Renewable energy power generation and rural economies

Estimating money flow and incomes/payments related with non-residential solar photovoltaic power generation business

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Summary

Great expectations are placed on renewable energy that is domestically produced and emits no carbon dioxide. At the same time, renewables power generation is attracting attention as commercial business. Particularly, power generation capacity approved under the Feed-in-Tariff system in Japan at the end of FY2014 was as high as 79 gigawatts for non-residential solar photovoltaic power generation including so-called mega- and middle-solar plants. Solar PV power generation can be launched even without resource or industry accumulation and used to take advantage of low land prices. The business is easy to conduct in rural areas. In fact, rural areas other than the 10 metropolitan areas in Japan account for two-thirds of the approved non-residential solar PV power generation capacity. This report estimates money flow to local economies, especially to rural economies, and incomes/payments related with the non-residential solar PV power generation business that has attracted attention as a local economic promotion measure.

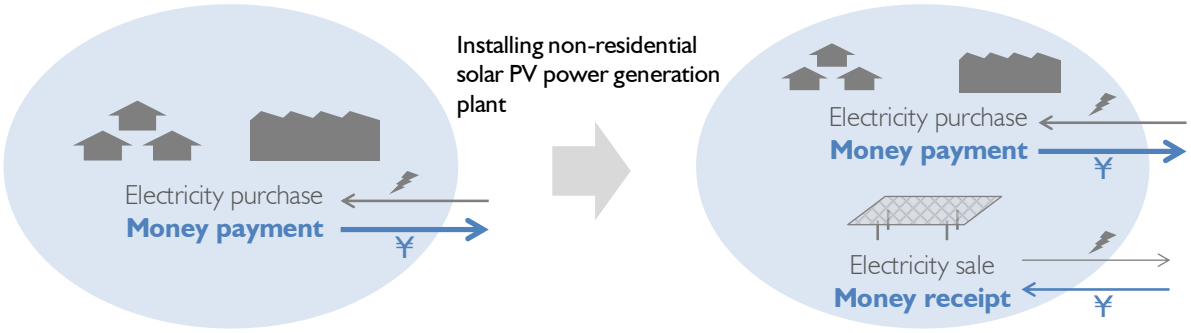
Keywords: Solar photovoltaic power generation, renewable energy, rural economy, Feed-in tariff

Attention-attracting solar photovoltaic power generation business

The Feed-in-Tariff system for renewables power generation has entered its fourth year. The cancellation of FIT approval for projects without land or equipment, the establishment of grid connection capacity limits, the enhanced power output control and other measures have reduced rapid growth in power generation capacity approved under the FIT system. Even so, an estimated 63 GW in FIT generation capacity is expected to be in operation at the end of FY2016[1].

Great expectations are placed on renewables that are domestically produced and emit no carbon dioxide. At the same time, renewables power generation is attracting attention as commercial business. While purchase prices for renewables power generation have gradually been lowered, renewables power generation still features a higher profitability and less risk than other business operations. Particularly, solar PV power generation can be launched even without resource or industry accumulation and used to take advantage of low land prices. Therefore, the non-residential solar PV business, including mega- and middle-solar plant operations, has attracted attention as a local (particularly rural) economic promotion measure.

Figure 1 | Expectations placed on local economic promotion by non-residential solar PV power generation business

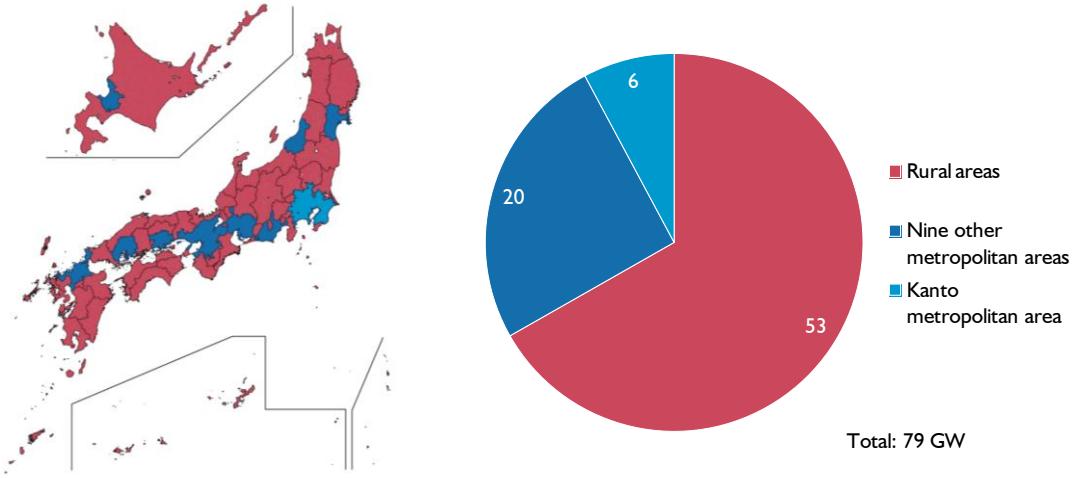


In fact, non-residential solar PV systems account for 79 GW of 108 GW in total power generation capacity by renewables approved under the FIT system (at the end of FY2014). Two-thirds of non-residential solar PV plants are in rural areas outside the 10 metropolitan areas[2] in Japan (Figure 2). This report estimates money flow to rural and other local economies and incomes/payments related with the non-residential solar PV power generation business.

[1] Yanagisawa, Shibata, et al. (2015) "Economic and Energy Outlook of Japan through FY2016"

[2] Sapporo and its neighbors, Sendai and its neighbors, Kanto metropolitan area, Niigata and its neighbors, Shizuoka/Hamamatsu and their neighbors, Chukyo metropolitan area, Kinki metropolitan area, Okayama and its neighbors, Hiroshima and its neighbors, and Kitakyushu/Fukuoka and their neighbors. See Appendix.

Figure 2 | Regional classification and non-residential solar PV power generation capacity



Note: Approved capacity at the end of FY2014
Source: Ministry of Internal Affairs and Communications [Regional classification], Website for FIT system information disclosure [Power generation capacity]

Exploiting FIT system for regional revitalisation?

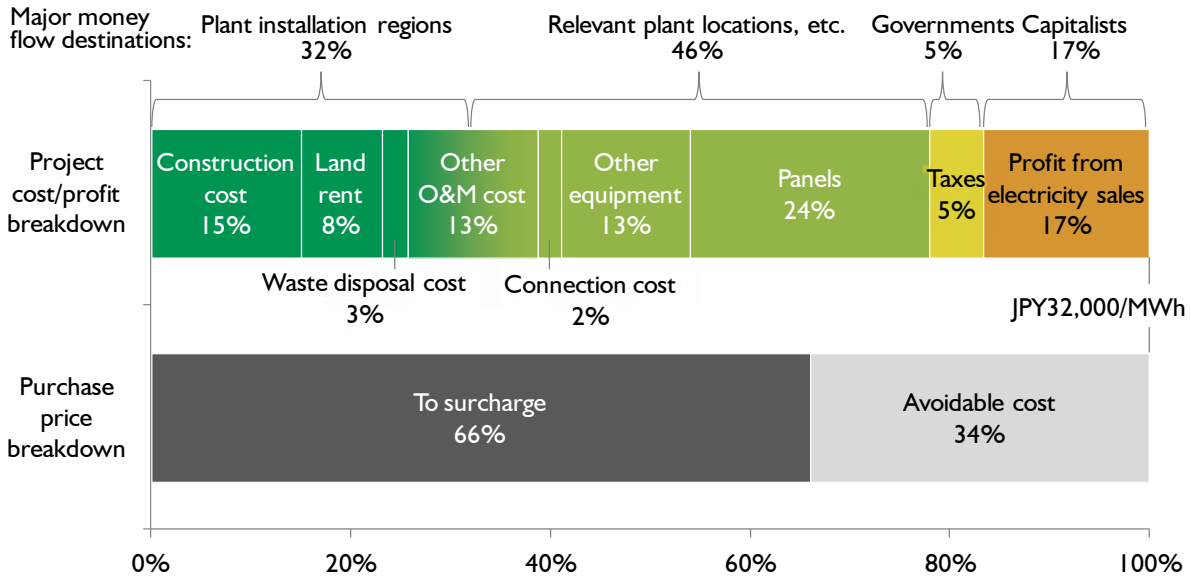
Non-residential solar PV power generation business cost/profit breakdown

The solar PV power generation business costs include those for purchasing, installing, maintaining and managing plants, as well as leasing land and paying fixed property tax. Of these costs, construction, land rent, weeding and some other costs represent incomes for economies of regions where plants are installed. However, solar PV panels and power conditioners are usually procured from other regions or foreign countries[3]. If capitalists of a solar PV project in a region are from outside the region, profit from electricity sales may not be left in the region.

The region in which a solar PV power generation plant is located is expected to get some one-third of the total project value (Figure 3). Meanwhile, nearly half the value is expected to go to other regions including foreign countries. Nevertheless, solar PV power generation projects can be expected to bring more money to rural economies than indicated by the sales pattern for the whole of the Japanese economy. In this sense, solar PV power generation projects may contribute to rural economic promotion.

[3] Imports accounted for 63% of solar panel shipments in Japan in FY2014 (Japan Photovoltaic Energy Association).

Figure 3 | Breakdown of model non-residential solar PV plant project cost/profit and of purchase price



Note: Indicative numbers for 2014
Sources: Estimated from Power Generation Cost Verification Working Group documents, etc.

The purchase price consists of the above cost and profit components. The price for non-residential solar PV projects approved in FY2014 stood at JPY32,000/MWh. The avoidable cost – the cost a power utility can save by purchasing electricity and cancelling planned power generation – accounts for some one-third of the price. The remaining two-thirds represent an additional cost for relatively expensive solar PV power generation. This portion is shouldered by electricity consumers in the form of surcharge according to consumption, irrespective of whether they are corporations or households. The high profitability and low risks of FIT projects are backed by the long-term unavoidable levy on consumers. The surcharge rose sharply from JPY350/MWh in FY2013 to JPY750/MWh in FY2014 and to JPY1,580/MWh in FY2015[4].

Incomes and payments assumed related with non-residential solar PV project in rural municipality

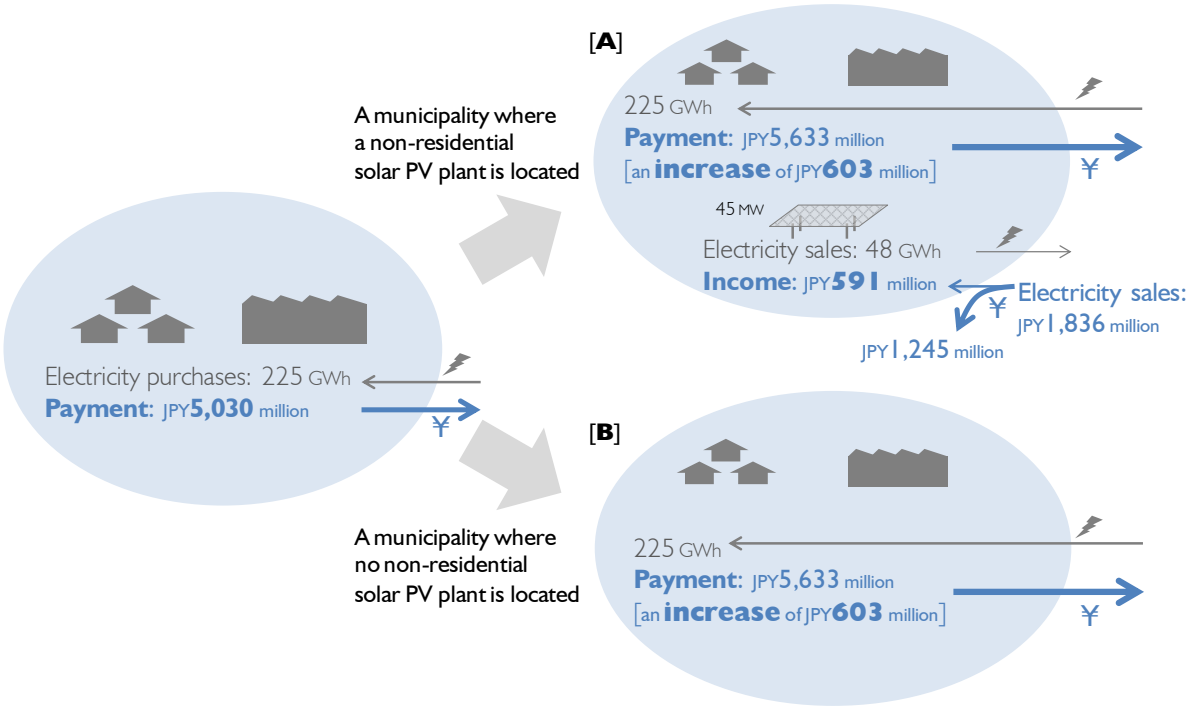
Here, a solar PV power generation project's impacts on regional incomes and payments are estimated. The estimation is based on a simple average picture for plants approved in rural areas in 2014 and 1,160 municipalities classified as rural – solar PV plants totalling 45 MW introduced in a municipality with slightly less than 40,000 residents, with relevant factories and capitalists for the project being outside the municipality (Figure 4-[A]).

Of JPY1,836 million[5] in proceeds from annual sales of 48 GWh from the power plants, the municipality receives some one-third or JPY591 million in the form of construction, land rent and other payments[6]. Meanwhile, the

[4] When explaining the FIT system bill at a plenary session of the House of Representatives on 14 July 2011, then Economy, Trade and Industry Minister Banri Kaieda said the system would be managed to prevent the surcharge from rising above JPY500/MWh.
[5] The electricity sales for the 45 MW plants installed in the region is based on a total of JPY64 trillion for all non-residential solar PV capacity approved throughout Japan as described later.

surcharge on 79 GW in non-residential solar PV power generation capacity approved throughout Japan stands at JPY2,680/MWh[7], indicating the total surcharge in the municipality – an increase for 225 GWh in electricity purchases – at JPY603 million. This means new income of JPY590 million against a payment increase of JPY600 million, resulting in a small loss. This is not because of the capacity of 45 MW. Even if all municipalities try to expand capacity in a bid to increase incomes from electricity sales and achieve some profit, the surcharge may rise proportionately, leaving the unprofitability unchanged.

Figure 4 | Incomes/payments related with electricity purchases and non-residential solar PV project



Note: Based on a simple average picture of 1,160 municipalities classified as rural. Relevant factories and capitalists are assumed to be outside the municipality.

While regions where solar PV plants are located can expect incomes from electricity sales, these plants' impact on other regions without solar PV plant is limited to an electricity purchase payment increase corresponding to the surcharge ([B] in Figure 4). Under the FIT system, therefore, regions having solar PV plants can impoverish those without such plants. Attention should be paid to the fact that all people in regions with these plants are not necessarily economic winners. Economic agents that have financial resources for launching power generation projects or can undertake peripheral business operations may benefit from the FIT system. For people or corporations that cannot be involved in power generation in their regions, however, electricity purchase payments increase due to the surcharge. A beggar-thy-neighbour effect can emerge even within a region where solar PV plants are located.

[6] The amount represents an annual average of the total cost for the entire project period. Actually, however, the construction cost is generated only in the first year.

[7] The surcharge is only for non-residential solar PV power generation. The surcharge for 108 GW in total renewables power generation capacity approved throughout Japan at the end of FY2014 stands at JPY3,190/MWh.

Box 1 | Economic problem for FIT system

The solar PV power generation business, though expected to help vitalise local economies, is failing to play such role and causing a beggar-thy-neighbour effect. Why?

The fundamental reason is the high price. For consumers, the energy service from electricity consumption would be the same whatever the power generation method is. If the value of a service remains unchanged with the price of the service being raised forcefully, an adverse effect may emerge. The effect generally takes the form of a decline in consumer surplus.

If the purchase price declines to the equivalent of alternative power generation costs or avoidable costs, or even lower levels, thanks to a substantial drop in renewables power generation costs under the rapid advancement of technologies, the problem will be resolved. Renewables power generation operators will acquire profits from electricity sales, while electricity consumers will benefit from lower-priced electricity.

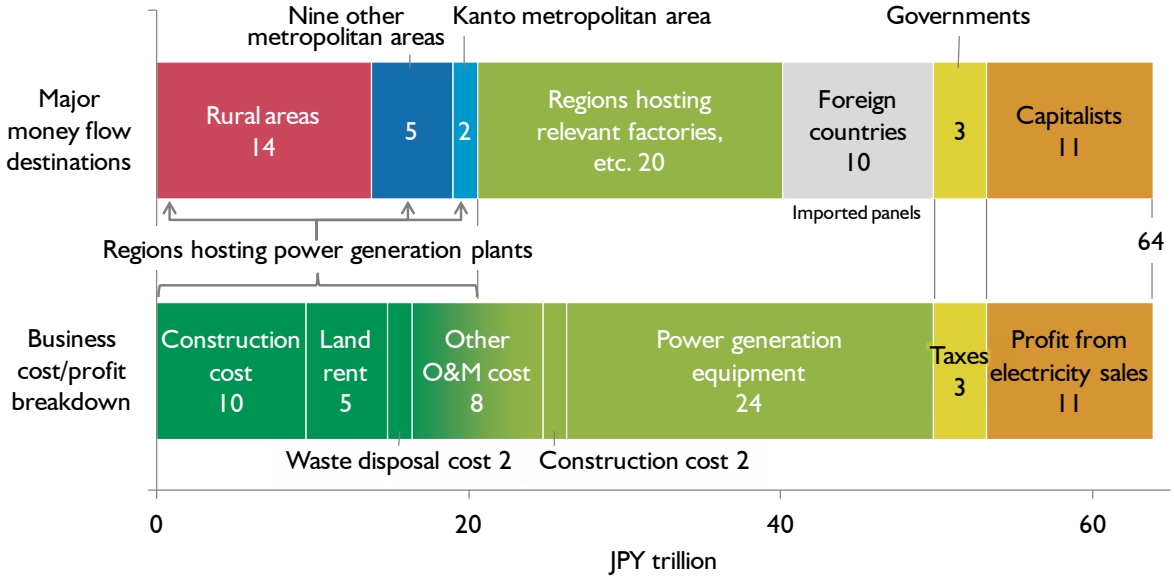
Macroeconomic description of money flow destinations and incomes/payments related with non-residential solar PV power generation business

How would the macroeconomic picture be for money flow destinations and incomes/payments related with the non-residential solar PV power generation business? If all 79 GW in total non-residential solar PV power generation capacity approved at the end of FY2014 starts operation, the total business value (equal to total purchase payments) over the FIT period of 20 years will total as much as JPY64 trillion. According to the cost and profit breakdown in Figure 3, domestic payments will total JPY54 trillion excluding JPY10 trillion[8] in payments for solar PV panel imports[9]. A region-by-region breakdown of money flow to regions hosting power plants based on a breakdown of approved power generation capacity in Figure 2 indicates that JPY14 trillion would flow to rural areas while half the amount would go to metropolitan areas (Figure 5). Accounting for the largest share of money flow related with solar PV power generation will be regions hosting factories that provide goods and services for solar PV power generation (Box 2).

[8] Total business value of JPY64 trillion × panel cost rate of 24% × panel import rate of 63%

[9] Given that foreign capitalists have invested in many solar PV projects, outflow from Japan, including profit from electricity sales, would be far larger.

Figure 5 | Money flow destinations related with non-residential solar PV power generation business



Note: Indicative numbers based on non-residential solar PV power generation capacity approved at the end of FY2014.
Sources: Estimated from Website for FIT system information disclosure, Power Generation Cost Verification Working Group documents, etc.

Box 2 | Where are the relevant factories and capitalists?

Although a total of JPY20 trillion is estimated to go to relevant factory-hosting and other regions, the total is difficult to break down by region because of statistical constraints. However, it may be easily suspected that money may not be distributed evenly throughout Japan. As for panels representing solar PV equipment, for example, solar cell module manufacturers belonging to the Japan Photovoltaic Energy Association have factories in only 22 of about 1,700 municipalities in Japan (Table 1).

Table 1 | Cell module factory locations

Areas	Number of municipalities	Municipalities
Rural areas	10	Kazuno City of Akita Prefecture, Tendo City of Yamagata Prefecture, Iida City of Nagano Prefecture, Saku City of Nagano Prefecture, Ise City of Mie Prefecture, Toyooka City of Hyogo Prefecture, Unnan City of Shimane Prefecture, Sanyoonoda City of Yamaguchi Prefecture, Miyazaki City of Miyazaki Prefecture, Kunitomi Town of Higashi Morokata County in Miyazaki Prefecture
Nine other metropolitan areas	12	Ishikari City of Hokkaido Prefecture, Ohira Village of Kurokawa Country in Miyazaki Prefecture, Otsu City of Shiga Prefecture, Yasu City of Shiga Prefecture, Higashiomi City of Shiga Prefecture, Kyoto City of Kyoto Prefecture, Nagaokakyo City of Kyoto Prefecture, Sakai City of Osaka Prefecture, Kaizuka City of Osaka Prefecture, Himeji City of Hyogo Prefecture, Tatsuno City of Hyogo Prefecture, Hisayama Town of Kasuya County in Fukuoka Prefecture
Kanto metropolitan area	0	None

Major mega-solar plant operators are listed in Table 2. Although solar PV plant operators may invite more capitalists to invest funds, projects are financed primarily by capitalists outside project regions as far as large-scale solar PV power generation is concerned.

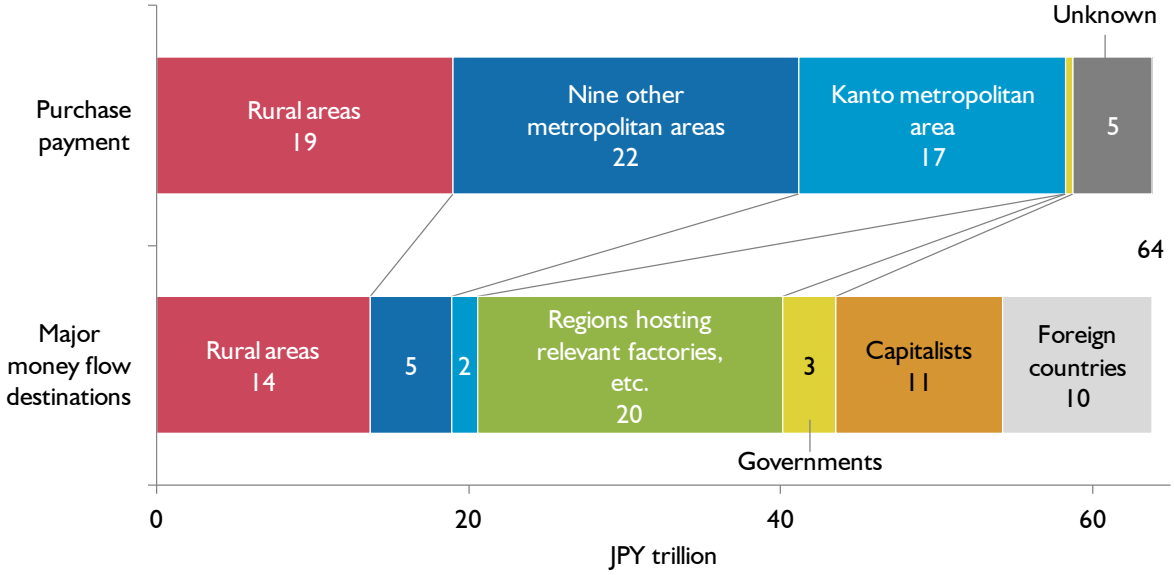
Table 2 | Major mega-solar plant operators

Project	Location	Capacity (MW)	Operators
Ukujima Mega-solar Park	Sasebo City, Nagasaki Prefecture	430	Photovolt Development Partners, Ukujima Mega-solar Park Service, Kyocera, Kyudenko, Orix, Mizuho Bank
Setouchi Mega-solar Project	Setouchi City, Okayama Prefecture	231	Setouchi Kirei Mirizukuri Rengotai (IBM Japan, NTT West, Toyo Engineering, Shizen Energy, GE, Kuniumi Asset Management, German International)
Eurus Rokkasho Solar Park	Rokkasho Village, Kamikita County, Aomori Prefecture	148	Euras Energy Holdings
SoftBank Tomatoabira Solar Park	Abira Town, Yufutsu County, Hokkaido Prefecture	111	Mitsui & Co., SB Energy
Watari Town Mega-solar Project	Watari Town, Watari County, Miyagi Prefecture	100	NTT Group
Minamisoma Mega-solar	Minamisoma City, Fukushima Prefecture	100	Toshiba, Taisei, Sojitz
Pacifico Energy Hosoe Mega-solar	Miyazaki City, Miyazaki Prefecture	96	Pacifico Energy, GE Energy Financial Services
Kanoya Osaki Solar Hills Solar Power Plant	Kanoya City / Osaki Town, Soo County, Miyazaki Prefecture	92	Kanoya Osaki Solar Hills Godogaisha (Gaia Power, Kyocera, Kyudenko, Tokyo Century Lease)
Oita Solar Power	Oita City, Oita Prefecture	82	Marubeni
Tahara Solar No. 1/2 Power Plants	Tahara City, Aichi Prefecture	81	Tahara Solar (Mitsubishi Corp., Ceatec, Mitsubishi UFJ Lease & Finance)

Source: PVeyeWEB

As for payments, corporations and households in metropolitan areas must shoulder at least JPY39 trillion out of JPY64 trillion in payments for purchasing electricity generated by solar PV (Figure 6). The amount is far heavier than JPY7 trillion in almost secure returns to metropolitan areas. Rural areas' payments also total as high as JPY19 trillion. Rural areas' payments may exceed JPY14 trillion that is expected to go to rural areas under the FIT system, depending on local industries and the locations of capitalists.

Figure 6 | Incomes/payments related with non-residential solar PV power generation business



Note: Indicative numbers based on non-residential solar PV power generation capacity approved at the end of FY2014. The "unknown" portion includes construction, information and communications, financial and other sectors of which regional data are not made available in the Economic Census.
Sources: Estimated from Website for FIT system information disclosure, Cabinet Office "SNA Input-Output Table," Ministry of Internal Affairs and Communications "Economic Census," Ministry of Economy, Trade and Industry "Energy Consumption Statistics," Power Generation Cost Verification Working Group documents, etc.

Balancing benefits to be gained with acceptable costs

If 79 GW in solar PV power generation capacity approved at the end of FY2014 replaces liquefied natural gas-fired power generation, carbon dioxide emissions may be cut by about 640 Mt over two decades. LNG import savings may total JPY13 trillion exceeding solar PV panel imports even at the present time when international LNG prices have declined[10]. If not only imports but also power generation costs as a whole are taken into account, however, solar PV power generation still costs more than LNG-fired power generation[11], bringing about electricity price hikes. In this sense, a massive spread of solar PV power generation inevitably brings about an overall economic loss.

The FIT system can bring about profit for some entities at low risk. However, the profit will emerge from high electric bills that households and corporations in all regions including rural areas would pay over a long time. A massive surcharge may lead renewables power generation regions and operators to impoverish the other regions and business operators. The estimates given in this report, though based on specific assumptions, indicate that we must objectively recognise that the FIT system could fail to support local revitalisation, contrary to general expectations.

[10] Calculated at the import CIF price of JPY55,252/t in June 2015.
[11] For example, the Power Generation Cost Verification Working Group has estimated the unit LNG-fired power generation cost for a 2014 model plant at JPY13,700/MWh (including JPY1,300/MWh for carbon price, with the LNG import CIF price being an average of JPY88,657/t for 2014), against JPY24,200/MWh for mega-solar PV power generation.

How to balance benefits from renewables power generation with acceptable costs is a realistic problem that should always be kept in mind.

Appendix: Definitions and estimation approach

Definition of regional classification

The definition of "Metropolitan and Urban Areas in the 2010 Population Census" is adopted here.

The 10 metropolitan areas are Sapporo, Sendai, Kanto (including Tokyo), Niigata, Shizuoka/Hamamatsu, Chukyo (including Nagoya), Kinki (including Osaka), Okayama, Hiroshima, and Kitakyushu/Fukuoka. A metropolitan area consists of a core city (cities), its neighbouring municipalities from which 1.5% or more of workers and students aged 15 or more commute to the core city, and other municipalities surrounded geographically by those neighbouring ones. In this report, municipalities outside the metropolitan areas are considered to be rural.

Breaking down solar PV power generation cost and profit

Estimating a breakdown of solar PV power generation cost and profit for a model plant

Estimated from Power Generation Cost Verification Working Group "Specifications of Each Electricity Source" (26 May 2015), Ministry of Economy, Trade and Industry "Present Situation and Challenges Involving Renewable Energy" (17 June 2014), and Cost Verification Commission "Specifications of Each Electricity Source" (19 December 2011). Tax covers fixed property and enterprise taxes. The panel import rate is from FY2014 domestic module shipments in "Solar Cell Shipment Statistics" by the Japan Photovoltaic Energy Association.

Major money flow destinations

The total business value is estimated from approved capacity. The total business value is prorated to relevant regions according to approved capacity. The region-by-region business value is broken down by money flow destination in line with business cost and profit shares.

The total purchase payments at JPY64 trillion are calculated from the approved capacity on the website for FIT system information disclosure, fixed prices and the capacity factor of 12%. The total business value is equal to the total payments. Cost burden coordination agency costs are ignored.

Approved capacity by municipality on the website for FIT system information disclosure is compiled into a region-by-region breakdown. The total nationwide business value is prorated to relevant regions according to approved capacity. The region-by-region business value is broken down by money flow destination in line with earlier-estimated business cost and profit shares for non-residential solar PV power generation.

Purchase payments by area

The total payments are prorated in line with regional light and power electricity purchases.

As for light services mainly for households, nationwide light electricity sales are prorated to regions in line with population in "Population, Demographic Situation and Number of Households Based on Resident Registry" (25 June 2014) by the Ministry of Internal Affairs and Communications.

Power services (including those for specific demand sizes) mainly for the industrial sector are prorated as follows: (1) Electricity consumption per production by industrial category is calculated from output by industrial category in the "SNA Input-Output Table (2013)" by the Cabinet Office and electricity consumption by industrial category in the Energy Consumption Statistics (2013) by the Ministry of Economy, Trade and Industry. (2) Production by industrial category and region is compiled from the "Economic Census [Activity Survey] (2012)" by the Ministry of Internal Affairs and Communications. Nationwide power electricity sales are prorated to regions in line with each region's share of power electricity consumption as determined in the first and second steps. Data for construction, information and communication, transportation, finance and other sectors whose regional data are not available in the Economic Census are classified as unknown. Consumers and payers are considered to be identical to each other. Payment relief measures are ignored.

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