A Comparative Analysis on Three Different Supporting Methods to Expand Renewable Energies in Japan

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Abstract

Taking the Paris Agreement, the 26% GHGs reduction target up to 2030 and the 50% GHGs reduction target in the long-run up to 2050 into consideration, the reasonable increases of electricity by renewable energies will be one of quite important options as an effective GHGs reduction measure. In this study, we would like to arrange merits and demerits of three different supporting methods adopted in Japan in order to expand renewable energies.

Considering from the viewpoint of rapid and drastic expansion of renewable electricity, it would be concluded that the FIT system is the most suitable. Considering from the viewpoint of gradual and systematic expansion of renewable electricity, it would be concluded that the RPS system is the most preferable.

On the other hand, considering from the viewpoint of PPP (public and private partnerships), participants widely expanded and induced advertisement effects, it would be concluded that the green certificate system is the most excellent.

Three different supporting systems have individual merits and demerits discussed in this paper. We should pursue reasonable and effective improvements for the future by taking excellent merits of other systems.

Contents

1. Introduction

After the adoption of Kyoto protocol in 1997, in Japan, the expansion of renewable electricity has been focused to a great extent by using the supporting systems such as the green certificate system (started from 2001), the RPS (renewable portfolio standard) system (started from 2003) and the FIT (feed-in tariff) system (started from 2012). The partial FIT system for surplus solar electricity in the residential sector also introduced from 2009 in addition to the RPS system. In the past 20 years, we have experienced so many happenings and troubles related to the introduction and expansion of renewable energies.

In December 2015, the Paris agreement on post Kyoto GHGs reduction was finally approved by many countries including various developing countries. In May 2016, Japanese Government has authorized the new target of GHGs reduction to achieve 26% reduction from the emission level in 2013 up to 2030. In addition, Japan need to intensify her GHGs reduction measures, because she already agreed 50% (or 80%) reduction of GHGs in 2050 in the long-run.

Thus, the reasonable increases of electricity by renewable energies will be one of quite important options as an effective GHGs reduction measure. In this paper, we would like to arrange merits and demerits by making a comparative analysis on three different supporting methods adopted in Japan for the sake of expanding renewable energies furthermore.

2. Methods

First, we would like to survey historical changes in the increases of electricity generated by renewable energies and developments on three above-mentioned supporting methods, after entering in the 2000's. We especially would like to discuss what kinds of renewable energies were expanded by three different supporting methods, respectively.

Second, we would like to check the players' structure in the activities to expand renewable electricity by using three different supporting methods, respectively. We would like to classify merits and demerits of these supporting methods. We also would like to discuss what kind of system is suitable from the viewpoint of increasing renewable electricity and what kind of system is suitable from the view point of PPP (public and private partnerships).

Finally, we would like to summarize several conclusions of this paper.

3. Results

(1) Expansion of renewable electricity by the RPS (Renewable Portfolio Standards) system

Based on the situations that the Kyoto Protocol was adopted in December 1997 and the Marrakech

Agreement was achieved in July 2001, the measures for GHGs reduction in Japan was scheduled to be strengthened. Of these, the expansion of renewable energies was one of crucial measures which should be adopted. However, the large expansion could not be expected by the traditional support methods, and the introduction of new support methods was required.

Germany, Denmark, Italy and Spain introduced the FIT (Feed-In-Tariff) system in the 1990's and Australia, Texas in the US, United Kingdom and Sweden introduced the RPS (Renewable Portfolio Standards) system entering the 2000's. Italy also chenged from the FIT system to the RPS sysytem entering the 2000's. Considering these overseas movements, Japan also started to discuss about the itoroduction of new support method in order to expand renewable energies.

As a result, Japanese government determined to adopt the RPS system and "Special Measures Law concerning the Use of New Forms of Energy, etc. by the Electric Power Industry" (RPS Law) was enfoced from April 2003. Figure 1 shows the mechanism and structure of the RPS system adopted in Japan.

Under the RPS system in Japan, total amount of electricity generated by renewable energies which must be supplied to consumers was fixed. This amount was increased year by year and was allocated to individual retail electricity companies such as large-scale electricity companies, specified-scale electricity companies and so on. Each electricity company was obligated to supply electricity generated by renewable energy that corresponds to the allocated amount.

As shown in Fig. 1, solar, wind, biomass, geothermal and mini-hydro were assigned to renewable energy under the RPS system. Five renewable energies make a market competiton and therefore, the competitive power of renewable energies can be improved through the competition.

The method to fulfil the amount condition allocated by the RPS system is the following three: (i) the retail electricity company itself make a power generation by renewable energy and supply this generated electricity, (ii) the retail electricity company purchase the electricity generated from renewable energy by the other producer and supply this purchased electricity, and (iii) the retail electricity company purchase only the value of environment (the RPS equivallent amount) included in the electricity generated from renewable energy by the other producer (In this case, the electricity generated from renewable energy itself is sold to the local electricity company).

The utilization target and actual obligation of renewable electricity to expand up to 2010 by the RPS system is shown in Fig.2. The retail power companies obligated in 2003 were total 31 companies including 10 large-scale power companies, 6 specified power suppliers and 15 specific-scale power companies. Total amount of obligation imposed on these power companies was about 3.6 B kWh (0.43% of total electricity supply). 17 companies among total 31 retail power companies made a bunking to next year (Total amount of bunking was about 2.1 B kWh).

Fig. 3 shows the increases in electricity generated by renewable energies from 2003 to 2011 under the RPS

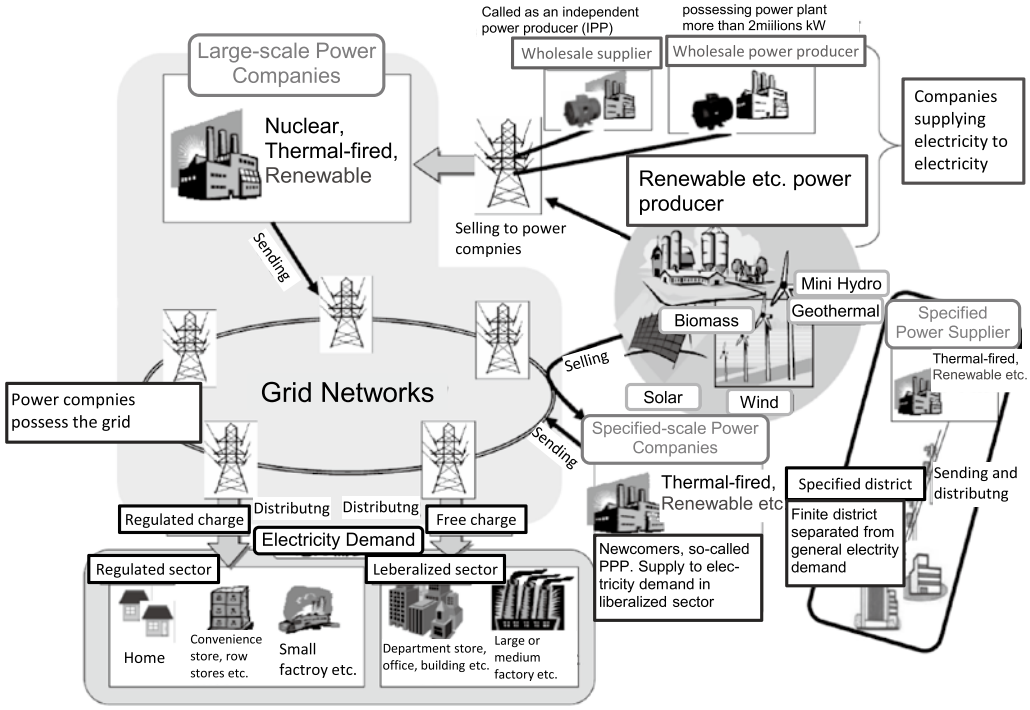

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Fig. 1 Mechanism and structure of the RPS system adopted in Japan

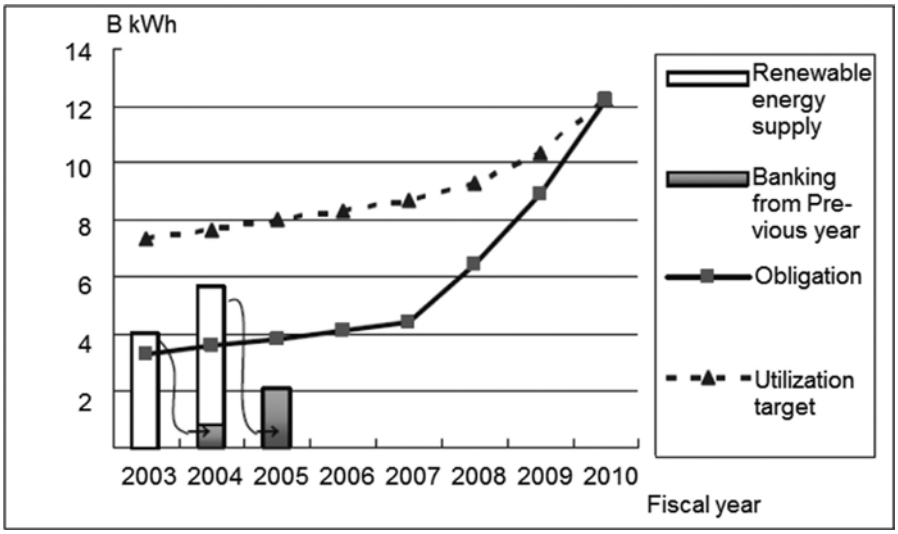

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Fig. 2 Utilization target and actual obligation of renewable electricity up to 2010 set by the RPS system

system. The electricity generated by renewable energies increased from 4 B kWh in 2003 to 12 B kWh in 2012 steadily. Especially, the electricity generated by biomass and wind increased largely, but the electricity generated by solar was not always increased so much.

The ratio of electricity generated by renewable energy from 1990 and 2000 was leveld off at 2.1~2.5% stably and used renewable energy was mini hydro, biomass or geothermal. From 2003, the RPS system introduced and the ratio of electricity generated by renewable energy increased from 2.7% in 2002 to 3.5% in 2010.

Totally speaking, we can evaluate that the introduction of RPS system could play a certain role on the expansion of renewable energies.

Under the RPS system, the electricity generated by solar did not always expand largely, as shown in Fig. 3 and therefore, the government determined to introduce the partial FIT system for surplus solar electricity in 2009. Because of this system, the electricity generated by solar was increased drastically from 2009, also as shown in Fig. 3.

(2) Expansion of renewable electricity by the Green Electricity Certificate system

On the other hand, the green electricity certificate system was already introduced as early as 2001. In the second half of 1990's, several countries in Europe and several states in the United States introduced the certificate system as one of measures for coping with environmental problems. After the Kyoto Protocol in 1997, the Japanese government started to discuss the introduction of system for expanding renewable energy

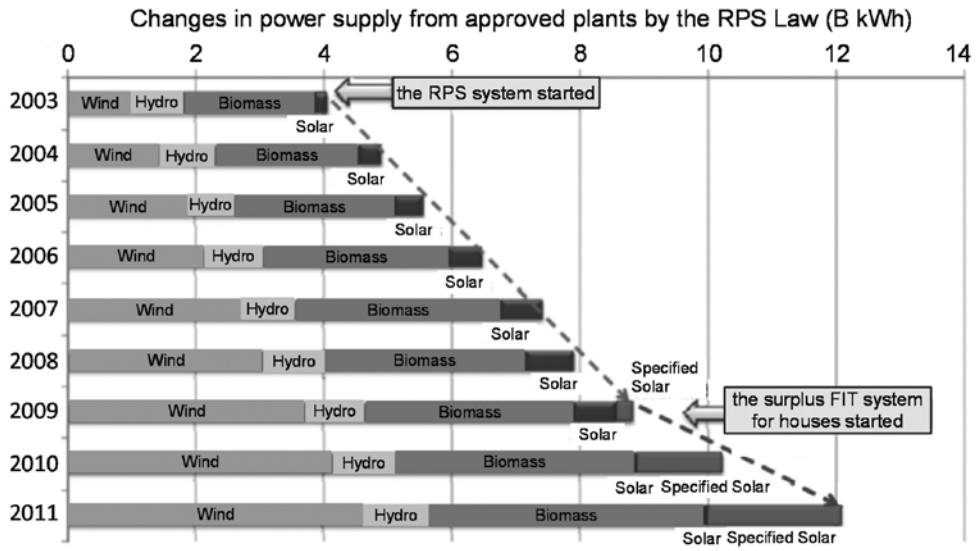

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Fig. 3 Changes in electricity generated by renewable energies by the RPS system

which can play a compulsory force.

However, in those days, many Japanese private companies centering electricity companies opposed the introduction of obligatory system. The green electricity certificate system is a kind of voluntary system in the private sector, and this system has no obligation by the government. Figure 4 shows the mechanism and structure of green electricity certificate system.

Under the green electricity certificate system, the certificate applier and issuer (the trading company) firstly looks for environmental value purchasers and gets a request on green electricity certificate purchase. Then the certificate applier and issuer asks for the green electricity producer to construct a power generation plant using renewable energy and to produce green electricity.

After the producer generates green electricity using renewable energy, the environmental value of green electricity is transferred to the certificate applier and issuer. The certificate applier and issuer, then, asks to

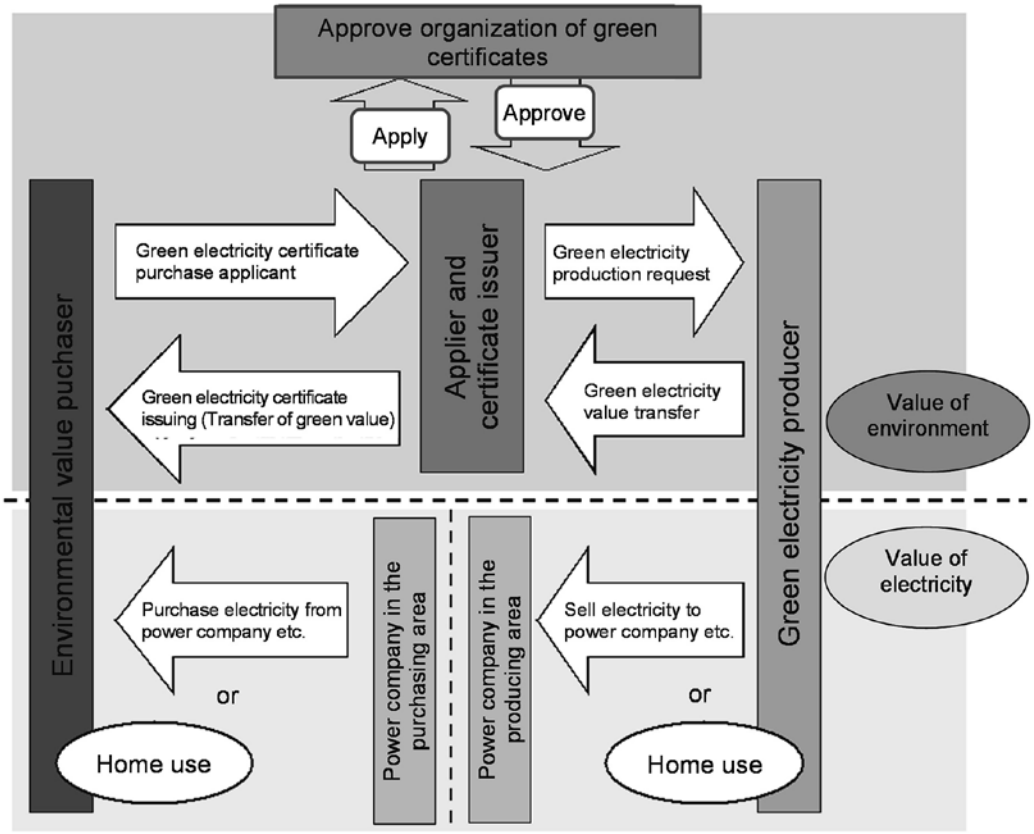

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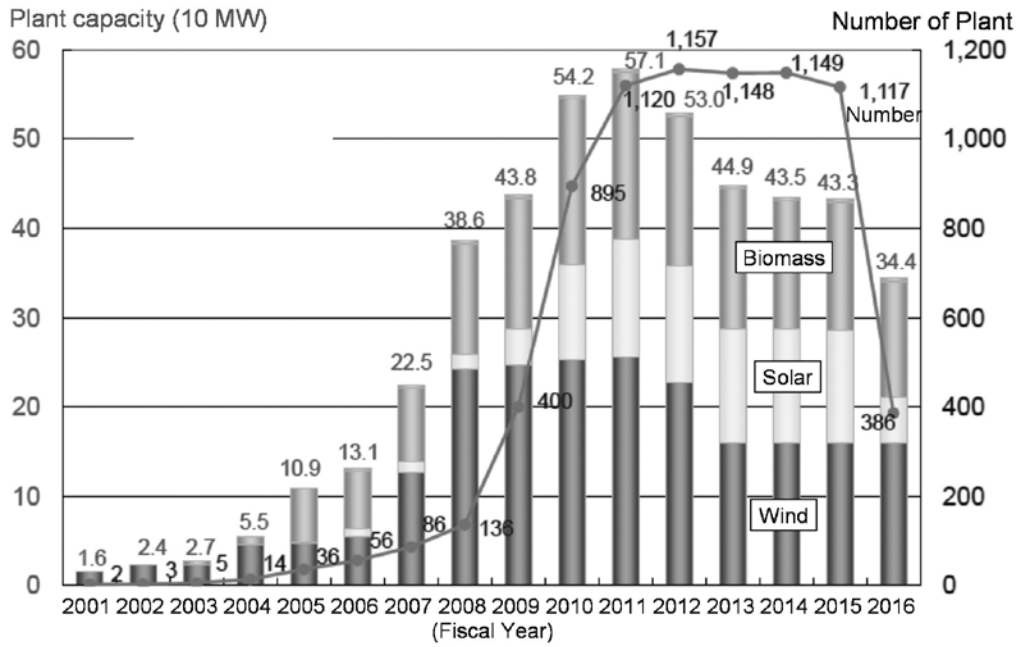
Fig. 4 Mechanism and structure of the green electricity certificate system introduced in Japan

certify the green electricity to the approval organization of green electricity certificate. When finishing the approval of green electricity certificate, the green electricity certificate is issued to the environmental value purchaser from the certificate applier and issuer (the environmental value is finally transferred to the purchaser).

The green electricity itself genereted by renewable energy is sold to local electricity company in the area the green electricity producer is located. The electricity consumed by the envronmental value purchaser is bought from the electricity company in the area the environmental value producer is located. The enviromental value of grenn electricity finally transferred to the purchaser can offset the electricity consumed with pollution.

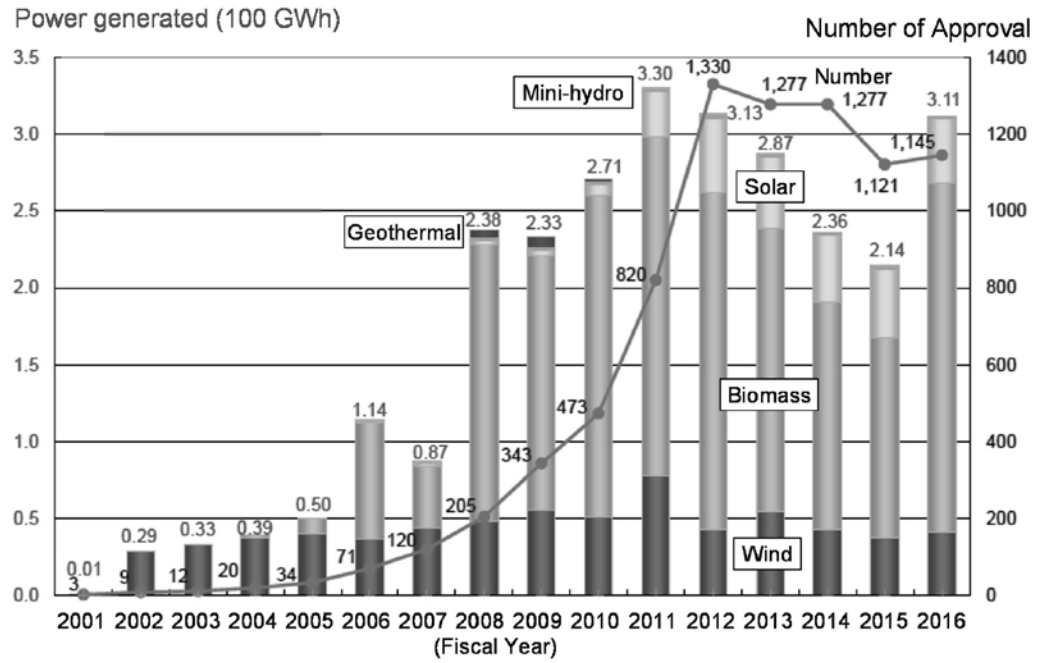
The changes in the capacity of green electricity power plants introduced by the green certificate system are shown in Fig. 5 and the changes in the approved green electricity generated by renewable energies through the green certificate system are also shown in Fig. 6.

The size of renewable electricity approved by the green certificate system is lower than one tenth of the size of that generated by the RPS or FIT system. When the RPS system started in 2003, the green electricity treated with the green electricity certificate system was expected to be reduced. However, the green electricity approved by the certificate system continued to increase, because the green electricity certificate system permitted to deal with the environmental value of green electricity supplied for home use. The green



(Source) IEEJ [2016], "Historical changes in approved electricity by the green certificate system."

Fig. 5 Changes in numbers and capacity of green electricity power plants



(Source) IEEJ [2016], "Historical changes in approved electricity by the green certificate system."

Fig. 6 Changes in approved green electricity generated by renewable energies

electricity supplied for home use is not accepted both by the RPS and FIT systems.

The renewable electricity approved by the green certificate system increased up to 2011, but thereafter, they reduced largely because of the introduction of full-scale FIT system in 2012. Especially, the green electricty generated by wind and biomass is considered to be shifted to the FIT system.

In the first four years, Nippon Natural Energy Co. only was the certificate applier and issuer in the green electricity certificate system. From about 2005, a variety of appliers and issuers with unique activity participated to the green certificate system. The green electricity producer started from wind energy mainly in the first, and expanded to mini hydro, various types of biomass and solar gradually. The environmental value purchaser started from Sonny, and soon expanded to other various companies widely.

Figure 7 shows various activities made by the individual environmental value purchasers in the green certificate system. We can easily understand that each purchaser used received green electricity certificate so uniquely. Under the RPS and FIT system introduced in Japan, such utilizations of environmental value were not made yet entirely. Considering this specific character, the green electricity certificate system is quite different from the RPS and FIT systems.

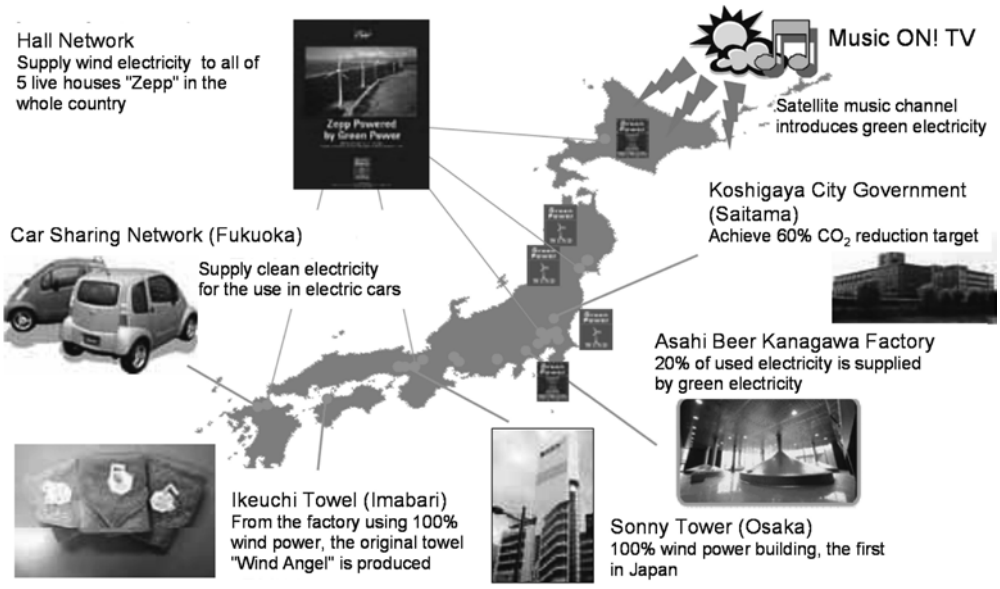


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Fig. 7 Wide and various utilizations of the environmental value by certificate purchaser

(3) Expansion of renewable electricity by the FIT (Feed in Tariff) system

Based on the successful results by the introduction of the partial FIT system which was already described in Section 3-(1), the government determined the introduction of full-scale FIT system in July 2012.

Figure 8 shows the mechanism and structure of full-scale FIT system intorduced in Japan from July 2012. Under the FIT system introduced in Japan, electricity companies were obligated always to purchase the electricity generated from renewable energy by other producers at the FIT fixed price. Renewable energies dealt with the FIT system is the following five: solar, wind, biomass, geothermal and mini hydro the same as those in the RPS system, as shown in Fig. 1.

The purchased renewable electricity is supplied to electricity users from electricity companies and these electricity companies can gather a surcharge together with normal electricity charge in order to cover the cost burden brought by the higher FIT purchased price. The cost burden adjustment organization gathers whole surchage revenue from electricity companies and then, reallocates surchage revenue to electricity companies according to the cost burden by the FIT price for puchasing of renewable electricity.

The estimating committee for purchasing price etc. makes discussions on the FIT system every year and gives opinions about FIT prices of renewable electricities and FIT periods. The Minister of METI approves power generation plants using renewable energies and detemines unit sercharge per kWh every year, based on opinions from the estimating committee.

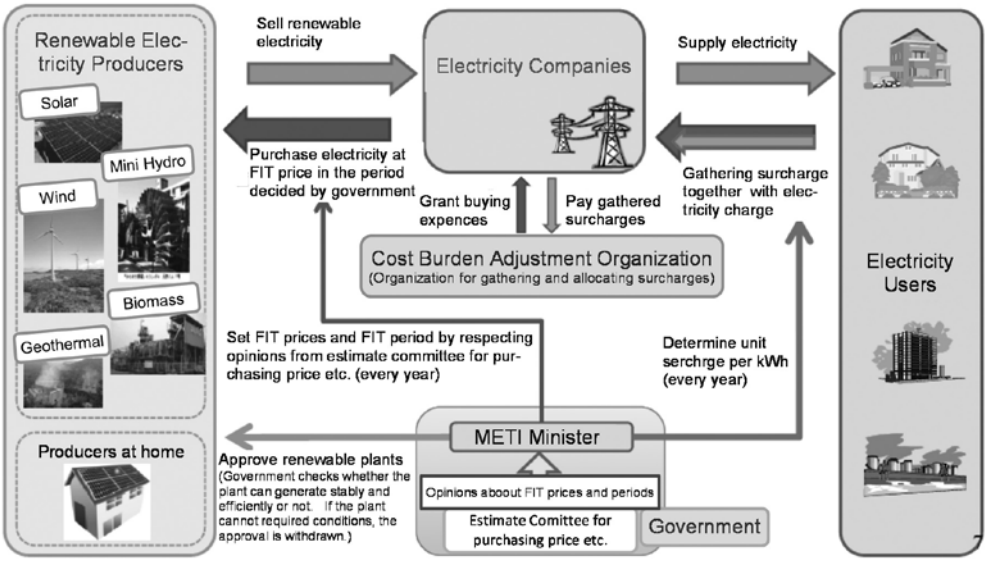

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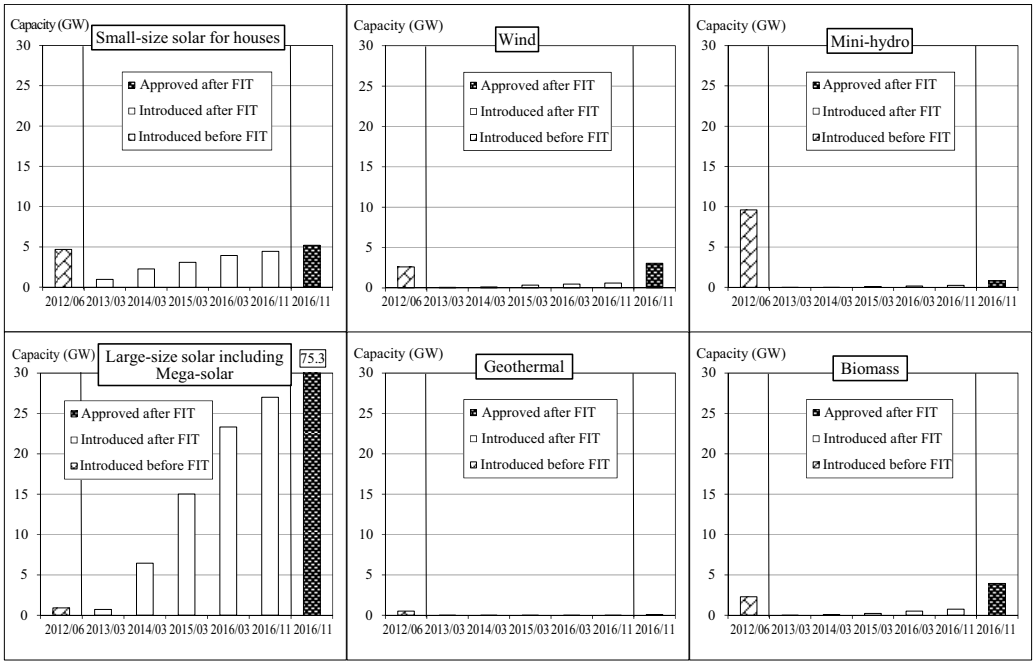
Fig. 8 Mechanism and structure of the full-scale FIT system adopted in Japan

As shown in Fig. 9, after the full-scale FIT system to five renewable energies in July 2012, the electricity generated especially by solar was rapidly increased in earnest. The ratio of electricity generated by renewable energies increased from 4% in 2012 to 7.5% in 2015.

The electricity generated by renewable energies other than solar was not expanded so rapidly, also as sown in Fig. 9. Entering 2015, the electricity generated by biomass seems to be increased moderately.

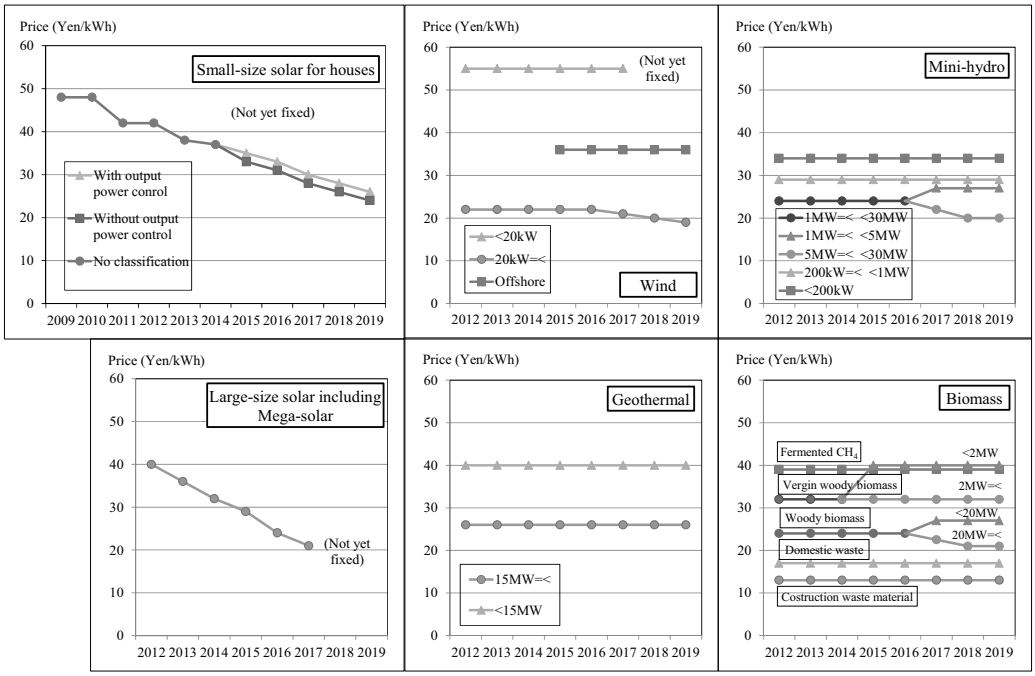
We can definitely evaluate that the introduction of full-scale FIT system in Japan made several large distortions as followes. First, only the electricity generated by solar expanded so sharpely by using the FIT system, because solar electricity was given a quite more favorble FIT price than other renewable energies. Second, as the introduction of large-scale solar including Mega-solar concentrated in the specific areas in Japan, the problems of imbalancing electricity network became severe. Third, the huge capacity of renewable power plants was already approved by the government, but of these, the reneable power plants already operated in actual were not so many.

Considering these distortions, the FIT system in Japan largely revised in 2016 and 2017. The FIT price for large-scale solar electricity was reduced to 21 Yen/kWh in 2017 from 40 Yen/kWh in 2012 and other renewvale electricities were given a more favorable FIT price, as shown in Fig.10. Entering 2017, the FIT price of mini-hydro with the capacity between 5 MW and 1 MW and the FIT price of woody biomass with the capacity smaller than 20 MW was reveised to the upper level. The FIT price of offshore wind was introduced



(Source) made from the data of FIT system results announced periodically by METI

Fig. 9 Increases in the capacity of power plants generated by renewable electricity after the FIT



(Source) made from the data of FIT system results announced periodically by METI

Fig. 10 Changes in FIT prices by renewable electricity

from 2015, also as shown in Fig.10.

The cancellation procedure was also prepared for the renewable power plants approved but not yet operated. The companies obligated to purchase renewable electricity by the FIT system was changed to sending and distributing companies from retailing companies.

Therefore, we need to watch and check the influences of the revised FIT system for the time being. Anyway, we can evaluate that the full-scale FIT system started in 2012 would be too drastic and cause several severe problems.

One of the severe problems is that the extra purchasing costs by the FIT system has increased sharply and steadly from 2012. In actual, the extra purchasing costs increased largely from 250 billions Yen in 2012 to 2,300 billion Yen in 2016 only within five years, as shown in Fig.11.

Because of the sharp increases in the extra purchasing costs by the FIT system, the unit surcharge was revised and increased from 0.22 Yen/kWh in 2012 to 2.25 Yen/kWh in 2016 (10 times higher), also as shown in Fig, 11. Therefore, the monthly burden in the standard household by the FIT surcharge also increased from 66 Yen/Month in 2012 to 675Yen/Month in 2016.

In addition, the extra purchasing costs by the FIT system are expected to reach to 3.7~4.0 trillions Yen in 2030, as

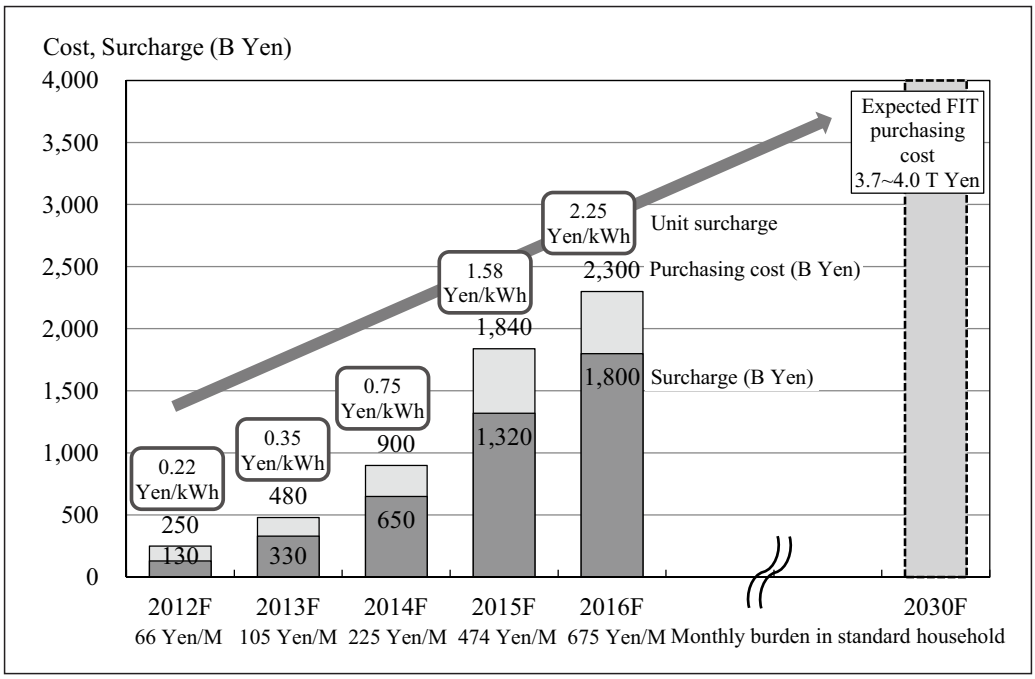


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Fig. 11 Increases in purchasing extra costs and unit surcharge by the FIT system

shown in Fig, 11. Therefore, Japan will directly face with the same problem as Germany has already experienced.

Japan needs to consider the practical methods to solve this critical issue. It would be one of the crucial options that the effective and useful utilization of the environmental values brought by the FIT system is developed before the operation of surcharge burdens.

(4) Comparison of the players' structure in three different supporting systems

Finally we would like to discuss the players' structures of the three different supporting methods to expand renewable energies. Figure 12 shows the players' structure of the RPS system. In this case, the regulator is the central government who obligates power companies to achieve the allocated target of renewable electricity. The starters of this system are power companies such as large-scale and specific-scale power companies who is obligated to achieve the target.

In response to the requests of power companies (the starter), power produces such as company, NGO etc. and individual begin to produce electricity using reneable energy. These producers have a market risk, because it is uncertain whether renewable electricity they produces is chosen by power compnies or not. Therefore, power producers cannot easily decide their plan of generation plant construction. In this

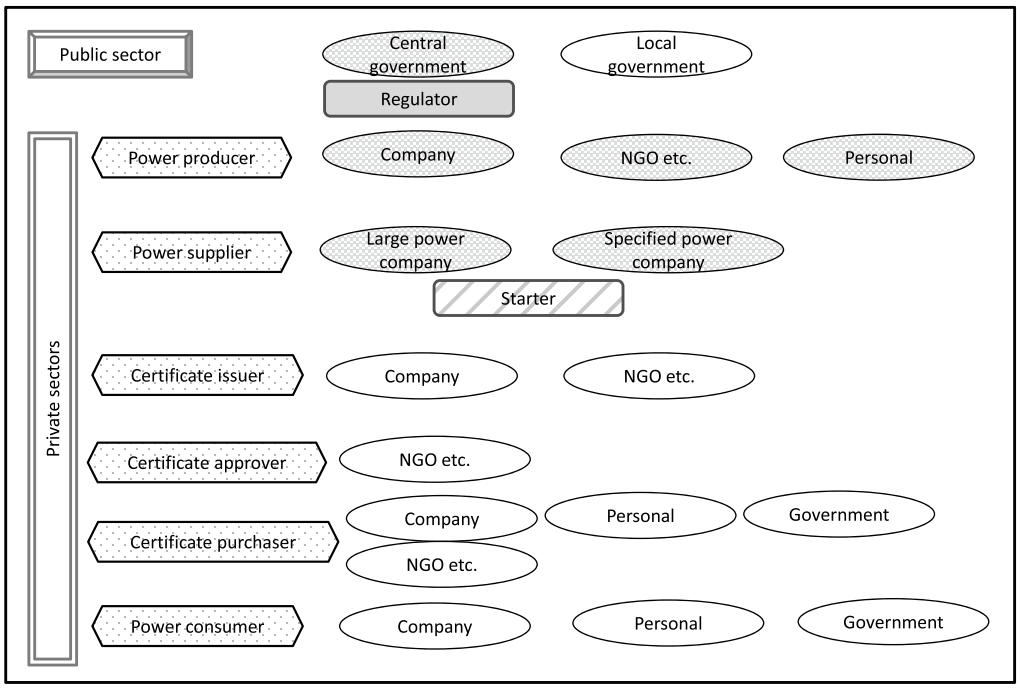

Fig. 12 Players' structure of the RPS system

system, the additional cost for accepting renewable electricity is a burden to power companies. Considering altogether, the initiative of the RPS system is taken by power companies (the starter).

Figure 13 shows the players' structure of the FIT system. In this case, the regulator is also the central government who obligates power companies to purchase all renewable electricity generated at the FIT fixed price. The starters of this system are power producers such as companies, NGO etc. and individuals who generate renewable electricity.

In response to the accepting requests from power producers (the starter), power companies such as large-scale and specified-scale power companies must receive renewable electricity because of the government regulation. In this case, the power producers have no market risk, because all of their renewable electricity generated is accepted by power companies. Different from the case of RPS system, power producers can more easily decide their plan of generation plant construction.

In this system, the additional cost for purchasing renewable electricity at the FIT fixed price is a burden to electricity consumers such as companies, individuals and governments, because the gathering of sercharge together with normal electricity charge is permitted by the central government. Considering altogether, the

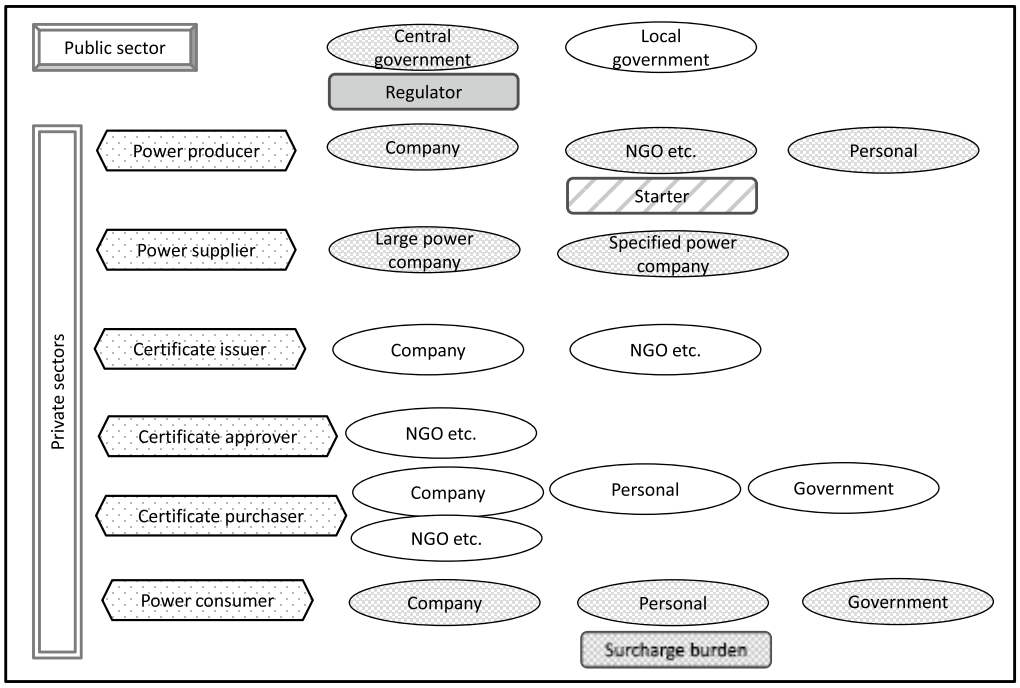

Fig. 13 Players' sturucture of the FIT system

initiative of the FIT system is taken by power producers (the starter).

Figure 14 shows the players' structure of the green electricity certificate system. In this case, there is no regulation made by government (No regulator). The coordinator of this system is the certificate applier and issuer such as companies, NGO and so on. The starter of this system is the certificate purchaser (the environmental value purchaser) such as companies, NGO etc, individuals and governments. Based on the certificate (the environmental value) requests gathered from the crtificate purchasers, the coordinator asks for power produsers such as companies, NGO etc. and individuals to construct power plant and produce electricity by renewable energy.

In this case, power companies purchase electricity generated by renewable energy at nomal electricity charge. This means that the environmental value and the electricity value are treated separately in this case. The point worthy of special mention is that the certificate approval organization such as NGO is required in the green electricity certificate system.

In this system, the additional cost for producing renewable electricity is a burden to the certificate (environmental value) purchasers (the starter). Considering altogether, the initiative of the green electricity

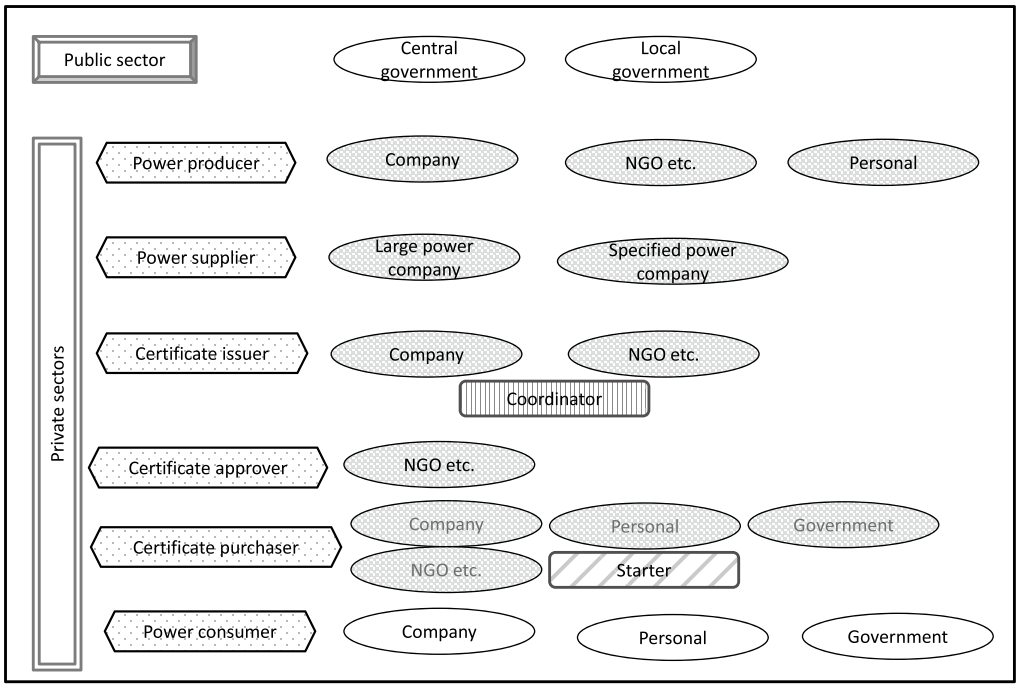

Fig. 14 Players' structure of the green electricity certificate system

certificate system is taken by the certificate appliers and issuers (the cooordinator). The certificate purchaser (the starter) and the certificate approval organization also play a crucial role in this system.

Table 1 summarizes specific characteristics of three different systems to expand renewable energies which were adopted in Japan since 2000. Three systems showed quite different characters in the terms of obligation, starter, producer risks, ectra cost burden, total size of expanded electricity, related players, use of environmental value and home use, as shown in Table 1.

Table 1 Comparison of three different systems to expand renewable electricity

	RPS system	FIT system	Green certificate system
Obligation	**Exist** Government	**Exist** Government	**Not exist** Voluntary
Starter	Retail electlicity company	Renewable power producer	Green certificate purchaser
Producer risks	**Exist** Renewable Energies competition	**Not exist** Governmental obligation	**Not exist** Guarantee between Purchaser and issuer
Extra cost burden	Retail electlicity companies	Surcharge to end-users	Green certificate purchasers
Total size of electricity	**10 TWh** (2003-2011)	**138.43 TWh** (2012-2016)	**0.3 TWh** (2001-2016)
Related players	**Quite simple** Power suppliers Reneable power producers	**Simple** Renewable power producers Power suppliers End-users	**Complicated** Players related to green certificate Rewable power producers Power suppliers
Use of environmental value	**Not used**	**Not used**	**Used** Various methods
Home use	**Not accepted**	**Not accepted**	**Accepted**

In summary, though the regulator is the central government as for both of the RPS and FIT systems, the starter of renewable electricity activities is power supplying companies in the case of RPS and on the other hand it is power producing companies in the case of FIT. The players' structure of the activities under the green electricity certificate system is quite different from that of two other systems. The participants under the green electricity certificate system expand more widely and the advertisement effects are induced by using the green electricity certificate.

4. Concluding remarks

Considering from the viewpoint of rapid and drastic expansion of renewable electricity, it would be concluded that the FIT system is the most suitable. Considering from the viewpoint of gradual and systematic

expansion of renewable electricity, it would be concluded that the RPS system is the most preferable.

On the other hand, considering from the viewpoint of PPP (public and private partnerships), participants widely expanded and induced advertisement effects, it would be concluded that the green certificate system is the most excellent.

Three different supporting systems have individual merits and demerits discussed in this paper. We should pursue reasonable and effective improvements for the future by taking excellent merits of other systems.

For this porpose, it is quite important to apply various activities utilizing the environment value of green electricity observed in the green electricity certificate system to the other two system, RPS and FIT system. This application is also expected to play a crucial role on the reduction of surcharge burden to people.

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