＜REVIEW ARTICLE＞

Spread of Photovoltaic Power Generation into Farmland under the FiT System

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Abstract： Japan launched a Feed-in Tariff (FiT) system in July 2012, and the Act on the Promotion of Renewable Energy in Rural Areas came into force in May 2014. This legislation aims to breathe new life into rural communities through the deployment of renewable energy generation plants . Such communities face structural problems including increasingly aged populations, shortage of successors, and price competition stemming from globalization, and abandoned farmland accounted for over 10% of the total area of farmland in Japan in 2010. From the launch of the FiT system up to March 2014, a total renewable energy generation capacity of 68.641 million kW was installed, with photovoltaic energy generation accounting for 95.8% of this total, accompanied by a rapid increase in farmland conversions. In the case of Wakayama Prefecture, 112 permits for farmland conversion were granted for the purpose of power generation in the 24 months after the launch of the FiT system. Citizen-funded and other local community-based renewable energy generation projects have been launched nationwide, but the deployment of photovoltaic power plants on farmland has brought even more dramatic change to local communities, as the FiT system provided an immediately effective means of generating profit. Conversion of farmland to photovoltaic power plants under the FiT system may boost farmer income, but this boom can hardly be described as contributing to the sound development of Japan's agriculture and forestry sector.

Key words: feed-in tariff, photovoltaic power generation, abandoned farmland, farmland conversion, community revitalization

INTRODUCTION

In July 2012, the Japanese government launched a Feed-in Tariff (FiT) system requiring utilities to purchase electricity generated from renewable energy sources at a fixed price for a set length of time. Public interest in renewable energy generation grew rapidly as a result, and in the ensuing 15 months, a total capacity of 5.58 million kW—six times that installed in the previous year, equivalent to six nuclear reactors—was installed (Iida 2014). Renewable energy is energy derived from sunlight, wind, water, geothermal heat, biomass and other replenishable sources, and has low environmental impacts. Rising demand for renewable energy in Japan is being driven by the benefits it can bring in terms of (1) energy self-sufficiency, (2) protection of the natural environment, and (3) safety and community revitalization.

With respect to (1), Japan's energy self-sufficiency stood in fiscal 2012 at just 6%, ranking 33rd among the 34 OECD member countries. Nuclear power generation throughout Japan was brought to a halt after the Fukushima Daiichi Nuclear Power Station accident triggered by the Great East Japan Earthquake (Tohoku Earthquake) of March 2011. As a result, Japan's already high dependence on imported fossil fuels rose 10.4 points from 81.8% in fiscal 2010 immediately prior to the disaster to 92.2% in fiscal 2012. Japan's vulnerability to rising energy prices at a time of expanding worldwide energy demand has made energy self-sufficiency an increasingly critical issue.[1)]

With respect to (2), in conjunction with rising energy consumption by emerging nations, global CO_2 emissions from oil, coal and natural gas combustion increased approximately 1.5 times

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between 1990 and 2011, and are expected to continue to increase. Reducing these emissions, a source of global warming, is of worldwide concern.

With respect to (3), the unprecedented scale of the nuclear power station accident has sparked serious public concern regarding the safety of nuclear power generation, and a groundswell of opinion in favor of renewable energy as safe energy whose generation could also revitalize local communities. The potential for renewable energy generation is particularly high in rural communities with their abundant forest resources, water and land. Moreover, stagnation in agriculture and forestry, the core industries of the countryside, is creating increasing areas of abandoned farmland and neglected forests.

Renewable energy generation is consequently regarded as a hopeful new source of income in rural communities. Particularly since the introduction of the FiT scheme, photovoltaic power generation capacity deployed on farmland currently in use as well as abandoned or unused farmland has risen conspicuously.

However, there has not been sufficient discussion concerning photovoltaic power generation in relation to the importance of agriculture and forestry as core industries and the many different functions of these industries.

1. METHODS

In this paper, I focus on the deployment of photovoltaic power generation plants particularly in rural communities from the perspective of community revitalization, looking at government policy, and at trends and issues related to the conversion of farmland to photovoltaic power generation in Wakayama Prefecture, where agriculture is a key industry.

2. RESULTS AND DISCUSSION

2.1 The Feed-in Tariff (FiT) system

In April 2014, the Japanese government's Fourth Basic Energy Plan received Cabinet approval. Renewable energy accounted for approximately 10% of the electricity consumed in Japan in fiscal 2013, but if hydroelectric energy is excluded, this share drops to 2.2%. Basic Energy Planning Committee materials for 2010 proposed a target share for renewables of approximately 20% (214 billion kW) by 2030, but the Fourth Basic Energy Plan calls for accelerating the deployment of renewable energy generation capacity to a maximum feasible level over the space of three years from 2013.[2)]

The FiT system guarantees the purchase of electricity derived from renewable sources at a price that covers the average cost of generation of such electricity. Under the system, the pretax price paid per kWh of electricity generated by facilities with a capacity of 10 kW or more was set at ¥40 for facilities established in fiscal 2012, ¥36 for those established in fiscal 2013, and ¥32 for those established in fiscal 2014.

These purchase prices will be maintained for 20 years. According to a private-sector simulation[3)], a power generation business could recoup its investment in photovoltaic energy generation in approximately 10 years. As such, a 20-year scheme could be seen as a stable investment model, and private sector deployment accelerated dramatically as a result of the introduction of the FiT system.

During the 20 months from July 2012 when the FiT system was launched up to March 2014, a total renewable energy generation capacity of 68.641 million kW was installed. Photovoltaic power generation accounted for 65.725 million kW (95.8%) of this total. "Mega-solar" plants with capacities topping 1,000 kW account for 54.6% of this photovoltaic power generation, with smaller plants accounting for a further 41.15%. During the same period, 583,224 newly certified plants with a capacity of at least 10 kW were deployed, and the fact that only 8,780 of these are mega-solar plants reflects aggressive deployment of midsized photovoltaic energy generation plants.

The final month of fiscal 2013 showed a particularly remarkable increase of 27 million kW in capacity certified under the FiT system[4)], this increase no doubt driven by last-minute demand

for certification to lock in the higher tariff.

2.2 Deployment of renewable energy capacity on farmland and forestland

The Japanese government's Act on the Promotion of Renewable Energy in Rural Areas came into force in May 2014. This law's full name is the "Act for Promotion of Power Generation of Renewable Energy Electricity to take Harmony with Sound Development of Agriculture, Forestry and Fishery Villages". The law's intention is to promote local community revitalization through the deployment of renewable energy generation plants in rural communities. Such communities in Japan currently face a variety of structural problems that are tied to global economic factors, including aging populations, a shortage of successors and slumping income(Motani,2013). One concept that is attracting attention as a means of leveraging local resources to drive community revitalization is the creation of so-called "senary" or "sixth order" industries that combine primary industries (agriculture, forestry, and fisheries) with secondary (manufacturing) and tertiary industries (commerce, etc.). Leveraging the high potential of rural communities, with their plentiful land, water, biomass and other resources, to generate renewable energy is another approach that is being promoted by utilizing the FiT system to improve the profitability of renewable energy generation. Japan's Ministry of Agriculture, Forestry and Fisheries (MAFF) is pursuing this policy as a means of boosting incomes in rural communities through the sale of electricity.[5)]

The term "abandoned farmland" is defined in Japan's Census of Agriculture and Forestry as land "that was once farmed, but has not been cultivated for at least a year with no plans for the further cultivation of crops in the next several years". This definition for statistical purposes reflects the subjective intentions of farmers to farm their land. In more recent years, however, data based on surveys of actual farmland usage status has come to be used. The total area of abandoned farmland in Japan has steadily increased over the past 20 years in conjunction with the decline in agriculture and rural communities, with the farmland abandonment ratio also rising concomitantly. In 2010, the total area of abandoned farmland in Japan stood at about 400,000 ha, representing 10.6% of the total area of farmland (Figure 1).[6)]

The area of abandoned farmland has increased in step with the severity of the structural problems faced by Japan's agricultural sector, and is an issue that requires urgent attention from the perspectives of both the conservation of land and food security. However, large swathes of farmland have remained abandoned in an increasing state of dilapidation owing to the lack of effective solutions to this issue. It is against such a backcloth that the generation of renewable energy has emerged as a means of using this land.

2.3 Expectations for community revitalization

The concept of leveraging local natural resources to produce energy for consumption in the same locality has stoked considerable interest from the perspectives of potential economic benefits of stemming the flow of wealth away from local communities as a result of energy consumption, the disaster mitigation benefits of securing a localized energy supply, and the effect of community-based energy production and

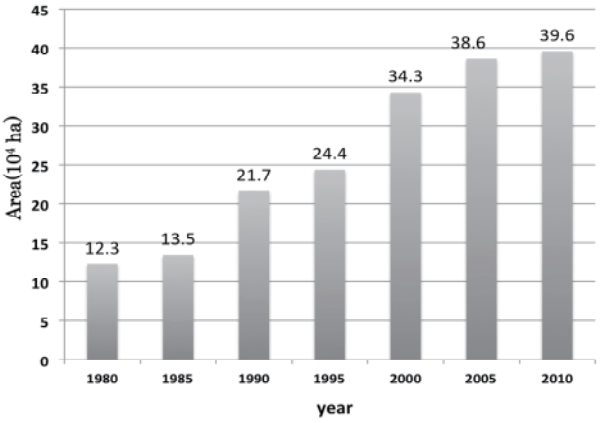

Figure 1. Area of abandoned farmland

Source: Created from Census of Agriculture and Forestry.

Table 1. Area of abandoned farmland in Wakayama Prefecture

(year)	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*
Abandoned farmland (ha)	322	189	171	132	56	163*
Cultivated farmland (ha)	36000	35600	35200	35000	34700	34600

Source: Created using Ministry of Agriculture, Forestry and Fisheries statistics.
＊"delapidated farmland" by renamed

consumption schemes on local community revitalization. Local production and consumption of energy was already being advocated conceptually around the year 2000, but failed to take root owing to the large initial investments required. However, the 2011 nuclear power station accident triggered antipathy toward nuclear power and a groundswell of opinion in favor of autonomous local energy production and localized small-scale distributed energy generation models (Niizuma 2011, Motani 2013).

Enacted for the purpose of stimulating rural economies at the same time as promoting the adoption of renewable energy, the Act on the Promotion of Renewable Energy in Rural Areas employs FiT to implement its basic principle of revitalizing rural areas. Specifically, this Act envisages that income from selling electricity could be used for the maintenance of farmland, for running agricultural product processing facilities and farmers' markets, and for acquiring biomass from farmers and foresters. The act incorporates special provisions to smooth the introduction of generating businesses by enabling all administrative procedures to be handled on a one-stop basis, and to enable the conversion of Type 1 farmland, for which conversion is not normally permitted. Particular attention was given to make clear the whole project planning process, from national and local government basic plans to field plans for plant deployment.

2.4 Conversion of farmland to land for power generation

With the launch of the FiT system, demand rose for vacant land to install generation capacity. According to Ministry of Economy, Trade and Industry (METI) data for 2012, 13% of photovoltaic electricity generation plants were installed on forest land, 3% on farmland, and the rest on other land categories including residential land, wilderness, reclaimed land, and former industrial land. Farmland must go through a re-categorization process before it can be used for purposes other than agriculture.

To conserve quality farmland and promote systematic land use, permission is required under the Agricultural Land Act to convert farmland to another category. The Agricultural Land Act was adopted to rigorously regulate the use of choice farmland.[7] Table 2 shows the permission policy according to farmland category.

The area of abandoned farmland has increased steadily. The area of abandoned farmland in Wakayama Prefecture in 2013 amounted to 4,578 ha, with a cultivated farmland area of 35,000 ha. In 2008, 322 ha of farmland were abandoned, followed by about 150 ha in each subsequent year

Table 2. Farmland conversion permission criteria (outline)

Category	Type of farmland	Permission policy
Farmland zone	Productive farmland within an agricultural development area	Not permitted
Type 1 farmland	Farmland grouping and land improvement project land and other choice farmland	Not permitted in principle
Type 2 farmland	Small grouped farmland with low productivity that does not qualify for land improvement	Permitted when alternatives are not available
Type 3 farmland	Farmland close to built-up area	Permitted in principle
Urbanization area	Farmland in an urban zone	Permitted on notification alone

Source: Created from Ministry of Agriculture, Forestry and Fisheries materials.

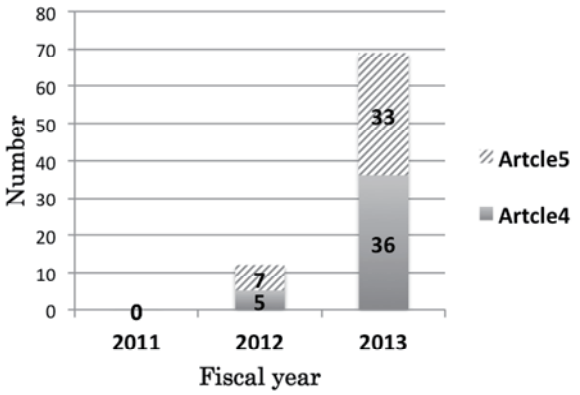

Figure 2. Farmland conversions for PV plant deployment in Wakayama (2014: April–June)

Source: Created from Wakayama Prefecture materials.

(Table 1).[8] Meanwhile, farmland conversion permissions granted for the installation of photovoltaic power generation plants numbered zero in fiscal 2011, 12 in fiscal 2012, 69 in fiscal 2013, and 31 from April to June in fiscal 2014 (Figure 2). Farmland may be converted by owners themselves (Agricultural Land Act, Article 4), or may be transferred or leased to someone else who can then apply to convert it (Agricultural Land Act, Article 5). The ratio of Article 4 to Article 5 conversions for power generation facilities is about 50-50.

2.5 Locally initiated power generation businesses

The San-O Neighborhood Association in the city of Tamba, Hyogo Prefecture, was the first such association in Japan to drive its own revitalization through renewable energy generation. Consisting of only 12 households with increasingly elderly residents, the Association was finding it difficult to continue maintaining its land, waterways and temple. It sold some of its land to Hyogo Prefecture and used the income to install photovoltaic panels on a plot of its own land with the aim of using earnings from the sale of electricity to fund its operations and breathe new life into the neighborhood by supporting agricultural production and addressing the issue of abandoned farmland. Annual power generation amounts to 44,000 kW. The plant cost approximately ¥17 million to install, so based on the FiT price at the time, the association should recoup its investment within approximately 10 years.[9]

Another example is Nanki Renewable Energy, which launched operations in January 2014 at Shionomisaki in the town of Kushimoto on the southernmost tip of Wakayama Prefecture as the Prefecture's first citizen-funded power plant. The aim of launching a power plant with funds contributed by local residents was to plow the profits from the sale of electricity back into the local community to spur its revitalization. The project's leader is a young local who gave up city life to return to his birthplace, and used his own savings to install the first unit on abandoned farmland owned by his grandmother. He solicited investments from local residents to install a second unit as a citizen-funded plant, with the aim of keeping any profits from the sale of electricity within the local community.[10]

In May 2014, over 30 organizations involved in projects to spur local development through leveraging sunlight, wind, biomass and other local resources to generate energy for local consumption launched the All Japan Community Power Association. It was on March 11, 2014, three years to the day after the Fukushima Daiichi Nuclear Power Station accident, that these organizations declared their plans to launch the Association.[11]

This indicates a clear desire for community-based energy generation as an important means of creating a safe and sustainable community.

2.6 Indiscriminate proliferation of photovoltaic power plants on converted farmland

There are, however, still relatively few citizen-led electricity generation projects aimed at local community revitalization. Over half of such renewable energy generation plants have been deployed by entities that are not part of the local community. A survey based on METI's Survey of Factory Location Trends 2012 showed that of the entities deploying photovoltaic power plants, 25% were local enterprises, 15% enterprises within the

same prefecture, 48% enterprises with head offices in Tokyo or Osaka, and 12% located elsewhere. Almost 50% of such plants were deployed by entities located in or around Tokyo, while local farmers, forest owners and others accounted for less than 12%. Some mega solar projects funded by outside capital have also antagonized the local communities involved. In some cases, residents have failed to reach consensus or have actively opposed such projects out of concerns regarding conservation of the environment and the risk of landslides in the case of plants installed on sloping ground. Local agricultural commissions have also voiced concerns regarding the lack of options available to them when wishing to proceed cautiously in order to preserve farmland in the face of a continuous stream of applications seeking to convert farmland for photovoltaic power plant deployment.[12)]

Although such applications are required to be screened, they are rarely rejected as long as they satisfy documentation requirements. Given the increasing area of abandoned farmland and age of the farming population, outside businesses have an almost unlimited choice of location. Farmland conversion applications from elderly farmers lacking successors and eager to secure a stable income to see them through the rest of their lives are also invariably accepted as being realistic and justified.[13)] Moreover, there are few reasons for farmers to hesitate over deployment considering that land is virtually the only requirement and no specialized management skills are needed.

There are examples of active farmers installing photovoltaic power plants on parts of their farmland due to the attraction of an additional source of income. There are also cases of children who have no intention of succeeding their parents as farmers borrowing their parents' farmland for conversion to photovoltaic power generation. These examples suggest that photovoltaic power generation is, if anything, likely to encourage farmers to cut back or abandon farming rather than stick to it. Farmers who have already lost their motivation to farm and have abandoned their fields, or active farmers who are anxious about the future no doubt view photovoltaic power generation as an attractive opportunity to cut down on the area they farm or abandon their fields altogether. From the perspective of attempts to preserve farmland, the increasing deployment of photovoltaic power generation on farmland is an issue of concern.

Nevertheless, deploying photovoltaic power plants on farmland entails initial investment. Further analysis is required to determine the economic effect of variations in the feed-in tariff and costs of repairing the plants when they age.

2.7 Power generation businesses and a sense of responsibility

Turning the concept of local production and consumption of energy into a reality requires initiative, followed by the bringing together of funds, land, business framework and other components required to launch a project. The first community-based renewable energy generation projects have shown that the departure point for initiators of such projects is a sense that they themselves should take responsibility for their own energy consumption. (Nomura 2014).

A survey on attitudes to renewable power generation[14)] found that people with no plans to invest in or contribute to community power generation businesses may become more ready to invest or donate if there are "benefits for the individual", if there is "development of efficient new technology", or if it "makes an effective contribution to the environment or community" (Yuzaki, Nakashima 2014)(Figure3).

In other words, enlisting the participation of people in such projects requires that they first be made aware of the concrete social and economic benefits of renewable energy generation in their local community. Fostering understanding of the direct benefits—particularly economic benefits—of renewable energy utilization would likely be highly effective in winning their participation in a way that leads to local community revitalization.

CONCLUSIONS

The Act on the Promotion of Renewable Energy in Rural Areas was born out of an alignment of national policy aimed at promoting renewable power generation with the need to breathe new life into rural communities. However, even though the kind of community-based renewable energy generation initiatives that the law sought to promote have been launched around the country, the deployment of photovoltaic power plants on farmland by individual land owners has brought even more dramatic change to local communities.

Photovoltaic power plants are being deployed in increasing numbers on cultivated as well as abandoned farmland. Farmers have been able to transform themselves with consummate ease and speed into power generation businesses.

Since the launch of the FiT system, newcomers to the renewable energy generation market have largely been individuals rather than community-based initiatives. The reason for this is that the need to come to a quick decision before the purchase price is changed has worked in favor of individual landowners who either become power generation businesses themselves or lend or sell their land to such businesses for personal profit rather than community-based initiatives for which time is often required to reach consensus.

The aim of the Act on the Promotion of Renewable Energy in Rural Areas is purportedly to promote the generation of renewable energy as a means of driving the sound development of agriculture and forestry, but further research is required to confirm that the reality is consistent with this assertion.

The FiT system made a sensational entrance in Japan's agricultural sector as an immediately effective means of generating income at a time when the sector faced a plethora of intractable problems including lack of successors, increasingly aged farming population and low profitability. The policy attempted to address the two issues of promoting renewable energy generation and driving local community revitalization, but the public quickly chose to use the policy in a way that has overwhelmingly favored personal profit.

If community-based renewable energy generation were the departure point, it could serve as an engine for driving community revitalization on a sustained basis, directly benefiting society while also indirectly leading to personal profit. However, if the departure point is individual incentive, only individuals profit. The conversion of farmland to photovoltaic power plants under the FiT system may boost farmer income, but insofar as the profits from such operations accrue mostly to individuals, this boom could hardly be described as contributing to the development of Japan's agriculture and forestry sector. This debate warrants further attention in conjunction with the continuing implementation of the FiT system.

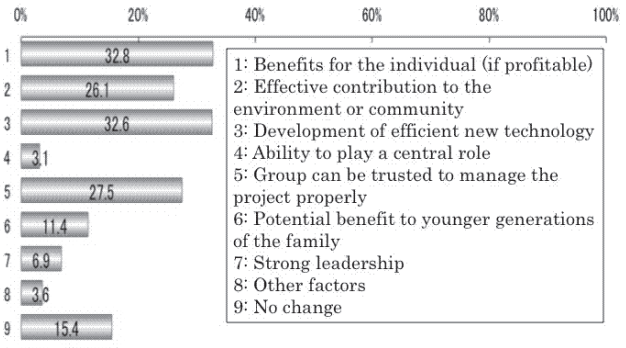

Figure 3. Factors that could change attitudes towards investing in/donating to community-based renewable power generation projects

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