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Managing Electricity Price Volatility Risk and the Importance of Electricity Futures

― Risk Realization in Cases of Spot Price Surges ―

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Japan's electricity market has undergone significant liberalization since the 2000s through a series of institutional reforms, and the full liberalization of the retail electricity market in 2016 marked a major expansion of the competitive environment. In this context, the spot market of the Japan Electric Power Exchange (JEPX) plays an important role in ensuring price formation based on electricity supply and demand and in enhancing transaction transparency. The introduction of mechanisms such as gross bidding and implicit auction on interregional interconnectors has improved spot market liquidity, and, as the entry of new power retailers has expanded and competition has intensified, spot trading has grown to account for approximately 30% of total electricity demand.

At the same time, the expansion of the spot market has been accompanied by greater exposure to price volatility risk. In January 2021, spot prices surged to as high as JPY 251/kWh due to a cold wave and LNG shortages, placing many retail electricity suppliers under severe financial strain. In March 2022, prices spiked again as reduced supply capacity caused by a major earthquake, lower solar output due to adverse weather, and increased demand occurred simultaneously. More recently, rising risks of LNG price increases associated with escalating tensions involving Iran have increased the likelihood of an impact on spot prices, and uncertainty in fuel markets is further heightening volatility in the spot market.

Under these circumstances, the use of electricity futures is indispensable. Electricity futures help mitigate price volatility risk by locking in future prices in advance, while also providing price discovery and credit risk mitigation functions. Although the scale of the futures market in Japan remains limited, broader adoption of hedging instruments such as electricity futures, as seen in Europe, is expected to contribute to the business stability of electricity companies.

1. Progress of Electricity Market Liberalization in Japan and the Role and Mechanism of the Spot Market

Since the 2000s, Japan's electricity market has been subject to a series of phased institutional reforms aimed at improving the efficiency of electricity businesses, revitalizing the market, reducing electricity charges, and enhancing service quality. By introducing competitive principles into an electricity industry that had traditionally been operated under a regional monopoly structure, these reforms have sought to promote competition among market participants and establish a more efficient and user-oriented electricity supply system.

To this end, entry regulations in the retail electricity market were progressively relaxed, and in April 2016, the retail electricity market was fully liberalized. Full liberalization enabled all consumers, including households, to freely choose their retail electricity supplier, thereby creating an environment in which a diverse range of businesses could enter the market. As a result, the mechanisms for electricity procurement and sales changed significantly, and the importance of exchange-based transactions through the wholesale electricity exchange increased relative to the traditional model centered on long-term bilateral contracts. In this regard, the Japan Electric Power Exchange (JEPX) launched its spot market in 2005, providing a platform for the trading of electricity for next-day delivery.

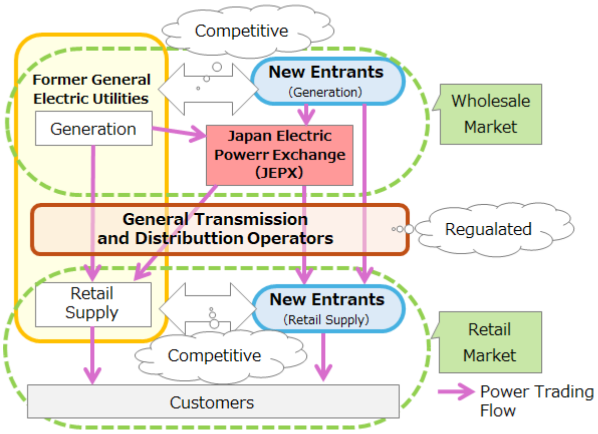

Figure 1. Structure of the Electricity Market in Japan

Source: Prepared by the Institute of Energy Economics, Japan (IEEJ)

The spot market serves to establish benchmark spot prices between power generators and retail electricity suppliers. Because prices are determined on the basis of supply and demand, spot prices are made visible, transaction transparency is significantly improved, and the efficient operation of the electricity system as a whole is supported. Moreover, the activation of the spot market has facilitated the entry of retail electricity suppliers that do not own generation assets. Previously, it was difficult to ensure a stable electricity supply without owning power plants. However, with the development of mechanisms that allow the procurement of required electricity volumes through the spot market and other channels, barriers to entry have been lowered, making it possible for businesses with diverse business models to participate in the market. As a result, competition has intensified further, and consumers now benefit from a wider range of choices and more diversified services.

The spot market operates by dividing each day into 48 half-hour time slots, in which electricity for delivery on the following day is traded. Power generators and retail electricity suppliers submit bids by 10:00 a.m. on the day prior to delivery, specifying the prices and quantities at which they wish to buy or sell electricity in each time slot. The Japan Electric Power Exchange (JEPX) then arranges these bids in price order to form supply and demand curves. The intersection of these curves determines the clearing price and clearing volume, and all cleared transactions are settled at a single price under a single-price auction system. However, where the market is segmented due to interconnector capacity constraints, transactions may be cleared at different prices in

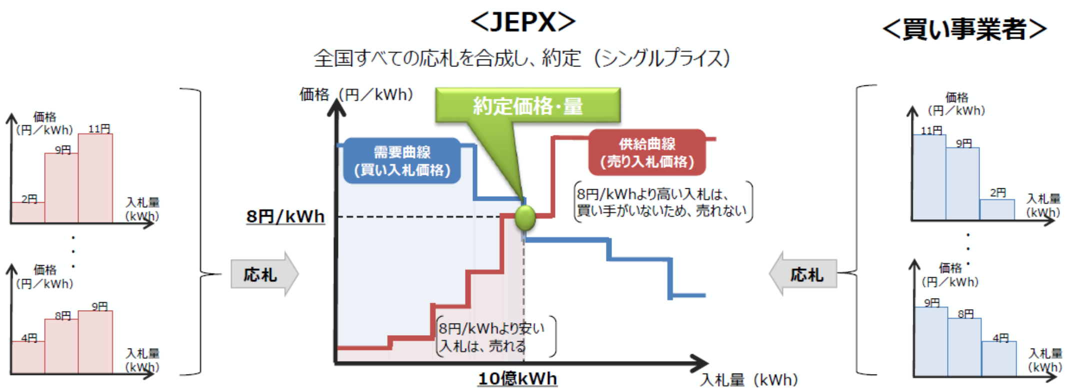

Figure 2. Price Formation Mechanism in the Spot Market

Source: Ministry of Economy, Trade and Industry (METI), https://www.meti.go.jp/shingikai/enecho/denryoku_gas/jisedai_kiban/pdf/001_05_00.pdf (accessed April 13, 2026)

different areas.

2. The Role of Electricity Futures in Wholesale Market Activation and in Addressing Spot Price Risk

Since the full liberalization of the retail market in 2016, the volume of spot transactions has steadily increased as a result of measures introduced to activate the wholesale electricity market, and spot trading is expected to account for approximately 30% of total electricity demand as of December 2025. This growth in transaction volume has been driven in large part by several institutional measures designed to stimulate the market. One such measure was the introduction of gross bidding in April 2017. Under this mechanism, incumbent major electricity utilities, including the former General Electricity Utilities (GEUs), no longer offset supply and demand internally, but instead submit their generation and retail positions separately into the spot market. This has the effect of increasing trading volumes on both the sell side and the buy side of the market. As a result, the volume of electricity offered in the spot market increased, the transparency of price formation improved, and spot market liquidity rose. Consequently, it became easier for new power retailers to procure electricity through the spot market, thereby contributing to the activation of spot trading.

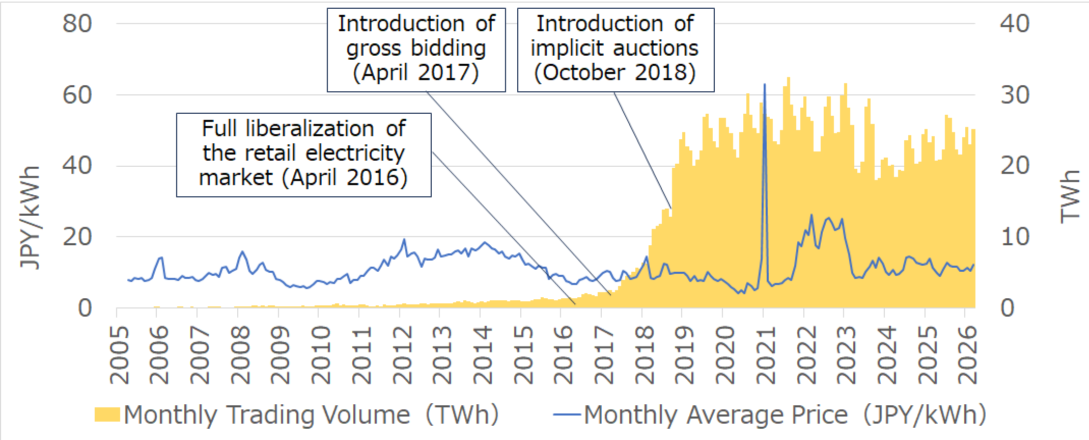

Figure 3. Trends in Spot Market Trading Volume and Spot Prices

Source: Prepared by the Institute of Energy Economics, Japan (IEEJ) based on materials from the Japan Electric Power Exchange (JEPX) and other sources

Furthermore, the implicit auction on interregional interconnectors, introduced in October 2018, revised the method of utilizing interregional interconnectors. Under the previous system, market participants secured transmission capacity on a first-come, first-served basis. Under the implicit auction mechanism, by contrast, transmission capacity is allocated in coordination with spot market transactions, such that transactions cleared in the spot market are assigned interconnector transmission capacity. As a result, wide-area electricity trading based on the merit order has been promoted, contributing to improved liquidity in the spot market through narrower interregional price differentials and expanded trading opportunities.

As a consequence of these measures to activate the wholesale electricity market, the market share of new retail suppliers in the retail electricity market has also expanded, reaching approximately 22% overall and about 27% in the low-voltage segment, including households, as of December 2025.

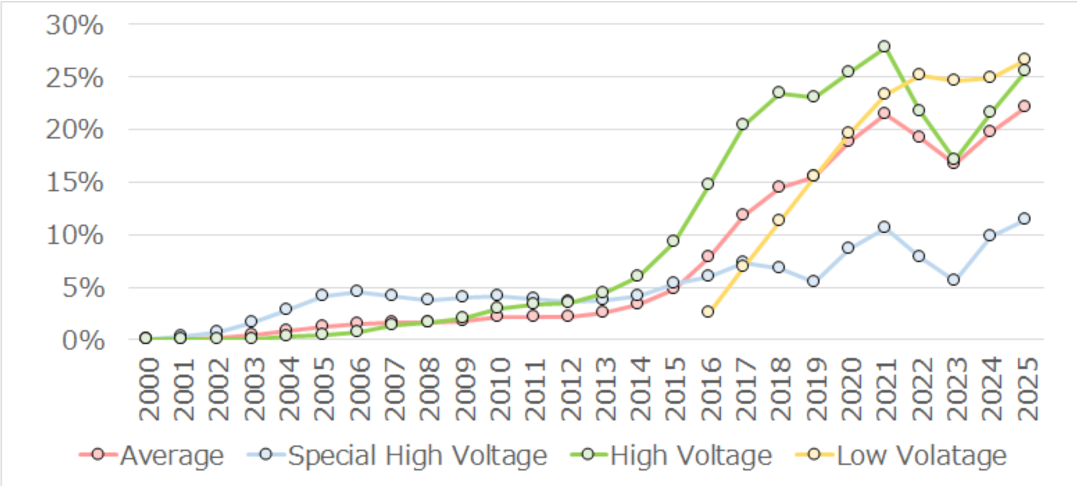

Figure 4. Market Share of New Power Retailers (Fiscal Year Average, kWh Basis)

Note: The figure for 2025 represents the market share as of December.

Source: Prepared by the Institute of Energy Economics, Japan (IEEJ) based on materials from the Agency for Natural Resources and Energy

At the same time, as spot market trading has increased, addressing price volatility risk has become an important challenge. In Japan, although the share of spot trading has risen to around 30%, it is difficult to say that sufficient risk hedging through futures trading and similar instruments has become widespread among retail electricity suppliers. In Europe, the share of spot trading is relatively high, at around 60% in Germany and around 30% in France, and retail electricity suppliers are considered to hedge price volatility risk by utilizing futures trading. In Japan as well, the environment for hedging price volatility in next-day spot trading has been gradually developing, following the launch of an electricity futures market by the Tokyo Commodity Exchange (TOCOM) in September 2019 and the introduction of Japan power futures by the European Energy Exchange (EEX) in May 2020.

In general, fluctuations in spot prices constitute a major business risk for electricity companies. Specifically, when spot prices rise sharply, the burden on retail electricity suppliers that procure electricity from the spot market increases. Conversely, when spot prices decline, the revenues of power generators selling generated electricity are reduced. In this way,

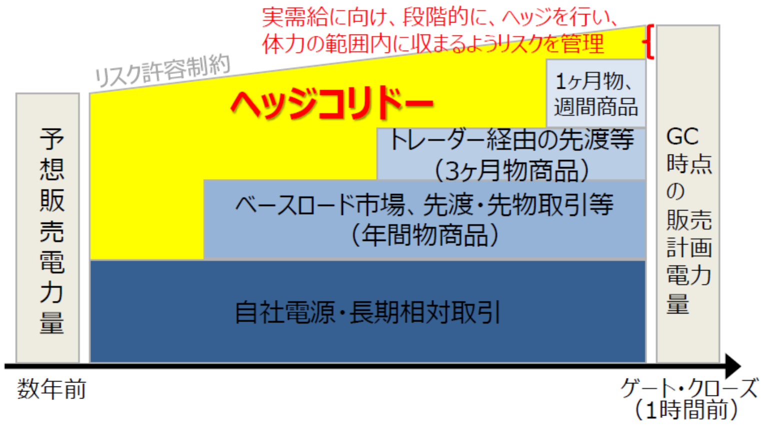

Figure 5. Conceptual Illustration of Risk Management by Retail Electricity Suppliers

Source: Ministry of Economy, Trade and Industry (METI), https://www.meti.go.jp/shingikai/enecho/denryoku_gas/denryoku_gas/pdf/032_06_00.pdf (accessed April 13, 2026) price movements in either direction function as risks for different types of market participants. It is therefore undesirable for market participants to operate while bearing excessive risks beyond their financial capacity, making appropriate risk management indispensable. From this perspective, a risk management approach has been adopted in which procurement volumes are hedged gradually over time. By building up hedging positions from long-term to short-term horizons so that they remain within a hedge corridor[1] at each point in time in anticipation of future supply and demand conditions, the impact of price fluctuations is smoothed and risks are managed.

In major European countries, electricity futures trading plays an important role in the electricity market, and trading volumes have reached levels far exceeding actual physical demand. In Germany, for example, the trading volume of electricity futures is approximately 12 times the country's electricity demand, suggesting that the futures market functions as the central venue for price formation and risk hedging. In Europe in particular, EEX has become firmly established as the principal platform for electricity futures trading. It offers a comprehensive range of electricity futures products covering multiple countries, including Germany, France, Italy, and Spain, and is widely used as the standard trading infrastructure across Europe. As a result, liquidity is concentrated in a single marketplace, enabling market participants to conduct efficient price hedging and price discovery under conditions of high liquidity. In contrast, although Japan's electricity demand is itself about twice that of Germany, the scale of electricity futures trading remains relatively small, leaving substantial room for future expansion.

[1] A hedge corridor refers to the range within which price risk is gradually hedged over time in electricity trading, in preparation for future physical supply and demand. Because electricity prices are highly sensitive to the balance between supply and demand, it is neither practical nor desirable to fix all positions at once. Instead, it is necessary to progressively manage risk by combining multiple instruments across different time horizons, from long-term to short-term. Specifically, at an early stage—several years in advance—base volumes of electricity are secured through in-house generation assets or long-term bilateral contracts. Thereafter, the hedging ratio is gradually increased through the use of annual products, futures, and forward contracts. As the delivery period approaches, further adjustments are made using shorter-term instruments such as quarterly, monthly, and weekly products. Ultimately, positions are fine-tuned to align closely with planned volumes up to just before gate closure. In this way, the entire process of progressively building up hedging positions along the time axis is described as a "corridor." The objective of this approach is not to eliminate price volatility risk entirely, but to keep it within the firm's risk tolerance.

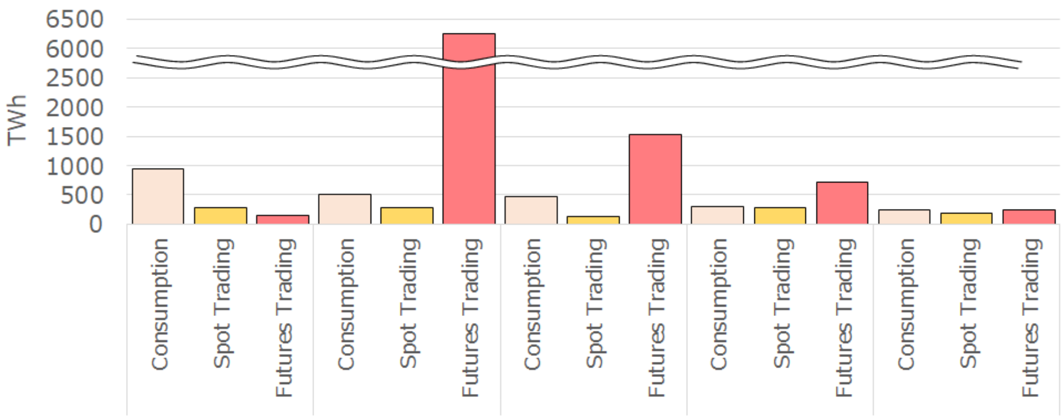

Figure 6. Trading Volumes of Spot and Futures Markets in Major Countries

Note: Electricity demand data are based on 2024 data from IEA Electricity Information for reference purposes. Spot trading volumes refer to day-ahead spot markets: JEPX for Japan; EPEX Spot for Germany and France; GME for Italy; and OMIE for Spain. Futures trading volumes refer to electricity futures markets: TOCOM and EEX for Japan; and EEX for Germany, France, Italy, and Spain.

Source: Prepared by the Institute of Energy Economics, Japan (IEEJ) based on various sources

3. Case Studies of Spot Price Volatility Risk

As noted above, there is a possibility that risk management has not yet been sufficiently developed, and under such circumstances, sharp fluctuations in spot prices have had a major impact on retail electricity suppliers. Against the backdrop of the supply-demand tightening in January 2021 and the failure of some retail electricity suppliers to respond adequately to the price volatility associated with the Ukraine crisis in 2022, the number of business suspensions and withdrawals among retail electricity suppliers increased. As a result, from the standpoint of consumer protection, retail electricity suppliers are now required to submit business plans,

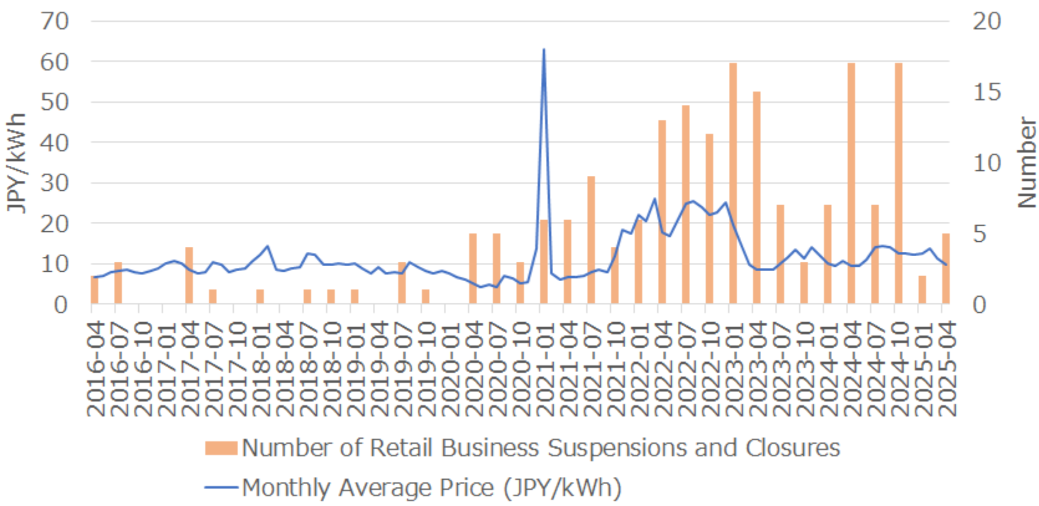

Figure 7. Trends in Spot Prices and the Number of Business Suspensions and Closures of Retail Electricity Providers

Source: Prepared by the Institute of Energy Economics, Japan (IEEJ) based on materials from the Agency for Natural Resources and Energy establish risk management frameworks, and report on their financial conditions.

Spot price fluctuations also exhibit certain characteristic patterns even under normal conditions. Where battery storage has not yet been sufficiently deployed, fluctuations in the output of weather-dependent sources such as solar power make it difficult to adjust electricity supply and demand in line with changes in demand, with imbalances in supply and demand being directly reflected in spot prices. Specifically, during daytime hours, supply tends to be relatively abundant because solar generation output increases, and spot prices tend to decline. This tendency is particularly pronounced on sunny days, when solar generation increases significantly, expanding the volume of electricity supplied to the spot market and easing supply-demand conditions, thereby pushing down spot prices. In contrast, from evening through nighttime, solar generation output declines sharply while electricity demand from households and businesses increases, tightening supply-demand conditions and driving spot prices upward.

Seasonal factors also have a significant impact on price fluctuations. In particular, during spring and autumn, when heating and cooling demand is relatively limited, overall electricity demand remains low. During such periods, renewable generation such as solar power may exceed electricity demand, and cases of surplus electricity become more frequent. As a result, spot market prices can decline sharply, and in some time slots have in fact fallen to the minimum price of JPY 0.01/kWh.

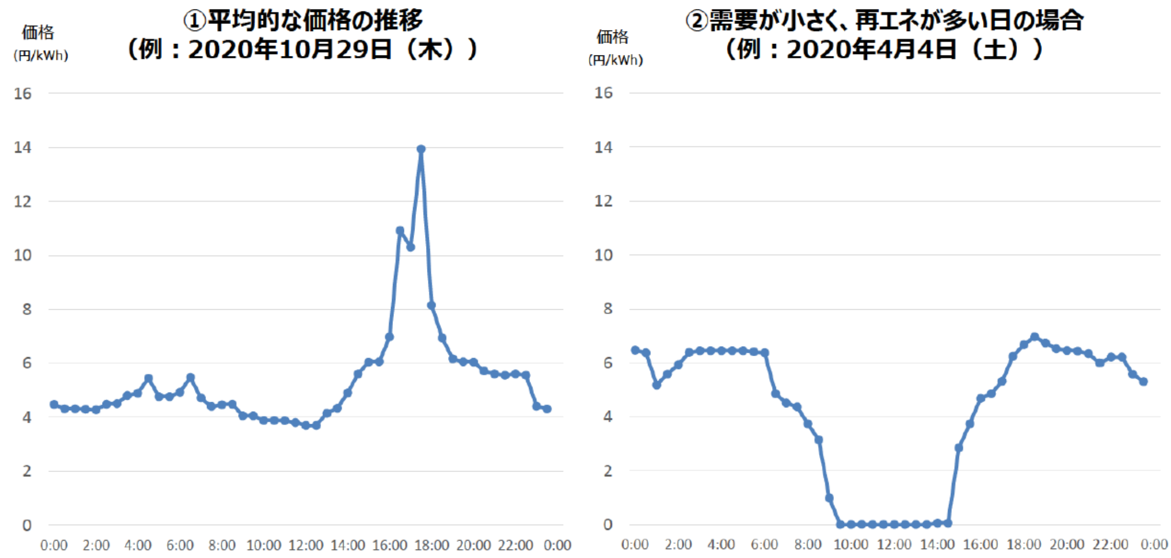

Figure 8. Spot Price Trends under Normal Conditions

Source: Cabinet Office of Japan, https://www8.cao.go.jp/kisei-kaikaku/kisei/conference/energy/20201201/201201energy05.pdf (accessed April 13, 2026)

3.1. Spot Price Volatility Risk: Supply-Demand Tightening Caused by LNG Shortages in 2021[2]

In January 2021, a combination of increased demand caused by a record cold wave, outages at coal-fired power plants, and fuel shortages resulting from LNG supply troubles and transportation delays drove spot prices to a record high of JPY 251/kWh. As a result, many retail electricity suppliers found it difficult to continue their operations and were forced to suspend or discontinue their businesses.

Viewed chronologically, the tightening of supply and demand in January 2021 began in mid-December 2020, when electricity demand increased and LNG consumption advanced, although market prices remained relatively stable. During this period, while demand was rising, overall stability was maintained on the supply side through the use of LNG and the operation of certain power plants.

Thereafter, from late December to early January 2021, demand itself remained around average levels, but fuel constraints became apparent and the electricity supply-demand balance began to tighten. Unplanned outages at coal-fired power plants compounded the problem, and conditions of persistent sell-side scarcity began to emerge in the spot market, with spot prices shifting to an upward trend. During this phase, wide-area responses such as electricity interchange were implemented, but supply shortages became increasingly evident.

In early January, consecutive days of increased demand due to the cold wave and related factors brought supply-demand conditions to their most severe stage. With fuel constraints continuing, supply capacity was tightly constrained, spot prices rose sharply, and the spot market entered a highly stressed condition. Emergency measures were taken nationwide to maintain supply and demand balance, including frequent electricity interchange across regions.

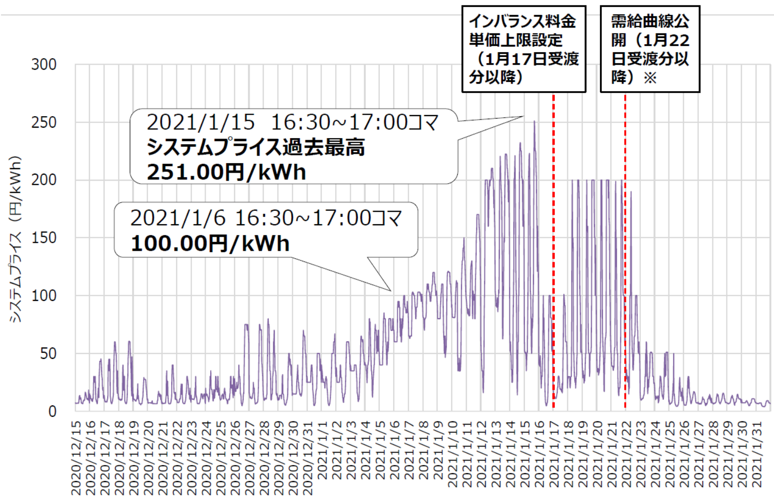

Figure 9. Spot Price Trends in the Winter of FY2020/21

Source: Ministry of Economy, Trade and Industry (METI), https://www.meti.go.jp/shingikai/enecho/denryoku_gas/denryoku_gas/pdf/032_06_00.pdf (accessed April 13, 2026)

From mid-January onward, electricity demand gradually began to stabilize, fuel inventories showed signs of

[2] Ministry of Economy, Trade and Industry (METI), https://www.meti.go.jp/shingikai/enecho/denryoku_gas/denryoku_gas/pdf/032_07_00.pdf(accessed April 13, 2026)

recovery, and some improvement appeared on the supply side. Nevertheless, as a result of the preceding supply-demand tightness, sell-side scarcity and elevated prices continued in the spot market, and prices remained high even after supply-demand conditions had eased. Institutional responses aimed at stabilizing supply and demand were also introduced, including calls for efficient electricity use and the setting of caps on imbalance charges.

3.2. Spot Price Volatility Risk: Supply-Demand Tightening Caused by Reduced Solar Output in 2022[3][4]

In March 2022, the electricity supply-demand balance in the Tokyo area tightened rapidly, causing significant volatility in spot prices. This tightening was a complex event in which a decline in supply capacity and a sudden increase in demand occurred simultaneously. On the supply side, the offshore Fukushima earthquake of March 16 caused unplanned outages at power plants totaling approximately 3.35 GW, significantly reducing supply capacity for the Tokyo area by about 1.1 GW. In addition, the interregional interconnector responsible for transmitting electricity from the Tohoku area to the Tokyo area suffered equipment damage, reducing its operating capacity from approximately 5 GW to 2.5 GW and severely constraining the ability to transfer electricity from other areas. Furthermore, after the earthquake, additional trouble-related outages occurred at multiple power plants on and after March 17, resulting in a further loss of approximately 1.34 GW of supply capacity and a substantial decline in reserve margin.

On the demand side, March 22 saw temperatures comparable to midwinter, and electricity demand greatly exceeded expectations due to increased heating demand, with peak demand projected to reach 48.4 GW. This was the highest level recorded for the month of March since the Great East Japan Earthquake in 2011, further aggravating the supply-demand tightness. In addition, poor weather conditions on March 22 reduced solar irradiance, and solar generation output was limited to a maximum of only 1.75 GW, around 10% of installed capacity. As a result, renewable generation, which would normally contribute to easing daytime supply-demand conditions, could not provide sufficient supply capacity.

Seasonal factors also played a role. Since the high-demand season of January and February had already ended, many power plants had entered scheduled maintenance and inspection, and compared with the period of peak demand on January 6, approximately 5.11 GW of generation capacity was offline. Thus, the direct cause of the supply-demand tightening was the combination of a sharp increase in electricity demand with multiple supply-side constraints, including

[3] Ministry of Economy, Trade and Industry (METI), https://www.meti.go.jp/shingikai/enecho/denryoku_gas/denryoku_gas/pdf/046_03_01.pdf(accessed April 13, 2026)

[4] Ministry of Economy, Trade and Industry (METI), https://www.meti.go.jp/shingikai/enecho/denryoku_gas/denryoku_gas/pdf/047_03_04.pdf(accessed February 19, 2026)

earthquake-induced unplanned outages, reduced interconnector capacity, further generation outages, and lower renewable output.

In the spot market, concerns over insufficient supply intensified, and spot prices surged to the upper limit in place at the time. However, because this tightening was heavily dependent on weather conditions, the situation changed substantially only a few days later. As weather conditions improved and solar generation output increased, supply capacity recovered, supply-demand conditions eased rapidly, and spot prices fell significantly.

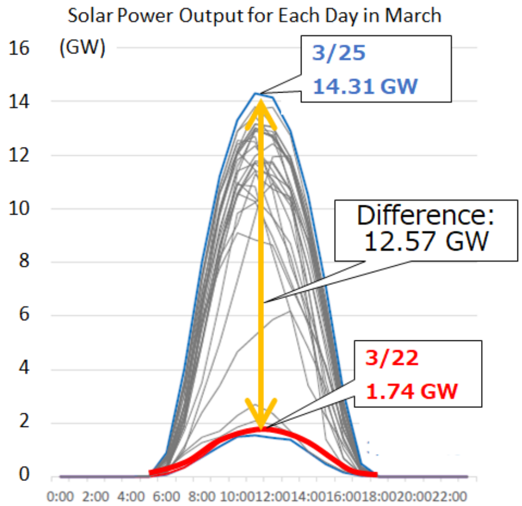

Figure 10. Solar Power Output in the Tokyo Area (March 2022)

Source: Prepared by the Institute of Energy Economics, Japan (IEEJ) based on materials from the Agency for Natural Resources and Energy

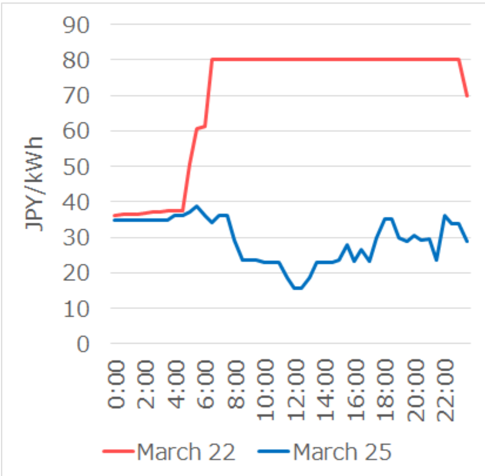

Figure 11. Spot Price Trends on March 22 and 25, 2022 in the Tokyo Area

Source: Prepared by the Institute of Energy Economics, Japan (IEEJ) based on materials from the Japan Electric Power Exchange (JEPX)

3.3. Spot Price Volatility Risk: Escalating Tensions in the Middle East in 2026

Since late February 2026, escalating tensions in the Middle East have increased uncertainty in international energy markets, and their effects are gradually being priced into Japan's electricity spot market and electricity futures market. In Japan's generation mix, gas-fired power generation often serves as the marginal source of supply, and increases in LNG prices therefore directly affect spot prices. Accordingly, if rising geopolitical risks in the Middle East materialize in the form of LNG supply concerns or upward pressure on LNG prices, they will become factors pushing up both the price level and volatility in the spot market.

That said, spring is a period in which heating and cooling demand is relatively limited, and electricity demand remains low over the course of the year. As a result, supply-demand conditions tend to be relatively relaxed, and the number of hours in which gas-fired generation acts as the marginal price-setting source in the spot market is comparatively limited. In practice, during time periods when solar generation output rises, lower-cost sources often become the marginal source, and spot prices therefore tend to remain subdued.

However, if electricity demand increases sharply in the coming summer, the number of hours in which gas-fired generation serves as the marginal source will increase. As a result, the number of hours during which spot prices rise sharply may also increase. On the other hand, although coal-fired generation, with its relatively lower fuel costs, is expected to play a role as a source of supply during periods of rising prices, there are constraints on increasing its output. From the standpoint of facilities, many power plants undergo scheduled maintenance outages during the low-demand spring season, making it difficult to raise output immediately. From the institutional standpoint, policies have been introduced limiting the utilization rate of inefficient coal-fired power plants to 50% or less, and this acts as an operational constraint. Although this restriction has been temporarily lifted for fiscal 2026, it is expected to remain a constraint in the longer term. From the operational standpoint as well, high-efficiency coal-fired power plants are normally operated at high utilization rates as baseload power sources, and because they are already running near rated output during peak hours, additional output potential is limited. Thus, although coal-fired generation is, in theory, a low-cost power source, in practice, flexible output adjustments are difficult from the standpoints of facilities, institutions, and operations, and there are limits to the additional expansion of supply capacity during periods of tight supply and demand.

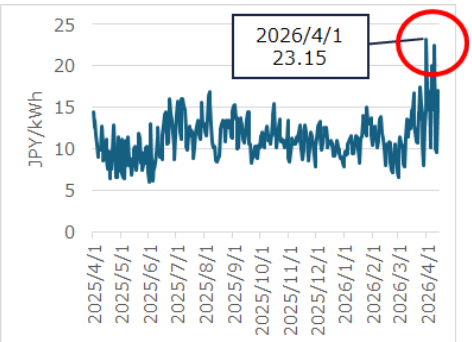

Figure 12. Trends in Electricity Spot Prices (Daily Average)

Source: Prepared by the Institute of Energy Economics, Japan (IEEJ)

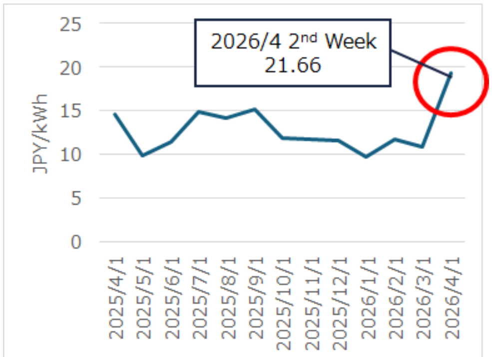

Figure 13. Trends in Electricity Futures Prices (East Area, Weekly-based)

Source: Prepared by the Institute of Energy Economics, Japan (IEEJ) based on materials from the Tokyo Commodity Exchange (TOCOM)

Against the backdrop of rising fuel price risk associated with instability in the Middle East, particularly during the summer when electricity demand increases, Japan faces a structure in which both greater dependence on LNG-fired generation and supply-side constraints combine to heighten the risk of rising spot prices. Under such circumstances, price volatility risk in the electricity market may become even more pronounced, further increasing the importance of risk hedging through the use of futures trading and similar instruments.

4. The Future of Electricity Futures

Electricity futures function as a risk hedging tool in the business management of electricity companies, serving not only as protection against price fluctuations but also as a mechanism for price discovery in the market and for mitigating counterparty credit risk. The importance of these functions is closely related to the recent changes in the environment surrounding the electricity market.

First, the electricity market environment has changed significantly. Progress in activating the wholesale electricity market has led to increased transaction volumes and improved market liquidity, while the large-scale introduction of renewable energy sources has altered the generation mix. In addition, fuel-side constraints such as tightening LNG supply-demand conditions have become increasingly apparent, making the factors affecting electricity supply costs and price formation more complex.

These changes in the market environment have led to greater risks in the electricity market. Specifically, volatility in electricity prices and fuel prices has increased, and large price movements driven by supply-demand conditions and developments in fuel markets are becoming more common. In transactions between electricity companies, moreover, credit risk dependent on the financial condition of counterparties has also become a factor that cannot be ignored.

Against this backdrop of increasingly visible risk, demand for electricity futures is rising. Electricity futures not only provide a price hedging function by enabling participants to lock in future prices in advance and thereby mitigate price volatility risk, but also provide a price discovery function by indicating future price levels through market trading. Furthermore, they make it possible to mitigate credit risk without relying on individual counterparties.

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