10 Impact of Chinese renewable technology exports on Japan's energy transition

The case of the solar photovoltaic industry

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1 Introduction

Triggered by the need for renewable energy, the installation of solar photovoltaic (PV) systems has increased in the past decade. The cumulative capacity in the world increased from 15 GW in 2008 to 505 GW in 2018 (REN21, 2019). Although advanced countries such as the United States, Japan, and Germany led in its research and development (R&D), application, and diffusion, PV technology has experienced a major change in the past decade, such as the emergence of new players from emerging countries, such as China, Taiwan, and South Korea, in manufacturing, and the remarkable price drop in PV cells and modules (Carvalho, Dechezleprêtre, & Glachant, 2017; Wu & Mathews, 2012). This also intensified industry competition and bankruptcy of some PV manufacturers in the previous leading countries in PV (Carvalho et al., 2017; WIPO, 2017). As of 2018, China's share of world solar cell production was approximately 74%, and its PV system installation was approximately 44% of the world annual installation (RTS, 2019). These findings reveal that a certain portion of Chinese solar products has been exported overseas to maintain this production. Facing the pouring of the Chinese PV products into other countries' markets, some countries such as the United States and those in the European Union have imposed anti-dumping and anti-subsidy tariffs as countermeasures. In summary, China is the main player in the global PV market, and other governments must tackle its "power" when promoting solar PV installation in their countries.

Feed-in tariff (FiT) is a policy tool frequently employed when promoting the diffusion of renewable energy. The implementation of FiT, which creates business incentives for renewable energy installation, starting with the European countries such as Germany and Spain, has also supported the emergence of these new players, such as China and Taiwan. From the 1990s to the early 2000s, Japan ranked first in PV installation and manufacturing in the world, with its PV manufacturers such as Sharp and Kyocera, as global major PV firms. Japan as the leader was replaced by Germany, which introduced FiT to facilitate PV diffusion. In addition, Japanese manufacturers' PV products exported to Europe competed with the aforementioned

emerging players. Where FiT was executed, Chinese and other overseas PV products entered these markets. Japan introduced FiT in 2012 as well, which resulted in the rapid diffusion of PV, and became 3rd in the cumulative PV capacity in the world (as of 2018; ISEP, 2019). Perhaps not surprisingly, as reported in the mass media, this diffusion has been, to a certain extent, supported by the large import of foreign PV cells and modules, particularly those of China, into Japan's market, which is competition for Japanese PV manufacturing. Additionally, this quick solar PV diffusion has been driven by the FiT mechanism; hence, an increasing financial burden to citizens has become a concern in Japan's discussion on energy policies.

As stated in its FiT law,¹ the Japanese government intended that the FiT mechanism would not only facilitate renewable energy diffusion but also contribute to "...promotion of Japanese industry and the revitalization of local communities" (Article 1). However, if the situation does not progress as the policy intended, as the media has reported, negative feedback may be observed or at least an adjustment will be necessary. Thus, we pose this question: How has the import of Chinese PV products affected Japan's PV industry and its related policies?

Regarding the solar PV deployment in Japan during recent years, the aforementioned reports in the media have provided some simple numbers, situations, and voices from the industry but neither a comprehensive picture of the detailed data nor analyses based on it. Some researchers have investigated Japan's high cost of PV system installation (Kimura, 2019; Kimura & Zissler, 2016). Others have investigated problems related to the quick diffusion of utility-scale PV systems (Fraser & Chapman, 2018; Yamashita, 2018) or community power in Japan (Yamashita & Fujii, 2016). Additionally, still other work, such as that of Muhammad-Sukki et al. (2014), has indicated that FiT in Japan ensures an increasing installation of solar PV in the following years.

Covering the suggestions for Japan, analysis of the Chinese PV industry has attracted interest. Marukawa (2012) analyzed the development of the Chinese PV industry and suggested that it is not a smart move to exert a protectionist procedure on the Chinese PV products. Moreover, based on the China case, Marukawa (2014) indicated that the FiT scheme has caused negative competition in the PV industry. These studies have demonstrated some aspects and perspectives on the recent PV market and installation in Japan but cannot portray the real condition of the impact of Chinese PV products on Japan.

Therefore, in this chapter, we fill this gap in the literature and explore two research questions:

- 1 What is the actual importation of Chinese and foreign PV products into the Japanese market and its impact on the PV industry, and how have the Japanese PV manufacturers responded to this?
- 2 What is the impact on Japan's renewable energy-related policies responding to the situation on the importation of Chinese PV products and reflecting the impact on the Japanese PV industry?

The remainder of this chapter is structured as follows: Section 2 presents the methodology and data used in this research; Section 3 discusses our first research question, and we briefly review the development of Japan's PV industry and investigate the situations of the PV industry after FiT was introduced; Section 4 provides the feedback from the government and examines adjustments in energy policy, answering our second question; Section 5 discusses the results from Sections 3 and 4; and Section 6 concludes the chapter.

2 Methodology and data collection

To understand the changes in Japan's PV market and the penetration of Chinese products, we collected numerical data and plotted charts to understand the trends between Japanese and Chinese/foreign PV products. We compiled the number of shipments of solar cells/modules from the Japan Photovoltaic Energy Association (JPEA), and data of production value from the Optoelectronics Industry and Technology Development Association (OITDA) to present annual changes in Japan's PV market in domestic and overseas production. Because the data show only Japanese and overseas production, information from news articles that indicated the shares of PV system brands in the market was compiled to verify the influence of Chinese manufacturers in the market.

Regarding the response from Japanese manufacturers, we focused on the five major Japanese PV firms: Sharp, Kyocera, Panasonic, Mitsubishi Electric, and Solar Frontier. We traced their moves after the introduction of FiT by searching news articles from the database of the *Nihon Keizai Shimbun* (Nikkei), mainly from 2012 to early 2020, with some solar PV-related articles from *Smart Japan* as supplementary information. A chronological completion of the main events was then summarized to a table to understand the companies' business strategies.

For the second research question on the response from the Japanese government, we conducted interviews with Japanese government officials at the Agency of Natural Resource and Energy, Ministry of Economy, Trade and Industry (METI) on February 8 and November 11, 2019, and attempted to analyze major characteristics of the Japanese government's policy-making to manage the penetration of overseas PV products in Japan's market. The interviews were, among others, with the Director and Director-General in charge of renewable policy at METI.

3 Import of Chinese solar modules and its impact on Japan's PV market

3.1 Solar PV diffusion in Japan

Renewable energy (conventional hydropower included) in Japan's power generation increased from 10.5% (2011) to 17.4% (2018), among which 6.5% is from solar power (ISEP, 2019). The cumulative PV capacity of Japan

Figure 10.1 Annual and cumulative installed PV capacity in Japan.

Sources: Charted by the authors based on the data compiled from the IEA, “Japan National Photovoltaics Status Report 2012,” and Snapshot of Global PV Markets 2014–2019.

reached 55 GW (Figure 10.1), which ranks third in the world, behind China and the United States.

The R&D of PV in Japan has a long history. Because of the oil crisis, the Japanese government launched the Sunshine Program (1974–1992) to support the R&D for searching for alternative energy sources, among which solar power was included (Table 10.1). This induced private companies to join the R&D of solar energy technology. Japan succeeded in initiating and practicing the world’s first connection of residential photovoltaic power generation to feed-in to the grid to the utility (reverse power flow). With the subsidy support, Japan promoted the earliest residential use PV diffusion (NEDO, 2007). This leading position was triggered by the government’s support, and Japan has ranked first in PV installation and manufacturing in the world since the late 1990s. Subsequently, regarding policy measures promoting renewable energy, Japan introduced a renewable portfolio standard (RPS) instead of FiT in 2003, which is one reason why Japan lost its leading position in solar PV (Muhammad-Sukki et al., 2014; Taki, 2018).

The Fukushima nuclear disaster in 2011 highlighted Japan’s power system problems and was a driver for the Japanese government to reconsider its energy policy. A comprehensive FiT scheme was introduced in July 2012 to promote the diffusion of renewable energy in Japan. The scheme, particularly because of its preferential rates during the first three years, ensured a diffusion of renewable energy and a prosperous renewable energy market

Table 10.1 Development of solar PV in Japan

Year	Events
1974	Sunshine Program
1992	– Surplus electricity purchase for residential solar panels; initiated the idea of reverse power flow – End of Sunshine Program
1993	Kyocera launched Japan's first residential solar power generation system
1994	Subsidy for residential PV system
1997	Japan ranked first in PV installation in the world (1997–2004)
1998	Kyocera ranked first in solar PV manufacturing
1999	Japan surpassed the United States, ranked first in solar PV manufacturing
2000	Sharp ranked first in solar PV manufacturing
2003	Introduction of RPS
2005	– Germany surpassed Japan as first in PV installation – Abolition of subsidy for residential PV system (revival in 2009) – Top 5 PV manufacturers in the world: Sharp, Q-Cells, Kyocera, Sanyo, and Mitsubishi
2007	Q-Cells (Germany) ranked 1st
2009	FiT for residential solar PV (only for surplus electricity)
2010	Four of the Top 5 of PV manufacturers in the world are Chinese firms
2011	Fukushima nuclear disaster
2012	Introduction of FiT for all renewables

Sources: NEDO (2007); Shimamoto (2012); Taki (2018); summarized by the authors.

(Muhammad-Sukki et al., 2014). Because PV has a short lead time, unlike wind power, whose deployment is subject to environmental impact assessments, a rapid growth subsequently occurred in solar power installation after FiT was introduced.² The total installation of PV was approximately 4,900 MW in 2011 but soon reached 13,500 MW at the end of 2013. The average annual installation was approximately 8,200 MW in recent years. This rapid diffusion caused Japan to surpass Germany in the cumulative PV capacity, and to rank the third, only behind China and the United States (ISEP, 2019). However, rates of FiT decreased rapidly, from 40 JPY/kWh in 2012 to 21 JPY/kWh in 2017, that is, reduced by half (the case for 10 kW–2 MW; Table 10.2). The auction scheme started in 2017.

Different from Japan's history of being the leader in PV and Germany's growth in PV installation, the global PV industry has a different outlook now. That is, in 2006, four of the top 10 global major solar cell manufacturers were Japanese and one was Chinese, and in 2011, one Japanese manufacturer remained in the top 10 list, and the Chinese manufacturers accounted for six in the top 10, becoming the main global players (Movellan, 2016; Shimamoto, 2012, p. 101). This result reveals a more complicated policy planning process other than the old measure of “diffusion triggers the PV industry” might be necessary.

The introduction of FiT has rapidly diffused PV in Japan. The cost for PV system installation has reduced 32%, from JPY 421,000 in 2012 to JPY 286,000 in 2018 (Procurement Price Valuation Committee, 2019, pp. 9–10).

Table 10.2 Rates of FiT in Japan

Fiscal year	>2,000 kW	500–2,000 kW	10–500 kW	<10 kW (no obligation to install output control compatible devices)		<10 kW (obligation to install output control compatible devices)	
				(Double power generation)		(Double power generation)	
2012	40	40	40	42	34	42	34
2013	36	36	36	38	31	38	31
2014	32	32	32	37	30	37	30
2015	27	27	27	33	27	35	29
2016	24	24	24	31	25	33	27
2017	17.2–21*	21	21	28	25	30	27
2018	14.25–15.45*	18	18	26	25	28	27
2019	*	*	14	24	24	26	26

Note: Rate represents 1 kWh/JPY (Japanese Yen). * means “via auction.”

However, issues such as grid connection and the financial burden on the citizens, which resulted from the FiT scheme, particularly the preferential rates for the first three years of FiT introduction, became the concerns. Although the rate of FiT has been halved after its introduction, the cost of installing a PV system in Japan remains higher than that in other countries; thus, the call to further reduce the price. In addition, attracted by favorable FiT rates, foreign PV manufacturers’ entrance into the Japanese market has threatened Japan’s manufacturers and its PV industry. Hence, although a useful measure to promote the diffusion of renewable energy (Morotomi, 2015), FiT has become a target of criticism in Japan.

3.2 Penetration of China’s PV products into Japan’s market

Introducing FiT changed Japan’s PV industry from exporting PV overseas to domestic selling and importing foreign cells and modules (JPEA, 2012, 2013, 2015). The domestic consumption of PV shifted from mainly for residential use to nonresidential use (large scale). The domestic shipment of PV increased from approximately 1,000 MW in 2011 to over 9,000 MW in 2014 (Figure 10.2). Among them, domestically produced PV increased three times, from 1,034 to 3,688 MW. Additionally, Japanese manufacturers imported cells from overseas, such as from China and Taiwan, as original equipment manufacturers, to fulfill domestic need (JPEA, 2013). In the beginning stage of FiT, namely, around 2013–2014, there were over 50% imported products in the market, and foreign brands owned approximately 30% share of the market (Figure 10.2). Both domestic and overseas products reached their peak of shipment in 2014 (Figure 10.2). In terms of brands in shipment, the share of Japanese brands (overseas production included) was

approximately 70% in 2014 and has been below 50% since 2018; thus, foreign brands possess more of the market share than Japanese brands do. We further examined manufacturers' production location: approximately 37.42% of modules shipped to the domestic market were manufactured in Japan by Japanese manufacturers in 2014, but this share gradually decreased to less than one-fifth (17%) of the total market in 2019 (Figure 10.3).

Figure 10.2 Shipment of domestic and foreign solar cells/modules in Japan's PV market.

Note: The data present the shipment of cells and modules during 2008–2012 and modules after 2013.

Sources: Compiled by the authors based on the data from JPEA (2009–2020).

Figure 10.3 Share of Japanese brand and foreign brand PV modules in Japan's market.

Source: The authors charted the information based on the data from JPEA (2014–2020).

In terms of production value, the peak of Japan's PV industry value was in the fiscal year (FY) of 2014, accounting for JPY 3.01 trillion, and continued to decrease; in 2018, the figure was almost half that (1.58 trillion; Figure 10.4). The introduction of FiT only benefitted domestic production value in solar cells/modules in the beginning (FY 2012, 2013), with a margin smaller than that of FY 2011 (Figure 10.5). The overseas production value soon surpassed the domestic production value, in FY 2013, revealing that the Japanese firms relied on the imported products.

Although the decline in FiT rates led to the downsizing of the market scale, foreign brands produced overseas maintained a steady shipment of modules after 2014 and have had recent growth (2018–2019; Figure 10.6). The domestic module production of Japanese brands continued to decline, and finally, the overseas production surpassed domestic production, namely, the Japanese manufacturers produced more modules overseas than domestically. In addition, this finding reveals that Japanese PV manufacturers rely not only on imported cells but also on modules manufactured overseas.

Regarding the major PV cell and module manufacturers, 90% of the market share belonged to the major Japanese manufacturers, for example, Sharp, Kyocera, and Panasonic (Figure 10.7a–g). In the early stage after introducing FiT (FY 2013), the top five manufacturers, all Japanese, maintained approximately 64% of the market share. In FY 2014, foreign manufacturers entered the top five, where JA Solar (Chinese) was third and Canadian Solar

Figure 10.4 Domestic production value of PV industry in Japan.

(Unit: JYP hundred million; fiscal year)

Note: FY 2018 is expected value.

Sources: Adapted from OITDA (2019:12).

Figure 10.5 Production value of solar cells and modules in Japan (Japanese manufacturers).

Note: X-axis presents the fiscal year. FY 2018 is the expected value.

Sources: Compiled and charted by the authors based on data from OITDA (2014–2019).

(Canadian) was fifth. Since FY 2015, three of the top five manufacturers have been from Canada, China, and South Korea. In FY 2018, for the first time in Japan's history, a foreign brand, Hanwha Q-Cells (Korean), ranked first in the Japanese market. In addition, the Japanese manufacturer that had ranked first obtained approximately 30% of the market share, but this decreased to approximately 10% for the top five firms after FY 2015, revealing the fierce competition in the PV market.

These compiled data and figures and the aforementioned analysis show that the manufacturing and deployment of PV in Japan is increasingly relying on overseas production and foreign brands.

3.3 Impact on and response from the Japanese PV manufacturers

The data and analysis demonstrate that Japanese manufacturers could have maintained their market shares at the initial stage of introducing FiT, although they provided more expensive products than foreign manufacturers did. This result could be attributed to the preferential rates of FiT during the first three years. However, as the rates decreased, increasingly more foreign brands and overseas products entered the market. The marketing battle then shifted from large-scale PV to residential PV, which was where

Japanese companies had the advantage. Some even referred to the battle-field as the last stronghold for the Japanese PV manufacturers competing with the prevailing Chinese solar modules (Matuki, 2019). This advantage for Japanese manufacturers can be attributed to several reasons. One reason is that Japan has promoted residential PV domestically and advanced

Figure 10.6 Shipment of Japanese brand and foreign brand PV modules with different production locations.

Source: The authors charted the information based on the data from JPEA (2014–2020).

Figure 10.7a Top five PV manufacturers in Japan's market (2011 fiscal year).

(Unit: %)

Sources: Data compiled from Nikkei Sangyo (2012) and charted by the authors.

Figure 10.7b Top five PV manufacturers in Japan's market (2012 fiscal year).

(Unit: %)

Sources: Data compiled from Nikkei Sangyo (2013a) and charted by the authors.

Figure 10.7c Top five PV manufacturers in Japan's market (2013 fiscal year).
(Unit: %)

Sources: Data compiled from Nikkei Sangyo (2014) and charted by the authors.

Figure 10.7d Top five PV manufacturers in Japan's market (2014 fiscal year).
(Unit: %)

Sources: Data compiled from Nikkei Sangyo (2015) and charted by the authors.

Figure 10.7e Top five PV manufacturers in Japan's market (2015 fiscal year).
(Unit: %)

Sources: Data compiled from Nikkei Sangyo (2016) and charted by the authors.

Figure 10.7f Top five PV manufacturers in Japan's market (2016 fiscal year).
(Unit: %)

Sources: Data compiled from Nikkei Sangyo (2017) and charted by the authors.

Figure 10.7g Top five PV manufacturers in Japan's market (2017 fiscal year).
(Unit: %)

Sources: Data compiled from Nikkei (2018) and charted by the authors.

Legend of Figure 10.7
Note: Different patterns in the legend represent the nationalities of the PV manufacturers.

its R&D. A second reason is that Japanese PV manufacturers have their sales channels such as through house builders to market their PV systems. Furthermore, the Japanese brand is highly accepted in the domestic market because of its high quality. Some have even indicated a “tacit rule” in the Japanese market: the adoption of made-in-Japan PV panels is a condition for solar financing (Nikkei Sangyo, 2013b).

On the basis of the shipment data according to PV usage (Figure 10.8), Japanese brands prevail over foreign brands by holding 70%–80% of the residential PV market. However, this share is declining, decreasing from 87% in 2015 to 76% in 2019. By contrast, the share of foreign brands almost doubled its growth (from 12.64% to 23.28%). Regarding nonresidential PV, the Japanese manufacturers possessed more than half the market share (56.59%) in 2015, but that decreased to approximately 40% in 2019. Thus, Japanese manufacturers are losing their market shares in not only nonresidential PV but also in residential PV. Thus, we would not be surprised if the penetration of foreign brands becomes more obvious in the market, as long as the FiT rates continue decreasing or the government adjusts the scheme while the foreign manufacturers continue their marketing in Japan.

Because of the introduction of FiT and the foreign PV manufacturers that thus entered into the market, the Japanese manufacturers have implemented strategies and adjusted their businesses to respond to this change (Table 10.3). In the beginning, because FiT was passed, the emerging needs of PV systems were expected, and hence, manufacturers expanded their production. The resulting competition from cheap Chinese solar modules also propelled them to attempt to reduce the cost, causing them to adopt actions

Figure 10.8 Share of Japanese brand and foreign brand PV modules in Japan's market according to usage.

Sources: The authors charted the information based on the data from JPEA (2015–2020).

Table 10.3 Moves/business strategies of the major Japanese PV manufacturers during recent years

<i>Manufacturers</i>	<i>Moves</i>
Sharp	<ul style="list-style-type: none"> increased staff to manage mega solar power generation business reduced the production of solar cells at its Katsuragi factory and consolidated them at its Sakai factory started manufacturing a new type of solar cell with a power generation efficiency 20% higher than the conventional types at the Sakai factory expanded sales via their joint company with LIXIL (a manufacturer of building materials and housing equipment) procured cells from foreign companies provided services from construction to operation of solar power generation continual development of solar technology (combination of InGaP, GaAs, and InGaAs) and realized the world's highest level of conversion rate
Kyocera	<ul style="list-style-type: none"> manufactured cells in Japan and shipped them to its factory in Europe to assemble panels to reduce cost and fulfill needs improved existing facilities rather than increasing manufacturing lines sold PV with its other energy-efficient products in 2017, terminated panel assembling at its Ise factory, switched to outsourcing and producing at group companies in China accelerated the shift to business in Southeast Asia consolidated manufacturing at its Yasu factory increased automation of its production developed business in “providing [a] service” other than selling products, such as leasing PV systems
Panasonic	<ul style="list-style-type: none"> focused on residential PV sold solar power storage systems marketed through the sales channels of Panasonic and the former Panasonic Electrical Works Co. in 2012, adjusted its overseas solar panel production system: reducing overseas panel assembling and setting up its first overseas factory that realized vertically integrated production in Malaysia in February 2016: <ul style="list-style-type: none"> stopped operating the Hama factory, one of the three domestic factories producing residential PV, because of sluggish demand. increased profitability by increasing sales of storage batteries and other system products in addition to panels expanded sales in emerging markets such as that in India by using its main production facility in Malaysia in August 2017: cooperated with Tesla (US) to set up a factory in Buffalo manufacturing solar cells, which is planned to provide products to Tesla exclusively in FY 2017: <ul style="list-style-type: none"> terminated assembling at its Shiga factory

- ceased silicon material manufacturing at its Oregon factory
 - focused on cell manufacturing and overseas sales
 - in 2018: announced switching the exclusive supply contract with Tesla for solar cells to supply them to other companies within the United States
 - in 2019:
 - announced the selling of its Malaysia factory to GS Solar (China) but will continue procuring modules from it
 - sold cells made in its Buffalo factory to Japanese housebuilders
 - in February 2020: ended the cooperation of joint production of solar cells with Tesla
 - in July 2020: announced the termination of the contract with GS Solar (i.e., not selling Malaysia factory)
- Mitsubishi Electric
- strengthened sales for nonresidential PV by using the group's sales channels
 - terminated production of cells, kept solar panel manufacturing and roof installation in 2018
 - ceased manufacturing and sales of its brand of solar power systems by the end of March 2020 (i.e., total withdrawal from the manufacture and sale of own-brand equipment related to solar power generation); formed a partnership to introduce Kyocera's products, if necessary
- Solar Frontier
- in 2013:
 - restarted its Miyazaki 2nd factory to fulfill domestic needs
 - developed and produced PV cells that maximize the efficiency under the Japanese weather conditions
 - in 2015:
 - operated its new factory (Tohoku factory) with the newest mass-production technology, aimed at acquiring overseas production and sales
 - promoted Build-operate-transfer business domestically and overseas
 - achieved 22.3% conversion efficiency for CIS thin-film solar cells (a new world record for thin-film solar cells)
 - in 2017:
 - halted new orders in overseas markets, including the countries where profitability was deteriorating
 - reduced panel production at its domestic factories by 30%
 - focused on developing high value-added products by focusing on domestic residential and factory-use
 - in 2018:
 - announced “no initial cost” business of solar PV system installation
 - withdrew from overseas and mega solar markets
 - cooperated with house builders to provide PV and storage batteries as a combined unit

such as decreasing the number of factories in operation and consolidating production in only one or several factories, procuring cells or assembling modules overseas, renewing manufacturing facilities to improve efficiency, and abandoning vertical integration of production or upstream material manufacturing. As the competition in the domestic market becomes more severe for manufacturers, some of them expand their businesses overseas; moreover, they must adopt new business models or expand their scopes to maintain an adequate share of this industry, for example, by combining other energy appliances with PV systems in their marketing packages, providing operation and maintenance service, selling electricity, or providing solar panel leasing services.

Based on Japan's actions in recent years (Table 10.3), we observe that these Japanese PV manufacturers can only continue adjusting their strategies to maintain their PV business in the increasingly severe market circumstances. However, as demonstrated in the list of the top five manufacturers in Japan's PV market (Figure 10.7), Japanese manufacturers have not revived themselves and returned to the top-share seats. Finally, one of the main players, Mitsubishi Electric, withdrew from the PV system business, including sales and production.

4 Impact on Japan's renewable energy-related policies

How the government perceives and thinks about the current situation of the PV industry, market, and power supply will decide its feedback on the ongoing energy transition, affecting its energy and industry policies. We conducted interviews with several Japanese government officials on February 8 and November 11, 2019, to analyze major characteristics of the Japanese government's policy-making to manage the penetration of overseas PV products in Japan's market.

Major events regarding renewable energy and FiT policies are summarized in Table 10.4. According to the authors' interviews with the Director-General and the Director in charge of renewable energy policy at METI, the Japanese government understands the situation of Chinese PV products' penetration in Japan's market. However, the current PV cell/module production has been commodified, and the Japanese government did not change their renewable energy-related policies to drastically reverse this situation.

Although some countries such as the United States and those in the European Union have attempted to leverage tariff duties as a measure to stop the dumping of Chinese PV products into their markets, the Japanese government has not been working toward this direction. Regarding trade disputes, they will be difficult to resolve; whether a favorable result can be obtained is difficult to predict. According to the interviewees, the Japanese PV manufacturers did not strongly ask the government to do so, and the government did not impose the import restriction.

Table 10.4 Major events regarding renewable energy/FiT policies

<i>Time</i>	<i>Policies and events</i>
2011.03	3.11 Fukushima nuclear disaster
2012.07	Introduction of FiT
2014.04	4th Strategic Energy Plan: 3E+S
2015.07	“Long-term energy supply-demand outlook:” increase renewable energy to 22%–24% in power generation by 2030
2017.04	Revision of FiT: introduction of bidding
2017.08–2018.04	METI Roundtable for Studying Energy Situations
2018.07.03	5th Strategic Energy Plan: sophisticated 3E+S; technology self-sufficiency; Renewable energy as a major power source

Source: Made by the authors.

The decrease in FiT rates does not mean that the Japanese government has abandoned PV technology. According to the interviewees, the Japanese government thinks that the current adjustment of FiT is appropriate, with a speed that is not too fast. Regarding the call for price decline to reduce the cost of electricity from renewable energy, in the case of solar PV, the interviewees explained that panels account for only part of the price in deployment. Whether the modules are made in Japan or not, how fierce the competition is between Chinese and Japanese manufacturers is a secondary issue, compared with avoiding high energy costs in Japan.

The interviewees confirmed that the thriving of Japanese PV manufacturers was a crucial aspect when considering its renewable energy-related policies. However, for the government’s policy and stance, to maintain the long-term stability of the energy supply is more important, rather than using a single technology. The interviewees emphasized that the Japanese government is promoting the development of new, next-generation PV technologies.

In addition to energy self-sufficiency, the concept of “technology self-sufficiency” was emphasized in the 5th Strategic Energy Plan (SEP; METI, 2018). Because of the changing PV market and the response to the global energy situations and global warming countermeasures, the fifth SEP was announced in 2018, which set the basis for Japanese energy policy, namely, changes to tackle these situations. In the 5th SEP, there is no definition of “technology self-sufficiency,” but this concept was used to highlight the importance of domestically developed and maintained “technology.”

One side of the PV diffusion in Japan presents a situation of the import of foreign PV products, the impact on the local PV industry, and the national wealth flowing overseas (because of FiT). This is against the government’s goal, which pursues increasing energy self-sufficiency. Such concerns were raised in the METI Roundtable for Studying Energy Situations and were the emphasis of the “technology self-sufficiency” to be included in the 5th SEP, namely, the stress of “the amount of energy supply which is covered by Japan’s technologies with respect to domestic energy consumption.”

The government realized the dependency on China's PV panels and hence emphasized the need to ensure Japan's obtaining core technologies in the energy supply chain. Moreover, the current situation cannot satisfactorily promote the green industry necessary to improve the economy, because its intention is written in the FiT law, "...contributing to the strengthening of the international competitiveness of Japan and the sound development of the national economy, including the promotion of Japanese industry and the revitalization of local communities."

In addition, the call for a diversity of energy sources in power generation, the search for the next promising technology, and the improvement of power generation efficiency have been highlighted in this regard. These demonstrate the strategic consideration from the government as it manages the domestically and internationally changing situation in energies.

Furthermore, the 5th SEP introduced "efforts for the utilization of renewable energy as the major power" as a policy response. The introduction of FiT undoubtedly facilitated the PV diffusion in Japan. The import and penetration of foreign PV products, with the continued decrease in FiT rates, also decreased the PV diffusion cost. Although this intensified competition in the industry and downsized the share of domestic manufacturing, the continued cost reduction and growth in installed capacity led renewable energy to become a "major power source" in the long term. For the Japanese government, long-term planning of the development of energy technology and maintaining stable energy supply are more important than that.

5 Discussion

The introduction of FiT in 2012 caused the importation of Chinese PV products into the Japanese market. The original purpose of FiT was to reduce the risk for investors to enter the renewable energy industry and power generation. With the decrease in FiT rates, which fosters innovative activities to reduce the cost of renewable energy, finally, renewable energy can compete economically with mainstream, conventional energy sources. Some appropriate protection and nurturing of an infant industry could be justified. However, Japan has had a high-quality PV industry. The preferential rates of FiT in the beginning were greater, such as protecting the Japanese PV manufacturers to allow the Japanese PV manufacturers to find a means to sustain themselves and maintaining the industry while diffusing renewable energy, rather than helping nurture an infant renewable energy industry. The policy makers probably realized the situation of the global PV industry and the "vulnerability" of Japan's manufacturers under such a situation and hence adopted the preferential rates in the beginning as a balanced policy.

After the first three years, the Japanese government continued to adjust the FiT rates, did not restrict the importation of Chinese products, and allowed market penetration according to the market mechanism. Japanese PV manufacturers did not find their new position in developing this industry in

time and hence were unable to stop the penetration of Chinese PV products. This further continues the dilemma in PV diffusion in Japan, where the request for a decrease in the cost of PV installation has continued, and by contrast, a concern for the penetration of Chinese PV modules in its market has been indicated.

Nevertheless, the competition with the Chinese manufacturers did urge Japanese companies to develop their downstream business and diversify their sales to maintain their profits. Additionally, despite the fierce competition and losing the dominant position in the current global market, the Japanese manufacturers continue developing next-generation PV technologies, with a vision to again acquire the market share.

Considering Japan's industry as a whole, PV manufacturers are small, and the impact on the Japanese economy has been limited. Additionally, PV manufacturers in Japan are merely a branch of electronics companies. The industrial policy was not applied to protect domestic PV manufacturers when much cheaper PV products were manufactured in China. Energy security through allowing cheaper PV products from China might have been prioritized compared with maintaining the commercialized PV production within Japan. Regarding domestic PV manufacturing, the Japanese government promoted developing new PV technologies. This manner of seeking a balance between energy and industry, and exploring promising technologies, has become a background and a challenge in Japan's energy transition.

6 Conclusion

In this chapter, we investigated the impact of the introduction of FiT and the import of Chinese solar modules and cells on Japan's PV industry and its related policies. The results show the rapid diffusion of PV in Japan led to the quick penetration of Chinese and other foreign countries' PV cells and modules in Japan's market; and with the decrease in FiT rates, the situation became more serious. These have caused the Japanese manufacturers to withdraw from cell or module manufacturing and to adjust their business models and strategies dynamically. However, the Japanese government continued to allow the drop in FiT prices while continuing the promotion of renewable energy in Japan's energy mix. The Japanese government has focused on new technology development rather than protecting the domestic manufacturing of commercialized products. These resulted in adjustments in energy policy, which emphasizes technology self-sufficiency, diversification of energy choices, and searching for the next energy technology while facilitating renewable energy to be promoted as the main power supply in Japan's energy mix. Instead of protecting the current PV commodity manufacturing, the Japanese government is applying a long-term vision and a holistic energy policy principle to tackle this challenge during its energy transition.

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Notes

- 1 The full name of the legal basis for FIT is the “Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities.”
- 2 However, the environmental impact assessment for large-scale solar power generation began in April 2020.

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