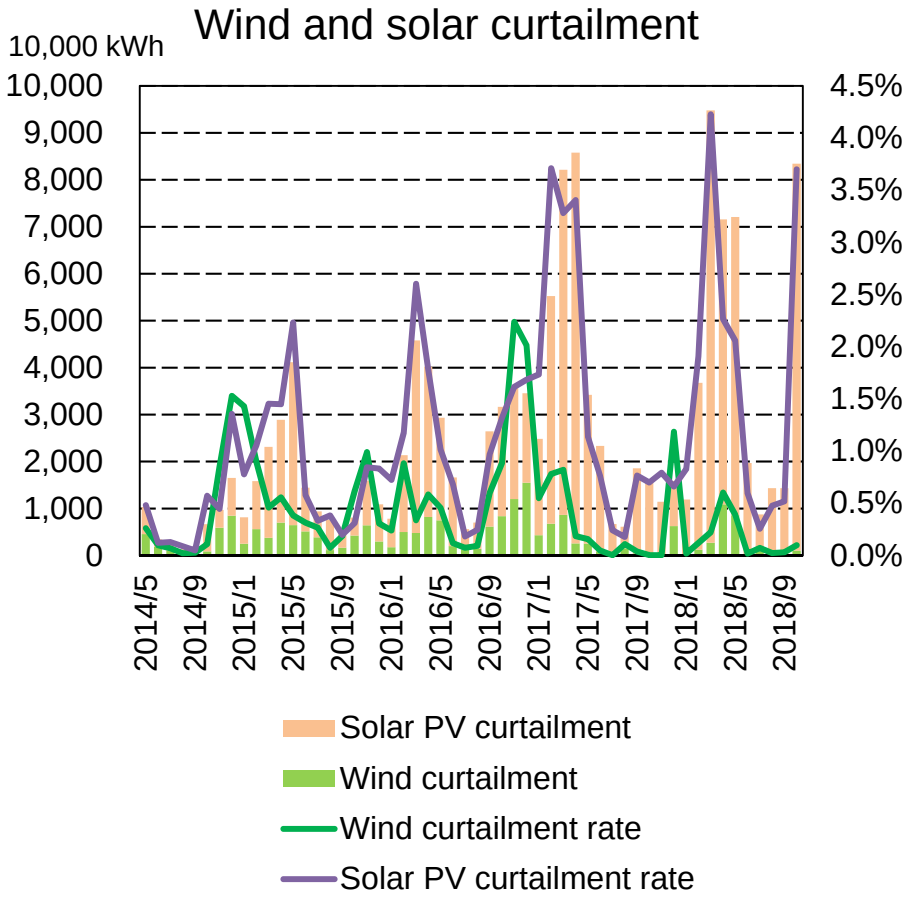


(Note) Percentages in the figure represent renewable energy power generation's coverage of regional demand.
(Source) Kyushu Electric Power Co., "Report on renewable energy power generation control orders based on the feed-in tariff system for renewable energy"

California ISO situation

- In the California ISO service area where solar PV power generation has been expanding, solar PV power generation curtailment exceeds 4% in some months. The frequency of such curtailment tends to increase in spring when power demand is lower.

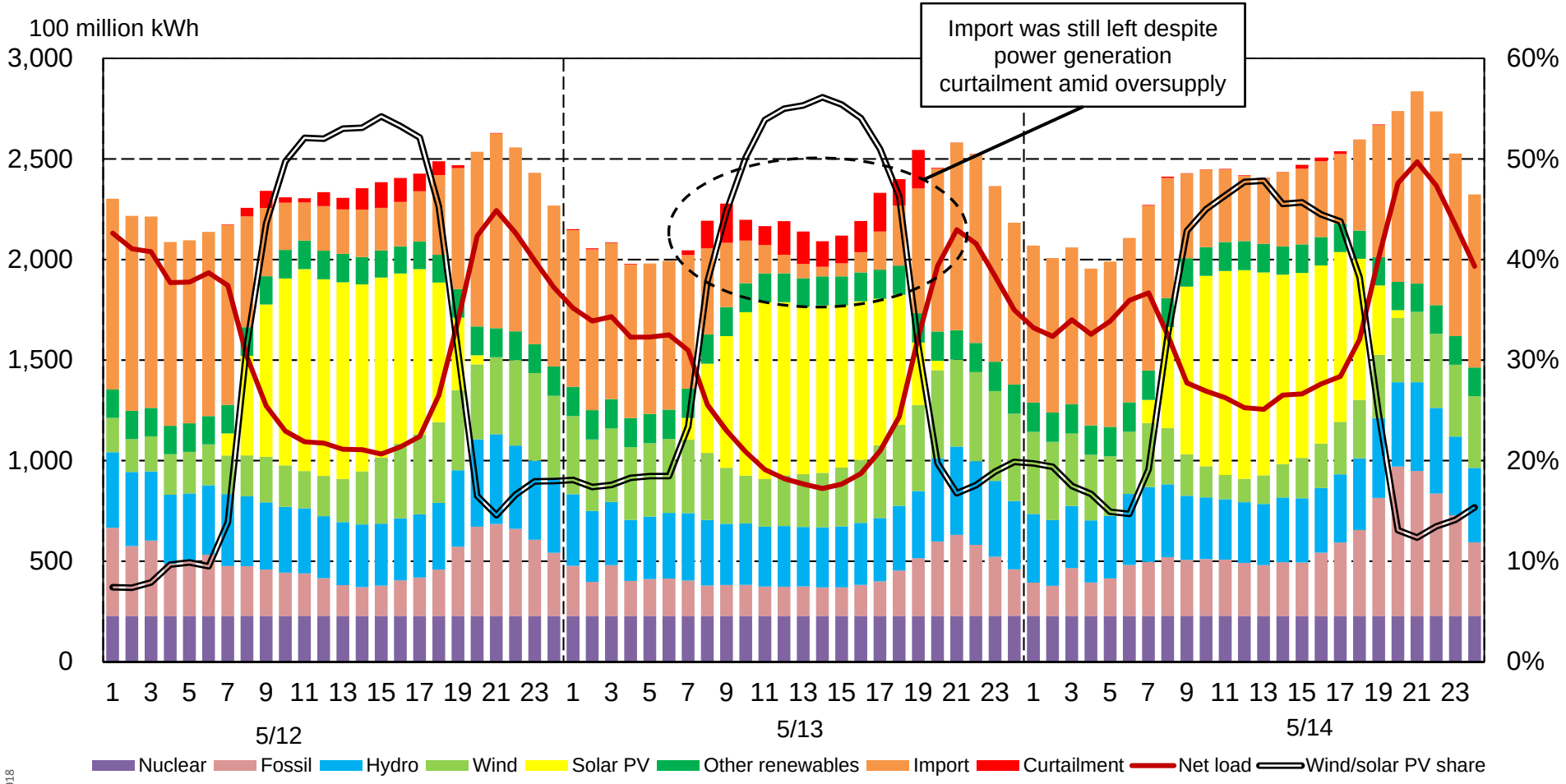




(Source) California ISO, “Historical wind and solar curtailment”

California ISO situation during May 12-14 period of 2018

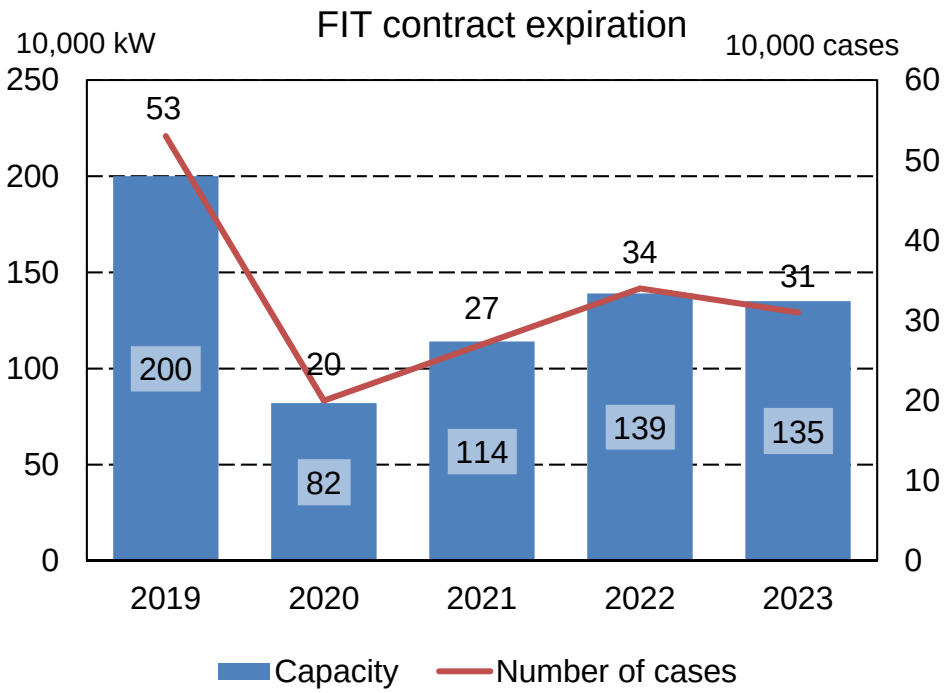
- The following figure indicates the situation on May 12 and 13, 2018, when power generation curtailment was large. Although the development of a wide power supply and demand adjustment market made it easy to curtail import, power generation curtailment was implemented when import was still left amid daytime oversupply.



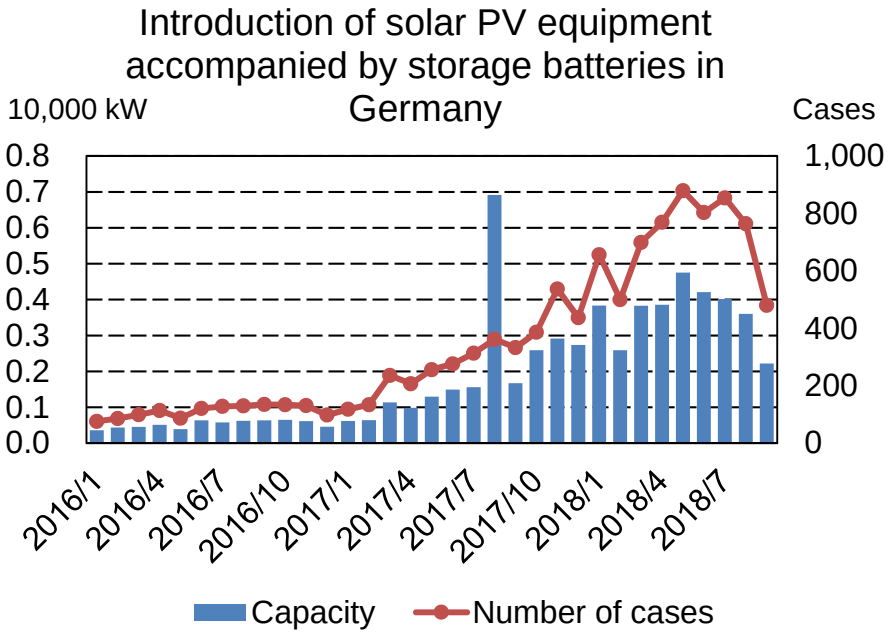
(Sources) California ISO, ”Daily renewables watch” and ”Wind and solar curtailment report”

Responding to 2019 problem

- From November 2019, the period for electricity retailers' purchase of electricity from residential solar power panels under the FIT scheme will begin to expire. The government is considering responses to the expiration. Even after the 10-year period, solar panels are assumed to remain available for power generation for at least another decade according to their service life.
  - ※ If no party is available for purchasing surplus electricity temporarily, the power transmission and distribution sector is planned to purchase it.
- In Germany, storage batteries have rapidly been installed because solar PV power generation equipment costs have slipped below residential electricity charges and subsidies are offered for storage batteries accompanying such equipment. Similar support is given in California. Given that no progress has been seen in the installation of such batteries in the world other than Germany and California, it would be difficult to diffuse storage batteries without some support measures.

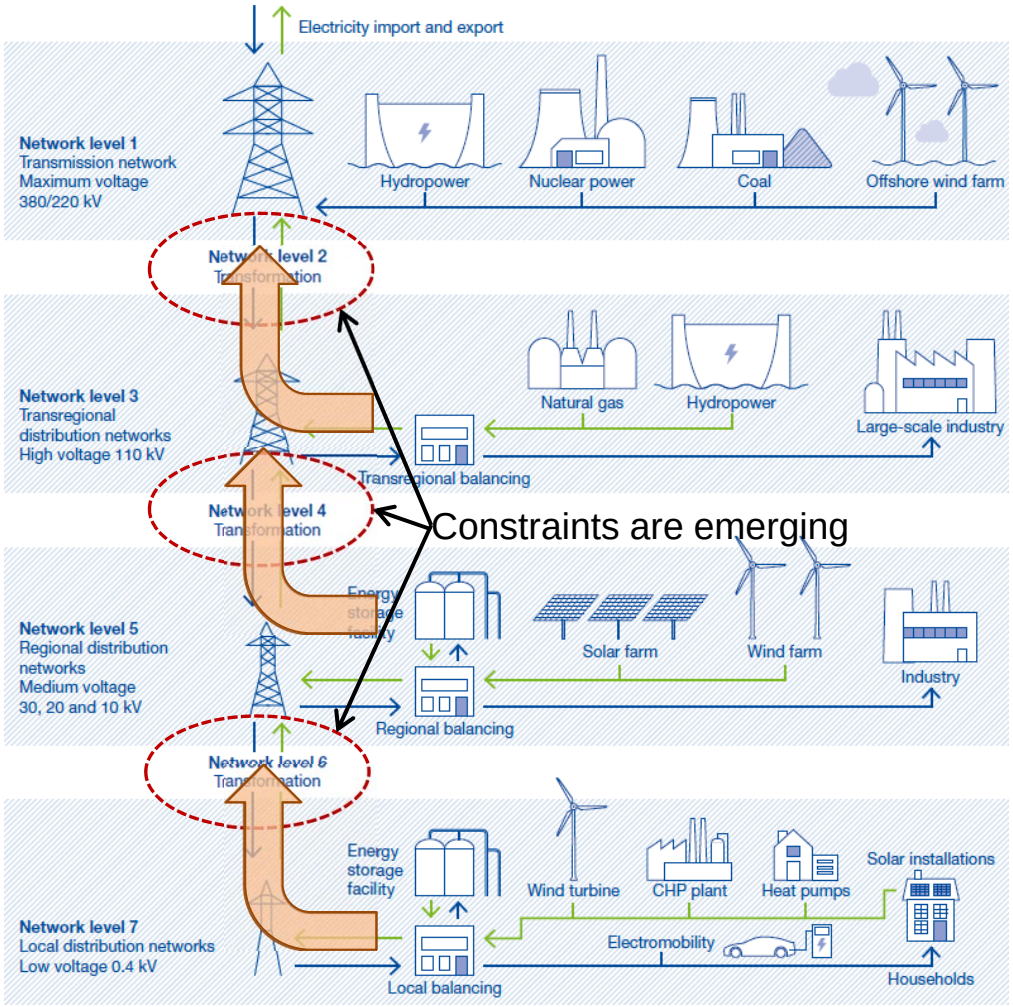


(Source) Agency for Natural Resources and Energy, "Responding to expiration of FIT contracts for residential solar PV power generation," September 2018



(Source) Federal Network Agency, "Publication of EEG Battery Storage - November 2017 to September"

New grid constraints



(Source) GEODE, “Flexibility in the Energy Transition: a Toolbox for Electricity DSOs,” February 2018

- Congestion management has been designed to resolve congestion at transmission systems available for reciprocal transmission.
- As small renewable energy power generators have growingly been connected to the grid, however, congestions have begun to emerge at the substation level.
- Europe is debating whether to integrate the congestion management services for distribution system operators (DOSs) with those transmission system operators (TSOs) or use a separate system for TSOs.
- Problems include TSO-DSO cooperation and congestion detection methods, a desirable procurement market for DSOs, and regulated and unregulated platforms.
- Japan is considering N-1 power control and non-firm connection systems (Note) to ease power transmission congestion. However, ideas about how to control substation capacity at voltage adjustment points vulnerable to congestion and about efficient output control may have to be put into order.

(Note) The N-1 power control system allows spare transmission cables for use in the event of accidents to be connected to grids on condition of disconnection upon accidents. The non-firm connection system allows business operators without transmission systems to be connected to grids operating below capacity on condition of disconnection in the event of constraints.

Short-term challenges for renewable energy power generation

- China accounts for some 50% of annual growth in global renewable energy power generation capacity. A large change in FIT electricity purchases resulting from the modification of the FIT system for renewable energy power generation in China exerts influence on the global renewable energy market. As China announced a plan to suppress solar PV electricity purchase in May 2018, for example, solar PV panels came into oversupply with prices declining.
- Japan is expected to make progress in developing systems to encourage cost cuts for renewable energy power generation's independence from the FIT scheme. As FIT contracts for residential solar PV panels are planned to expire one after another from November 2019, the government is considering response to the expiration, including a guidance encouraging households to use solar electricity for themselves. In the world other than Germany and California where subsidies are offered for storage batteries for solar PV power generation, however, no progress has been seen in the installation of such batteries. Given this situation, it would be appropriate to consider mainly how electricity retailers should purchase solar electricity.
- As well as FIT electricity generation control, next-generation networks for the effective utilization of small-capacity renewable energy power generation facilities are under consideration. Japan is considering N-1 power control and non-firm connection systems to ease power transmission congestion. However, ideas about how to control and communicate substation capacity at voltage adjustment points vulnerable to congestion and about efficient output control may have to be put into order.

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