A Study on Policies for Sustainable Investment on Renewable Energy at the Post-FIT Era

Yu Nagatomi

This paper estimates a future wholesale power market price with the power generation mix model and discusses policies for renewable energy. The result of power generation mix model analysis describes that a massive introduction of renewable energy would stagnate the wholesale power market price. If Japan would increase a total amount of renewable energy continuously, it would suppress the wholesale power market price. Renewable energy would impair their profitability under lower market prices in some regions. Japan will need some policy measurements to promote their sustainable growth for the future low carbon power generation mix, considering regional differences of power generation mix. The Government of Japan has already decided to revise their policy for the utility-scale PV and biomass from FIT (Feed in Tariff) to the auction scheme in order to alleviate cost burdens for promoted renewables by FIT. This paper presents study on policies for sustainable investment on renewable energy at the post-FIT era to increase the share of renewable energy in the future generation mix beyond 2030.

Keywords : Renewable, Feed in Tariff, Wholesale market price

1. Introduction

The 5th Strategic Energy Plan was approved by the Cabinet on 3 July 2018. It positions renewable energy as a main source of power, and seeks to implement initiatives swiftly in order to lay the groundwork for making renewable energy the main source of power, with the aim of realizing the composition ratio for Japan's energy mix in 2030. Renewable energy makes up 22 – 24% of the power generation mix for Japan in 2030, as presented in the 5th Strategic Energy Plan[1]. On the other hand, most recently, the period for purchasing surplus solar power for residential use that commenced from 2009 will be coming successively to an end from 2019, and we are confronted by the so-called "2019 problem" of needing to find new buyers for this surplus electricity. To achieve our goal for 2030 and ensure the continued widespread use of renewable energy even after 2030, it is necessary to consider measures for the sustainable growth of renewable energy in a time when the feed-in tariff (FIT) system, including solar power for residential use, is coming to an end.

When in operation, renewable energy sources incurs a significantly lower cost, including maintenance cost, than other sources such as thermal power generation. As such, renewable energy sources can generate electricity for the purpose of making profits, regardless of the market conditions in the fuel market. In Europe and the United States, low operational costs and priority power supply as a result of preferential policies for renewable energy have contributed to a massive influx of electricity generated through renewable energy sources into the market. This has eased supply and demand, bringing down wholesale market prices and leading to a situation where prices are negative (Ministry of the Environment, 2015[2]). With regard to this effect of relying on renewable energy to bring down market prices, Sensfuß et al. (2007)[3] have pointed out that prices fall as a result of the shift in the power supply curve, brought about by the expansion in renewable energy supply. This in turn makes more the benefits to consumers than raises the policy cost related to providing renewable energy subsidies. On the other hand, the fall in wholesale market prices is also becoming a factor obstructing investment in power generation facilities. Nagai et al. (2016)[4] estimated the average wholesale power market price for one week in January 2030 to be 6.75 yen/kWh, and pointed to the possibility that sufficient investment may not be put into power generation facilities in order to ensure long-term adequacy. The Fujii-Komiyama Laboratory (2016)[5] estimated each price point to be approximately 5.6 – 6.7 yen/kWh in 2030. These price levels fall

*The Institute of Energy Economics, Japan
Electric Power Industry & New and Renewable Energy Unit
Inui Building Kachidoki, 1-13-1 Kachidoki, Chuo-ku, Tokyo 104-0054

This article is a presenting at the 35th Conference on Energy, Economy, and Environment that Japan Society of Energy and Resources (JSER) hosted.

below the target cost [1] for renewable energy in 2030. Furthermore, Asano et al. (2016)[6] have reviewed Europe's renewable energy promotion policy, and estimated that the mass introduction of renewable energy in Japan would push down the kWh value of renewable energy itself by 2 yen/kWh. The author (2016)[7] has also pointed to the possibility that wholesale market prices may slump as a result of the mass introduction of renewable energy, leading to a lack of replacement investment in solar power generation, particularly. This study focuses on the possibility of a decline in additional or replacement investment in power generation facilities due to future slump in wholesale market prices or a fall in the value of renewable energy itself, with the growth of renewable energy. Using the power generation mix model to analyze future wholesale market prices for each region, the author considers the policies and challenge related to sustainable investment in renewable energy.

2. Methodology

2.1 Overview of the analysis

This analysis uses the power generation mix model to estimate future wholesale market prices (hereafter, "wholesale market prices"), and compares it with the expected cost of renewable energy in the future. By doing so, it analyzes the differences in power sources and regional differences in the profitability of renewable energy investment.

2.2 Major assumptions

Taking reference from previous research carried out by the authors[8], the power generation mix and wholesale market prices in each region are estimated based on the following assumptions:

- Target year: 2040
- Target regions: Analysis is carried out for the East Japan and West Japan regions, respectively. In particular, with respect to wholesale market prices, the results are presented for the service areas covered by the Hokkaido Electric Power Company, Tohoku Electric Power Company, and Kyushu Electric Power Company.
- Demand: Demand is assumed to stabilize based on the long-term outlook for 2030. [9]
- Thermal power generation: Accumulation of currently announced plans.
- Nuclear power: Assumption of installed capacity that achieves the market share in the long-term outlook.
- Renewable energy: Expected to increase linearly from the expected installed capacity in the long-term outlook [10].
- Energy prices: Refer to IEA WEO2016[11].
- Batteries: Refer to the NEDO forecast[12] for the cost of storage batteries.
- The following points are taken into consideration in the estimates of wholesale market prices.
  - The maximum value of the marginal cost for each power generator at a certain point in time is taken as the marginal cost for the market, and this is assumed to be the market price.
  - For Hokkaido and Kyushu, market segmentation due to constraints in the interconnection lines between regions is taken into consideration.
  - In cases where surplus electricity is generated in the area, market price is taken to be 0 yen/kWh. [2]
- Cost of renewable energy: Taking reference from government targets for 2030[1], the cost of solar power generation is assumed to be 6 yen/kWh and the cost of wind power generation is assumed to be 8 yen/kWh. In cases where curtailment occurs, the decline in load factors is reflected in the cost.[3]

3. Results and analysis

3.1 Results

The results of the estimation of wholesale market prices and comparison with the expected cost of renewable energy are shown below. According to Figures 1 and 2, solar power generation becomes increasingly widespread in the service area of Hokkaido Electric Power Company, and as there is a strong possibility for market segmentation to occur, market selling price for electricity is expected to be approximately 7.4 yen/kWh, lower than that of other areas. For this reason, profit margin is not large in comparison with the level of the predicted costs of solar power and wind power generation in 2030. As such, there is a possibility that it would be difficult to inject additional investment into these renewable energy sources. Market prices within the service area of Tohoku Electric Power Company is expected to be relatively high at about 9.1 yen/kWh, partly due to the market linkages with the Tokyo area. Gains from the sale of electricity in the wholesale market can also be expected.

[1] With regard to the cost targets for renewable energy for 2030, the Government has set 7 yen/kWh for solar power generation and 8-9 yen/kWh for wind power generation. [1]

[2] When total demand (Power demand + Stored power + Interconnection lines) exceeds total supply (Variable renewable energy (Solar power, wind power) + Fixed power sources (Nuclear power, hydropower, geothermal power, other forms of renewable energy).

[3] In this analysis, the impact of cost related to the imbalance accompanying prediction error is not incorporated as an element of renewable energy cost.

Market prices for the service area under Kyushu Electric Power Company are expected to be higher than prices for the service area under Hokkaido Electric Power Company, and there is also a possibility for profits to be generated if the cost of renewable energy falls. However, as there is a strong possibility for curtailment to occur in the service area under Kyushu Electric Power Company. According to the Agency for Natural Resources and Energy (2018)[13], it is likely for power generation cost per kWh of renewable energy to increase as a result of curtailment. Strictly speaking, while it is also possible to see significant differences in the cost forecast for renewable energy between each region and point, under the assumptions of this analysis, solar power, which costs relatively lower in the comparison with wind power, has higher profitability; looking at the regions, profitability is high in the service area under Tohoku Electric Power Company. In particular, there are also concerns for the risk of curtailment in the service area under Kyushu Electric Power Company, which has already introduced a large volume of solar power. Taking solar power generation as an example, ultimately, in the simple comparison of wholesale market prices and the cost of solar power generation, investment will be more advanced in the Tohoku region than in Hokkaido and Kyushu in 2040.

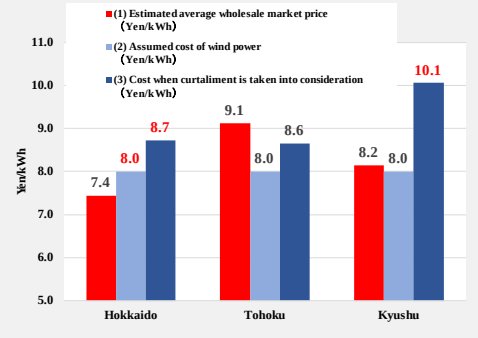

Figure 1 Comparison of estimated average wholesale market prices and cost of wind power

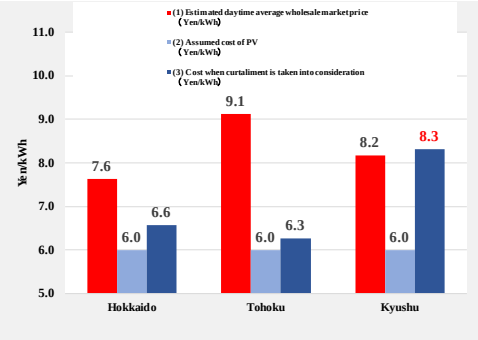

Figure 2 Comparison of estimated daytime average wholesale market prices and cost of PV[4]

[4] Estimated daytime average wholesale market price is the average price from 7:00 – 19:00.

3.2 Discussion

Based on the results described in the previous section, wholesale market prices are sluggish in the long-term and insufficient profits are generated only through the sale of electricity in the wholesale market. There are concerns that there will be inadequate additional investment in renewable energy generation facilities, and the total capacity of such facilities will decline over time. In such cases, it is necessary to introduce some form of policy in order to stimulate the replacement of renewable energy facilities and additional investment.

(1) Overview of representative policies to promote renewable energy

In Europe, policies are increasingly changing direction from FIT to FIP (Feed-in Premium) and auctions.[5] In the United States, renewable energy is becoming increasingly widespread, centered around the Renewable Portfolio Standard (RPS). In Japan as well, since FY2017, auctions are being introduced for large-scale solar power generation and biomass power generation. Other policies to promote renewable energy include tax rebates on investment, subsidies, and carbon pricing. The following provides an overview of the characteristics and issues of the representative policies.

- FIP

For FIP, electricity is sold at a price with an added premium over the market price. For this reason, the profits generated from renewable energy fluctuate depending on the market price. As there is also the possibility of a need for a price setting that incorporates the risk of suppression as a loss of power generation opportunity, accuracy of future forecasts is required when setting the premium.

- Carbon pricing (Carbon tax, emissions trading)

The competitiveness of renewable energy as a form of low carbon energy source is expected to improve as a result of putting a price on carbon. Through system design, it is possible to rebalance low carbonization initiatives not only in the power sector, but also between sectors and with the problem of cost burden across different sectors.

[5] For the details of each policy and the comparison/evaluation, refer to Asano et al.(2016), etc. [6]

Table 1: Comparison of representative policies related to renewable energy investment

	Policy	Merit	Demerit	Main entity taking on the risk	Issues, etc.
Regulation of prices	FIT	Easy to forecast profitability	Difficult to set appropriate prices	Consumers	・Accurate forecast of long-term costs ・Promotes the rebalancing of renewable energy in the case of a unified price
	Carbon pricing (Carbon tax)	Promotes cost-efficient measures across sectors	Possibility of leading to increase in cost for the country overall	Business operators that use fossil fuels Consumers	・Review of tolerable level of burden on the citizens ・Promotes the rebalancing of renewable energy in the case of a unified price
	Subsidies	Can work directly	Ensuring transparency and fairness	Those not eligible for subsidies	・Deciding on the level of subsidies ・Ensuring fairness between technologies
	FIP	Selling price of electricity is tied in with the wholesale market	Difficult to set an appropriate premium in the long-term	Renewable energy power producers	・Accurate forecast of long-term demand and supply ・Promotes the rebalancing of renewable energy in the case of a unified premium
	Auction	Both price and quantity can be regulated	Difficult to set appropriate prices	Renewable energy power producers	・Accurate forecast of long-term demand and supply ・Promotes the rebalancing of renewable energy in the case of a unified price
	Renewable energy value trading	Reflects demand for renewable energy	Instability of trading values	Renewable energy power producers Retail power suppliers	・Grasping long-term trends for renewable energy demand ・Promotes the rebalancing of renewable energy in the case of unified trading
	Carbon pricing (emissions trading)	Promotes the introduction of cost-efficient technology	Unfairness in environmental costs between power sector and other sectors	Fossil fuel power producers Consumers	・Ensuring fairness between sectors ・Promotes the rebalancing of renewable energy in the case of a unified market
Regulation of volume	RPS	Easy to tie in with quantitative policy goals such as long-term forecasts	Instability of prices	Renewable energy power producers Retail power suppliers Consumers	・Accurate forecast of long-term demand and supply ・Review of quantitative goals (promotes rebalancing of renewable energy in the case of unified goals)

- Subsidies

Providing direct support for renewable energy in the form of subsidies is considered to be an easy way of reflecting the intentions of policymakers. However, from the perspective of the transparency of decision-making and the goal of making renewable energy the main source of power, there is room for discussion on continuing to grant subsidies over the long-term.

- Auctions

In auctions, it is possible to set both the price and quantity. It is necessary to grasp an outlook of the future from the long-term perspective, in order to ensure the setting of an appropriate bidding price and recruitment quantity.

- Renewable energy value trading

The spread and expansion of renewable energy is promoted through the direct trading of the value of renewable energy in a form that reflects the market and the needs of customers. As the price at which the value of renewable energy is traded is impacted by the setting of long-term goals by the government and the demand-supply balance of trade, the instability of prices is an issue.

- RPS

The spread of renewable energy is promoted through the setting of targets for the introduction of renewable energy. An issue is that like the trading market, the value of renewable energy is impacted by the setting of long-term targets.

The respective representative policies for promoting renewable energy all have their strengths and weaknesses. Moreover, in the case where a uniform price and adoption target are set nationwide in these policies, taking into consideration wholesale market prices and curtailment risk, it is possible that investments may shift from the regions that are currently experiencing active investment activity, such as Hokkaido and Kyushu, to other regions, and that investments may also shift from high-cost power sources to low-cost power sources. Consequently, changes to the current biases by region and by type of power source may lead to a “rebalancing” in the amount of renewable energy that is introduced. In short, based on the analysis in the previous section, if the cost of renewable energy were to be the same in each region, hypothetically, then there is a possibility of a rebalancing from Hokkaido and Kyushu, where wholesale market prices are relatively low, toward the Tohoku region. With regard to this point, additional analysis is carried out using the example of fluctuations in market prices when carbon pricing is imposed, in particular.

(2) Rebalancing of renewable energy (based on the example of carbon pricing)

Based on the analysis carried out in the previous section, we analyzed market price when a cost of 5,000 yen/t-CO_2 is imposed as carbon pricing, including oil and coal tax on energy prices. The estimated average wholesale market price in the service area covered by Hokkaido Electric Power Company rose from 7.4 yen/kWh to 9.9 yen/kWh, and in the service area covered by Tohoku Electric Power Company from 9.1 yen/kWh to 10.5 yen/kWh. In contrast, the margin of price increase was smaller in the service area covered by Kyushu Electric Power Company, from 8.2 yen/kWh to 8.8 yen/kWh. This is due to the differences in power generation mix in the respective service areas of the power companies. In regions where coal-fired thermal power is the marginal power source, cost increases are greatly impacted by carbon pricing, so market prices increase more significantly. As a result, as shown in Figures 3 and 4, the gap between the power generation cost for renewable energy and its market price increases, and thereby contributes to improving the profitability of renewable energy. Looking at this by region and by type of power source, as the respective degrees of improvement in profitability are different, investment increasingly shifts from areas of low profitability to areas with higher profitability, and in turn stimulates a rebalancing in the introduction of renewable energy.

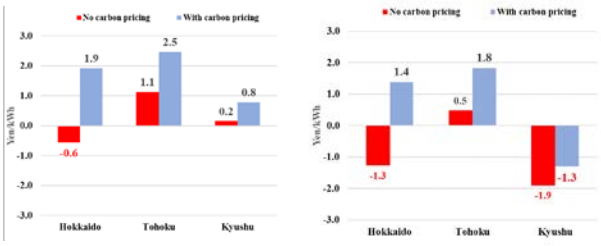

Figure 3 Difference between estimated average wholesale market prices and cost of wind power
（Left: Assumed cost, Right: Cost when curtailment is taken into consideration）
(Carbon price: 5,000 yen/t-CO2)

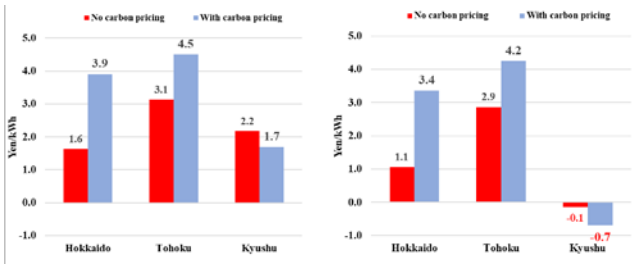

Figure 4 Difference between estimated daytime average wholesale market prices and cost of PV
（Left: Assumed cost, Right: Cost when curtailment is taken into consideration
(Carbon price: 5,000 yen/t-CO2）

As seen from the above, as power generation mix and demand-supply balance differ between each region, in the case where a policy that uses a uniform indicator nationwide for price and quantity, including carbon pricing, is introduced, it may promote rebalancing in the regions where renewable energy is introduced as well as the technology that is introduced. Taking this into consideration, the merits and demerits, as well as issues, of the post-FIT policy can be summarized as shown in Table 1.

To achieve the widespread use of renewable energy in the long-term, it is necessary to move forward on the appropriate replacement of facilities, as well as invest in additional facilities, even after the contract period of FIT has ended. However, due to distortions in the current market accompanying the spread and expansion of renewable energy, as well as uncertainty in the future outlook, there is a risk that sustainable investment will not be carried out only with the continued fall in the cost of renewable energy. As a result, many of the facilities that are currently in operation will be abandoned without being managed appropriately, such as replacement, and the shift of investment to other regions and other renewable energy sources could lead to rebalancing. In order to achieve sustainable investment in renewable energy, it is necessary to engage in a detailed review of the policies that can be effective, from the perspective of fairness in burden, rationality, and the effective utilization of locations that have already been developed. For future analysis, it is necessary to incorporate issues such as reflecting regional differences in the cost of renewable energy, as well as the impact of imbalance, which was not addressed in this analysis.

4. Conclusion

This analysis focused on the approach of post-FIT policies with regard to the spread and expansion of renewable energy. In Japan, FIT has significantly stimulated the introduction of renewable energy. Countries other than Japan area already making the transition from FIT to other policies, and Japan has also just changed direction from FIT toward auctions. Discussion is ongoing about the 2019 problem of how to deal with renewable energy after the contract period comes to an end, but an even larger scale of renewable energy contract period will be ending from around 2032. This analysis shed light on the possibility of sluggish wholesale market prices in the future, as well as the possibility of the emergence of regional differences in wholesale market prices. On top of that, it also set out the risks related to investing in renewable energy and the possibility of rebalancing by region and by type of power source. In order to realize sustainable investment in renewable energy, it is expected that policies will promote the appropriate rebalancing and eliminate distortions, and harness market forces to build a desirable energy system for the country as a whole.

References

1) Cabinet Decision; “Strategic Energy Plan” (2018)
2) Ministry of the Environment; “FY2014 Report on the outsourced Verification and Review on the Possibility of Promoting a Decentralized Energy System such as Renewable Energy by 2050”, (2015)
3) Sensfuß F. et al; “Energy Policy”, 36-8, (2007), pp.3086-3094
4) Yu Nagai et. al.; “A Quantitative Evaluation on Securing Adequacy Based on the Premise of Long-term Energy Demand and Supply Outlook”, Discussion Paper for the Socio-Economic Research Center, Central Research Institute of Electric Power Industry SERC16001, (2016)
5) School of Engineering, The University of Tokyo, Fujii-Komiyama Laboratory; Report on the Study for the Industrial and Economic Research Outsourcing Program (Simulation Using a Power Demand and Supply Model), (2016)
6) Kenji Asano et. al.; “An Analysis of Renewables Market Integration Policies in the European Liberalized Electricity Market”, Research Report for the Central Research Institute of Electric Power Industry, Y15022, (2016)
7) Yu Nagatomi; 8-3-3 “A rapid growth of renewable energy and challenges of replacement of photovoltaic facilities under the renewable energy support scheme”, Proceedings of the 25th Annual Conference of The Japan Institute of Energy, (2016), 208-209.
8) Yu Nagatomi et. al.; “Analysis of Post-2030 Power Generation Mix with an Analysis Model Considering Control Reserve and Policy Implications” , Proceedings of the 34th Conference on Energy, Economy, and Environment, (2018), 7.
9) Agency for Natural Resources and Energy; Materials on Long-term Energy Demand and Supply Outlook, (2015), 63
10) Cross-Regional Systems Development Committee; Materials from the 18th Meeting of the Cross-Regional Systems Development Committee, (2016)
11) IEA; World Energy Outlook 2016, (2016)
12) NEDO; NEDO Technological Development Roadmap for Secondary Cells 2013, (2013)
13) Agency for Natural Resources and Energy, METI; Materials on the “Recommendations by the Round Table for Studying Energy Situations – Initiatives for Energy Transitions”, (2018)