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The Japanese Solar PV Market and Industry

-Business Opportunities for European Companies-

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Table of Content

Executive Summary IV-V
List of Abbreviations VI
List of Tables, Charts, and Diagrams VII

1. Introduction 1-3

2. Rejuvenating a Market – the Policy Framework 3 -15
   - 2.1. FiT Scheme
   - 2.2. Regulatory Framework
   - 2.3. Development of the Japanese PV Market
     - 2.3.1. Market Expansion under the FiT
     - 2.3.2. PV Component markets

3. Industry and Market Evolution
   - 3.1. Residential PV sector 16-21
     - 3.1.1. Housing market & Solar PV
     - 3.1.2. Cost structure
     - 3.1.3. Market entry opportunities
   - 3.2. Non-Residential PV sector 21-31
     - 3.2.1. Market Structure
     - 3.2.2. Organizational Trends
     - 3.2.3. Cost structure
     - 3.2.4. Market entry opportunities

4. PV in Japan - Quo Vadis? 30-33
   - 4.1. The Electricity Market Reform & Solar PV
   - 4.2. Growth Projection

5. Conclusion 33-37
   - 5.1. Recommendations to European Companies
   - 5.2. Recommendations to the Commission
   - 5.3. Recommendations to Japanese Authorities

6. List of references 38-39

7. Annex 40-41
   - 7.1. Major Solar PV Manufacturer active in Japan (2013)
   - 7.2. Household Electricity Prices in Japan
   - 7.3. Solar-related Events in Japan (2015)

Executive Summary

Prior to the Fukushima nuclear disaster of March 11th, 2011 renewable energy has only played a minor role in Japan's energy strategy –only about 2 percent of the total energy supply have been provided by means of renewable energy (excluding hydro power). However, Japan's rapid denuclearisation in the aftermath of the catastrophe determined a reconsideration of the importance of renewable energy sources, which was reflected in a series of government incentives such as the enactment of a Feed-in Tariff (FiT) in July 2012. Due to this new promotional policy scheme, in particular, the Japanese PV market has been able to gain strength. Within a period of 2 years a total of 10.5 GW of new PV capacity has been installed and by 2013 Japan emerged as the second fastest growing PV market in the world (after China and ahead of the US). The FiT targeted especially the non-residential sector with generous purchasing tariffs. More than 70 percent of total installations have been utility and commercial installations, and only 30 percent residential installations.

The growth in the residential sector has been particularly due to a broader dissemination among newly constructed detached houses. In order to differentiate themselves many homebuilders started after the introduction of the FiT to equip their housing models with solar PV systems. In FY 2013, almost every fourth newly build detached house has been equipped with a solar PV system. This trend is prone to expand further with declining system costs. The non-residential sector has experienced a myriad of companies entering the marketplace throughout the last two years – among them trading companies, general contractors, banks, electrical manufacturers, developers, etc. The largest growth area in terms of installed and approved capacity has been the mega solar segment (above 1 MW). In parts, due to the lack of suitable wide land plots in the vicinity of grid power connection points, this trend is currently shifting toward mid-scale solar farms.

Market entry strategies and potential for PV component manufacturers varies across the different sectors. While rigid market channels and relatively high market control in the hands of a few domestic PV panel manufacturers have complicated market access to the residential sector, the non-residential sector has been more welcoming to foreign PV components. A particularly favorable entry route for European PV components manufacturers has been the close relationship to EPC contractors active in the Japanese PV market. The future development of solar PV in Japan is overshadowed by the recent announcement of a number of electricity utilities stating that they stop taking in more renewable energy due to grid stability issues – this, if not tackled early, may have a detrimental impact on the further development of the non-residential sector.

However, the still generously high tariffs offered by the Japanese government (excessive tariff reductions are unlikely) offer potential for innovative European PV solutions. For instance, due to weight limitations of Japanese rooftops, lightweight PV systems are in high demand. In addition, the willingness of Japanese consumers to pay a premium for aesthetic PV system design creates potential for integrated rooftop PV panels and *Building-Integrated Photovoltaic* (BIPV) elements. Furthermore, innovative

PV systems solutions that do not impair the usage of land underneath (e.g. farmland, greenhouses and parking lots) possess likewise high potential.

Thus, the report aims at clarifying trends and recent movements in the Japanese PV market. For instance, does the Japanese market *still* offer enough growth potential and stability to European businesses in order to consider market entry? What are the segments, services, and technologies that are going to be increasingly in demand in a market that shifts from expansion to consolidation?

In terms of content, the report begins with a detailed analysis of the policy framework facilitating the current growth in solar PV. That includes the FiT scheme as well as other policies, regulating for instance the usage of land plots and rooftops for PV-Installation. Secondly, the report provides the development of the Japanese PV market after July 2012 as well as selected appliance sectors. The market analysis is clearly divided between the residential and non-residential sectors. Thirdly, by taking current market trends into account, the report points out the yet untapped potential and suggests a number of market entry opportunities for European businesses, including SMEs. It concludes with a number of recommendations for European companies and the policy makers involved (the European Commission and Japanese authorities). For the authorities, both sides should make efforts in reducing market entry barriers in form of technical and safety regulations for PV components. Furthermore, the European Commission should consider proactively promoting the visibility of European SMEs– for this matter, the EU could make use of the annual PV trade fairs in Japan to stage an **EU PV Pavilion** promoting innovative European PV companies. As for the Japanese side, it is pivotal to rapidly resolve the issue of grid stability in the face of PV capacity growth.

List of Abbreviations

kW	Kilowatt, 1000 Watt = 1 KW
kW/yen	Kilowatt per hour
TW/yen	Terawatt per hour
MW	Megawatt, 1000 kW = 1 MW
GW	Gigawatt, 1000 MW = 1 GW
ABL	Asset-based Lending
ANRE	Agency for Natural Resources and Energy
APRERD	Act for the Promotion of Renewable Energy in Rural Districts
ASM	Special Measures Concerning the Procurement of Renewable Energy
BEMS	Building Energy Management Service
BSA	Building Standards Act
CEE	Chief Electrical Engineer
DSM	Demand-Side Management
FAT	Fixed-Asset Tax
FLA	Factory Location Act
HEMS	Home Energy Management Service
IRR	Internal Rate of Return
J-PEC	Japan Photovoltaic Expansion Center
JPEA	Photovoltaic Energy Association
MAFF	Ministry of Agriculture, Forestry and Fishery
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOF	Ministry of Finance
METI	Ministry of Economy, Trade and Industry
NRA	Nuclear Regulatory Agency
NREL	National Renewable Energy Laboratory
PF	Project Finance
PV	Photovoltaic
REIT	Real Estate Investment Trust
SPC	Specific Purpose Company
VRE	Variable Renewable Energy

List of Tables, Graphs, and Diagrams

Diagram 2-1	FiT Scheme	4
Table 2-1	FiT Scheme Details	5
Table 2-2	FiT Surcharge	6
Diagram 2-2	The Act on the Promotion of Renewable Energy in Rural Districts	8
Table 2-3	Changes in the Electricity Utility Act	9
Chart 2-1	Total PV Capacity before FiT	10
Chart 2-2	PV Panel Shipment across the Residential and Non-Residential Segment	11
Chart 2-3	Market share, by shipped capacity in FY 2013	12
Chart 2-4	PCS market shares, by shipped capacity in FY 2013	13
Chart 3-1	Number of newly Constructed Houses	15
Chart 3-2	Number of subsidy applications for residential solar PV systems	16
Table 3-1	Homebuilders Initiatives	17
Chart 3-2	Change of residential PV system prices (FY 2011 to FY2014 Q1)	18
Chart 3-3	Residential PV Supply Chain in Japan	19
Chart 3-4	Approved capacity under the FiT by June 2014	21
Chart 3-5	Cumulative amount of approved and installed PV capacity	21
Table 3-2	Electricity Utilities Stopped Signing RE Agreements	22
Diagram 3-1	Workflow for Large-Scale PV Plants	23
Diagram 3-2	New Market Actors Enter the EPC Market Field	24
Diagram 3-3	Project Finance arrangements	26
Chart 3-5	Cost Breakdown per PV Farm Class	27
Chart 3-6	Average PV System Prices (above 100 kW) in Selected European Countries	28

Following exchange rate are utilized in this report: 1 euro converts to 137 yen, 1 dollar to 100 yen.

1. Introduction

The Japanese *Photovoltaic* (PV) market seems to be flourishing – since the inception of a *Feed-in Tariff* (FiT) in July 2012[1] the market has added large amounts of PV capacity across all customer segments. From July 2012 to June 2014 a total of 10.5 GW of new PV capacity has been installed – of this figure, roughly 70 percent has been utility- and commercial installations and only 30 percent residential installations. This ratio suggests a significant sectorial migration towards large-scale PV projects, away from residential installations that have historically dominated the Japanese PV growth. The Fukushima Nuclear Disaster of March 2011 and the subsequent shutdown of all 49 Japanese nuclear plants – has catalysed support for renewable energy among the public and within government circles. In particular, the former Japanese Prime Minister *Naoto Kan*, in office from June 2010 to September 2011, is emblematic in this regard. He fiercely advocated in the aftermath of the disaster for the ratification of the *Act on Special Measures Concerning the Procurement of Renewable Energy* (hereafter ASM). The ASM centres on a generous *FiT* that obliges utilities to purchase electricity produced by means of solar and/or other forms of renewable energy. The current solar PV Roadmap ("JPEA PV OUTLOOK"), presented by the *Japan Photovoltaic Energy Association,* predicts that Japan is going to install 49 GW by 2020 and 102 GW by 2030! - a capacity that would account for roughly 10 percent of Japan's annual electricity consumption (ca. 1 billion kWh) (JPEA VISION SECTION, 2014).

In contrast to Japan, many European PV markets are stagnating – former European PV growth centres, Germany and Italy, are the paragon of this situation. Prohibitively high costs for households as well as technical issues with implementing *Variable Renewable Energies* (VRE) into the power grid resulted in harsh headwind. In Germany, for instance, annual solar installation halved compared to the previous year to 3.4 GW in FY 2013. And it is predicted to plunge further in FY 2014 to around 2 GW. Italy achieved a mere growth of 1.5 GW in FY 2013 and is thus decreasing from 3.8 GW compared to the previous year. This gap have been, despite some substantial growth in the UK, Romania, and Greece, only insufficiently filled – the European market has installed 11 GW in 2013 and is going to install about 10 GW in 2014[2]. In this sense, expanding to non-European PV markets has increasingly become a 'need' rather than being a 'want' for European PV businesses. In fact, the recent change of the Japanese PV market has been in this regard hardly unnoticed by the European PV industry.

Despite the seemingly large potential, market predictions are nevertheless an inherently difficult exercise in a political environment characterised by indecision and opposition.

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[1] The law was approved by the Cabinet *prior* to the earthquake, on the morning of March 11 and ratified by the diet later on in August 26.

[2] EPIA: http://yen.epia.org/index.php?eID=tx_nawsecuredl&u=0&file=/uploads/tx_epiapublications/44_epia_gmo_report_ver_17_mr.pdf&t=1415291496&hash=4e867a532806bcc2f3160531e5c5ee555578f837, 30.10.2014.

In April 2014, the Japanese government released the *New Energy Basic Plan* stating that nuclear and coal-based energy are going to once again play an important role as base load power (NERB 2014). Notably, the plan defers quantitative energy resource targets to a later point in time[3]. Within the decision-making process of restarting a few of the idle 49 commercial nuclear reactors, the approval of the *Nuclear Regulatory Authority* (NRA) is of immense importance, yet it is not the only hurdle that needs to be taken – prefectural and local authorities also have to agree to a reactor restart in their administrative area. The question as to what extent nuclear energy is going to resurge is ultimately of major concern, as it determines the level playing field for other energy resources including solar PV.

A further example of the political conundrum revolving around Japan's energy policy is the most recent announcement by a number of electricity utilities, accusing the government to 'act irresponsible in their renewable energy policy' (NIHON KEIZAI SHINBUN, 30.09.2014). This statement refers to the incoherence of FiT approvals given to renewable energy producers and the actual capacity of the power grid. Five of the ten electricity utilities revealed that they will stop signing renewable energy contracts as overcapacity of intermittent energies, such as solar PV, threaten the stability of the power grid. This created not only political havoc but also prompted the government to review the incentives given to solar PV and will most-likely lead to drastic changes of the scheme within this year[4].

The report departs from the conclusions drawn in the earlier released *Market Study on Environment & Energy-related Technologies 2013*[5] – a comprehensive *report* on Japan's green technology marketplace that, inter alia, provides substantial insights into Japan's PV market environment. However, the "EU Gateway" report fails to address recent FiT-driven developments, resulting thus in the need to revisit the topic of solar PV in Japan.

Thus, the present report aims at clarifying trends and recent movements in the Japanese market. For instance, does the Japanese market *still* offer enough growth potential and stability to European businesses in order to consider market entry? What are the segments, services, and technologies that are going to be increasingly in demand in a market that shifts from expansion to consolidation?

The report begins with a detailed analysis of the policy framework facilitating the current growth in solar PV. That includes the FiT scheme as well as other policies, regulating for instance the usage of land plots and rooftops for PV-Installation. Secondly, the report provides the development of the Japanese PV market after July 2012 as well as selected appliance sectors. The market analysis is clearly divided between the residential and non-residential sectors. Thirdly, by taking current market trends into account, the report points out the yet untapped potential and suggests a number of market entry opportunities for European businesses, including SMEs.

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[3] According to a not releasable source, energy targets are going to be potentially released in December 2015.

[4] TOKYO SHINBUN: http://yen.tokyo-np.co.jp/s/article/2014100190071001.html, 30.09.2014

[5] A report sponsored by the *EU Gateway Programme*.

The report concludes with a number of recommendations for European companies and the policy makers involved (the European Commission and Japanese authorities).

This research relies on a myriad of publications available online, in magazines, books, and newspapers. Utilized data sets have been retrieved from government organisations' websites, such as the *Japan Photovoltaic Expansion Centre* (J-PEC), the *Ministry of Economy, Trade and Industry* (METI), etc. as well as third party resources including *IJGlobal*, *RTS*, etc. In addition, this report profited substantially from the knowledge of a few experts in the field who made themselves available for interviews and other queries.

2. Rejuvenating a Market – the Policy Framework

2.1. The FiT Scheme

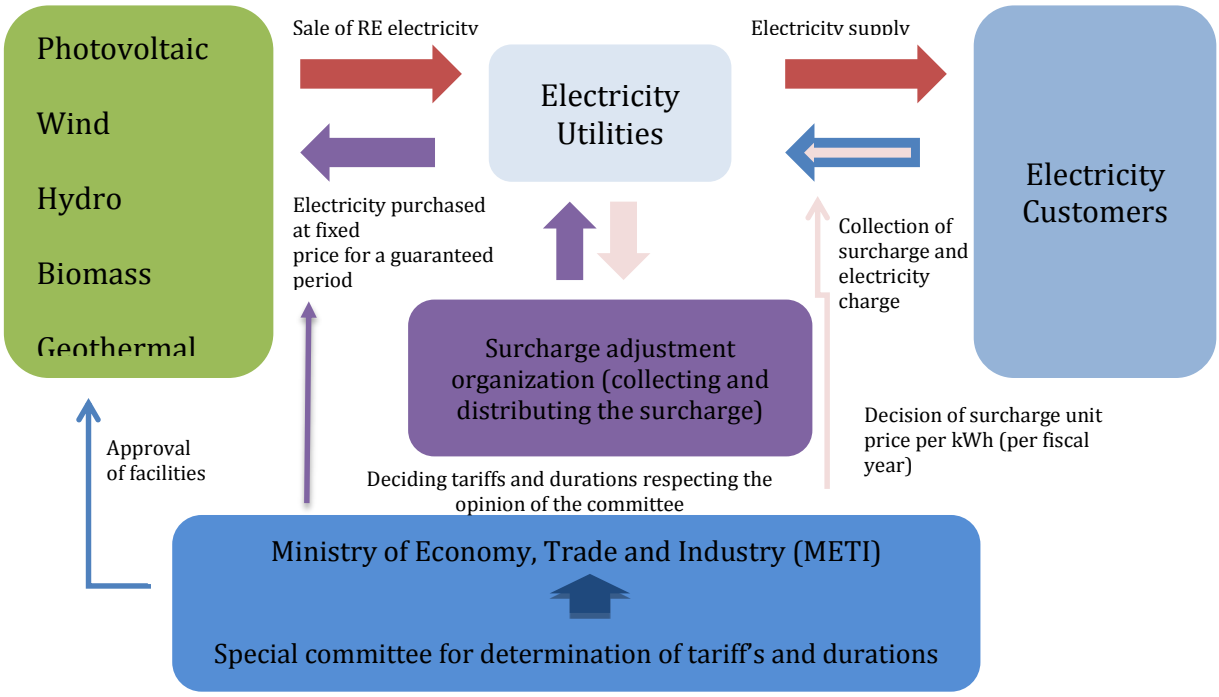
With the ratification of *the Act on Special Measures Concerning the Procurement of Renewable Energy* (hereafter the ASM) on the 26th August 2011, the Japanese government attempted to counterbalance the decommissioning of all 49 commercial nuclear reactors in the aftermath of the Fukushima I nuclear energy plant accident[6]. The Feed-in Tariff (FiT) lies at the very core of the ASM providing long-term contracts to renewable energy generators guaranteeing a fixed purchasing tariff (price). The FiT was enacted in July 2012 obliging the 10 regional electricity[7] utilities to purchase electricity from renewable energy producers. The current FiT scheme includes solar photovoltaic (PV), wind, biomass, geothermal, and hydro energy. According to the current FiT arrangement, purchasing tariffs are reduced on an annual basis; this, however, may be adjusted if deemed necessary (Diagram 2-1). The ASM prescribes that the FiT is going to be in place until FY 2021. A revision of the scheme is going to be conducted every three years. According to Article 2 (Paragraph 3 and 10) of the ASM, the Japanese FiT is going to remain in place until 2021.

In case of solar PV, two different schemes differing in purchasing period and purchasing price are offered. For PV systems smaller than 10 Kilowatt (kW), the government guarantees a purchasing rate of 37 yen (FY 2014) per each excess Kilowatt-hour (kWh) for a time period of 10 years. Such systems are mostly installed on residential dwellings such as single-family houses, smaller apartment blocks, etc. Systems above 10 kW receive a purchasing tariff of 32 yen per kWh (excluding taxes) for a contracting period of 20 years granted for the total electricity production. The latter described systems are also referred to as non-residential – they are largely distinguished between commercial-scale systems (up to 1000 kW) and utility-scale systems (above 1000 kW).

[6] US Energy Information Administration: http://yen.eia.gov/countries/cab.cfm?fips=JA, 23.07.2014.
[7] Hokkaido Electric Power Company, Tohoku Electric Power Company, Tokyo Electric Power Company, Hokuriku Electric Power Company, Chubu Electric Power Company, Kansai Electric Power Company, Chugoku Electric Power Company, Shikoku Electric Power Company, Kyushu Electricity Utility, Okinawa Electric Power Company (TACHIBANA, 2014)

The former, also called mid-scale, are either installed on larger rooftops (e.g. storage houses, production facilities, supermarkets, etc.) or on the ground (e.g. abandoned farmland, undeveloped land, meadows, etc.). The latter, refers to large-scale systems, which are most commonly installed on the ground. Large-scale rooftop installations are, however, rare – its weight might require additional investment in strengthening the rooftop construction (PVEYE, 2014).

Diagram 2-1: FiT Scheme



Source: METI, 2014[8]

Since 2011, the *Ministry of Finance* (MOF) has offered preferential tax treatment for so called *Green Investments.* This allows system owners to write off up to 100 percent of the non-residential PV system costs[9]. The scheme favours companies that plan to install PV systems on their office, storage, or production facilities. Furthermore, it applies to all PV projects submitted by the end of FY 2016 and construction commenced within one year of granted approval (YAMADA, 2014). From July 2012 to March 2013 the FiT guaranteed a purchasing price of 42 yen per kWh for residential systems. In FY 2013 and FY 2014 the purchasing tariff rate had been subsequently lowered from 38 yen per kWh to 37 yen per kWh. For non-residential systems tariff rates have fallen from 38 yen per kWh in FY 2012 to 32 yen per kWh in FY 2014. Under the German FiT system PV electricity is currently (August 2014) purchased for 20 to 13 yen (12.88 - 8.92 eurocent) per kWh, depending on the system size. METI sets the purchasing tariff and degression[10]

[8] METI: http://www.enecho.meti.go.jp/category/saving_and_new/saiene/kaitori/kakaku.html, 23.05.2014.
[9] SOLARNAVI: http://panerou.com/green_tax/repayment_30/, 20.10.2014.
[10] *Tariff degression* – a mechanism according which the price (or tariff) ratchets down over time. This is done in order to track and encourage technological costs reductions.

in alignment with an Internal Rate of Return (IRR)[11] of 3.2 percent for residential PV systems and 6 percent after tax for non-residential PV systems [12]. Due to the high purchasing tariff, large-scale systems generated an IRR of more than 10 percent[13].

Table 2-1: FiT Scheme Details

		Residential	**Non-residential**
Capacity		Below 10 kW	Above 10 kW
Duration (in years)		10	20
Scheme		Excess electricity only	Total amount of electricity produced
Purchase price (yen/kWh)	**2012**	42	40 + tax
	2013	38	36 + tax
	2014	37	32 + tax
IRR		3,20%	6%

Source: METI, 2014[14]

The scheme finances the accruing purchasing costs by imposing the *Renewable Energy Surcharge* per kWh used on consumers [15]. As depicted in Table 2-2, the FiT surcharge increased steadily from 0.24 yen per kWh (FY 2012) to 0.35 yen per kWh (FY 2013) and in FY 2014 to 0.75 yen per kWh.

Prior to the launch of the surcharge programme the *Japan Business Federation*, better known as *Keidanren[16],* expressed its concern about the impact of such a surcharge on the Japanese industry and estimated in a report handed to the government that a surcharge of 2 yen per kWh would result in a loss of 460 billion yen to the whole industry (this equals approximately three percent of the ordinary profit)[17]. Particularly, energy intensive sectors, such as manufacturing, metal, and soda production would be detrimentally affected[18]. Taking these concerns into account, the government granted a reduction of 80 percent to energy-intensive companies whose electricity consumption is higher than 1.000.000 kWh. In addition, for the period of August 2012 to April 2013 (9

[11] The IRR measures the profitability of investments. The IRR of an investment or project is the annualized effective compounded return rate or rate of return that makes the net present value of all cash flows (both positive and negative) from a particular investment equal to zero. The higher a project's IRR, the more desirable it is to undertake the project. The IRR is not considering external effects such as the interest and inflation rate.

[12] METI: http://yen.meti.go.jp/committee/chotatsu_kakaku/pdf/005_02_00.pdf, 28. August 2014.

[13] NIKKEI: http://techon.nikkeibp.co.jp/article/WORD/20131004/307467/, 18.September 2014.

[14] METI: http://www.enecho.meti.go.jp/category/saving_and_new/saiene/kaitori/kakaku.html, 24.05.2014.

[15] Another surcharge, the *Photovoltaic Promotion Surcharge*, had been levied during the time period of July 2012 to September 2014 together with the Renewable Energy Surcharge. Its costs refer to the FiT's predecessor the Solar FiT (2009 – 2011). Its costs vary across electricity utility.

[16] *Keidanren* is the abbreviation of *Nippon Keizai Dantai Rengokai*.

[17] The Lower House: http://yen.sangiin.go.jp/japanese/annai/chousa/rippou_chousa/backnumber/2011pdf/20111108038.pdf, 30.09.2014.

[18] The electricity intensity of the above mentioned three sectors are respectively 10, 1 26 times higher than the average.

months) the government exempted the part of the population affected by the *Great East Japan Earthquake* from the levy[19]. These measures, however, allocate the burden of the FiT across a smaller circle of net contributors, thus making the scheme more prone to a rapid cost surge. In fact, the costs of the RE surcharge seem to rise fast. While in FY 2012 a total of 130.3 billion yen (0.951 million euros) had been allocated, the total costs of the RE surcharge rose in FY 2013 fivefold to 654.7 billion yen (4.7 million euros). According to estimations forwarded by METI, costs could further rise to 2.7 trillion yen (19.7 billion euros), if the total amount of the approved renewable energy capacity would be deployed by June. This would increase the monthly levy from 225 yen (1.64 euros) to 935 yen (6.85 euros) per household[20]. Similar concerns are uttered by for instance HAMASAKI (2013), pointing out that the financial burden on an average Japanese household would rise to 820 yen by 2020.

Table 2-2: FiT Surcharge

	2012	**2013**	**2014**
FiT Surcharge	0.24 yen/kWh	0.35 yen/kWh	0.75 yen/kWh
A: Costs accrued with the purchase of renewably produced electricity.	250 billion yen	480 billion yen	900 billion yen
B: Administrative costs	1.7 billion yen	2,5 billion yen	2.7 billion yen
C: Avoided costs	120 billion yen	167 billion yen	248 billion yen
D = A+B-C	130.3 billion yen (951million euros)	313.3 billion yen (2,2 billion euros)	654.7 billion yen (4,7 billion euros)

Source: JREF[21] and RTS, 2014

2.2. Regulatory Framework

Prior to the start of the FiT, the government has, based on a report by the *Government Revitalization Unit*, started to address a number of regulatory issues that have been identified as constituting a barrier to the dissemination of renewable energy in Japan. As regards to solar PV[22], it is aimed at simplifying the dissemination of large-scale PV plants and rooftop systems. A harmonization of the regulatory framework shall also enhance the emergence of new business models including *rooftop sharing* and others[23]. This subsection provides insight into two major regulatory areas; the (1) usage of land and other suitable installation sites[24], and (2) grid access related issues.

[19] Chubu Electric Companies: http://yen.chuden.co.jp/ryokin/shikumi/saienefukakin/saienetokurei/, 30.09.2014.
[20] NIKKEI: http://yen.nikkei.com/article/DGXLASDF30H03_Q4A930C1MM0000/, 30.09.2014.
[21] JREF: http://jref.or.jp/images/pdf/20130919/20130919JREF_Avoided_cost_analysis.pdf, 12.12.2014.
[22] NIKKAN: http://yen.nikkan.co.jp/news/nkx1520120727abaw.html, 20.08.2014.
[23] PHOTOVOLTAIC-POWER: http://yen.photovoltaic-power.org/newsblog/renewable_energy_20120403.html, 30.09.2014.
[24] The Japanese Government strictly regulates the usage of land/space; Reason for that is, for instance the low food sufficiency rate of 39 percent in 2013. Nevertheless, a decline of the agricultural population to 2,6

Regarding the former, the government is confronted with the need to make practical use of a large amount of unused areas such as abandoned green areas and larger rooftops, etc. Regulatory changes shall be highlighted with reference to the *Factory Location Act, Building Standards Act,* and the *Act on the Promotion of Renewable Energy in Rural Areas.* As for the latter-mentioned, it is referred to the *Electricity Utility Act;* Depending on plant size and corresponding voltage, a more stringent supervision by local authorities and electricity utilities is applied, requesting a greater number of examinations, safety compliance reports, etc. The application of rules, however, changed prior to the start of the FiT, thus generating the need for update on this law.

A: Land usage

In the run-up of the FiT scheme, the government initiated a number of regulatory fixes regarding the usage of PV installation space. For instance, the revision of the *Factory Location Act (FLA)* provides incentives for the setup of solar PV systems on larger rooftops. The FLA regulates ratios for the creation of production facilities as well as green and environmental areas for factories of a certain size[25]. While the term production facilities encompasses all areas related to production and storage, green and environmental areas refer respectively to meadows, shrub thickets, trees, etc. Environmental areas are considered for instance parks, sports facilities, and landscaped space. The ratio of the pertaining areas differs by prefecture – ranging from 30 to 65 percent for production facilities and the remaining share for green and environmental areas. In May 2012, a revision of the FLA considers grid-connected solar PV systems as possible environmental facilities (prior to this, it had been only the case for self-consumed electricity) and created an incentive for factory operators/owners to comply with the FLA ratio obligations by installing solar PV systems. In addition, the government shortened the previously required 90 days pre-notification notice to 30 days (Article 2, paragraph 11).

A revision of the *Building Standards Act* (BSA) on October 1, 2011 states that solar PV systems do not fall under the BSA as long as the space below the PV panels is not used for the purpose of living, working, amusement and/or storage, etc. (Article 5, Paragraph 2). In addition, the revised BSA points out that retrofitted PV systems no longer necessitate a final building examination (Article 13, Paragraph 2)[26].

A major constraint for the dissemination of renewable energy, and in particular of PV had been the acquisition of land usage rights. Renewable energy development often requires the consent of governmental and municipal institutions based upon numerous laws such as the Forest Act, Agricultural Land Act, etc. Additionally, the acquisition of multiple landownership or land usage rights delays and complicates the planning process of certain renewable energy endeavours even more. The MAFF initiated with the enactment of the *Act for the Promotion of Renewable Energy in Rural Districts* (APRERD)

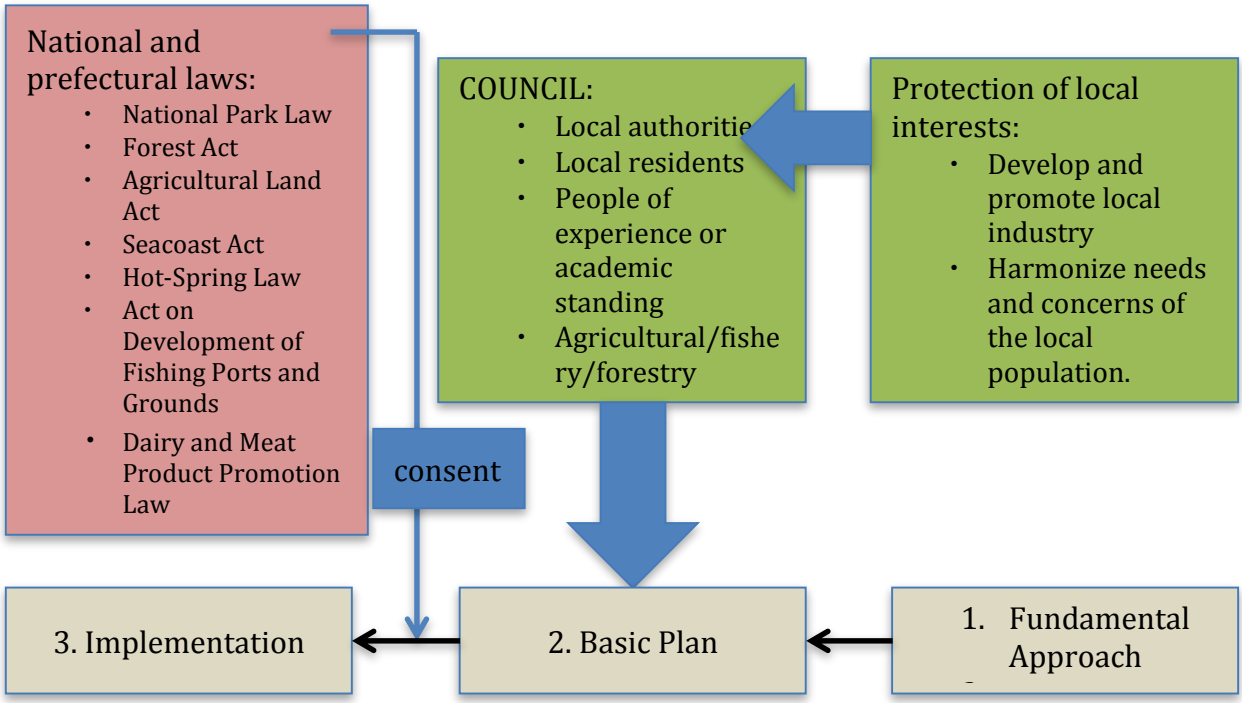
million people by 22.3 percent (FY 2012) compared to the last five-year census marks also an increase of the abandoned agricultural land (here, as in 耕作放棄地) (396.000 ha, FY 2010) (KIRIMURA, 2014).

[25] Factories above a total area size of 9000 m2 and building area of 3000 m2 are concerned

[26] MLIT: http://yen.mlit.go.jp/common/000216346.pdf, 30.09.2014.

in May 2013, a *one-stop solution* processing all inquiries related to the development of renewable energy projects in local areas[27]. Municipal authorities are positioned at the centre of the scheme. They are authorized to provide permissions based on a number of laws that regulate the usage of land in Japan (Article 9 to 15) (See Diagram 2-2). The decision-making process for or against an RE project includes local stakeholders such as residents, people of experience or academic standing, as well as agricultural, fishery, and forestry associations. They decide in close dialogue whether a certain renewable energy project has a positive impact on the local environment, industry and population. This new legal arrangement is supposed to provide a tool to short-cut time-intensive application processes. However, it does not determine how long the approval processes shall take; this constitutes, in fact, another barrier as the process could be extensively delayed.

Diagram 2-2: The Act on the Promotion of Renewable Energy in Rural Districts



Source: SHINOBU, 2014

C: Electricity Utility Act

Since 2011, the Electricity Utility Act underwent frequent revision. For solar PV projects, the following changes are of relevance (Table 2-3): In line with an initial revision undertaken in June 2011, PV plants smaller than 50 kW (prior 20 kW) are not obliged to submit a safety regulation compliance report as well as engage a *chief electrical engineer* (CEE). The CEE condition had been subsequently further relaxed allowing PV plant operators to outsource the position of a CEE for plants smaller than 2000 kW. However, outsourcing a CEE position is only to be executed for plants requiring voltage below 6.6

[27] Prefecture of Yamanashi: http://yen.pref.yamanashi.jp/energy-seisaku/documents/120725nousanngyosonnhatudenhouanngaiyou.pdf, 30.09.2014.

kV (high voltage). The projects have to be additionally approved by the respective *Regional Industrial Safety and Inspection Department* (METI) (Paragraph 52, Article 2)[28]. The submission of a construction plan as well as the conduction of a pre-usage safety examination by local METI authorities is compulsory for PV plants above a size of 2000 kW (prior 500 kW).

Table 2-3: Changes in the Electricity Utility Act

Capacity	Construction plan	Pre-usage examination	Chief Electrical Engineer	Safety regulations compliance report	Notification recipient	Grid connection negotiations
Below 50 kW (low voltage)	Not necessary	Not necessary	Not necessary	Not necessary	Not necessary	around one month
50 - 500 kW (high voltage)	Not necessary	Not necessary	Outsourcing approval necessary	Necessary	METI, Regional Office	within three months (210.000 yen +)
500 - 1000 kW (high voltage)	Not necessary	Not necessary	Outsourcing approval necessary	Necessary	METI, Regional Office	within three months (210.000 yen +)
500 - 2000 kW (high voltage)	Not necessary	Not necessary	Outsourcing approval necessary	Necessary	METI, Regional Office	within three months (210.000 yen +)
Above 2000 kW (extra high voltage)	Notification necessary	To be carried out	Has to be assigned	Necessary	METI, Regional Office	within three months (210.000 yen +)

Source: METI, 2014

2.3. Development of the Japanese PV market

2.3.1. Market Expansion under the FiT

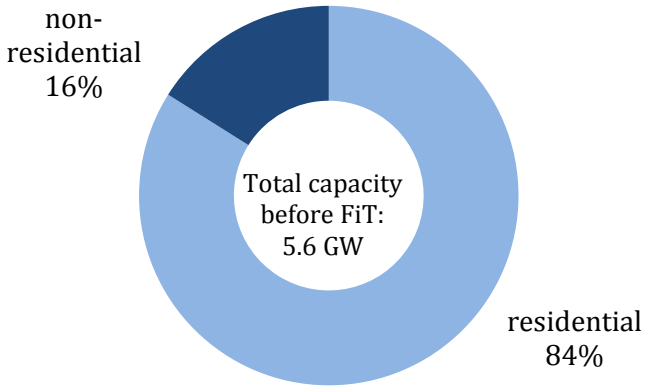
Prior to the start of the FiT in July 2012, the accumulated Japanese PV capacity amounted to 5.6 GW – as depicted in Chart 1: 84 percent of the total capacity had been added by small-scale PV systems for residential purposes (Chart 2-1). This development is largely due to early demand-side policy efforts, such as the *Residential PV System Dissemination Program* ("long-term subsidy") from 1994 to 2005.

In 1994 subsidies started at 50 percent of the system costs, and were then gradually reduced to 33 percent in 1999. Towards the end of the program, the subsidies were distributed on a kilowatt basis, declining to 20.000 yen per kW. As a result, over 250,000 residential PV systems were set up and increased the cumulative solar PV capacity from 43.3 MW to 1422 MW – Japan had thus been an early *lead market* for solar PV technology worldwide (KIMURA AND SUZUKI, 2007). Market support on the national level, however, had been terminated afterwards, leading to a decline in FY 2007 and 2008. Subsequently, the government re-launched a subsidy program in 2009 elevating residential installations more than 10 percent within the first few months. In November 2009, the government also initiated the *New Purchase System for Photovoltaic* (hereafter Solar FiT) under which residential PV systems as well as non-residential systems (up to

[28] Kansai Electricity Utility: http://yen.ksdh.or.jp/service/security/outsource.html, 17.09.2014.

500 kW) were eligible for preferential purchasing tariffs. This led also to a moderate growth in the non-residential solar PV market.

Chart 2-1: Total PV Capacity before FiT



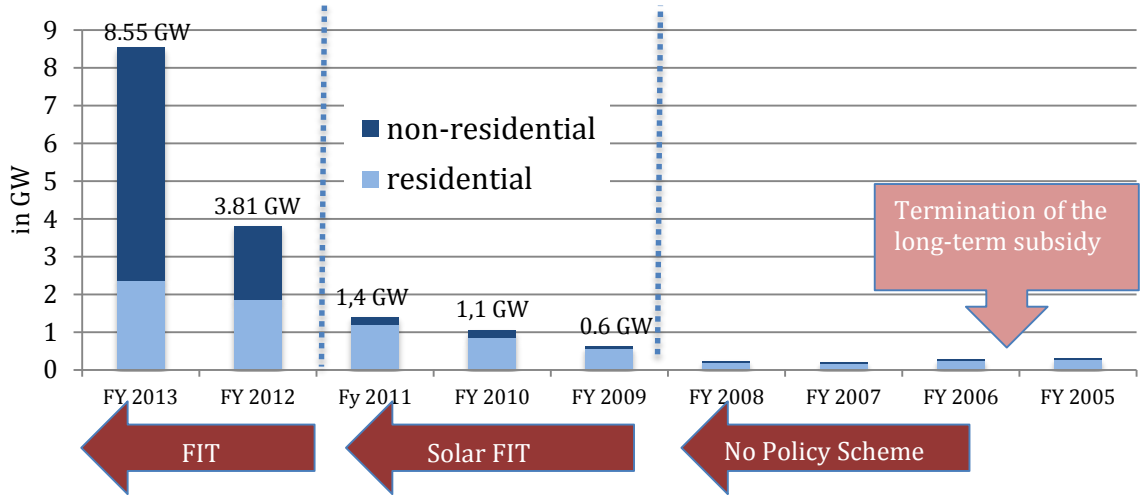
Source: JPEA, 2014[29]

The introduction of the FiT scheme changed the dynamics of the market in terms of market scale and segmentation significantly. PV panel shipment in Japan increased to 3.81 GW in FY 2012 and 8.55 GW in 2013 (see Chart 2-2). Although residential PV panel shipments followed a continuous growth trajectory (in FY 2012 residential PV shipment grew by 50 percent and in FY 2013 by 25 percent compared to previous year), it is, however, the non-residential PV sector that constituted the larger portion of panel shipments. Since the start of the FiT, approximately 77 percent of the total amount of installed PV capacity had been generated by non-residential PV systems. Smaller systems of up to 50 kW (29 percent) and systems in the range of 1000 kW to 2000 kW (19 percent) take respectively the largest share. Extensive allocation of PV capacity across these two segments attributes to the following: the *Electricity Utility Act* – it requires additional personnel (i.e. engagement of a Chief Electricity Engineer) as well as extended safety planning efforts for plants above this threshold; moreover, physical access constraints to extra high voltage transmission lines likewise does not favour systems above 2000 kW – costs are, an important factor as grid connection costs are burdened on the developer (RTS 2014). On the contrary, solar PV systems above 10 kW offer a higher return on investment (IRR) and are thus a more lucrative investment for small-scale businesses, factories, and house owners.

The extensive market growth under the FiT created an immense demand for hardware components such as PV panels, power conditioners, BOS systems, racking systems, etc. According to an estimate by *FUJI KEIZAI (*2013), the PV appliances sector encompassed in FY 2013 a total market size of 449.64 billion yen (3.17 billion Euros) – that compares to a market volume of 39.3 billion yen (286.8 million Euros) in FY 2011. Of all the component parts of a solar PV system, PV panels have the largest market share due to their (high) price. Next, a few major developments in the respective appliance markets are going to be highlighted.

[29] JPEA: http://www.jpea.gr.jp/document/figure/index.html, 12.09.2014

Chart 2-2: PV panel shipment across the residential and non-residential segment



JPEA, 2014[30]

2.3.2. PV Component Markets

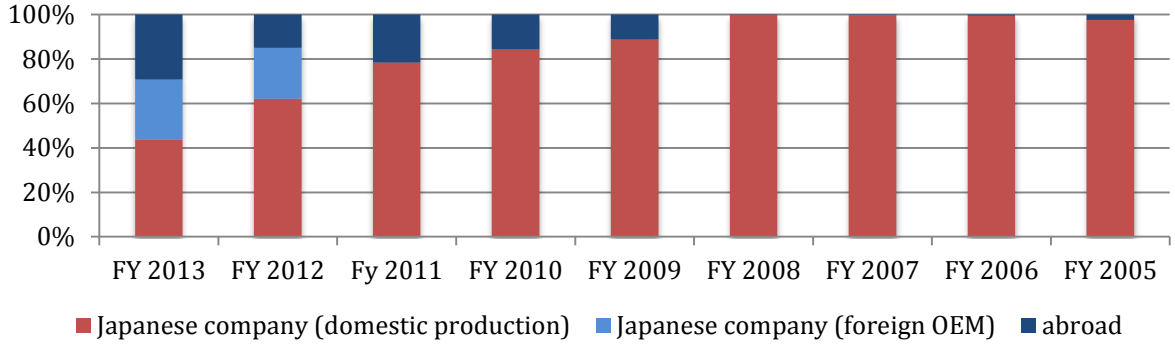
A: PV panel makers

The Japanese PV panel landscape used to be largely dominated by domestic manufacturers such as *Sharp*, *Kyocera,* and *Solar Frontier*[31]. However, the proactive market promotion starting in 2009 and the subsequent introduction of the FiT in July 2012 led to an increasing influx of foreign manufacturers[32]. The former German panel maker *Q Cells*[33] has been the first European manufacturer entering the Japanese market in April 2011[34].

In line with the introduction of the FiT, the share of foreign panels has been gradually increasing. Foreign produced PV panels that have been shipped to Japan in FY 2013, split in 48 percent of OEM production (sold under a Japanese brand name) and 52 percent of retail done under the label of the respective foreign brands (See Chart 2-4) - major (non-OEM) foreign brands active in Japan have been *Hanwha Q Cells, Canadian Solar* and *Suntec Power*. A greater number of Chinese PV panel manufacturers such as *Trina Solar, JA Solar*, *Yingli Solar*, etc. are playing an increased role in the market, since the second half of 2012. The accumulated figure of planned installations by Chinese makers approximates to 3100 MW for 2014[35]. A strong European manufacturer in the Japanese marketplace is the Norwegian *REC* planning to ship a total of 300 MW in 2014 (SHITAMURA, 2014). Other European PV panel manufacturers that are represented through an office in Japan include *Solar World, Luxor Solar and Recom*.

[30] JPEA: http://www.jpea.gr.jp/document/figure/index.html, 15.09.2014.
[31] Solar Frontier is a subsidiary of *Showa Shell Sekiyu Corp.* focusing on thin-film technology (RTS 2014)
[32] The first European PV panel maker entering Japan had been Q-Cells in 2011.
[33] Q Cells filed for bankruptcy in April 2012. The Korean conglomerate *Hanwha Group* bought the company subsequently (Q Cells 2014).
[34] ECOOL: http://yen.ecool.jp/foreign/2011/04/qsells11-1218.html, 22.09.2014.
[35] See Annex 7.1 for a ranking list of major foreign companies in Japan (by capacity)

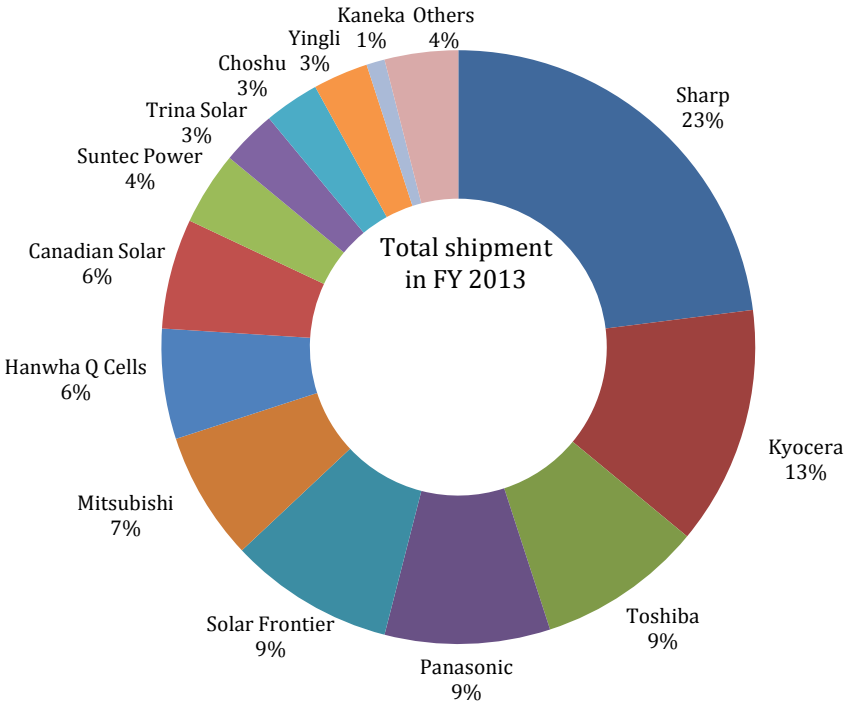
Chart 2-3: Foreign and domestic market share in Japan



JPEA, 2014[36]

Market penetration by foreign PV panel makers varies across the residential and non-residential sector. While the residential PV market in FY 2013 had been significantly dominated by domestic makers - *Sharp* (25 percent), *Panasonic* (20 Percent), *Kyocera* (17 percent), *Toshiba* (10 percent), *Solar Frontier* (7 percent) and *Choshu Industries* (6 percent), the non-residential sector presents a more balanced picture with Japanese PV panel makers almost on par with foreign PV makers. The strongest foreign market participants are *Hanwha Q Cells*, *Canadian Solar,* and Suntec Power (SHITAMURA, 2014) - this suggests that entry barriers for the latter market segment are less stringent.

Chart 2-4: Market share, by shipped capacity in FY 2013



JPEA, 2014[37]

[36] JPEA: http://www.jpea.gr.jp/document/figure/index.html, 18.09.2014.

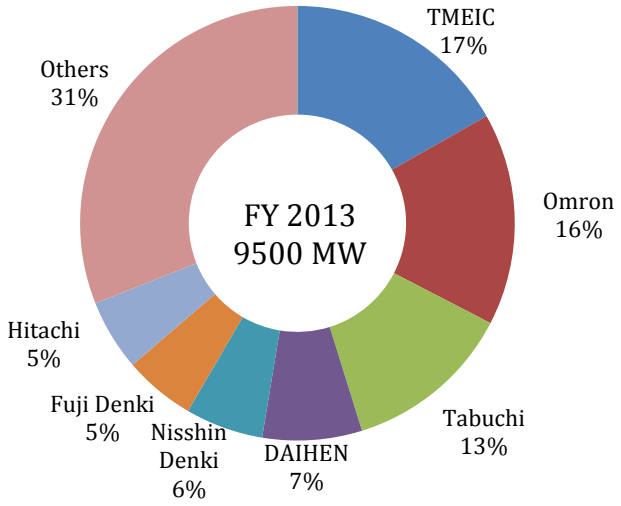
[37] JPEA: http://www.jpea.gr.jp/document/figure/index.html, 18.09.2014.

B: PV Components Sectors

In FY 2014, Japan is going to become the world's largest PCS market – worth an estimated 1.7 Billion euros (2.2 billion dollars) – outstripping the US, China, and other European investment centres such as Germany and Italy[38]. The European presence on the Japanese PV market, despite strong global performance, is so far only limited to a few projects of mid- to large-scale[39]. In other words, Japanese PCS manufacturers dominate the market in an almost exclusive manner – such as *TMEIC[40], Omron, Tabuchi* and *Yaskawa* (see Chart 2-5). As for the residential PCS segment, it should be noted that PV panel makers such as *Sharp*, *Panasonic*, etc. also hold a certain market share due to the practice of bundling and shipping the PV systems with in-house PCS solutions (YANO, 2013).

European PCS businesses are hampered by limited access to supply channels as well as the reluctance of the Japanese consumers to purchase foreign products. Another tangible barrier consists of the Japanese safety accrediting system (JET[41]) that has been a bottleneck of its own; JET is the only institution, able to certify PCS up to a unit size of 20 kW. Specific test guidelines are not public. The testing process may take up to four to six months. However, in case of testing failure, this process is further delayed, as product modifications have to be undertaken. For bigger units no certification scheme exists. *TÜV Rheinland* and other providers of technical, safety, and certification services are able to provide testing data, which has to be later approved and discussed by the respective power companies. The limited testing capacity in Japan and somewhat lack of information in English are perceived as impediment by PCS manufacturers.

Chart 2-5: PCS market shares, by shipped capacity in FY 2013



Source: JPEA 2014[42]

[38] PVMAGAZINE:http://yen.pv-magazine.com/news/details/beitrag/yaskawa-expands-into-us-inverter-market-with-solectria-acquisition_100015776/#axzz3HPcLlVNm, 30.09.2014.
[39] For instance, SMA's PCS systems had been used for the so far biggest grid connected utility–scale PV project in Japan (Kagoshima City, 70 MW)
[40] *TMEIC* is a joint venture by Mitsubishi Electric and Toshiba.
[41] JET - *Japan Electrical Safety & Environment Technology Laboratories*
[42] JPEA: http://www.jpea.gr.jp/document/figure/index.html, 18.09.2014.

Despite the rather gloomy market development so far, many European manufacturers express hope that higher market penetration can be reached in the mid- to long-term. Japanese EPCs favoured a voltage of 600 Volt PCS systems – a trend, which is shifting towards 1000 Volt power conditioners; one reason is potential cost reductions of up to 20 percent per Watt unit (PVEYE, 2014)[43]. A shift towards 1000 Volt PCS systems is also most likely going to create momentum for other European installation methods and appliances such as string systems, monitoring systems, etc. (PVEYE, 2014).

The market landscape of above-mentioned appliances as well as racking systems is less clear-cut; a myriad of specialised suppliers mingle with larger PV panel manufacturers, supplying in-house solutions. While a few European SMEs entered the respective market segments, it is obvious that larger market actors possess more staying power than their smaller counterparts[44]. The total market volume is small – BOS, junction box, racking systems, monitoring systems, etc. are estimated to comprise only 13 to 14 percent of the total market in FY 2013 (FUJI KEIZAI, 2013).

3. Residential PV systems

3.1. Residential Sector

3.1.1. Housing Market & Solar PV

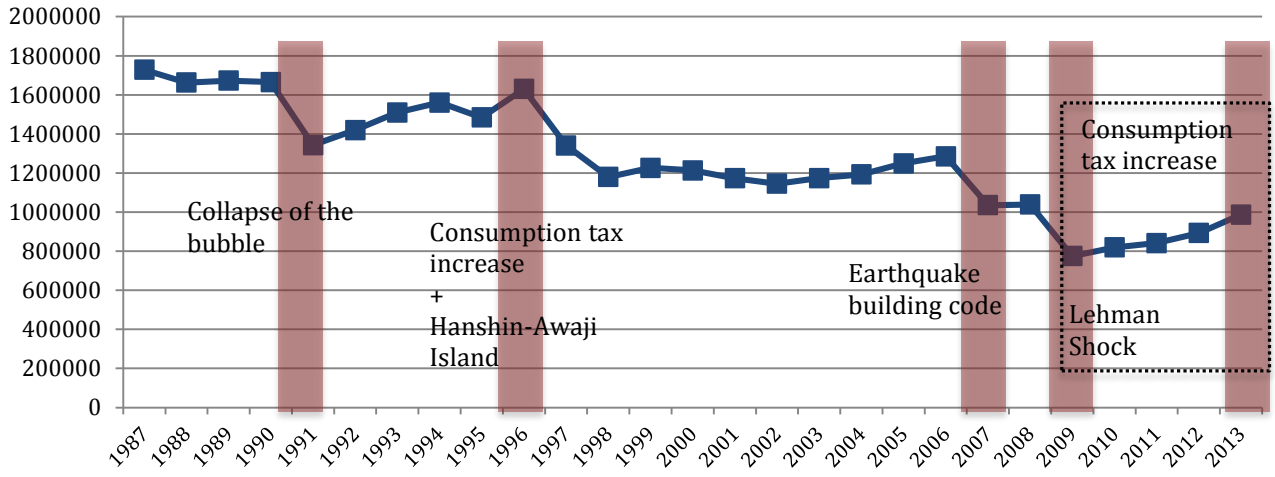
The *Statistical Survey on Construction Starts*, as shown in Chart 3-1, illustrates that the Japanese housing market has experienced a prolonged growth period over the last four years. In reaction to the *Lehman Shock*, the market contracted in FY 2009, but demand subsequently recovered – in anticipation of the *consumption tax* increase in FY 2014, the market for new houses surged 11 percent in FY 2013 compared to the previous year. However, the overall trend in the Japanese housing market diverts from this short-lived phenomenon. Over the last two decades the Japanese housing market has declined by 50 percent, and as KOHO (2014) indicates, is bound to fall from approximately 980,000 (FY 2013) new construction starts to around 620,000 in 2025 (see Chart 3-1).

The reasons behind the downturn are manifold and complex, yet, a few major aspects can be identified; (1) the already declining Japanese population deteriorates (with some time lag) the size and number of the average household in Japan. The number of households is forecasted to peak in 2019, falling thereafter; (2) economic stability and growth is another significant factor influencing the housing market. Certain economic growth has to be sustained in order to justify a certain rate of housing constructions. (3) The quality and the amount of the housing stock; currently, the life cycle of an average Japanese house is merely 22 years – a value extremely low compared to Europe and the US. With this value increasing, logically, the number of houses will move to the other

[43] WEIDMUELLER: http://yen.weidmuller.co.jp/panel/pdf/Megasolar_References_in_Japan_WMJ_20140926.pdf, 30.09.2014.
[44] Examples include the Zech Group (Mounting Systems GmbH), Krinner GmbH, and Weidmueller GmbH, etc.

direction (Another aspect falling under this issue, is the increasing ratio of vacant dwellings in Japan. According to the NIHON *KEIZAI SHINBUN (31.07.2014)*, 13.5 percent of the whole housing stock in Japan is unoccupied – a circumstance that is contributing to the overall slowdown of the new construction market; particularly influenced are the prefectures of Yamanashi (22 percent), Nagano (19,8 percent), Wakayama (18,1 percent), and Shikoku (17 percent)[45]. Readjusting incentives in this field, would most-likely have a reviving effect on housing market.

Chart 3-1: Number of newly Constructed Houses



Source: NRI and MLIT, 2014

Since the setup of the first PV test field at *Rokko Island* (Kobe City), extensive government support (i.e. *Residential PV System Dissemination Program*) developed the residential market as the major source for solar PV capacity growth in Japan. In total, more than 250,000 houses have been equipped with solar PV systems. The average system size ranges from 4 to 6 kW – with the largest systems in Okinawa (5.81 kW), Miyazaki (5.13 kW), and Kagoshima (5.10 kW)[46]. The start of the FiT also gave incentive to install rooftop systems larger than 10 kW – a capacity size that entitles house owners to sell the total amount of produced electricity. Such systems stretch across the whole roof space and replace normal roofing materials.

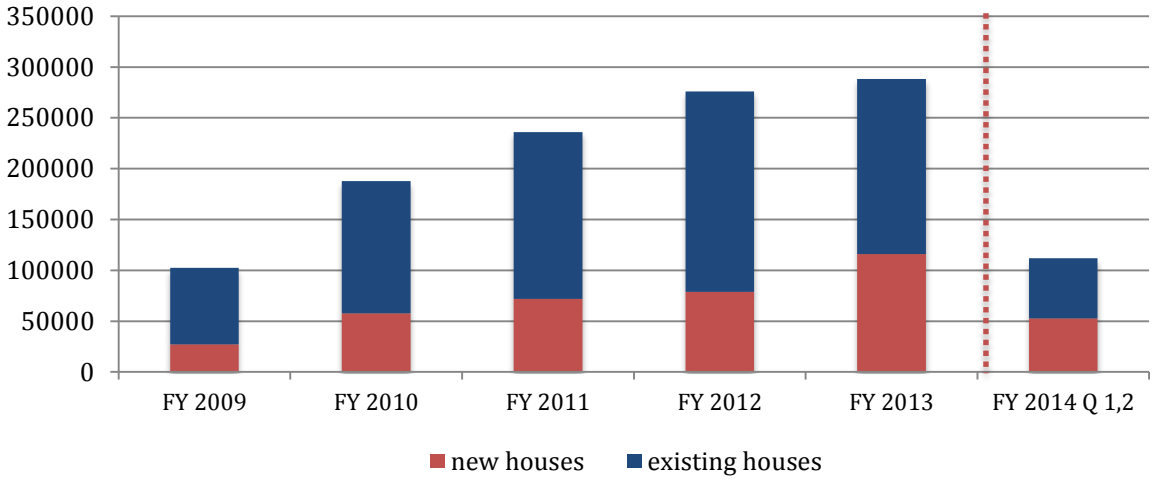
Retrofitted PV systems have traditionally taken the largest share within the pool of residential PV systems. N*ew houses,* on the other hand, accounted so far only for a negligibly small share within this development. In recent years, this trend is, however, shifting due to a series of policy support measures and intensive involvement of housing companies in the marketplace - a trend that can be observed from the total number of pre-installed PV subsidy applications. As shown in Chart 3-1, the number of pre-installed PV

[45] Partially liable for this situation is the fixed asset tax that gives an incentive for house owners to keep their house than to demolish it.

[46] HOUSING INDUSTRY NEWS: http://yen.housenews.jp/feature/9352, 31.10.2014.

systems has been increasing from 26 percent in FY 2009 to almost 50 percent in FY 2014 (Q 1, 2).

Chart 3-1: Number of subsidy applications for residential solar PV systems



Source: J-PEC, 2014

In the early 1990s a few larger companies such as *Misawa House* and *Sekisui House* started to offer housing models with pre-installed PV systems. Only in recent years has this trend turned into mainstream. The total number of new stand-alone houses equipped with solar PV systems increased from a mere 4.6 percent in FY 2008, to 23.3 percent in FY 2012[47]. Furthermore, in order to differentiate their product line-up, major housing companies increasingly embarked on a trend of "Smart Houses". This concept, also promoted and subsidized by the central government, incorporates solar PV and so-called *Home Energy Management Systems* (HEMS)[48] as core technologies, aiming at consumer side cost reduction, and energy consumption *peak cutting*. Major housing companies, including *Sekisui House, Sekisui Chemicals, Panahome, Daiwa House,* and *Misawa House*, announced to equip a large share of their housing models with both solar and so-called HEMS (see Table 3-1).

The start of the FiT also gave incentive to install rooftop systems larger than 10 kW – a system capacity that entitles house owners to sell the total amount of produced electricity. Such systems stretch often across the whole roof space and replace normal roofing materials. A few homebuilders such as Daiwa House embarked recently on this development offering house models with pre-installed 10 kW PV systems (RTS, 2014). It seems, however, that roof-integrated PV systems are considered as fixed assets under tax law and are thus disadvantageously treated compared to PV systems mounted on racking systems[49]. A further peculiarity of the Japanese residential market is the willingness to

[47] ITMEDIA: http://yen.itmedia.co.jp/smartjapan/articles/1306/21/news060.html, 23.10.2014.

[48] HEMS encompass battery systems (i.e. electric vehicles), smart meters, and any other product that monitors, controls or analyses energy in the home. This definition includes residential utility demand response programs, home automation services, personal energy management, data analysis and visualization, auditing, and related security services (BOJANZCYK, 2014 http://yen.greentechmedia.com/articles/read/home-energy-management-systems-redefined, 3.10.2014).

[49] AMEBA: http://ameblo.jp/yadokari6669/entry-11626598130.html, 30.09.2014.

pay a substantial premium for aesthetic and harmoniously rooftop-integrative PV systems[50]. A few Japanese manufacturers try to meet consumer demands by selling, i.e. roof-tile formed PV modules – one example is here Sharp's *NT-59K5C* modules.

Table 3-1: Homebuilders Initiatives

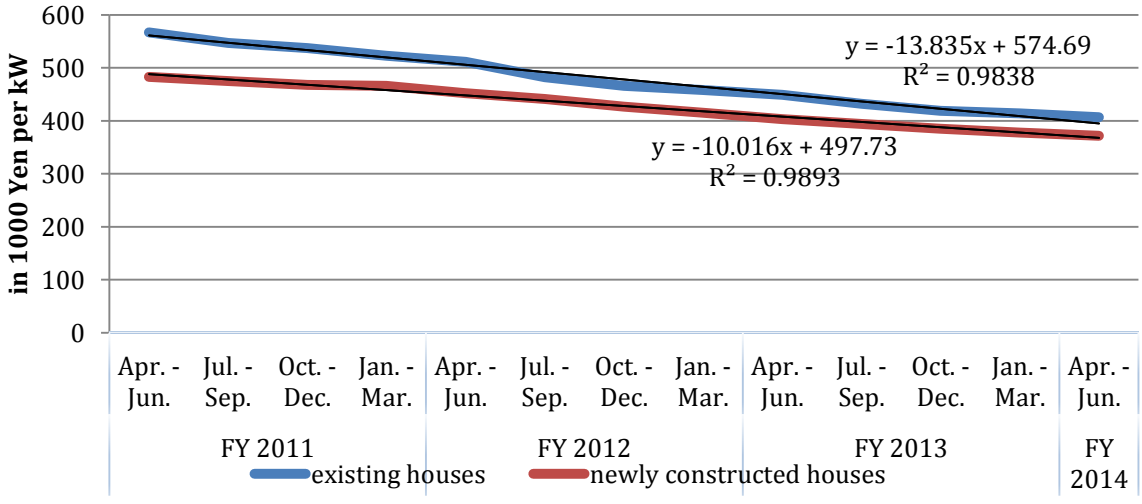
Homebuilder	**Initiatives**
Sekisui Chemicals	By 2016 all houses shall be equipped with solar PV and HEMS systems
Daiwa House Company	Since April 2014 all products are shipped with solar PV and HEMS systems
Sekisui House	Additionally to Solar PV systems 60 percent of all products shall be fitted with fuel cell devices
Panahome	60 percent of all products shall be fitted with solar PV systems. By 2018, all products shall be shipped with solar PV systems
Misawa House	By 2016, 65 percent of all shipped houses shall be shipped with solar PV systems. Misawa is additionally offering to increase the purchasing price for 1 yen.

Source: NIHON KEIZAI SHINBUN, 31.07.2014

3.1.2. Costs, supply chain and product premium

The *Japan Photovoltaic Expansion Center* (J-PEC) collects residential PV system costs of all systems that applied for installation subsides[51] - this set of data proposes that residential PV system costs amounted to 407,000 yen per kW for retrofitted and 372,000 yen per kW for pre-installed PV systems in the first quarter of FY 2014. A linear display of both series of data points indicates that for both, retrofitted and pre-installed PV system's price levels are converging, as retrofitted system prices fall slightly faster (retro: 13,835 euros; pre: 10,016 yen per quarter) (see Chart 3-2).

Chart 3-2: Change of residential PV system prices (FY 2011 to FY2014 Q1)



Source: J-PEC, 2014

[50] METI: http://yen.meti.go.jp/report/downloadfiles/g90224c01j.pdf, 14.09.2014
[51] J-PEC: http://yen.j-pec.or.jp/information/data.html, 30.09.2014.

Costs for residential systems are, however, on a rapid decline. Latest cost assessments undertaken by the author anticipate residential prices of around 215,000 yen per kW for retrofitted PV systems (September costs levels for retrofit systems). As for pre-installed systems prices, the NIHON KEIZAI SHINBUN (31.07.2014) states that the average cost for a new two-storey house with 120 m^2 space of living amounted to 30,000,000 yen, while equipped with a solar PV system the price goes up to around 33,000,000 yen (218,000 ~ 240,000 euros).

The cost of residential systems comprise of *hard* and *soft* costs. While the former, as the name suggests, comprise of costs for PV panels, racking system, and the BOS, the latter accounts for costs related to the installation of the system, customer acquisition, permitting inspection and interconnection. FRIEDMAN, MARGOLIS et al. (2014) produced a study on the Japanese and US American residential PV market for the *National Renewable Energy Laboratory* (NREL), in which they asked 81 Japanese installers and their US counterparts about the costs accruing for the installation of residential PV systems. Their results indicate that overall costs in Japan level off at 3.69 dollars (2.95 euros) per Watt, thus cheaper than in the US with 4.48 dollars (3.58 euros) per Watt. The study identified labour costs, supply chain mark-ups and the willingness of Japanese consumers to pay a premium price for Japanese products as cost driving factors. While labour costs, in general, make up a larger part of the accruing soft costs; the latter two additional costs are rather unique for the Japanese residential market.

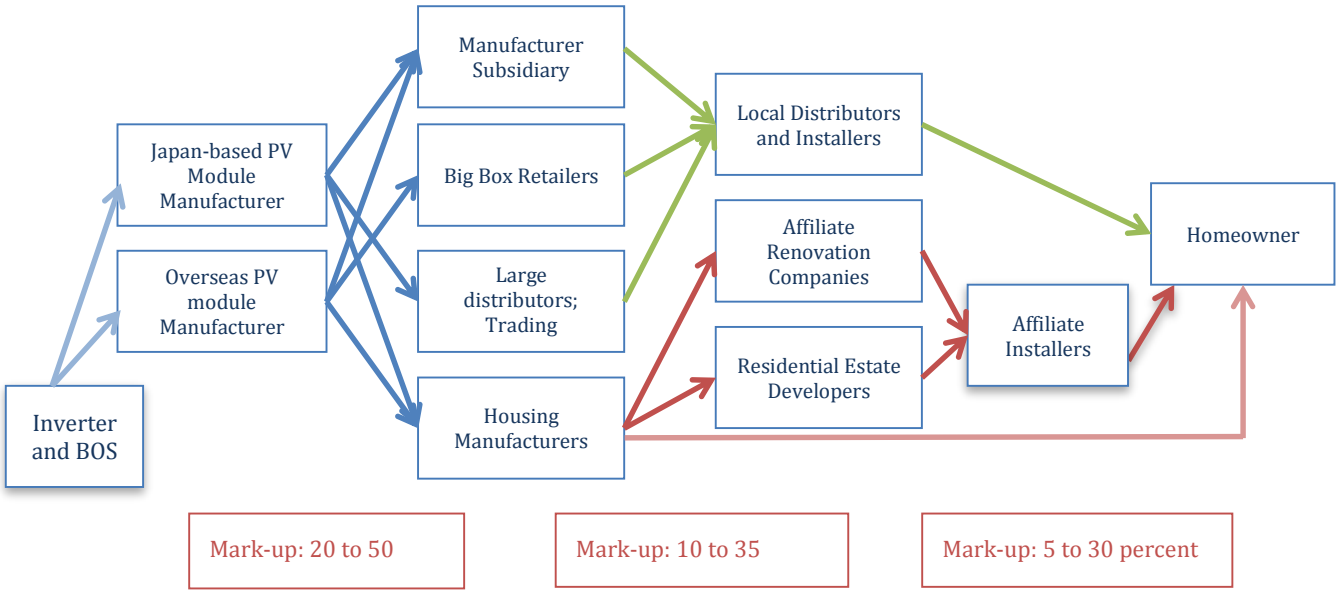
The Japanese supply chain, as depicted in Chart 3-3, presents itself as a complex system that grants the supplier side various effective means of control. For instance, hardware kitting takes place at the PV panel manufacturers end, who are thus largely in control of the pool of appliances used in the residential sector. In addition, in order to be able to sell and install these hardware kits, installers have to receive PV panel manufacturers' *identifications* (IDs). The IDs require re-certification once per year, which an installer may find difficult to maintain for multiple manufacturers. Conversely, the installer may effectively function as the exclusive dealer of the brand in a specific city or prefecture. It remains, however, unclear how long, in the face of foreign price pressure, the dominance of higher-priced domestic brands will last.

The NREL study also points out that numerous sub-stages contribute significantly to the prices, customers are eventually paying. These sub-stages consist of numerous wholesale distributors that positioned themselves as almost insurmountable middlemen between the supplier and installer side; major wholesalers are big box retailers[52] (*Yamada Denki, Yodobashi Kamera*, etc.), large distributors, trading companies (*Marubeni Corp., Itochu Corp. Mitsui Corp., etc*.) and homebuilders (*Sekisui House, Daiwa House, Panahome, etc.*). Homebuilders usually cooperate tightly with affiliated renovation companies and real estate developers to whom they supply PV hardware kits. Furthermore, due to the immediate vicinity to the supply and consumer side,

[52] Big box retailers offer a large variety of PV systems that consists of non-Japanese appliances. For instance, a large portion of PV panels, *Yamada Denki* is selling, are produced by the Chinese PV panel makers *Suntec Power*. http://yen.hatsudenman.co.jp/article/13485998.html, 30.09.2014.

homebuilders are able to circumvent further sub-stages and bring pre-installed PV systems approximately 10 percent cheaper to the market (see Chart 3-2). Interestingly, customers in Japan seemed to be willing to pay a premium for domestic brands they can associate themselves with; This again is driven by the perception that domestic PV manufacturers produce more durable and safer PV equipment and offer faster service response in case of a malfunction (FRIEDMAN, MARGOLIS et al., 2014).

Chart 3-3: Residential PV Supply Chain in Japan



Source: FRIEDMAN, MARGOLIS et al., 2014

3.1.3 Market Entry and Policy Recommendations

Enduring market support by the government (i.e. pre-FiT) created a price competitive industry functioning in a complex web of market relations. Within this system, extensive market control is concentrated in the hands of a few manufacturers and distributors. In fact, Japanese PV component providers and system installers control almost the whole residential market. Having this in mind, it should be noted that the FiT scheme created market space and opportunities for other competitive and innovative players bringing new appliances and services in. At is point, we would like to specify a few areas in the market that still have growth potential and constitute significant market opportunities for European companies, including SMEs.

Since average sized Japanese rooftops offer relatively little space for solar PV systems, rooftop systems that enable the utilization of the whole rooftop surface as well as high conversion rate PV panels (e.g. HIT) had been well perceived by the market. In addition, Japanese rooftops are often not designed for additional weight burden; therefore light systems may also incur an advantage in the market, particularly because larger systems (above 10 kW) appear to be high in demand. In addition, the willingness of the Japanese consumer to pay a premium for aesthetic system design might entail

opportunities for architectural elements such as *Building Integrated Photovoltaic* (BIPV) that would replace conventional building materials in parts of the building envelope such as roofs, skylights, or facades. Potential cooperation partners include homebuilders, trading companies, and free-agent architects[53].

Wholesale distributors such as trading companies are traditional routes for entering the Japanese residential PV market. One recent example is the US roof-structure manufacturer, *Zep Solar*. The racking system maker recently concluded an exclusive sales agreement with *Marubeni Inc.*, which is going to supply Zep Solar's rooftop systems to installers and homebuilders across the country. On the other hand, it should be noted that circumventing larger distributors and trying to reach installers [54] and regional homebuilders directly might be also a viable entry route. Contacts could be established via experienced and well-connected Japanese sales personnel showcasing your company's products directly to installers and homebuilders. Furthermore, it should be highlighted that *national chambers of commerce* as well as the *EU-Japan Centre for Industrial Cooperation* could provide initial support in liaising with potential partners.

Throughout the year, the year, a large number of product fairs in Japan's urban centres such as Tokyo, Osaka, and Nagoya (i.e. *PVJapan*) are offering valuable opportunities (A list of annual trade fairs – see Annex 7.3).

3.2. Non-residential sector

3.2.1 Market development

The start of the FiT generated an immediate surge of PV applications to METI. In the first month METI approved approximately 500 MW. Two years later, in June 2014, this number spiked to 68.7 GW. As depicted in Chart 3-4, 55 percent of the approved capacity had been added by large-scale projects, 41 percent by mid-size projects and only 4 percent by residential PV projects (below 10 kW). To date, only 19 percent of the total amount of approved capacity has been connected to the grid. Latest government data (May 2014) revealed that only 14 percent of all approved large-scale PV plants had been set up. This ratio is 21 percent for mid-scale PV plants. An opposite development can be observed for the residential PV segment, where 80 percent of the approved PV systems have been installed or construction has started (Chart 3-5). In addition, in order to be eligible for a specific purchasing price agreement, the Japanese FiT scheme requires that signing a FiT application has to be finalized before each fiscal year[55]. This led to an application rush during the last three months of each consecutive fiscal year.

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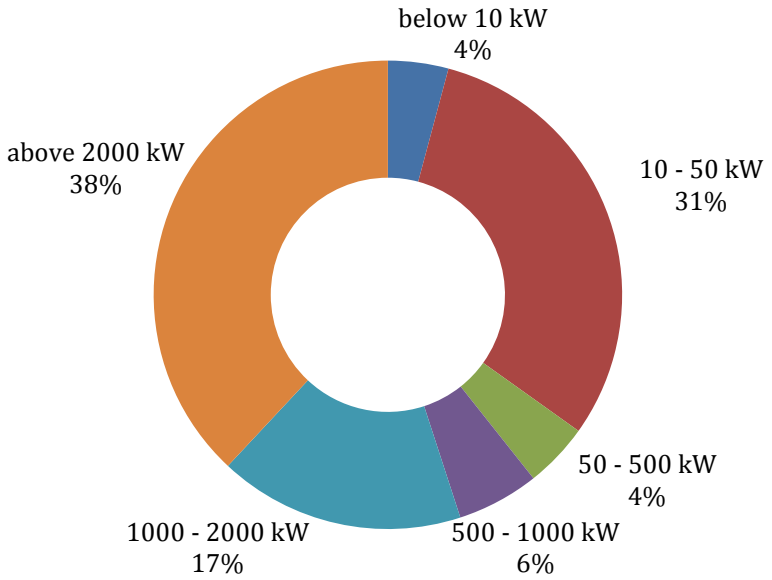
[53] A group of Dutch architects working with solar PV in Japan, hides itself behind http://yen.nihonsolar.de

[54] A comprehensive list of available installers in Japan can be found under: http://yen.installerinfo.com/facts/Japan, 30.09.2014.

[55] A practice, different to Germany's FiT, that rather takes the grid connection as starting point for determining the purchasing price.

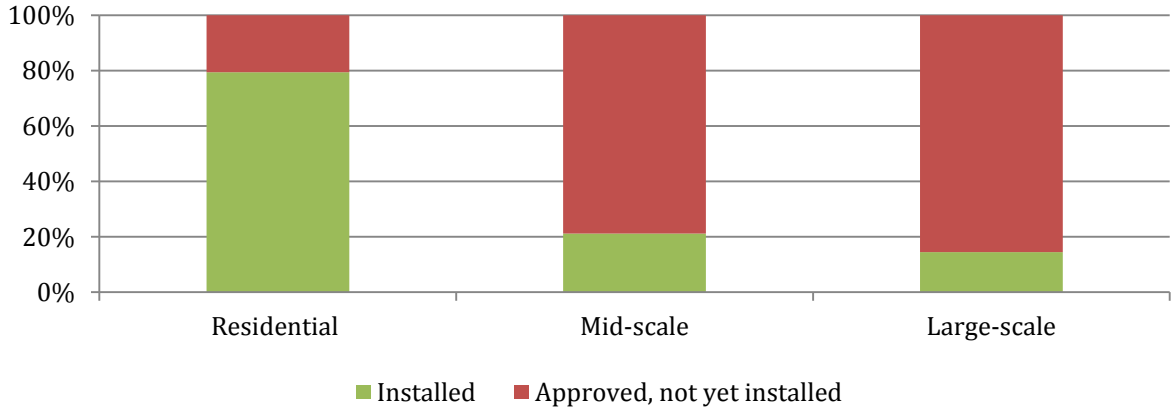
Chart 3-4: Approved capacity under the FiT by June 2014



Source: METI, 2014

In order to offset the above-described discrepancy METI announced to cancel or encourage cancellation of some previously approved projects that have not been able to procure neither PV appliances, nor a suitable land plot within 180 days. This concerns all projects above a capacity of 400 kW, or projects which were at the same site but divided into smaller partitions in order to avoid high-voltage[56] grid connection. According to KIMURA (2014), the three major reasons for the construction delay were (1) the lack of transparency in the power grid connection; (2) the complicated land usage rights regulations and (3) the continued reduction of the purchasing price. The latter point refers to the intrinsic uncertainty involved in the FiT scheme as purchasing prices are cut annually.

Chart 3-5: Cumulative amount of approved and installed PV capacity



Source: METI, 2014

Besides some time lag expected between the approval of a project and its actual set up, due to grid connection and/or land ownership issues (particularly in the disaster-struck

[56] Below a threshold of 50 kW the system is going to be connected to the grid with low-voltage and above 50 kW with high-voltage.

regions) the government assumes that some developers are deliberately delaying installations to profit from rapidly falling hardware prices. In other cases, individuals are aiming to achieve a speculative gain by merely reselling the acquired purchasing price agreement (RTS, 2014).

The prefecture with highly favourable conditions for large-scale solar farms, Hokkaido, has seen the largest imbalance between approved and installed capacity. Although it received approval for several GW of mega solar under the FiT, the *Hokkaido electric power utility* (Hokuden) has been confronted with difficulties in (1) bringing the approved energy to the grid, and (2) stabilising the grid in the face of a growing amount of intermittent capacity. Due to the latter, Hokuden announced in April 2013 that the power grid reached its maximum capacity for utility-scale PV generating plants, and will do so for mid-size PV plants very soon (NEF, 2014). A recent joint statement by the regional utilities revealed the full scale of this dilemma; Apart from Hokuden, six other utilities announced subsequently that they will stop signing solar PV agreements due to the overcapacity and the potential electricity outage, if further intermittent energy sources are connected to the power grid (Table 3-2).

Table 3-2: Electricity Utilities Stopped Signing RE Agreements

Hokkaido	Starting from October 1, the Hokkaido Electric Power Company signs no agreements for renewable energy anymore.
Tohoku	Starting from October 1, the Tohoku Electric Power Company signs no agreements for renewable energy anymore.
Kanto	In parts of Kanto, the Tokyo Electric Power Company denies large-scale solar PV projects access to the grid.
Kansai	In parts of Kansai, the Kansai Electric Power Company denies large-scale solar PV access to the grid.
Shikoku	Starting from October 1, the Shikoku Electric Power Company signs no agreements for renewable energy anymore.
Kyushu	Starting from October 1, the Kyushu Electric Power Company signs no agreements for renewable energy anymore.
Okinawa	Starting from October 1, the Okinawa Electric Utility is not signing any new contracts (including residential)[57]

Source: Tokyo Shinbun, 2014[58]

5.2.2 Organizational Structure

The launch of the FiT scheme induced a vibrant non-residential marketplace that not only attracted the attention of solar appliance manufacturers but also new market entrances, holding various industrial backgrounds, such as in electricity and gas, trading, construction, electronics, telecommunications, leasing, engineering, real estate, municipals, NPOs, homebuilders, finance, etc. stoked the market.

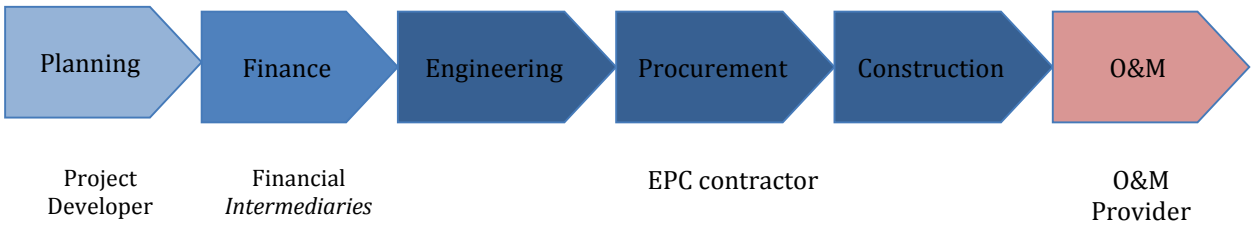
In terms of large-scale solar PV, principle service areas encompass the provision of project development including the planning and consent acquisition for land usage; *Engineering/Procurement/Construction* (EPC), finance, *Operation & Maintenance*

[57] OKINAWA ELECTRIC COMP.: http://www.okiden.co.jp/shared/pdf/news_release/2014/140930.pdf, 23.10.2014.

[58] TOKYO SHINBUN: http://yen.tokyo-np.co.jp/s/article/2014100190071001.html, 30.09.2014.

(O&M) (see Diagram 3-1). Raising demand for suitable land and rooftops has also promoted leasing and land matching services. While some market participants operate only in a limited and specified niche, while as others cover the whole or large parts of the value chain of services indispensible for setting up a PV plant – the latter is particularly true for market participants who target large-scale PV projects. In terms of installed PV capacity, major market participants include *NTT Facilities*, Softbank's *SB Energy, Mitsui Co., Orix and JAG.*

Diagram 3-1: Workflow for Large-Scale PV Plants



Source: Authors design

A: Developer, EPCs, and O&M service providers

The EPC business area, formerly almost not existent in Japan, has attracted a myriad of new entries from adjacent industries. New entries to this business field are usually related to one of the EPC expertise areas. They possess simplified access to wholesale channels for PV appliances (Panels, PCS, BOS, junction boxes, and racking systems) and/or in-house expertise. In other cases, had been a major driving force for market entries. As depicted in Diagram 5, major entry areas are the following: general contractors, civil engineering and trading companies, funds, PCS manufacturers, solar PV panel manufacturers, electronics facilities makers, telecommunication companies, project developer, gas and oil companies, NPOs, and solar PV installers. In addition, the market also experienced a few entries from foreign EPC contractors and subcontractors.

Many small-scale domestic EPC contractors focus on systems below 2000 kW, as it requires less reporting to authorities and less qualifications in-house (i.e. Chief Electrical Engineer). In addition, avoiding extra high-voltage grid connection makes the use of transformer substations obsolete, and thus the whole process less technical. Once an EPC contract is signed, the EPC contractor becomes liable for completing the project to the set conditions. EPC contractors, in turn, may hire sub-contractors to complete certain preparatory work. In some cases, EPC contracts are expanded with O&M ancillary clauses in which the EPC commits to provide O&M services for a certain period of time. As foreign EPCs are concerned, O&M services are usually not offered, as it would require having experienced and trained staff ready and available for inspections and trouble shooting at any time. Such services are usually passed on to locally available O&M providers.

Relationships between contractor and sub-contractor are usually long-term to avoid lass of trade secrets. Market channels for PV appliances differ by the size of the plant; plants below a capacity of 50 kW tend to use similar supply chains as existing for

the residential PV sector; PV panel manufacturers' kit PV systems including PCS, BOS, racking systems, etc. and sell the *ready-to-install* kits via wholesale distributors such as trading companies to franchise stores. Trading companies take almost 50 percent of the sales of solar PV hardware packages. As for high-voltage connected PV systems, appliance sales are conducted via (specialized) trading companies, EPCs, general contractors and sub-contractors (FUJI KEIZAI, 2013).

Diagram 3-2: New Market Actors Enter the EPC Market Field

Source: RTS, 2014

A few European EPC contractors operate highly successful in the Japanese market - examples are *Shizen Energy*, *Gestamp Solar*, *Belectric, IBC Solar*. Most of the European companies that entered the market had a reliable domestic or foreign partner, with whom they either worked before or who is familiar with the market and could thus provide contacts and market expertise. The examples of juwi Shizen Energy and Gestamp Solar illustrate this: The German EPC contractor *juwi*, active in solar and wind energy, is partnering with the Japanese project developer *Shizen Energy*. Both sides entered a joint venture in 2013; juwi Shizen Energy provides ground mounted but also rooftop solutions. O&M services are currently not provided for projects in Japan. Additionally, juwi Shizen Energy plans to develop renewable power (major parts are wind and solar) plants with an output of as much as 1000 MW by 2017. Major customers are Japanese industrial energy users or investors as well as international renewable energy investors or utilities.

The other example is the Spanish EPC provider, Gestamp Solar: For the Japanese market, Gestamp Solar is in close cooperation with a Japanese energy consulting company, *Souken Keiei Senryaku Souken*[59] (hereafter: Souken), that possesses a large customer base of 4400 facilities, including supermarkets, Pachinko machine arcades, and others. Souken functions as middles men and introduces their customers to Gestamp Solar, who are in

[59] No English name provided for this company. 環境経営戦略総研。

charge of installing a solar PV system on the respective rooftops. In this business model, rooftop owners provide their roofs and receive for a period of 20 years a leasing fee of around 100 to 200 yen per square-meter[60]. Gestamp Solar receives the whole turnover out of the sales of the electricity to the utilities. On the other hand, Souken is receiving a reimbursement covering introduction efforts and O&M services provided. In FY 2013, Gestamp Solar had been able to install 30 MW on various rooftops across Japan and is planning to top this result by installing up to 200 MW by the end of FY 2014 (TAIYO DENCHI 2013-2014, 157).

B: Finance

With the start of the FiT, a large number of private investors, small and large banking corporations and investment institutions entered the market field providing financial means underpinning the development of the non-residential PV market. In terms of actual investment, large domestic banks such as *Mitsubishi-UFJ Banking Corp. (hereafter MUFG), Mizuho Banking Corp.* (hereafter Mizuho), and *Sumitomo-Mitsui Banking Corporation* (hereafter SMBC) are leading the field. For instance, in FY 2013 MUFG provided approximately 730 million Euros of asset financing to eight solar projects and one wind project build in Japan. Another example is the *Shinsei Bank*, planning to invest roughly 1.6 billion Euros (2 billion Dollars) by March 2016. Many individual investors invested directly or via (community) funds in the setup of solar farms. The market also experienced a large influx of foreign investment companies including *Goldman Sachs*, *Deutsche Bank*, and investments funds such as *Wirsol*, *Greenpower Capital* and *Equis Funds*. Foreign investment entities seem to be particularly important for foreign developers/EPCs - while there are no legal barriers to entry, the large number of entrenched Japanese financial institutions makes foreign capital often the only source of funding, as Japanese banks have been busy over the last two to three years serving their loyal customers[61].

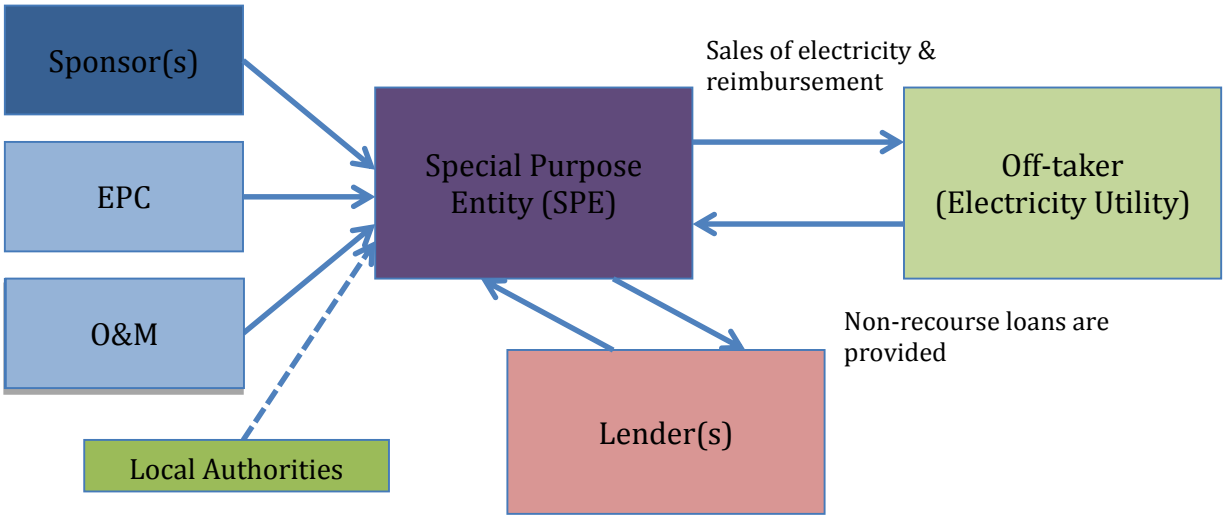
Finance for renewable energy can take the form of corporate and project finance (PF). Until recently the latter had been an almost untapped form of finance. That is despite the fact that Japanese banks had quite some track record abroad in providing limited-recourse project finance[62]. This changed with the start of the FiT – for instance, the *IJGlobal Project Finance Database*[63] lists for Japan within the time period of January 2000 to June 2012, only twenty renewable energy-related non-recourse projects - non of them solar. This picture changed dramatically after July 2012 – in only two years, the number of projects that received project funding grew to 34 of which 24 had been large-scale solar PV projects.

[60]Some municipalities offer similar services by organizing seminars and matching events for rooftop owners and installers. For instance, in Kanagawa: http://yen.pref.kanagawa.jp/cnt/f421164/, 21.09.2014.
[61] ECO-BUSINESS: http://yen.eco-business.com/news/deutsche-bank-lends-1-billion-japans-solar-gold-rush/, 30.09.2014.
[62] IFLR: http://yen.iflr.com/Article/3196272/Non-recourse-loan-unlocks-Japans-renewables.html, 30.09.2014.
[63] IJGLOBAL: http://ijglobal.com, 22.9.2014.

A *Special Purpose Entity* (SPE), set up by sponsors or a syndicate of sponsors, usually serves as the main vehicle of project finance (Diagram 3-3). In its most common form SPEs are an incorporated entity with no other previous operations, other than its mandated business, and its assets shall be comprised solely of the assets of the project itself. Most commonly, project finance takes the form of a non-recourse loan, in which the lender relies largely on the generated *cash flow* and SPE assets for its collateral.

Against the background of the recent announcement of 5 of the 10 utilities, not to sign any new solar PV agreements, many investors including banks, but also individual investors and municipalities that already procured funds from their community for the setup of a solar PV farm, are confused about the further development of the market. Further actions by the government, to avoid the dry out of the market, and thus regain investors' trust, are in this regard less bright – the government considers, inter alia, the introduction of a moratorium on the approval of large-scale solar PV farms[64].

Diagram 3-3: Project Finance Arrangements



Source: Based on Fukushima, 2012[65]

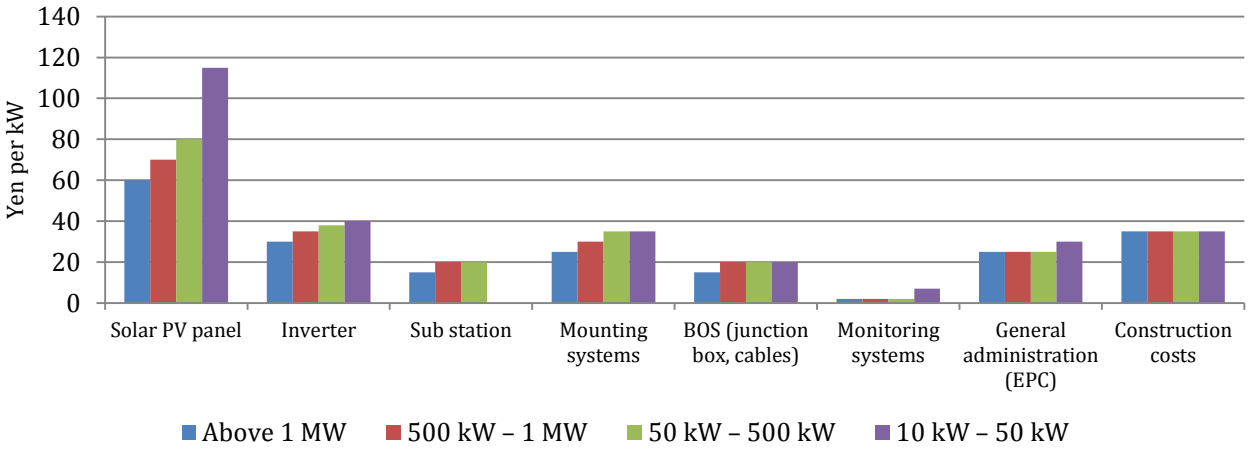
3.2.3 Cost structure

As already highlighted at an earlier point, the costs involved in the setup of PV plants comprise of hard and soft costs (see also 3.1.2)[66]. Chart 10 provides a breakdown of the major cost elements, hard costs include Solar PV panels, PCS, Substation, Mounting systems BOS, Monitoring Systems, while soft costs are general administration costs as well as construction costs (Chart 3-5). It should be kept in mind that the larger the PV system is, the smaller the costs are for each element on a per Watt basis a circumstance that leads to a wide price spectrum.

[64] TOKYO SHINBUN: http://yen.tokyo-np.co.jp/article/economics/news/CK2014101202000112.html, 30.10.2014.
[65] MIZUHO: https://yen.ares.or.jp/works/pdf/j10/ares_j_084_089.pdf, 30.09.2014.
[66] NREL: http://yen.nrel.gov/docs/fy14osti/60360.pdf, 30.09.2014.

Across all capacity classes, solar PV panels account for more than 30 percent of the costs accruing and are thus, by far, the largest hard cost element for non-residential PV plants. Until recently, only Chinese and Southeast Asian PV panel manufacturers, were able to decrease panel costs below 60 to 65 yen (0.44 to 0.47 eurocents) (PVEYE, 2014). However, latest panel cost analysis reveal that Japanese *out-of factory* prices for PV panels declined to 0.64 cents (US) (0.46 eurocents) per Watt in August 2014 - a development that can be brought in close connection with the latest favourable development of the domestic PV market[67]. The marked price (yen per Watt) discrepancy, across all four capacity classes, is explained by the different market channels utilized; While larger EPCs are able to purchase PV panels and other appliances directly *out of factory*, smaller plants have to rely on installers that are usually one of the end members in a longer supply chain (FUJI KEIZAI, 2013).

Chart 3-5: Cost Breakdown per PV Farm Class



Source: PVEYE, 2014

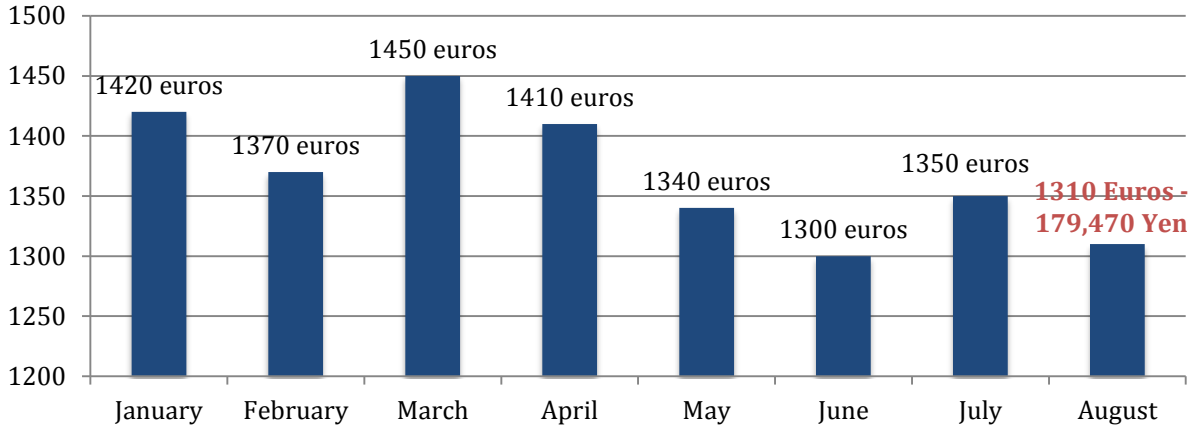
Due to the nature of construction work at a PV plant site (i.e. the size of a plant is easily scalable), construction costs are constant across the capacity classes. In order to reduce their own overhead, many EPC contractors are outsourcing this task to sub-contractors that possess specialised machinery and trained manpower. European EPCs, actively engaged in the Japanese market, subcontract to domestic but also European EPCs with whom they have already worked on other projects with.

The annual purchasing tariff reduction as well as the significant competition in the non-residential market segment function as the main driver for the price decrease. According to a major EPC active in the Japanese PV market, costs for the different categories are as follows: PV systems above 1 MW range between 200,000 and 230,000 yen (160,000 – 167,000 euros) per kW. Costs go up for systems between 500–1000 kW ranging from 215,000 to 275,000 yen (1580 – 2010 euros) per kW. And systems between 50–500 kW systems cost between 230,000 – 290,000 yen (1680 - 2120 euros) per kW.

[67] PVXchange: http://pvxchange.com/priceindex/Default.aspx?langTag=de-DE, 30.09.2014.

When compared to its European peers – as a benchmark the *Photovoltaikumfrage*[68], surveying system prices (above 100 kW) in Austria, Germany, and Switzerland, is suggested – costs for August 2014 have been 1310 euros (179,470 yen) per kW, thus roughly 30 percent, lower (see Chart 3-6).

Chart 3-6: Average PV System Prices (above 100 kW) in Selected European Countries



Source: Photovoltaikumfrage[69], 2014

Another cost item that comes into the picture are land prices – the FiT has been stoking up demand for well-located land plots, increasing land prices of 500 yen per square-meter. Prices again depend on factors such as the location of the land plot to the power grid, solar irradiation, and slope of the property, ownership rights, etc. In fact, for foreign developers acquiring good land can be difficult and requires good Japanese partners, including contractors and developers. Finding suitably large land plots is a major reason why market predictions foresee a shift towards mid-scale solar farms.

3.2.4. Market entry Recommendations

The non-residential PV market has been almost feverish over the last two years. The government provided generous purchasing tariffs creating, especially in the large-scale segment, a rush on installations. However, almost 90 percent of all approved solar PV has been concentrated on only 5 of the 10 utilities. This prompted a recent announcement of these utilities to boycott solar PV agreements. In other words, FiT applications for non-residential solar PV systems are going to be deferred at some indefinite future date. The electricity utilities argue that an oversupply of intermittent solar energy jeopardizes the stability of the power grid, thus *forcing* the utilities to stop the further intake of new agreements – a circumstance that only considers non-residential solar farms.

[68] On a monthly basis, around 300 installers participate in a survey, *Photovoltaikumfrage that addresses the prices (euros per kW) for PV systems above 100 kW.*
[69] PHOTOVOLTAIK-GUIDE: http://yen.photovoltaik-guide.de/pv-preisindex, 30.09.2014.

The above-described situation of political limbo surrounding the further development of large-scale solar PV in Japan creates an infertile environment for market entry. The current status of the Japanese market should urge European EPC contractors wishing to enter Japan's non-residential market field to rethink or postpone their plans to do so – particularly, since large-scale plants are prone to be deferred. Also in terms of a long-term market strategy, the market may not provide enough incentive, unless the situation cannot be satisfactorily resolved. A viable partner can provide helpful advice, observing the further development of the market field.

It is to be expected that the recent announcement of the respective electric utilities harms smaller non-residential solar farms only to a lesser extend – that is largely due to the fact that power grid connection is easier to facilitate. In addition, it seems that the market is shifting gradually towards systems below 1 MW – here ground-mounted but also rooftop PV systems have large potential, particularly due to the higher availability of land plots and suitable rooftops. Similar to the residential market segment market potential can be identified for lightweight rooftop racking constructions and solar PV panels.

There is also an explicit interest in solar PV solutions combining the usage of areas such as farmland or parking lots with solar PV. Concerning the latter, recent deregulations facilitated the installation of solar PV systems on parking lots as long as parking is not extensively impaired. The former considers the potential combination of farming and renewable energy production. This means, that there is an explicit demand for innovative scaffold solutions or green houses, integrating PV panels (transparent thin-film PV panels, etc.). The government operates currently a three-year test programme for affirm the impact of solar PV panels on crops. The French company *Ciel et Terre* provides another example of addressing successfully the need of intelligent space usage in Japan - the company installed two floating solar PV farms on calm water lakes in Hyogo Prefecture in 2013.

The accelerated growth in PV capacity creates the need to expand the focus away from just the cost of day 1 and instead, look at the cost per watt of day 1000 – this increases the importance of O&M solutions. Here, innovative monitoring technologies, weather forecasting technologies, battery systems, etc. are going to be asked for. For instance, in light of the upcoming FiT revisions, the Japanese government announced that it consider to request operators to build up capacity for turning off solar energy production a few hours after notification. So far, not many large-scale PV plants are equipped with technology able to do so. Other services such as weather derivatives, insurances, solar farm risk hedging, etc. become increasingly important, too.

4 PV in Japan - Quo Vadis?

4.1 The Electricity Market Reform & Solar PV

The Japanese power sector has an approximate market volume of 280 GW/1000 TWh, and is quasi-monopolized by 10 electricity utilities; several waves of reforms[70] starting since 1995 liberalized the high-voltage and high-voltage customers retail market for competition by other market competitors. In addition, "to encourage more active electric power exchange on a nationwide scale and to bring about greater diversity in electric power procurement, the cross-wheeling service system was revised and the Japan Electric Power Exchange (JEPX) was established" (TACHIBANA, 2014). A prominent early market entry is for instance *J-Power*. Despite partial liberalization of the market (62 percent, by market volume), price and market control remained largely in the hands of the electricity companies. For instance, in FY 2013 *Power Producers and Suppliers* (PPS) have supplied only four percent of the electricity supply. The Japanese power grid system presents to be highly effective – before March 2011, Japan had only 17 minutes of electricity blackouts, compared to 138 minutes in the US. In addition, the system operated with a comparatively low rate of transmission loss of around 4.8 percent – in comparison, the US had a loss of 5.8 percent and France of 6.9 percent (in 2009)[71]

However, the Fukushima I nuclear plant accident in March 11, 2011 revealed the urgent need to be able to react with greater flexibility to supply and demand changes countrywide. The Japanese grid system developed regionally, creating only weak links between each other's systems – a model also referred to as *Kushizashi Grid* – and has been thus only insufficiently capable of offsetting supply/demand imbalances in certain regions[72] in the aftermath of the Fukushima accident. Matters have been even further complicated with the regional division of frequency in a 50Hz and 60 Hz. The government, therefore, pledged to (1) expand the operation of wide-area electrical grids, (2) fully liberalize the retail power market, as well as (3) conduct a legal structural separation of transmission/distribution and power generation. The reform is going to be divided into the three phases: The first phase, starting in 2015, is going to establish the *Organization for Cross-regional Coordination of Transmission Operators* (OCCTO) in 2015. OCCTO is going to balance supply and demand and address coordination of the wide-area network; the second phase, due in about 2016, is going to allow households and other small-scale user to choose freely their electricity supplier, rate plan, option depending on power source, etc. Until full liberalization, achieved with the legal unbundling of generation and distribution/transmission in the third phase, due in about 2018 to 2020, previous electricity prices are going to be maintained.

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[70] Before the Fukushima nuclear accident the four electricity reforms had been undertaken in 1995, 1999, 2003 and 2008 (Tachibana 2014).

[71] FEPC: http://www.fepc.or.jp/library/words/keiei/shihyou/gainen/1225633_4545.html, 20.10.2014.

[72] Matters had been aggravated by the fact that frequency utilized in the west (60 Hz) and east (50 Hz) is different. Both areas had been only weakly connected via three conversion stations with a cumulated capacity of 1.2 GW.

The electricity market reform is going to be a major driving force after the phasing out of the FiT scheme. It is assumed that new business models are going to emerge in form of supplying renewable energy to environmentally conscious consumers. This is a development the European electricity markets have been undergoing for quite some time and, could in this respect provide know-how and services. Crucial for the establishment of a competitive market, addressing different energy rates and options depending on power source, is the entrance of new players in the market field; While in May 2012 only 58 PPS had been registered, in October 2014 this number surged to 390 PPS[73]. One of them is the homebuilder *Misawa House* that has recently also entered the mega solar market and is going to provide the retail market. With approaching grid-parity, thus decreasing purchasing tariffs, the electricity market liberalization is likely to become a major driving force of solar PV and other renewable energies. This, however, implies the building of a rigid regulatory framework that punishes fraudulent behaviour that is involved in the sales of renewable electricity such as solar PV (HIOKI, 2014).

4.2 Growth projection

Due to the recent announcement by some of the electricity utilities the future development of the Japanese PV market is in limbo. As of 1st October 2014, 5 out of the 10 electricity utilities[74] stopped signing approved solar PV agreements – the rational behind this measure, is that the further intake of intermittent energy could result in a higher number of energy outages.

Against this background the further development of the non-residential PV sector is highly questionable and, in fact a difficult endeavour. Over the last two years, especially *mega solar* projects have been adding large amounts of PV capacity to the grid - this trend is most likely going to shift toward the mid-scale class. On one hand, deregulatory efforts created fertile ground for the dissemination of mid-sized rooftop systems (e.g. office buildings, factories, and storage facilities), on the other hand, the lack of suitably sized land plots in the vicinity of grid connections, and the fact that larger projects, due to feasibility issues, are going to be more stringently scrutinized than smaller projects under the currently revised FiT, are major reasons for the decline of large-scale solar PV farms.

To what extend solar PV is going to add capacity in the respective classes is difficult to quantify, especially since the government has so far deferred the release of (new) official energy targets. If to believe the JPEA, the *umbrella organization* of the Japanese PV Industry[75], non-residential sector is projected to accumulate roughly 60 GW by 2030 – capacity growth for mid-size PV systems is going to add in average 1.7 GW by 2020 and is

[73] PPS PORTAL: http://yen-pps.hpmap.net, 30.09.2014.

[74] Those six are - Hokkaido Electric Company, Tohoku Electric Company, Kyushu Electric Company, Shikoku Electric Company, Okinawa Electric Company, Tokyo Electric company and Kansai Electric Company

[75] They released in line with the government's 2009 energy PV targets for 2020 and 2030 the PV Outlook that is reviewed on annual basis.

subsequently going to increase annual growth to approximately 2 to 3 GW. PV systems above 1 MW are going to add roughly 0.7 GW annually over the next 15 years. After the phasing out of the FiT scheme, a major task for non-residential solar farm operators is going to be the utilization of the electricity market reform as the new vehicle for growth (JPEA VISISON SECTION, 2014).

Capacity growth in the residential PV market segment is going to maintain a stable level of 2 GW per year. The JPEA (JPEA VISION SECTION, 2014) estimates that by 2030, a cumulative amount of 40 GW will be installed. Areas of growth are *new and existing houses,* and *residential PV systems above 10 kW*. An important driving force for the dissemination of residential solar PV seems to be the high electricity costs, which increased even further in the aftermath of the Fukushima nuclear accident [76] (NIHON KEIZAI SHINBUN, 30.07.2014). Recently, the Hokkaido electricity utility has been the first to announce a second full-rate hike of 12.43 percent since March 2011[77].

In contrast, an average Japanese house (115-120 m^2) could, if making use of the FiT scheme, generate an annual savings in heating and lighting costs of approximately 320,000 yen, compared to a conventional house (NIHON KEIZAI SHINBUN, 31.7.2014). Some home builders also used the FiT scheme to advertise housing models with pre-installed PV systems stressing that the money earned through electricity sales would offset loan payments - a sales point that has been abandoned, as purchasing tariffs dropped[78].

The JPEA also points out that solar PV is going to be increasingly combined with other appliances such as battery systems (i.e. electric vehicles, etc.), and energy control and analysis tools such as smart meters, etc. Such systems, referred to as *Home Management Systems* (HEMS) or *Smart Houses*, are projected to become a major vehicle for residential PV capacity growth after the phasing-out of the FiT. Notably, the concept of *Zero-Emission Houses* (ZEH) has emerged as an alternative model – it promotes the idea of a net energy production, achieved by large solar PV systems installed (JPEA, 2014).

5. Conclusion

The Japanese PV market has experienced extraordinary PV capacity growth since the start of the FiT. Within two years roughly 10.5 GW have been added to the power grid with the largest share of installations observed for large non-residential PV systems.

The generous incentives set by the FiT, have been swiftly incorporated by the industry side, making residential PV systems an integral part of almost every fourth detached house build in FY 2012. The start of the FiT has also incentivised a tendency toward rooftop PV systems of above 10 kW. Solar PV has been increasingly combined with other appliances such as battery systems (i.e. electric vehicles, etc.), and energy control

[76] Please find a Chart on household electricity prices of selected Countries attached to Annex 7.3.
[77] THE JAPAN TIMES: http://yen.japantimes.co.jp/news/2014/11/02/business/hokkaido-electric-jacks-household-electricity-prices-by-12/#.VFb1_kv0aao, 03.11.2014.
[78] THE JAPAN TIMES: http://yen.japantimes.co.jp/community/2014/10/31/how-tos/homeowners-resume-debate-on-renewables/#.VFb0t0v0aaq, 31.10.2014.

and analysis tools, such as smart meters, etc. Such systems, referred to as *Home Management Systems* (HEMS) or *Smart Houses*, are projected to become a major vehicle for residential PV capacity growth after the phasing-out of the FiT. Notably, the concept of *Zero-Emission Houses* (ZEH) has emerged as a complementary model – it promotes the idea of a net energy production, achieved by large solar PV systems installed (JPEA, 2014).

Prior to the FiT, the non-residential sector has been largely relying on CSR, voluntary initiatives, and educational purposes – a circumstance that changed abruptly. After July 2012, roughly 77 percent of all PV installation has been non-residential – of this figure, mega *solar farms* (above 1 MW) took a large share. This trend is, however, now shifting toward mid-scale PV systems, due to a lack of suitable land in the vicinity of power grid connection points. The large influx of different market actors (e.g. project developers, Investors, EPCs, installers, etc.) contributed to the rapid maturation of market structures. A few European EPC contractors operate highly successful in this market environment; examples are *juwi Shizen Energy* and *Gestamp Solar*. Most of the European companies that entered the market did so with a domestic partner.

But the market seems to edge its physical boundaries - seven of the ten electricity utilities stopped signing renewable energy agreements (for the whole region or for parts of it). In other words, FiT applications for non-residential solar PV systems are going to be deferred at some indefinite future date. The electricity utilities argue that an oversupply of intermittent solar energy jeopardizes the stability of the power grid, thus *forcing* them to stop the further intake of new agreements. The government is currently discussing a review of the FiT – to what extent market incentives are going to be altered still remains to be seen. METI indicated that a decision is going to be made within 2014. At this point, it is, inter alia, discussed to implement a tender system that favours lower priced operators, or shorten the purchasing tariff revision period to half a year (NIHON KEIZAI SHINBUN, 15.10.2014).

5.1. Recommendations to European companies

Non-residential Sector

The above-described situation has inevitably a negative impact on the future market outlook – In particular, European EPC contractors should be urged to reconsider their market entry ambitions as large-scale projects are going to be under higher scrutiny in terms of their feasibility. Market entry should be only considered with strong local partners that are able to do negotiations with local authorities and electricity utilities. Many PV components manufacturer have so far entered the Japanese non-residential PV market by following an EPC they have good business relations with.

In regard to mid-scale solar farms, continuous market growth can be expected – here, ground-mounted as well as rooftop PV systems have large potential. Specifically lightweight rooftop racking constructions and solar PV panels are identified areas of

demand. A further trend, which could be interesting for European installers/EPCs as well as for PV Component manufacturers, is the explicit interest of the Japanese PV market in installations and technologies allowing the usage of solar PV without impairing land usage (e.g. farmland, greenhouses, and parking lots). This means that there is an explicit demand for innovative scaffold solutions or green houses, integrated PV panels (transparent thin-film PV panels, etc.).

The growth in PV capacity increases the importance of O&M solutions: Innovative monitoring, weather forecasting technologies, battery systems, etc. are going to be increasingly asked for. For instance, in light of the upcoming FiT revisions, the government announced that they consider to request operators to build up capacity for turning off solar energy production a few hours after notification. So far, not many large-scale PV plants are equipped with technology able to do so. Other services such as weather derivatives, insurances, and risk hedging, etc. have become increasingly important, too.

Residential Sector

Average Japanese rooftops offer relatively little space for solar PV systems. Therefore, PV systems that enable the utilization of the whole rooftop surface as well as high conversion rate PV panels (e.g. HIT) have been perceived well. In addition, Japanese rooftops are often not designed for additional weight burden - therefore light systems may also incur an advantage in the market.

The willingness of the Japanese consumer to pay a premium for aesthetic system design might entail opportunities for architectural elements such as *Building Integrated Photovoltaic* (BIPV) that would replace conventional building materials in parts of the building envelope such as roofs, skylights, or facades. Potential cooperation partners include homebuilders, trading companies, and free-agent architects[79].

Wholesale distributors such as trading companies are traditional routes for entering the Japanese residential PV market. At the same time, it should be noted that circumventing larger distributors and trying to reach installers [80] and regional homebuilders directly might be also a viable entry route. Contacts could be established via experienced and well-connected Japanese sales personnel showcasing your company's products directly to installers and homebuilders.

Over the year, a large number of trade fairs in Japan's urban centres such as Tokyo, Osaka, and Nagoya (e.g. *PVJapan*) have offered valuable opportunities for connecting with potential Japanese partners (For a list of annual solar-related trade fairs in Japan please refer to Annex 7.3).

[79] A group of Dutch architects working with solar PV in Japan, hides itself behind http://yen.nihonsolar.de
[80] A comprehensive list of available installers in Japan can be found under: http://yen.installerinfo.com/facts/Japan, 30.09.2014.

5.2. Recommendations to the European Commission

Harmonization of International standards relating to technical, safety, and certification services:
The issue on technical and safety certification looms large. The current regulatory framework differs from international standards and is thus one of the major constraints for market entry. This report stresses, in particular, the situation for PCS - the Japanese technical, safety, and certification service, **JET**, is the only institution able to provide approval for PCS up to a capacity of 20 kW. It is often criticized by foreign market participants that information in English is insufficiently available. Similar barriers seem to also be available for other PV components such as BOS systems, etc. The platform to address these issues could be the *EU-Japan Industrial Policy Dialogue* or even a wider framework, namely the ongoing *EU-Japan FTA Negotiations*.

Enhancing the visibility of European SMEs at tradeshows:
On an annual basis, a number of larger PV-related events are taking place in Japan (for a list events see Annex 7.3). In order to enhance exposure of European PV SMEs, it is necessary to provide European SMEs with a meaningful platform of a certain scope. This could be conceptualized as a **European PV Pavilion,** showcasing innovative European PV solutions and technologies. Former participants of the *HRTP* (a 1-month long training programme under the umbrella of the EU-Japan Centre for Industrial Cooperation) and the *EU Gateway Programme* (organized by the EU Delegation) could serve as an initial pool of participants.

Creating awareness of the close relationship between energy production and conservation at the residential level:
In the discussion on modern residential housing in Europe, two aspects loom large: **energy consumption** as well as **energy conservation**. This dual approach is, however, yet to be developed in Japan. In fact, Japanese policy makers have so far largely neglected the enhancement of energy conservation in residential buildings. This report proposes seminars and workshops, jointly organised with Japanese (e.g. Passive House Japan and others) and European business stakeholders, creating more awareness among the public and the government, advocating the close linkage between energy production and conservation at residential level.

5.3. Policy Recommendations to Japanese authorities

Implement well-balanced measures to resolve the stringent market situation: The current situation of more than half of all **electricity utilities** refusing to sign renewable energy agreements constitutes an immense drawback to the further development of the market. Well-tempered measures should be implemented in timely fashion. In this regard, the experiences of many European Countries offer a large pool of knowledge and expertise.

Renewable energy providers should be protected by strict market rules: Many solar PV energy providers regard the ongoing **electricity market reform** as the new vehicle of growth in a post-FiT era. As the new regulatory framework is currently set out, it is of paramount importance that the new market rules guarantee maximum protection against fraudulent behaviour in the form of misleading energy labelling.

Better alignment with international technical and safety standards and practices: It appears that safety and technical certification, indispensable for entry to the Japanese market, constitute a barrier for market entry. As regards in particular to PCS, the lack of English documents and the fact that **JET** is the only institution able to grant market access is often perceived as an impediment by foreign marker players.

Enhancement of housing standards: The promotion of carbon free electricity production should be closer aligned with stricter rules on energy conversion, as it would not only curb demand energy peaks but also greenhouse gas emissions of the building segment. Currently, the Japanese government is promoting the concept of *Zero Emission Houses* (ZEH) with solar PV systems as an integral part – the currently ongoing discussions on new housing standards in Japan should consider stricter standards for insulation materials used in office, apartments and housing units.

Revision of the Fixed-Assets Tax (FAT): In order to further promote the dissemination of residential solar PV, the Japanese government should consider a revision of the **Fixed-Assets Tax** (FAT). *Two issues can be highlighted: First,* the tax burdens extra costs on homeowners who decide to install rooftop-integrated residential PV systems, or so-called *Building Integrated PV systems* (BIPV). Second, the FAT increases six-fold if demolishing a house – it is assumed that this regulation is contributing to the high ratio of unoccupied houses in Japan. Adjusting the incentives given within the framework of FAT could contribute to a more modern, PV-equipped dwelling stock.

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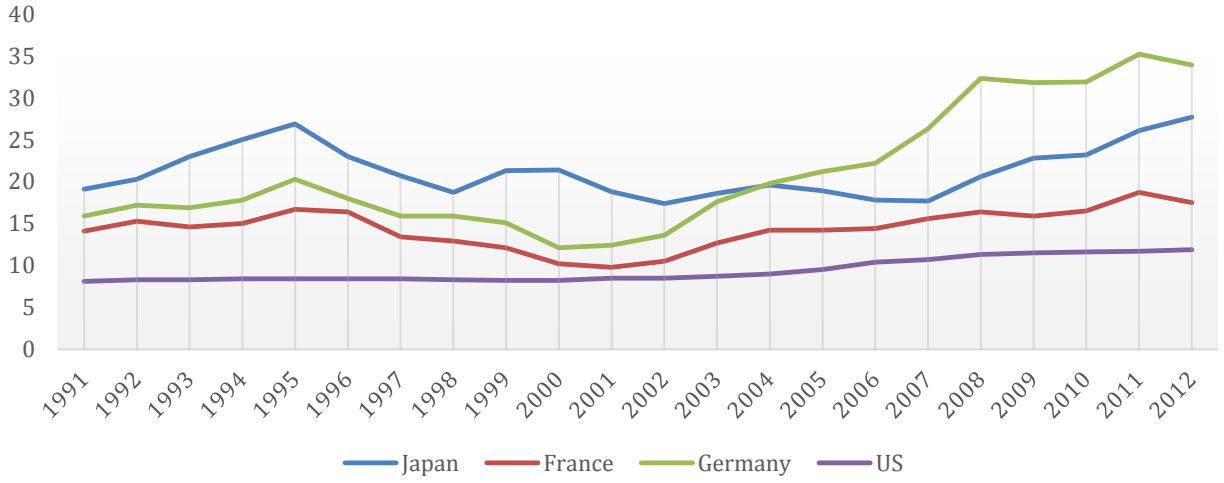
7. Annex

7.1. Major Solar PV Manufacturer active in Japan (2013)

	PV panel Manufacturer	Shipment in 2013 (Japan)	Shipment in 2013 (Global)
1	**Hanwha Q Cells**	520	1618
2	**Canadian Solar**	508	1890
3	**JA Solar**	380	2000
4	**Suntec Power**	350	-
5	**Chaori Solar**	300	800
6	**Trina Solar**	270	2600
7	**REC**	250	850
8	**Yingli Green Energy**	230	3300
9	**LG**	183	420
10	**LS Sanden**	150	400
11	**Renesola**	100	1500
12	**Moserbear Solar**	65	-
13	**UPSolar**	50	-
14	**Hareon Solar**	30	800
15	**Lipton Energy**	30	-
16	**Ablytek Solar**	23	120
17	**Kingdom Solar**	17	150

Source: SOLVISTA, 2014

7.2. Household Electricity Prices in Japan



Source: EDMC, 2014

7.3. Solar-related Events in Japan (2015)

Event Name	Period of Time	Location
Convertech JAPAN 2015	28-Jan-2015 to 30-Jan-2015	Tokyo
2015 Kumamoto Industrial Business Fair	12-Feb-2015 to 13-Feb-2015	Kumamoto
PV EXPO 2015 - 8th International Photovoltaic Power Generation Expo	25-Feb-2015 to 27-Feb-2015	Tokyo
World Smart Energy Week 2015	25-Feb-2015 to 27-Feb-2015	Tokyo
Plant Factory & Smart Agriculture Exhibition	17-Jun-2015 to 19-Jun-2015	Tokyo
Renewable Energy 2015 Exhibition	29-Jul-2015 to 31-Jul-2015	Tokyo
PV EXPO Osaka 2015 - 3rd International Photovoltaic Power Generation Expo Osaka	2-Sep-2015 to 4-Sep-2015	Osaka
2nd Natural Energy Expo 2015	8-Sep-2015 to 9-Sep-2015	Yokohama

Source: JETRO, 2014[81]

[81] JETRO: http://www.jetro.go.jp/j-messe/?action_enFairList=true&type=v2&v_2=009&v_3=002, 2.11.2014.