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Feed-in Tariffs in Japan: Five Years of Achievements and Future Challenges

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About Renewable Energy Institute

Renewable Energy Institute is a non-profit think tank which aims to build a sustainable, rich society based on renewable energy. It was established in August 2011, in the aftermath of the Fukushima Daiichi Nuclear Power Plant accident, by its founder Mr. Son Masayoshi, Chairman & CEO of SoftBank Corp., with his own resources.

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Introduction

Purpose of this report

Energy systems that depend on fossil fuels and nuclear power generation face various risks. Continued dependency on fossil fuels will worsen the atmospheric environment of the planet and cause climate change. At the same time, the country will have to rely on external sources of supply, meaning a continuous exposure to risks of global fuel price volatility. In addition, nuclear power generation is associated with risks of severe accidents, while the issue of nuclear waste disposal has yet to be solved. These factors lead to negative impacts and pose risks to the entire society, yet they are not appropriately internalized in the price of electricity and remain “hidden costs” (social costs). Continued reliance on these conventional energy sources, while neglecting social costs, is making Japan’s energy system vulnerable.

Reducing these social costs associated with energy use and making the system less vulnerable are the major challenges for the energy policies in Japan, particularly after the nuclear accident of Tokyo Electric Power Co. (TEPCO)’s Fukushima Daiichi Nuclear Power Plant in March 2011.

Renewables can be purely domestic energy resources that contribute to energy security. They do not emit additional carbon dioxide (CO_2) in the generation stage. Furthermore, the development of these energy resources is expected to contribute to the growth of related industries and job creation in Japan.

Against these backdrops,[1] the Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities (hereinafter the “Feed-in Tariffs (FIT) Act”) was passed unanimously as a result of a political agreement across the ruling and opposition parties in August 2011.

By the end of June 2017, five years have passed since the enforcement of the FIT Act in July 2012. How have the renewable energy situation in Japan changed under the FIT Act? This report has compiled the main findings concerning achievements, challenges, and future prospects of the FIT scheme in Japan.

The role of the FIT scheme as a policy

To begin with, what role does the Feed-in Tariff scheme (hereinafter referred to as “FIT”) play? Here we place the role of renewable energy support schemes, including FIT, as follows. Costs of renewable energy sources are high during the initial stage of deployment. When social costs of conventional energy sources are not assessed economically, economic advantages of renewable energy cannot be found. As a result, private investment will be limited, and deployment will remain low. In this case, the scale of production will be small and related industries will stay immature, inevitably keeping the cost high. Consequently, deployment will remain slow, creating a vicious cycle.

The role of renewable energy support schemes is to break this vicious cycle. In the case of FIT, the government sets procurement conditions of renewable electricity (period and price) and obliges the utilities to purchase it. These schemes reduce the risk of failing to recover investment, hence likely to lead to more investment. Moreover, production of associated equipment will expand, related industries will grow, and cost reduction will be achieved.

By implementing the renewable energy support policies in the initial stage of deployment, the gradual cost reduction will eventually enable renewable energy to compete over time in the electricity market against conventional energy sources, inclusive of social costs, without any particular policy support. Therefore, critical points of assessment would be whether the cost is reduced through the policy support, and whether renewable energy is able to stand on its own feet in the market in the future. Managing the cost of the policy as a whole is also an important point.

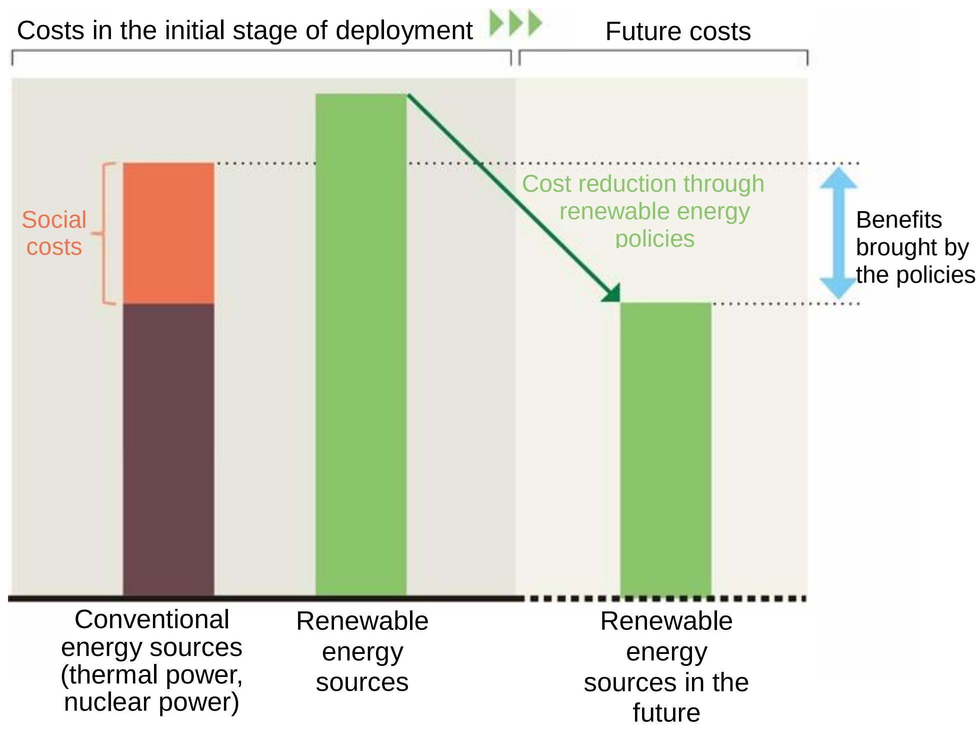

Figure 1 The role of policies accelerating renewable energy deployment

The Results of the FIT Over the First Five Years

Accelerating deployment – the road has been opened toward making renewable energy a main energy source

Renewables have expanded rapidly under the FIT Act. Electricity purchased under the FIT in fiscal year (FY) 2016 reached 57.0 TWh.[2] However, this figure includes electricity from the facilities that were deployed on or before FY2012, which have been changed to approved installations under the FIT Act.[3] Meanwhile, part of the electricity produced by residential solar PV approved under the FIT Act is used for self-consumption; this proportion for self-consumption is estimated to be 1.6 TWh. Added together, renewable power amounts to 58.6 TWh, which is equivalent to the annual electricity consumption of all households in the Kanto region comprising Tokyo and six other prefectures (approx. 18.89 million households).[4]

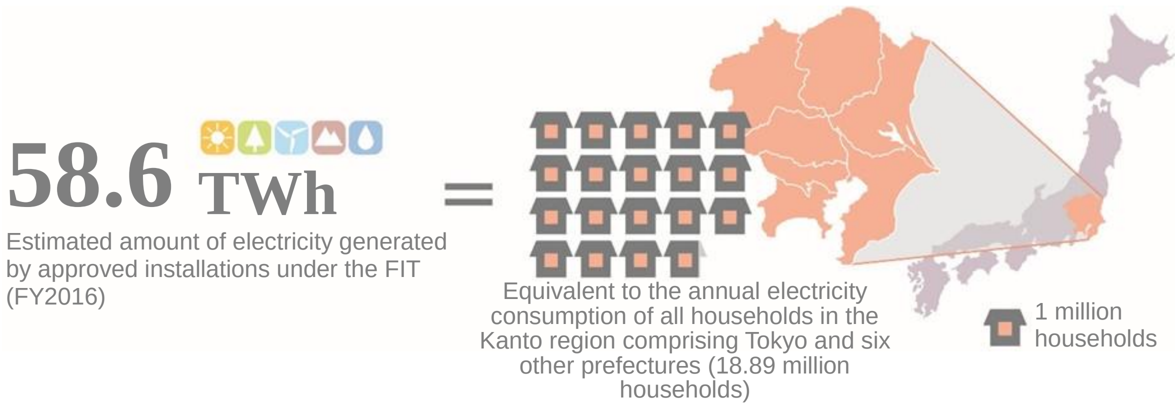

Figure 2 Estimate of electricity generated by FIT registered installations in 2016[5]

Large-scale hydro power used to be the main type of renewable energy in Japan. Since there was limited room for further development of large-scale hydro, the amount of renewable electricity generation remained low over a long period of time. However, the FIT Act changed this trend drastically. The share of renewable electricity, which was 9% in FY2011, has increased to as much as 15% in FY2016 (Figure 3), due to the growth of other renewable energy sources. As a result, renewable energy has become the third largest energy source after liquefied natural gas (LNG) and coal. We can judge that the FIT Act has opened new perspectives toward making renewable energy a main energy source.

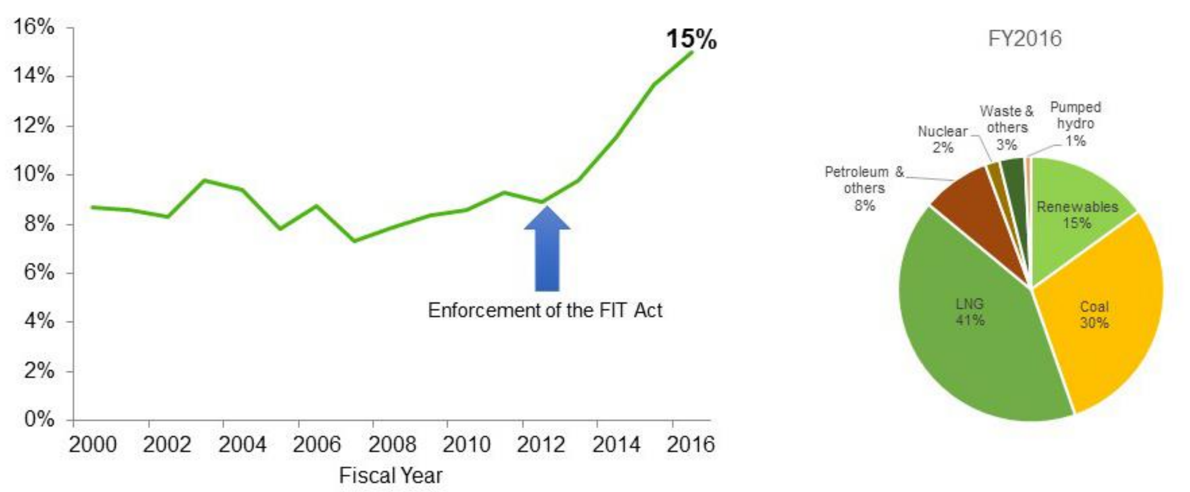

Figure 3 Change in the share of renewable energy in total electricity generated and purchased[6] in Japan

Deployment by energy source – high growth observed except for wind power

When looking at the impacts of FIT in accelerating deployment of each energy source, it will be unfair if we simply compare their installed capacity; because the length of time required for developing power plants differs by energy source, and the quantities of potential resources are not the same. Therefore, we will compare two periods of approximately same length; i.e., after the enforcement of the FIT Act (four years and nine months from July 2012 to March 2017) and the five years prior to the enforcement (from FY2007 to FY2011, under the RPS Act[7] at the time). If the installed capacity after the enforcement of the FIT Act is greater than the installed capacity before the FIT, then we will say that the FIT Act has had a positive impact in accelerating deployment.

Based on this analysis, the greatest impact in accelerating deployment was observed for solar PV. While the installed capacity was 2.68 GW over the five years prior to the FIT, it was 33.50 GW after the enforcement of the FIT Act, 12.5 times the installed capacity of the earlier five years. Although to a lesser extent than for solar PV, other energy sources (medium and small scale hydro, bioenergy, and geothermal) have also seen growth in their installed capacity after the enforcement of the FIT Act, by 1.6 to 7.5 fold compared to the earlier five years. Hence, we can judge that the impact in accelerating deployment has been significant.

Wind power was the only technology that recorded lower installed capacity compared to the earlier five years. While 1.01 GW was installed in the five years prior to the FIT, the amount installed after the enforcement of the FIT Act remained at 0.79 GW. Since FY2012, an environmental impact assessment (EIA) has become mandatory for wind power above a certain scale, which has resulted in longer development period. We believe that this has affected these figures.

Table 1 Comparison of installed capacities

(Five years prior to FIT versus after the enforcement of the FIT Act)[8]

	New installed capacity from FY2007 to FY2011 (GW)	New installed capacity after the enforcement of the FIT Act (GW)	Ratio of installed capacity
	(A)	(B)	B/A
Solar PV	2.68	33.50	12.5
Wind	1.01	0.79	0.8
Geothermal	0.002	0.015	7.5
Bioenergy	0.52	0.85	1.6
Medium and small scale hydro (below 30 MW)	0.06	0.21	3.5

Various effects of large deployment

With the rapid deployment of renewables under the FIT Act, various effects have been observed in the energy industry and market, and in society. Positive impacts will be discussed first, followed by difficulties.

(1) Declining generation cost

Generation cost of electricity has declined as renewable energy has expanded. Five years after the enforcement of the FIT Act, the three types of energy source with relatively large installed capacity; namely, solar PV, onshore wind power, and general woody biomass, have seen their generation cost (levelized cost of electricity) reduced, although at different magnitudes. However, factors contributing to the reduction of the generation cost differ by energy source.

In the case of solar PV, the generation cost has fallen by about 38% regardless of scale. The main contributing factor is the declining capital cost, due to the fall in the price of equipment such as PV modules and construction costs, associated with economies of scale and competition.

The capacity factor of onshore wind power is also improving overall, despite its slow deployment. This has been due to the progress in deployment in Tohoku and other regions of favorable wind conditions after the introduction of FIT, improvement in maintenance, and other factors. Capital cost is also declining for facilities of 7.5 MW or more. As a result, the generation cost has declined by 29%.

In terms of woody biomass, the scale of power plants has become larger than the initially assumed 5 MW range. The average installed capacity of the facilities deployed in one year in 2016 was 19 MW. As a result, thermal efficiency of power plants has improved, and the generation cost is estimated to have been reduced by 16%.

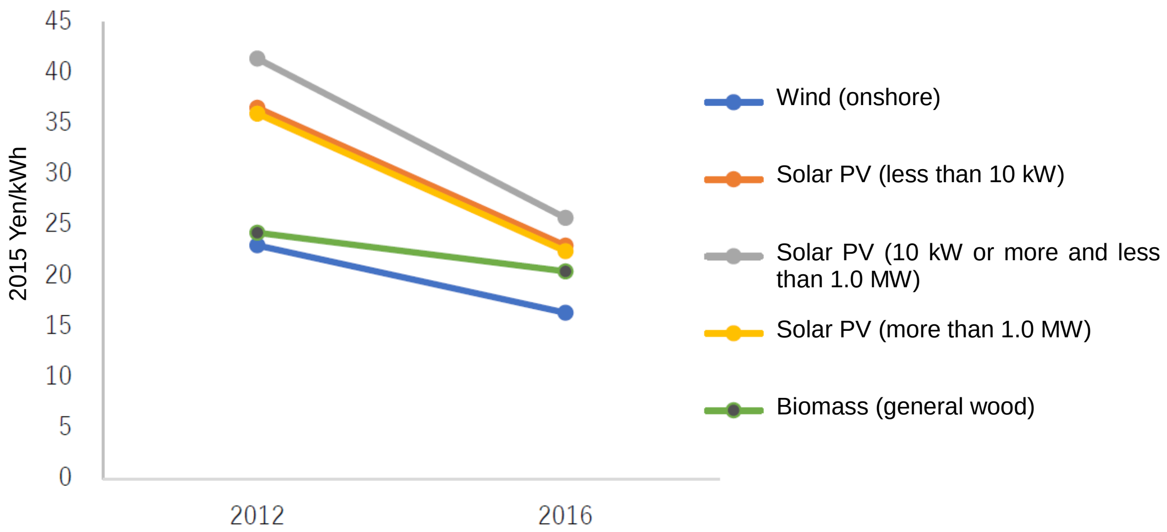

Figure 4 Estimated generation cost of electricity by energy source[9]

(2) Contribution to CO_2 emission reduction

The electricity sector (including on-site generation) is the largest CO_2 emitting sector in Japan, accounting for about 40% of total CO_2 emissions.[10] Especially after the accident of the Fukushima Daiichi Nuclear Power Plant, CO_2 emissions from the electricity sector rose temporarily with the shutdowns of nuclear reactors. However, CO_2 emissions associated with power generation have continually declined since FY2013 due to rapid deployment of renewable energy under the FIT Act, in addition to the progress in energy savings and efficiency.

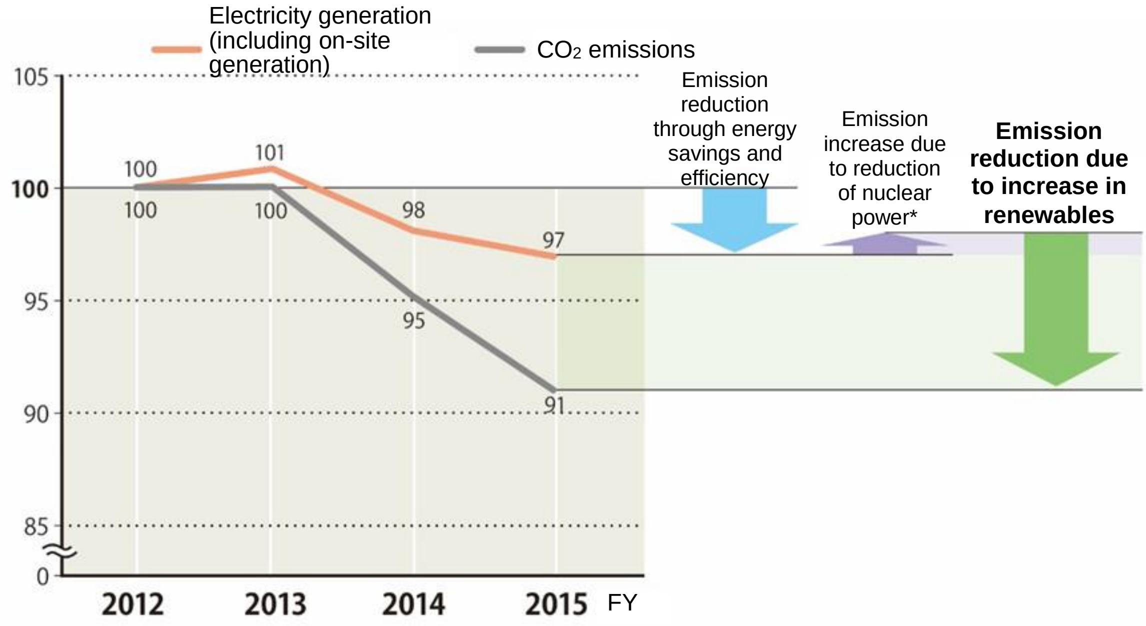

Figure 5 The impact of renewable energy sources on CO_2 emissions reduction[11]

* FY2012 has been set as the base year here to see the impact of the FIT Act. It must be noted that the amount of electricity generated by nuclear power was 15.9 TWh in FY2012, and many nuclear power plants had been shut down already. Also, although the reduction due to energy saving was most significant in FY2011, the year the Great East Japan Earthquake occurred, the figure does not show the portion for FY2011 as it starts from FY2012.

When looking at the change in CO_2 emissions associated with power generation while setting FY 2012, the year the FIT Act was enforced, as the baseline (100), emissions in FY2015 are lower by 9 points. Since the total amount of electricity generated declined by 3 points during the same period, the remaining 6 points can be considered to be due to the change in electricity mix.

Concerning the electricity mix, the amount of electricity generated by nuclear power in FY2015 declined by 6.5 TWh compared to FY2012, which has contributed to increasing CO_2 emissions. Meanwhile, generation by renewable energy has increased by 39.1 TWh during the same period, which can be said to have contributed significantly in reducing CO_2 emissions in the electricity sector.

(3) Reduction in the wholesale electricity price due to the merit-order effect

The wholesale electricity price during the daytime period does not rise easily in recent years, due to the expansion of renewable energy deployment, and solar PV in particular. The upper graph in Figure 6 shows the average wholesale electricity prices in FY2011 and FY2016 by time periods (1 unit = 30 minutes; 48 slots per day). Prices in FY2016 are generally lower than in FY2011. The main factor causing this decline is considered to be the lower cost of fuel for thermal power plants, which is due to the decline in crude oil prices.

The lower graph in Figure 6 shows the price difference between FY2016 and FY2011. The wholesale electricity prices show a significant decline, particularly during the daytime period. This is considered to be the effect of rapid deployment of solar PV. In principle, in the wholesale power market, electricity is arranged in order from those with lowest marginal costs (variable costs). The wholesale electricity price is determined by the variable cost of the power plant that fills the final portion of demand. Solar PV and wind power have close to zero variable costs and should therefore always dispatch first from a cost optimization perspective. By generating massive amount of electricity from these energy sources, thermal power plants with high variable costs are gradually pushed out from the market. Accordingly, wholesale market price of electricity declines as energy sources with no variable costs increase. This is called the "merit-order effect." The wholesale electricity price has actually declined significantly in Germany associated with the significant expansion of renewable energy deployment. While the decline in wholesale electricity price due to the merit-order effect might be a threat for conventional power producers, particularly, it would be beneficial to electricity consumers.

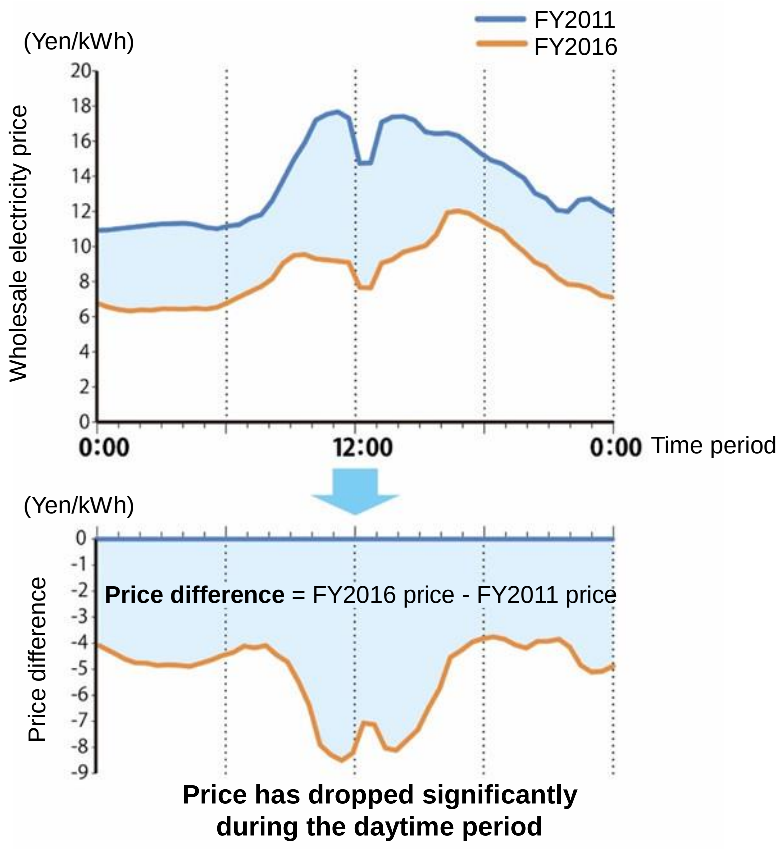

Figure 6 Comparison of average wholesale electricity price in FY2011 and FY2016 by time periods[12]

(4) Renewable energy industry showing steady growth

The renewable energy industry is also scaling up along with wider capacity deployment. Jobs created in relation with the construction, operation, and maintenance of renewable electricity facilities in 2016 are estimated to have reached about 365,000 persons/year (Figure 7). This figure includes not only the jobs directly required for construction and services related to areas such as operation and maintenance, but also other jobs required for producing materials and parts, associated equipment, and services of facilities.

Solar PV provided jobs for about 299,000 persons, which was the greatest among various types of renewable power. Woody biomass followed, providing jobs for 45,000 persons. Bioenergy has the nature of providing a great number of jobs at the stage of operation. However, the future increase in domestic jobs may become limited, as the ratio of woody fuel imported from abroad is expected to rise.

The number of jobs at the construction stage may fall in the future, associated with the decline in the capital cost. However, the scale of the industry is expected to remain steady or expand sustainably along with accelerated renewable energy deployment, as operation and maintenance jobs will be created continuously.

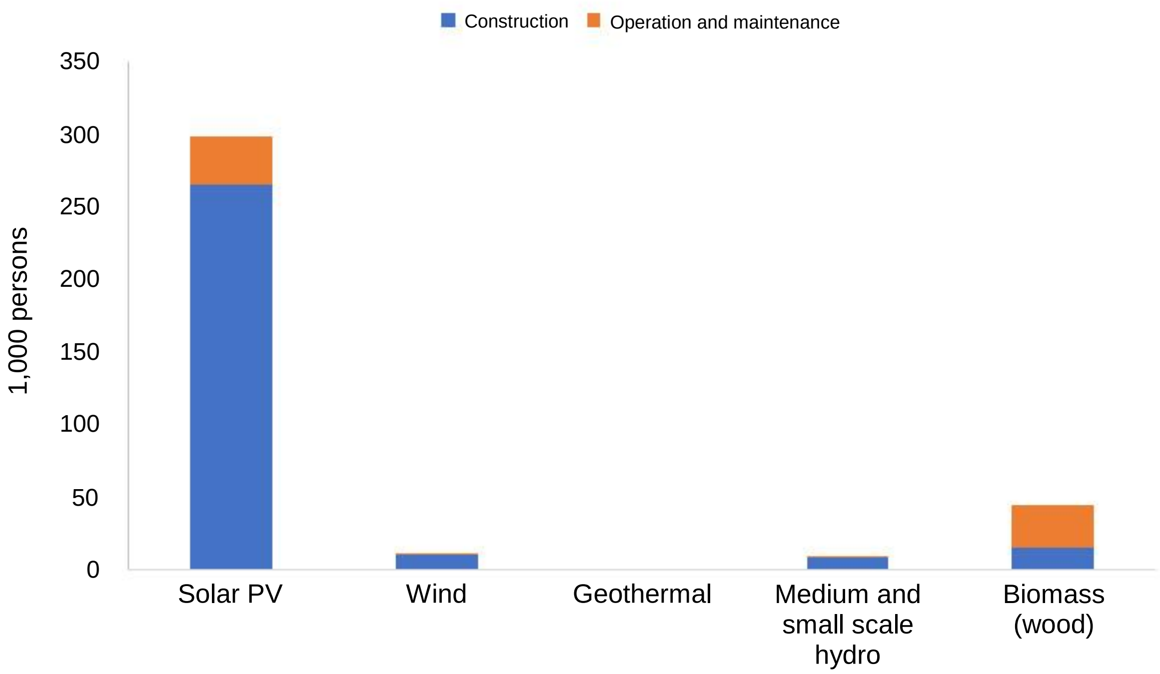

Figure 7 Estimated numbers of jobs in 2016 by energy source[13]

(5) Diverse entities joining the energy business

Prior to the introduction of the FIT, it may have been a general understanding that power generation business is for large companies with big power plants. However, a large number of entities are joining power generation business with the introduction of the FIT and progress of electricity system reform.

First, the number of corporations involved in power generation business has drastically increased.[14] The average number of newly established electricity suppliers prior to the introduction of the FIT (between 2009 and 2011) was only 39 corporations per year. Compared to this figure, the average number of newly established corporation has reached 1,973 per year after the introduction of the FIT (between 2012 and 2016), which is a 51-fold increase. The accumulated number since 2012 has reached 9,864, 91 percent of which are corporations related to renewable energy.

Secondly, not only the initiatives by corporations but also those conducted by communities and citizens have become active. The number of groups nationwide involved in power plants set up by citizens or communities have almost doubled from 115 in 2013 to 200 in 2016, and the number of power plants has grown to 1,028.[15] These power plants are set up by citizens or communities, receiving capital investment and other support from a broad range of citizens. So the actual number of citizens involved through investment and other means is likely to be even larger.

Thirdly, the number of households that install solar PV in their houses has steadily increased. According to the Japan Photovoltaic Energy Association, the number of households that have installed residential solar PV has reached 2.05 million by the end of 2016.[16] This is equivalent to about 8% of all stand-alone houses.

As described above, it has become possible for many corporations and citizens to set up power generation facilities and be engaged in power generation business. This indicates not only that the facilities themselves have become distributed but also the entities involved have become distributed and diversified.

Additional burden of expenses and the impact on the unit cost of electricity

While various positive impacts of the policy are being observed as described above, additional burden of expenses are being placed on electricity consumers. Here we must be careful in defining what a "burden" means. Total expenditure for the procurement of renewable electricity under FIT is often described as a "burden," but this is misleading. Procurement of electricity does involve expenditure, whether it's renewable electricity or not. The portion of the expenditure for renewable electricity under FIT, which is an additional burden of expenses, must be clarified.

What is an additional expense under the FIT Act? It is the difference between the expenditure for renewable electricity under FIT and the procurement cost for conventional electricity (avoided costs).[17] This difference is being filled using the surcharge collected from electricity consumers (FIT surcharge), and this portion being filled is called a subsidy. Since the amount of FIT surcharge and that of subsidy are equal in principle, we will call it the surcharge hereinafter.[18]

The surcharge has increased drastically from 0.3 trillion yen in FY2013 to 1.4 trillion yen in FY2016. The following are the two main contributing factors to this increase. First, the expenditure for renewable electricity under FIT has risen because the amount of electricity purchased under the FIT has increased. Second, price of fuel for thermal power plants declined as the crude oil prices dropped during this period, and avoided costs (in per unit terms) declined, linked to this change. As described above, since the surcharge is the difference between the expenditure for renewable electricity under FIT and the avoided costs, the decrease in the avoided costs led to the increase in the surcharge.

In any case, it is true that additional burden of expenses associated with the FIT Act has kept increasing, which is preferred to be modified if possible. Hence, proper management of the system as well as maximum efforts toward reducing power generation cost are necessary, as described later in this report.

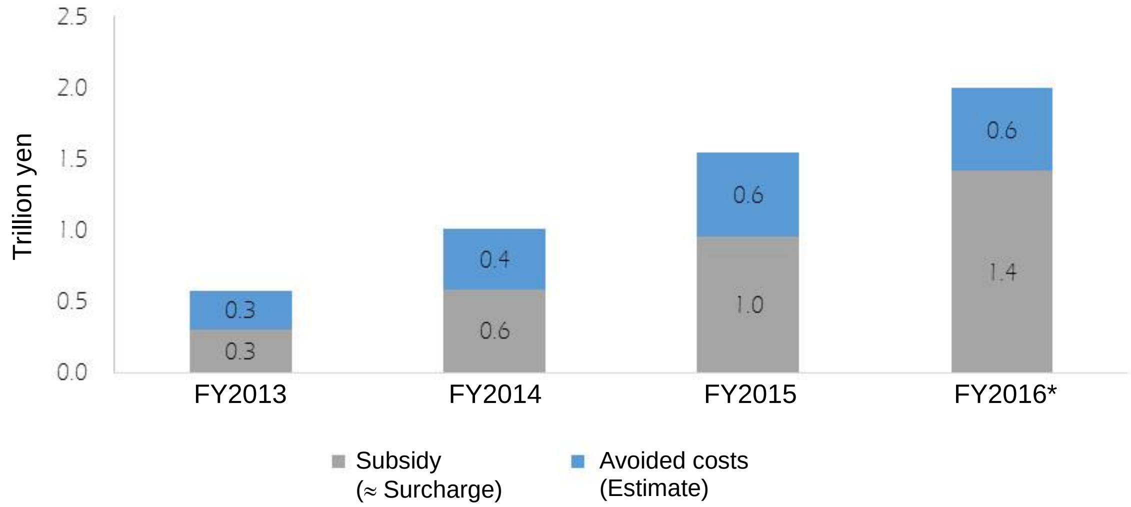

Figure 8 Change in the amount of subsidy and avoided costs under the FIT Act[19]

The point often overlooked in the discussion concerning the additional expense associated with the FIT is the existence of factors other than FIT that significantly affect the unit cost of electricity. Here we define the unit cost of electricity as the cost for generating, transmitting, distributing, and selling 1 kWh of electricity. This includes the costs related to power plants owned by the company, and also the costs to procure electricity from other companies, cost of transmission and distribution of electricity, selling and administration expenses, and taxes. Electricity charge includes profit (or loss) of utilities in addition to the above-mentioned costs.

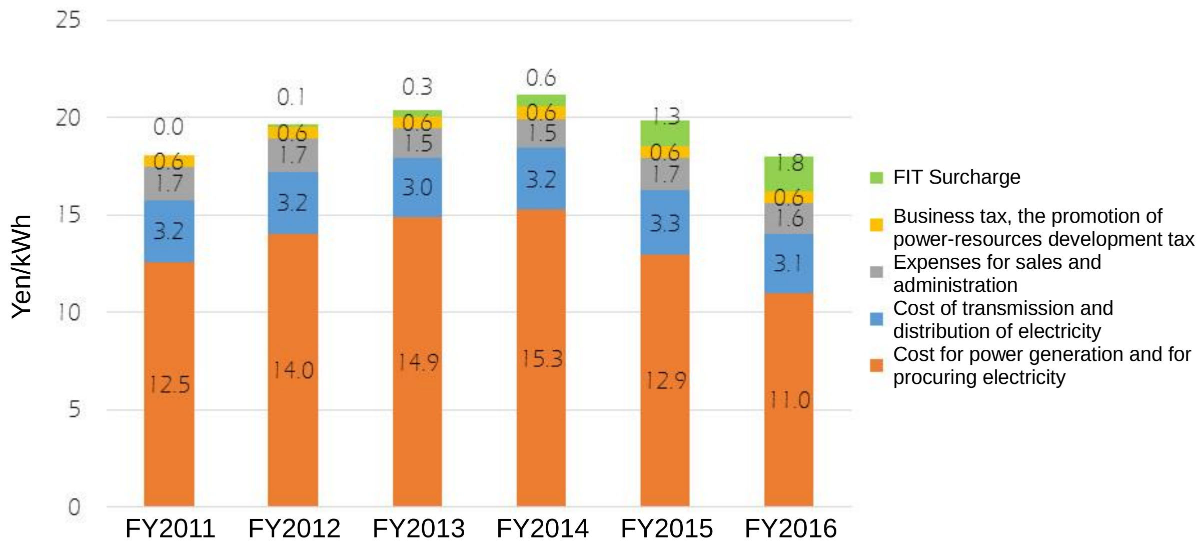

Figure 9 Weighted average unit cost of electricity of the ten major utilities (former General Electricity Utilities)[20]

As shown in Figure 9, the unit cost of electricity of the ten major utilities (former General Electricity Utilities) in FY2016 remained at almost the same level as in FY2011, the year prior to the introduction of the FIT Act, despite the rise in FIT surcharge. This is due to the drastic reduction of the "cost for power generation and electricity procurement." This may be explained by the drop of fossil fuel prices, as well as the decline in the amount of electricity generated from thermal power plants due to the expansion of renewable energy deployment, which resulted in lower fuel cost that offset the increase of FIT surcharge.

In fact, fuel cost of thermal power plants has a stronger impact on the unit cost of electricity compared to the change in FIT surcharge. Although power generation cost of thermal power plants of the ten major utilities peaked at 8.9 trillion yen in FY2013, it declined by 4.5 trillion yen in FY2016 to 4.4 trillion yen. Hence the cost of thermal power plants has contributed to reducing the unit cost of electricity by 4.8 yen/kWh.

The increase in FIT surcharge is often viewed as the only concern when discussing electricity charges. However, it must be noted that the change in fossil fuel prices has a far greater impact on electricity charges as described above.

This indicates that the impact of another run-up in fossil fuel prices would be far greater than the impact of FIT surcharge. In such case, renewables will contribute in relaxing the sharp rise of the unit cost of electricity, for the cost of fuel for thermal power plants that must have been purchased can be saved by the amount of power generated by renewable energy sources.

Challenges in coexisting with local communities

Deployment of renewables, mainly solar PV, has been progressing under the FIT Act. Meanwhile, more troubles are occurring with local communities and governments concerning the impact of development on the natural environment, the way projects are implemented, and other aspects. It is said that the causes of troubles related to solar PV include: concerns about the impact on natural and historical landscapes; concerns on disaster management aspects, such as logging and other activities triggering sediment discharge and flood damage; concerns about the impact on the living environment; and concerns related to nature conservation.[21]

Background of the problem

The fundamental issue behind the troubles occurring at local levels is the land-use classification scheme in Japan, which is evaluated as "ambiguous and rigid." While on the one hand there are rigid regulations that restrict development of protection forests and agricultural land, on the other hand, the regulation system is ambiguous, as development is allowed without sufficient consideration on environmental impacts.

Also, the government's system on environmental impact assessment (EIA) sets a stricter condition on wind power plants even compared to thermal power plants, though the latter place a greater load on the environment. Meanwhile, EIAs are not required for solar PV regardless of the scale.

Germany and other leading countries in renewable energy deployment have strict land use planning systems within which there are incorporated mechanisms that enable smooth deployment of renewable electricity facilities, such as the establishment of "areas where development is allowed." The land-use classification scheme in Japan not a "strict yet flexible" one that enables coexistence of nature conservation and promotion of development, and this is the reason behind troubles associated with siting of renewable electricity facilities.

Direction of responses

Central government and local authorities have started to take some practical actions in response to troubles occurring at local levels. First, the government has presented "project planning guidelines" for each energy source under the Revised FIT Act enforced in April 2017 as a mechanism to ensure proper project implementation. The guidelines call for proper communication with local authorities and residents, as well as considerations for local residents, associated with the development. These are only recommendations and not sufficient to stop development of projects that fail to give consideration to local areas. However, a mechanism has been set whereby the registered information of project owners is made public. In addition, improvement orders may be issued or the registration of the project may be cancelled if the points of compliance are not followed. The points of compliance include those at the stage of examination prior to project implementation, those concerning inspection and maintenance during project implementation, and those concerning the removal of facilities after project termination.

Second, local authorities have also started working on guiding development projects to give consideration to local areas; for example, by enacting landscape ordinances, assessment ordinances, installment guidelines, and other measures. In the future, when expanding these efforts, they should preferably encourage renewable energy project owners to build consensus with residents, help the project owners to understand in advance which geographic areas and issues they should take into consideration, and encourage the project owners to deploy renewable energy in a carefully planned way and in harmony with the local community.[22]

Challenges in Operating the FIT Scheme

We have so far explained concisely about the achievements under the FIT Act in five years. Below we point out three major issues concerning operation of the system over the five years.

The rules for facility registration that raised the burden of expenses

The FIT scheme in Japan stipulates that procurement price for each renewable facility is to be fixed when the FIT registration is approved or when application for grid connection is made, whichever occurred later. Nothing was prescribed concerning the deadline for starting operation. When the procurement price was anticipated to get reduced, there has been an incentive for project owners to register before the procurement price fell, even at the stage when the project plan was immature. As a result, a massive amount of applications came in at the very last minute before the procurement price was changed. This led to creating a large amount of "non-operating projects" that retained old procurement prices despite the fall in the generation cost, making the system instable.

The bubble-like market expansion has a problem from the perspective of cost reduction as well. To begin with, project owners aim to maximize their own profits, and so their rushing in at the very last minute before the change in the procurement price is a natural behavior. However, when they crowd over high procurement prices and create a market bubble, the supply and demand of related materials and human resources may tighten, and construction cost may rise or have difficulty falling in the short term, which may create an overall environment that is not optimal.

Thus, the government has introduced various measures since 2014. From April 2015, the timing of determining the procurement price for solar PV has been changed to the time when the grid connection agreement is signed with a grid operator. It has also become a requirement to pay the cost of construction related to grid connection within a certain timeframe after signing the grid connection agreement, and to start operation prior to the expected date of entering into the agreement. Through these requirements, the time when the procurement price is determined and when the operation starts have become tied to a certain extent. This mechanism has been extended to renewable energy sources other than solar PV under the revised FIT Act enforced in April 2017, and there is a new provision for solar PV (with grid connection agreements dated August 2016 and after) requiring them to start operation within a certain timeframe after the registration of the project plan. With these requirements, conditions for securing a procurement price have become stricter, including the preparation of a proper project plan and entering into a grid connection agreement with an electricity transmission and distribution company. Hence, it has become difficult for project owners to obtain an approval for registration at the very last minute before the procurement price goes down.

However, rushing in at the very last minute may still occur under the revised FIT Act, since one can do so if it is possible to have some idea on the time required to obtain a grid connection agreement, and to foresee the timing of the change in the procurement price. Foreseeability is high particularly for energy sources for which procurement prices are set for several years into the future. Therefore, a system must be designed in such a way that last-minute rushing in would not occur, or that problems would not be found even if such rushing in occurred.

The rule of unlimited curtailment without compensation has great negative impacts

Under the FIT Act Enforcement Regulation in Japan, grid operators(*) can enforce curtailment against renewable electricity producers without compensation up to 30 days per facility per year to balance supply and demand, and are obliged to compensate for curtailment over 30 days. Further, grid operators are allowed to refuse connection agreements when curtailment is anticipated to go over 30 days. Just 6 month after the enforcement of the Act, the government approved that the balancing area of Hokkaido Electric Power Co. might need curtailment over 30 days, which meant that Hokkaido Electric Power Co. could refuse further grid connection agreements. In order to encourage the grid operating utilities to accept more connections, the government added a tentative rule to allow uncompensated curtailment for more than 30 days against generation facilities newly connected to the grid.

This tentative rule was formalized later. An 'Acceptable Capacity (now called the Compensated Capacity for Curtailment over 30 days)' was set for each area, and the utilities likely to get grid connection applications exceeding the 'acceptable capacity' would be approved as 'designated electricity utilities', allowed to enforce unlimited curtailment without compensation.

However, the scheme of unlimited curtailment without compensation carries the following two problems.

First, the development of new energy sources becomes extremely risky in regions where unlimited curtailment without compensation is applied, and financing will also be affected. As a result, development may be stopped or financing cost may become high, even when high-quality resources are available.

Second, utilities would have incentives to set the Acceptable Capacity as low as possible, rather than to minimize curtailment, because curtailment is allowed without any limitation or compensation for the connections above the Acceptable Capacity. As grid operators, they should be encouraged to improve the accuracy of predicting the variable renewable power sources and to make investment to avoid curtailment, but they are incentivized to move in an opposite direction.

To solve these issues, curtailment should neither be unlimited, nor without compensation. Rather, curtailment of solar PV and wind power should be considered one of the adjustment factors, and curtailment should be done on a chargeable basis. It is important to aim for effective use of this adjustment factor. More specifically, curtailment of solar PV and wind power should be allowed to be exchanged in the market as an adjustment factor, through which a chargeable and more flexible use will be expected. Market-based curtailment of solar PV and wind power is already implemented in European countries, including the United Kingdom, Denmark, and Spain, and in power transmission control areas in the United States, including Electric Reliability Council of Texas (ERCOT), New York Independent System Operator (NYISO), and Midcontinent Independent System Operator (MISO).[23]

* In Japan, 10 conventional utilities or their affiliated companies serve as grid operators of their respective service areas. Hokkaido Electric Power Co., Tokyo Electric Power Co., Chubu Electric Power Co., and Kansai Electric Power Co. mentioned in this chapter, are among those 10 utilities.

Detailed analysis is required for calculating procurement prices

Procurement prices of each energy source are discussed at the Procurement Price Calculation Committee. However, the basis of discussion is the average and median values of the capital cost or cost of operation and maintenance, and the discussion does not go into details of cost breakdown. Therefore, it is not possible to understand the factors behind the change of cost. For example, the capital cost can be broadly divided into: (1) costs related to equipment; (2) construction costs; and (3) development costs. In principle, the relevance and predictions of costs related to equipment can be discussed and verified by comparing them with international prices. For construction costs, it is possible to assess whether the amount is relevant by looking into statistical data on labor costs, price of materials, and other factors.

Under the revised FIT Act, in particular, it is becoming a requirement to set a long-term price target and to calculate values such as procurement prices for several years into the future. It has become extremely difficult to predict future costs from the sum of the capital cost and cost of operation and maintenance alone, which has been the practice so far. Therefore, a detailed analysis by expenditure category as mentioned above has become essential.

In addition, the analysis should not rely solely on interviews of industrial associations. Rather, third party organizations (research institutions) or other entities should be engaged to study the current generation cost and future potentials by energy source, and such studies should be used as reference as well. In fact, a third party organization conducted a study in Germany prior to revising the law, which looked into market trends and cost trends of each energy source. The study report was used as a basis for designing a system, setting prices, and for other purposes.

Future Prospects: Projections of the FIT surcharge

We have discussed the achievements and challenges found in the five years of FIT enforcement. As a final point, we provide an outlook of the future additional burden of expenses, which is one of the biggest challenges in accelerating large deployment of renewable energy in the years to come. Negative views exist on the expansion of renewables itself, based on the rapid increase in the FIT surcharge in the five years after the enforcement of the FIT Act.

However, as described earlier, we cannot see the forest for the trees, if we just focused on the change in the FIT surcharge. As we have shown in our analysis of the unit cost of electricity since FY2011, the change in the fuel price of thermal power plants has a greater impact on the unit cost of electricity, compared to the change in the FIT surcharge. Also, the change in the fuel price of thermal power plants affects the FIT surcharge itself in the form of avoided costs.

In order to study the impact of the increase of renewable energy on the unit cost of electricity in the future, we have to look into the trend of the unit costs of power generation and electricity procurement (i.e., wholesale electricity price) in addition to the FIT surcharge. Here, we will estimate the FIT surcharge and wholesale electricity price in FY2030. For this purpose, we developed a simple supply and demand model covering all of Japan, and run a simulation to estimate wholesale electricity price based on the principle of short-term marginal cost pricing and assuming installed capacity and other figures for each energy source in FY2030. However, this simulation does not consider the restrictions related to regional interconnections.

Assumptions for the estimations

In making estimations, we assumed two scenarios each for the future change in fossil fuel prices and for installed capacity of renewables, and came up with the following four scenarios by combining them.

We set two different assumptions for fossil fuel prices using IEA's World Energy Outlook 2016 as a reference. One is the "New Policies Scenario," which is a medium scenario concerning fossil fuel prices. The other is the "450 Scenario," under which progress is made on de-carbonization. This is a low fuel price scenario in which the demand for fossil fuels drops and their price increase is controlled.

Table 2 Estimation scenarios of FIT surcharges and wholesale electricity prices

		Assumptions on renewable energy	
		Long-term Energy Supply-demand Outlook, 2015	Promotion of deployment/ cost reduction
Assumptions on fossil fuel prices	IEA WEO2016 New Policies Scenario	Low renewable energy, medium fuel price	High renewable energy, medium fuel price
	IEA WEO2016 450 Scenario	Low renewable energy, low fuel price	High renewable energy, low fuel price

We set two assumptions for renewable energy. The first is the low renewable energy scenario, for which the outlook of the deployment of renewables is determined using the Long-term Energy Supply-demand Outlook of 2015 as an assumption and also referring to the latest amount of facilities approved under the FIT scheme. Under this scenario, the amount of electricity generated by renewables will be 25% of the total in FY2030.

The second is an assumption for the case in which deployment of renewables progresses further while reducing costs (high renewable energy scenario). Since the remaining capacity for development is high, especially for solar PV and wind power, we used the target figures provided by the Japan Photovoltaic Energy Association and the Japan Wind Power Association. Meanwhile, we assumed that the installed capacity of general woody biomass will be controlled in consideration of resource restrictions within and outside of the country, and other factors. Under this scenario, the amount of electricity generated by renewables will be 34% of the total in FY2030.

Table 3 Assumptions for the scenarios

<table>
<tr><th>Name of the scenario</th><th>Low renewable energy scenario</th><th>High renewable energy scenario</th></tr>
<tr><td>Amount of electricity generated from renewables in FY2030 (Ratio)</td><td>262.5 TWh
(25%)</td><td>364.8 TWh
(34%)</td></tr>
<tr><td rowspan="3">Assumptions on installed capacity</td><td>The Long-term Energy Supply-demand Outlook of 2015 is used as an assumption. In cases where the registered capacity already exceeds the outlook, the exceeding figure is used instead.</td><td>Target figures for FY2030 provided by the industrial associations have been adopted for solar PV and wind. Figures from the Energy Supply-demand Outlook are used for other energy sources.</td></tr>
<tr><td colspan="2">Solar PV of 10 kW or more: Among the facilities registered by FY2016, those in operation are assumed to be 50 GW.</td></tr>
<tr><td colspan="2">General woody biomass: While the last-minute registration in March 2017 is said to have been 6.32 GW, we assumed that only 2 GW would start operation, in view of the amount of domestic resources and the amount that can be imported from abroad. Adding the existing capacity, the figure for FY2030 was assumed as 7.98 GW.</td></tr>
<tr><td>Assumptions on procurement prices</td><td>Procurement price for solar PV and onshore wind power are gradually brought down toward the long-term price target.
The latest prices are retained for other energy sources.</td><td>Procurement price for solar PV and onshore wind power are gradually brought down toward the long-term price target.
General woody biomass: Reduced to the price assuming multi-fuel combustion with coal. Registration is controlled in terms of quantity.
Unused woody biomass: Reduced to the price assuming cogeneration.
Procurement price is reduced for other energy sources too, at a fixed rate.</td></tr>
<tr><td>Total generation in FY2030</td><td colspan="2">Same as the assumed amount of electricity generated under the Long-term Energy Supply-demand Outlook of 2015.</td></tr>
</table>

Results of the estimations

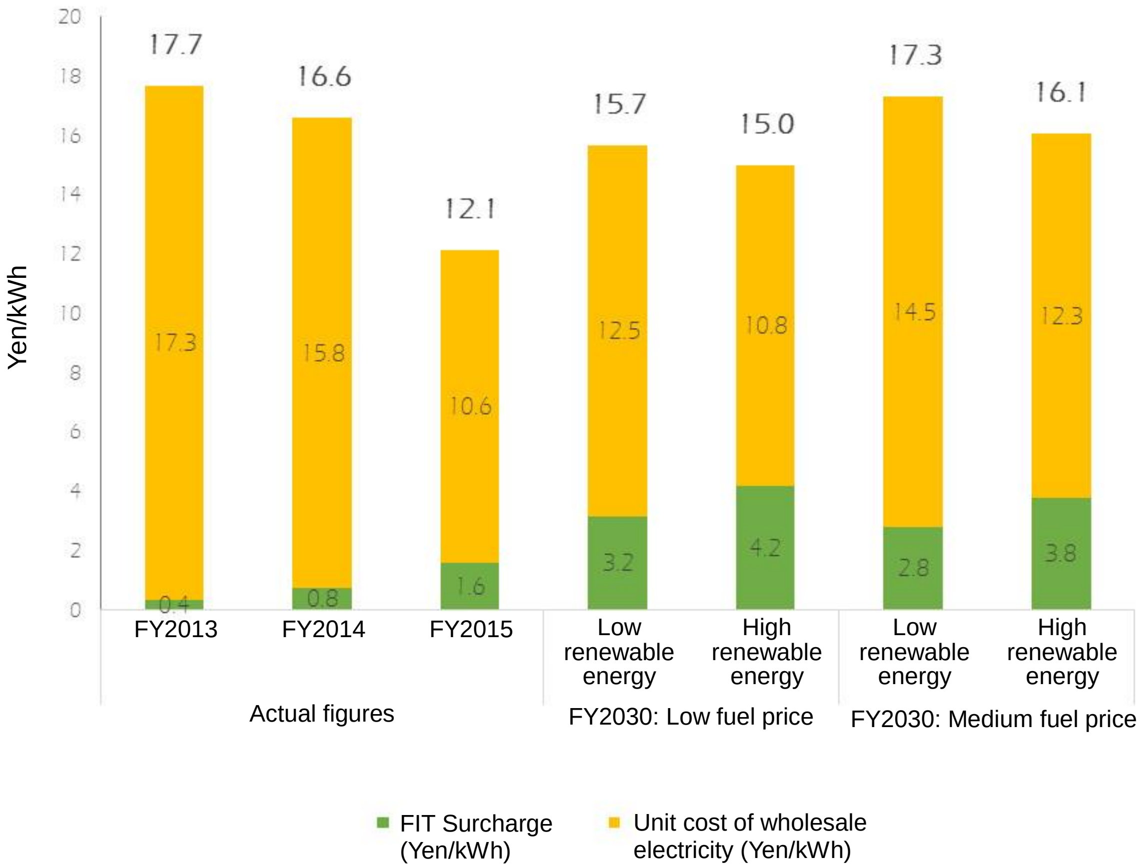

Figure 10 FIT surcharges and average wholesale electricity prices

(actual figures and estimations)

(1) Two scenarios with low fossil fuel price

Wholesale electricity price in FY2030 was estimated as 12.5 yen/kWh under the scenario of low fossil fuel price and low renewable energy (25%). The expenditure for renewable electricity in FY2030 will be approximately 4.3 trillion yen, and avoided costs will amount to about 1.8 trillion yen. The difference between the expenditure for renewable electricity and avoided costs will be about 2.5 trillion yen, and this portion will become the FIT surcharge. The FIT surcharge will be 3.2 yen/kWh. The sum of the FIT surcharge and wholesale electricity price will be 15.7 yen/kWh.

On the other hand, there will be a stronger merit-order effect under the low fossil fuel and high renewable energy (34%) scenario, due to the increase in solar PV and wind power. Hence, wholesale electricity price in FY2030 will be lower than in the low case scenario, and is estimated to be 10.8 yen/kWh. In this case, the expenditure for renewable electricity will be about 5.8 trillion yen in FY2030, and avoided costs are estimated at about 2.4 trillion yen. The difference, or the FIT surcharge, is about 3.4 trillion yen, and the FIT surcharge will be 4.2 yen/kWh. While the FIT surcharge will become higher than that in the low renewable energy scenario by about 1 yen/kWh, the sum of the FIT surcharge and wholesale electricity price will be 15.0 yen/kWh, which is slightly lower than that in the low renewable energy scenario.

(2) Two scenarios with medium fossil fuel price

These are the two scenarios for the case in which fossil fuel prices rise. In this case and when renewable energy follows the low case scenario (25%), wholesale electricity price in FY2030 is estimated as 14.5 yen/kWh, whereas it will be 12.3 yen/kWh when renewable energy follows the high case scenario (34%). The reason why wholesale electricity price is lower in the high renewable energy scenario is because the installed capacity of renewables is higher, which means the merit-order effect would be greater.

The FIT surcharges for both the low and high renewable energy scenarios are lower compared to the low fossil fuel scenarios, since avoided costs increase due to the rise in fossil fuel price. The FIT surcharge was 2.8 yen/kWh under the low renewable energy scenario and 3.8 yen/kWh under the high renewable energy scenario.

The sum of the FIT surcharge and wholesale electricity price was 17.3 yen in the low renewable energy scenario and 16.1 yen in the high renewable energy scenario. Here too, the sum is smaller in the scenario in which deployment ratio of renewable energy is high.

Summary of estimation results

There are three important findings from the results of the scenario analysis. First is that discussions simply focusing on the scale of the FIT surcharge are insufficient. A comprehensive assessment is required, in which the impact of large deployment of renewable energy on wholesale electricity price as well as other aspects are considered.

According to the results of our estimate, the sum of the FIT surcharge and wholesale electricity price was smaller in the scenario with higher deployment ratio of renewable energy in both low and medium fossil fuel price cases, even though the FIT surcharge was higher.

Second, the fall in wholesale electricity price due to merit-order effect becomes greater in association with the rise in fossil fuel price. This means that renewables function as a hedge against the rise of fossil fuel price, and also implies that expanding deployment of renewable energy has an extremely great significance in stabilizing the price of electricity in Japan, a country which relies heavily on fossil fuel imported from abroad.

The third finding is the importance of reducing the cost of renewable energy. Wholesale electricity price is pulled down by the merit-order effect under the high renewable energy scenario, and the total cost becomes lower than in the low renewable energy scenario even when the FIT surcharge is added. However, to achieve these results, the cost of renewable energy must be reduced in addition to having a merit-order effect.

Conclusion

Developing renewable energy resources, which are domestically abundant, and making them a main energy source, is an economically and socially rational choice in shifting away from relying on fossil fuels and nuclear power. We can say that the FIT Act succeeded as a system to support the promotion of large deployment of renewable energy in the early stage. As a result, power generation cost has declined for solar PV, onshore wind power, and general woody biomass, and related industries are developing as well.

Meanwhile, costs of renewable energy, mainly solar PV and wind power, have dropped significantly in the world, and they are gaining price competitiveness against conventional energy sources. In comparison, power generation cost of renewable energy in Japan is still high. According to a study conducted by Renewable Energy Institute on the costs of solar PV and wind power,[24] the main contributing factor was the high costs related to construction in Japan. It is therefore important to encourage construction companies to make efforts so that project owners can carry out construction efficiently. At the same time, a detailed study is needed to examine whether there are unnecessary, excess regulations related to construction.

On the other hand, implementation of the FIT scheme, has not been appropriate in some aspects. As a result, the burden of FIT surcharge has risen and deployment of renewable energy has been limited. As explained in this report, the revised FIT Act is designed to address the challenges in operating the system – but unless it is implemented properly and strictly, it would not be effective. Some challenges still remain, which also must be addressed. The important points particularly concerning the implementation of the system are to ensure that investment on renewable energy is not lost, and at the same time, to manage the additional policy expenses appropriately. It will be a critical challenge for policymakers to achieve both of these two policy tasks. Also, since renewable energy is a small-scale, distributed energy resource, coexistence with local communities is an important challenge. It will be preferable to operate projects in collaboration with local authorities and residents.

As we have shown in the outlook of FIT surcharge, the increase in the unit cost of electricity itself total can be controlled if we can achieve the cost reduction and further acceleration of renewable energy deployment, by relaxing the risk of fossil fuel price volatility and pulling down wholesale electricity price. This, along with the reduced social costs, will contribute to increasing the benefits for the country as a whole.

Endnotes and References

[1] Reasons for making a proposal on the "Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities" (House of Representatives, Committee on Economy, Trade and Industry, 15 July, 2011)

[2] Refer the "website for releasing information of the Feed-in Tariff System," the Agency for Natural Resources and Energy.

[3] The actual figure is unknown, since the amount of electricity purchased from facilities which have changed to approved installations has not been made public. The figure is estimated to be about 10 TWh. Most of these facilities are residential solar PV systems below 10 kW, onshore wind power, and biomass.

[4] Here the Kanto region comprising Tokyo and six other prefectures means Tokyo, Kanagawa, Saitama, Chiba, Gunma, Tochigi, and Ibaraki prefectures. The number of households refers to the number of private households in the national census of 2015.

[5] Annual power consumption per household in the Kanto region is calculated by using the monthly figure of 248.7 kWh (2015), based on the information from TEPCO "The amount of electricity used and the contracted power per household (monthly average in the area serviced by TEPCO)" (website [in Japanese] : https://www4.tepco.co.jp/corporateinfo/illustrated/power-demand/residential-customer-j.html)

[6] Prepared based on "Total Energy Statistics," "Energy White Paper," and "Monthly Report on Electricity Statistics," of the Ministry of Economy, Trade and Industry (METI). Figures from FY2000 to FY2012 are for former General Electricity Utilities, and figures for FY2013 onwards are figures that cover all electricity utilities, including newcomers.

[7] RPS Act is a short name for "Act on Special Measures Concerning New Energy Use by operators of electric utilities." The Act was enforced in FY2003, and the system requires electricity utilities to purchase a certain amount of new energy every fiscal year. Conditions for purchase were left for each electricity utility to decide.

[8] For installed capacity under FIT, refer to the "website for releasing information of the Feed-in Tariff System" of the Agency for Natural Resources and Energy. The figures from FY2007 to FY2011 indicate newly installed capacity under the RPS Act. However, the coverage is different between the Acts concerning medium and small scale hydro; capacities below 1 MW were covered under the RPS Act, whereas capacities below 30 MW are covered under the FIT Act. Therefore, the newly installed capacities between FY2007 and FY2011 for medium and small scale hydro indicate the increase in installed capacity below 30 MW based on "potential hydropower by output" provided by the Agency for Natural Resources and Energy.

[9] Generation cost has been calculated by Renewable Energy Institute based on reference documents of the Procurement Price Calculation Committee. The IRR was calculated as a value subtracting the premium. The figures are converted into 2015 yen values taking into account the inflation rate.

[10] Greenhouse Gas Inventory Office of Japan (2017), "Japan's National Greenhouse Gas Emissions (Final Figures, FY1990 to FY2015)," National Institute for Environmental Studies.

[11] CO_2 emissions were calculated referring to the "Total Energy Statistics" of METI, aggregating the figures for utility generation, on-site generation, and the own use portion of utility generation. The amount of electricity generated was calculated based on the "Monthly Report on Electricity Statistics" of METI, aggregating the electricity generated and purchased, the own use portion of on-site generation, and the loss within the facility.

[12] The figure shows the average figures over one year for each of FY2011 and FY2016, for each of the 30 minute slots in the respective time periods. The bottom figure shows the difference in prices of FY2011 and FY2016. Where the figure is negative, it means that the price in FY2016 was lower. Data are from the spot market activity results of the Japan Electric Power Exchange.

[13] Renewable Energy Institute estimated the 2016 figure referring to Yue Moriizumi, Hiroki Hondo, and Satoshi Nakano (2017), "Renewable Energy and Employment Potential: A Comparative Analysis Based on an Input-Output Model," Journal of the Japan Institute of Energy, Vol. 96, pp 16-27.

[14] Data aggregated from the following reports by Tokyo Shoko Research, Ltd.: "Newly created 'electricity utilities' in 2013 recorded 1,799, a 2.2 fold increase compared to the previous year (2014)," "A study on newly created 'electricity utilities' in 2014 (2015)," "A study on newly created 'electricity utilities' in 2015 (2016)," and "A study on newly created 'electricity utilities' in 2016 (2017)."

[15] Yosuke Toyota (2017), "Report on the National Survey on power plants set up by citizens or communities 2016," Kiko Network.

[16] Refer the Japan Photovoltaic Energy Association (2017), "JPEA PV OUTLOOK – The dawn of solar PV in 2050."

[17] Strictly speaking, the social costs of existing energy sources must be subtracted from the additional burden of expenses of renewable energy, because existing energy sources are generating social costs such as CO_2 emissions. However, to make it simple, we have not considered the social costs.

[18] In practical terms, it will not be equal, for the amount of subsidy to be paid would not be known in advance. The amount of subsidy is estimated, based on which the surcharge unit cost is determined. Therefore, the surcharge could be greater than the subsidy in one year, and the opposite in another year.

[19] The amount of subsidy is from the "Income and Expenditure Report" of the Green Investment Promotion Organization. The expenditure for renewable electricity is from the "website for releasing information of the Feed-in Tariff Scheme" of the Agency for Natural Resources and Energy, METI.

[20] Prepared based on the financial statements of the former General Electricity Utilities.

[21] Noriaki Yamashita (2016), "Research on troubles and corresponding policies in utility-scale solar PV project development in Japan," Institute for Sustainable Energy Policies.

[22] For details, please refer to Renewable Energy Institute (2017), "Recommendations on regional energy policies – To expand renewable energy from the regions"

[23] WindEurope, (2016) WindEurope views on curtailment of wind power and its links to priority dispatch, (http://windeurope.org/wp-content/uploads/files/policy/position-papers/WindEurope-Priority-Dispatch-and-Curtailment.pdf)

[24] For details, please refer to Renewable Energy Institute (2016), "Comparing Prices and Costs of Solar PV in Japan and Germany," and Renewable Energy Institute (2017), "A Study on Cost of Wind Power in Japan."

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