Report

Analysis of Framework Conditions for Foundation of Green Retailers in Japan

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Abbreviations

ANRE	Agency for Natural Resources and Energy
BG	Balancing Group
Big Utilities	10 Electric and Power Companies (EPCO): integrated suppliers and regional monopolists before the market liberalization who still own a strong position in Japan's electricity supply system
CDP	Carbon Disclosure Project
CO_2	Carbon Dioxide
DSM	Demand Side Management
DR	Demand Response
EHV	Extra High Voltage
EIA	Environmental Impact Assessment
ELCC	Effective Load Carrying Capability
EMSC	Electricity and Gas Market Surveillance Commission
EPCO	Electric and Power Company
EV	Electric Vehicle
FIT	Feed-in Tariff
Green retailers	New electricity retailers that focus on green electricity in their portfolio.
GHG	Greenhouse gas
GIO	Green Investment Promotion Organization
GO	Guarantees of Origin
GPC	Green Power Certificate
HHI	Herfindahl-Hirschmann-Index

IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
ISEP	Institute for Sustainable Energy Policies
JAPC	Japan Atomic Power Company
JEPX	Japan Energy Power Exchange
KEPCO	Kansai Electric and Power Company
kWh	Kilowatt hour
LV	Low Volt
METI	Ministry of Economy, Trade and Industry
MoE	Ministry of Environmenrt
NFFC	Non-Fossil Fuel Certificate
NFFC-RE	Non-Fossil Fuel Certificate for Renewable Energy
NFFC-NS	Non-Fossil Fuel Certificate for Non-Specified Sources
OCCTO	Organization for Cross-regional Coordination of Transmission Operators
OTC	Over the Counter
P2H	Power to Heat
P2G	Power to Gas
PPA	Power Purchase Agreement
PV	Photovoltaic
REC	Renewable Energy Certificates
RES	Renewable Energy Sources
RPS	Renewable Portfolio Standard
TDSO	Transmission and Distribution System Operators

TSO	Transmission System Operators
TEPCO	Tokyo Electric and Power Company
UNFCCC	United Nations Framework Convention on Climate Change
VRE	Variable Renewable Energy

Executive summary

This report analyses the necessary changes in the Japanese electricity market design to enable more green retailers to enter the market and sell green electricity products to consumers. The electricity market design shall enable green retailers to develop new and innovative green electricity products that make a contribution to the energy transition and goals of the Paris Agreement. These products are offered to customers who are willing to pay a price premium for this additional value. Together, green retailers and their customers see themselves as agents of the energy transition instead of mere points of sale. After an overview on the current regulation (chapter 2), recommendations for the immediate, mid- and long-term are given (chapters 3-5) before the report concludes (chapter 6).

In chapter 2 the report provides an overview on the current state of climate targets and the general market design setup as well as renewable energy sources (RES) policy in Japan. The overview of the market design shows that the current degree of concentration is still high and there are significant barriers for newcomers trying to enter the market, especially for green retailers with large shares of variable renewable energy (VRE) in their portfolio. One important reason is the current regulation on the obligation to secure capacity and its conservative calculation method. It requires unnecessary high backup capacity for VRE. That is, instead of using the market to optimize their portfolio, retailers are required to procure more capacity as backup than their customers' demand – mainly from the large utilities who still own more than 75% of Japan's whole capacity. This puts green retailers at a particular disadvantage, as they have to pay more for the so-called baseload capacity than the large utilities.

On the other hand, Japanese green retailers using the Feed in Tariff (FIT) scheme can free themselves from the obligation of keeping the supply of their renewable portfolio with the electricity demand of their customers in balance (i.e. managing their Balancing Group). Transmission and Distribution System Operators (TDSOs) in Japan are required to offer this special treatment under the planned schedule balancing as a means not to overload small newcomers with this task. However, by setting the schedule 48 hours in advance, more precise near-term forecasts for VRE cannot be used. And again, VRE-retailers have no opportunity to optimize their portfolio at the spot market (day-ahead market). However, retailers need to develop the capabilities to utilize these opportunities. Further, the current setup of the short-term (day-ahead and intraday) market with a the gate-closure 1 hour before the delivery and 30-minute trade units should both be shortened for balancing based on the market.

In the current RES-policy, – apart from the fact that the current RES-targets are insufficient to reach the Paris goals – the FIT-scheme has been successful with capacity additions mainly in PV but not with other RES, leading to a growth in the generation share from 10.5% in 2011 to 16.7% in 2017. Due to problems with public acceptance of the increasing FIT-surcharge, the Non-Fossil Fuel Certificate (NFFC) has been created on the initiative of the Japanese government. This may allow the re-sell of the environmental value from the FIT facilities as a financing mechanism to reduce the FIT-surcharge in order to maintain the acceptance. Since this does not further contribute to the energy transition, it cannot be called additional. While large old hydro is renewable, the additionality of electricity from these plants is at least questionable. Since nuclear energy is also included in the NFFC-scheme, it raises further questions of additionality. This shows the high significance of transparency in the green electricity market and the necessity of strict ecological standards. A labelling scheme may be useful to safeguard those standards.

Chapter 3 recommends *immediate* measures, which should be implemented right away to overcome the current market barriers. The preferable way would be to abolish the obligation for retailers to secure capacity and its calculation method. This can be done without compromising energy security. The key is a functional short-term market. Particularly, balancing demand and supply should be done in the market in order to integrate renewable sources and flexibility options into the system. Instead, the current systems artificially drives up system-wide demand for baseload power that is hardly ever needed – and is mainly owned by the large utilities. For the (rare) case the market is not able to balance supply and demand, grid operators may contract a small amount of reserve capacities (capacity reserve) as backup. If this solution cannot be implemented, at least the calculation method should be more balanced. Further, once retailers have the capabilities, they should choose real-time balancing as balancing mechanism.

Hydro, the largest existing renewable secure capacity should be made available to all retailers. If not fully, at least the environmental value of the hydro which now constitutes a windfall profit to the large utilities should be deprived from them and transferred to a fund to be established. The revenues from the fund should be made available to all market players as loans for investments into the energy transition. This would introduce some additionality to the NFFC. The revision of NFFC by specifying it with location and source would help green retailers to procure green electricity and be transparent to their customers. To ease balancing in the market with rising VRE-shares, various flexibility options should be implemented. In the short-term this means flexible system services, flexible demand and better grid management based on the technologies actually applicable.

Chapter 4 recommends mid-term measures, which should be implemented by 2025. They focus on a framework for more balanced RES-capacity additions, in particular with regard to wind. But also, further capacity additions of PV require public acceptance and sometimes conflicts between wind and PV additions need to be moderated. To install new RES, participation is a key. Therefore, various measures are recommended such as zoning, environmental impact assessments, notifications in advance and voluntary agreements. Furthermore, the liberalized system should rely on its market mechanisms, i.e. the forward market. However, this will only happen, if it takes the center stage. Therefore, the baseload market should be abolished altogether and no capacity market should be introduced.

Chapter 5 recommends long-term measures, set for 2030. These are further flexibility options like power to heat and power to gas. Finally, grid expansions become relevant, in particular a periodically updated grid planning taking into account the future growth of renewable energy necessary for the Paris Agreement. For this sake, cost distribution for the grid connection as well as grid expansions should be directed to the general electricity consumer as frontrunners in Europe do instead of being directed to the single RES-project developer.

Chapter 6 summarizes the overall conclusions. First of all, neither the current RES-addition targets nor the actual rates suffice. The question arises what additional measures should be taken to reach the Paris Agreement. This report, in particular, asks what electricity market regulations needs to be changed so that new green retailers could contribute to the goal. The report has shown how much current regulation is still skewed towards the large utilities. Furthermore, it is skewed towards securing capacity instead of relying on energy trade as would be the case for a liberalized market. As a legacy of the slow liberalization, the large utilities have basically been left untouched so that 75% of the capacity is still in their hands (including hydro and its windfall profit). On top of that the regulations to secure supply capacity put an unnecessary high burdens on green retailers, in particular when they have large shares of VRE in their portfolios. Another major problem is the unequal distribution of existing renewable capacities as well as the lack of new renewable capacities. A political discussion on the distribution of the large windfall profits from hydro is necessary and already ongoing. The report proposes a fund where the windfall profits could be used for investment into new RES-capacity. For the lack of new renewable capacities, a regulation on more balanced capacity additions is needed taking into account environmental and acceptance issues. Finally, in light of the obvious non-additionally of the current NFFC, it remains unclear whether electricity consumers will appreciate the re-sell of the environmental value that has already been created (and financed) by them under the FIT or whether this measure will actually decrease acceptance of the FIT-surcharge in the end. For green retailers, transparency is a key so that they can communicate about the additionality of their specific product. Therefore, a labelling scheme can be a tool for safeguard. Once regulation has established a level-playing field for green retailers, they can – together with their customers – make a significant contribution to Japan’s RES future and energy transition.

1. Introduction

1.1. Introduction by authors

With Japan signing the Paris Agreement it has taken the next step in its fight against climate change as part of the global community. For this, it is necessary to cut greenhouse gas (GHG) emissions significantly, i.e. to decarbonize its economy and likewise increase capacity of green electricity, which is generated by renewable energy sources (RES)[1]. Japan clearly needs a more ambitious target for RES. In particular, this includes more capacities of Variable Renewable Energies (VRE) like wind and PV. According to the 5th energy plan (METI 2018a) Japan decided to make RES a “key power source” in Japan. However, this is still not sufficient, compared to the necessary goals of the Paris Agreement and more is indeed possible. There are a number of reasons for the slow progress. One reason is certainly the traditional reliance on nuclear energy that has led to the slow introduction of RES-policies, resulting in a current lack of RES-capacities. Another reason is the slow progress of electricity market liberalization so that most of the electricity market design is still skewed towards the incumbents of the former monopoly areas, called the “ten large utilities” in this report. These are still in a dominant position.

However, rules can be changed and decarburization of the energy system does require a fundamental structural change. In order to raise RES, in particular VRE, to sufficient levels and sell the new green electricity to customers, new players are needed in the electricity market. These are players that develop innovative green electricity products with an additional value. This additional value is a financial contribution to the energy transition of the country, taking the form of investments in either in additional new renewable capacities or supporting infrastructure. Together with their customers – a customer group who is willing to pay this price premium in order to finance this contribution for the energy transition – these retailers may see themselves as stakeholders and agents of the energy transition instead of mere points of sale.

Despite some new green retailers in the market, their market shares and power are small compared to what is necessary (the same is true for RES-capacities) and the reason is the current regulatory environment. Therefore, this report analyzes the current electricity market design and points out where regulation not only constitutes barriers for green retailers but is also obstructive for the energy transition. It then recommends regulatory changes to policy makers to lower barriers and level the

[1] The Japanese government defined renewable energy as photovoltaic (PV), wind, hydro, geothermal, solar thermal, environmental heat and biomass. According to the Act on Special Measures Concerning Procurement of Renewable Electric Energy by Operators of Electric Utilities many electricity consumers and corporations also want to use green electricity.

playing field for new green retailers and the larger regulatory environment to make it more conducive to the energy transition. At first, chapter 2 provides an overview on the legacy of the Japanese electricity market regulation, including the current climate change policy, history of liberalization, current degree of concentration and market setup and the implications for newcomers trying to enter the market before renewable energy policy is laid out. Chapter 3 recommends for the immediate term (i.e. right away) for the general electricity market setup to lower the secure capacity requirements and to switch to real time balancing. Furthermore, the need to improve access to hydro energy, to the better use of hydro's environmental value (creation of a public fund) and the revision of the NFFC (provide location and source). Furthermore, various short-term flexibility options are recommended. Chapter 4 recommends for the medium-term (i.e. until 2025) to abolish the baseload market and abstain from a capacity market in order to promote the forward market as well as to create a better framework for more balanced RES-additions (zoning, environmental impact assessment, notifications in advance, voluntary agreements). Finally, chapter 5 recommends measures for the long-term (i.e. until 2030) including further flexibility options as well as grid expansions. Chapter 6 concludes.

1.2. Introduction by Greenpeace Energy

Green electricity products for customers can be a powerful means for promoting, accelerating and shaping a nation's energy transition. But only if it's done right. Many consumers understand the necessity of a green sustainable energy system and wish to contribute to its emergence. However, such wishes tend to remain marginalized and irrelevant in a uniform commodity market. Green electricity products can change this. Customers start to have a real choice and can express their preferences, thus becoming a market force that cannot be ignored.

However there are two preconditions. Firstly, the design of an electricity market must be "green retailer ready". Substantial amendments to the pre-existing market design are necessary in order to achieve this. Plus, green electricity products shouldn't be just "image products", they must trigger a real change.

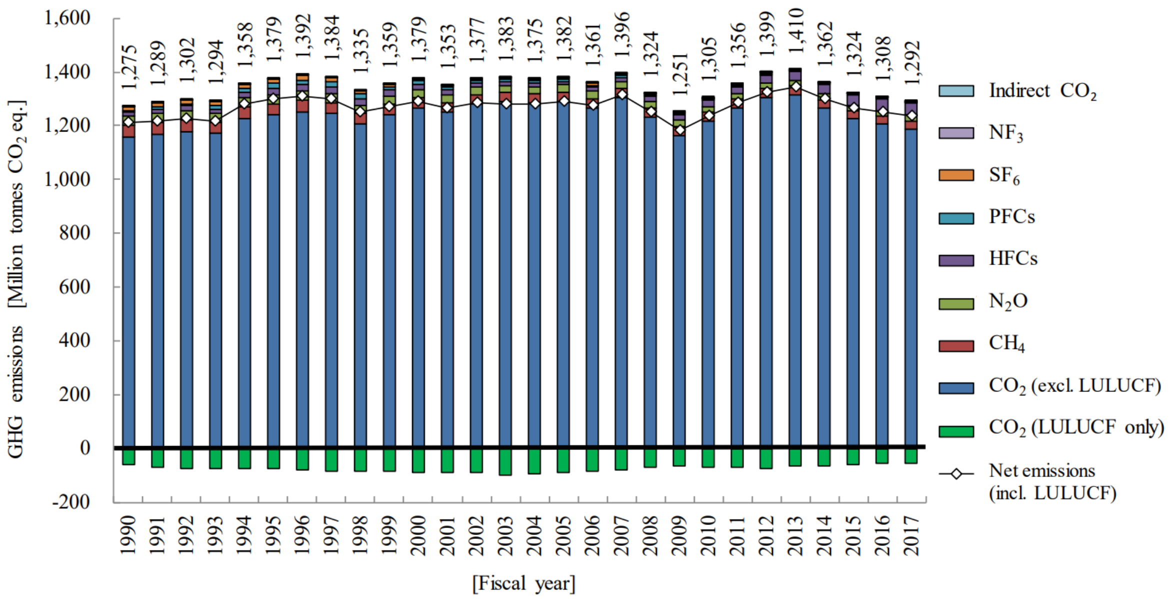
For 20 years, Greenpeace Energy has been active in the German energy market. With 150,000 customers and 25,000 co-operative members, it has become a substantial voice for a faster, profound and fairer energy transition. That we could come this far is also due to the design of the German energy system, which – in spite of its many shortcomings – facilitated the two preconditions mentioned above. The window of opportunity for similar green electricity products may now be emerging in Japan. Technology, ability, dedicated people: everything seems to be in place. Greenpeace Energy feels privileged to be able to commission this study which expertly surveys the Japanese energy system and offers valuable recommendations on what needs to be done to make green electricity products a success story for Japan.

2. The big picture

2.1. The Paris agreement and Japan’s energy plan

In order to limit the global temperature rise to 1.5 degree Celsius[2], the energy system as one of the largest sources of Greenhouse Gases (GHGs) needs to be decarbonized. Japan, as the fifth largest GHG emitting country with 1,292 million tons emission in 2017 (MOE 2019b), has to take responsibility for mitigating global climate change. To this end, the Japanese government set a goal to reduce GHG emissions by 26% by 2030 and by 80% by 2050 (with respect to 2013). However, Japan’s total GHG emission in 2017 increased by 1.3% compared to 1990 (MOE 2019b). Looking at the breakdown of GHG emissions in 2017 by sector, “the energy (excluding indirect CO2) accounts for 88.0% of total GHGs emissions” (MOE 2019b) (see Figure 1).

Figure 1 Trends of GHGs emissions and removals in each sector



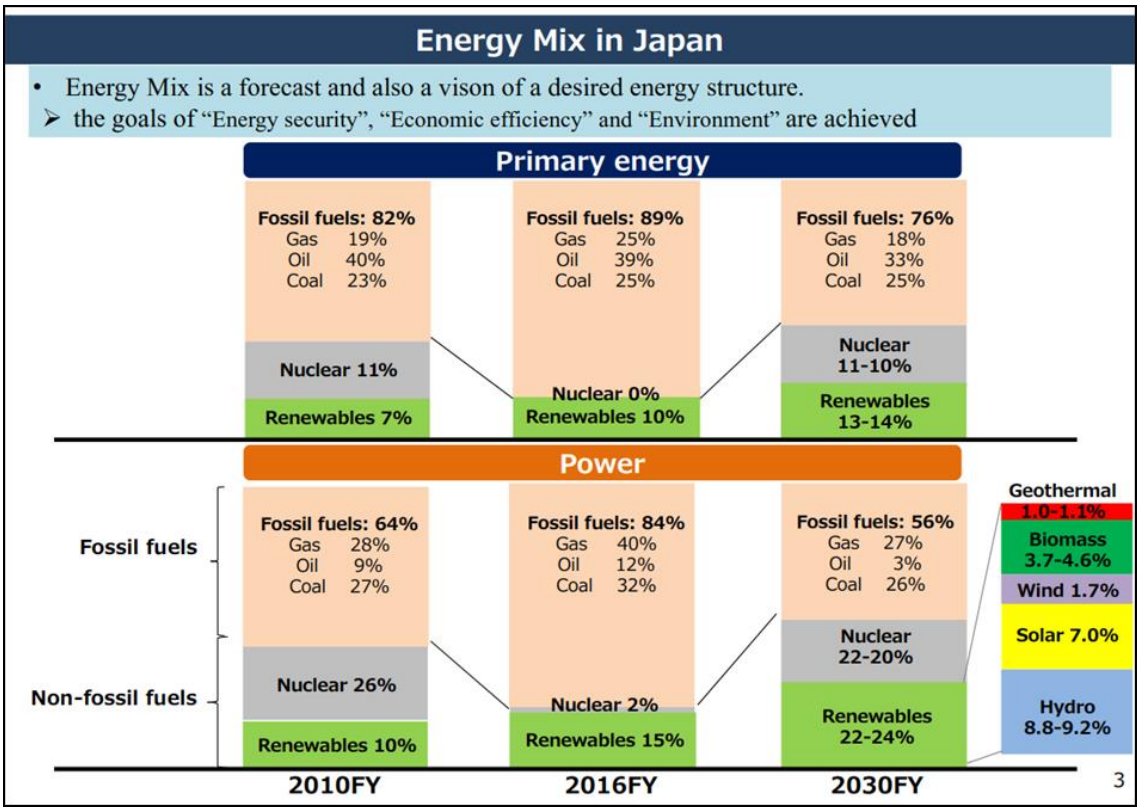
Source: (MOE 2019b)

Therefore, Japan needs to significantly reduce GHG emissions in the energy sector. This implies a massive expansion of green electricity. For this sake, the Japanese government introduced the energy mix target for 2030 (METI 2015). In the energy mix 2030, the Japanese government introduced its target to increase the share of RES in

[2] United Nations Framework Convention on Climate Change (UNFCCC) explains “(t)he Paris agreement central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius” UNFCCC 2015.

electricity consumption (kWh) of between 22-24% in 2030, in which hydro, including large hydro and pumped storage will have a share of 8.8 to 9.2%. Photovoltaic (PV) will account for 7.0%, followed by biomass with 3.7 to 4.6%, wind with 1.7% and geothermal of 1.0 to 1.1%, respectively (see Figure 2).

Figure 2 Energy mix



Source: (ANRE 2018d)

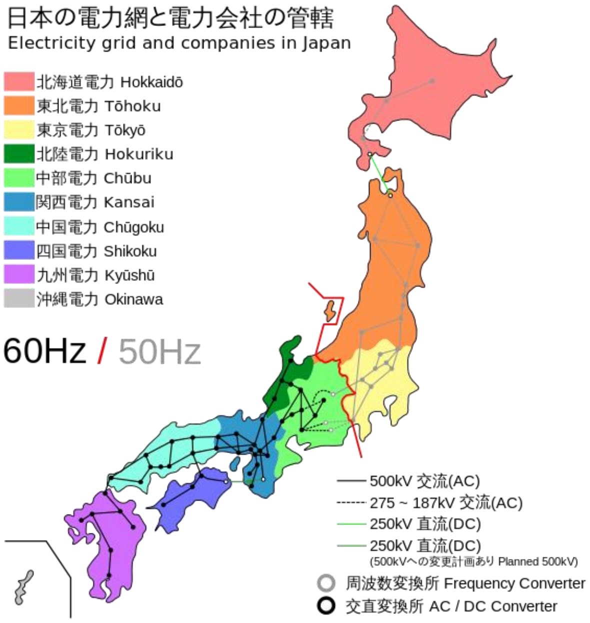
Though the target of the nuclear power's share was set between 20-22% by 2030, due to the strong opposition of Japanese citizens against restarts as well as new constructions of nuclear reactors the attainment of this share of nuclear energy is highly uncertain. While some experts, the large utilities (see Figure 3) and economic organizations claimed that Japan would need the nuclear energy to meet the Paris target (Keidanren 2018), the restart of the nuclear power plants is deadlocked.

To achieve substantial GHG reduction while replacing the nuclear power generation, Japan would need more renewable energy than the proposed target in the energy mix 2030 to reach the national climate target by 2030. Apart from the Paris Agreement, the Great East Japan Earthquake on 11th March 2011 and the resulting accident at the Fukushima Daiichi Nuclear Power Plant, operated by Tokyo Electric and Power Company (TEPCO) raised the awareness of green electricity among Japanese power users. Though different studies on consumers' attitudes towards green electricity yield different results (see Appendix A1-1), an increasing number of Japanese citizens seems to be interested in choosing green electricity. There are also some initiatives emerging. For instance, “power-shift” (Power-Shift 2019) supports to change to green electricity tariff and products[3]. A broader range of alternatives of green electricity retailers can help the citizens to significantly contribute to the energy transition. There are also corporate initiatives, like RE100 (RE 100 2019).

2.2. Electricity market liberalization and market concentration

In the post-war-period, the Japanese electricity system had been organized by ten regional monopolies with a big Electric and Power Company (EPCO) in each region (“big utility” hereafter). All of these own nuclear power plants except Okinawa Electric and Power Company. These EPCOs have dominated the electricity supply system. For historical reasons, the network has been divided into two different frequency areas (see Figure 3). For the rapid post-war construction and operation of power plants, the dedicated companies J-Power and Japan Atomic Power Company (JAPC) had been established by the large utilities in the 1950s (for details, see Appendix A1-2).

Figure 3 10 large utilities in Japan



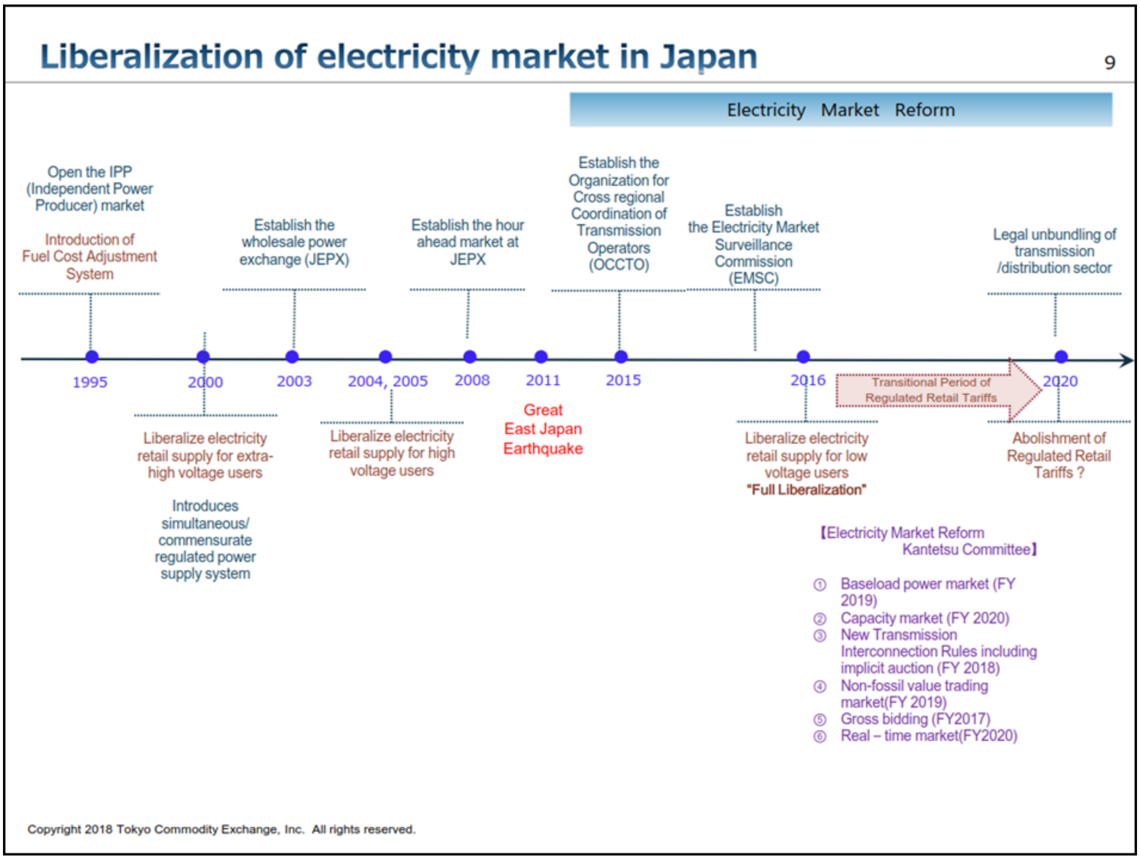
Source: (Aitchison 2012)

EPCOs have long been vertically integrated, but the Japanese government started a process of electricity market liberalization in the 1990s (see Figure 4). However, the government followed a step-by-step-approach and decided to implement unbundling not before 2020. Unbundling is prerequisite in order to make competition work. Since

[3] Power-Shift is a campaign to provide the information about green retailers to compare and how to change the tariff to one of green retailers.

electricity networks constitute a natural monopoly they have to be regulated by an independent body to ensure open and equal access at the same cost for newcomers as well as for incumbents (Matschoss et al. 2017, Ch. 2; Matschoss et al. 2019). Some of EPCOs have unbundled in advance but others consider how they split the grid operation and power generation. This means some of the large utilities still own units in the complete value chain, "power generation", "transmission and distribution grid operation" and "marketing and sales" until 2020 (for details, please see Appendix A1-3).

Figure 4 Liberalization of electricity market

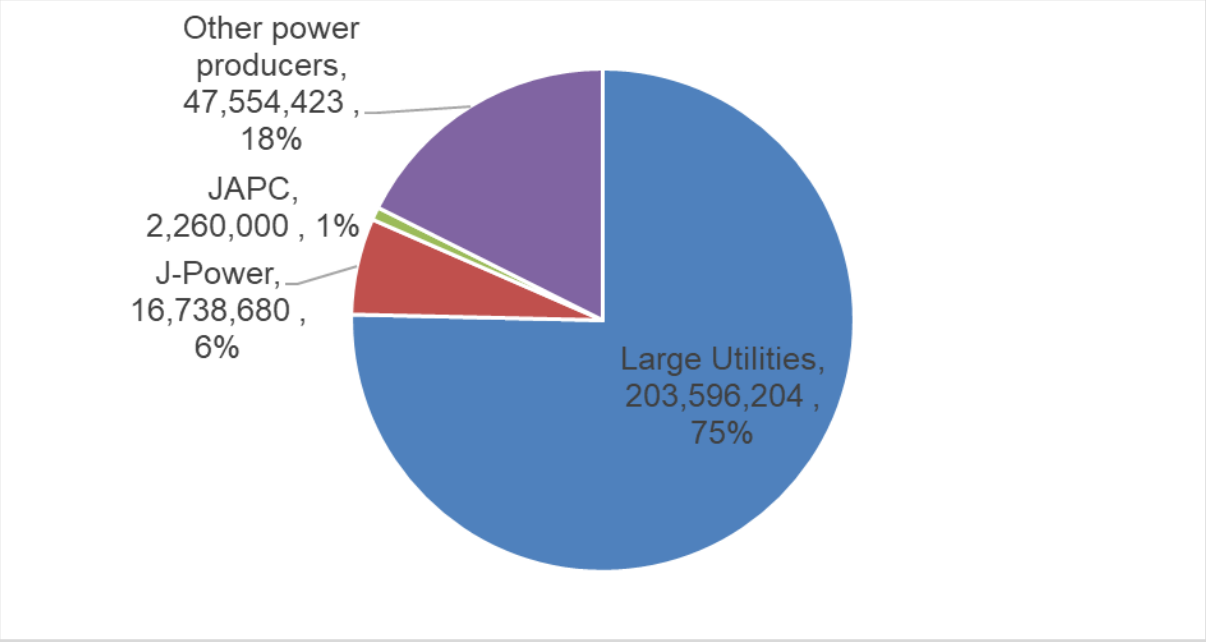


Source: (Yamashita 2018)

Since 2016 the retail market for low voltage (LV) level has been liberalized, resulting in newcomers entering the market. Despite the ongoing liberalization process, common concentration measures still show very high concentration values, meaning a dominant position of the incumbents (Matschoss et al. 2017, Ch. 3, for details pls. see appendix), for details, please see Appendix A1-3). Likewise, the share of generation capacity displays a dominant position of the incumbents (see Figure 5). Despite opening the market for independent power producers (IPP) in 1995, the large utilities own 75% of Japan's generation capacity. 6% and 1% of the annual generation are owned by J-Power and JAPC, respectively. Other power producers own just 18%

(the amount of self-consumption is excluded from Figure 5). For details on generation capacities, please refer to Appendix A1-3.

Figure 5 Share of power generation capacity (in kW, as of January 2019)



Source: (ANRE 2019b)

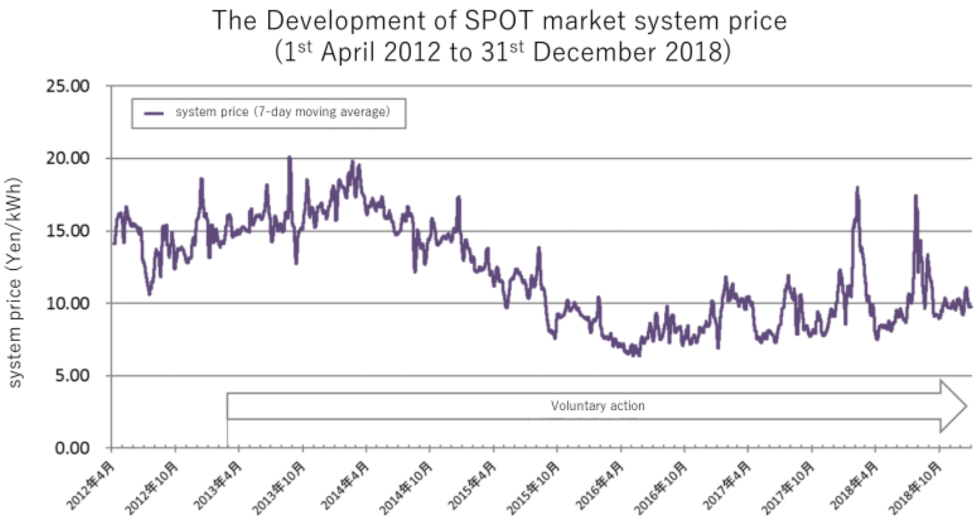
In 2003, the Japan Electricity Power Exchange (JEPX) was established to provide a transparent market place and enable efficient trade and pricing as the operator of the Japanese wholesale market. It organizes the day-ahead (spot)[4] and intraday market, the forward market, the decentral or green retail market, the non-fossil fuel certificate market (JEPX 2019). Furthermore, cross-regional grid capacities, managed by the Organization for Cross-regional Coordination of Transmission Operators (OCCTO), are also traded at the day-ahead market by way of indirect auctions. The current gate-closure of the intraday market is 1 hour before the delivery and the trade unit is 30 minutes (for details, please see Appendix A1-4). The spot market system prices and contract volumes in the day-ahead market are displayed in Figure 6 and Figure 7.

The trade amount of JEPX increased over time. However, despite rising shares of trade at JEPX spot market, it is still rather low compared to other countries (Matschoss et al. 2017, Ch. 3). Reasons are the high market concentration as shown above and the regulations that require the retailers to purchase high amounts of supply capacity as will be shown later. Therefore, the challenge is to make the large utilities sell more power in JEPX because they dominate 75% of the Japanese supply capacity (see Figure 5). In order to increase the trade volume at spot market gross bidding was

[4] In Europe, the spot market includes the intraday and day-ahead market (EEX 2019)

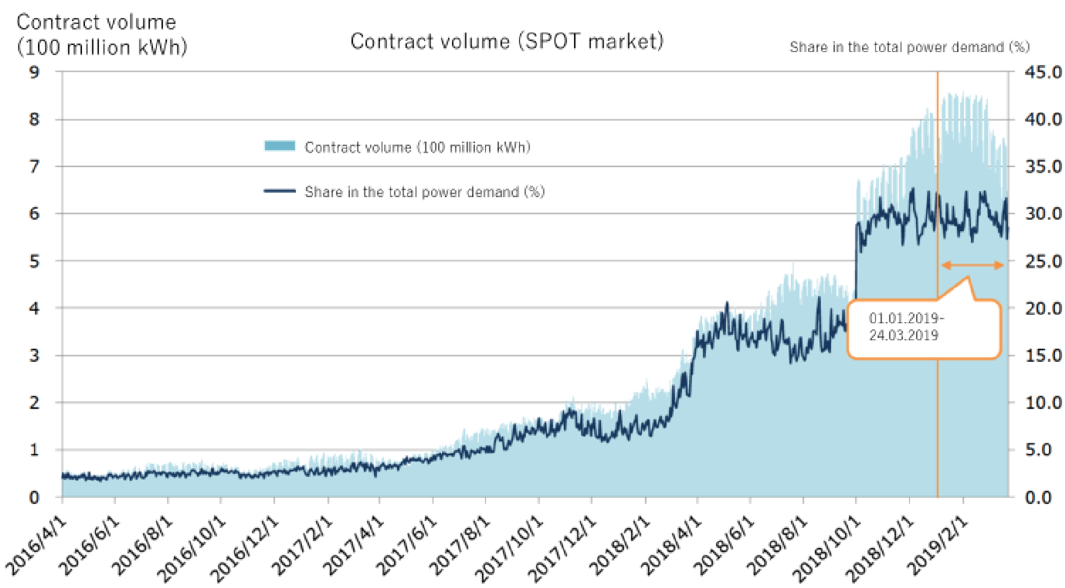
introduced in 2017. Gross bidding mandates the large utilities to sell electricity at JEPX, so far with mixed results (see Appendix A1-5).

Figure 6 Development of spot market system price



Source: (EGC 2019)

Figure 7 Contract volume in the day-ahead market



Source: (ANRE 2019d)

Note: The sudden change of the trade volume in October 2018 is attributed to the opening of the indirect auction. However, a deeper analysis is beyond the scope of this report.

2.3. Obligation to secure capacity and real-time balancing

In a liberalized electricity market all retailers organize their customers in Balancing Groups (BG). They have to estimate and purchase the right amount of electricity their customers will consume to keep their BG in balance. If estimated demand is higher than supply (being “too little”) retailers can buy additional energy on the market, if demand is lower than supply (being “too much”), they can sell. That is, the retailor either has to be the Balancing Responsible Party (BRP) itself or has to delegate this responsibility to another organization. In case the BG cannot avoid being out of balance, causing imbalance to the system, the retailer has to pay imbalance costs for the additional energy that has to be supplied by the system operator which is usually one of the large utilities. It leads to balance the *overall* demand and supply of the system. Therefore, there is *no need to secure capacity in advance for every single retailer*. In a liberalized market, the methods to handle deviations from the balance should be on the short-term market for energy instead of long-term capacity obligations, so that retailers can fulfill their obligation to balance their BG via purchases (and sales) of electricity on the wholesale market. That is, an open and liquid market is crucial (see Appendix A1-6).

The system of balancing was changed over time. The government replaced the obligation to supply for the large utilities with the obligation to secure capacity for retailers. Before the market liberalization, only the large utilities generated and sold electricity (with the exception of some independent retailers). This means no BGs were needed. The large utilities as monopolistic power suppliers were obliged to supply the electricity (obligation to supply). This rule implied that only monopolistic utilities existed and retailers who do not generate but only sell electricity were not considered. The government was concerned that new retailers who do not own generation units would fall short if they sold more electricity than they could make available (METI 2013) (see Appendix A1-9).

All of this has resulted in the current regulation, which requires *all retailers* as prerequisite to “secure sufficient power supply capacity to meet demand from potential customers” (Mac Pherson 2017). The supply capacity that *each retailer* shall secure is calculated as the sum of the maximum load of all customers with redundancy of a safety buffer. That is, every retailer should secure 100+% secure capacity. The retailers shall keep the supply capacity including some upper room for the hypothetical demand until one hour before the delivery (IEEI 2014). That is a barrier especially for new electricity suppliers.

Another issue is how to determine the amount of secure capacity itself. Different energy technologies have different capacity factors, expressing the respective rates of utilization[5]. Furthermore, VRE capacities in the portfolio involve some risk of forecast (over- and underestimation of generation) and these forecasting errors may fall together with high or low demand, i.e. different combinations are conceivable. Here, too, from a system point of view, it is important that forecasts (for VRE) on average are correct. However, the currently applied method that is used as the basis for calculating the day-to-day backup capacity requirements, called the “L5 output rate”, assumes a rather extreme supply-demand-situation that rarely occurs. More specifically, the L5 output rate combines the average of the 5 lowest outputs with the 5 highest demand days over the plant’s lifetime (see Appendix A1-7) That is, for almost all the time, retailers are oversupplied with electricity, driving system wide demand for backup capacity artificially high.

Finally, all retailers have to make a forecast for the next 10 years as they have to submit their supply plans to OCCTO, which is responsible to formulate regulations and codes, to formulate Long-term Policy and Cross-regional Network Development Plan and to supervise grid access operation. However, the long-term supply plans, submitted by retailers, are non-binding but they will be used for analyzing the national demand and supply outlook. For the next year, the retailers submit a monthly supply plan. OCCTO may advise the retailers to amend the monthly supply plan if the plan seemed to be hardly implemented.

Balancing refers to the short-term adjustment of the BG in terms of electricity (kWh), not capacity (kW). There are different options to organize balancing. In April 2016 the government switched from real value to planned value balancing.[6] Under the former real value balancing, the power producers (mainly the large utilities) took the responsibility for balancing based on the realized demand and supply volume as described above, so called the obligation of supply (kWh). The imbalance cost per kWh was stable under the Japanese real value balancing. In the planned balancing introduced in April 2016, power producers submit their supply schedule and retailers their demand schedule, respectively. The retailers are obliged to secure the required capacity according to the schedule via direct bilateral contracts (over the counter, OTC) or the wholesale market, i.e. via auctions at JEPX. The primary schedule must be submitted one day before and the power producers and retailers can adjust the deviation of the schedule and the latest forecast on an intraday market until gate-closure (one hour before delivery; a trade unit is 30 min.). The imbalance cost per kWh is varying under the Japanese planned balancing according to market situation.

[5] For instance, variable renewable energies (VRE) like PV or wind, have fewer full use hours during the year and therefore lower capacity factors than e.g. base load technologies (nuclear, coal).

[6] Retailers who made a contract of transportation service with the big utilities before 31st March 2016 could take its choice from real value and planned balancing. In Japan the unbundling will be planned for 2020. After the unbundling the contract will be made between a retailer and a network operator.

Currently, making accurate forecasts of VRE generation is still a challenge in Japan. In particular, the forecasts of smaller retailers are less accurate (ANRE 2018c) This shows that participation in the market also requires capacities and skills, and small retailers with large shares of VRE have a larger imbalance risk (ANRE 2018a).

In 2012, for the sake of protection of those new green (small) power producers supported by the FIT and retailers buying the FIT electricity, the government introduced two FIT Special Treatment methods; i) planned balancing by the TDSO (called Special Treatment 1) and ii) planned balancing by retailer (called Special Treatment 2) (see Table 1). To reduce the imbalance risk, the retailers procure electricity from the FIT units can use one of these FIT special treatments. The Special Treatment 1 is especially beneficial for the retailers because they are freed from the imbalance risk associated with VRE, i.e. they do not need to forecast the FIT units' electricity generation (see Appendix A1-8)

Table 1 Overview of the FIT special treatments

	Who makes a supply schedule	Who takes an imbalance risk	The cost of imbalance	Who is motivated to improve the schedule
Special Treatment 1	TDSO	TDSO	Avoidable costs under the FIT-scheme	TDSO
Special Treatment 2	Retailer	Retailer	Regular imbalance cost	Retailer
Regular balancing	Power producer	Power producer	Regular imbalance cost	Power producer

Source: (MOE 2014)

However, the Special Treatment 1 fixes the schedule 48 hours before delivery, which means there is too little room to correct forecasts. Therefore, retailers with the Special Treatment 1 are not motivated to look for better options to balance their schedule like using flexibility (see section 5.1.) This might also result in the overestimation of the necessary secured supply capacity of conventional dispatchable power plants to compensate for the imbalance caused by VRE[7], raising the total electricity system costs and causing lock-in effects of conventional power plants like coal.

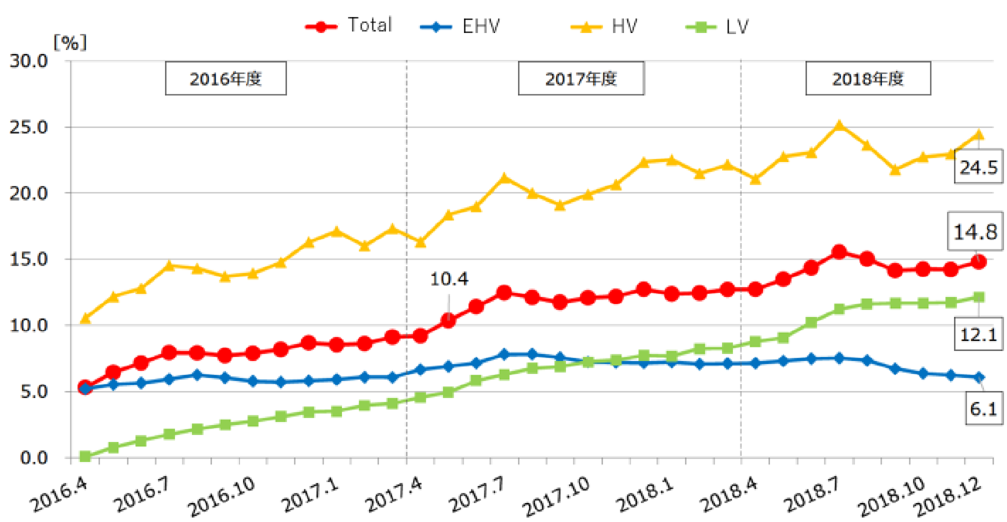
Japan plans to open a cross-regional balancing market in 2021. This would introduce a separate market for system services that is actually needed from a grid perspective. However, the modalities are yet unclear (see section 5).

[7] It is correct that clean and dispatchable generation capacity like as batteries or biomass are available in the global market. But looking at the current situation in Japan they are not sufficient for all retailers who would buy the FIT electricity.

2.4. Impact on new and green retailers: low market shares, high dependence on large utilities

The concentration in the Japanese energy market is still high as was shown in section 2.2. This can also be seen in a rather low share of new retailers (see Figure 8) at various voltage levels. As shown, due to the obligation to secure capacity, new – especially green – retailers are forced to secure large amounts of capacity. However, even though the share of the new retailers has risen after the market liberalization, their share of capacity is still low. That is, the large utilities still have a large share in the market. Figure 9 shows a comparison of the structure of the supply capacity between large utilities and newcomers according to their supply plan (ie. a forecast until 2025) which reveals some significant differences. First of all, the total amount of the capacity of the incumbents is significantly higher. Secondly, the share of baseload[8] capacity (hydro, coal and nuclear according to the source) of the large utilities (31.9%) is significantly higher than of the new retailers in the future (4.6%). Figure 10 shows a similar breakdown according to the size of the newcomers. It shows that their own capacities are smallest for the small retailers (3%). Expressed differently: the new retailers need to secure a large share of their capacity in the short-term market, that is, from the large utilities which dominate this market.

Figure 8 Share of new retailers



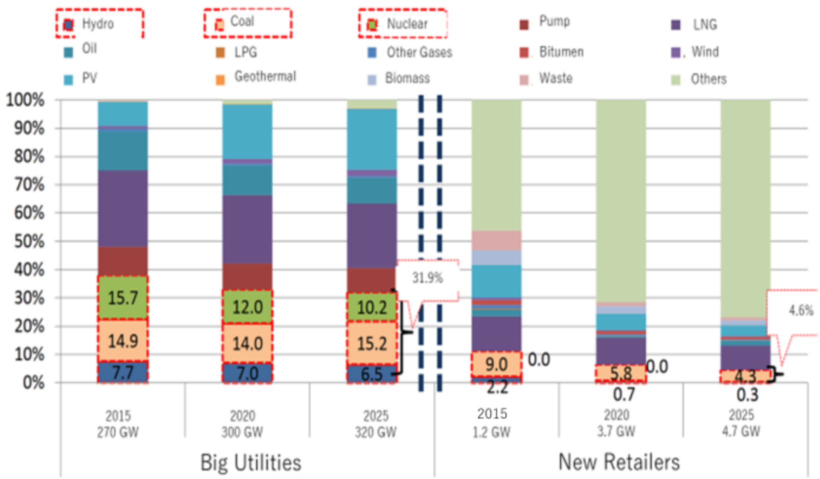
Source: (ANRE 2019d)

Since current regulation requires new – especially green – retailers to secure large amounts of secure capacity, access to baseload capacity is vital for new green retailers in order to be competitive. Together with the unequal capacity breakdown, this

[8] Baseload capacity generates power that is traded at the lowest prices in the wholesale market. With regard to the societal cost of nuclear energy it may be disputable to call this form of energy low cost.

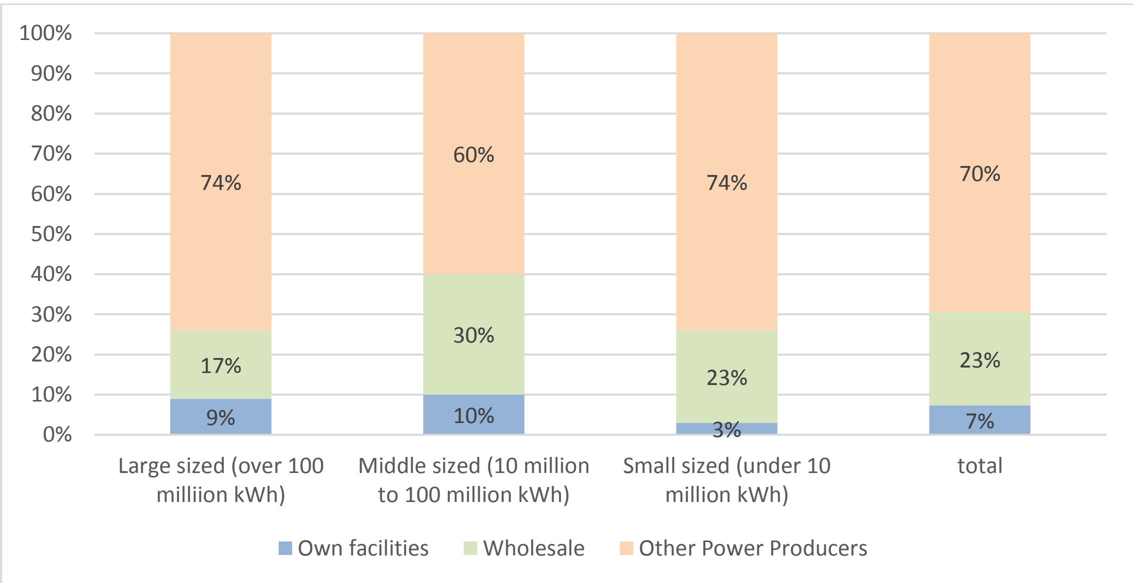
constitutes a significant market barrier for new green retailers. Over time, new retailers may invest in their own capacity. However, this requires a sustainable business model in the first place.

Figure 9 Portfolio of large utilities



Source: (ANRE 2017b)

Figure 10 Breakdown of capacity of new retailers



Source: (ANRE 2017b)

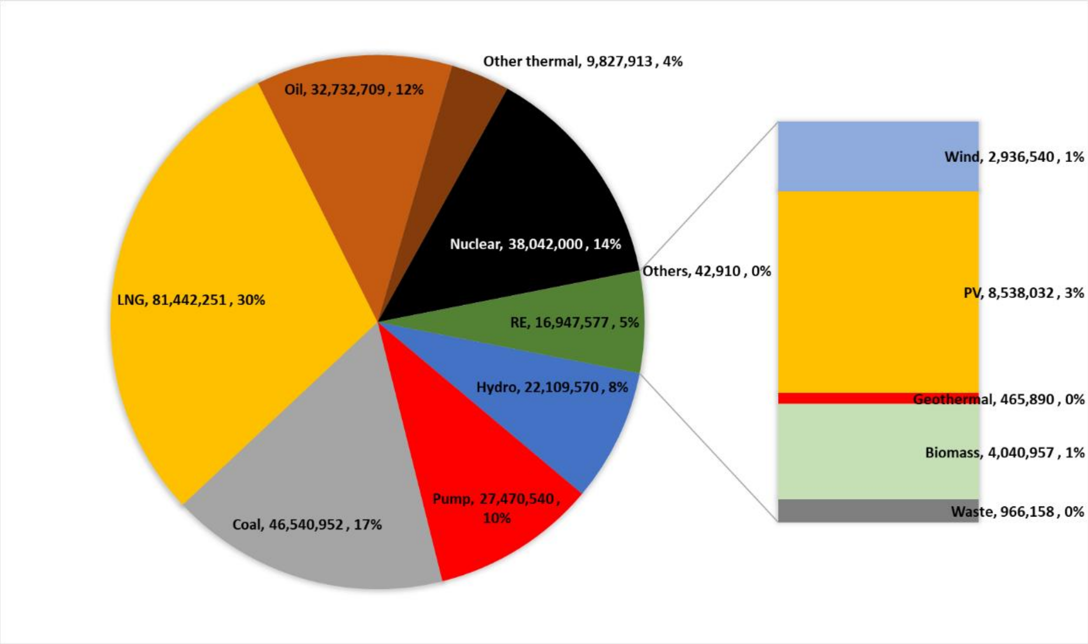
In order to improve the new retailers' access to the large utilities' baseload capacities, the Japanese government introduced a number of measures. In 2000 the "anytime back-up agreement" was introduced as an interim measure. With this measure, the large utilities were obligated to sell power to new retailers. However, since it was based on bilateral contracts between one of the large utilities and the newcomer, bargaining power was unequal and the new utilities were mainly offered (more expensive) mid-load capacity (see Appendix A1-9). In 2019 the so-called “baseload market” replaced the anytime backup agreement. The baseload market is an auction system for which the large utilities are obliged to offer (low-cost) baseload supply instead of mid-load. While the baseload market has the potential to enhance competitiveness of newcomers, it also has a risk to prolong the lifetime of nuclear and coal-fired power plants (see Appendix A1-10). Furthermore, gross bidding was introduced at JEPX in 2017 as mentioned in 2.2.

2.5. Renewable energy

2.5.1. Renewable capacity development, role of hydro

The breakdown of Japan’s generation capacity is shown in Figure 11. PV is dominant among the “new” RES as it has been growing the fastest after the introduction of the Feed-In-Tariff (FIT) scheme in 2012.

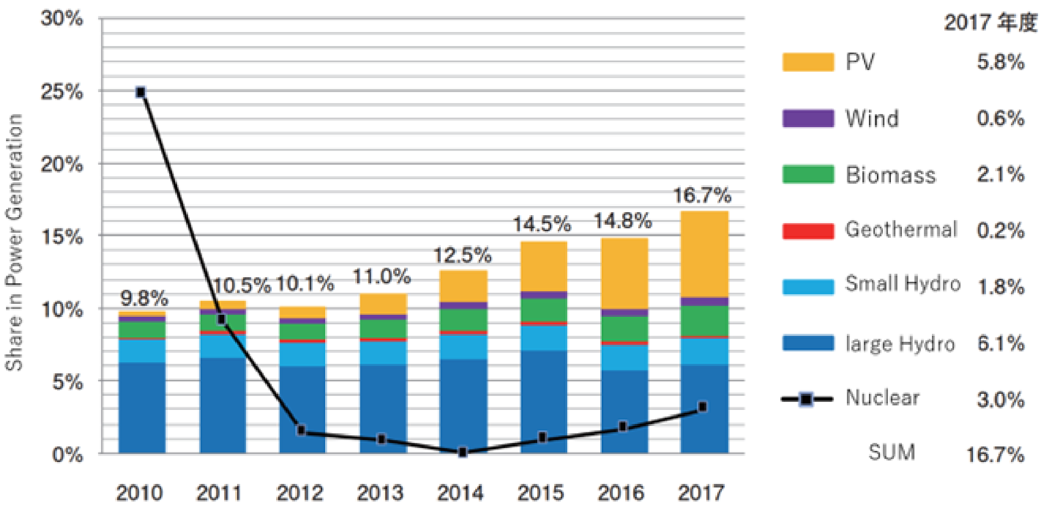
Figure 11 Breakdown of generation capacity (as of January 2019, in kW)



Source: (ANRE 2019b)

It can be seen in Figure 12 that before the FIT was implemented, renewable energy accounted for 2,060 MW, meaning that about 15,000 MW has been added due to the FIT (ISEP 2019a). During this period no nuclear capacity has been added and the permission to restart was granted to 9 reactors as of May 2019 (Nippon.com 2019). However, as was mentioned in section 1, the energy plan foresees a higher contribution from RES altogether. In particular, since the public acceptance of nuclear energy is low, it implies replacement by RES. Therefore, higher growth rates of RES are necessary. On historical growth rates of all power sources and regional distribution of RES, see Appendix A1-11.

Figure 12 Share of RES and nuclear in generation (in kWh)

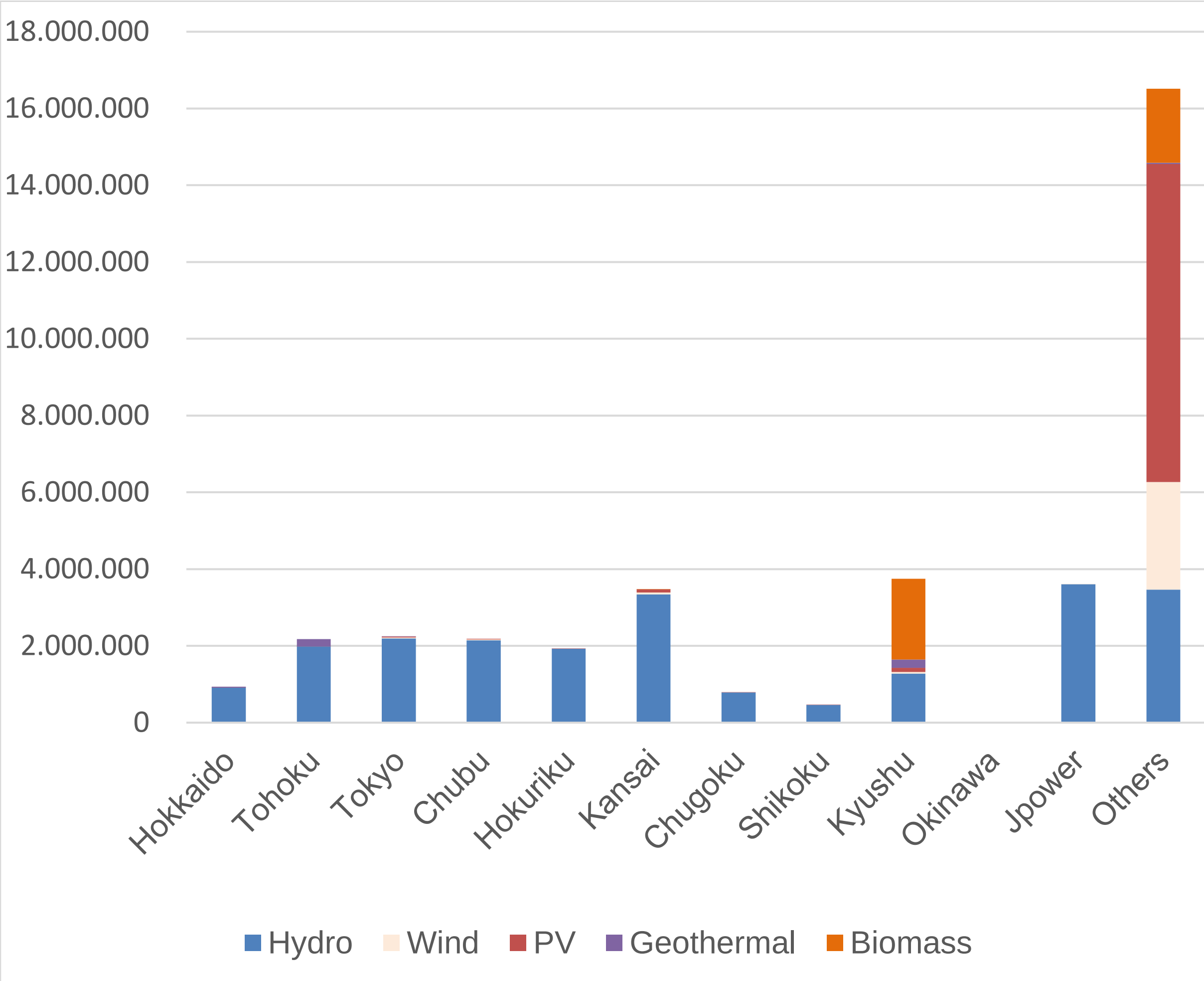


Source: (ISEP 2019b)

Furthermore, Figure 13 shows that nearly all of the “new” RES-capacities – that is, except hydro and some biomass – are owned by the newcomers in the market and vice versa. That is, on the other hand the newcomers own very few capacities – mainly some hydro and even less biomass – that may be utilized as supply capacity.

The largest renewable technology, however, is hydro energy, putting it in a unique position. Most of the capacity, however, can be considered as “large and old”, belonging mostly to the large utilities and accounting for around 15,000 MW that have been built before 1970. Since 1970 another 5,000 MW have been added, most of which were small hydro, owned by the large utilities as well as by municipalities. As a result, municipalities own 16.2% of hydro capacity in Japan (see Appendix A1-11). Since hydro power plants with a capacity of up to 30 MW (called small hydro) are supported by the FIT, they have been getting more attention from green retailers as well as municipalities. Additionally, 26 MW of municipal hydro are under construction and 56 MW are planned by 2030 in total (PEUEF 2018). Those plants will be supported by the FIT. Local actors see small hydro as a useful renewable resource for “local production for local consumption”. For more information on the development of hydro power, (see Appendix A1-11).

Figure 13 RES capacity of Japanese utilities (in kWh)



Source: (ANRE 2019b)

Note: the data of EPCOs includes all group companies. Others includes municipal entities.

2.5.2. Green electricity policy

As was shown in the previous section and in the introduction, the percentage shares of RES in the Japanese electricity market are still far too low in order to reach the objectives of the Paris Agreement. Furthermore, the introduction of large scale RES, other than hydro, is still fairly new to Japanese energy policy because before the Fukushima accident it was planned to fulfil the GHG reduction commitment mainly with nuclear as a low carbon energy. Therefore, a number of policy measures are still skewed towards i) the inclusion of nuclear and ii) using already existing renewable capacity, namely hydro. Therefore, Japanese renewable policy cannot be analyzed without these aspects in mind, especially when looking for business models that are meant to contribute to additional RES capacity and true system change to enhance the energy transition.

Globally, there are several examples for renewable electricity certificates designated for certifying renewable electricity. These are adopted in different countries or regions such as Guarantees of Origin (GO) in Europe or Renewable Energy Certificates (REC) in the US. They can be detached from the renewable electricity and traded on separate markets. That is, energy from fossil fuels can be combined with an equal amount of renewable electricity certificates. The certificate usually contains standardized information (source, timestamp, address of the facility, owner and commissioning date) so that each certificate can be identified individually. As electricity in the grid is not distinguishable, a certificate scheme is used to avoid double counting. Usually, only one certificate system per country exists.

In Japan, various green certificate schemes have been introduced. The purpose of these certificates is to certify that the electricity consumed is low carbon. A certificate is issued for generated low carbon electricity (for example 1 unit of certificate for 1 kWh) and canceled when the low carbon electricity is consumed (delivered to consumers). The Green Power Certificate (GPC) scheme, a green electricity scheme for power plants, was introduced in 2008. The J-Credit scheme, introduced in 2013, is a project-based mechanism for green electricity and energy efficiency measures. It was originally introduced to use in CO2-emissions trade (for both, see Appendix A1-12). Both have been introduced prior to the FIT (see below) and due to their different history and purposes, they have different merits and pitfalls.

Table 2 Comparison of 3 types of green power certificates

	Green Power Certificate	**J-Credit**	**Non-Fossil Fuel Certificate**
Overview	Issuance based on each registered facility and its power generation	Project-based accreditation, emission credit	NFFC-RE and NFFC-NS. The detail is following.
Includes information about sources and location	YES	YES	NO
Consumers can purchase	YES	YES	NO
Price Yen/kWh	2-5 Yen/kWh	0.5-1 Yen/kWh	1.3-4 Yen/kWh
Volume Issued	311GWh (2016)	1,500GWh (2016)	50,000GWh (Apr.-Dec. 2017)

Source: Own table

Note: Currently only the NFFC-RE from the FIT facilities is issued and traded. The price and volume of the NFFC is thus valid for NFFC-RE from FIT only.

Due to the low RES capacities the FIT was introduced in 2012. This is a political support scheme for renewable energy, in which a renewable power producer receives a fixed rate for the electricity produced by a renewable power generation unit (FIT facility) that enables her/him to pay back the investment over time. FIT-schemes had first been introduced in Germany in 2000 with a predecessor in 1990 (Matschoss et al. 2017, section 4.2.2) (see Appendix A1-13). They have shown to be effective in raising RES capacities and have been adopted by a number of countries in the world (Mitchell et al. 2012). In Japan, the system has mainly been successful for PV, leading to unbalanced capacity additions (see Figure 6). The FIT-rates are technology-specific and have been amended several times (for details see A1-13).

In 2018, Non-Fossil Fuel Certificate (NFFC) was introduced as a new certificate system. The NFFC was primarily introduced to enable to trade the environmental value from FIT facilities. That is, the revenue from NFFC RE from FIT (FIT NFFC) shall be used to reduce the FIT-surcharge as explained below (SAESR 2017). The three certificate schemes are compared in Table 2. In total, there will be several types of NFFC, NFFC-RE (FIT NFFC), NFFC-RE (Non-FIT NFFC) and NFFC-NS (Non-FIT NFFC) as shown in Table 3. For example, NFFC explicitly includes nuclear power in addition to existing renewable energies (including large hydro) because one aim is that retailer shall use the NFFC to comply with the target to reach the 44% of non-fossil electricity rate by 2030 (in section 1). Furthermore, the environmental value from large old hydro shall be included to NFFC scheme from fall 2019 or winter 2020 (discussion ongoing). The environmental value from the first so-called post-FIT-facilities[9] (as of fall 2019) shall be included, too, to prevent them from going out of service. Although it's not currently traded, NFFC-NS (Non-Specified) is planned to be issued for electricity from nuclear, large and old hydro, post-FIT facilities and non-FIT facilities. It is likely that NFFC-RE and NFFC-NS have different prices in the market. However, it is not possible to distinguish the different forms of non-fossil fuel sources as discussed in detail later.

In addition, the NFFC raises a number of questions on additionality (see also section 2.5.3). Under the FIT, the general electricity consumer finances renewable energy capacity additions. As the rate paid to the FIT producer is usually higher than the electricity market price, the differential costs are levied as a surcharge on all electricity consumers (unless they are exempt, like energy intensive industries). Therefore, it is believed in other countries, for instance in Germany, that the general electricity consumers have a right to the environmental value from the FIT facilities. And the value is not tradable as those trades are perceived as not additional (called "double marketing" or "double sales"). Instead, the contribution to the FIT payments of each electricity consumer's is declared in an electricity declaration to her/his electricity bill

[9] FIT-facilities whose FIT-period has expired

(see Appendix A1-14). The NFFC, however, is specifically designed that power producers and retailers can trade the environmental value of the FIT electricity as mentioned. One political motivation seems to restrain the increase of the FIT-surcharge. This implies that retailers (all retailers, not just green ones) sell RES capacities again to customers that have been financed by the general electricity consumers already.

Table 3 Categorization of three types of NFFC

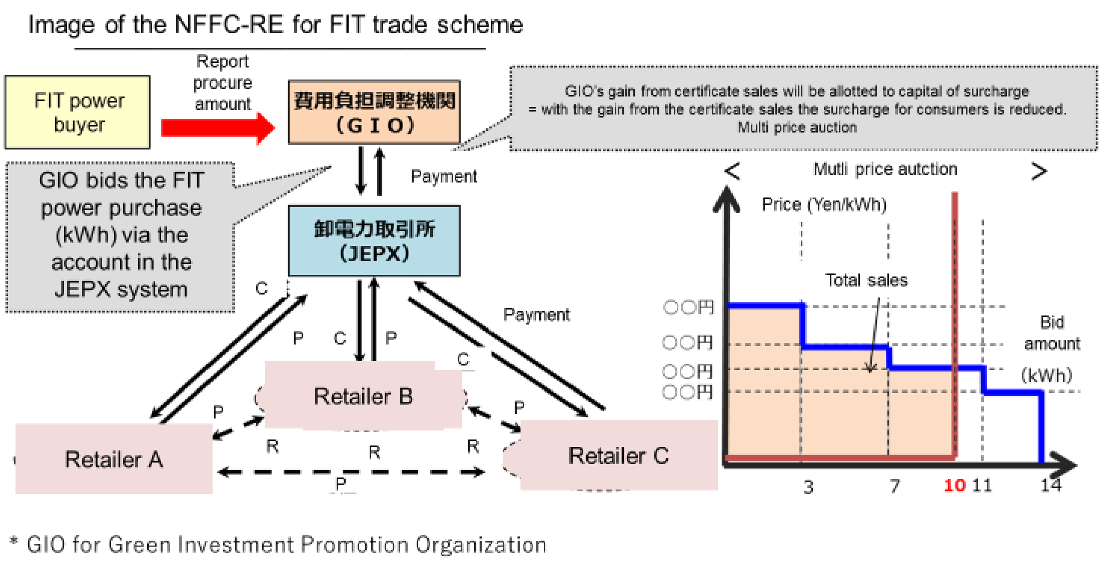
		NFFC-RE		NFFC-NS
		FIT NFFC	Non-FIT NFFC	Non-FIT NFFC
Target sources		FIT facilities (PV, wind, small hydro, biomass, geothermal)	Non-FIT RE facilities (Large hydro, post FIT)	Non-FIT facilities (large hydro, post-FIT, nuclear)
Seller of NFFC		GIO	Power Producer	Power Producer
Buyer of NFFC		Retailer	Retailer	Retailer
Min. Price		1.3 Yen/kWh	Not set	Not set
Max. Price		4 Yen/kWh	To be considered	To be considered
Pricing		Multi Price	Single Price	Single Price
Non-Fossil Value		Yes	Yes	Yes
Zero Emission Value		Yes	Yes	Yes
Env. Value to declare	Net RE	Yes	Yes	No
	Net Zero Emission	Yes	Yes	Yes

Source: (ANRE 2018e)

Note: GIO: Green Investment Promotion Organization. The overlap between the categories is intentionally designed

Flow of NFFC-RE (FIT NFFC) is as below (see Figure 14). The Green Investment Promotion Organization (GIO), which is the coordinating body of the FIT's costs allocation, gathers all NFFC RE from the FIT power producers to sell them to green retailers via an auction opened at JEPX. The green retailers who bought the NFFC report the procurement amount to GIO to cancel the NFFC. The revenue from the NFFC sales is then used for the compensation of the increasing surcharge. That is, green retailers may only purchase the NFFC from GIO and not from facilities directly (other NFFC such as NFFC-NS can be bought directly from power producers once the trade will begin).

Figure 14 NFFC's scheme



Source: (ANRE 2019d)

Note: C stands for certificate, P for payment and R for resale.

As explained, currently available NFFC is only NFFC-RE (FIT NFFC). However, the government aims to extend the NFFC. NFFC will certify power from facilities whose FIT-period has expired (called post-FIT facilities) as well as facilities that are built without FIT support altogether (called non-FIT facilities, but those are still rare in Japan). In addition, old hydro and nuclear (the latter being non-fossil low carbon) capacities will be able to be accredited by the NFFC as well. One of the issue is current NFFC does not contain any information about the source, location or the date of implementation. NFFC lacks the very basic information as green certificates that would allow to distinguish renewable electricity from others. To solve this problem, some new green retailers have developed a tracking tool for green electricity on their own. It enables green retailers to combine the NFFC bought from the auction market with electricity from the FIT facilities that they have an electricity wholesale agreement with. This enables retailers to prove that the green electricity is from the designated FIT facilities and thus RES. However, this scheme causes extra costs for the green retailers.

2.5.3. Green retailers, energy transition, additionality and labelling

Globally, the idea of energy transition has been accelerating and investments in renewable energy have been increasing rapidly (REN21 2018). That is, energy transition is understood as a fundamental change of the energy system switching to renewable energies, raising energy efficiency in almost all sectors, thereby reducing energy imports, stimulating technology innovation and the green economy, reducing and eliminating the risks of nuclear power, raising energy security and strengthening local economies and providing social justice (Matschoss et al. 2017, section 2.2.4; Morris und Pehnt 2014).

It is therefore necessary to create a framework that enables green retailers to create business models that contribute to the energy transition, i.e. that provide *additionality*. That is, when customers switch from a “normal” to a “green” tariff (that is in Japan supposedly more expensive) the extra money has to provide an *extra incentive* to transform the energy system *beyond the current regulation* (in fact, this is the intrinsic motivation for customers who want to contribute to the transition to switch to the green tariff). For example, since the “normal” customer already pays the FIT-surcharge, switching to a green retailor needs to imply an additional contribution beyond that. What this contribution exactly is, depends on the energy system, i.e. it is country-specific. First and foremost, this may be via the creation of “additional” (i.e. beyond FIT-induced) renewable capacity. This implies that FIT renewable capacities are not additional. Furthermore, it implies that other renewable capacities that have been built long before (such as old hydro) are not additional either. However, if these capacities are used in a business model where the revenue is used to create new renewable capacities, there is a case for additionality. Furthermore, an electricity product could be considered additional if it supports the energy transition. For example, this could be investments into certain transition-relevant technologies (e.g. electrolyzer run by renewable energy) or investments into transition-relevant infrastructure in specific regions to enhance public acceptance towards renewable facilities. Here, green retailers may develop (combinations of) new products and offer them to the market.

In order to enhance transparency and make products comparable, labelling schemes may be useful. Transparency and trust is among the most important values in the green retailers business. Therefore, safeguarding additionality is vital. The information specifying location and source or GO of renewable electricity only provides the information that the electricity is renewable but without giving any evidence on its additionality. On the other hand, no labelling scheme will ever be able to anticipate all business models that may be eligible in the future (kinds of complementary investments etc.) and include them. Therefore, a transparent sets of strict criteria instead of a whole labelling scheme may be used to keep flexibility so that different retailers can attach different properties to their renewable energy products and differentiate their marketing strategies, thereby aiming at different customers with different preferences and willingnesses to pay. For example 100% renewable, 50% renewable, from new or old facilities, from large or small facilities, from local facilities, from specific technologies, in combination with transition-relevant technology, retailor with or without connection to nuclear industry just to name a few. Other countries have introduced a variety of labels such as OK Power, TÜV Nord and so on that are validated by independent institutions (Hauser et al. 2019, Ch. 1). Greenpeace Germany has developed its own set of visions and criteria that is used by Greenpeace Energy, the client of this study:

- Climate and environmental protection
- Sustainable energy supply
- Reducing the economic costs of energy supply
- Integrating long-term external effects
- Conserving fossil resources
- Developing renewable energy technologies
- Global energy transformation
- Democratization: Citizens not just "points of sale" but also producer-consumer communities
- Energy transition as a blueprint for the transformation of industrial society

It is beyond the scope of the study to develop a labelling scheme for Japan. However, as shown above transparency is key, in particular when it comes to the additionality of green electricity products. It is at the core of the green retailers' business model to offer renewable electricity products where customers are willing to pay a premium. This is particularly relevant for Japan because a large part of available RES is not additional (i.e. hydro and NFFC for FIT units, see section 2.5.2). Therefore, when green retailers choose to offer these non-additional products in their portfolio it has to be clearly made transparent. As labelling scheme is one example of a safeguard to differentiate between these non-additional resources and products that are indeed additional. In that way, retailers have the chance to develop more ambitious, transition-relevant products and are able to recover the costs on the markets if their products are more expensive than others.

3. Immediate measures

The immediate measures concern changes in regulation that need to be tackled immediately and take effect within the next 2-3 years. These concern some of the most fundamental barriers in the general electricity market design as well as regulations on renewable energy.

3.1. Fundamental electricity market design issues

3.1.1. Lower secure capacity requirements

The requirement to secure capacity constitutes one of the most important barriers for all new retailers. In particular, it constitutes a barrier for new retailers with high shares of VRE – PV and wind – in their portfolios and for small retailers. The requirement can be lowered significantly or even abandoned altogether without jeopardizing energy security.

As was shown in section 2.3 all new retailers are required to purchase secure capacity. The retailers with more than 2,000 MW capacity secure 105% of the demand on average (METI 2019). That is, each new retailor has to pay for excess capacity instead of being able to optimize its portfolio on the short-term electricity market. In addition, the method of calculation of secure capacity for VRE results in unnecessary high safety margins. Both sometimes forces retailers to additionally secure the same amount of capacity they already provide (see Appendix A1-7), artificially driving up their costs and jeopardizing their competitive position. Finally, this requirement places the highest burden on small retailers who have the least capacities on their own and have to purchase these on the market. As was laid out in section 2.4, this implies an unequal bargaining with the large utilities who own the most power generation capacity. That is, the regulation exacerbates the already existing market power of the incumbents. So far, regulations like the anytime backup agreement were of little help since they do not solve the fundamental problem of the unequal distribution of baseload capacity.

Apart from discriminating against new as well as green and small retailers the capacity requirement regulation ignores the fact that the short-term wholesale market is the place to optimize the retailers' energy demand and supply in liberalized electricity markets. Here, retailers take responsibility for their Balancing Group (BG) and may buy additional energy if they have a deficit or sell if they are over-supplied. As mentioned in section 2.2, spot market volumes are still rather low (so-called "shallow markets") but this is partly due to the current regulation. That is, mandating retailers to secure capacity in advance restricts the functionality of the short-term market even further. Instead, regulation should give a clear signal that the market shall be used more for the short-term optimization of demand and supply. For the (rare) case that the market does not balance, the grid operators may contract some reserve capacity as backup. Germany, for example, opted against a capacity market (see section 3.1.2) and now builds up a capacity reserve instead at a size of around 5 percent of maximum load (around 80 GW) (BMWi 2015, p. 78). 2 GW will be contracted for two years starting in winter of 2020/2021, equalling about 2.5 percent of maximum load. Another 2 GW shall be contracted for two years in winter 2021/2022. Apart from production facilities secure capacity may also include storage and load management. Where possible, the contracted capacities may also take over the function of the network reserve. (Netztransparenz 2019b; BMWi 28.01.2019).

Furthermore, the calculation method artificially drives up system wide demand for conventional capacity, in particular with rising shares of wind and PV in the system. This further contributes to the demand for conventional capacity prolonging the lifetime of baseload capacity such as nuclear and coal.

If the principle of "backup capacity" is still deemed necessary, at least the calculation method needs to be changed, in particular with regard to VRE. The current regulation uses a rather conservative method and there are other, more balanced methods to use.

3.1.2. Retailers to choose the real-time balancing, do not introduce capacity market

As was shown in section 2.3, the FIT Special Treatment does not provide opportunities to save the total system costs which consumers eventually pay. If generation would not be fixed 48 hours prior to gate-closure but could still be corrected, then balancing took place in the market. This will enhance the short-term market. If retailers have developed the capacities and skills to manage their BGs by themselves it would also be good for their competitive advantage. This way, they can reduce costs by continually updating their schedule to reduce the imbalance, reflecting more accurate weather and demand forecasts. They will adjust in the intraday market or with flexibility they secure in advance. It was shown that more frequent amendments of the schedule have yielded better results for the retailers (ANRE 2018c).

So the government and the regulatory bodies should enhance the functions of the JEPX's spot market and forward market (see section 2.2) in order to maximize the capability of the non-fossil flexibility. The short-term products should be 15 minutes or less and the gate-closure should be closer to the delivery, for example 15 minutes before. This, in turn, would lead to fewer and less imbalances, resulting in less need for regulating power.

Another major barrier for a better uptake of the forward market (section 2.2) would be the introduction of a capacity market, currently being planned in Japan (see Appendix A2-1). Therefore, an immediate measure would be to revise the current plan and not to introduce any capacity market. Focusing just on capacities instead of the range of flexibility options (see sections 3.4 and 5.1) would prevent the usage of the forward market. In addition both capacity markets and the baseload market have a risk of prolonging the life-time of conventional technologies, thereby hindering structural change towards energy transition (Deign 2018). Furthermore, capacity markets involve a number of risks of miss-parametrizations. Because capacities are announced a long time before realization and construction, there is a risk of inaccurate predictions on the future power mix and needs. In addition, in the current system, there is a risk of coal power plants as the cheapest resource winning the bid. This is incompatible with the Paris target. In particular, since coal power plants have life times of 40 or more years, i.e. they would remain in the system until 2060-2070 (Matschoss et al. 2017, Ch. 4.1.2). Taken together "capacity markets are susceptible to regulatory failure and make it more difficult to transform the energy system" (BMWi 2015, p. 4).

3.2. Access to hydro energy: vital for green retailers

Even though there are concerns with the additionality of existing hydro energy, it has a number of important dimensions for green retailers in Japan. That is, from a purely energy market design view, it may be used as renewable secure capacity. Furthermore, there is a political question of who should own the environmental value from hydro that is currently owned by the large utilities. This can be traced back to the problem of liberalization, concentration and market power of the large utilities that is typical for the Japanese electricity market. For the same reason, the issue of municipal hydro energy needs to be considered. When green retailers get access to hydro, they also have access to its environmental value (i.e. they buy both in a bundled form). If a bundled trade is impossible, it is still preferable to separate the environmental value, i.e. buying them to "make fossil or nuclear energy green" from an environmental point of view (despite concerns with additionality). Therefore, the fund is proposed.

3.2.1. Improve access to hydro from large utilities as well as from municipalities

Hydro is the largest renewable energy in Japan, accounting for 44.8% of Japan's green electricity generated in 2018 (ISEP 2019a). It is also dispatchable capacity. Therefore, it can be used under the current regulation as secured capacity. However, because hydro capacity is one of the cheapest dispatchable sources but concentrated in the hands of the large utilities, the Japanese government introduced measures to improve access of the new retailers. An earlier measure was the "anytime backup agreement", and a more recent one is the baseload market established in 2019 (see section 2.4) However, none of the measures have been really successful so far in bringing hydro to the market, while baseload also includes coal and nuclear.

Therefore, in order to tackle the issue of market power and to be able to meet secure capacity requirements in a “green” way, the green retailers must be given better and fair access specifically to the large utilities’ hydro plants, which is called equal-footing. That is, regulation has to find a way to make the large utilities offer hydro in the market prior to fossil fuel power plants. Currently, this is the “baseload market” but in the more medium-term this should be the forward market. Since regulation is necessary, there are various conceivable ways: it could be a regulation which requires each big utility to provide a certain percentage of its’ large hydro capacity, a percentage of each large hydro plant, a number of large plants or according to simulated merit order etc. After opening the electricity balancing market in 2021, hydro can play a larger role as green regulating power with a high adjustment speed. Another necessary measure is to ban the current practice of shutting-down some of the hydro power plants. At least, the large utilities should be required to offers these capacities to the market (via conducting a bid or the like) before they are closed down.

In the medium term, however, the baseload market should be abolished since it has fundamental problems on its own (see section 4 below). Hydro energy could then be offered in the forward and short-term market as well as in the balancing market.

Regulation also has to improve access to municipal hydro capacities. On the one hand, this can be done by the municipalities themselves. On the other hand, this needs to be done by federal regulation because some municipalities still have ordinances to sell electricity exclusively to the large utilities. Even though most of the hydro capacities are owned by the large utilities, many medium and small hydro power plants are owned by municipalities in Japan. As of 1st April 2018, it is estimated that 25 prefectures and 1 city own 296 hydro power plants with 2,315 MW in total (PEUEF 2018) . This is 10.5% of total Hydro capacity, excluding pumped storage. The public power producers account for 1% of Japan’s electricity demand, and 98% of the municipal capacity is hydro in 2017 (METI 2017) . Most of the municipal hydro capacity has been developed before 2012 (i.e. before the introduction of the FIT).

Even though these hydro capacities are municipal-owned, the electricity is mostly sold to the large utilities via a bilateral private contract (OTC). The municipalities and the large utilities often close a specified wholesale contract for 10 or 15 years (Fukunishi 2015). However, local governments are able to sell electricity to whoever they want because of electricity market liberalization. As discussed in other sectors like water supply, some of hydro power plants are and will be opened for a concession. Because some local governments still have an ordinance which stated that the local government sells electricity exclusively to a big utility, a federal regulation is necessary to override this regulation and open this capacity and electricity to the market.

Furthermore, it is recommended to new local retailers to buy electricity from public hydro power plants once private bilateral contracts between municipal wholesalers and large utilities expire (TMCCCA 2017).

3.2.2. Who should own the environmental value of old hydro? Create a fund, increase additionality of NFFC

On top of the issues of high concentration and market power of the large utilities and difficult regulatory environment for green retailers, the green electricity regulation has created a large monetary value to the benefit of the large utilities, called a windfall profit. It is due to the fact that large renewable capacities – i.e. large old hydro capacities – have been built before the climate change commitment came into force and the new profit (the new environmental value) was not foreseeable at the time of investment. In particular, after the Paris Agreement the property of being "low carbon" gained a completely new magnitude. In addition, these capacities have been built and financed before the liberalization, i.e. under the fully distribution cost method being similar to the FIT in terms of cost distribution[10]. Therefore, the capacities have been financed by the general electricity consumer – i.e. the general public. It is a political question whether this unequal distribution is acceptable or whether society requires the large utilities to give back – at least part of – this value. Meanwhile, the issue has reached the Committee on the Electricity System Reform, whose members questioned if the environmental value that old hydro or geothermal power plants create should belong to the large utilities (Kudo und Kaneko 2018). So far, large amounts of the value created by old hydro is mostly traded by the large utilities. Meanwhile, some of the large utilities do now offer green electricity tariffs with their old power plants. For example, TEPCO Energy Partner offers 100% renewable electricity tariffs from TEPCO's old hydro power plants, called "Aqua Premium" and "Aqua Energy 100".[11,12]

As far as the above measure on improving retailers' access to hydro via the baseload market are successful (or via an enhanced forward market, see section 4), they may get some low cost environmental value. However, as was laid out in section 2.5.2, with the integration of hydro into the NFFC-scheme the environmental value can be traded separately from the electricity. This has two implications: first, the windfall profit stays with the large utilities when they sell the NFFC at market prices (i.e. they get the money of the non-fossil value of hydro). Secondly, if the environmental value separated from hydro is used to make gray electricity (fossil or nuclear) green, it is even the least preferable option from an additionality / energy transition point of view.

[10] See for example: IEEI 2016.

[11] For the list of the old hydro power plants for Aqua Premium or Aqua Energy 100, see: TEPCO 2019.

[12] As a side note, the majority of the big utilities (6 out of 10) do not offer any green electricity tariff at all because they seem to reject the idea altogether to sell electricity (with different properties) to different customers at different prices. Rather they see themselves as universal service providers for consumers and green products that segregate their customers do not suit their philosophy. One of those argued that a green electricity tariff from their hydro would not be acceptable because they need to treat all customers the same (Yamane 2017). But this means that the environmental value of these big utilities' hydro is wasted.

Taken together, trading electricity together with the environmental value would be the preferred option. However, considering the currently proposed regulatory framework, it does not appear very likely. Therefore, a public fund is proposed that could be supplied by the revenue from the NFFC. That is, when NFFC are auctioned, the revenue would go to the fund instead to the large utilities. It could then be used to provide low-interest loans for investments into new renewable energy capacities and supporting infrastructure (that is, for measures with additionality). This would have two effects. First, it solves the problem of unequal distribution of windfall profits. Other methods of distributing the NFFC (setting artificially low or even zero prices) are all questionable as well, considering that the windfall profits belong to the society at large. As a second effect, the fund would introduce some additionality to the NFFC. Using the revenue to provide low-interest loans to all players in the electricity market would be particularly helpful to those players with weak financial resources (cooperatives communities etc.). Furthermore, any player in the market is entitled to buy / auction the environmental value (the certificates), including the large utilities. That is, they may buy back the values if they want.

3.3. Revision of Non-Fossil Fuel Certificates (NFFC): Specify location and source of and allow bilateral trade

The main weaknesses of the NFFC have been discussed in section 2.5.2. The whole system is designed as a mechanism to lower the FIT-surcharge and to give retailers the opportunity to comply with the energy plan's goal. So environmental benefit or additionality were not sufficiently considered when designing the scheme. However, since it is currently the main certificate system in Japan in terms of its volume, two recommendations are given. The first recommendation is that the NFFC should ensure the traceability. The second recommendation is that the direct trade of NFFC between power producers and retailers should be allowed (currently they are traded via auctions)[13].

On the first issue of traceability some steps have already been taken in the ongoing NFFC reform process while preparing this report (see section 2.5.2). However, implementation is vital here. Once the tracking information is established, it is comparable to the GO or REC mentioned already (section 2.5.2). The Japanese government conducted a demonstration project for the NFFC with tracking information in 2018 and continues this year. This demonstration project tests which information should be included in the NFFC. Currently, those are the source, the name of the facility, address, generated amount, date of the issue and the period of generation (METI 2018b). From the perspective of quality and additionality, the information on the

[13] There are other issues like the residual mix, but this report focuses on the information issue.

NFFC needs the date of commissioning, the owner and the usage of the FIT support. For biomass it is also relevant to know which substrates are used as well as co-combustion with fossil fuels. With this information, the users of the NFFC are able to know that green electricity really contributes to the energy transition or not. Another concern is for example who the owner of the facility is. So far there is only a pilot project for tracking that discloses the technology and owner of the facility (METI 2018b). For a just energy transition, the allocation of the ownership of the renewable facilities is crucial. For instance, some retailers may wish to build their business model on citizen-owned renewable facilities (local value creation) instead of big-utilities-owned ones. Again, this shows the importance of a labelling scheme. The tracking information is prerequisite but the labelling can go beyond that (see section 2.5.3).

The second recommendation of the sooner introduction of direct trade directly follows from the first one. In the current system NFFC-RE and NFFC-NS (both non-FIT facilities) are both auctioned via the single price method via GIO through JEPX. So the different values of the different facilities cannot be reflected. This makes it difficult to purchase specific NFFC with specific properties (e.g. from non-FIT or post-FIT facilities or from new facilities, from the citizen cooperative or from the large utilities). The government now considers how many products should be set up in the auction (METI 2018b).

Direct trade, which also started to be discussed in the expert committee. This is also important for the issue on bundled products as has been shown in the previous section on hydro, the NFFC and the fund. There it became clear that separating the environmental value from hydro provides the least environmental benefit. Therefore, from an additionality / environmental point of view, it is preferable if a retailer buys green electricity and the NFFC from the same power producer as a bundled product. However, direct purchases from power producers are not possible under current NFFC-regulations as retailers are only able to buy the NFFC via auctions. Therefore, retailers have to purchase both separately, for example gray electricity in the spot, baseload or forward market or directly from coal power producers and make them green by combining it with the NFFC. The problem is that the auction is the only place to trade the NFFC. Therefore, the direct trade of the NFFC between a power producer and a retailer should be allowed to enable the purchase of such bundled products.

3.4. Flexibility options in the short term

The energy transition puts VRE at the center of the energy system. This requires more than just the exchange of one energy carrier for another. Rather it means a systemic shift. That is, the energy system needs to be changed on a technological, economic and regulatory level to serve the VRE (i.e., the old energy system has to adapt to the VRE, not vice versa).

For serving the VRE, the energy system needs to develop new capabilities. A central new capability is *flexibility*. With rising shares of VRE, the conventional concept of base- mid- and peak-load will disappear and instead the concept of residual load takes the center stage. Whereas under the old system, various capacities were used to satisfy demand (load), the new system uses various *flexibility options* to close the gap between VRE supply and load. That is, when load is higher, additional supply from various options may be supplied (or load to be voluntarily reduced, for instance “nega-watt trade”) and when supply is higher it may be used elsewhere or stored.

The wholesale market is the place where the systemic needs are translated into the economy. Since prognoses are vital for VRE and since these are more accurate in the short term (see Appendix A1-4), the further development of the short-term market is key to integrate VRE at the maximum level. That is, the gap between the planned schedule and realized generation of renewable energy should be adjusted as much as possible in the intraday market, i.e. by using market processes.

There are a number of *flexibility options* that increases the systems flexibility. Some can be implemented over the short term as they are mainly about changes in rules. Others take longer to develop since they require investment, technological developments or larger organizational changes that need to be developed over time. Here, the flexibility options are discussed that can be implemented in the short term. Flexibility options for the longer term are discussed in section 5.1 (based on Matschoss et al. 2017, pp. 87-88):

- Flexible system services
- Flexible demand (load management)
- Regional connectedness: better grid management & grid expansion
- JEPX: better development of short-term market (shorter interval between gate closure and realization, more short-term products suitable for gate closure and for VRE)

System services can be provided by renewable energies, including VRE, as well as batteries (balancing energy, reserve power and reactive power). Here, it is necessary to change the prequalification criteria (see Appendix A2-2).

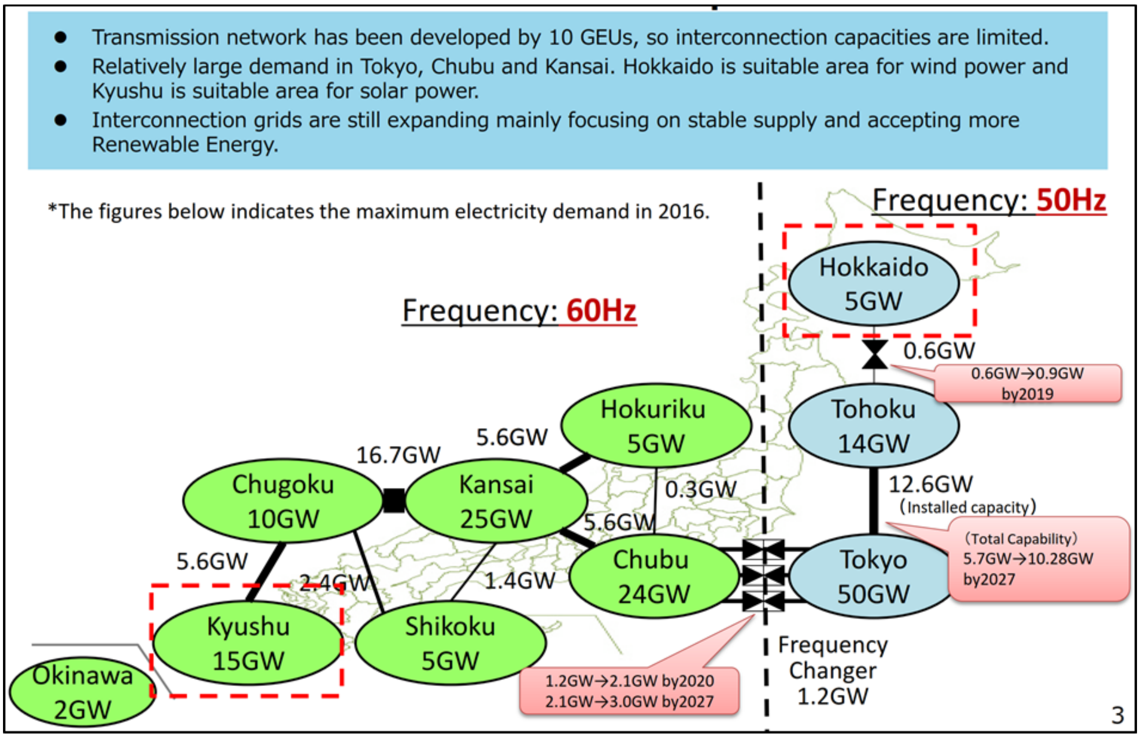
Another option is flexible demand. It means that consumers may voluntarily change their consumption in reaction to electricity prices. The market is the place for a whole new range of products. It requires that end-use prices reflect the load situation (scarcity) and market actors (aggregators) who are able to “collect” the consumer preferences and develop business models. The highest potential is seen in energy intensive industries. In the household sector implementation is currently rare but it might increase with the advancement of digitization (smart meters, smart homes etc.).

That is, decentralization and digitization provide further opportunities to foster the energy transition, i.e. to make many of these products work. Aggregators may bundle different flexible capacities together with demand, called virtual power plant (VPP) (Matschoss et al. 2017, Ch. 5), and supply in an energy only market. In Japan a VPP is currently discussed in the context of regulating power, however the strength of a VPP lays on the generation forecast and the trade in the short-term market. For example, in Germany many VPPs are already in operation. As a result, the trade in the intraday was highly activated and the price in the electricity balancing market has fallen and the regulating power is less activated (BNetzA 2018). As will be described in more detail in section 5, the introduction of a balancing market is crucial to trade flexibility instead focusing on the current baseload market. That is, the advanced market, especially the electricity balancing market in which flexibility will be traded, must be designed applicable for the renewable and zero-emission flexibility.

Grid integration as another option serves to enhance connections between regions within a country or between countries. As shown in Figure 15, the grid in Japan is mainly structured by its former monopoly areas. In addition, it has two frequency areas between which the electricity needs to be transformed. There are several options to enhance grid capacity. The longer term option is to invest into the grid infrastructure (the “hardware”) to enhance the physical capacity (discussed below in section 4). The immediate option, discussed here, is to better utilize the existing capacity by better management (“the software”). With regard to RES, the Japanese government should continually observe whether priority connection and priority feed-in for RES is realized at the maximum level in order to facilitate RES-integration.

One of the main problems with current grid management is, that current grid utilization is estimated by static rating capacity of connected capacity of e.g. connected generators, regardless of actual physical flows (Yasuda 2018). Furthermore, access to the grid is organized on a first-come-first-serve-basis. Therefore, new capacities (usually renewable ones, very often wind) were often rejected or had to pay prohibitively high grid connection (including grid enforcement) costs. Instead, grid operators should adopt the principle of “connect and manage” where the dynamic electricity flows (i.e. real network usage) are the basis for utilization. Similarly, the so-called N-1-criterion (operation rule in the event of failure of one component) should be checked with real measurements instead theoretical maximum utilization (Yasuda 2018). It is therefore estimated, that the grid could accept a share of renewable energy of 35% by 2030 without any physical capacity increases, if non-discriminatory access and up-to-date management is introduced (REI und Agora Energiewende 2018). However, there some progress has been made by switching from the previous first-come-first-serve-rule to indirect auctions where the result of the spot market determines the right to access line capacities. Similarly, the interconnectors between the former monopoly regions and different frequency areas are now managed the same way. But the main problem of estimating the capacity itself remains (see Appendix A2-3).

Figure 15 Power grid in Japan



Source: (Shinkawa 2018)

Finally, JEPX, the market place itself needs to be developed further and adapted to the new flexibility needs. That is, the times of trade need to be put closer to the actual time of generation so that the planned schedule can be adapted on a short-term basis. Therefore, shorter time between gate closure and realization is necessary so that short-term prognoses can be utilized better. Furthermore, suitable products are necessary (e.g. 15 min products).

4. Mid-term measures

Mid-term measure should be tackled soon, too but may require somewhat longer than the immediate measures until they are finally implemented (i.e. until 2025). For instance, some of the short-term measures should be implemented to increase liquidity before abolishing the baseload market. Enhancing the frameworks for renewable capacity additions and grid expansions may take time to implement. Nevertheless they need to be tackled as soon as possible.

4.1. Promote forward market: abolish baseload market

The previous sections have shown that the short-term market is the place to adjust differences of the retailers' BG in the short-term. For the longer term, the forward energy market is the place where retailers should be given the opportunity to hedge longer term price risks and volatility from the spot market in a non-discriminatory way. Longer term demand for electricity (kWh) would also send appropriate investment signals, either for new flexible generation capacity or other flexibility options (see section 3.4). However, the current system requires retailers to secure capacity on the baseload market as has been laid out in section 3.1.1.

Therefore, despite an existing forward market where retailers have the possibility to purchase electricity from 3-day to 3-year ahead, it has barely been used. Instead, new retailers have generally purchased electricity via direct long-term contracts with power producers (OTC or PPA). As of October of 2017, the share of JEPX in the total electricity trade was about 8.0%, thereof the day-ahead accounted for 97.16%, the intraday for 2.82%, the forward market only for 0.03% (EGC 2018). That is, the baseload market – and its discriminatory rules of usage as laid out in section 3.1.1 – actually constitutes a barriers to more utilization of the existing forward market. The baseload market is planned as a transitional step until the forward market gets enough matured. JEPX tries to activate the forward market through the amendment of the market rules, for example the cut of the participation fee, which is welcome.

Therefore, the largest contribution, would be the abolishment of the baseload market altogether. As already mentioned in section 2.3 the introduction of a capacity market would create another barrier to the forward market. This is why a capacity market should not be introduced in the first place either. If it is introduced, it should be abolished again in the medium-term.

In the forward market, the market decides when and how much capacity will be needed, sending a market signal. Retailers buy the electricity in the forward market, they buy additional electricity or sell the surplus electricity in the market if needed. Different from the capacity market in which generation source is fixed, the retailers can also quickly change their plan in the forward market to cleaner technologies like batteries, advanced biomass, power-to-gas (P2G) and other sector-coupling technologies, once they become available in the market. The electricity traded in the forward market does not originate solely from power plants but also demand side management (DSM). That is, the forward market is more open for future technologies than the capacity market.

4.2. Create better framework for more balanced renewable energy capacity additions

Lack of renewable capacity is among the most fundamental problems in Japan. Furthermore, as was shown in Figure 11, capacity additions have been unevenly distributed with most additions on PV. That is, since the FIT was implemented in 2012, total capacity additions for PV amounted to nearly 44,000 MW whereas for wind capacity additions have been only nearly 1,300 MW[14] (ANRE 2019a). While it is less a problem of the electricity grid (see section 3.4), this has led to some conflicts over natural resources such as sites for facilities as well as environmental and acceptance problems, especially for PV projects.

Therefore, it is necessary to enhance the regulatory framework for capacity additions, in particular for wind energy projects. The current expansion path has led to competition between wind and PV. In some cases, areas suitable for wind have been reserved for very large PV projects. That is, more balanced renewable energy additions require to abstain from some of the so-called mega-PV projects exceeding a couple of hundred MW. For example in case of Ukushima, an island in Kyushu region, a wind farm project constructing 50x2 MW turbines began in 2013. While this project had a delay due to the long Environmental Impact Assessment (EIA) process and protests from citizens, a 430 MW mega-PV project was approved on the same island because the mega-PV project did not need an EIA at that time (Ishida 2015). In Japan, further mega-PV projects over 100 MW are currently ongoing, many of which are planned in the areas suitable for wind[15].

Another significant barrier for wind energy is connection costs that are dealt with in the next section 5.2. In general, four approaches are suggested for more balanced renewable capacity additions and to increase public acceptance (ISEP 2016):

1. Zoning: specifies areas for renewable energy projects
2. Environmental Impact Assessment (EIA): obligatory, especially for PV exceeding one MW

[14] More specifically: small PV under 10 kW: 5,828 MW, large PV over 10 kW: 37,722 MW, wind onshore: 1,110 MW, wind offshore: 176 MW and small hydro: 348 MW

[15] For the wind potential see: NEDO 2014.

3. Notification in advance: raises transparency among the local actors
4. Voluntary agreement between developer and citizens: may ease conflicts by consensus building

Zoning may not be easy in Japan as it is not common but it is a useful tool. In particular, it is needed to identify zones for wind energy. The Ministry of Environment (MoE) demonstrated the zoning for wind power projects and published “renewable energy implementation potential map” on its website (MOE 2019a). MoE also published a “Zoning Manual” for wind turbines for municipalities (MOE 2018). The Japanese government should further support municipalities to make a binding zoning policy.

EIA is needed to ensure the integrity of renewable energy projects (as with any infrastructure project). Issues are forest protection, landscape, birds and biodiversity protection and other. There are different recommendations from which size on EIA should be obligatory (30 or 40 MW) (Nikkei Shimbun 2019) or even smaller (a couple of hundreds kW) (ISEP 2016).

In terms of notification municipalities may promulgate an ordinance to obligate developers of PV-projects exceeding a certain size (e.g. exceeding a couple of MW) to submit the plan before construction begins. Through this measure, municipalities would have the possibility to acknowledge planned mega-PV projects at an early stage and force the developers to communicate with the local citizens. Currently the Agency for Natural Resources and Energy (ANRE) publishes the number of the FIT projects in each municipality according to the accreditation, but the municipalities are not able to know individual projects. ANRE is considering to inform the municipalities about the individual projects at an early stage in the future but it is still hardly possible that local citizens talk with the developer about the project. An appropriate ordinance could require the developers to communicate with local citizens before the construction begins (ISEP 2016).

A voluntary agreement is a popular measure in Japan for mitigating the environmental impact and enhancing acceptance (Ushifusa 2006). Through the voluntary agreement, the municipality can suggest to the developers to talk with the citizens about the environmental impact mitigation or citizens’ participation as explained below. This process, functions as a preventive measure, and can maintain the acceptance of the local community.

Another important tool to maintain the acceptance is citizen participation. In Germany 804 energy cooperatives were established between 2006 and 2015 (Terabayashi 2016). Citizens invest in renewable projects together via a cooperative at the local level. This type of financial participation of citizens led the growth of renewable energy in

Germany. In Japan there are also some cases similar to the German cooperative models, like Ohisama Shimpo Energy in Nagano prefecture.

Some German state governments obliged renewable energy developers to make citizens participate in the project they are planning. In the Land of Mecklenburg-Vorpommern (northern Germany), at least 20% of the project's capital must be opened for citizens or 10% of the profit must be paid to the local government (BüGembeteilG M-V vom 18. Mai 2016).

5. Long-term measures

The longer term is the time frame of up to 2030. During that time, additional flexibility options need to be implemented. Furthermore, grid expansions will become necessary at one point which is also a flexibility option.

5.1. Flexibility options in the long-term

As was laid out in section 3.4, flexibility options are crucial for VRE-based system. That section provided some flexibility options for the short term. Here, the flexibility options are laid out that take longer to develop since they require investment, technological developments or larger organizational changes that need to be developed over time:

- Flexible firm low carbon non-renewable and renewable generation capacities
- Storage
- Sectoral connectedness: increase integration between sectors / sector coupling (buildings, transport)
- TDSO: introduction of balancing market

The list shows that firm capacity is just one option to secure supply. Furthermore, also supply capacity needs to be flexible. That is, hydro, despite being old, is better qualified than nuclear. That is, as flexibility requirements rise with rising shares of VRE the concept of inflexible baseload power become incompatible. Instead, natural gas capacities provide an important transitional technology, as they have fast-ramping abilities and the lowest CO2-emissions among the fossil technologies. In addition, natural-gas-infrastructure may be used for renewable-based gases as well. Biomass capacities also provide an option. (see appendix A2-5).

In terms of storage, a number of options are available. Batteries (electrical storage) have so far been regarded as an expensive option but their prices have decreased faster than those of PV or wind as shown in Figure 41 in A2-5. Moreover, they can be used in combination with other technologies (e.g. heat pump) and can be used as a flexibility option. For long-term (i.e. seasonal) storage of large amounts of energy, hydro is one option. Other options are H2-based energy carriers.

Sector coupling is important to increase connectedness with the heat system (buildings, industry i.e. power-to-heat) as well as with the transport system (electric mobility, H2-mobility and synfuels). This can also be seen in connection with flexible demand. For example, a product “Eco-Cute” a heat pump produced by Panasonic is now demonstrated as a flexibility combined with PV in the Miyako island in Okinawa

(Fujimoto, 2019). Here, a variety of technologies and business models that provide additionality are conceivable (e.g. electrolyzers based on wind energy).

Another flexibility option to provide system services across regions is the extension of the balancing market as it was mentioned in section 2.3. Japan plans to open a cross-regional balancing market in 2021 (see appendix A2-6). This would introduce a separate market for system services that is needed from a grid perspective. However, the modalities are yet unclear. From a grid perspective, it would require regulating power that may be activated within different speeds[16]. From the perspective of RES a decision on the design and products on this market is necessary so that RES can be taken into account when designing the criteria for prequalification. So far, however, the planned balancing is foreseen only to have products on a 15min-basis and discussions on further design are only foreseen for 2022 (OCCTO 2019b). Therefore, the electricity balancing market (planned to be opened in 2021) needs to be defined better in terms of regulating power and prequalification criteria should be designed RES-friendly so that RES could offer system services.

5.2. Expand the grid

As already mentioned in section 3.4, grid expansion is an important flexibility option and whereas that section dealt with improvements in management of the existing grid (“software”), this section here deals with expanding the physical grid infrastructure (“hardware”). For this purpose, comprehensive grid planning is vital that takes into account the RES capacity additions necessary for reaching the Paris target. In Europe, ENTSO-E, an alliance of European TDSOs, publishes 10 Year Network Development Plans (TYNDP) every two years on a rolling basis (entso-e 2019). In TYNDP, the existing pan-European grid is analyzed taking into account its bottlenecks, current potential of RES integration, capacity addition targets as well as a cost-benefit balance of grid expansions. This functions as the overall grid expansion plan in which concrete projects are introduced (Yasuda 2016b). In coordination with TYNDP, each EU member country also develops its own grid development plan or grid demand plan.

On the contrary, in the past, the Japanese large utilities have managed their respective control areas independently. However, along with electricity market liberalization (i.e. free choice of the consumers to choose a retailer) and growing renewable energy integration, more cross-regional interconnection capacity is required. Currently, four grid expansion projects are ongoing. One project between Hokkaido and Tohoku to enhance capacity by 300 MW is to be finished by 2019, one project between Tohoku and Tokyo to enhance capacity by 4,580 MW is to be finished by 2027 and two projects

[16] For example, in Germany the primary reserve may be activated within 30sec., the secondary reserve within 5min and tertiary reserve within 15min (50hertz et al. 2019). Other systems are also conceivable.

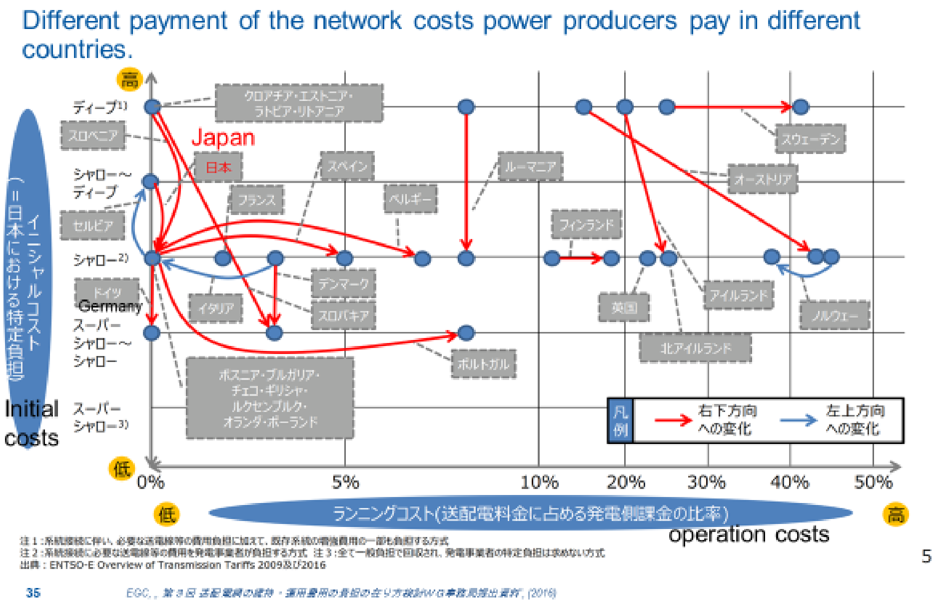
between Tokyo and Chubu to enhance capacity by 1,800 MW in total are to be finished by 2027. The development of a comprehensive national grid plan that takes into account the necessary VRE-expansion to reach the Paris target is therefore recommended. However, this is beyond the scope of the report.

The current method of cost allocation of grid expansions constitutes a significant barrier for RES-projects. Currently, new power producers are required to pay for all grid expansions triggered due to the connection of their power plants. The current method, called the polluter-pay principle, has two fundamental problems: First is a lack of transparency. Apart from the TDSOs themselves it is difficult to calculate the expansion costs due to little information disclosed to the power producers who plan new capacities. So cost cannot be validated. Secondly, resulting from the first problem, this can significantly drive up costs of renewable energy construction and due to the intransparency, these may be even higher than necessary. There are cases where real costs are sometimes lowered compare to the first assessment by the TDSOs. But with the lack of transparency the risk premium will remain high. As an example, a wind farm project in the Fukushima region was abandoned due to prohibitively high connection costs that were offered by Tohoku EPCO. Under the current system, the regional grid operator could require the project to finance the grid expansion costs that amounted to 2.1 billion yen while the construction costs of the wind farm itself were about 4,000 million yen (TV Asahi 2017). Financing the connection costs of renewable energy projects via the general grid instead of the project itself would be an important measure to enable a number of projects. Since restructuring the underlying infrastructure is a project of common interest, it may be levied on the general electricity consumer (beneficiary-pay principle).

The issue refers to the so-called “shallow” or “deep” connection costs to the producer. That is, in some countries, connection costs are shallow (TSO and/or DSOs pay for the connection and expansion costs and pass them onto the final electricity consumers) and in other countries connection costs are deep (the power producers take almost all of the grid costs) as shown in Figure 16. Most countries adopt somehow in-between. Japan has now basically adopted the shallow-cost principle. However, the TDSOs still have some discretion when allocating the costs between the RES-project and the grid. Therefore, the deep-costs-principle partly (and officially) remains. However, most countries with successful RES-capacity additions – e.g. Germany, Denmark, The Netherlands – have mainly adopted the shallow-cost-principle.

The deep-cost-principle also magnifies the unequal treatment between the large utilities and newcomers. Because 75% of existing generation capacity belongs to the large utilities, newcomers are, by definition, the ones who trigger the grid expansion. Furthermore, as shown above, connection costs can be a large cost factor for the newcomers (if not an insurmountable barrier). Therefore, despite unbundling in 2020 and a theoretically equal treatment of all power producers, the large utilities have never paid any connection costs and the grid was constructed for the existing capacity and financed by the fully cost distribution method. That is, the procurement costs for the newcomers are in general higher than for the large utilities to the extent which they have to pay the grid connection and expansion. This puts the newcomers at a competitive disadvantage. From the equal-footing perspective, the discussion is analogous to the one on hydro's environmental value. The issue of fair costs allocation for the grid (not only for the future grid expansion) should take the historical grid construction costs into account. How this can be reached should be discussed for example in the committee for wide grid development in OCCTO.

Figure 16 Different payment methods for power producers



Source: (EGC 2016)

6. Conclusions

Some overall conclusions can be made. First of all, Japan has committed itself to the Paris Agreement requiring a back-casting approach. That is, policy makers need to consider the necessary measures to reach the target. Currently neither the RES-addition targets nor the actual rates suffice. Therefore, the question arises what additional measures could be taken to reach the goal. This report, in particular, asks what electricity market regulations needs to be changed so that new green retailers could contribute to the goal.

The report has shown how much the current regulation is still distorted in favor of the large utilities. Furthermore, it is skewed towards securing capacity instead of relying on energy trade as would be the case for a liberalized market. As a legacy of the slow liberalization process the large utilities have basically been left untouched so that 75% of the capacity is still in their hands (including hydro and its windfall profit). On top of that the regulations to secure supply capacity puts an unnecessary high burden on green retailers, in particular when they have large shares of VRE in their portfolios. It shows that despite liberalization, there is no real trust in the market yet, in particular in the idea that retailers should optimize themselves while trading energy (kWh) instead of oversupplying themselves with capacity (kW) – or being forced to do so by regulation. It is the latter philosophy that still prevails in the Japanese electricity market regulation and that forces the green retailers into further dependencies on the large utilities. Therefore, these regulations need to be changed as a matter of urgency. For the same reason, the forward market should be at the center for future commitments of retailers. However, as long as the baseload market exists, the future market will not be utilized. Therefore, the baseload market should be abolished, too and regulation should abstain from introducing a capacity market. Furthermore, green retailers should choose real balancing if they have the capabilities to do so because it would give them the opportunity to optimize their portfolio.

Another major problem is the unequal distribution of existing renewable capacities, namely hydro and its environmental value as well as the lack of new renewable capacities (i.e. other than hydro). The first part is connected to the above issue of leaving the large utilities untouched and green retailers need immediate improved access to hydro. Furthermore, a political discussion on the distribution of the large windfall profits from hydro is necessary and already ongoing. The report proposes a fund where the windfall profits could be used for investment into new RES-capacity, given that i) this would introduce some additionality to the NFFC that are currently completely non-additional and ii) the lack of RES-capacities other than old hydro is another main problem. The second part of the problem, lack of new renewable (i.e. non-old hydro) capacities, is due to the fact that Japanese policy makers' focus has only quite recently shifted to renewable energies. Here, a regulation on more balanced capacity additions is needed that takes into account environmental as well as acceptance problems. Another issue for capacity additions is the grid. Although the current grid can integrate large amounts of VRE, an integrated approach to grid-planning is necessary, taking into account the necessary scale and timeframe of VRE-additions to reach the Paris targets.

Finally, the current regulation on the NFFC is meant to enhance public acceptance by lowering the FIT-surcharge. However, in light of its obvious non-additionally, it remains unclear whether electricity consumers will appreciate re-selling of the environmental value that has already been created (and financed) by them under the FIT or whether acceptance for this measure (and RES in general) will even be lower in the end. That is why transparency is key for green retailers so that they can communicate about the additionality of their specific product. Therefore, strict standards are necessary which could implemented via a labelling scheme. Once regulation established a level-playing field for green retailers, they can – together with their customers – make a significant contribution to Japan's RES future and energy transition.

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Appendix 1: big picture

The vertical integration of the power system which allows the insider communication hinders the market competition. In Europe the regulators have implemented the unbundling for the last decades. The unbundling means the split of the power production, transportation and retail of large utilities. The unbundling is essential for dismantling the vertical structure.

Vertical integration tends to prefer the concentration of the investment because it is cost effective. In the decentralized world, such kind of the centralized investment is no more profitable and effective. The adjustment of the demand and supply should be realized through the market harmonization.

There are 4 types of unbundling: accounting, legal, ownership and functional unbundling, and Japan chose the legal unbundling. For example, under the ownership unbundling the transmission and distribution network operators (TDSOs) must be fully independent from power generators and retailers. On the other hand, under the legal unbundling it is allowed that the TDSO, power generators and retailers can be established under one holding company. The independency is higher in the ownership unbundling than the legal unbundling (Matschoss et al. 2017, p. 54).

A1-1 The attitude of Japanese citizens towards green electricity

According to a research of Electricity and Gas Market Surveillance Commission (EGC) in 2017, 5.1% of the respondents who changed a power retailer answered that they were satisfied with their choice because they could choose green electricity. 7.6% were satisfied because electricity they used was not generated by nuclear power. On the contrary, 56% were satisfied because the new tariff was cheaper than the older one (EGC 2017). Another example which Mizuho Information and Research Institute conducted in 2015 revealed that more than half of the respondents regarded the environment as important by choosing an electricity tariff and 87% would choose it if its price was lower than (51%) or as same as (36%) the then tariff (Mizuho Information & Research Institute 2015) .

A1-2 Post-war construction, nuclear power plants

For the rapid post-war construction, the Japanese government thought it needed companies which could concentrate on the construction of power plants on behalf of the 10 large utilities. Therefore, J-Power, was established in 1952 to accelerate building power stations for the post-war reconstruction, originally owned by the financial minister and 9 large utilities at the time (Shimbun 2019b). The Japan Atomic Power Company (JAPC) was established in 1957, funded by 9 large utilities and J-

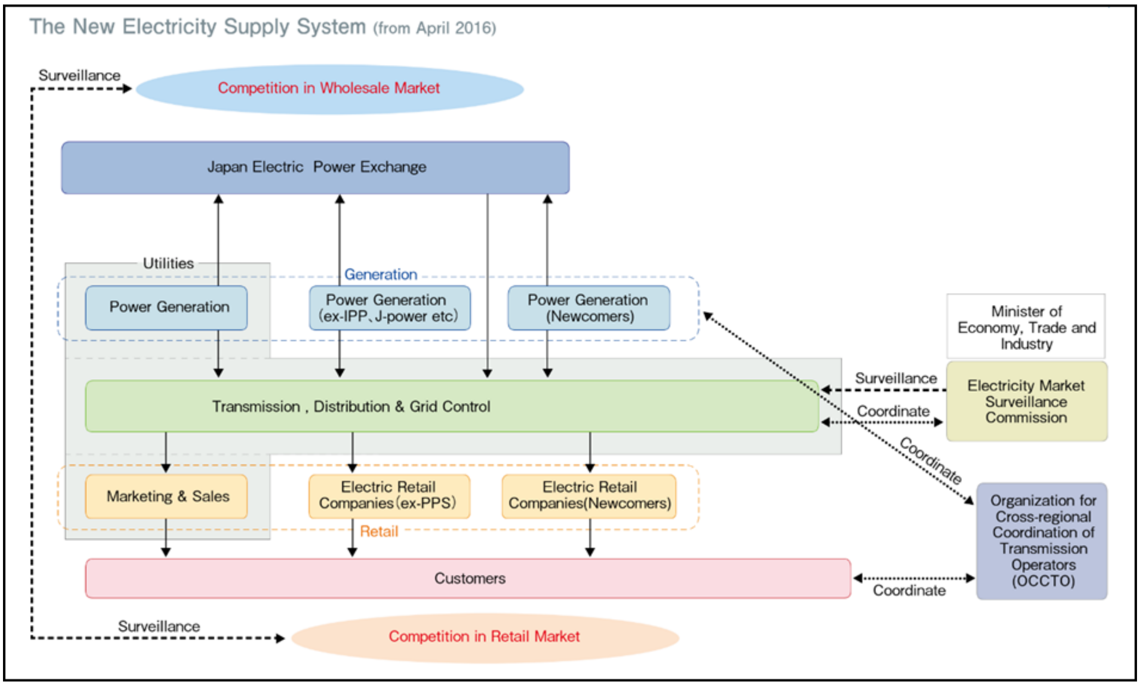
Power in order to commercialize the nuclear technology. JAPC owns Tokai Daini Nuclear Power Plant and Tsuruga Power Plant (Shimbun 2019a). As of June 2019, 9 reactors are in operation and further 5 reactors met the new safety standards (Jiji 2019). The EPCOs together with JAPC own all of Japanese nuclear power plants.

A1-3 Liberalization and market concentration

The liberalization of Japan's electricity market has been ongoing in a step-by-step approach. The market liberalization started in 1995 with opening the independent power producer (IPP) market, which is a power wholesale market, and introducing the fuel cost adjustment system, followed by the liberalization of electricity retail supply for users who are connected to extra high voltage (EHV) lines in 2000 (see Figure 4). At this timing, J-Power turned from a power station developer into an IPP.

The establishment of IPP made the contract for power sales in a Japanese wholesale market, Japanese Electricity and Power Exchange (JEPX). The contract had long 10 years for wholesalers with the 1,000 kW generation capacity or 5 years for those with 100,000 kW. Renewable power producers were also possible to be the IPP, but the category IPP was dissolved in 2016 and now all power producers are called just power producers.

Figure 17 New electricity supply system in Japan



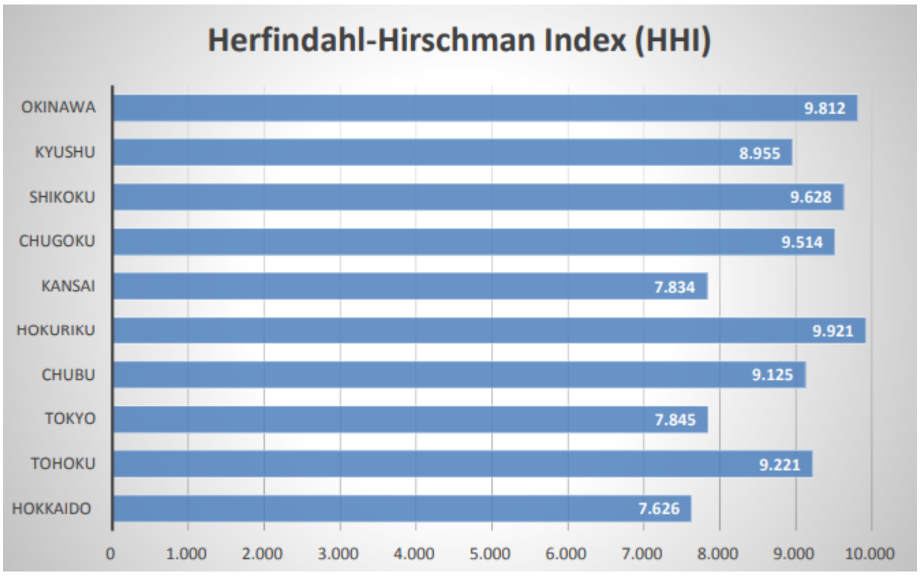
Source: (FEPC 2017)

Retail was liberalized in 2016. Though succeeding regulation amendment for the power market, households could choose an electricity retailer for the first time in 2016. Along with the liberalization of the electricity retail business in the low voltage (LV) lines, a number of utilities have been established. The structure of the new electricity system is shown in Figure 17.

Despite market liberalization, there still remains a bias between the large utilities and the new retailers. Therefore, the government established the Organization for Cross-regional Coordination of Transmission Operators (OCCTO), which conducts the market surveillance.

Concentration in the Japanese electricity market is high. As noted in Matschoss et al. (2017, p. 43): "Assuming that the Japanese electricity market is a single market, the Herfindahl-Hirschmann-Index (HHI)[17] is 1,521. However, in light of shortage of interconnectors between areas resulting in market splitting, HHI will remain high for the foreseeable future". For the HHI of the single market areas see Figure 18.

Figure 18 Regional Herfindahl-Hirschman-Index in Japan (as of Sept. 2016)



Source: (Matschoss et al. 2017, p. 44)

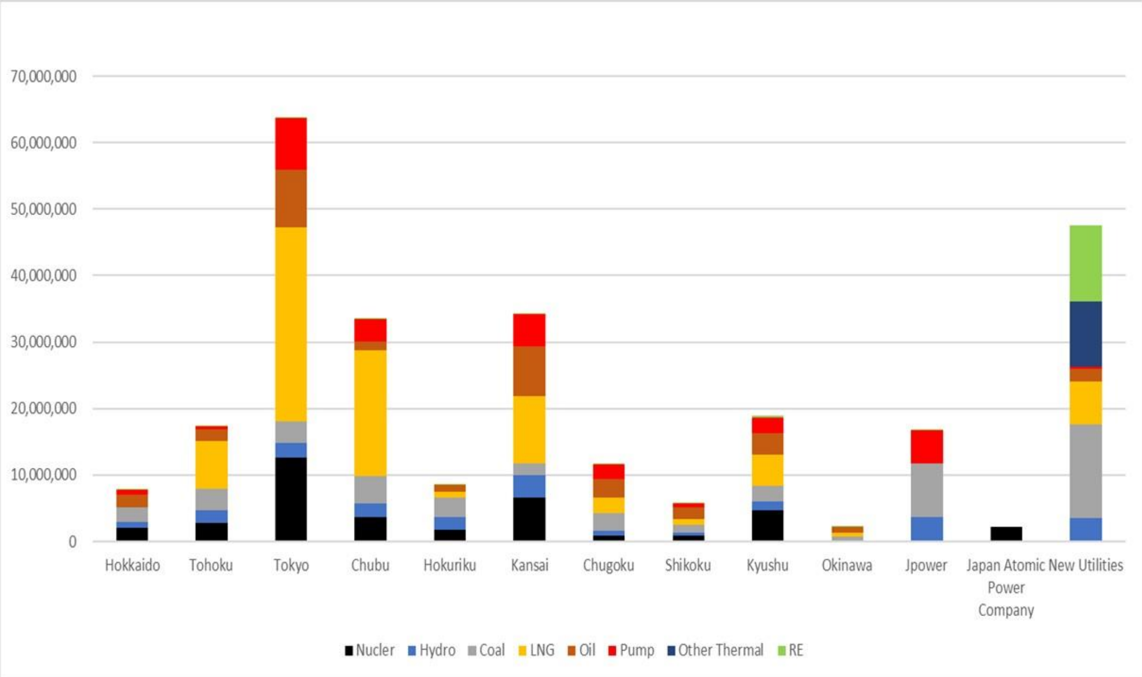
In Japan, as of January 2019, Hokkaido EPCO owns 26 MW of renewables, Tohoku 193.6 MW, Tokyo 54 MW, Chubu 38.5 MW, Hokuriku 40 MW, Kansai 110 MW, Chugoku 60 MW, Shikoku 2 MW, Kyushu 209 MW and Okinawa 2.3 MW, respectively. On the other hand, the new power producers, some are utilities, own 11,391.9 MW in total.

There is no exact figure about renewable power plants owned by the new utilities but it might be rare that green retailers own sufficient power plants. The breakdown of the

[17] The Herfindahl–Hirschman-Index (HHI) is a commonly accepted measure of market concentration. It is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. If the number is 10,000, then it is perfect monopoly while zero means perfect competition as shown in Matschoss et al. 2017, p.43.

generation capacities (see Figure 19) – utilities being different from retailers though – gives some impression of the difficulties of new retailers to secure supply capacity.

Figure 19 Utility's Generation capacity sorted by sources



Source: (ANRE 2019b)

Note: Data as of January 2019. The figure of Tokyo (TEPCO) represents the sum of whole group. In February 2019 Hokkaido opened a new LNG power plant which is not yet reflected in the data.

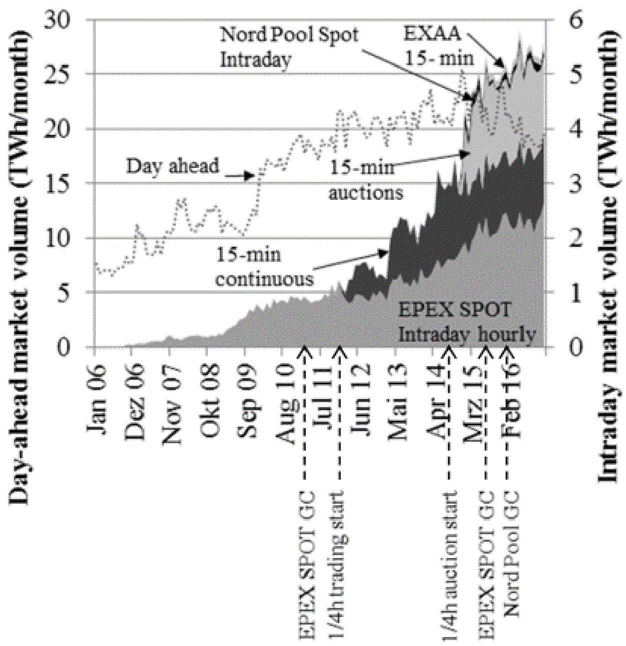
A1-4 Japan electric power exchange (JEPX) and German electricity market 2.0

A wholesale market is crucial for the stable grid operation when renewable energy have the large share in the power generation. The Japan Electric Power Exchange (JEPX) was established in 2003 to provide a transparent wholesale market but the traded amounts are rather low. Various measures are necessary to enhance trade volumes and for the better integration of VRE. One is the shortening of the periods between gate closure and delivery as well as shorter trading periods. Another may be the introduction of gross bidding (see below).

Germany, as an example, chose to enhance the function of the wholesale market, which it calls Electricity Market 2.0 (BMWi 2015; Weber et al. 2017, ch. 3.2). In the electricity market 2.0 the power production and retail are fully liberalized. This means, the adjustment of demand and supply takes place in the market as much as possible. The main instrument for keeping demand and supply in balance in Germany is the balancing group (BG). Every retailor has to manage a balancing group (balancing responsible party, BRP) that contains its customers (=demand) and its purchases and/or production (=supply). The BRP have to keep it in balance via trades at the wholesale market for every trading unit. If the BRP are not able to keep it in balance they have to pay a fee that reflects the costs of the Transmission System Operators (TSOs) to bring the BG back in balance. Therefore, in the liberalized market all participants take the responsibility for the grid stability through financial incentives provided that the incentive are set correctly.

Each BRP has to submit its production and consumption schedule until 14:30 for the following day. Then the retailer may submit corrections for every trade unit until gate closure (day-ahead and intraday). The TSOs checks the schedules and the corrections. If any BG is not in balance, the TSOs purchase regulating power to get the grid in balance and the BGs that were out of balance (i.e. who caused the imbalance) have to bear the costs. These costs are called balancing costs. There are ongoing corrections to the system but in general the system is set up in a way that balancing costs are higher than the costs of doing short-term trades in the day-ahead or intraday market (BMWi 2015).

Figure 20 Development of monthly trade volume in Germany

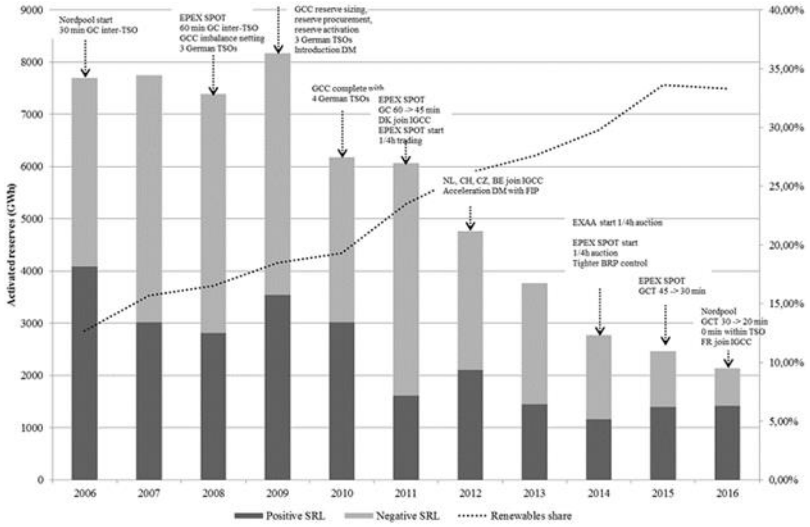


Source: (Kuwahata und Merk 2017)

The function of the wholesale market has been step-by-step enhanced. The gate-closure was shortened up to 15 minutes before the delivery. One trading unit is 15 minutes. This is particularly important with large shares of Variable Renewable Energy (VRE) in the portfolio. Because the quality of the forecast increases with the short-term, market participants need the short-term forecast of renewable generation and demand to adjust their trade volume in the intraday market until the gate closure. The intraday market performs the important adjustment function. In fact, the trade volume in the German intraday market has increased over the years (see Figure 20). The short-term market is also called Energy-Only-Market because only the energy (kWh) is traded in the market.

In Germany, renewable energy grew and the operation of the regulating power decreased at the same time (see Figure 21). This means the adjustment of the demand and supply basically takes place in the wholesale market.

Figure 21 Development of renewable and implementation of frequency control



Source: (Kuwahata und Merk 2017)

Also the rules of FIT were changed, too. In Germany the FIT was abolished in 2014 and Feed-In Premium or Market Premium was introduced. That is, RES units supported by Feed-In premium or market premium must join a BG and sell the electricity in the wholesale market. The BG adjust the gap between the demand and supply until the gate-closure in the intraday market to avoid the imbalance. This is why the German short-term market is important for renewable energy.

A1-5 Gross bidding

As noted, Japan tries to increase trade volumes at JEPX's spot market and therefore gross bidding was introduced in 2017. This measure has been already introduced in the UK or Scandinavian countries. The gross bidding is useful in the sense that the trade volume in the day-ahead market increases because of the obligation for the large utilities to sell their electricity in the wholesale market and to buy it back if needed. The goal is to activate the electricity market (Hattori 2016).

Along with the gross bidding expanding, the need for a forward market and a future market is also increasing because market players want to hedge the price swing risk through these markets. However, in the case of the UK, it is said that the forward market was not enough activated (Hattori 2016). In Japan's case, after the gross bidding was introduced in 2017, the trade volume in the day-ahead market has been increasing. The government announced that the gross bidding should achieve the share of 10% in the total electricity trade volume this year and 20 to 30% in a couple of years. The large utilities also announced the similar targets for the gross bidding. The rise of the volume in the day-ahead market in 2018 is the result of the gross bidding.

The regulator introduced the gross bidding because it is a price neutral system and reduces the volatility. However, the market participants might be aware of the bargaining power examined by the large utilities in gross bidding. There is a skeptic that the large utilities tried to manipulate the market in the day-ahead market. There were some cases in which the large utilities were questioned to misuse their market power in the gross bidding. For instance, the area splitting, has occurred for 5 days in June 2018 between the Tokyo and Tohoku grid areas. In this case the closed trade volume was 5 times more in Tokyo Area than Tohoku area and the price in Tohoku area was up when the areas connected and down when split. This was actually a rare case and it was asked if the actors in Tokyo area manipulated market price of these two areas (Nikkei xTECH 2018)[18]. Market manipulation can occur when the transparency is not sufficient and information asymmetry is there. When one large retailer can secretly communicate with one large power producer and know how much electricity amount will be offered when, and they examine the market power, this is the market manipulation inhibiting the fair competition. To solve this problem, blocking of information exchange between the generation department and the sales department in the big utility must be strengthened (Koura 2017). The government should exercise its competence to ban the insider communication between the different departments in one big utility and EMSC continuously observes the JEPX. The penalties for the violation must be enough strong.

A1-6 Obligation to secure supply capacity

The obligation to secure supply capacity is determined by the Electric Utility Industry Law, the article 2.12. The supply capacity that a retailer must secure is calculated as the sum of the maximum load of all customers with redundancy of a safety buffer. The retailers must keep the supply capacity which takes the upturn of the hypothetical demand into account until one hour before the delivery. Under the current rule, retailers do not need to specify the power plants by neither conclusion of the contract of transaction service nor the registration for network usage.

[18] See the source for the theoretical explanation why it might be the market manipulation.

The large utilities tended to set the safety buffer as 7 to 8% but they wanted to lower the rate after the unbundling. For example, Kansai EPCO announced that its retail department would bring the rate down by 5% (KEPCO 2017).

New retailers with more than 2,000 MW demand kept 105.1% of the supply capacity on average in 2017 but they plan to reduce it up to 102.6% by 2023. Small and medium sized new retailers with less than 2,000 MW demand have secured 43.8% on average and it is planned to down by 21.5% 2023 (METI 2019). The small and medium-sized retailers with little bargaining power have a difficulty with securing the supply capacity via OTC or PPA.

However, as the requirements are very high some retailers are suspected to occur imbalance intendedly (Nakanishi 2017), leading to a more closely control by OCCTO. The government has discussed how high the appropriate rate should be for the secured supply capacity. Even though, the obligation to secure capacity can be relaxed in order to integrate more procurement from the short-term market into the balancing system because the short-term market is able to stabilize the grid by corresponding to the fluctuation of renewable energy at the very last timing.

The supply capacity of one power plant is expressed as an hourly average output and calculated for each month. A simple formula for a supply capacity is as shown in Equation 1.

Equation 1 Calculation Method for Secure Supply Capacity

Supply Capacity = (generation capacity of a power plant) – (suspended capacity due to planned maintenance etc.) – (station service power in the maximum demand period)

Source: (ANRE 2015)

Note: The supply capacity does not mean a rated capacity in this context but the actual feed-in ability of a power plant.

All retailers must take a safety buffer into account. Committee on Evaluation of Regulating Power and Demand Supply Balance stated that 3% is applied for the appraisal standard for the safety buffer in Japan (CERPDB 2018).

The guideline says the generation capacity of a power plant is calculated differently for different technologies. There are 5 categories of the technologies, hydro, thermal, nuclear, “new energies” and others. New energies include wind, PV, geothermal, biomass and waste according to the guideline. Others means herein sources which are hard to specify, for instance, power purchased via JEPX. Among new energies, the different calculation methods are applied for different sources.

A1-7 L5 output rate

The L5 output rate is applied for renewable sources because this is a traditional method probabilistically to estimate a generation adequacy of run-of-river hydro in Japan. The

L5 output rate evaluates the supply capacity of hydro, wind and PV as follows: Pick up the 5 lowest output values of a wind turbine or a PV asset realized during the 3 days on which the highest electricity demand occurred in each year. For example, the calculation for PV, the plant owner picks the 3 highest demand days from the last 20 years, in total 60 samples. The plant's supply capacity is determined as the average of the 5 lowest values form these 60 samples. (ANRE 2015; METI 2015). The result of the L5 output rate often means the lowest capacity factor over the plant's lifetime, representing the most conservative method.

Table 4 Evaluation of expected available capacity of PV in summer 2013

10,000kW, %		Hokkaido	Tohoku	Tokyo	Chubu	Kansai	Hokuriku	Chugoku	Shikoku	Kyushu	Total
PV supply capacity		0	2	20	26	21	1	9	7	33	119
Break-down	Rated capacity (10,000 kW)	16	44	183	134	100	11	60	34	159	741
	Output rate (%)	0	16	23	29	30	22	27	30	31	-

Source: (METI 2013)

Note: rated capacity is the total installed capacity in each region. For the calculation an indicator of self-consumption (not displayed) is subtracted from rated capacity

Table 5 Evaluation of expected available capacity of wind in summer 2013 (demonstration)

10,000kW, %		Hokkaido	Tohoku	Tokyo	Chubu	Kansai	Hokuriku	Chugoku	Shikoku	Kyushu	Total
Wind supply capacity		0.4	0.4	0.2	0.1	0	0.01	0.2	0.02	0.8	2.13
Break-down	Rated capacity (10,000 kW)	29	61	37	22	12	15	30	12	43	261
	Output rate (%)	1.4	0.6	0.5	0.3	0.0	0.1	0.6	0.1	1.9	-
	Data period (years)	7	6	2	3	5	5	2	6	7	-

Source: (METI 2013)

Note: rated capacity is the total installed capacity in each region. For the calculation an indicator of self-consumption (not displayed) is subtracted from rated capacity. As wind project are rather new, the data period is given (L5-method usually uses longer time periods)

Examples of output rates for PV and wind that result from the L5-method are shown in tables Table 4 and Table 5 and are displayed in the line "output rate". Taken PV-instalments of the Kansai-Area as an example, the output rate is 30%. However, an indicator for self-consumption (not displayed) needs to be subtracted first. For Kansai area, this is 300,000kW. Therefore, installed PV-capacity (rated capacity) in Kansai area deducted by self-consumption (1,000,000kW-300,000kW) results in 700,000kW rated capacity supplied to the grid. This is weighted by Kainsai's regional output of 30%, resulting in secure supply capacity of 210,000kW. Since the rated capacity for the grid is 700,000kW, another 490,000kW secure supply capacity (the remaining 70%) needs to be secured elsewhere (via the market). The output rate for wind energy in the Kansai region is rated as zero, according to the L5 output rate, resulting in secure supply capacity. That is, all wind capacity (100%) needs to be secured via the market despite instalments of 120,000kW, i.e. retailers need to back all wind capacities by coal, gas, nuclear or hydro or possibly by hydrogen.

Meanwhile, other methods have become the common tools of analysis, in particular with rising shares of VRE in power system. The Effective Load Carrying Capability (ELCC) is normally calculated by a coincident data set of grid data during several years including VRE output, load and other grid information. The ELCC is "a percentage that expresses how well a resource is able to meet reliability conditions and reduce expected reliability problems or outage events (considering availability and use limitations). It is calculated via probabilistic reliability modeling, and yields a single percentage value for a given facility or grouping of facilities." (CPUC 2014). Meanwhile, the ELCC is considered one of the most reliable methods so far to estimate reliability of power systems and is widely used in the world[19]. The L5 method, in contrast, was originally developed for run-of-river hydro at an age when fast numerical analysis was barely available. It is now considered over-simplified and, in particular with regard to VRE, it underestimates their reliability because of lack of coincidence between data sets between VRE output and load.

A1-8 FIT special treatment

In Japan, for final balancing producers and retailers must submit the schedule and they have to pay the imbalance costs, if they deviate from the schedule. Because most all of producers and retailers are newly established and VRE predictions involve insecurities, the government introduced the special treatments for the FIT users in order to avoid rising imbalance costs. Power producers can choose one of two special treatment methods for balancing.

In the Special Treatment 1, a TDSO takes over a responsibility to forecast all the renewable generations in a BG on behalf of the power producers and to announce it to the retailers, so that the retailers in the BG takes small risk for the imbalance. The

[19] For the detail of ELCC method, see for example IEA Wind Task 25 2009 or Ackermann 2012.

schedule is generated two days in advance. In the case of imbalance, the retailers that use Special Treatment 1 have to pay the same price as a day-ahead price for imbalanced energy. The retailers however should make the weekly schedule for themselves for which the L5 output rate is applied. Because making and optimizing the schedule according to varying renewable generation is costly, this treatment is beneficial for the smaller green retailers.

Retailers using the Special Treatment 2 should make the generation schedule for themselves within their BG, where a retailer takes a responsibility to forecast its contracted generation facilities in the BG and to announce to the TDSO. In the Special Treatment 2 a FIT power producer is freed from the balancing responsibility.

A1-9 Anytime Backup Agreement

Generally, there 4 ways to access capacity in the Japanese system, regardless of renewable, fossil or nuclear:

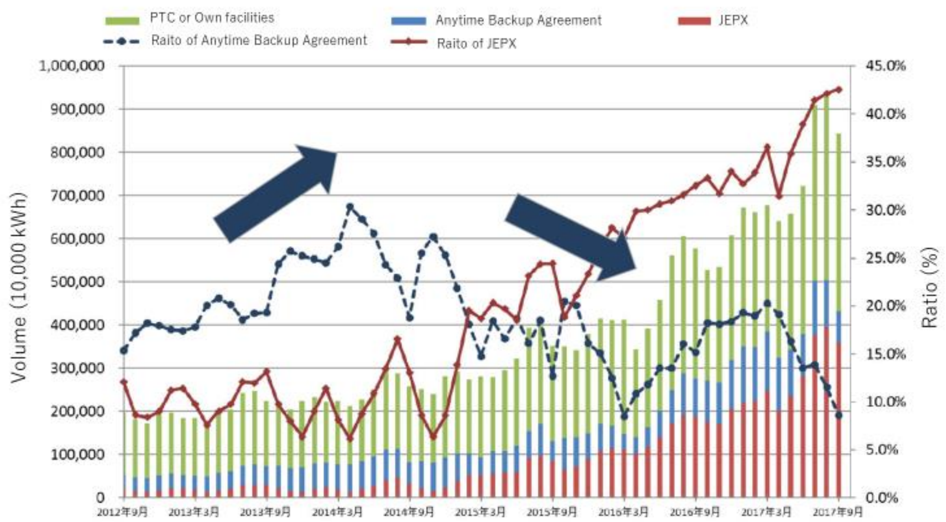
- Own generators: a retailer owns generators to provide electricity. It is then called utility or power supplier,
- Power Purchase Agreement (PPA): a retailer makes a procurement contract with power producers,
- Procurement in a wholesale market: a retailer buys electricity from wholesalers.
- “Anytime Backup Agreement”: the retailer signs a contract with a big utility for secured electricity supply. This is a temporal and transitional measure set by METI.

The capacity procured from wholesalers is able to be recorded only if a contract of delivery was completed. This means a retailer records the capacity in its supply plan as “supplier undecided” if it would buy the electricity the from short-term market of JEPX (ANRE 2016).

The “anytime backup agreement” was temporally set up for the sake of realizing of a more competitive market. The “anytime backup agreement” means that a new retailer and one of the big utility sign on the agreement that the big utility delivers the secured generation capacity, which they call “anytime backup”. This started in 2000 to improve the situation of the scarce capacity. The large utilities were required to deliver electricity up to 30% of the demand the new utility has expanded in the latest time for a high voltage range and up to 10% for a low voltage, respectively. While the anytime backup agreement was designed for the final resort for the new retailers, the new retailers initially had to look for the opportunities to procure electricity through PPA or the wholesale market.

The rate of anytime backup capacity had its peak in March 2014 with about 32% and then dropped down up to 10% in September 2017 (Figure 22). However, the agreement was usually made between the big utility and the new utility bilaterally. The unequal bargaining power between two allows the large utilities to offer middle-load supply, may be gas, which is more expensive than the baseload capacity, hydro, coal or nuclear.

Figure 22 Purchased capacity of new retailers (Sep. 2012 to Sep. 2017)



Source: (ANRE 2018c)

The new retailers are therefore confronted with a significant cost disadvantage compared to the large utilities. The large utilities' electricity price for the large consumer (EHV) is by trend 10 to 20% lower than that of the new retailers. For the small customers, the new retailers offer a bit cheaper price than the large utilities but, for example, Kansai EPCO tries to recover from a setback after the restart of its nuclear power plants.

A1-10 Baseload market

As of July 2019, the Ministry of Economy, Trade and Industry (METI) has introduced a new market, so-called "baseload market" as the substitution for the "anytime backup agreement". This new market is "to ensure equal access to cheap power supplies for new power retail companies as part of reforms to foster competition in the market" (Tsukimori 2016).

The "baseload market" is an auction system for which the large utilities are obliged to offer (low-cost) baseload supply for the cheaper price than that of middle load supply that was criticized under the anytime backup agreement scheme.

From the competitiveness point of view the "baseload market" is able to enhance the access of the new retailers to cheap and stable power supply, it has a risk to prolong the lifetime of nuclear and coal-fired power plants. In fact, the difference between the (obligatory) “baseload market” and the existing (voluntary) forward market in JEPX is the “baseload market’s” explicit priority for nuclear and coal (Yasuda 2016a). But without the mechanism to loosen the unequal power supply allocation, the new retailers would be forced out of the market because they could not access the capacity which is competitive to those the large utilities own.

From the green retailers’ view, however, the “baseload market” cannot solve the scarcity of renewable energy, even though hydro would be offered prior to coal or nuclear (the government does not mention about the ranking among the baseload capacity). Therefore, some green retailers now provide, for example, 20% or 50% green electricity products as a compromise.

Further, the government plans to introduce a capacity market in 2020 as will be detailed in appendix 2 below.

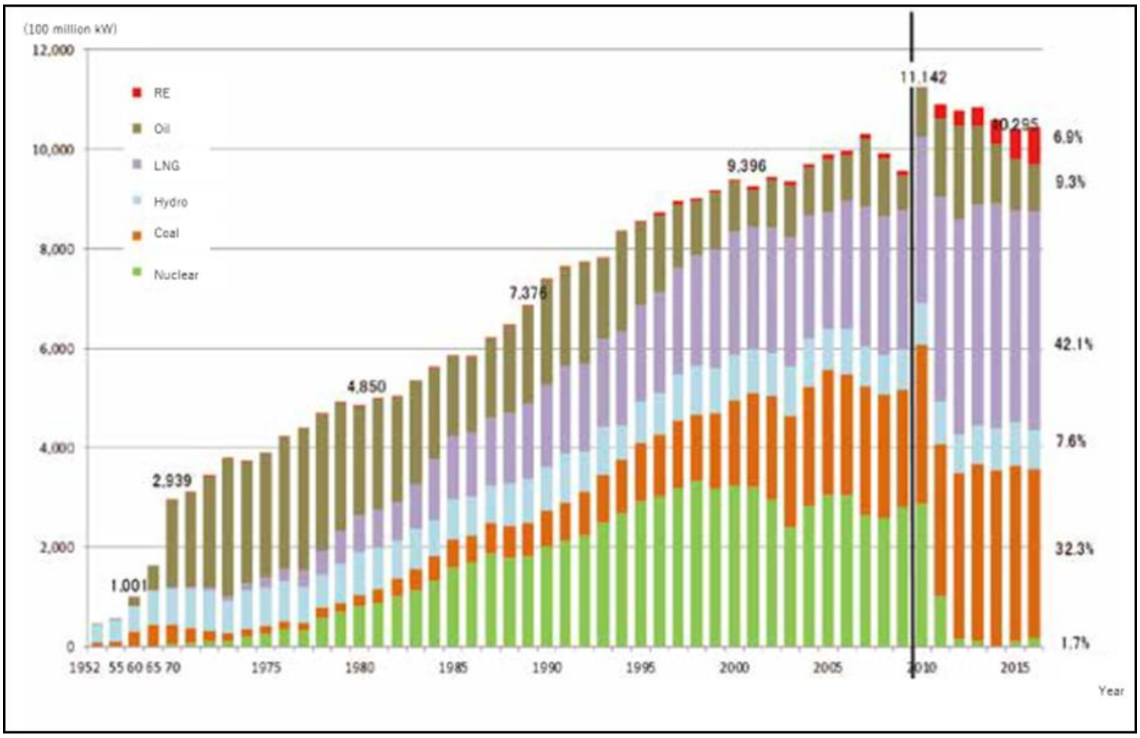
A1-11 RES: Generation and capacity development including hydro

The historical development of power generation is shown in Figure 23 and the regional distribution of installed RES-capacities is shown in Figure 24. The share of renewable arose up to 15% in 2016 from 10% in 2010 before the Great East Japan Earthquake. Renewable energy installed after 2012 strongly depend on PV.

As hydro is an important existing renewable source. A main period of the Japanese hydro power development ended before 1990. In 1990s many public construction projects, including hydro power plants have been Japan wide reconsidered. By now, Japan’s potential for small hydro has been less utilized than its potential according to the government (ANRE 2018a). Reasons are the scared profitability due to its small size and the fear of negative impacts on the environment. Looking at the size of hydro power plant under 30 MW, almost all of small hydro is over 1,000 kW[20] (see Figure 25).

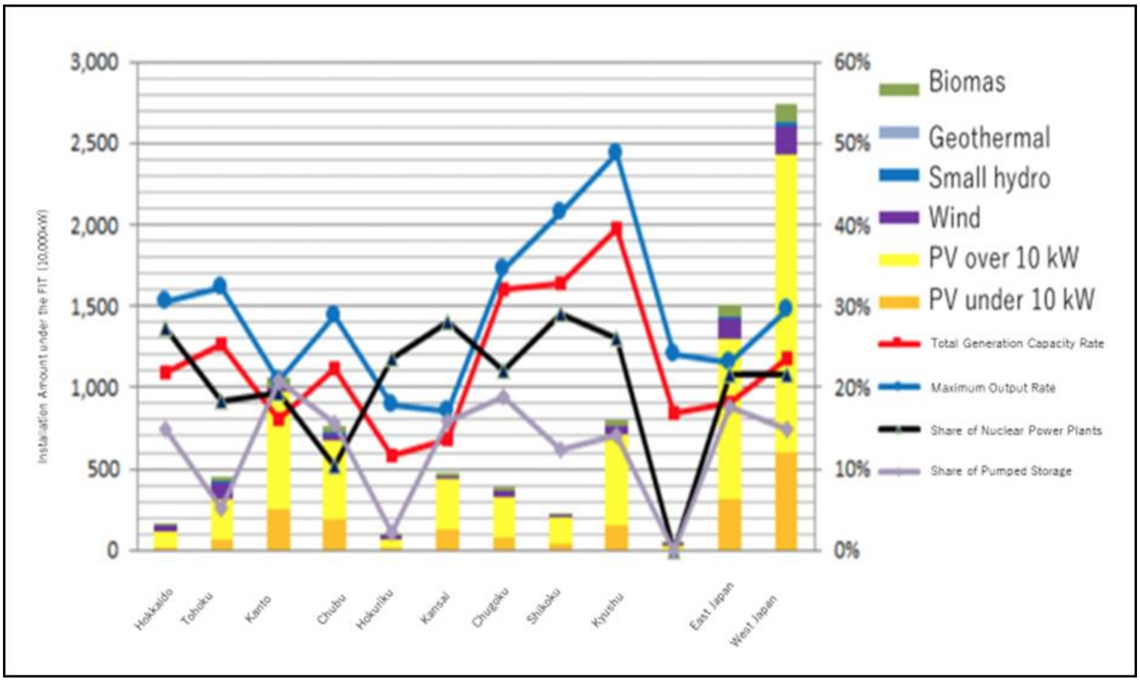
[20] In this report, hydro power plants under 30 MW are called small hydro because this is the range the FIT supports.

Figure 23 Japan's historical trend of power generation volume by source



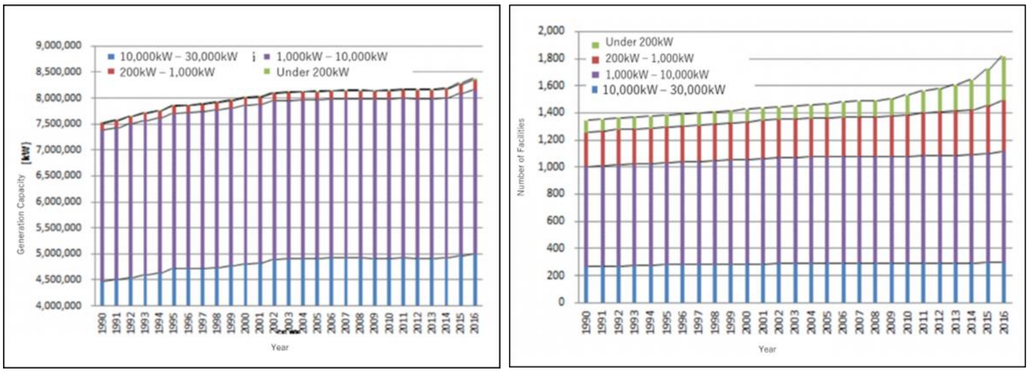
Source: (ANRE 2018b)

Figure 24 Installed renewable capacity in each region by source



Source: (ISEP 2018)

Figure 25 Development of small hydro capacity in Japan (left: capacity, right: number)



Source: (ISEP 2018)

The number and the ownership of hydro power plants are displayed in Table 6. There are 725 out of 2,064 hydro power plants that do not belong to the large utilities. Regarding the generation capacity, these 725 plants account for 16.2% of the total capacity. Assuming that the large utilities and their related companies are not willing to sell electricity generated from their own hydro power plants to new retailers who are competitors, this 16.2%, accounting for 3,610 MW, is available for the rest of the retailers.

According to the Ministry of Internal Affairs and Communications, there are 28 public organizations which operate hydro power plants under the Local Public Enterprise Act, and 51 public organizations which the Act does not apply for in 2013 (Fukunishi 2015). The Local Public Enterprise Act regulates the business fields of public companies, for example hospitals, water and sewage, train and power wholesaling, which are common for public wealth. Municipalities or prefectures own hydro power plants, operate and sell electricity or they entrust a third party with the operation as a wholesale business. So that the difference between two is that a municipality sells electricity as a wholesaler is regulated by the act (hereafter a municipal wholesaler) and a municipality does not sell electricity as a wholesaler is not regulated by the act (hereafter a municipal non-wholesaler).

Before the market liberalization municipalities sold hydro power to the large utilities following the act which restricted buyers. Even after the partial liberalization in 2000, 27 out of the 28 municipal wholesalers and 35 out of the 51 municipal non-wholesalers offered a private contract to the large utilities and the 11 non-wholesalers made a contract with a new retailer (Fukunishi 2015). These contract last for 10 or 15 years on average depending on sources.

In EU the obligation of the competitive bid for public services was enhanced in 2014 (2014/24/EC, 2014/25/EC, 2014/23/EC). This includes the energy businesses. For example, the operation of a grid must be auctioned (Table 7).

Table 6 Number of hydro power plants and owners

	Under 200kW	200kW – 999kW	1,000kW – 9,999kW	10,000kW – 29,999kW	Over 30,000kW	Total
Hokkaido EPCO	3	2	15	22	10	52
Tohoku EPCO	7	41	110	32	19	209
TEPCO	2	13	83	39	18	155
Hokuriku EPCO	2	13	70	28	17	130
Chubu EPCO	4	54	80	34	18	190
Kansai EPCO	3	25	53	29	38	148
Chugoku EPCO	6	17	44	25	3	95
Shikoku EPCO	0	6	35	10	3	54
Kyushu EPCO	20	26	65	17	10	138
Okinawa EPCO	1	0	0	0	0	1
J-Power	0	1	5	16	31	53
subsidiaries of large utilities	16	29	59	9	1	114
Private companies	24	32	83	33	6	178
State, municipalities	100	99	165	73	7	444
Agricultural associations	53	39	11	0	0	103

Source: (DBJ 2016)

Table 7 Contents of EU directive

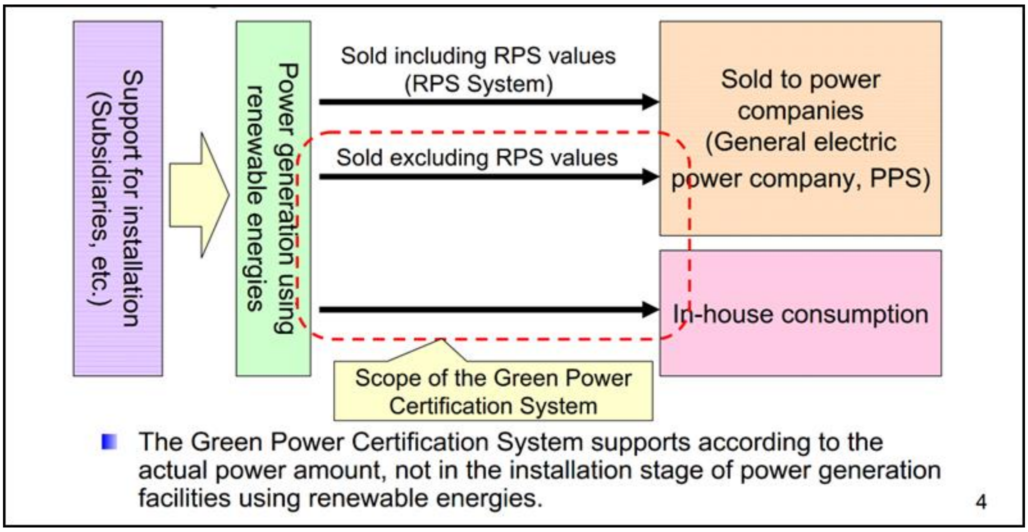
Revision of criteria	●unification of criteria for the Most Economically Advantageous Tender. This method evaluates not only the price but also quality as a whole. ●obligation of consideration of "life cycle cost" regarding the maintenance costs and environmental impacts ●addition of new criteria such as technical innovation, design, operation scheme, human resources
Expansion of a competitive dialogue auction	●expansion of a competitive dialogue auction scheme to water and sewage, power market

Source: (Yabu 2015)

A1-12 RES-Policy I: Green Power Certificates and J-Credits

Green Power Certificates (GPC) and J-Credit started in 2008 and in 2013, respectively. GPC (Figure 26) is a certificate "to translate the other value of electricity generated from natural energies, including energy conservation (reduction of fossil fuel consumption) and reduction of CO2 emissions (these values are called Green Power Added Value), into the form of Green Power Certificate, to allow companies and other organizations to use these values, as one of their voluntary energy conservation and environmental conservation measures" (Ogasawara 2008).

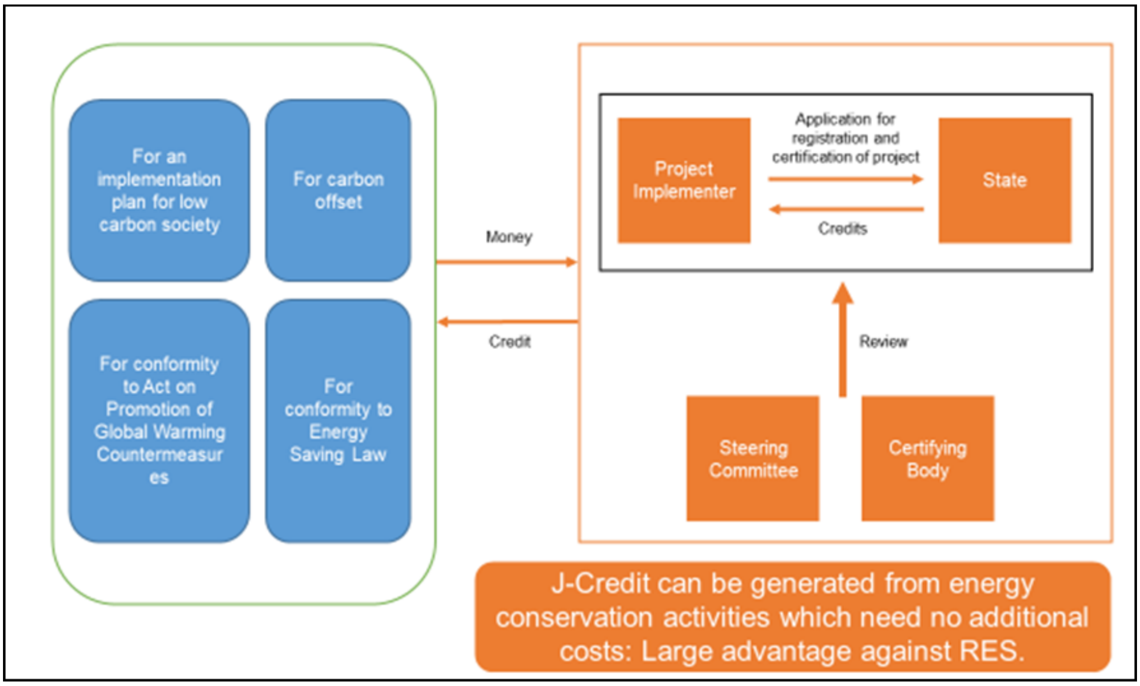
Figure 26 GPC's scheme



Source: (Ogasawara 2008)

J-Credit (Figure 27) was established as the unification of a domestic credit scheme and a carbon offset-credit scheme. J-Credit is, based on its background, a CO2-emission trading scheme. The credit is issued for not only renewable energy projects but also energy saving projects for which additionality is secured. A renewable project applicable for J-Credit is green power generation for self-consumption. Operators of renewable generators use electricity for their own but renounce to declare the usage of green electricity and sell its environmental value to the third party.

Figure 27   J-Credit's scheme

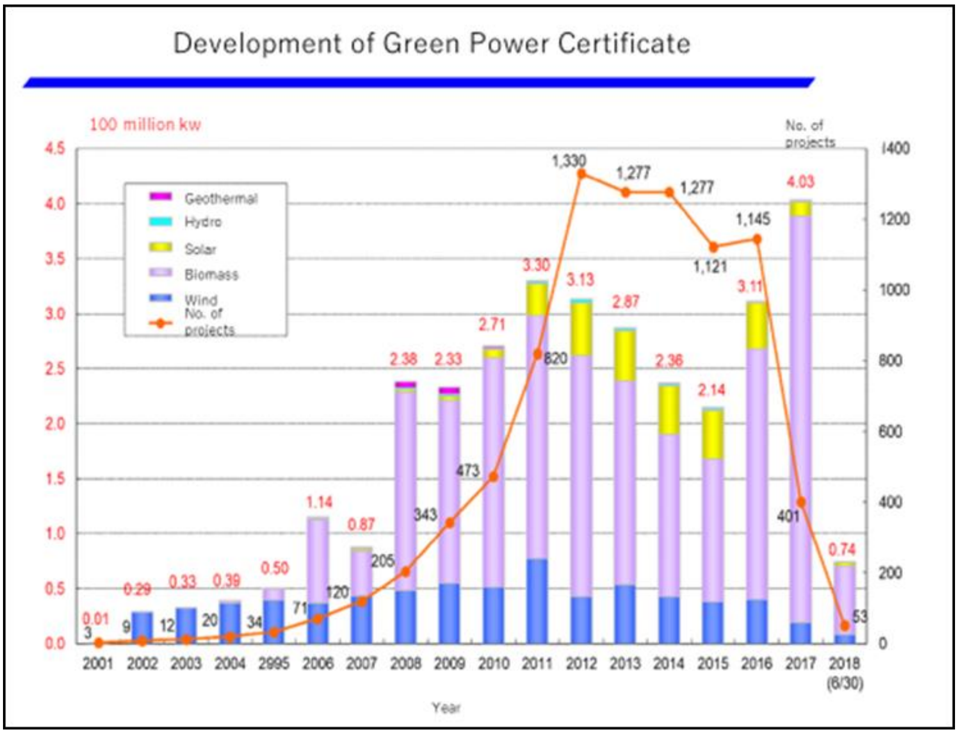


Source: (MOE 2013)

These certificate systems had been developed before the FIT was implemented. Parties bought J-Credits to declare their CO2 emission to fulfill the obligation set by the Ministry of Environment. GPC was started for using as the proof in Renewable Portfolio Standard (RPS), which was replaced by the FIT afterward. While consumers are not able to buy the NFFC, they can buy these certificates.

Looking at the current situation, the volume of J-Credit and GPC is insufficient for green retailers. Japan's electricity demand amounted to 900 TWh in 2016 (ANRE 2019c) but the sum of J-Credit and GPC was only 1,811 GWh. The number of GPC has significantly reduced in last few years as shown in Figure 28 because most all of renewable generators built after 2012 use the FIT for which GPC cannot be issued. In addition to that, the most of old hydro cannot issue J-Credit and GPC because they have been built before they started, either.

Figure 28 Volume of GPC issued



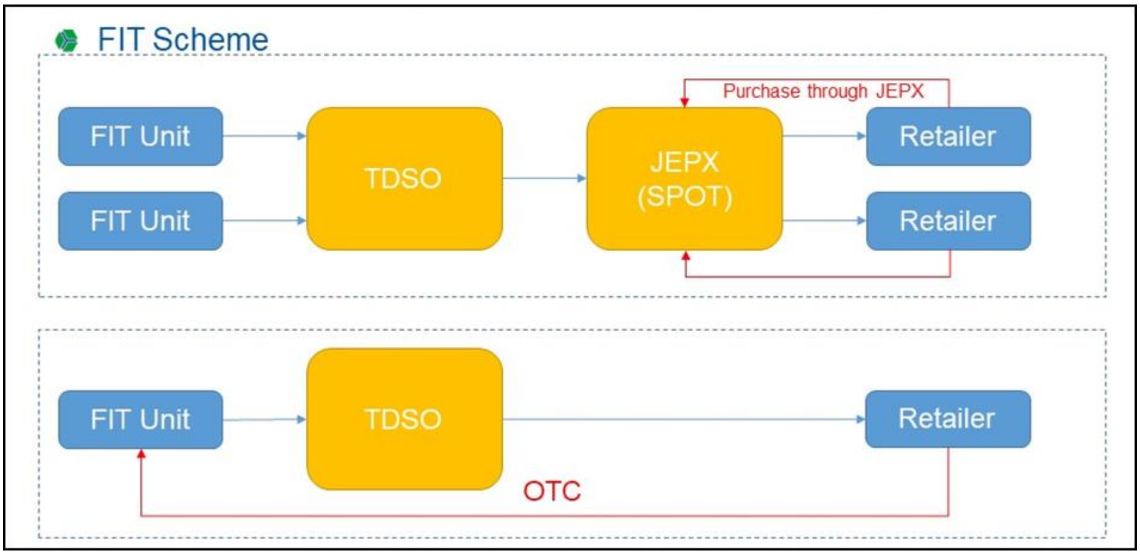
Source: (JQA 2018)

A1-13 RES-policy II: FIT-scheme

The FIT is a policy measure “under which producers of renewable energy repaid a set rate for their electricity, usually differentiated according to the technology used and size of the installation. The rate should be scientifically calculated to ensure profitable operation is guaranteed” (Mendonça 2012). Since the FIT paid to producers is usually higher than the revenue that is achieved at the spot market, the difference is paid via a surcharge by the general electricity consumers. The FIT is able to lower the generation costs of renewable energy by encouraging growth. That is, installation costs have constantly decreased in Japan (see Figure 31) In some countries, like Germany, the FIT has made the renewable energy’s generation costs the lowest among all technologies (Kost et al. 2018).

In Japan, there are two ways to market the FIT-generated electricity, as shown in Figure 29. The first way is that the whole amount of green electricity is initially bought by TDSOs. The TDSOs then sell this electricity in JEPX’s wholesale market (spot). After that, however, it cannot be distinguished from conventional electricity anymore and is therefore called gray electricity. The second (more exceptional) case is that a retailer had signed a contract for direct power delivery with a FIT power producer (called specified wholesaling). In this case, the TDSOs must pass the FIT electricity on to the retailer. However, because this electricity through TDSOs is labelled as gray electricity, the green retailer must buy the same volume of the NFFC as electricity from the FIT units.

Figure 29 Japan's FIT-scheme



Source: Own Diagram

In Japan, the Act on the FIT approved at The Cabinet Meeting in the morning on March 11. 2011, on the same day as the East Japan Great Earthquake, and the FIT was implemented in 2012. This led to a growth of renewable energy. At the beginning only one price was applied for one technology. That it, the same prices was applied for both large ground-mounting and small rooftop PV and payments are granted for periods of 10-20 years. The initially high rate for PV (42 Yen per kWh in 2012) was one reason for the capacity growth among renewables being skewed towards PV in Japan. Rates have been reduced subsequently for PV (and all other renewable energies) and payments were made dependent on technology and size of installations (Table 8).

In the revision of 2018, the government decided to introduce an auction scheme instead of the FIT rate fixed by the government in order to curb the generation costs further because it is still higher than the world average. The regulator fixes the amount of the new installed capacity for the auction and the bidder offers the FIT price which they want to receive for 1 kWh. The auction is multi-price auction and the bidder who offer the lowest price gets the contract. This ends when all auctioned capacity is sold.

The background of this amendment is a strong criticism from citizens that the surcharge is high. The surcharge has increased from 57 Yen per month in 2012 to 686 Yen in 2017 (Figure 30), even though the generation costs have decreased during this period (Figure 31). This is due to the fact that the FIT-payments usually last for 20 years and many early facilities that receive high payment rates are still in the system. Furthermore, a number of current facilities that are going online now have been contracted under older conditions (i.e. are still receiving higher FIT-rates). Therefore, even when new facilities now enter the system at low FIT-rates (for example due to auctions), this will not lower the FIT-surcharge for electricity customers because the old FIT-facilities are still in the system and have to be “paid-off”. Only when the old FIT-facilities reach the end of the 20-year-period and drop out of the system, it will relieve the FIT-surcharge. The high FIT-rates in the beginning actually represent technology development, innovation and market introduction costs. For other energy technologies, for instance nuclear energy, these have been financed (less transparently) via general taxes instead via an extra surcharge that the electricity consumer has to pay.

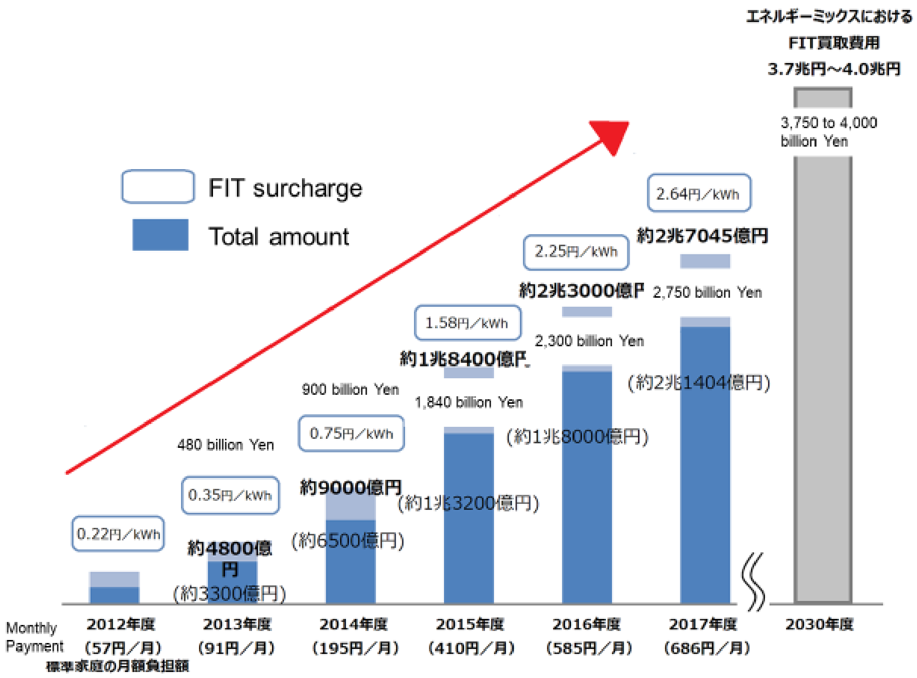
Table 8 Japan’s FIT rates (as of 2019)

			Purchase prices (JPY/kWh)				Purchase period
			FY2017 Apr.-Sep.	FY2017 Oct.-Mar.	FY2018	FY2019	
Solar	Less than 10 kW		28		26	24	10 years
		when output control system are required	30		28	26	
	Less than 10 kW (+ energy storage system)		25		25	24	
		when output control system are required	27		27	26	
	10-2,000 kW		21				20 years
	2,000 kW or more		Auction				
Wind	Less than 20 kW		55				20 years
	Onshore	20 kW or more	22	21	20	19	
		replace	18		17	16	
	Offshore	20 kW or more	36		36	36	
Geothermal	Less than 15,000 kW		40		40	40	15 years
		replace whole equipment	30		30	30	
		replace above-ground equipement	19		19	19	
	15,000 kW or more		26		26	26	
		replace whole equipment	20		20	20	
		replace above-ground equipement	12		12	12	
Hydro	Fully new facilities	Less than 200 kW	34		34	34	20 years
		200-1,000 kW	29		29	29	
		1,000-5,000 kW	27		27	27	
		5,000-30,000 kW	24	20	20	20	
	Utilize existing headrace channels	Less than 200 kW	25		25	25	
		200-1,000 kW	21		21	21	
		1,000-5,000 kW	15		15	15	
		5,000-30,000 kW	12		12	12	
Biomass	Wood (general)	Less than 20,000 kW	24		24	24	20 years
		20,000 kW or more	24	21	21	21	
	Forest residues	Less than 2,000 kW	40		40	40	
		2,000 kW or more	32		32	32	
	Wood waste from buildings		13		13	13	
	Municipal waste		17		17	17	
	Biogas		39		39	39	

Source: METI

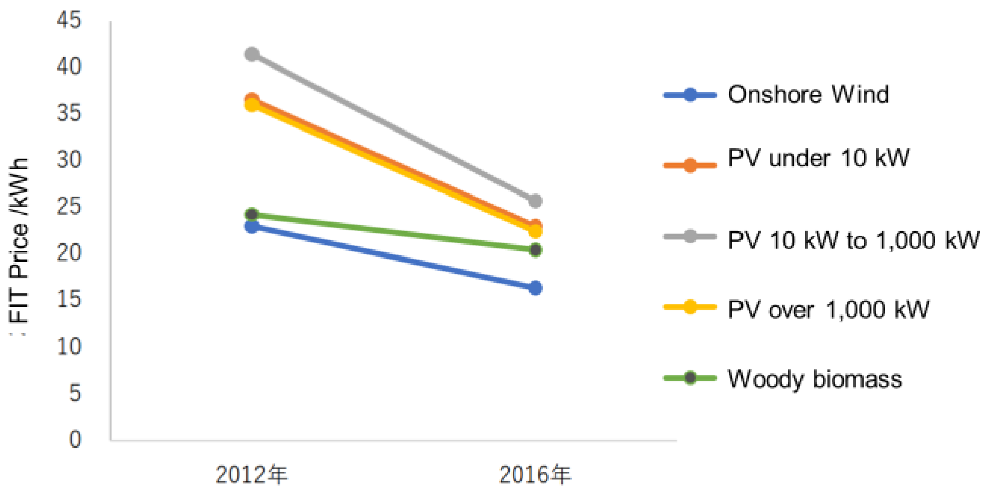
Source: (IEA 2018)

Figure 30 Development of FIT payment



Source: (ANRE 2017a)

Figure 31 FIT price

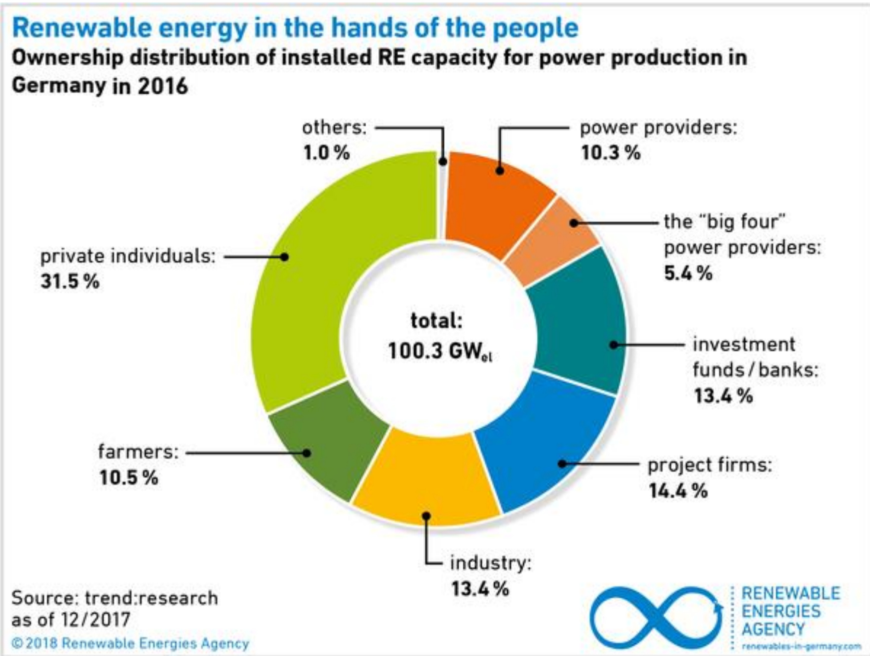


Source: (Kimura 2017)

Therefore, the FIT-surcharge is expected to peak at one point once the old facilities start to phase out of the system and new facilities receive lower rates. However, the criticism of rising FIT-surcharge seems to be the main topic (Ishikawa 2018). There have been similar discussions in Germany, too. Therefore, and in order to level the playing field of renewable energies against other technologies and to increase transparency, an innovation fund has been proposed. More specifically, FIT-rates beyond a certain level should be defined as technology development cost and should be taken out of the FIT-system and be financed by the innovation fund (Matschoss und Töpfer 2015b, 2015a). Meanwhile, the German FIT-surcharge has peaked in 2017 (Netztransparenz 2019a). Older studies had estimated the peak in 2023 (Öko-Institut 2015) due to the phase out of the old facilities. However, apart from technology costs several political factors influence the level of the surcharge. One main driver is the extent of exemptions from the surcharge granted to industry. Since the missing revenue from the exceptions has to be compensated by the remaining ("non-privileged") electricity consumers, larger exemptions means a higher FIT-surcharge for the rest (Öko-Institut 2015).

In 2018, Germany achieved a share in renewable electricity consumption of 38.2%. This is due to a decline in electricity generation from fossil fuels and an additional 12.4 TWh of electricity generation from renewable energies with respect to 2017 (Agora Energiewende 2019). Germany is likely to miss the climate target in 2020, but the German government shows strong will to achieve the 2030 target to cut the GHG emission by 55% compared to 1990. One of the most important feature of Germany's renewable energy is the structure of the ownership. The largest part of the renewable sources in Germany was invested by the private individuals, followed by the farmers.

Figure 32 Ownership of German renewable energy

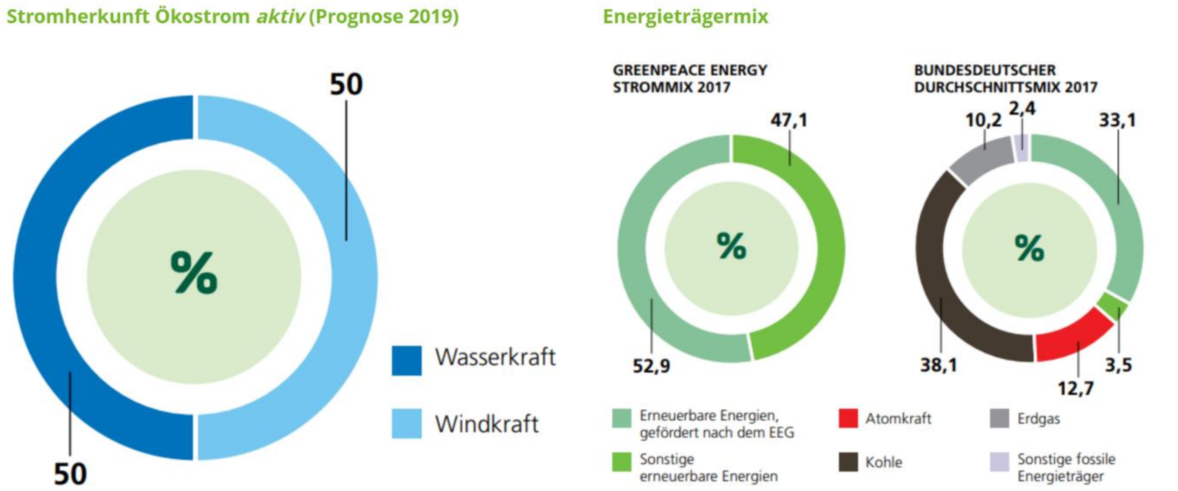


Source: (AEE 2017)

A1-14 Energy mix declaration

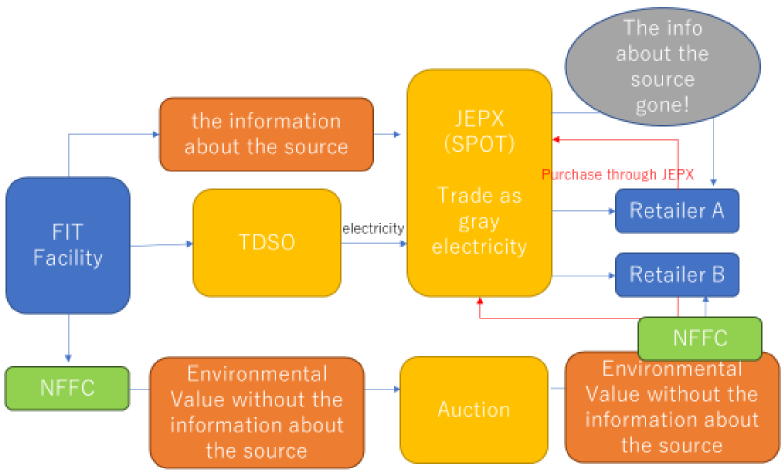
In Germany all retailers must disclose the information about the electricity mix of the tariffs. Germany‘s electricity declaration looks as follows. As the FIT electricity shared equally in all surcharge payers, this must be separately displayed in the electricity declaration.

Figure 33 Electricity declaration of Greenpeace Energy



Source: (Greenpeace Energy 2019)

Figure 34 Energy mix declaration using NFFC RE



Source: Own Diagram

In Japan, the current NFFC does not contain any information about the source, location or the date of implementation. The electricity from the FIT facility is either sold at the spot market and becomes “gray” electricity. The environmental value of that electricity is auctioned without the information on location and source. The second option is to auction the electricity directly, where the information on location and source is lost as well. To solve this problem, some new green retailers have developed a tracking tool for green electricity on their own. It enables green retailers to combine the NFFC bought from the auction market with electricity from the FIT facilities that they have an electricity wholesale agreement with.

Appendix 2: measures

A2-1 Non-introduction of capacity market

The government plans to introduce a capacity market in 2020 (OCCTO 2019a). In such a market, the regulator decides how much generation capacity will be needed and secures the capacity via a bid. The bid would be organized by the regulation body or grid operators. The bid trades the power generation ability (kW or MW) and the successful bidders will get the payment for keeping the plants in operation in parallel to their usual power trade (Matschoss et al. 2017, pp. 92-94). To make it sure that the power plant can generate electricity whenever it needs, wind and PV are often excluded from the market. UK and France adopt the capacity market and Germany did not implement a capacity market because it was believed by policy makers that it hinders the further flexibilization of the system (Matschoss et al. 2017, pp. 90-92, 94).

A2-2 Short-term flexibility options

Better provision of system services increase flexibility. In Germany, for instance, the electricity balancing market has been tuned more for variable renewable energy. For example, batteries and biomass are already participating in the market. To sell the flexibility in the market every facility must pass the prequalification requirement. The prequalification requirements for biomass and batteries already exist and basically all technologies can be involved into the market if the technology can ensure the capacity for the certain time and certain amount which are in the contract clearly stated. If so, for example wind technology can also provide the flexibility though it is variable renewable technology. Along with the development of the forecast ability of wind, many technicians for example operators of virtual power plants (VPP) can predict the generation amount of wind for the next day with high accuracy so that it is sufficient for regulating power. The regulator changed thus the rule of the market to integrate the wind. That is, TSOs did the auction one week before in the past and one day before now, because the forecasting accuracy for the wind is already sufficient.

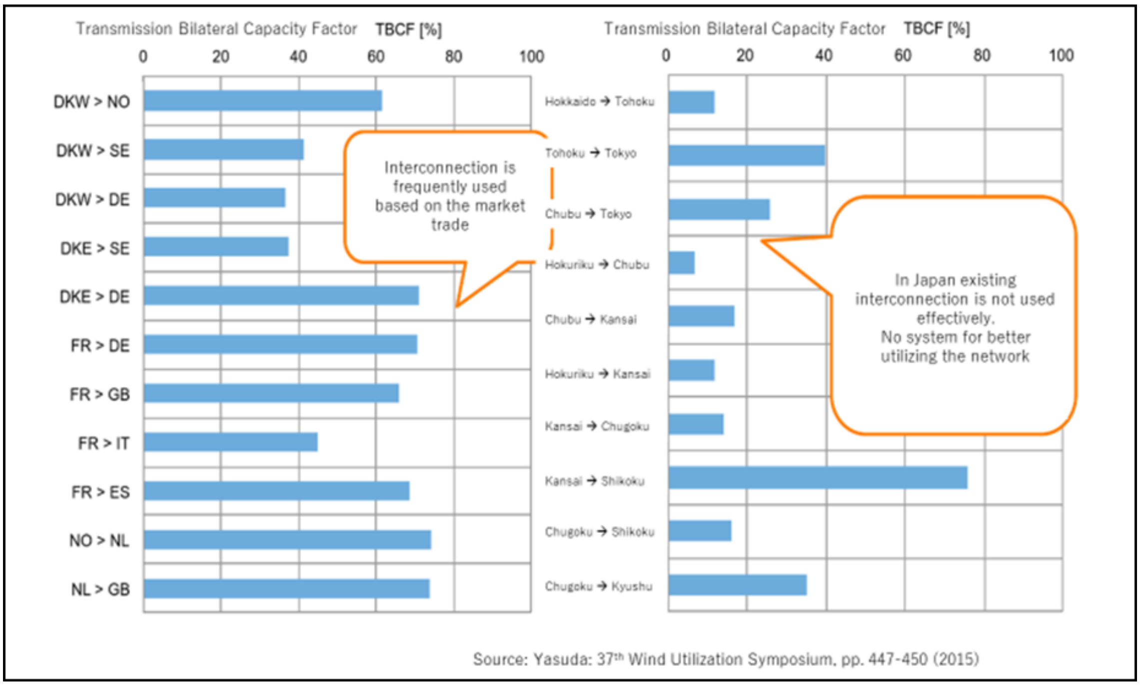
Other short-term flexibility options include Demand Side Management (DSM) or Demand Response (DR). The above-mentioned batteries may be used for DSM or VPP. That is, they may be connected and remotely controlled in the internet to provide flexibility. Furthermore, different kinds of renewable capacity may be added.

A2-3 Short-term grid options: grid management

As mentioned in section 3.4, flexibility options implementing organizational changes (the “software”) may be implemented in the short-term. Therefore, in terms of grid management, the government and TDSOs are currently discussing two measures. One is the enhancement of cross-regional connection, meaning grid operators accept more electricity flow to and from other regions. This is done via so-called indirect auctions. The second measure is the principal of “Connect and Manage”. This shall better utilize existing grid capacity within regions and give fair access to new – especially renewable – capacities to the grid.

Currently, cross-regional connection capacities are used less efficiently in Japan than in Europe, for example. The lower utilization rates are shown in Figure 35 where bilateral transmission capacity factors between European countries (left hand side) and between Japanese regions (left hand side) are compared.

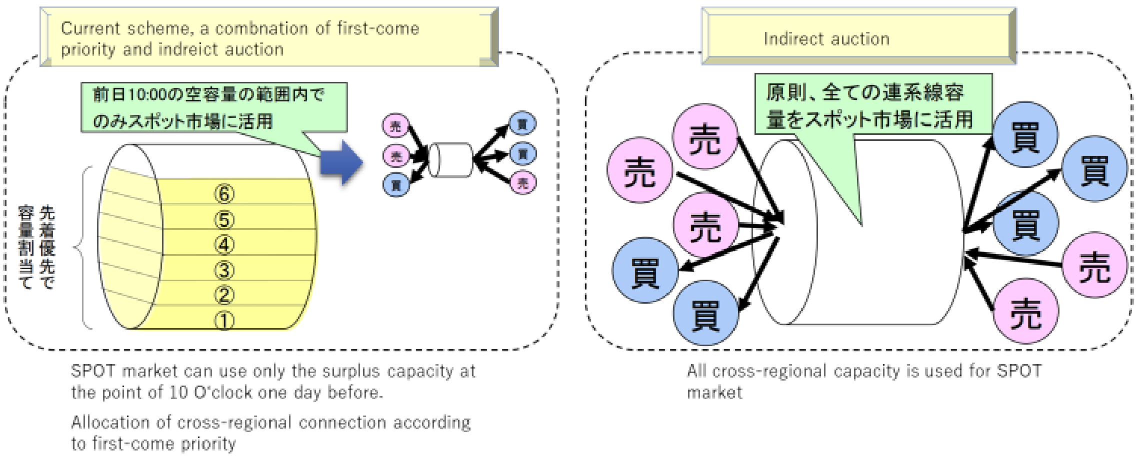
Figure 35 Comparison of interconnection rates



Source: (Yasuda 2016c)

The indirect auctions as the first measure are conducted to determine the volume of cross-regional connection. In the past the utilities with their pre-existing capacities had priority access to the cross-regional connection capacity. Therefore, the power producers and retailers who bought power in the spot market could transfer the power only for the amount which the cross-regional connection allowed. Even in the period where renewable energy generates much electricity, this could not be transferred at the maximum level because the connection capacity was closed, leading to the inefficient use of the cross-regional connection capacity. Under the indirect auction the electricity flows (and needs for transfer capacities) are determined not by a direct auction of right to use the grid but by the result of the spot market, so it is called indirect auction over spot market (Figure 36). With the new system the utilities have lost the priority connection. This is a new scheme and too early to evaluate its impact on renewable energy but this is expected to expand the cross-regional renewable energy and flexibility transfer.

Figure 36 Indirect auction of cross-regional connection

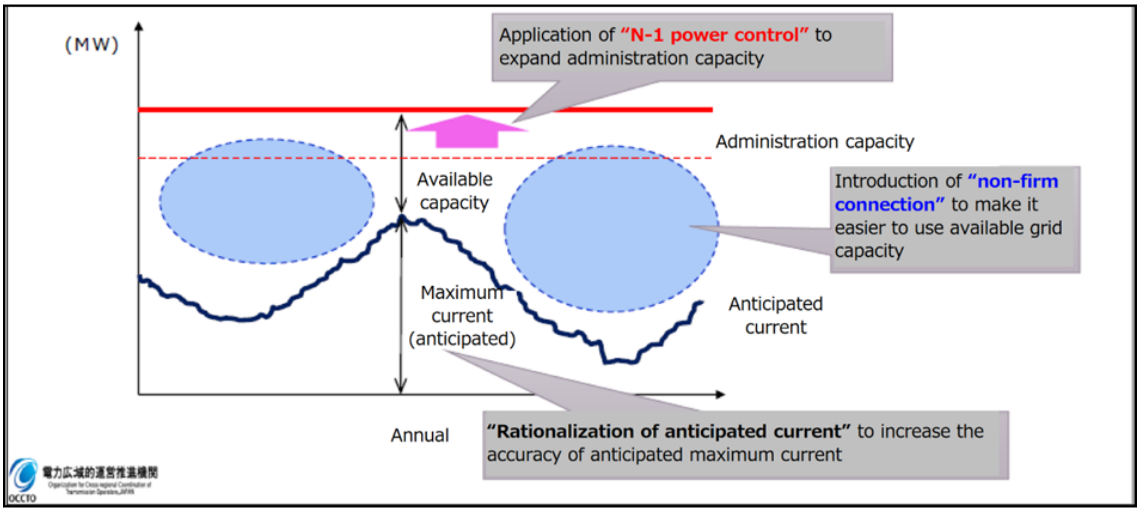


Source: (CRCC 2017)

The other measure of “Connect and Manage” introduces dynamic load management to the grid and opens access also to new capacities. The old way of grid connection is based on “first come, first served” (FEPC 2018). That is, each power plant reserves a grid capacity for transferring the electricity. Further, the reserved transmission capacity is determined as the maximum output capacity, or the rated capacity, of each plant. For example, once a nuclear power plant reserves the transmission capacity, this capacity cannot be used by other power plants regardless whether the nuclear power plant is in operation or not. Once the rated capacity is fully reserved, the only way to connect new power plants is the reinforcement of the grid. This was a barrier for new RES capacities, in particular since RES project developers were forced to finance the reinforcement costs, which is sometimes unacceptably high (see section 5.2).

However, using dynamic physical flow management under “Connect and Manage” would enable the grid to adopt more electricity without any large reinforcement (Yasuda 2018). The Japanese grid operators started to change their mind in some fields. METI is now in consideration about the introduction of “Japanese-version of Connect and Manage” for grid operation. The Connect and Manage is typically used in the UK (ofgem 2019). According to the OCCTO, the neutral federation of grid operators, the situation will change after the introduction of the Connect and Manage. Connect and Manage allows the grids to adopt more power plants to feed in (see Figure 37). Which power plants feed the power in the grid is decided by the results of the market trade. The shift to Connect and Manage or non-firm connection expects to “make it easier to use available grid capacity” (FEPC 2018).

Figure 37 Connect and manage realizes higher rate of electricity flow



Source: (FEPC 2018)

Note: The primary source was provided by OCCTO, here cited the English version translated by the Federation of Electric Power Companies of Japan.

This is beneficial for the integration of VRE because most of power plants reserved the grid capacity are nuclear or thermal power plants that had been built before renewable came active, even there are cases in which no more wind can be installed because another renewable generator exists.

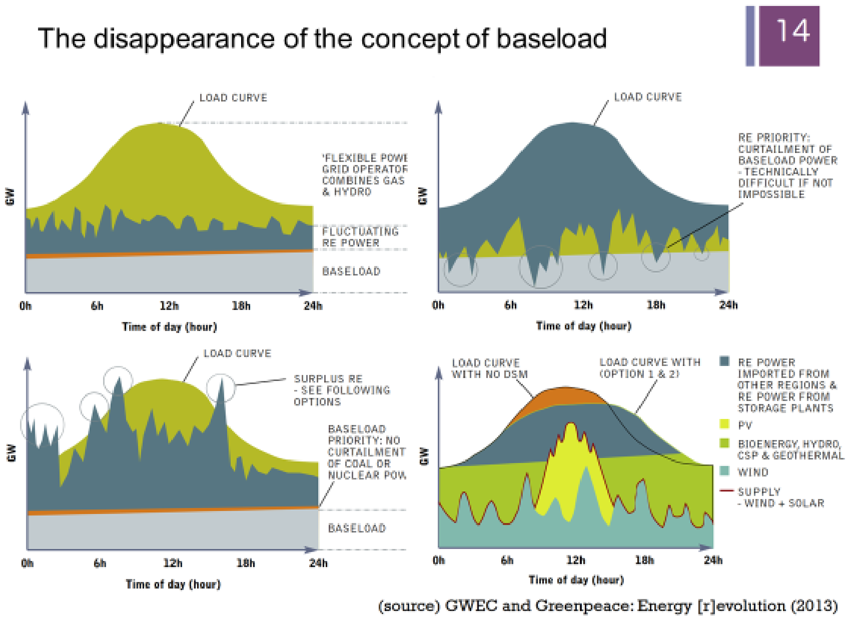
Also, under the N-1 power control, there is a difference in Germany and Japan. "The basic principle of (N-1) security in network planning states that if a component – e.g. a transformer or circuit – should fail or be shut down in a network operating at the maximum forecast levels of transmission and supply, the network security must still be guaranteed. This means that, in this case, undue interruptions in supply or the spreading of a failure must not occur. Voltage levels must remain within the permitted limits and the remaining resources must not be overloaded."

Another study analyzed the Japanese grid and its infeed capacity of renewables. It showed that "on conservative assumptions concerning renewable energy developments, the annual share of renewables in Japan can be increased to at least 33% by 2030, while still maintaining grid stability within a tolerable range and without additional transmission line reinforcement" (Renewable Energy Institute & Agora Energiewende, 2018). However, "Non-discriminatory market rules, enhanced transparency, and state-of-the-art operational and planning practices can facilitate the integration of variable renewables in Japan (REI und Agora Energiewende 2018).

A2-4 Excurse: grid management in Germany

With rising shares of VRE, the concept of base-, middle and peak load will disappear (see Figure 38). Instead of that, the variable renewable energy and flexibility will be basic principle of grid management.

Figure 38 Disappearance of the concept of baseload



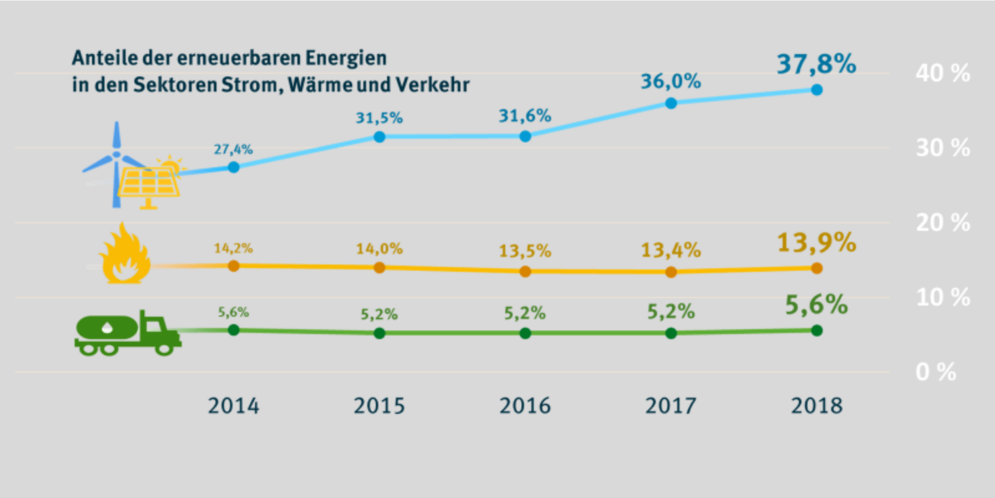
Source: (Yasuda 2016c)

In German grid management, an operator adopts renewable power as it generates and then adjust the gap between supply and demand. Therefore, the capacity which fulfills this gap must be flexible in speed and volume. This is Europe's standard grid management concept. It is important, that not only renewable energy but also demand always varies. Due to the delay of the grid expansion, there is time in which power generation is in excess. It is often called renewable energy surplus, but electricity is same once it flows in grid no matter what generates power. In Germany it is called thus a problem of inflexible power generators. They are for example, lignite or nuclear technology.

In Germany, thanks to the strong political commitment and the support measures, renewable energy has developed in last 20 years in the electricity industry. But in the heat and transportation renewable has struggled.

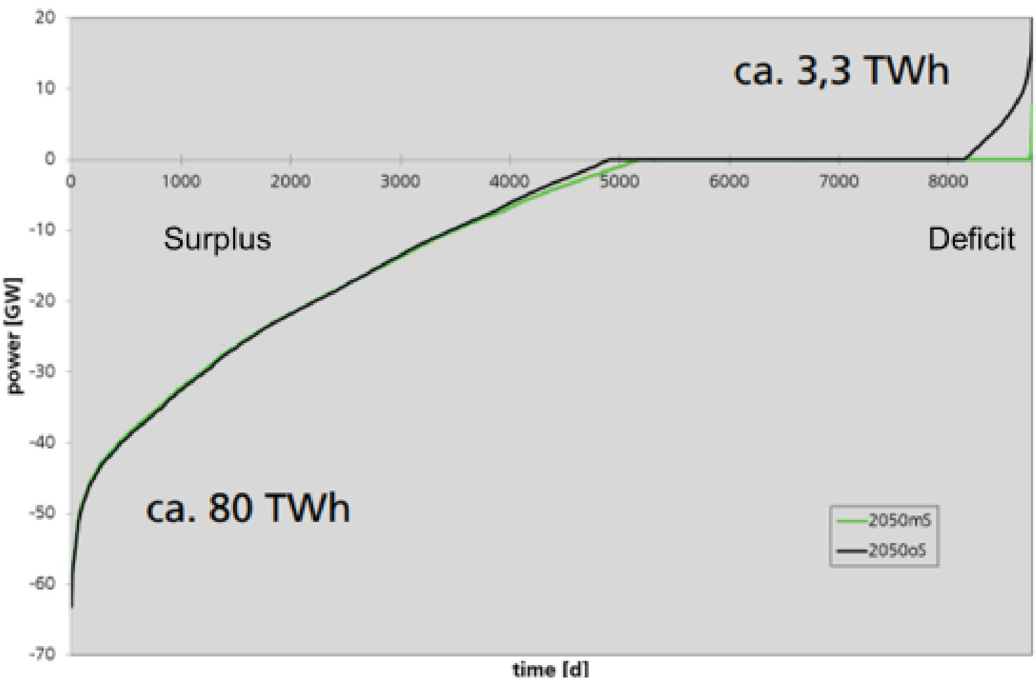
The German target is to raise renewable electricity to 65% by 2030 (Figure 39). If the development will continue further, Germany will have 80 TWh surplus of renewable power and 3.3 TWh deficit of renewable power in 2050 (Figure 40). This means, that the electricity system needs to be able to absorb the electricity.

Figure 39 Development of renewable energy



Source: (UBA 2019)

Figure 40 Surplus and deficit of renewable power in 2050 scenario



Source: (Krassowski und Overhage 2018)

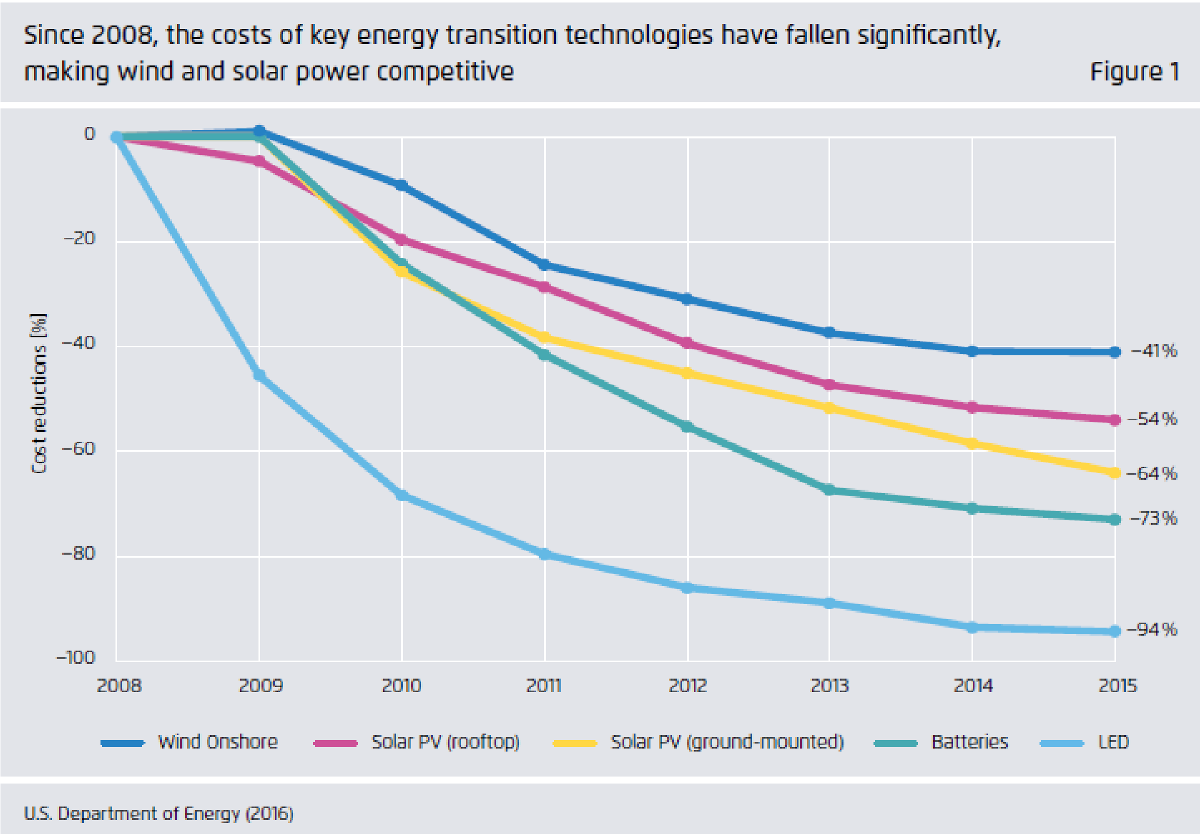
Therefore, renewable energy and flexibility is a basic principle in Germany, as already mentioned. German TDSOs consider what can here supply the flexibility. Conversion of surplus renewable energy to heat or transport energy is one part of the solution.

A2-5 Long-term flexibility options

More long-term options to provide flexibility across sectors include the production of heat with renewable electricity (power to heat, P2H). P2H features an electric water heater or a heat pump to create the heat from power. This helps when electricity surplus happens in the grid.

In the transport sector an electric vehicle (EV) can absorb electricity from the grid during power surplus and reverse flow during power deficit. Stationary batteries can contribute to the grid stability also. As already mentioned, batteries are especially well-suited at is the high-speed charge and discharge. So far, they have been considered an expensive option. However, their costs have been declining significantly, as shown in Figure 41.

Figure 41 Trend of cost down of renewable energy, battery and LED



Source: (Agora Energiewende 2017, p. 12)

A problem of the battery is that it cannot store power for the long period and not in a large amount. Renewable energy sometimes needs more than a couple of days the complementary capacity, which is called dark doldrums ("Dunkelflaute"). Power to Gas (P2G) is expected to be able to fulfill the gap. Because Germany has already well-developed gas pipeline, it can save a lot of investment by using P2G. P2G produces hydrogen. Hydrogen can be then used by a fuel cell technology or by direct combustion.

Another way of P2G is to create methane gas with the hydrogen. The methane gas can be stored easily thanks to the gas infrastructure.

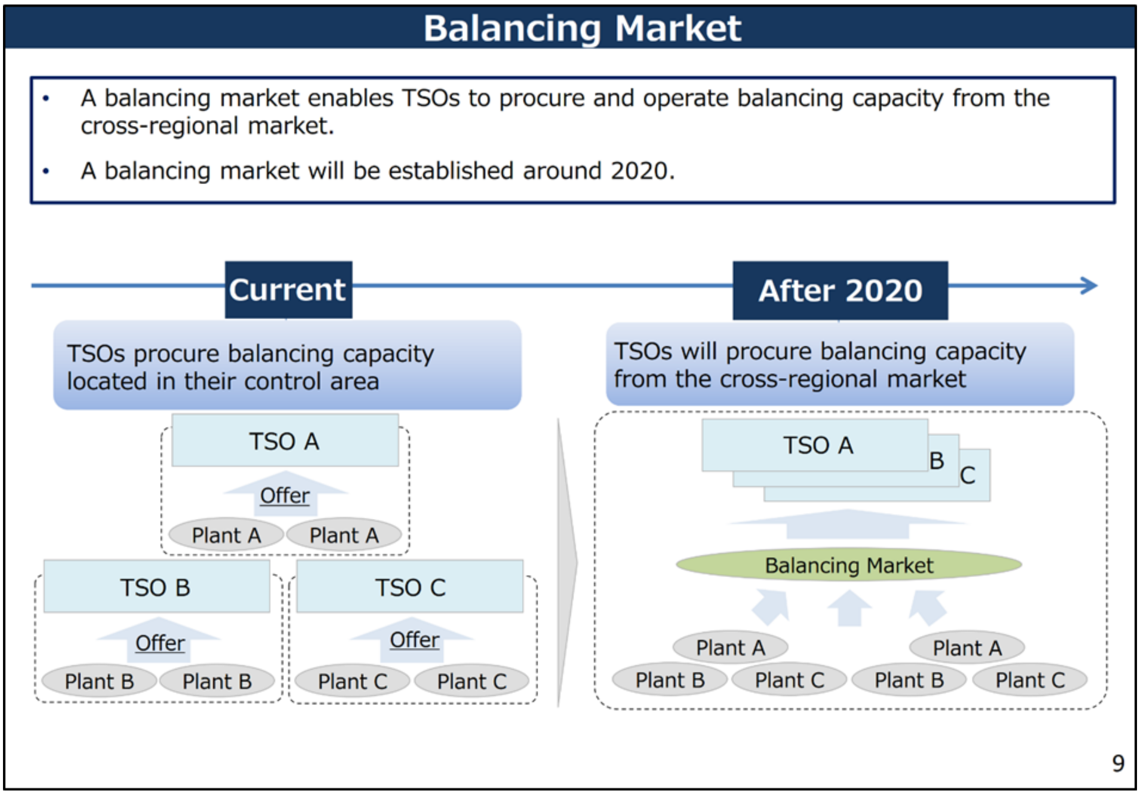
A2-6 Cross regional balancing market

To adjust the demand and supply in the market, the designated market is needed. This is called a balancing market which Germany implemented in 2012 and Japan plans in 2021. The balancing market adopts often a bid. The regulating power is to be used for the frequency control, for example. This is an important market mechanism to adjust the demand and supply in coordination of the power producers and users (retailers). However, for the balancing market the transparency is crucial.

As mentioned in the previous sections on liberalization, unbundling has not occurred yet in Japan, though the market has been liberalized step by step. To make the market competition fair, the Japanese government plans the unbundling in 2020. This means that the large utilities still own units in all three branches, “power generation”, “transmission, distribution and grid operation” and “marketing and sales” until 2020. This vertically integrated situation can lead to unfair competition, “newcomers” claim. Newcomers are new power producers, retailers or even utilities.

There are also further changes planned for coming 5 to 10 years. Some of the largest changes are the above mentioned introduction of a capacity market and a balancing market. Currently, the balancing market is partly liberalized but METI plans to make it open for whoever wants to offer their controllable capacity for stabilizing the network if they pass the prequalification.

Figure 42 Japan's planning balancing Market



Source: (Nabeshima 2018)

After the completion of opening the balancing market, plant owners are going to be able to provide the regulating power regardless of their location (Figure 42). However, it is still unclear how renewable sources will be handled in the new framework coming into effect after 2020.