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CREATING CLARITY

Shulman Advisory

Decarbonising Japan: A Focus on its Long Term Decarbonisation Auction

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Getting to grips with the intricacies embedded in the energy market can be a daunting task. There is a wealth of information online to help you keep up to date with the latest developments, but finding what you are looking for and understanding the impact to your business can be tough. That's where Cornwall Insight can help, by providing independent and trusted expertise.

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About Shulman Advisory

Shulman Advisory is a leading consultancy helping foreign companies and stakeholders succeed in the Japanese energy market. Our deep understanding of Japan's power market ecosystem and our ability to bridge cultural, language, and other barriers enables us to provide bespoke consulting services that cater to each client's unique business needs.

Led by **Dan Shulman**, who has nearly 15 years of experience in the Japanese energy market, we are supported by a fully bilingual team and a number of well-established partner companies, including Cornwall Insight. Our clients rely on us to provide an unparalleled level of understanding of policy and regulation and extensive practical operational experience in the sector.

We strive to equip our clients with the tools and insights they need to navigate the rapidly changing market environment and achieve their business objectives through:

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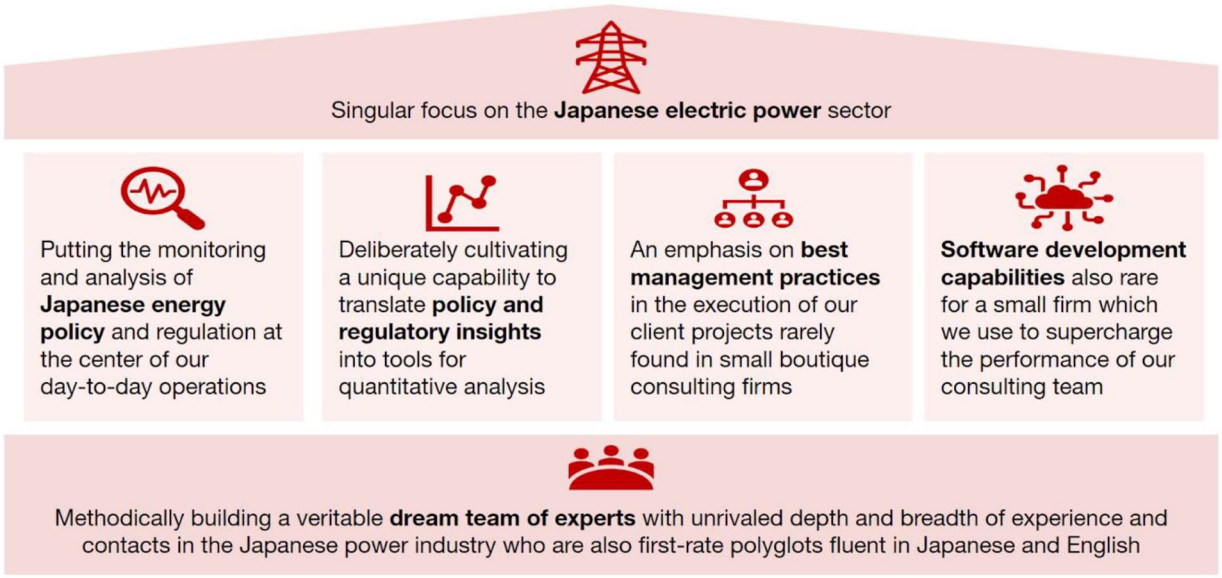
- Seminars and workshops
- Market entry strategy and support
- Local representation and project management
- Focused and specialized tools developed with our partners, such as the suite mentioned above

Shulman Advisory has proudly built its position of market leadership on six pillars, beginning with its singular focus on the Japanese Power market:



It has been our pleasure to collaborate with Cornwall Insight on this project. Client interest in battery storage has increased sharply in recent years, and **we are proud to have supported several grid-scale battery storage developers in making site acquisition decisions and refining their business models in Japan**. If you are interested in learning more about how we can help you achieve your goals in the Japanese Energy sector, please contact us via:

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Executive Summary

Like many countries across the globe, Japan is working towards achieving net zero – or carbon neutrality – by 2050, with an interim 2030 target to reduce greenhouse gas (GHG) emissions by 46% compared to 2013 levels. Compounding this challenge is the realisation that Japan's electricity demand is now forecast to significantly increase due to the construction of new data centres and semi-conductor factories, rather than reduce with a declining population and greater energy conservation.

For Japan to reach its 2030 GHG emissions reductions targets it needs to address its energy supply capabilities to ensure security of supply in a market with increasing renewable capacity and therefore more intermittency. All the while, it must also maintain sustainable competition and market stability. Moreover, an increasing amount of mothballing or closure of aged thermal and oil-fired power plants alongside the dwindling nuclear fleet has exacerbated these challenges.

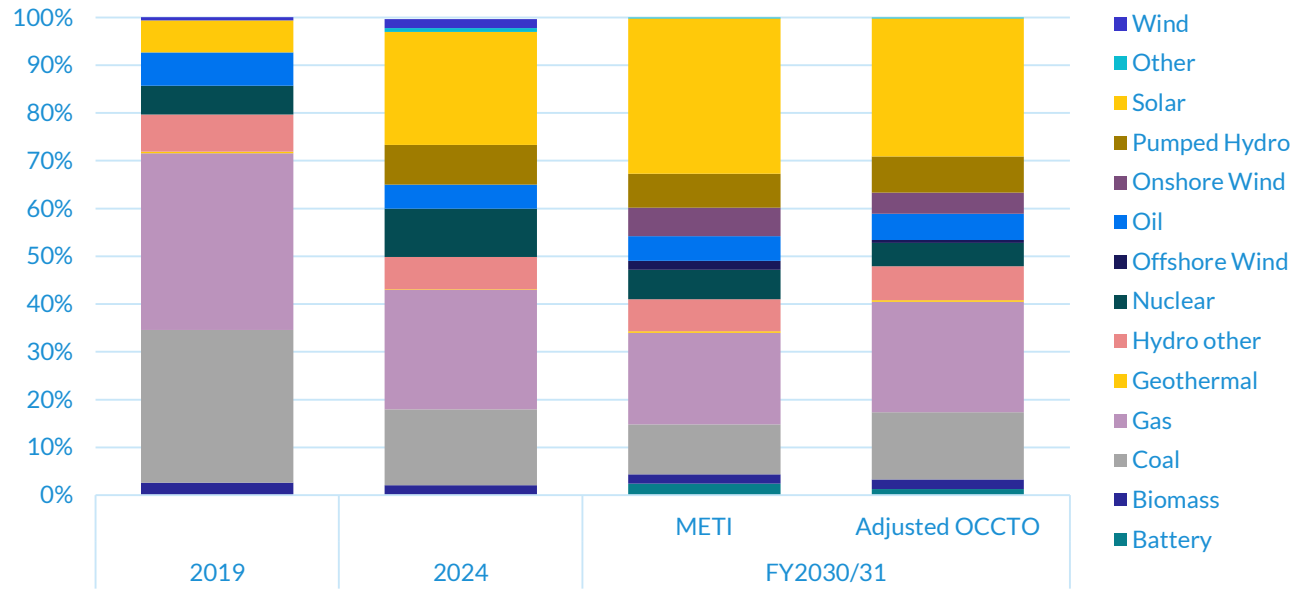
Japan's Sixth Strategic Energy Plan (SSEP), published in October 2021, noted that there is an increasing risk of supply capacity becoming insufficient in the near future as the capacity factor for thermal power plants falls, equipment ages, and services become suspended or discontinued due to declining profitability.[1] Meanwhile, new technologies such as battery storage and hydrogen are still too nascent to sufficiently replace thermal power generation capacity or bridge the gap left by post-Fukushima changes to the nuclear fleet.

Our Japan Benchmark Power Curve, a 30-year power price modelling service developed in partnership with Shulman Advisory, presents two scenarios, a more ambitious scenario from Japan's Ministry of Economy, Trade and Industry (METI) and our alternative "Adjusted OCCTO" scenario, consistent with the "Aggregation of Electricity Supply Plans"[2] published by the Organisation for Cross-regional Coordination of Transmission Operators (OCCTO). While the scenarios differ regarding the share of low carbon generation in the capacity mix by 2030, technologies such as wind (particularly offshore wind), solar, hydrogen, and battery storage are all forecast to see growth (Figure 1).

The need for investment in low carbon generation capacity is therefore greater than ever before in Japan. There are various mechanisms that the country has put in place to increase low carbon capacity including: the Feed-in Tariff (FiT), which has since been superseded by the Feed-in Premium (FiP); the Green Transformation (GX) Promotion Act; GX Economic Transition Bonds; wind power auctions; the single year capacity market; and most recently the Long-Term Decarbonisation Auction (LTDA). The introduction of a capacity market is particularly important here as it ensures a degree of predictability for returns on investment. This applies to both the single year capacity market and the LTDA.

[1] Ministry of Economy, Trade and Industry
[2] OCCTO

Figure 1: Installed generation capacity for 2019, 2024 and forecast capacity mix for Japan's power market in 2030



Source: METI SSEP, OCCTO's 2024 Aggregation of Electricity Supply Plans, and Cornwall Insight—Japan Benchmark Power Curve

**2019 and 2024 data does not separate onshore and offshore wind*

This report has been produced in collaboration with our partners in Japan, Shulman Advisory. The report explores Japan's LTDA, why it was introduced, and the design of the auction as well as the results from the inaugural auction in Financial Year (FY) 2023 in which the success of Battery Energy Storage Solutions (BESS) has helped to kick-start the technology. We also look into what we can expect from future LTDA auctions and the challenges impacting the growth of renewable generation in Japan including:

Given wider macroeconomic factors and the weak Yen (¥), partnerships and collaborations by foreign developers with Japanese companies that have on-the-ground experience of where other sources of revenue can be made alongside the LTDA will be vital to their success. Moreover, an ability to forecast generation, profit and revenues accurately and robustly will also be key to future project viability.

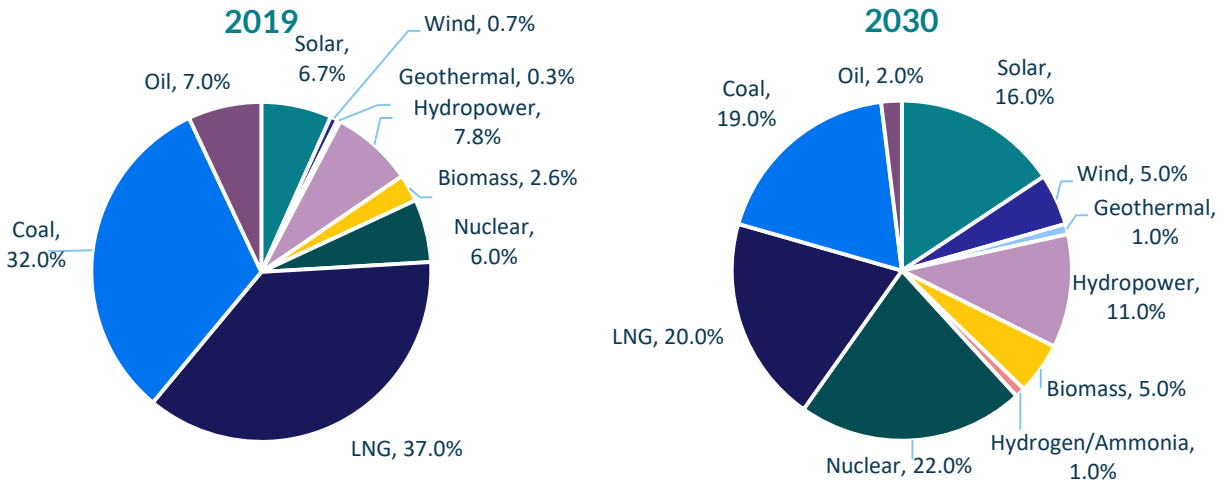
Japan's Decarbonisation Goals

The Targets

In October 2020, the Japanese Government announced its ambition for Japan to obtain carbon neutrality by 2050.[3] An additional announcement from the government in April 2021 set a new interim target to reduce GHG emissions by 46% in 2030, compared to 2013 levels.[4] It is worth noting that in pursuing these targets, Japan also aims to become more internationally competitive in the production and sale of existing decarbonisation technologies as well as new innovations.

In the SSEP, published in October 2021, METI set out the policy directions towards 2030. This included ensuring optimal siting for new renewable developments – with an emphasis on harmonising projects with local communities[5] – and expanding existing solar photovoltaic and onshore wind capacity.[6] Additionally, investment in offshore wind capacity was slated to be addressed by setting renewable energy "promotion zones" under the *Utilisation of Sea areas for the Development of Marine Renewable Energy Power Generation Act*. The SSEP also highlighted how future policy would help to overcome power grid constraints, with plans for the bulk system to be upgraded in a "push-type" approach with non-firm access extending to local grid connections, and a review of power grid rules that favour renewable energy over coal fired power. Towards 2030, METI also proposed that assessments would be undertaken to optimise the smooth introduction of offshore wind power generation, inclusive of a review of the regulations and compliance of Acts toward the introduction and expansion of geothermal power.

Figure 2: Japanese electricity mix in 2019 and 2030



Source: Sixth Strategic Energy Plan

[3] Ministry of Economy, Trade and Industry
[4] Ministry of Economy, Trade and Industry
[5] This is important to reduce conflict between renewable energy developers and local communities around issues such as landscape changes and impacts of renewable development on the local community, for example increased risk of landslides.
[6] Ministry of Economy, Trade and Industry

In light of Japan's updated GHG emission reduction target of 46% in 2030, the SSEP provided an outlook on energy supply and demand.[7] In its assumptions for the outlook, METI has considered the degree and timing of various routes for implementing measures to ensure that a stable supply of energy is not impaired. Figure 2 shows a comparison between the electricity generation mix in 2019 and the electricity generation mix that is required by 2030 to be on track to meet decarbonisation targets.

GX Agenda

Japan's GX agenda sets out the roadmap for energy policy in the next 10 years, including improvements in energy efficiency, the wide utilisation of clean energy, and the promotion of a transition to a decarbonised society whilst simultaneously "achieving economic growth".

In May 2023, the GX Promotion Act was passed, which broke out two core components of economy-wide decarbonisation: GX Economic Transition Bonds, to foster investment in decarbonisation; and the GX Carbon Pricing concept, or "growth-oriented carbon pricing", inclusive of an Emissions Trading Scheme (ETS).[8]

GX Economic Transition Bonds will be redeemed, with aims to realise up to ¥150tn (approximately €0.91tn) of public or private investment in GX over the next 10 years. The GX Decarbonised Power Supply Act was also passed in 2023. This set out to promote the use of decarbonised power sources, ensure a stable supply of electricity, and maximise the introduction of renewable energy technologies which benefit local communities. The Act also supported nuclear energy but only if ensuring safety was the top priority. The promotion strategy for GX was approved by the cabinet in July 2023.

Progress Towards Decarbonisation So Far

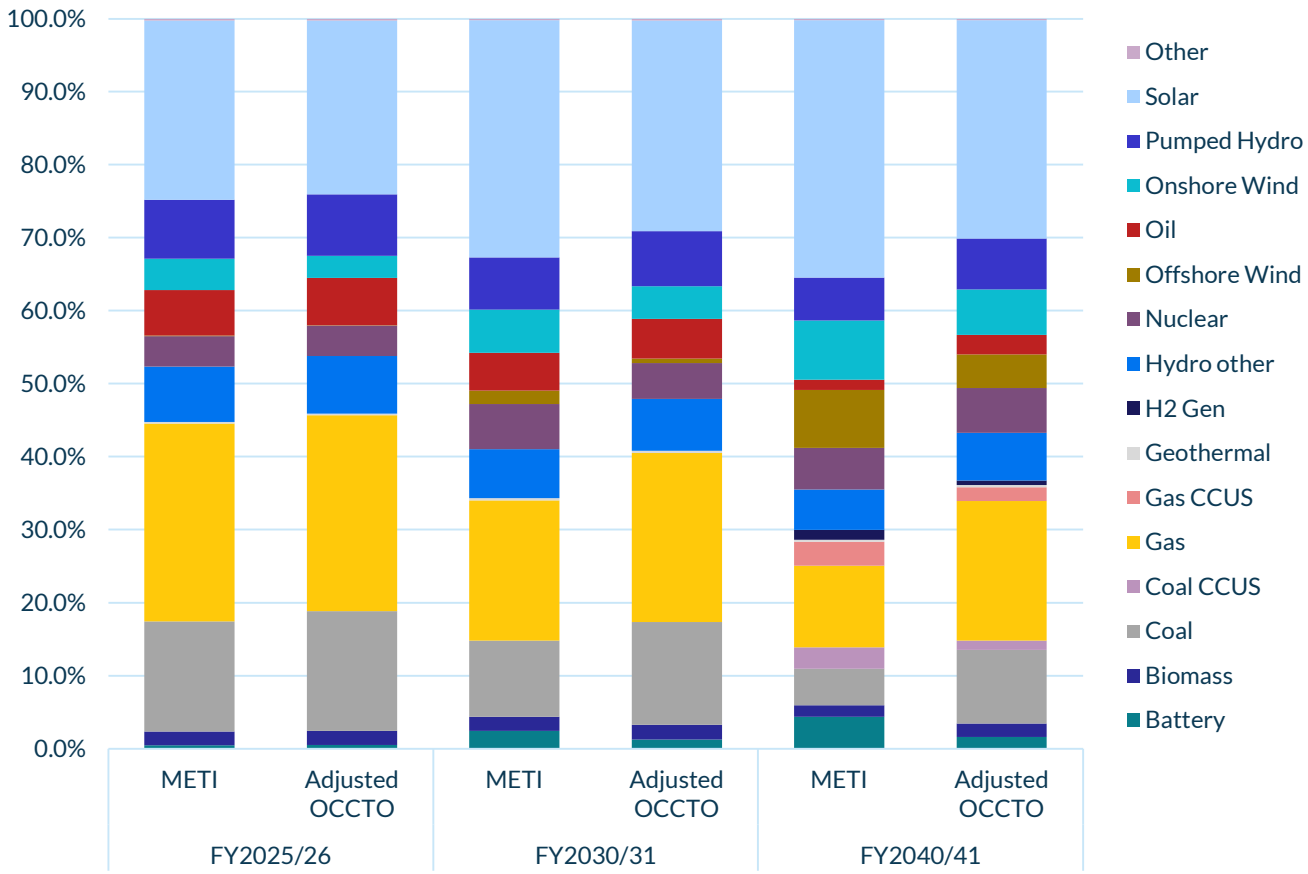
In the OCCTO's 2024 supply plan for 2024, it outlined the installed capacity figures across different power generation technologies alongside capacity estimates for 2028 and 2033.[9] Based on figures submitted by developers, which are subject to change in line with updates to relevant policies, OCCTO provides a breakdown of the total accumulated renewable energy technologies across each FY. This provides an outline of the technology types that Japan is promoting to aid its transition. There is a push for increased solar capacity by 2030, with this being the largest source of renewable technology in Japan at present and in 2033

In partnership with Shulman Advisory, Cornwall Insight's Japan Benchmark Power Curve presents two scenarios for the electricity market out to 2050: a more ambitious scenario that is consistent with the forecast from METI; and an alternative scenario consistent with the "Aggregation of Electricity Supply Plans" published by OCCTO[10] (Figure 3). Compared to the target of 61% of generation from low-carbon sources in the first scenario, the second scenario suggests that only a 41% share will be achieved from these sources by 2030, highlighting the uncertainties in Japan's renewable rollout.

[7] Ministry of Economy, Trade and Industry
[8] Ministry of Economy, Trade and Industry
[9] Organisation for the Cross-regional Coordination of Transmission Operators
[10] Organisation for the Cross-regional Coordination of Transmission Operators

In both scenarios, while coal and gas are expected to remain a significant part of Japan's capacity mix over the next 15 years or so, albeit with decreasing proportions, technologies such as wind (particularly offshore wind), solar, hydrogen, and battery storage are all forecast to see growth.

Figure 3: Forecast capacity mix for Japan's power market



Source: Cornwall Insight—Japan Benchmark Power Curve

Schemes to Bring Forward Renewable Generation

Feed-in Tariffs

Even prior to the government announcing its carbon neutrality targets, Japan had begun to introduce schemes to raise the level of renewable capacity on the system. The FiT scheme was introduced in 2012, and has resulted in an increase in the installed capacity of renewables, particularly solar. The scheme worked by mandating power companies to buy electricity generated from certified power generating renewable sources at fixed prices set by the government for a given period. This then enabled the prospect of stable revenues for renewable developers, which stimulated an acceleration of capital investment into renewables. This resulted in a significant growth in renewable capacity with 65.5GW becoming operational between the launch of the FiT scheme in 2012 and the scheme closing

to new capacity in December 2021. Of this total, solar power comprised approximately 86% of FiT-certified renewable power generating capacity.[11]

The FiT scheme did encounter some issues as renewable adoption increased, including rising renewable surcharges on electricity rates and issues with receiving power generated by renewables on the grid-side.[12] To address some of these challenges, in April 2022 the government launched the FiP scheme that adds a "premium" to the market prices of power sources, such as large-scale commercial solar and wind power. The shift from FiT to FiP was designed to increase competition in the renewable industry, while lowering consumer cost burdens from the prior FiT programme. The FiP scheme sets a base price through bidding, from which a reference price is calculated. The reference price represents the expected revenue of electricity generation utilities and is revised monthly by subtracting the balancing cost from the sum of the wholesale power price non-fossil value trading market price. The difference between the base and reference price is then paid to electricity generation utilities as a "premium", thereby incentivising generators.

Balancing Market

A new balancing market also began operating in April 2021, alongside existing regional balancing operations until their transition to the new system. The Replacement Reserve for FiT, which supported capacity with a long response time that balances errors in renewable energy predictions, was the first product to be launched in this new market, with further plans to add other products.[13] Alongside arbitrage and the capacity markets, the balancing market is another potential revenue stream for renewables. As of April 2024, it completed its transition from regional grid operations to one single consolidated balancing market with multiple products. Interim results from this new format have revealed that although BESS are participating in this market, not as many assets are bidding in as expected. It is worth noting that any asset bidding into the balancing market is unable to participate in the FiT scheme, whereas assets certified under the FiP scheme can participate in both.

The Long-Term Decarbonisation Auction (LTDA)

The LTDA is another scheme introduced in 2023, following the government's carbon neutrality announcement, with an aim to gradually increase the proportion of renewable assets on the system. The LTDA, also referred to as the "Decarbonisation Capacity Market" was introduced to encourage and promote new investment in decarbonised power sources and to accelerate Japan's transition towards carbon neutrality by 2050 through the provision of long-term financial support to specified power sources. The rationale behind the way this market operates is to facilitate and attract investment in the steady deployment of low-carbon power sources and mitigate the risk of wholesale price surges. While the primary reason for the introduction of the LTDA was to encourage and promote new investment in decarbonised power sources and to accelerate Japan's transition towards carbon neutrality by 2050, it also helps to address a broader capacity problem in Japan.

[11] Japan Electric Power Information Center Inc.
[12] Japan Electric Power Information Center Inc.
[13] Japan Electric Power Information Center Inc.

Capacity Problem

For Japan to reach its 2030 GHG emissions reductions targets it needs to address its supply capabilities to ensure security of supply amidst increasing intermittent renewable capacity, while also maintaining sustainable competition and market stability.[14]

Japan's SSEP[15] noted that there is an increasing risk of supply capacity becoming insufficient in the near future as the capacity factor for thermal power plants falls, equipment ages and services become suspended or discontinued due to declining profitability. The increasing amount of mothballing or closure of aged thermal and oil-fired power plants has resulted in a decrease in their capacity – by around 10GW in the five years from 2014 to 2019 – reducing their electricity supply capabilities and therefore risking the stability of supply.

The dwindling nuclear fleet has exacerbated these challenges. In 2010, nuclear power contributed ~27% of Japan's generation capacity, however, by 2013, this had fallen to zero as the entire nuclear fleet was shut down following the Fukushima disaster in March 2011. A party change in government in 2013, coupled with challenges exposed by the absence of nuclear power generation, saw a 180 degree turn on the outlook for nuclear power. While concerns around safety remain common, nuclear power has gradually become more and more accepted and prominent in Strategic Energy Plans. By 2016, nuclear power production had resumed, contributing 1.7% of Japan's generation capacity and in the SSEP, Japan set targets for the technology to comprise between 20-22% of the power mix by 2030. In the meantime, however, while nuclear capacity remains low, Japan has a reduced supply of baseload generation capacity. As such, the country is faced with the issues of ensuring that it has sufficient supply capability to not only cover intermittent renewable generation but also ensure that it can provide capacity in the intervening time while both renewable and low-carbon generation capacity increases.

Meanwhile, new technologies such as BESS and hydrogen are still too nascent to sufficiently replace thermal power generation capacity. METI has stated that it would investigate countermeasures for securing additional supply capabilities, prevent excess withdrawal of power sources, constantly review the potential to increase efficiency further, and continue to operate the capacity market to secure supply capabilities by auction four years ahead of time.[16]

Acknowledging the emerging associated energy security risks from decreased supply capability, the SSEP noted in October 2021 that a steady operation of the single-year capacity market and the method to provide new investments with predictability of long-term income via a LTDA would be considered to make decarbonisation compatible with steady energy supply."[17] The introduction of a the LTDA therefore ensures a degree of predictability of investment recovery.

[14] Ministry of Economy, Trade and Industry
[15] Ministry of Economy, Trade and Industry
[16] Ministry of Economy, Trade and Industry
[17] Ministry of Economy, Trade and Industry

Long Term Decarbonisation Auction

Despite the shared name and introduction as a "capacity market" of sorts, the LTDA cannot be compared on a like-for-like basis with the single-year CM (Box 1), the main purpose of which is to secure capacity from existing assets for four years in the future. The LTDA instead provides opportunities for new low-carbon power sources with a steady and predictable revenue flow for up to 20 years (Figure 4).

Box 1: Single-year CM:

The single-year CM has a one-year payment and started in 2020 (for delivery in 2024). Three auctions have been conducted so far. The single-year CM primarily secures baseload capacity with renewable sources making up only 0.05-0.1% of secured capacity so far.

The single-year CM can hold two auctions per delivery year (DY): the main auctions (T-4) are held four years before DY, and the supplemental (optional) auctions (T-1) are held one year before DY. The single-year CM sets a single market clearing price for each of the nine zones (Hokkaido to Kyushu), unless there is a market split whereby the clearing prices may vary by zones.

The procured capacity amounts in the single-year CM so far have ranged between 162-5GW. In the 2023 auction for DY2027 just over 167GW cleared the total capacity. The procured ("cleared") volume was 1.8% lower than the required (targeted) volume of 167.5GW. The Tokyo, Kansai, and Chubu regions, where the major metropolitan areas are located (Tokyo, Osaka and Nagoya), currently hold the highest procured capacity for the next four DYs (DY2024, DY2025, DY2026 and DY2027). Over 99% of capacity was secured by baseload sources, whereas renewables and BESS secured 0.2% and 0.05% respectively. Most of the contracted capacity supply is from "stable assets".

Figure 4: Single capacity market

Source: Shulman Advisory

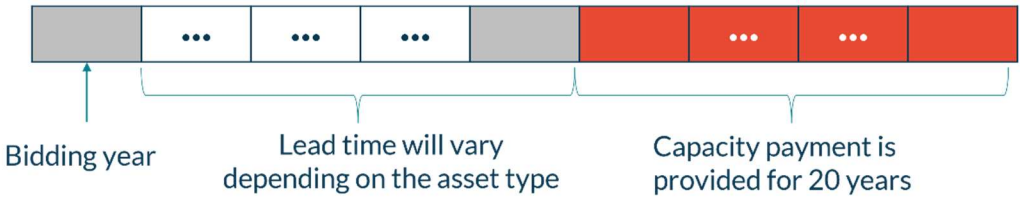
The LTDA was launched at the end of 2023, with the first auction opening for bids in January 2024.[18] It offers a 20-year fixed revenue for newly developed assets defined as "low-carbon" power sources that will contribute to the decarbonisation of Japan. The LTDA is not designed necessarily to meet grid demand, rather it is a way of increasing renewable rollout and to incentivise developers to build assets. Acknowledging that renewable capacity, hydrogen, and BESS will not – at this stage – be able to fill the void of reduced thermal and oil-fired capacity, particularly with demand forecast to rise, the LTDA also allows LNG-fired power plants with relatively low CO_2 emissions to enter the auction. This is providing

[18] Organisation for the Cross-regional Coordination of Transmission Operators

they begin to take steps toward decarbonisation within 10 years of starting to provide supply capacity and achieve full decarbonisation by 2050.

The LTDA is a pay-as-bid auction, meaning that assets that clear the auction receive the amount they bid for. Thus, the support mechanism is available to successful bidders at a fixed revenue of the auctioned price for 20 years. The LTDA will only account for a small fraction of total procurement going forward, at least initially. In 2023 it set a target of 4GW, which included a target of 1GW of storage capacity (BESS and pumped hydro). Procurement volume is expected to grow in future years and is under consideration to be up to 5GW in the second round of the LTDA.

Figure 5: Long Term Decarbonisation Auction



Source: Shulman Advisory

To participate in the LTDA, applicants must either be a domestic entity or a consortium that will incorporate a "special purpose company" and any entity that considers participating must register with OCCTO. Another stipulation of the auction is that the capacity providers are required to return 90% of their additional revenue from other markets, including the Japan Electric Power Exchange (JEPX), Electric Power Reserve Exchange (EPRX), and non-fossil markets to OCCTO.

The projects that are awarded contracts also have deadlines to construct and commission their assets, with consideration given to the lead times for the various technologies (Figure 6). The LTDA varies the bidding time window prior to commissioning by asset type. For BESS for example, the window to commission is four years, meaning that BESS assets clearing the LTDA must be commissioned by the end of the four years on from when the capacity is contracted, or it will be subject to penalties. Successful projects will be subject to specific requirements, not only including the ability to start supplying power within a certain time frame, but also in maintaining capacity throughout the contract term and reporting project performance to OCCTO to ensure they are contributing to national decarbonisation goals.

OCCTO can impose penalties if successful LTDA projects are non-compliant. These penalties are tiered, increasing as the contract progresses and differ between asset types, with more severe penalties for stable assets. Under the terms and conditions of a contract in the LTDA, the penalty for any given asset or power source that does not commission by the deadline will be proportionate to the delay period. If a power plant does not meet the commission deadline set for its generation technology type, the period during which the plant can receive the capacity reservation contract amount will be shortened by the duration of its delay. For example, if a plant delays commissioning by

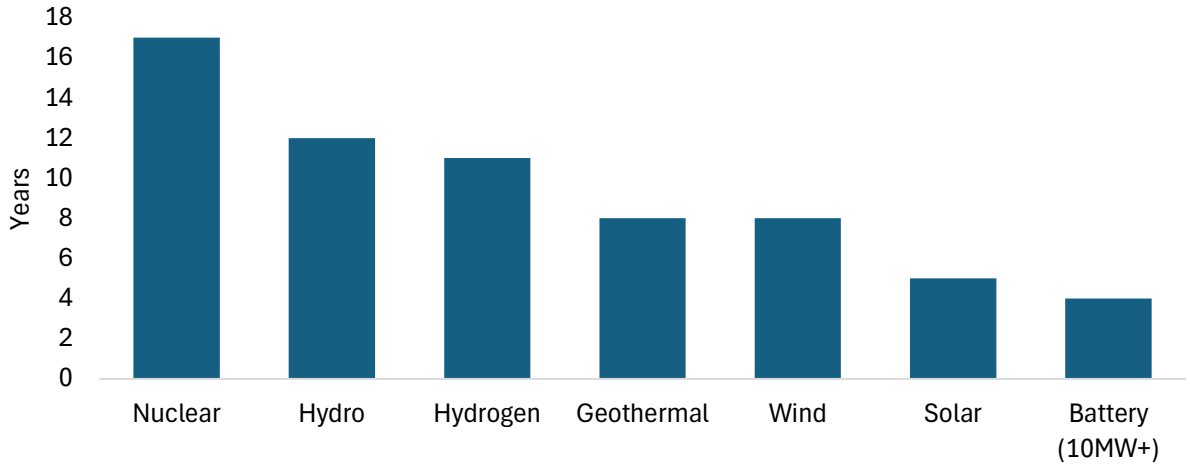
Box 2: Economic Penalty calculation

Economic Penalty = Contracted Capacity of Power Asset x Contracted Unit Price* x 0.1 (10%)

*This is the contract amount for securing capacity (for each year), divided by the contracted capacity. The total economic penalty of exiting after a successful bid will be rounded down to the nearest yen.

one year, the period during which the capacity reservation contract amount can be received will be reduced from 20 years to 19 years.

Figure 6: Deadlines to commission decarbonisation assets under the LTDA



NB: There is no distinction between onshore and offshore wind

Source: METI

The LTDA is broadly split into two categories—stable resources and variable resources (Figure 7). It is worth noting that the auction does not distinguish between onshore and offshore wind at present.

Figure 7: Stable and Variable Resource Categories in the LTDA

Stable Resources (new installations or replacements)	Variable Resources
Thermal power (co-firing of LNG and hydrogen of 10% or more (on an energy basis) or 100% hydrogen)	Hydroelectric (run of river)
Nuclear power	
Geothermal power	Solar
Biomass power with an interconnection point capacity of 100MW or more	
Hydroelectric (adjustable or reservoir type)	Onshore and offshore wind projects of 100MW or more
Battery storage (with a capacity of 10MW or more)	
Conversion of an existing thermal power plant to ammonia co-firing	

Source: METI

Total targeted capacity for the first LTDA auction was 4GW. Of this there was a 1GW cap for pumped hydro and BESS and 1GW for other renewable energy that included hydrogen co-firing and biomass co-firing. These initial target levels were set relatively modestly to allow for expansion of the auction in future years. The auction uses a multi-price method to determine the winning power sources, whereby bids are awarded in ascending order starting with the power sources that submitted the lowest bid price until the target volume of the FY is met. OCCTO also set a price ceiling for each newly constructed technology and replacement technology.

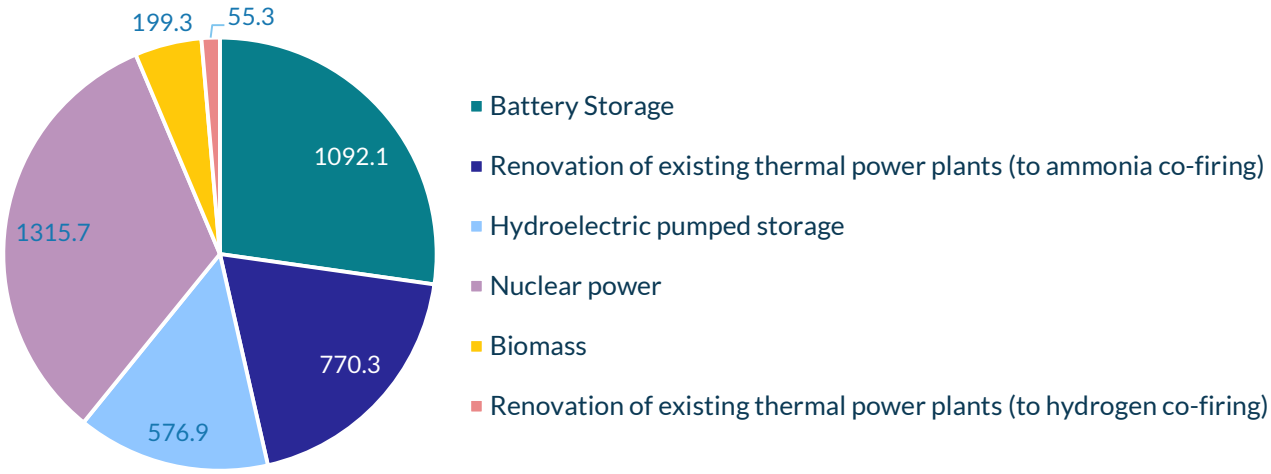
At present, LNG can bid in the auction, as it provides back up capacity in the short term as thermal power is phased out, and Japan's low-carbon capacity increases. High potential markets, such as BESS and hydrogen, are still too nascent to be able to fully replace the thermal power capacity at present. LNG is therefore bridging the gap between the reducing thermal capacity and gradually increasing renewable capacity. LNG is expected to be phased out from the LTDA over the coming years.

Some thermal power sources that intend to bid into the LTDA are required to prepare a decarbonisation roadmap[19] outlining the path to decarbonisation up to 2050 and submit it to OCCTO prior to registering to participate in the auction. The decarbonisation roadmap for the successful bidders will be made publicly available around three months after the results announcement.

Inaugural Results

The results of the inaugural LTDA were published by OCCTO in April 2024 (Figure 8).[20] Out of the total 9.8GW awarded, 5.7GW was LNG supply and 4GW was non-LNG 'clean power sources' supply contracted for 2027-47. Notably, 1.7GW of capacity was awarded to electricity storage – 0.6GW of pumped hydro and 1.1GW of BESS –which exceeds the initial 1GW collective procurement target for electricity storage technology, with 69% and 24% of bidding projects selected as winners respectively.

Figure 8: Long Term Decarbonisation Power Source Auction Awarded Capacity (MW)



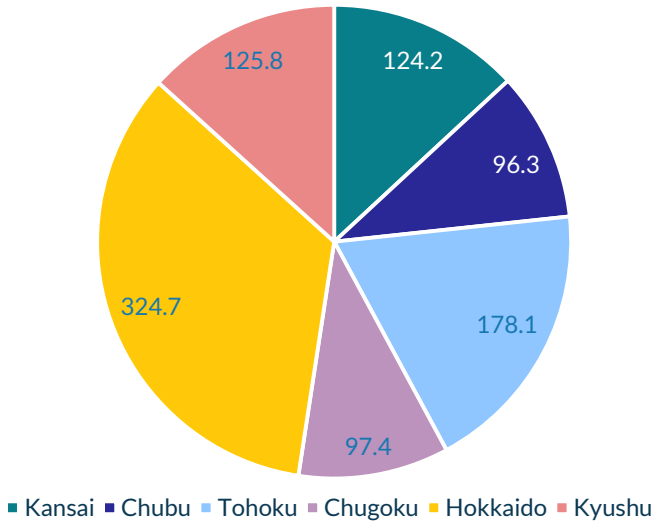
Source: OCCTO

The low success rate for BESS indicates a high level of competition among an increasing number of BESS providers with the received bids totalling five times the upper limit of 1GW.[21] There were 11

[19] Organisation for the Cross-regional Coordination of Transmission Operators
[20] Organisation for the Cross-regional Coordination of Transmission Operators
[21] Ministry of Economy, Trade and Industry

companies that successfully bid for BESS projects, with the majority of this capacity set to be located in Hokkaido, Japan's most northern island (Figure 9). At present, Hokkaido has limited interconnection capability to the country's 'main' island of Honshu, which houses the major energy demand centres of Tokyo and Osaka. With Hokkaido attracting an increasing amount of intermittent renewable energy projects, batteries are being promoted as a viable option to aid grid congestion and stability on the network while concurrently reducing curtailment at times of high generation but low demand.

Of the successful BESS projects, ORIX secured the largest single project at 96MW, while HEXA Energy Services secured the most BESS projects totalling 342MW over 11 projects. The auction is likely to have attracted a significant number of BESS developers, as this is one of the only major subsidy avenues for BESS developers in Japan, aside from co-location with other assets. Factors contributing to successful bids are likely to include low strike prices (although information on successful bid prices is not made publicly available), collaboration with Japanese partners, and the ability to demonstrate existing expertise in power trading within Japan. The success of BESS in this auction certainly signifies the kick-start of battery storage build-out in Japan.



Source: OCCTO, Cornwall Insight, Shulman Advisory

It is also worth highlighting the 825MW of ammonia and hydrogen co-firing capacity was successful in the inaugural auction and will comprise of refitted existing coal plants. Since the auction results were announced, the Japanese Parliament passed a 15-year subsidy for low-carbon hydrogen use on 17 May.[22]

What is particularly noteworthy from the LTDA results is the number of winning bids from foreign investors. Around half of the successful contracts were awarded to companies with non-Japanese backing. All of these, bar one biomass contract, were BESS contracts. This is particularly poignant given that historically it has generally been ex-utility companies that have been successful in the single-year CM auctions. While foreign developers can bid into the single-year CM, there are different criteria. As eligibility requirements for both markets continue to evolve, we expect to see more foreign investment. The Round Two offshore wind auction, for which the results were announced in December 2023,[23] saw just two foreign developers secure contracts as part of larger consortia, with RWE and Iberdrola both in successful consortia that secured offshore wind projects. This was viewed positively at the time, so the results of the LTDA will also be seen as a positive step forward in providing opportunity for and attracting foreign investment in both the global decarbonisation arena and in helping Japan move towards its decarbonisation goals.

Another noteworthy observation from the first LTDA auction is that there were no bids for wind or solar capacity. For many of these developers the auction is not seen as an attractive revenue

[22] Ministry of Economy, Trade and Industry
[23] Ministry of Economy, Trade and Industry

proposition as many are instead securing private bilateral agreements with offtakers. Even the FiP scheme does not incentivise wind developers in the auctions, as it requires extremely low bids, often as little as ¥0/MWh, due to the methodology used by METI to assess the credibility of projects.

Geothermal capacity was another technology which did not submit any bids in the inaugural LTDA auction. However, upon closer inspection, the existing rules deter the technology from participating due to unrealistic criteria – the minimum criteria for geothermal assets to bid is currently set at 100MW, whereas the average geothermal asset capacity in Japan in 2023 was 17MW. Additionally, the lead time for developers is set at eight years, when in reality the lead time can be as long as 30 years. Geothermal power is also particularly unfavourable in Japan, with the logistics of drilling and bureaucracy relating to development, as well as being stifled by public opposition.

Alongside increasing renewable capacity, the Japanese Government sees nuclear power as a key decarbonisation technology[24] which will also increase the country's self-sufficiency in power generation. As such just over 1.3GW of nuclear power capacity was successful in the first LTDA. All of this capacity was awarded to one project, The Chugoku Electric Power Company's Shimane Nuclear Power Plant Unit 3, which began construction in 2005,[25] was then suspended in 2011, and applied to the Nuclear Regulation Authority for safety checks in 2018.[26] Commercial operations are reported to commence by 2030.

Next Auctions

In June 2024, METI and the Agency for Natural Resources and Energy (ANRE) announced several changes to the second auction of the LTDA, expected to take place in January 2025.[27] After meeting its target of 4GW in the inaugural auction in 2023, the total auction capacity is expected to increase to 5GW in 2024. This also reflects OCCTO's updated electricity demand forecast due to the construction of new data centres and semi-conductor factories. This is a significant increase from previous forecasts which predicted a downward trend in demand due to population decline and energy and power conservation. The need for investment in generation capacity is therefore greater than ever before.

The design of the LTDA is to steadily promote the construction and replacement of decarbonised power sources while accelerating the restart of existing nuclear power plants. As such, the category "Safety Investment for Existing Nuclear Power," has been allocated a target cap of 2GW in the second auction, aimed at promoting the construction and enhancement of nuclear power. This power source contracted 1.3GW in the first auction.

In the second auction, the BESS category will be split in two, which will open up the market significantly more in the future for BESS. In the pumped hydro and BESS category, a capacity cap of 750MW will be set for storage durations of both three to six hours, and six hours or more. This takes the total procurement target to 1.5GW for these energy storage options, with different price ceilings for each of the two groupings (the first round only had a minimum duration of three hours and procured 1.09GW, surpassing METI's target of 1GW for this category). The plan to implement these

[24] Ministry of Economy, Trade and Industry
[25] The Chugoku Electric Power Co. Inc.
[26] World Nuclear Association
[27] Ministry of Economy, Trade and Industry

changes has received broad agreement from committee members and has also undergone a period of public consultation.

Considering batteries will be used to help manage the intermittency of output from renewables, OCCTO believes it is necessary to promote the introduction of batteries that can operate for a longer period and are more likely to respond to the long-term fluctuations.[28] The minimum bid capacity for BESS projects is therefore increasing from 10MW in the first auction to 30MW in the second auction. In the first auction, bids for BESS far exceeded the upper limit, but just half of the projects were below 30MW and the average bid capacity was 35MW. To align with the auction's original purpose of aggregating large-scale power sources, the minimum capacity for participation in the auction will be raised for the second round. For pumped storage, the minimum bid capacity will also be set at 30MW, aligning it with general hydropower.

LNG is procured separately under the LTDA whereby it has its own asset type/component. This will continue in the second and future auctions. The LNG capacity was due to gradually reduce over the next three FYs and be phased out as the other low-carbon technologies such as hydrogen and BESS become more established with increased capacity. However, the latest auction did not achieve its LNG capacity target and so the phase out date has been extended. METI is also planning to extend the deadline for the start of supply capacity provision from two to eight years for LNG. This is also in light of the increase in the forecast for electricity demand over the next 10 years.

With no significant changes expected to help incentivise more renewable technology assets such as wind and solar, the next LTDA auction is likely to see a similar basket of results, which in some respects contradicts the original purpose of the LTDA.

The next round of bids opens in October 2024 with the registration window closing in January 2025. Winners of the auction are expected to be announced in April 2025.

[28] Ministry of Economy, Trade and Industry

Future of Japan's Decarbonisation

Role for BESS

At present, Japan's electricity storage market is dominated by pumped hydro, with a capacity of nearly 22GW as of 2022, the second highest globally.[29] BESS, on the other hand, is significantly less developed in Japan with OCCTO noting around 240MW of installed capacity in 2023,[30] with 12GW under connection consideration and approximately 1.12GW which has applied for connections as of May 2023. Our Japan Benchmark Power Curve METI scenario forecasts there to be roughly a 12-fold increase in BESS capacity from 1.6GW in 2025/26 to 19.8GW in 2040/41. Meanwhile, our Adjusted OCCTO scenario forecasts a more reserved increase of roughly four-fold from 1.6GW in 2025-26 to 6.2GW in 2040/41.

With BESS performing well in the first LTDA auction and changes being implemented to the next auction to attract more BESS – alongside also 0.6GW of pumped hydro storage capacity being secured in the first LTDA auction – it is clear that electricity storage assets will play an increasingly important role in Japan's future energy system. Electricity storage will act to support the system as the penetration of intermittent renewables increases. One such action, as we highlighted in our Insight Paper Battery Storage in Japan: An Up-and-Coming Market? is wholesale market arbitrage, where, during periods of high output or low demand, excess generation could, instead of being curtailed, be used to 'charge' electricity storage systems for dispatch at a later time when demand outweighs supply. Arbitrage can be provided by a range of electricity storage technologies from shorter duration battery storage to longer-duration pumped hydropower or low-carbon hydrogen produced via electrolysis but is more suited to longer duration assets. Electricity storage assets can also provide frequency response services to help rebalance system frequency and account for reduced system inertia. These services are better suited to short-duration and fast dispatch technologies.

However, there are many challenges that will need to be overcome to secure the success of BESS and other low-carbon technologies in Japan.

Challenges Impacting Growth of Renewable Generation

One of the main challenges impacting low-carbon generation development in Japan is land availability. Its mountainous terrain, which covers three quarters of the country, can make it challenging to find suitable sites for renewable generation and BESS. Flat land is less of a priority for onshore wind and solar, particularly as solar generation tends to be agrivoltaics and perovskite flexi solar. Agrivoltaics reduce the competition for land as the same land can be used for both food and energy production, while perovskite flexi solar is much thinner, more flexible and lighter than traditional solar panels meaning they have much wider use cases and can be used in innovative ways. Meanwhile for onshore wind, the tops of rounded hills and mountain gaps that funnel and intensify wind can also be suitable

[29] International Renewable Energy Agency
[30] Organisation for the Cross-regional Coordination of Transmission Operators

locations for turbines to be built alongside open expanses of land, so they are not necessarily directly competing for the flat land.

With the minimum size of BESS project increasing from 10MW in the first LTDA auction to 30MW, will there be enough suitable land for the size of batteries that METI and OCCTO are trying to push for? The largest BESS project announced to date for Japan is a collective capacity of 290MW which will be split between two sites with one 88MW at ENEOS Miroran Plant and another 202MW at the Osaka International Refining Company.[31] It is possible that a lack of appropriate land availability could stifle the development opportunities for large developers, particularly in years to come when all the suitable land has already been used.

Local pushback continues to be an issue for many low-carbon projects, with developers needing to actively engage and work with local municipalities to allay concerns and promote the benefits of the project to residents and businesses. Developers are also required to demonstrate that renewable energy projects benefit the whole region. Reasons for local opposition can be diverse, ranging from "not in my backyard" to environmental concerns, such as an increased risk of landslides on mountainsides caused by land-clearing processes for solar panels or battery sites.

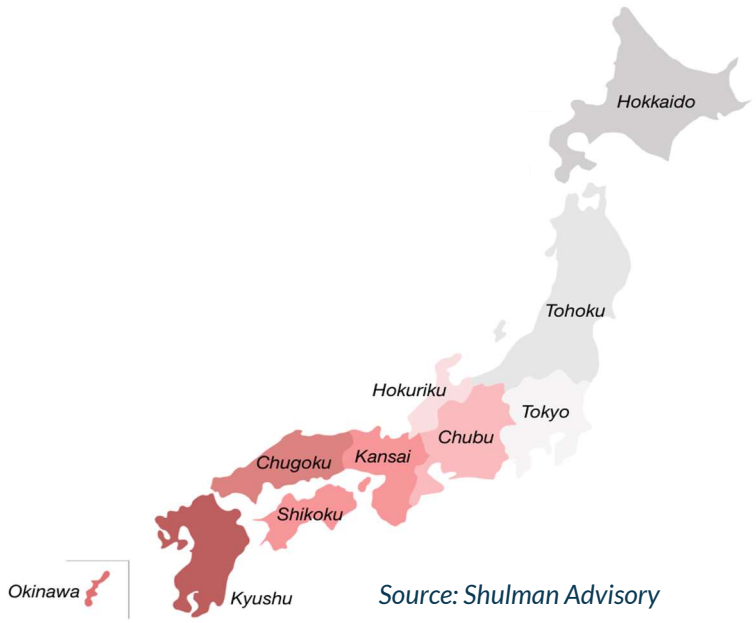
The government is also looking to introduce regional taxes for applicable renewable energy installations, which may or may not also include BESS. Aomori Prefecture, which has the highest onshore wind capacity in Japan, outlined plans[32] to implement an "ordinance for co-existence with local communities", inclusive of tax equivalent surcharge on renewable energy projects in September 2023,[33] which will be applicable to wind power projects over 0.5MW and 60m in height and over 2MW for solar power (around three hectares). The rates are yet to be determined but it is expected to fund environmental conservation, public awareness, and renewable energy promotion. Developers will be required to have business plans in place that take into consideration co-existence with the natural environment, scenery, history, and culture and disclose business information to the local community. Local authorities in the prefecture are also expected to have the power to retroactively apply the levies. If developers do not adhere to the regulations of the ordinance they will be subject to the surcharge. The Miyagi Prefecture has also introduced a tax on renewable projects under the Renewable Energy Local Coexistence Promotion Tax Ordinance from 1 April 2024.[34] These taxes will have an impact on revenues for renewable energy developers and owners, particularly if these costs were not applied to original project revenue forecasts. With these taxes mostly targeting onshore wind and solar, it is not a surprise that we did not see any bids in the LTDA from wind or solar when this tax has been so prolific.

In the first LTDA auction, most successful BESS projects were proposed to be located in Hokkaido. However, Hokkaido is positioned far from the main demand centres in Tokyo and Osaka. For these BESS facilities to be fully utilised, there would need to be sufficient grid infrastructure and/or upgrades in place to link BESS to offshore wind projects, many of which are located (or planned to be located) off the north part of Tohoku (the region below Hokkaido). This complication is further compounded by the multiple frequencies that Japan's grid operates at - the demand centres south of

[31] YUASA
[32] Aomori Prefectural Office
[33] Aomori Prefectural Office
[34] Miyagi Prefectural Office

Tokyo prefecture operate at 60Hz frequency, compared with regions north of Tokyo that operate at 50Hz (Figure 10).

Figure 10: Map of Japanese regions



Source: Shulman Advisory

The OCCTO Masterplan 2023,[35] otherwise referred to as the "Long-Term Policy for Wide-Area Grid - the Master Plan for Wide-Area Interconnected Grid", outlines on a national level to prefectural level the grid revitalisation plans, which includes new grid projects and upgrade projects, to allow for large volumes of electricity to move more easily between areas of major production to places of high demand. There are plans for grid upgrades to take place from 2026 to 2027 onwards when a lot of the offshore wind is expected to come online. It focuses on subsea transmission cables and interregional transmission and on prioritising big cables from Hokkaido to places of high demand. While there are 15-year plans for upgrades, there are already cases of delays, particularly for the ones expected to be completed soonest. There is also a lot of scrutiny on the costs of grid projects, which are considered by some industry commentators to be unrealistic. If the grid upgrades are not delivered on schedule – or at all – this could impact on the delivery of the winning LTDA capacity, their targeted connection dates and how effective their grid contributions are.

As previously mentioned, the inaugural LTDA auction did not attract any bids from wind, solar, or geothermal developers, despite these power source types being outlined in Japan's Strategic Energy Plan as providing significant volumes of capacity in 2030 and beyond. This is likely due to a range of factors, most notably the current market environment where private bilateral offtake is seen as more lucrative than participation in these new markets. In relation to the eligibility criteria as it links to project feasibility and track record, the risks of bidding in with the applicable prerequisites do not seem to be matched by the potential returns from the LTDA, given the requirement to return 90% of revenue from other markets to OCCTO. In order for developers bidding into the LTDA to make the most of both the revenue potential that this novel market offers, and other revenue opportunities (such as ancillary services and energy arbitrage), developers will need robust forecasting capabilities to ensure revenue can be optimised over the 20-year period.

How These Challenges Can Be Overcome

It will be vital for developers to work with and alongside local communities and principalities from conception and planning through to operation to reduce the pushback from local communities against decarbonisation projects. Unlike with offshore wind, where METI is taking a more centralised approach to community engagement, the same cannot be said for developers bidding into the LTDA,

[35] Organisation for the Cross-regional Coordination of Transmission Operators

whereby the onus is very much on the developer to have that engagement with local communities. Developers are expected to build rapport with the local areas in which they plan to establish projects. Therefore, education on the benefits of the project, transparency, and cooperation alongside the provision of opportunities for local businesses and input on regional re-development will also be important in aiding the success of projects.

Splitting the capacity of a large project such as BESS over smaller sites could help overcome issues of land suitability and availability and there being a site with enough land to house a large project. Having a portfolio of small capacity plants, such as BESS or solar, could increase the number of viable projects.

The inclusion of hydrogen and ammonia co-firing in the LTDA will present opportunities for hydrogen development within Japan, particularly as there are only specific subsidisation avenues from finite pots as it remains an unproven technology at this stage. However, with most hydrogen projects being small pilot projects focusing on building regional hydrogen development and concentrated on specific areas, such as Hokkaido for example, the more attractive route to developers is likely to be regional research and development rather than entering the LTDA, particularly as the technology is still so nascent.

Additionally, with the LTDA effectively disincentivising technologies such as wind, solar and geothermal generation from bidding into the auction, BESS stands to gain from this, particularly with the lack of other revenue streams for BESS. Moreover, changes to the second LTDA for BESS (splitting the category into 3-6 hour and 6+ hour durations and increasing the minimum bid capacity to 30MW) will help to stimulate more competition and fairness. This will also provide more scope for collaborations and partnerships and opportunities for foreign investors and developers to get involved in BESS rollout in Japan. Given wider macroeconomic factors and the weak Yen, partnerships and collaborations by foreign developers with Japanese companies that have on the ground experience of where other sources of revenue can be made, for instance on the wholesale market or the balancing mechanism, will be vital to their success. Moreover, an ability to forecast accurately and robustly will also be key to project viability.

If the challenges surrounding the LTDA can be overcome, then the LTDA can open up pathways to investment and opportunities for foreign investors to collaborate and provide a means of working towards Japan's decarbonisation.

Cornwall Insight's Japan Benchmark Power Curve developed in partnership with Shulman Advisory can help address long-term forecast challenges, providing long-term 30-year price forecasts informed by significant market, policy and regulatory expertise.

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