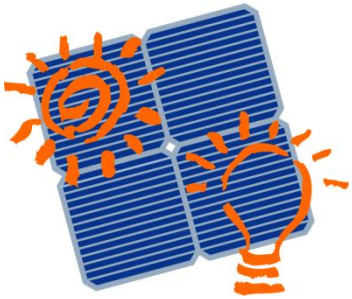

INTERNATIONAL ENERGY AGENCY

CO-OPERATIVE PROGRAMME ON PHOTOVOLTAIC POWER SYSTEMS

Task 1

Exchange and dissemination of information on PV power systems

National Survey Report of PV Power Applications in Japan 2012

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Definitions, Symbols and Abbreviations

For the purposes of this and all IEA PVPS National Survey Reports, the following definitions apply:

PV power system market: The market for all nationally installed (terrestrial) PV applications with a PV power capacity of 40 W or more.

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m^2, cell junction temperature of 25°C, AM 1,5 solar spectrum – (also see 'Rated power').

Rated power: Amount of power produced by a PV module or array under STC, written as W.

PV system: Set of interconnected elements such as PV modules, inverters that convert d.c. current of the modules into a.c. current, storage batteries and all installation and control components with a PV power capacity of 40 W or more.

CPV: Concentrating PV

Hybrid system: A system combining PV generation with another generation source, such as diesel, hydro, wind.

Module manufacturer: An organisation carrying out the encapsulation in the process of the production of PV modules.

Off-grid domestic PV power system: System installed to provide power mainly to a household or village not connected to the (main) utility grid(s). Often a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'. Can also provide power to domestic and community users (plus some other applications) via a 'mini-grid', often as a hybrid with another source of power.

Off-grid non-domestic PV power system: System used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. Usually a means to store electricity is used. Also referred to as 'stand-alone PV power system'.

Grid-connected distributed PV power system: System installed to provide power to a grid-connected customer or directly to the electricity grid (specifically where that part of the electricity grid is configured to supply power to a number of customers rather than to provide a bulk transport function). Such systems may be on or integrated into the customer's premises often on the demand side of the electricity meter, on public and commercial buildings, or simply in the built environment on motorway sound barriers etc. They may be specifically designed for support of the utility distribution grid. Size is not a determining feature – while a 1 MW PV system on a rooftop may be large by PV standards, this is not the case for other forms of distributed generation.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station. The power supplied by such a system is not associated with a particular electricity customer, and the system is not located to specifically perform functions on the electricity grid other than the supply of bulk power. Typically ground mounted and functioning independently of any nearby development.

Turnkey price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid PV system, the prices associated with storage battery maintenance/replacement are excluded. If additional costs are incurred for reasons not directly related to the PV system, these should be excluded. (E.g. If extra costs are incurred fitting PV modules to a factory roof because special precautions are required to avoid disrupting production, these extra costs should not be included. Equally the additional transport costs of installing a telecommunication system in a remote area are excluded).

Field Test Programme: A programme to test the performance of PV systems/components in real conditions.

Demonstration Programme: A programme to demonstrate the operation of PV systems and their application to potential users/owners.

Market deployment initiative: Initiatives to encourage the market deployment of PV through the use of market instruments such as green pricing, rate based incentives etc. These may be implemented by government, the finance industry, electricity utility businesses etc.

Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

Performance ratio: Ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per kW of installed PV power.

Currency: The currency unit used throughout this report is JPY, Japanese Yen.

PV support measures:

Feed-in tariff	an explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility business) at a rate per kWh that may be higher or lower than the retail electricity rates being paid by the customer
Capital subsidies	direct financial subsidies aimed at tackling the up-front cost barrier, either for specific equipment or total installed PV system cost
Green electricity schemes	allows customers to purchase green electricity based on renewable energy from the electricity utility business, usually at a premium price
PV-specific green electricity schemes	allows customers to purchase green electricity based on PV electricity from the electricity utility business, usually at a premium price
Renewable portfolio standards (RPS)	a mandated requirement that the electricity utility business (often the electricity retailer) source a portion of their electricity supplies from renewable energies
PV requirement in RPS	a mandated requirement that a portion of the RPS be met by PV electricity supplies (often called a set-aside)

Investment funds for PV	share offerings in private PV investment funds plus other schemes that focus on wealth creation and business success using PV as a vehicle to achieve these ends
Income tax credits	allows some or all expenses associated with PV installation to be deducted from taxable income streams
Net metering	allows PV customers to incur a zero charge when their electricity consumption is exactly balanced by their PV generation, while being charged the applicable retail tariff when their consumption exceeds generation and receiving some remuneration for excess electricity exported to the grid
Net billing	the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity account is reconciled over a billing cycle
Commercial bank activities	includes activities such as preferential home mortgage terms for houses including PV systems and preferential green loans for the installation of PV systems
Activities of electricity utility businesses	includes 'green power' schemes allowing customers to purchase green electricity, operation of large-scale (utility-scale) PV plants, various PV ownership and financing options with select customers and PV electricity power purchase models
Sustainable building requirements	includes requirements on new building developments (residential and commercial) and also in some cases on properties for sale, where the PV may be included as one option for reducing the building's energy foot print or may be specifically mandated as an inclusion in the building development

Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Co-operation and Development (OECD) which carries out a comprehensive programme of energy co-operation among its 23 member countries. The European Commission also participates in the work of the Agency.

The IEA Photovoltaic Power Systems Programme (IEA-PVPS) is one of the collaborative R & D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic conversion of solar energy into electricity.

The 23 participating countries are Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), China (CHN), Denmark (DNK), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Malaysia (MYS), Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Turkey (TUR), the United Kingdom (GBR) and the United States of America (USA). The European Commission, the European Photovoltaic Industry Association, the US Solar Electric Power Association and the US Solar Energy Industries Association are also members. Both Thailand and the International Copper Association are pending members.

The overall programme is headed by an Executive Committee composed of one representative from each participating country or organization, while the management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents. Information about the active and completed tasks can be found on the IEA-PVPS website www.iea-pvps.org

Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems. An important deliverable of Task 1 is the annual Trends in photovoltaic applications report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the Japan National Survey Report for the year 2012. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

The PVPS website www.iea-pvps.org also plays an important role in disseminating information arising from the programme, including national information.

National Survey Report of PV Power Applications in Japan

1 Executive summary

In FY 2012, the annual PV installed capacity in Japan exceeded 1,7 GW level with the start of the Feed-in Tariff (FIT) program under the Renewable Energy Law.

1) Under the “Renewable Energy Law” enacted in 2011, the “Feed-in Tariff (FIT) program for renewable energy power generation facilities” started from July 2012
2) In FY 2012, a record 1 718 MW of PV power generation systems were installed in Japan with the start of the FIT program. The share of non-residential PV systems (PV systems for public, industrial and commercial facilities and utility-scale PV systems) increased from about 15 % in 2011 to 30 % in 2012.
3) The Ministry of Economy, Trade and Industry (METI) continued the implementation of subsidy program for residential PV systems
4) METI allocated budgets for the research and development (R&D) programs of PV systems and conducted “Demonstration of Next-generation Energy and Social Systems” and “Demonstration Tests of Next-generation Energy Technologies”, and PV systems are installed under those projects. The New Energy and Industrial Technology Development Organization (NEDO) conducted PV R&D and the technological demonstration related to grid connection of PV power systems by implementing Smart Grid Demonstration Projects abroad
5) More than 1 000 local governments and municipalities implemented their own subsidy programs to promote the dissemination of residential PV systems. Recipients can take advantage of these subsidies in addition to the national subsidy program for relevant PV systems by METI
6) Total production of PV cell/ module in 2012 was 2 286 MW, slightly decreased from that of 2011 with 2 497 MW. In 2012, the import volume was 776 MW, approximately three times as much as the amount of 2011 (263 MW)
7) Some companies decided to withdraw from the silicon feedstock business for solar cell. However, business related to EPCs and system integrators are booming due to the growth in the medium-scale to MW-scale PV system market
8) Utilities completed construction of MW-scale solar power plants across the country and many of them started operation

1.1 Installed PV power

Total annual installed capacity of PV systems reached 1 717 721 kW in 2012, approximately 33 % increase from that of 2011 with 1 295 804 kW. In the first half of 2012, PV market was led by a subsidy program for residential PV systems and a program to purchase surplus PV power from systems with fewer than 500 kW at a preferential price. With the start of the Feed-in Tariff (FIT) program in July 2012, the market for public, industrial application and utility-scale PV systems has been growing. The breakdown of PV systems installed in 2012 is 3 276 kW for off-grid domestic application, 2 802 kW for off-grid non-domestic application and 1 711 643 kW for grid-connected distributed application. Cumulative installed capacity of PV systems in Japan in 2012 was 6 631 669 kW.

1.2 Costs & prices

In 2012, the average price of PV modules for residential PV systems dropped to 290 JPY/W from 335 JPY/W in 2011. Typical price of residential PV systems continued decreasing from 521 JPY/W in FY 2011 to 474 JPY/W in FY 2012. Price of PV systems with more than 10 kW generation capacity for public and industrial applications decreased from 518 JPY/W in FY 2011 to 437 JPY/W in FY 2012.

1.3 PV production

Total production volume of PV cell/ module in Japan in 2012 was 2 286 MW, a 8.4 % decrease from that of 2011 with 2 497 MW. The import volume in 2012 was 776 MW, approximately three times as much as the amount of 2011 with 263 MW.

The breakdown of production volume was as follows: 1 232 MW of single crystalline silicon (sc-Si) solar cells, 1 244 MW of multicrystalline silicon (mc-Si) solar cells and 585 MW of thin-film solar cells. (Note: This figure is different from total reported figures by PV manufacturers in Table 5.) The market share of crystalline Si solar cells is approximately 81 %. CIS PV modules are categorized in the thin-film solar cells in addition to thin-film silicon solar cells.

1.4 Budgets for PV

The Japanese government has been promoting measures for further deployment of PV systems and the Ministry of Economy, Trade and Industry (METI) has been taking a major role to implement research and development (R&D) programs, demonstrative researches, dissemination measures, laws and regulations. METI continued the subsidy program for residential PV systems in FY 2012. For FY 2012, using a multi-year budget allocated for “Subsidy for introducing residential PV systems as restoration measures” under the FY 2011 3rd supplementary budget, there was no new budget allocation. In the area of R&D, METI continuously promotes technology development of PV systems for cost reduction and dissemination of PV systems and demonstrative researches.

The Ministry of the Environment (MoE) promotes countermeasures for global warming as one of the efforts to create a low-carbon society and continued Fund to promote introduction of renewable energy (Green New Deal Fund) and Eco-lease business promotion project for households and business which subsidizes interest rate to eco-friendly leasing businesses leasing PV systems and other low-carbon equipment in FY 2012.

The programs for PV dissemination and support implemented in FY 2012 are as follows (the budget for item 4) - 7) includes those for PV and other types of new and renewable energy);

1) Subsidy for measures to support introduction of residential PV systems: the budget is based on “Subsidy for introducing residential PV systems as restoration measures (86,99 BJPY)” and “Projects for establishing a fund for high penetration of residential PV systems as restoration measures (32,39 BJPY)”, formulated as foundations within the FY 2011 3rd supplementary budget

2) Technology Development of Innovative Photovoltaic Power Generation (METI only): 10,31 BJPY
   - R&D for High Performance PV Generation System for the Future: 5,98 BJPY
   - R&D on Innovative Solar Cells (International Research Center for Innovative Solar Cell Program): 2,36 BJPY
   - Leading technological development for commercialization of organic PV: 1,97 BJPY (new)
3) Demonstration project on developing forecasting technology of PV power generation: 90 MJPY
4) Development of electric energy storage system for grid-connection with new and renewable energy resources: 2,0 BJPY
5) Project supporting acceleration of introduction of new and renewable energy: 32,6 BJPY (FY 2011 3rd supplementary budget: 32,6 BJPY)
6) Subsidy for the measures of off-grid renewable energy power generation systems: 0,98 BJPY
7) International collaboration project on efficient use of energy consumption (Smart Grid Demonstration Projects abroad): 20,4 BJPY
8) Fund to promote introduction of renewable energy (Green New Deal Fund): 12,1 BJPY
9) Eco lease business promotion project for household and business (Subsidy for lease interests by entities who lease low-carbon devices such as PV modules (3 % of the price of low-carbon devices)): 1,8 BJPY

In addition to the above, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and other ministries and agencies are promoting introduction of PV power generation, but amounts of their budgets have not been published.

More than 1 000 local governments and municipalities have implemented their own subsidy programs for residential PV systems, with their budget amounts unknown.

2 The implementation of PV systems

2.1 Applications for photovoltaics

The Japanese PV market is dominated by grid-connected PV systems for private housings, collective housings or apartment buildings, public facilities, industrial and commercial facilities, buildings and centralized PV power plants. In FY 2012, a record 1 718 MW of PV power systems were installed in Japan with the help of the start of the FIT program. The share of the market for public, industrial and utility-scale PV systems (MW-scale PV power plants) grew to 30 % from that of 2011 with approximately 15 %. The share of non-residential PV systems (PV systems for public, industrial and commercial facilities and utility-scale PV systems) increased from about 15 % in 2011 to 30 % in 2012. Residential PV systems account for 70 % of grid-connected market in Japan in 2012, decreasing from 85,4 % in 2011 due to the growth of public, industrial and utility-scale PV systems.

The off-grid domestic PV system market is small in size, and mainly for residences in remote areas including mountain lodges and huts, remote area, isolated islands, and some public and industrial facilities. The off-grid non-residential PV system market mainly consists of street lights, power source for telecommunications, power source for observatory facilities, pumps, disaster prevention, agricultural application, road and traffic signs and ventilating fans. Off-grid non-residential market has already established an independent market requiring no subsidies.

2.2 Total photovoltaic power installed

Table 1 shows the annual installed capacity of PV systems in 2012 by sub-market. Total installed capacity in 2012 was 1 717 721 kW, and the annual installed capacity for each application is as follows: 3 276 kW for off-grid domestic PV systems, 2 802 kW for off-grid non-domestic PV systems and 1 711 643 kW for grid-connected PV systems. After the start of the FIT program in July 2012, it has become difficult to distinguish the difference between grid-connected distributed and grid-connected centralized. Therefore, the installed capacity of grid-connected PV systems is reported.

Table 2 shows cumulative installed capacity of PV systems by submarket. In 2012, total cumulative installed capacity was 6 631 669 kW. Cumulative installed capacity for each application is as follows: 8 822 kW for off-grid domestic, 100 530 kW for off-grid non-domestic and 6 522 317 kW for grid-connected centralized application.

Concentrated PV systems are introduced mainly for demonstrative research and its installed capacity is small scale.

Table 1 The installed PV power in 4 sub-markets in 2012

Sub-market/ application	Off-grid domestic	Off-grid non-domestic	Grid-connected	Total
Installed PV power	3 276 kW	2 802 kW	1 711 643 kW	1 717 721 kW

Table 1a PV power and the broader national energy market

Total national (or regional) PV capacity (from Table 2) as a % of total national (or regional) electricity generation capacity (2012)	New (2011) PV capacity as a % of new electricity generation capacity (2012)	Total PV energy production as a % of total energy consumption (2012)
2,8 %	35 %	0,67 %

Table 2 The cumulative installed PV power in 4 sub-markets (as of December 31 of each year)

Sub-market/ application	1992 kW	1993 kW	1994 kW	1995 kW	1996 kW	1997 kW	1998 kW	1999 kW	2000 kW	2001 kW	2002 kW	2003 kW	2004 kW	2005 kW	2006 kW	2007 kW	2008 kW	2009 kW	2010 kW	2011 kW	2012 kW
Off-grid domestic	150	200	250	300	350	400	450	500	550	600	955	1 101	1 136	1 148	1 212	1 884	1 923	2 635	3 374	5 546	8 822
Off-grid non-domestic	15 260	19 170	23 260	29 360	35 890	44 900	52 300	56 200	63 000	66 227	71 692	77 792	83 109	85 909	87 376	88 266	88 886	91 998	95 420	97 728	100 530
Grid-connected distributed	1 220	2 300	5 130	10 820	20 500	43 100	77 750	149 000	263 770	383 086	561 295	777 830	1 044 846	1 331 951	1 617 011	1 823 244	2 044 080	2 521 792	3 496 017	4 741 464	6 522 317
Grid-connected centralized	2 370	2 600	2 600	2 900	2 900	2 900	2 900	2 900	2 900	2 900	2 900	2 900	2 900	2 900	2 900	5 500	9 300	10 740	23 333	69 210	
Total	19 000	24 270	31 240	43 380	59 640	91 300	133 400	208 600	330 220	452 813	636 842	859 623	1 131 991	1 421 908	1 708 499	1 918 894	2 144 189	2 627 165	3 618 144	4 913 948	6 631 669

2.3 Major projects, demonstration and field test programs

Field test and dissemination programs implemented in FY 2012 were “Subsidy for measures to support introduction of residential PV systems”, “Feed-in Tariff (FIT) program for renewable energy power generation facilities” and “Project supporting acceleration of introduction of new and renewable energy”. Besides, programs such as supports for dissemination and introduction model projects of PV systems are conducted by the Ministry of the Environment (MoE) as part of the projects to reduce CO2 emissions.

(1) Subsidy for measures to support introduction of residential PV systems

The Ministry of Economy, Trade and Industry (METI) implements a subsidy program for individuals and companies who install residential PV systems. Japan Photovoltaic Expansion Center (J-PEC), a part of the Japan Photovoltaic Energy Association (JPEA), has been appointed as a responsible organization and operates this subsidy program.

The amount of subsidy for the FY 2012 is 35 000 JPY/kW or 30 000 JPY/kW. The budget of subsidized systems per kW (tax not included, the system price) of between 35 000 JPY/kW and 475 000 JPY/kW are eligible for 35 000 JPY/kW subsidy. The PV system with the price between 475 000 JPY/kW and 550 000 JPY/kW are eligible for 30 000 JPY/kW subsidy. This subsidy program has a purpose of promoting the dissemination of high-efficiency and low-price PV systems toward healthy development of the PV market. Therefore, two levels of subsidy amounts are set depending on the system price for priority allocation. An eligible system must meet the requirements including the followings:

i) The conversion efficiency of PV module must exceed a certain value (Intrinsic conversion efficiency of solar cells when assembled into a PV module: 16,0 % or higher for single crystalline silicon solar cells, 15,0 % or higher for multicrystalline silicon solar cells, 8,5 % or higher for thin-film silicon solar cells, 12,0 % or higher for compound semiconductor solar cells)
ii) Grid-connected to low-voltage power distribution line with reverse power flow. Either maximum nominal output of PV modules or rated output of inverters should be less than 10 kW in total. In case of capacity enhancement, the total maximum nominal output should be less than 10 kW including existing system
iii) Eligible PV modules must be registered as eligible models by J-PEC and have the JETPVm certification issued by Japan Electrical Safety & Environment Technology Laboratories (JET) and other equivalent organizations or confirmed with the performance and quality equal to or greater than the certification
iv) PV modules and inverters must be not in use (used articles are not covered) (once grid connected, that product is used article)
v) A certain level of performance is ensured and after-installment support from manufacturers or relevant parties is guaranteed
vi) The maximum output is less than 10 kW and the price of a system is 550 000 JPY/kW or less (excluding tax)

The number of applications in FY 2012 was 329 986. The number of projects granted for the subsidy and the installed capacity were 197 964 and approximately 911 MW, respectively from April to December 2012. The number of projects granted for the subsidy and the installed capacity were approximately 236 000 and 1 023 MW, respectively in FY 2011. According to the actual number of installed PV systems and their capacities supported by the governmental subsidy since the subsidy program started, as well as sales results of PV manufacturers for the period before the subsidy was implemented, the cumulative number of residential PV systems and installed capacity, from FY 1994 to December 2012, were approximately 1 240 000 and around 5 GW.

This subsidy program for residential PV systems is implemented based on two funds (“Subsidy for introducing residential PV systems as restoration measures (86,99 BJPY)” and “Projects for establishing a fund for high penetration of residential PV systems as restoration measures (32,39 BJPY)”) launched under the FY 2011 3rd supplementary budget, passed in the diet on November 21, 2011, as a support for the reconstruction and revitalization after the Great East Japan Earthquake. These funds will be utilized as “Subsidy for measures to support introduction of residential PV systems” during FY 2011 - FY 2013.

In FY 2012, PV modules produced by 111 manufacturers have been registered as eligible models by J-PEC. This number was 75 in the previous year, and the number of registered manufacturers is increasing considerably. Registered PV modules obtained certification from TÜV Rheinland, TÜV SUD, TÜV InterCert, TÜV NORD, VDE, INTERTEK and UL in addition to JET.

(2) Feed-in Tariff (FIT) program for renewable energy power generation facilities

METI terminated the Program to purchase surplus PV power in June 2012. Based on the “Bill on Special Measures Concerning Procurement of Renewable Energy Sourced Electricity by Electric Utilities (Renewable Energy Law)”, which was enacted in August 2011, the Feed-in Tariff (FIT) program for renewable energy power generation facilities took effect on July 1, 2012 as an alternative for the Program to purchase surplus PV power.

In FY 2012 (by the end of March), the tariffs and periods of purchase are set as follows: 1) 42 JPY/kWh (incl. tax) for the gross electricity generated by PV systems with the capacity of 10 kW or more for the period of 20 years; and 2) 42 JPY/kWh (incl. tax) for the surplus electricity generated aside from the self-consumption by PV systems with the capacity below 10 kW for the period of 10 years. For PV systems with the capacity below 10 kW equipped with private power generator, the tariff is 34 JPY/kWh (incl. tax). The tariffs are subject to an annual review. All electricity users share the purchase costs of the electric utilities evenly as a part of electricity price. The surcharge for the purchase costs is proportional to the amount of electricity consumption. However, reduction of the surcharge is applicable for the energy-intensive businesses which fall under the relevant requirements specified by the government.

Under the FIT program, total capacity of approved PV systems with the capacity below 10 kW was 846,688 MW equivalent to 193 873 systems as of December 31, 2012. Total capacity of approved PV systems with the capacity between 10 kW and below 1 MW was 1 681,118 MW equivalent to 29 841 systems. Total capacity of approved PV systems of 1 MW or above was 2 175,923 MW equivalent to 742 systems, making the total capacity of approved PV systems 4 703,729 MW equivalent to 224 456 systems.

(3) Project supporting acceleration of introduction of new and renewable energy

In order to create employment in the renewable energy industry and stimulate its related industry in the areas damaged by the Great East Japan Earthquake, METI implemented subsidy programs for introducing renewable energy power generation facilities such as PV systems including ancillary storage batteries and transmission lines in the damaged areas from FY 2011. As well as the subsidy program for residential PV systems, JPEA Reconstruction Center (JPReC), established by Japan Photovoltaic Energy Association (JPEA), was appointed as the operator to administer the program. Eligible recipients of the subsidy are private institutions, nonprofit organizations (NPOs) and local authorities. Municipalities of ten prefectures located in the damaged areas by the Great East Japan Earthquake were identified as sites of the eligible projects of the subsidy. For PV systems, either 10 % or less of the eligible cost of the power generation facilities, or 80 000 JPY/kW (PV output), whichever the lower, is provided. To be eligible for the subsidy, it is required that the system should have the output capacity of not less than 10 kW, or the combined output capacity of not less than 10 kW from more than one sites. (The average output capacity per one site must be more than or equal to 4 kW.) In principle, a ceiling amount of the subsidy for one power generation facility is 500 MJPY annually or 1,5 BJPY for the maximum subsidy term of three years.

This subsidy program started the calls for proposals from FY 2011 and 409 facilities equivalent to 373,992 MW were selected in total to date. PV systems with various capacity have been installed from FY 2012 including large-scale PV power plants (MW-scale solar power plants) on the idle land, PV systems with the capacity of tens of to hundreds of MW on the roofs of the offices or stores.

This program is conducted based on the “(3) Project supporting acceleration of introduction of new and renewable energy (budget: 32,6 BJPY)”, a fund launched in the FY 2011 3rd supplementary budget, and is scheduled to be continued by the end of FY 2015.

(4) PV support programs implemented by the Ministry of the Environment (MoE)

Based on the Law Concerning the Promotion of Measures to Cope with Global Warming, the Ministry of the Environment (MoE) has been promoting projects to reduce CO2 emissions using natural energy. MoE implements various programs such as support for introduction and planning of system installations, including PV systems, for the purpose of reducing CO2 emissions to local authorities' facilities, industrial facilities, local communities, cities, and schools. It also offers support for technology development.

In FY 2012, one of the major program was "Model project to establish communities introducing independent and distributed energy utilizing renewable energy", a project which supports installation of independent and distributed energy systems by industrial, academic and governmental circles utilizing renewable energy and unused energy. The subsidy is up to the half of the total project cost. Four projects were selected in FY 2012.

The budget of 6.0 BJPY was allocated in FY 2012 for "Project for developing technology to prevent global warming (competitive funds)" to support private companies, public research institutes, and universities which conduct technological development of low carbon transportation and of low carbon houses and offices utilizing new and renewable energy including PV power generation. Moreover, in FY 2012, MoE started to accept applications for a subsidy program to promote introduction of storage batteries to stabilize power output of renewable energy power generation systems. This subsidy program supports the private institutions which introduce storage batteries with the capacity of 1 MW or above in order to centralize administrative control over PV power and wind power plants with the output capacity of not less than 1 MW each. Selected projects will receive subsidy to cover one-half of the project cost. With this subsidy program for the introduction of storage batteries, a commissioned business for verification of the effects to stabilize power output of renewable energy power generation systems using storage batteries is also accepted to verity the effects of the program.

Model project to demonstrate control of storage batteries, etc. to introduce renewable energy (budget: approximately 9 BJPY) was implemented with the FY 2012 supplementary budget. This model project is aimed at stabilizing power output of renewable energy power generation systems by introducing and effectively utilizing storage batteries to finally expand the introduction of storage batteries significantly. Eligible projects are those which equip large-scale storage batteries with large-scale renewable energy power generation systems of not less than 1 MW of rated power conducted by the private institutions. The eligible model projects are require to meet the following conditions; i) equip large-scale storage batteries at a remote island or rural village and not interconnect directly to the trunk transmission power line with 275 000 V and over; ii) available to supply electricity to other than electrical grid at the time of disaster. The subsidy amount is fixed and a total cost of approximately 1 BJPY to 1.5 BJPY for each project is subsidized. In FY 2012, 6 model projects were adopted including the projects of PV power plants and wind power plants combined with such as lithium ion batteries or lead-acid batteries.

In addition, MoE subsidizes the introduction project of renewable energy power generation systems, etc. in both public and private facilities utilizing the "Eco lease business promotion project for households and businesses (budget for FY 2012: 1,8 BJPY)" in which subsidizes lease companies when ordinary households or small and medium-sized companies introduce low-carbon equipment using the lease program and the "Green New Deal Fund (12,1 BJPY)" which was developed by MoE in prefectural and city governments and government-ordinance-designated cities in the FY 2012 budget. MoE announced that it would double the budget scale of the Green New Deal Fund in FY 2013.

(5) PV support programs implemented by other ministries and agencies

Construction of green government buildings equipped with PV systems and other new and renewable energy systems has been promoted by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) for the buildings for central ministries and agencies and local branch offices of the national government. For the private sector, MLIT subsidizes a fixed amount of grant or a part of maintenance cost to the projects which contribute to the implementation and enlightenment towards dissemination of renovation for longer life and CO2 reduction at houses and buildings. In FY 2012, MLIT subsidized up to 1,65 MJPY per one house for up to a half of the total cost of

research design cost to realize net-zero energy house and arrangement cost of building construction and facilities including PV systems aimed at small and medium-sized housing contractors under the “project to promote net-zero energy houses”. MLIT is also considering leasing of nationally-owned land such as road spaces to the private institutions to install commercial facilities and PV systems.

The Ministry of Agriculture, Forestry and Fisheries (MAFF) implements a subsidy program to install PV systems at facilities for agriculture, forestry and fisheries, in order to promote introduction of renewable energy into these industries. Introduction of PV systems are also included in the comprehensive maintenance supports of living environment in villages dependent on the primary industries. In FY 2012, MAFF started “Project for early establishment of renewable energy supply model in rural areas”, which aims at realization of independent and distributed energy supply systems and revitalization of the villages dependent on the primary industries. Eligible recipients are local authorities and private organizations and the amount of subsidy is the fixed amount or a half of the project cost. It supports the efforts which serve as a model for the renewable energy, such as PV power generation business utilizing the resources in the rural areas.

MAFF implemented the “project for early establishment of the model areas of promoting renewable energy which returns profits to local communities” in FY 2012 supplementary budget. This project supports the creation of the model efforts, which utilize the income from the renewable energy-based electric power generation business conducted by agricultural forestry industries and fisheries workers and organizations exploiting the resources of the rural areas for the development of the agricultural forestry industries and fisheries of the communities. The fixed amount of necessary funding for the introduction of the facilities such as PV power plants is subsidized by MAFF.

In addition, MAFF commenced studies toward necessary policy framework and easing of regulations, while conducting feasibility investigation on the introduction of renewable energy systems in the area where cultivation was abandoned across the country.

In FY 2012, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) started “Super eco school demonstration project” to promote the realization of zero energy at the public school facilities. This demonstration project subsidizes 50 % of the renovation cost for introducing renewable energy power generation systems such as PV systems for the project period of 3 years. In FY 2012, 3 municipalities including Kyoto City, Kyoto Prefecture, Yabuki Town, Fukushima Prefecture and Ikoma City, Nara Prefecture were selected.

Moreover, Eco-school Pilot Model Project which started in FY 1997 is also continuing. By February 2013, MEXT selected a total of 1 372 schools as Eco School Pilot Model Projects. Of the 1 372 schools, 112 schools were selected in FY 2012 (83 schools of them installed PV systems). For public schools, which introduce PV systems, government grant rate for FY 2012 was one-half (lower limit: 4 MJPY) of the cost. From FY 2012, solar thermal applications and wind power were included in the eligible renewable energy technology for the grant which is introduced to the facilities of public school in addition to PV systems. Upper limit of the grant amount is 10 MJPY and the grant rate was set at one-half. Besides, MEXT supports the improvement work of the both interior and exterior of the school to build environmentally-friendly facilities in the private schools.

2.4 Highlights of R&D

(1) Research and Development

The New Energy and Industrial Technology Development Organization (NEDO) continued to implement “R&D for High Performance PV Generation System for the Future” and “R&D on Innovative Solar Cells” in 2012 and a mid-term evaluation for these programs was conducted in August 2012.

In the “R&D for High Performance PV Generation System for the Future” program, academic-industrial consortium-based R&D projects covering crystalline silicon, thin-film silicon, thin-film CIGS, and organic thin-film solar cells have been conducted and as a recent progress,

the conversion efficiency of 17,8 % was achieved with the CIGS submodule.

R&D on CZTS solar cells is strengthened aiming at the substitution of rare materials in the future. In terms of common fundamental technology, technological development on the improvement of the reliability of PV modules including evaluation of PID phenomenon is enhanced as well as promoting the cooperation with the foreign organizations towards certification and standardization of PV systems. In the mid-term evaluation, acceleration of technological development and prioritization of the R&D themes are required in response to the rapidly changing current PV markets and technology so that the development will be continued over the next two years after reviewing the issues for 2013 and beyond.

In the “R&D on Innovative Solar Cells” program, four projects will be continued including “Development of high efficiency concentrator solar cells, PV modules and systems” which started as a new joint research of Japan and the European Union (EU) in addition to the on-going projects as follows: i) post-silicon solar cells for ultra-high efficiencies; ii) novel thin multi-junction solar cells with a highly-ordered structure; and iii) thin-film full spectrum solar cells with low concentration ratios. Some subprojects were required to be streamlined in the mid-term evaluation conducted in 2010, resulting in the termination of approximately 30 % of the sub-theme projects. The mid-term evaluation conducted in 2012 also called for review of agendas and issues based on prospects of the R&D and these four projects will be continued until the end of FY 2015 after sorting out the themes.

As for organic PV (OPV) technology, in addition to the technological developments related to the aforementioned projects, the project named “Development of Organic Photovoltaics toward a Low-Carbon Society” led by the University of Tokyo has been continued. A new NEDO R&D project started under the name of “Development of technologies to lead the practical application for organic photovoltaics” (research term: three years), aiming to identify challenges for commercialization.

In addition to the technological development and development of fundamental technologies of usage of PV modules as described above, development of grid control technologies such as i) electric-generating output forecast to mitigate the impacts of PV integration on the electrical grid and ii) storage system technology and technology to control distribution grid is conducted as part of the improvement of electricity infrastructure.

Moreover, NEDO started the review of the roadmap for PV technology development, “PV2030+” with the view of the rapidly growing PV market and price changes of late date. Furthermore, the National Institute of Advanced Industrial Science and Technology (AIST) is preparing for the establishment of a new research center in Koriyama City, Fukushima Prefecture to mainly support renewable energy related industries in relation to the project for restoration from the Great East Japan Earthquake. The purpose of this center is the technological development and creation of industries associated with renewable energy and R&D activities in the field of renewable energy including technologies of PV, wind power and geothermal will be carried out at the center. As for the PV technology, development of production technology with the pilot line for high efficiency crystalline silicon solar cells/ modules and research for demonstration of systems are planned to be conducted. The research will be proceeded in AIST Tsukuba Center until the completion of the building of the new center scheduled to be at the end of 2013.

The following two fundamental R&D programs under the control of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) have been continued: i) Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells (individual proposal-oriented programs with a research term of three to five years, 36 themes) and ii) Creative Research for Clean Energy Generation Using Solar Energy (team proposal-oriented programs with a research term of three to five years, 14 themes). Calls for new proposals were closed in FY 2011. From FY 2012, “Nanowire solar cells” research project (research term: five years) started with the new purpose of achieving high performance with the conversion efficiency of 30 % as part of the “Project to develop R&D centers for innovative energy”. This project will be conducted in the research facilities of above-described new center in Koriyama City. Until the completion of the building of the new center, it will be proceeded in Tokyo Institute of Technology (TIT).

(2) Demonstrative research

Demonstration projects were implemented in Japan and overseas mainly on smart community in FY 2012. METI implemented “Demonstration of Next-generation Energy and Social Systems” and “Demonstration Tests of Next-generation Energy Technologies” in Japan, and PV systems are installed under those projects. The New Energy and Industrial Technology Development Organization (NEDO) implemented Smart Grid Demonstration Projects abroad and the technological demonstration related to grid connection of PV power systems are conducted under that framework. Under the “Japan-U.S. Smart Grid Collaborative Demonstration Project in New Mexico, USA”, a demonstrative research aimed at the attainment of optimal electrical supply on a single distribution line by demand response of storage batteries for the grid, commercial buildings and general consumers is conducted to resolve the challenges (of such as effects on the voltage and upper grid) in case the large volume of unstable PV power generating electricity is fed into the distribution grid. Under the “Smart Community Demonstration Project in redevelopment district of Lyon, France”, a construction of mechanisms such as remote monitoring system of PV systems using information and communications technology, battery charging of electric vehicles, car-sharing service and energy management in the area of urban redevelopment is carried out in addition to introducing associated technologies in order to realize the positive energy building on the new buildings, which are constructed in line with the urban development. In these projects, not only the installation demonstration of PV systems alone, but also demonstration and development related to other renewable energy technologies, storage batteries, electric vehicles and management systems to control those technologies, information and telecommunications infrastructure and smart community combined with the transmission and distribution grid, etc. are increasing. Under the demonstrative research on Smart Community in GongQing City, Jiangxi Province, China, it is planned to establish and demonstrate an energy management system through introduction of low-carbon transportation control systems and Smart Grid on top of energy-saving and renewable energy technologies in small- and medium-sized cities in inland China where the population has been rapidly increasing. Besides, demonstration projects are also carried out in Java Island, Indonesia, Jiangxi Province, China and Mumbai, India. See “section 4.1 Indirect policy issues” for details.

Table 3 Demonstration projects implemented in Japan and overseas

Demonstration projects		Demonstration sites	Demonstration term
Demonstration of Next-generation Energy and Social Systems	Yokohama City	Yokohama City, Kanagawa Prefecture	FY 2010 - 2014
	Toyota City	Toyota City, Aichi Prefecture	FY 2010 - 2014
	Keihannna Science City	Kyoto Prefecture	FY 2010 - 2014
	Kitakyushu City	Kitakyushu City, Fukuoka Prefecture	FY 2010 - 2014
Demonstration Tests of Next-generation Energy Technologies	Smart City in Hitachi City	Hitachi City, Ibaraki Prefecture	FY 2011 - 2014
	Smart Campus of Mie University	Tsu City, Mie Prefecture	FY 2011 - 2014
	Huis Ten Bosch, a theme park	Sasebo City, Nagasaki Prefecture	FY 2011 - 2014
	Kashiwanoha Campus	Kashiwa City, Chiba Prefecture	FY 2011 - 2014
Japan-U.S. Smart Grid Collaborative Demonstration Project in New Mexico, USA		New Mexico, USA	FY 2010 - 2013
Japan–U.S. Collaborative Demonstration Project for World–leading Remote Island Smart Grid in Hawaii, USA		Maui Island, Hawaii, USA	FY 2011 - 2014
Smart Community Demonstration Project in redevelopment district of Lyon, France		Lyon, France	FY 2011 - 2015
Smart Community System Demonstration Project in Spain		Malaga, Spain	FY 2011 - 2016
Smart Community Demonstration Project in China		GongQing City, Jiangxi Province, China	FY 2011 - 2013

2.5 Public budgets for market stimulation, demonstration / field test programmes and R&D

The FY 2012 budgets for PV system-related R&D, demonstration programs and market incentives are mainly based on national budgets.

The budget for R&D is the sum of “R&D on Innovative Solar Cells”, “R&D for High Performance PV Generation System for the Future”, “Leading technological development for commercialization of organic PV” and “Demonstration project on developing forecasting technology of PV power generation”. In addition, Cabinet Office implements “Development of Organic Photovoltaics toward a Low-Carbon Society Project” with the budget of approximately 0.6 BJPY/year (3.067 BJPY/5 years.) The Ministry of Education, Culture, Sports, Science and Technology (MEXT) implements both “Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells Project” (approximately 0.35 BJPY,) and “Creative Research for Clean Energy Generation using Solar Energy Project” (approximately 0.72 BJPY.)

The budget for demonstration was allocated for “Field Test Project on New Photovoltaic Power Generation Technology” (40 MJPY). However, PV systems are not newly installed under the “Field Test Project on New Photovoltaic Power Generation Technology”.

The budget for market incentives is based on “Subsidy for introducing residential PV systems as restoration measures (86,99 BJPY)” and “Projects for establishing a fund for high penetration of residential PV systems as restoration measures (32,39 BJPY)”, formulated as foundations within the FY 2011 3rd supplementary budget. This budget will be spent for more than a fiscal year. PV systems are also introduced through “Project supporting acceleration of introduction of new and renewable energy” (FY 2011 3rd supplementary budget: 32,6 BJPY), however, this subsidy program covers other renewable energy power generation systems so that it is not included in the budget of market stimulation in FY 2012.

The budgets of local governments are complementarily appropriated for market incentives, mainly for residential PV systems. In FY 2012, more than 1 000 municipalities implemented their own subsidy programs for the introduction of PV system. The amount of subsidy for PV system varies by municipality and the total amount is unknown. Majority of municipalities provide the subsidy ranging from 20 000 JPY/kW to 50 000 JPY/kW (average subsidy is 38 000 JPY/kW).

Table 4 Public budgets for R&D, demonstration/ field test programs and market incentives

	FY 2010			FY 2011			FY 2012		
	R&D	Demo/ Field Test	Market Stimulation	R&D	Demo/ Field Test	Market Stimulation	R&D	Demo/ Field Test	Market Stimulation
National (BJPY)	5,98	2,38	55,13	5,98	2,38	55,13	10,4	0,04	119,38[1] (for multiple fiscal year)
Regional [2] (BJPY)	-	-	-	-	-	-	-	-	-

[1]: Market incentives: Budget for more than a fiscal year.

[2]: More than 1 000 municipalities such as prefectures, cities, towns, and villages are implementing their own subsidy programs for residential PV systems in 2012; the budget amount is unknown.

Souce: METI, NEDO and MoE compiled by RTS Corporation

3 Industry and growth

3.1 Production of feedstocks, ingots and wafers

In Japan, four companies manufacture polysilicon (including semiconductor grade) for the feedstock for solar cells: 1) Tokuyama (production capacity: 9 200 t/year), 2) Mitsubishi Materials (production capacity: 2 800 t/year), 3) OSAKA Titanium technologies (production capacity: 3 900 t/year) and 4) M.SETEK (production capacity: 7 000 t/year, subsidiary of AU Optronics (AUO) of Taiwan). Of them, those manufacture polysilicon for solar cells are Tokuyama and M.SETEK. Tokuyama was planning to construct a polysilicon plant in Malaysia for its 2nd phase production capacity expansion (projected to be 13 800 t/year) ahead of schedule. However, this plan was postponed to about 2015 on the background of rapid downturn of the market of polysilicon for solar cells as well as postponing the plan to increase the production capacity (1 800 t/year) at Tokuyama Factory to about 2014. JFE Steel, NS Solar Material and Japan Solar Silicon ended in making decisions to withdraw from the business.

Therefore, Tokuyama is the only major manufacturer conducting research and development (R&D) of solar grade silicon (SoG-Si) via vapor to liquid deposition (VLD) process. Other manufacturers engaged in projects conducted by the New Energy and Industrial Technology Development Organization (NEDO) are in the level of basic research.

M.SETEK is the only major company specialized in manufacturing crystalline Si ingots and wafers for solar cells. SUMCO withdrew from the PV business and JFE Steel made decision to withdraw from the business. In addition, Kyocera and Choshu Industry manufacture crystalline Si ingots and wafers in their own facilities. Ferrotec supplies solar Si ingots through commissioned manufacturing. SANYO Electric (Panasonic) operates a solar Si ingot/ wafer plant in Oregon, the USA. Space Energy, a company manufactured solar Si wafers from purchased Si ingots for solar cells, decided to withdraw from the business.

TKX, Osaka Fuji and Shinko Manufacturing, are conducting manufacturing business of silicon wafers. However, due to the weakening market, some companies such as Kitagawa Seiki and Ishii Hyoki ended in making decisions to withdraw from the business.

While Evonik Monosilane Japan and Taiyo Nippon Sanso completed a new monosilane manufacturing plant, they ended in dissolution of the joint venture due to a price decline caused by rapid decrease in demand. Meanwhile, for compound semiconductor solar cells, metal resources manufacturers dealing indium, selenium, tellurium and others are increasing transaction volume.

Table 5 shows an overview of Japanese manufacturers of Si feedstock, ingots and wafers for solar cells in 2011. Table 5a shows manufacturing process of each manufacturer. Table 5b shows specifications of Si ingots and wafers for solar cells. Table 5c shows new developments and products, Table 5d shows production expansion plans of manufacturers, and Table 5e shows overseas business development by the manufacturers.

Table 5 Production and production capacity information for silicon feedstock, ingot and wafer manufacturers (2012)

Manufacturer	Process & technology [1]	Total Production	Maximum production capacity
Tokuyama	Polysilicon	2 000 t [2]	9 200 t/yr [3]
M.SETEK	Polysilicon	4 102,6 t	7 000 t/yr
	sc-Si ingot	2 709,3 t	3 600 t/yr
Mitsubishi Materials	Polysilicon	N.A.	N.A.
Covalent Material	sc-Si ingot		
Kyocera	mc-Si wafer	800 MW	-
OSAKA Titanium technologies [4]	Polysilicon	very small amount	very small amount
Ferrotec			
Shin-Etsu Chemical			
SANYO Electric (Panasonic)	Si wafer for HIT (a-Si on c-Si)	N.A.	N.A.
Choshu Industry			
Spower			

[1]: mc-Si: multicrystalline silicon, sc-Si: single crystalline silicon
[2]: Excluding the production for semiconductor
[3]: Including the production capacity for semiconductor
[4]: Off-grade products only

Source: answers from each company for the questionnaire by NEDO

Table 5a Production process and technology for Si feedstock, ingot and wafer manufacturers for solar cells (2012)

Manufacturer	Production process
Tokuyama	- Polysilicon manufacturing using Siemens process
M.SETEK	- Production of Si feedstock → sc-Si ingots by CZ process
Mitsubishi Materials	- Polysilicon manufacturing using Siemens process
Covalent Material	
OSAKA Titanium technologies	- Manufacturing of polysilicon intended for semiconductor using Siemens process (no manufacturing of polysilicon for PV)
Ferrotec	
Shin-Etsu Chemical	
Kyocera	- Purchase of feedstock → mc-Si wafers → mc-Si cells → modules
SANYO Electric (Panasonic)	- Purchase of feedstock → sc-Si by CZ process → sc-Si wafers
Choshu Industry	
Spower	

Source: answers from each company for the questionnaire by NEDO

Table 5b Specifications of Si feedstock, ingots and wafers for solar cells (2012)

Manufacturer	Product	Specification
Tokuyama	High-purity polysilicon	
M.SETEK	sc-Si as-grown ingot (N-type)	125 mm x 125 mm, 0,5-3,0 Ωcm
	sc-Si as-grown ingot (N-type)	125 mm x 125 mm, 1,7-12,0 Ωcm
Mitsubishi Materials	Polysilicon	N.A.
Covalent Material		
OSAKA Titanium technologies	Polysilicon	No specification for off-grade production
Ferrotec		
Shin-Etsu Chemical		
Kyocera		
SANYO Electric (Panasonic)		
Choshu Industry		
Spower		

Source: answers from each company for the questionnaire by NEDO

Table 5c New products or new development of silicon feedstock, ingot and wafer manufacturers for solar cells (2012)

Manufacturer	New product/ new development
Tokuyama	- Nothing special
M.SETEK	- Nothing special
Mitsubishi Materials	N.A.
Covalent Material	
OSAKA Titanium technologies	- Nothing special
Ferrotec	
Shin-Etsu Chemical	
Kyocera	
SANYO Electric (Panasonic)	- Not disclosed
Choshu Industry	
Spower	

Source: answers from each company for the questionnaire by NEDO

Table 5d Plans for expansion of production capacity by silicon feedstock, ingot and wafer manufacturers for solar cells (2012)

Manufacturer	Process & Technology	Production capacity in FY 2012	Production capacity in FY 2013	Production capacity in FY 2014 onwards
Tokuyama	Polysilicon	9 200t/yr	17 200t/yr	31 0005/yr (by 2015)
M.SETEK	Polysilicon	7 000 t/yr	7 000 t/yr	7 000 t/yr
	sc-Si ingot	3 600 t/yr	3 600 t/yr	3 600 t/yr
Mitsubishi Materials	Polysilicon	N.A.	N.A.	N.A.
Covalent Material				
OSAKA Titanium technologies	Polysilicon			
Ferrotec				
Shin-Etsu Chemical				
Kyocera	mc-Si wafer			
SANYO Electric (Panasonic)	Si wafer for HIT (a-Si on c-Si)	Not disclosed	Not disclosed	Not disclosed
Choshu Industry				
Spower				

Source: answers from each company for the questionnaire by NEDO

Table 5e Overseas Business Development by manufacturers (2012)

Manufacturer	Business activities
Tokuyama	- Polysilicon production plant is under construction in Sarawak, Malaysia. The first-phase plant will start commercial production in September 2013 with production capacity of 6 200t/yr. The second-phase plant is expected to start commercial production in the spring of 2015 with production capacity of 13 800t/yr but it depends on the trends of PV market
M.SETEK	- Transferred its entire process of ingot slicing and wafer manufacturing to AU Optronics (AUO), the parent company
Mitsubishi Materials	N.A.
Covalent Material	
OSAKA Titanium technologies	- Nothing special
Ferrotec	
Shin-Etsu Chemical	
Kyocera	
SANYO Electric (Panasonic)	- Ingot/wafer production facility in Oregon, USA
Choshu Industry	
Spower	

Source: answers from each company for the questionnaire by NEDO

3.2 Production of photovoltaic cells and modules

Total production of PV cell/ module in 2012 was 2 286 MW, slightly decreased from that of 2011 with 2 497 MW. In 2012, the import volume was 776 MW, approximately three times as much as the amount of 2011 (263 MW)

In 2012, 12 companies were listed as PV cell/ module manufacturers: Sharp, Kyocera, SANYO Electric (Panasonic), Mitsubishi Electric (MELCO), Kaneka, Fuji Electric, Honda Soltec (Honda Motor Group), Solar Frontier (Showa Shell Sekiyu group), Clean Venture 21, PVG Solutions, Hi-nergy and Choshu Industry. Among them, major manufacturers mainly produce c-Si solar cells, while Sharp also manufactures back contact c-Si solar cells and thin-film Si PV modules. Kaneka manufactures thin-film Si PV modules, Fuji Electric manufactures flexible a-Si PV modules, Honda Soltec and Solar Frontier manufactures CIS PV modules, and Clean Venture 21 manufactures spherical Si solar cells. PVG Solutions and Hi-nergy manufacture bifacial c-Si solar cells and Choshu Industry manufactures c-Si solar cells. Mitsubishi Heavy Industries (MHI) withdrew from from the business of manufacturing thin-film Si PV modules.

In 2012, 9 manufacturers were specialized in PV modules are Suntech Power Japan, Fujipream, YOCASOL (current Japan Solar Factory, transferred its business to Nemy in February 2013), K-I-S, Itogumi Motech, Towada Solar, Noritz, Spower and E-SOLAR. Spower enhanced it its supply system of solar cells through cooperation with TSEC of Taiwan. E-SOLAR, a joint venture of Eversol of Taiwan and West Holdings, started manufacturing of PV modules in Matsuyama, Ehime Prefecture. Besides, Photlec Power and Amerisolar of USA plan to construct manufacturing facility of PV modules in Okinawa Prefecture. NPC decided to enter into the commissioned manufacturing of PV modules for special-purpose items and prototypes. With Kansai and Kyushu regions as two major manufacturing areas, production of PV cells and modules is spreading nationwide, including Chugoku, Shikoku, Chubu, Tohoku, Hokkaido and other regions.

Table 6 shows production volumes and capacities reported by solar cell and PV module manufacturers. Table 6a shows PV module production processes of manufacturers in Japan. Table 6b shows new developments and products of PV module manufacturers in Japan. Table 6c shows plans for future expansion of cell/ module production capacity by PV manufacturers. And Table 6d shows the overseas business development by manufacturers.

Table 6 Production volumes and capacities by solar cell and PV module manufacturers (2012)

Cell/Module manufacturer	Technology [1]	Total Production (MW)		Maximum production capacity (MW/year)	
		Cell	Module	Cell	Module
Silicon wafer-based manufacturers					
Sharp [2]	c-Si	Not disclosed	977	Not disclosed	1 555
Kyocera	mc-Si	800	800	-	-
SANYO Electric (Panasonic)	HIT (a-Si on c-Si)	Not disclosed	Not disclosed	Not disclosed	Not disclosed
Mitsubishi Electric	sc-Si	240	270	300	340
Clean Venture 21	light-collecting spherical Si				
Suntech Power Japan	sc-Si	-	0,4	-	100
Fujipream	sc-Si	0	10,4	0	50
	mc-Si	0	12,1	0	50
Choshu Industry	mc-Si				
	sc-Si				
Itogumi Motech	mc-Si, sc-Si		2		20
PVG Solutions	sc-Si	2,5	-	30	-
Towada Solar	mc-Si	0	3	0	10
G.M.G	sc-Si	0	0	0	0
	mc-Si	0	0	0	0
Noritz	mc-Si	-	12	-	20
YOCASOL (current Japan Solar Factory)	sc-Si	-	3	-	30
	mc-Si	-	0,4	-	30
Photlec Power					
K-I-S					
E-SOLAR					
Thin-film manufacturers					
Sharp	Thin film Si	-	81	-	320
SANYO Electric (Panasonic)	a-Si (for consumer use)	Not disclosed	Not disclosed	Not disclosed	Not disclosed
Kaneka	a-Si a-Si/poly-Si hybrid	42	42	120	120
Fuji Electric	a-Si	5	5	24	24
Solar Frontier	CIS	550	550	980	980
Honda Soltec	CIGS		13		30
CPV manufacturers					
Sumitomo Electric Industries					
Daido Steel	CPV		< 1		< 1

[1]: c-Si:crystalline silicon ,sc-Si: single crystalline silicon, mc-Si: multicrystalline silicon, a-Si: amorphous silicon, µc-Si: microcrystalline silicon [2]: Shipping volume and production capacity of modules

Source: answers from each company for the questionnaire by NEDO

Table 6a PV module production processes of manufacturers (2012)

Silicon wafer-based manufacturers	Description of main steps in production process
Sharp	<c-Si> - Purchase of wafers → c-Si cells → modules
Kyocera	- Purchase of feedstock → mc-Si wafers → mc-Si cells → modules
SANYO Electric (Panasonic)	- Purchase of Si feedstock → c-Si wafers → HIT cells → modules ↑ Purchase of c-Si wafers
Mitsubishi Electric	- Purchase of sc-Si wafers → sc-Si cells → modules
Clean Venture 21	
Suntech Power Japan	- Purchase of sc-Si → modules
Fujipream	- Purchase of sc-Si and mc-Si cells → module production
Choshu Industry	
Itogumi Motech	- mc-Si/sc-Si cells → modules
PVG Solutions	- Purchase of sc-Si wafers → production of sc-Si cells
Towada Solar	- Purchase of solar cells and related materials → modules
G.M.G [1]	<sc-Si> - Purchase of sc-Si wafers → sc-Si cells → modules <mc-Si> - Purchase of mc-Si cells → modules
Noritz	- Purchase of mc-Si cells → modules
YOCASOL (current Japan Solar Factory)	- Purchase of mc-Si/sc-Si cells → modules
Photlec Power	
K-I-S	
E-SOLAR	
Thin-film manufacturers	**Description of main steps in production process**
Sharp	- Purchase of gas → cells → modules - Purchase of glass substrates→ cells → modules
Kaneka	- Purchase of glass substrates → forming a-Si layers → modules
Fuji Electric	- Purchase of silane gas → a-Si cells → modules
Solar Frontier	- Integrated process from input of glass substrates to module production Input of glass substrates → forming of layer (CIS cells) → modules
Honda Soltec	- Purchase of materials → sub-modules → modules
CPV manufacturers	**Description of main steps in production process**
Sumitomo Electric Industries	
Daido Steel	- Purchase of solar cells → modules

[1]: Plan for FY 2014

Source: answers from each company for the questionnaire by NEDO

Table 6b New developments and products of manufacturers (2012) (1/2)

Cell/Module manufacturer	New developments and new products
Sharp	- Sharp introduces of roof integrated PV system “Solar Roof”, the first jointly-developed product of LIXIL and Sharp (March 29, 2012) - Sharp launches of “electricity visualization system” which enables real-time verification of electricity consumption of each home electrical appliances through special tablet terminal (April 12, 2012) - Sharp proposes comfortable energy-saving life enhancing the usability of PV systems and EcoCute and launches EcoCute and multi-energy monitor (April 23, 2012) - Sharp develops concentrator solar cell with world’s highest conversion efficiency of 43,5 %. Achieved with concentrator triple-junction compound solar cell (May 31, 2012) (http://www.sharp-world.com/corporate/news/120531.html) - Sharp starts “guarantee for 15 years entirely” which guarantees the entire domestic residential PV system components for 15 years and is the first in the industry (June 27, 2012) - Sharp launches portable lithium-ion rechargeable battery which enables to recharge from electrical outlet/ residential PV system (August 9, 2012) - Sharp launches and proposes see-through PV modules as a new glass fabric which enables both electricity generation and daylighting (September 25, 2012) - Sharp launches sc-Si PV module for hipped roof which increases the installed capacity by around 11 % on the hipped roof and comply with the new installation method of shorter-time installation (September 28, 2012) - Sharp launches sc-Si PV module for gable roof which increases the installed capacity by around 20 % on the gable roof. Achieved high throughput of 200 W by enlarging the cell area (October 22, 2012) - Sharp acquired “JISQ8901”, a certification of reliability assurance system of PV modules, obtaining high evaluation for its quality assurance system from designing to maintenance (November 6, 2012) - Sharp develops and launches 1kWh-type storage system module and achieves noise reduction by cooling fan-less structure for the first time in the industry (November 26, 2012) - Sharp launches 2 types of industrial PV modules compatible with high output and system voltage of 1 000 V and achieves high electricity generation and reduction of BOS (December 4, 2012) - Sharp develops solar cell with world's highest conversion efficiency of 37,7%. Sets a new record with triple-junction compound solar cell (December 5, 2012) (http://www.sharp-world.com/corporate/news/121205.html) - Sharp launches roof-tile-style sc-Si PV module which increases the module output by around 10,5 % and matches with the entire roof due to its black appearance (December 19, 2012)
Kyocera	- Development of high-efficiency solar cell - Integration of supporting structure (inlay supporting structure)
SANYO Electric (Panasonic)	- Achievement of world’s highest cell efficiency of 24,7 % (laboratory scale) (with full-scale c-Si PV cell) - Launch of half-type modules which size is half the standard module - Launch of 240 W high output model
Mitsubishi Electric	<New products> - Launch of “Multi-roof”, a sc-Si lead-free soldered PV module, in Japan Feature; i) increases installed capacity on the roof by combining various forms of PV modules, ii) secures electricity generation of more than the maximum nominal output through plus tolerance standard, iii) product line-up of modules for snow-covered area - Launch of PV inverter for outdoor installation (4,0 kW) in Japan Feature; i) achieves conversion efficiency of 96,5 %, highest in the industry for its outdoor-installation type with “gradationally controlled inverter”, ii) outdoor installation is available for such as exterior wall of collective housing with dustproof and waterproof capacity - Starts 20-year guarantee for PV modules in Japan - Launch of “Eco Guide TAB”, a 7-inches tablet monitor in Japan - Launch of high-output PV module (261 W) using half-size cells for professional use in Japan <Development> - Start of demonstrative research on electricity optimized control with “PV/EV combined HEMS” → By installing “PV/EV combined power conditioner” which jointly controls large capacity storage batteries such as PV and EV, “PV/EV combined HEMS” was developed in collaboration with HEMS for the first time in the industry. It enables independence from electricity for more than a week in case of blackout caused by a disaster
Clean Venture 21	
Suntech Power Japan	- High-output residential sc-Si PV module
Fujipream	- Ultralight PV module “Nozomi” - PV tracking system (for parking area and agricultural land)

Source: answers from each company for the questionnaire by NEDO

Table 6b New developments and products of manufacturers (2012) (2/2)

Cell/Module manufacturer	New developments and new products
Choshu Industry	
Itogumi Motech	- Launch of small-size mc-Si PV module (42 cells/48 cells) (June 2012) - Launch of sc-Si PV module (July 2012)
PVG Solutions	- Development of high-efficiency bifacial generating PV cells (surface efficiency: 20,0 %, reverse side efficiency: 19,5 %)
Towada Solar	- Development of modules which shed snow in snow-covered area. Verification test is undertaken aimed at commercialization
G.M.G	- Nothing special
Noritz	- Development of high-efficiency module
YOCASOL (current Japan Solar Factory)	- PV module integrated with carport “UFQxxx-A21BW” - PV module for installation in high-place “PIQxxx-A21(S)” - sc-Si PV module PCA series with antifouling coating - mc-Si PV module PCB series with antifouling coating
Photlec Power	
K-I-S	
E-SOLAR	
Kaneka	- Development of anti-glare PV module - Development of peripheral panel repair process of roof-integrated PV module - Development of supporting roof tile process of stationary PV module - Development of curbstone process of large-area PV module
Fuji Electric	- No new products as Fuji Electric because it is specialized in the sales of cells except for existing customers of modules
Solar Frontier	- Upgrade of electricity generating efficiency: achieved conversion efficiency of 19,7 %, highest in the world as thin-film PV cell without cadmium (this efficiency was achieved with cell which was cut from 30 cm square (0,5 cm^2), instead of cell which was developed for small area) - New supporting structure: a “cross-one process” significantly reduces number of components needed for fixing attachments and modules installed on the which roof ensuring more security and reliability than before, as well as reducing installation time by approximately 40 % using new module fixing method compared to Solar Frontier’s conventional construction method - Frontier Monitor Set: a service device which enables electricity visualization by making a package of measurement instruments, indicators and crowd services. It was certified as target device of the project to introduce HEMS in December 2012 (In addition to electricity generation measurement of PV cells, it continuously measures the electricity load in the household)
Honda Soltec	- Launch of 135 W PV module (April 2012) - Launch of 140 W PV module (December 2012)
Sumitomo Electric Industries	
Daido Steel	- Commitment to the dissemination of concentrated PV systems

Source: answers from each company for the questionnaire by NEDO

Table 6c Plans for future expansion of production capacity (2012)

Manufacturer	FY 2012 (MW/yr)	FY 2013 (MW/yr)	FY 2014 onwards	Technology
Silicon wafer-based manufacturers				
Sharp [1]	1 555	1 555	Not announced	c-Si
Kyocera	-	>= 1 GW/yr	-	mc-Si
SANYO Electric (Panasonic)	Not disclosed	Not disclosed	Not disclosed	HIT (a-Si on c-Si)
Mitsubishi Electric [2]	340	450	Will be planned considering market trends	sc-Si
Clean Venture 21				Spherical Si
Suntech Power Japan	100	None	None	mc-Si
Fujipream	50	50	Not yet determined	sc-Si
	50	50		mc-Si
Choshu Industry				mc-Si
Itogumi Motech	20	20	No plans	mc-Si, sc-Si
PVG Solutions	30	30	30	sc-Si
Towada Solar	10	15	In review	mc-Si
G.M.G	0	0	70	sc-Si
	0	0	30	mc-Si
Noritz	20	50	100 MW/yr by 2015	mc-Si
YOCASOL (current Japan Solar Factory)	60	60	60	mc-Si/ sc-Si
Photlec Power				
K-I-S				
E-SOLAR				
Thin-film manufacturers				
Sharp	320	320	Not announced	Thin film Si
SANYO Electric (Panasonic)	Not disclosed	Not disclosed	Not disclosed	a-Si
Kaneka				a-Si, a-Si/poly-Si hybrid
Fuji Electric	24	24	24 MW/yr by 2014	a-Si
Solar Frontier	980	980	980	CIS
Honda Soltec	30	30	30	CIGS
CPV manufacturers				
Sumitomo Electric Industries				
Daido Steel				CPV

[1]: Production capacity of module. [2]: Production capacity of module

Source: answers from each company for the questionnaire by NEDO

Table 6d Overseas business activities of PV manufacturers

Manufacturer	New developments and new products
Sharp	- Sharp and Enel Green Power begin operation of solar power plants at five sites in Italy (April 12, 2012) (http://www.sharp-world.com/corporate/news/120412.html) - Nine Japanese companies launch Japan-U.S. Collaborative Smart Grid Demonstration Project in business district of Albuquerque, New Mexico (May 18, 2012) (http://www.sharp-world.com/corporate/news/120518.html) - Regarding joint participation in solar power generation project in the Province of Ontario, Canada toward the achievement of a sustainable low-carbon society (June 15, 2012) (http://www.sharp-world.com/corporate/news/120615.html) - Launch of smart grid demonstration site in Los Alamos, Japan-U.S. Collaborative Smart Grid Project in New Mexico (September 10, 2012) (http://www.sharp-world.com/corporate/news/120918.html)
Kyocera	- Consider the power generating business in USA - Active proposal of systems for Asian policies
SANYO Electric (Panasonic)	- Manufacture of PV modules in Hungary - Manufacture of ingots and wafers in Oregon states in the USA - Construction of manufacturing facility of cell/module in Malaysia - Worldwide sales activities for PV modules
Mitsubishi Electric	- Expands sales activities in the USA and Asia based on the global sales framework
Clean Venture 21	
Suntech Power Japan	- Operations in Europe, North America, Middle East, and Asia-Pacific and Japan - 13 sales bases, production bases (mainly in China) and R&D bases are present around the world
Fujipream	- No plan
Choshu Industry	
Kaneka	- Marketing activities in Europe, America and Asia - Sales of modules - Measurement of production of electricity by Kaneka's PV systems all over the world
Fuji Electric	- Productization of Fuji Electric's cell - seeking partner company which can be engaged in sales
Solar Frontier	- Sales of products through overseas offices (Europe: Germany, USA: California) - Sales of products to RoW (Asia, Middle East, Oceania, etc.) - Cooperation with overseas system integrators (installation in the domestic market is also implemented under the cooperation with overseas system integrators)
Honda Soltec	- Now general sales is not undertaken except for installation in overseas Honda locations
Itogumi Motech	- Nothing special
PVG Solutions	- Nothing special
Towada Solar	- Nooverseas business activities
G.M.G	- Nothing special
Noritz	- None
YOCASOL (current Japan Solar Factory)	- Nothing special
Photlec Power	
K-I-S	
E-SOLAR	
Sumitomo Electric Industries	
Daido Steel	- Demonstration of power generation in various overseas sites - Installation sales in overseas markets

Source: answers from each company for the questionnaire by NEDO

3.3 Module prices

Table7 shows trends of typical module prices.

Table7 Trends of typical module prices (JPY/W) for residential use

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Price	966	950	927	764	646	652	674	598	542	481	462	451	441	428

Year	2006	2007	2008	2009	2010	2011	2012
Price	433	436	440	402	375	335	290

Source: Previous Natrional Survey Report Japan, 2012 figure : RTS Corporation

3.4 Manufacturers and suppliers of other components

More than 20 companies supply inverters (power conditioners) for PV systems, and most of them are PV manufacturers, manufacturers of power supply systems, electric/ electronic appliances manufacturers and general electrical manufacturers. 18 residential PV inverter manufacturers are registered to the voluntary certification program of the Japan Electrical Safety & Environment Technology Laboratories (JET): Sharp, Kyocera, SANYO Electric (Panasonic), Mitsubishi Electric (MELCO), Omron, Panasonic, Tabuchi Electric, IDEC, Diamond Electric Mfg., LS Industrial Systems, Hyundai Heavy Industries, West Holdings (Ablerex Electronics), SAMHWA, Delta Electronics, SMA Solar Technology, Sumitomo Electric Industries, YASKAWA Electric and Hitachi Appliances. Six companies, namely LS Industrial Systems, Hyundai Heavy Industries, Ablerex Electronics, SAMHWA, Delta Electronics and SMA Solar Technology, are non-Japanese manufacturers registered to the JET certification program. The capacity of inverters distributed in the market ranges from 1,2 kW to 5,5 kW, mainly 3 kW, 4 kW, 4,5 kW and 5,5 kW.

Standardization, mass commercialization, and size and weight reduction of inverters for residential PV systems including islanding protection devices integrated into the inverters have been advanced. Certification program for residential PV inverters has started shifting to a new certification program for multiple grid-interconnection for PV systems, and Omron, SANYO Electric (Panasonic) and YASKAWA Electric acquired the new certification.

10 to 13 000-kW PV systems have been installed in PV application for public and industrial facilities as well as power plants. 10-kW inverters are typically used for PV systems with the capacity not less than 10 kW and less than 100 kW. Inverters with 20-kW or less capacity are accredited by JET, and as for industrial applications, many 10-kW inverters are registered in the JET certification program. Seven companies, namely GS Yuasa, Sanyo Denki, Mitsubishi Electric (MELCO), Sanken Electric, Ebara Densan, Shindengen Electric Manufacturing and YASKAWA Electric, are registered as manufacturers of inverters for industrial applications.

Standardization of 100 to 500-kW inverters for large-scale PV systems has been advanced, and companies such as Sharp, GS Yuasa, Sanyo Denki, Meidensha, Sansha Electric Manufacturing, Nissin Electric, Toshiba Mitsubishi-Electric Industrial Systems (TMEIC), Hitachi, Mitsubishi Electric (MELCO), YASKAWA Electric, Fuji Electric and Daihen entered this area. Currently in Japan, functions of inverters for public and industrial applications including parallel operation, power factor control, measurement and controlled monitoring have been improved to be applied to PV systems with larger capacity.

Furthermore, products with new technology are sold in the market, such as multi-level inverters effective for improving conversion efficiency. As for PV inverters for industrial applications, it is expected that functions will be advanced to be applicable to multiple grid-interconnection for PV systems and fault ride-through (FRT) when the grid is under fault conditions.

From the launch of the new Feed-in Tariff program on July, 1, 2012, production of inverter is increasing.

Development of new type of storage batteries such as large capacity lithium batteries has been promoted for PV systems applicable to future micro-grid networks with improved autonomy as well as for PV systems designed to meet electric load-leveling. It is expected that systems for stable power supply combining PV systems and large-scale storage batteries will be launched to the market in the near future. Currently in Japan, installation of stand-alone PV systems remains much less common than that of grid-connected PV systems, so that standardization of stand-alone systems has not been established well enough. With development of smart grid and smart communities, it is expected that standardization of inverters and storage batteries for these applications will be promoted.

Table 8 shows the prices of inverters for grid-connected PV systems.

Table 8 Price of inverter for grid-connected PV application (average price per kVA in JPY)

Size of inverter	FY 2010	FY 2011	FY 2012
10 - 100 kVA	89 600	82 000	66 000
> 100 kVA	79 000	68 000	52 000

Source: Previous Natrional Survey Report Japan, 2012 figure : RTS Corporation

3.5 System prices

Table 9 shows typical applications and prices of PV systems by category. Table 9a shows the trends in system prices since FY 1994. The standardization of grid-connected systems has progressed with the growth of the PV market (mainly residential PV system market) in Japan, and the prices have been decreasing. On the other hand, off-grid system prices are determined case by case because there are various types of applications and the size of each market is small.

Table 9 Turnkey prices of typical applications (FY 2012)

Category / Size	Typical applications	Typical price (JPY/W)
Off-grid [1] up to 1 kW	Telecommunications, lighting, traffic and road signs, ventilating fans, pumps, remote monitoring, navigation signs, clock towers, etc.	case by case
Off-grid > 1 kW	Agricultural facilities, communication facilities, disaster prevention facilities, mountain cottages, park facilities, housing in remote areas, lighthouses, etc.	case by case
Grid-connected up to 10 kW	Residential houses, park facilities, small-scale public facilities, etc.	474 JPY/W
Grid-connected > 10 kW	Plants, warehouses, commercial buildings, large-scale public facilities, road facilities, railway facilities, etc.	437 JPY/W

[1]: Prices do not include recurring charges after installation such as battery replacement or operation and maintenance

Source: Previous Natrional Survey Report Japan, 2012 figure : RTS Corporation

Table 9a Trends in PV system prices (JPY/W)

Fiscal year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Public & Industrial (>10 kW)	2 800	2 400	1 500	1 300	1 190	1 040	1 010	850	840	770	770	732
Residential (3 - 5 kW)	1 920	1 510	1 090	1 062	1 074	939	844	758	710	690	675	661

Fiscal year	2006	2007	2008	2009	2010	2011	2012
Public & Industrial (>10 kW)	802	640	534	547	576	518	437
Residential (3 - 5 kW)	683	696	715	613	565	521	474

Source: Previous Natrional Survey Report Japan, 2012 figure : RTS Corporation

3.6 Labor places

Estimated labor places mainly engaged in PV power generation are as follows;

a) Public research and development (not including private companies): about 1 000

b) Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D: about 8 000

c) All other, including those within electric utilities, installation companies, etc.: about 30 000

Table 10 Estimated PV-related labor places in 2012

Research and development (not including companies)	ca. 1 000
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	ca. 8 000
Distributors of PV products	
System and installation companies	
Utilities and government	
Others	ca. 30 000
Total	ca. 39 000

Source: Analysed by RTS corporation based on the answers from each company for the questionnaire by NEDO

3.7 Business value

Table 11 shows business value of the domestic market of PV systems.

Table 11 Business value of PV system market **(BJPY)**

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Business value	84,9	110	150	170	200	215	205	150	152,3	290,4	577,1	664,5	766,4

* Export value of PV products is not included

4 Framework for deployment (Non-technical factors)

a) Measures for deployment

A subsidy program for residential PV systems has been continued in 2012. A program to purchase surplus PV power at preferential rates as well as support through a taxation system were also continued. This program was substituted by the Feed-in Tariff program from July 2012 Table 12 shows support measures and schemes for dissemination of PV systems implemented in 2012.

Table 12 PV support measures in 2012 (1/2)

	Ongoing measures	Measures that commenced in 2012
Enhanced feed-in tariffs	- The Feed-in Tariff (FIT) program for renewable energy power generation facilities took effect on July 2012 based on the "Renewable Energy Law". For PV systems with the capacity below 10 kW, the surplus electricity generated aside from the self-consumption is covered and for PV systems with the capacity of 10 kW or more, the gross electricity generated is covered by the program	- Based on the "Act on the Promotion of the Use of Nonfossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers", METI enacted the program which obligates the utilities to purchase surplus PV power since November 2009. The FIT program for renewable energy power generation facilities took effect on July 2012 as an alternative for the Program to purchase surplus PV power which ended in June
Direct subsidy	- "Subsidy for measures to support introduction of residential PV systems" by METI - More than 1 000 local governments implement their own subsidy programs - Subsidy for promotion of introducing renewable energy power generation systems (FY 2011 3rd supplementary budget)	- Subsidy for the measures of off-grid renewable energy power generation systems
Green Power schemes		- Utilities announced the termination of the Green Power schemes in connection with the start of the FIT program
PV-specific green electricity schemes	-	-
Renewable portfolio standards (RPS)	- RPS was amended in connection with the start of the FIT program	- Amendment of RPS was implemented
PV requirements in RPS	-	-
Funds for investment in PV	-	- Some financial institutions announced plans to establish investment funds for large-scale PV power plants

Source: METI, J-PEC, etc.

Table 12 PV support measures in 2012 (2/2)

	Ongoing measures	Measures that commenced in 2012
Tax credits	Residential PV systems - Tax credit for the investment on renovation of energy conservation and barrier-free house including PV power systems: reduction of 10 % of cost from income tax is applicable for the maximum installation cost of 2 MJPY to install residential PV systems. In case of introducing PV power systems, the applicable maximum installation cost is 3 MJPY Non-residential PV systems - Tax reduction for green investment (for PV power systems and wind power systems): special depreciation available for maximum of 30 % of acquisition cost, 7 % tax credit (only for small- and medium-sized enterprises (SMEs)) and immediate amortization (writeoff of 100 % of acquisition cost) - Special measure of the tax basis related to renewable energy power generation facilities (fixed asset tax): reduction of the tax basis to two-thirds of the cost of the tax basis for renewable energy power generation facilities (including storage batteries, transformation units and power transmission facilities) acquired under the approval of the FIT program (limited to the fixed asset tax of three years from the fiscal year when the fixed asset tax is charged)	- Special measure of the tax basis related to renewable energy power generation facilities (fixed asset tax) (see the left column)
Net metering	-	-
Net billing	- Voluntary purchase program for surplus electricity by utilities was terminated in October 2009	-
Commercial bank activities	- Low-interest loan programs - Introduction of PV systems to their own buildings	-
Electricity utility activities	- Construction of large-scale PV power plants for in-house use - Implementation of Renewable portfolio standards (RPS)	-
Sustainable building requirements	-	-

Source: METI, J-PEC, etc.

b) Interesting financing models

Nothing to report.

4.1 Indirect policy issues

a) International policies influencing the use of PV systems

Based on the Cancun Agreements of the 16th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP16), the Japanese government set out to establish a fair and effective international framework in which all major emitting countries participate, as part of measures against global warming on a global scale. Meanwhile, Japan takes the position of not participating in the second commitment period of the Kyoto Protocol as it would not contribute to establishing a comprehensive framework for the future.

The Japanese Government authorized the 4th Environment Basic Plan at the cabinet meeting. In the Plan, promotion of strategic efforts corresponding to the international circumstances in an appropriate manner is listed as one of the directions that was deemed to be a more important consideration in order to achieve a sustainable society. In the key areas to be preferentially addressed, following measures were stipulated based on the direction above; 1) Active implementation of support for developing countries to reduce increasing environmental burdens by providing Japan's knowledge and technologies, 2) Strategic efforts to establish fair and effective framework for the global society and to implement co-operation to ensure both national and global interests. As for the efforts against global warming in the Plan, following measures are listed; 1) 80% reduction of greenhouse gas emission by 2050, 2) Promotion of measures against global warming in 2013 and after based on a new plan to be considered and plot out inextricably linked with the revision of energy policy, 3) Contribution of the international discussion for the international negotiation on climate changes for earlier establishment of a fair and effective international framework that all the major countries participate.

b) Favorable environmental laws and regulations

As shown on table 13, various relaxations of the restrictions were conducted regarding installation of PV systems when the Feed-in Tariff (FIT) program started in 2012. Many ordinances were enacted without taking into account the installation of PV systems. Therefore, the government is promoting the deregulations and the dissemination of PV systems with the expectation that the PV market will grow significantly.

Table 13 Regulation reforms related to PV system (matters concluded in 2012)

Reform items	Content of the reforms	Responsible authority or relevant law	Date of conclusion
Authorization for the conversion under the agricultural land, Agricultural Land Law	Clarification of the management in case of the installation on the fields that have been abandoned and are no longer cultivated, slopes, or furrows, etc. Authorized the tentative conversion	Director-General of the Rural Development Bureau, the Ministry of Agriculture, Forestry and Fisheries (MAFF)	March 28, 2012
Clarification of the management concerning containers to store the accessory equipment of PV	Regarding the container for exclusive use of storing inverter, those which maintain unmanned operation and prevent personnel at any time except in case of serious trouble with the devices do not fall into the architectural structures	Building Standards Act Director of the Building Guidance Division, Housing Bureau, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) (technical advice)	March 30, 2012
Revision of the management from a standpoint of the Factory Location Act	Exclusion of PV power generating facilities from the target power generating facilities of the Factory Location Act	Amendment of the Factory Location Act enforcement order	May 29, 2012
Revision of the safety regulation from a standpoint of the Electric Utility Industry Law	As for PV power generating facilities, revise the scope of the notification of construction plan and the prior-to-use safety management examination which are required for the power generating facilities to “output of 2 000 kW and above” from “output of 500 kW and above”	Enforcement regulations of the Electric Utility Industry Law	June 29, 2012
Development permit under the City Planning Act	Permission is not required in case the PV power generating facilities do not fall into the architectural structures	Director of the Planning and Research Office, City Planning Division, City Bureau, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) (technical advice)	June 8, 2012
Installation on the roof of existing building	The building confirmation is unnecessary for PV power generating facilities installed on the supporting structures fixed on the roofs of the buildings which meet the both of the following conditions; i) prevent personnel from the space of beneath the supporting structures at any time except during the maintenance of the PV power generating facilities; and ii) does not utilize the space of beneath the supporting structures for habitation, goods storage, and other indoor use	Building Standards Act Director of the Building Guidance Division, Housing Bureau, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) (technical advice)	July 4, 2012
Method for self inspection under the Electric Utility Industry Law	Mitigation of the self inspection items under the Article 73 (4) of the enforcement regulations of the Electric Utility Industry Law. Mitigation of load test, etc.	Electric Power Safety Division of the Ministry of Economy, Trade and Industry (METI)	December 19, 2012 Public comment

The Act on the Rational Use of Energy under discussion requires the notification regarding the energy saving measures of the buildings in case of constructing or renovating and mandates the buildings above a certain level of size to conduct the routine reporting of the energy consumption. Improvement of the efficiency of energy consumption is required and the installation of PV systems which help reduce the electricity consumption will be effective.

Energy saving standard is set for the residential houses and the preferential treatments such as application of mortgage tax break are offered in case of exceeding a certain level of the standard by introducing PV systems, etc. are provided. It is also planned to establish a system for the recognition of such as energy saving performance.

c) Study on the comparison of external cost and invisible cost of conventional power generation and renewable energy

At the "Cost Estimation and Review Committee" administered by the National Policy Unit of the Cabinet Secretariat, estimated power generation costs of various power sources were studied in two time frames, as of 2010 and as of 2030. In the study, social external costs of various power sources were compared as they are essential for formulating an energy strategy after the nuclear power plant failures in Fukushima Prefecture in March 2011. So-called "social costs" including expenses for the risk of nuclear power plant failures and CO2 emissions and expenses related to policy measures were also taken into account in considering the calculation. All the calculation bases were disclosed and comments from various sectors were taken into consideration for making the estimate. Comparison of the power generating cost of the major power sources is shown in Figure 1.

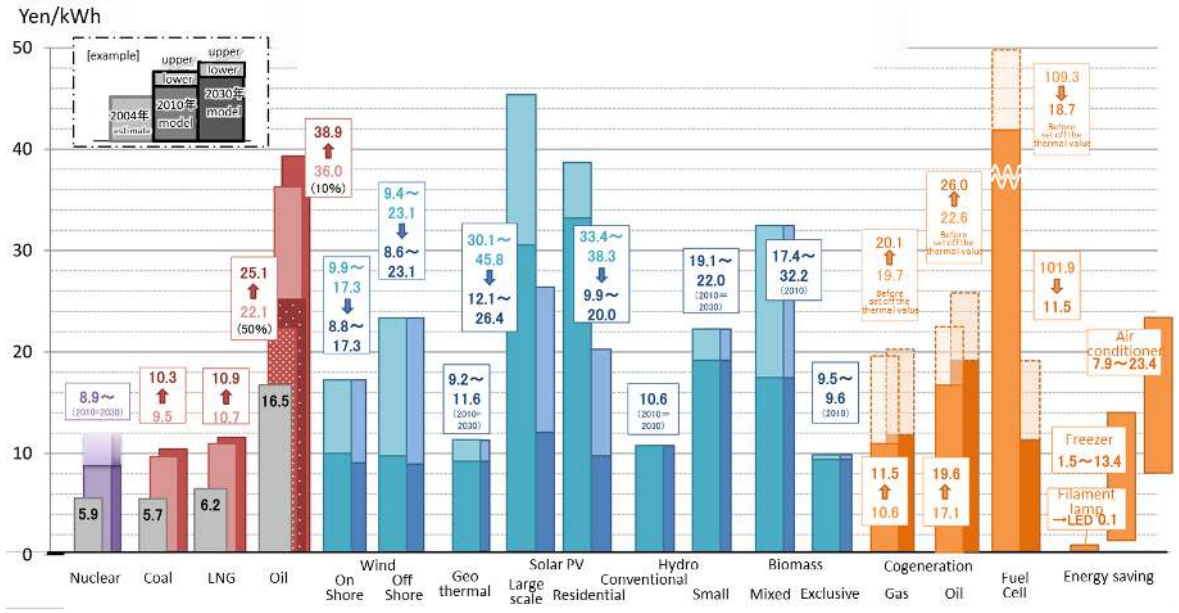

Figure 1 Comparison of the power generating cost of the major power sources

Source: Cost Estimation and Review Committee (November 2011)

d) Taxes on pollution (e.g. carbon tax)

"Tax for Climate Change Mitigation (Carbon Tax)" was introduced in October 2012 by 2012 tax revision. The environment tax is added to an existing tax (the petroleum and coal tax) for petroleum and other fossil fuels that emit CO2. While corporations will be responsible for tax payments, the tax burden is passed on to consumers through the increases in gasoline or other fuel prices.

By using the CO2 emissions factor of each fossil fuel, the tax rate per unit quantity (kilo litter or ton) is set in order that each tax burden to be equal to 289 JPY per ton of CO2 emissions. The tax rates will be raised in three stages over three and a half years in order to avoid the rapid increase in burden.

According to the simple calculations based on the current energy usage, an additional household burden caused by Carbon Tax is expected to be about 100 JPY/month, and 1,200 JPY/year for an average household. Since this assumes the state after all the three enforcement stages, the monthly burden in FY 2012 or 2013, for example, is supposed to be one-third of that (approximately 30 JPY/month).

Revenues of Carbon Tax are estimated to be 39.1 BJPY for the first year FY 2012 and 262.3 BJPY for each normal year after FY 2016. The government decided that it would implement various

measures for reducing CO2 emission from energy such as energy conservation, dissemination of renewable energy, clean and efficient use of fossil fuels By utilizing this tax revenue under the 4th Environment Basic Plan. Planned programs are as follows; domestic business location for innovative low-carbon technology-intensive industries, namely, lithium-ion batteries, installation of energy-saving equipment by small and medium-sized enterprises, introduction of renewable energy so-called “Green New Deal Funds” in accordance with local characteristics.

It remains to be seen the effects on the dissemination of PV power generation by the Carbon Tax is unknown.

e) National policies and programs to promote the use of PV in non-IEA PVPS countries

The national government promotes international cooperative activities across the globe especially in Asia in order to play an active role in the dissemination of PV systems through contribution to addressing global warming issues, improving living standards in developing countries and achieving energy security to curb energy consumption overseas. Also, CDM (Clean Development Mechanism) projects based on the mechanisms of the Kyoto Protocol and JI (Joint Implementation) projects are ongoing in different countries. The number of CDM projects approved by the Japanese government was 766, the number of projects registered on the CDM Executive Board of the United Nation was 529 and the number of JI projects approved by the Japanese government was 55. Of them, a total of 11 projects equivalent of more than 100 MW of PV projects are ongoing in Philippines, China and South Korea. Furthermore, the following PV-related projects are conducted by the New Energy and Industrial Technology Development Organization (NEDO).

- Smart Community demonstration research project in India (FY 2012 - 2014): This project was agreed as an India-Japan joint project, the "Delhi-Mumbai Industrial Corridor" (DMIC) for the joint development of smart community. Utilizing a MW-scale PV system and others, the two countries will start a demonstration project combining supply-demand monitoring for micro grid in industrial complex with technology for stable supply of grid electricity of the same quality.
- Smart Community Demonstration Project in an Industrial Complex in Java Island, Indonesia (FY 2012 - 2015): In an industrial complex in Java Island, Indonesia, technologies related to Smart Community will be introduced and demonstrated in order to achieve an environment-friendly low-carbon society while stabilizing quality of electricity. Sumitomo Corporation, Tokyo Electric Power Services (TEPSCO), Fuji Electric, Mitsubishi Electric (MELCO) and NTT Communications were selected as project partners from Japan.
- Collaborative Projects in the Solar Energy Field with Moroccan government: Governments of Japan and Morocco agreed to jointly promote a comprehensive cooperation in the solar energy sector in December 2010. Based on the agreement, the two nations plan to promote joint efforts such as large-scale introduction of power generation systems using solar energy and development of technologies to stabilize grids. Feasibility study for introduction was completed. Under the plan, total 2 000 MW of various facilities such as solar power generation facilities will be installed in Ouarzazate by 2019.

Japan International Cooperation Agency (JICA) and Japan Bank for International Cooperation (JBIC) also implement activities related to PV power generation overseas.

- JICA implements inter-governmental cooperation, through grant aid or loan assistance, as well as technological cooperation projects based on requests from developing countries. It supports developing master plans mainly for rural electrification using PV power generation through the study of development for rural electrification. In 2012, JICA installed PV systems in Palestine and other countries, while inviting interested persons to Japan to offer them technical trainings, and enhancing its efforts in cultivating human resources by providing trainings for PV engineers and improving the framework in the countries where they support.
- JBIC actively provides financing supports to environmental protection businesses as part of its GREEN (Global action for Reconciling Economic growth and ENvironmental preservation) activities. It also plays a central role in the acquisition of emissions rights based on the Kyoto Protocol.

4.2 Interest from electricity utility businesses

The Feed-in Tariff (FIT) program for renewable energy power generation facilities took effect on July 1, 2012. Utilities are dealing with the contracts for electricity supply and interconnection by building the special sector for the FIT program for renewable energy power generation facilities.

Utilities made plans to construct approximately 30 PV power plants with a total capacity of 140 MW across the nation by 2020 and started introduction of PV systems in their own facilities, which represent their commitment to taking the initiative in introducing PV systems. At the end of 2012, total 13 PV power plants with a total capacity of 65 MW started operation. Renewable portfolio standards (RPS) is still valid after amendment in connection with the start of the FIT program.

4.3 Interest from municipalities and local governments

In addition to the national support measures, PV support programs implemented by local governments and municipalities play an important role for the dissemination support of PV systems. As of November 30, 2012, 1 096 local governments and municipalities have implemented subsidy programs to support installation of residential PV systems. Support projects are undertaken in 69 municipalities in Hokkaido, 62 municipalities in Saitama Prefecture, 55 municipalities in Nagano Prefecture, and 53 municipalities in Aichi Prefecture and Chiba Prefecture, respectively. Majority of municipalities provide the subsidy ranging from 20 000 JPY/kW to 50 000 JPY/kW (average subsidy is 38 000 JPY/kW). Tokyo Metropolitan Government (TMG) continued the subsidy of 100 000 JPY/kW in FY 2011 and FY2012. This subsidy program expired in March 31, 2013. TMG started a called “Power of the Roof” solar project from April 2013 using a low-interest loan program in partnership with the financial institutions as an alternative for the subsidy program.

On top of the subsidy for residential PV systems, some local governments and municipalities offer subsidy programs for industrial installation and programs for low-interest loan or loan facilitation. Most of the programs provide subsidy ranging from 50 000 JPY/kW to 210 000 JPY/kW. Furthermore, the “roof-lease project” in which roofs of the public facilities and public land are leased for the PV installation sites for profit and cases of the investment for the construction of large-scale PV power plants by local governments and municipalities are emerging.

4.4 Standards and codes

(1) Standards

As for the standards regarding PV power generation, industrial associations for electric appliances, The Japan Electrical Manufacturers' Association (JEMA) and the Optoelectronics Industry and Technology Development Association (OITDA) are taking a major role in mapping out draft standards. The Japanese Standards Association (JSA) compiles the draft standards and proposes them to the Japanese Industrial Standards Committee (JISC) for a deliberation based upon the Industrial Standardization Act. After these procedures, the Japanese Industrial Standards (JIS) standards are formulated. Currently, a large number of standards are formulated according to the standardization framework listed in Table 14. Although the standards basically comply with the IEC standards by the International Electrotechnical Commission (IEC), some of them reflect unique circumstances of Japan. Recently, vigorous efforts have been made to establish standards for the entire PV system and reliability of the PV modules.

(2) Certification

Japan Electrical Safety & Environment Technology Laboratories (JET) started a certification program for PV modules, “JETPVm certification” in October 2003. This is equivalent to the TÜV certification which is conducted mainly in Europe covering non-concentrator type crystalline silicon and thin-film PV modules for terrestrial installation for sale.

Model certification of PV modules and annual investigation of factories are conducted and labels will be issued for the PV modules which satisfy the standards. Performance tests are conducted in compliance with IEC61215 Ed.2 (JIS C 8990) for crystalline silicon PV modules and IEC61646

Ed.2 (JIS C 8991) for thin-film PV modules. Furthermore, the following safety standards were added in 2006:

- IEC61730-1 Ed.1 (JIS C 8992-1): Certification of safety conformity of PV modules - Part 1: Structure requirements

- IEC61730-2 Ed.1 (JIS C 8992-2): Certification of safety conformity of PV modules - Part 2: Testing requirements

As the JETPVm certification system has been certified by the CB-FCS (Full Certification Scheme) of the IECEE (IEC System for Conformity Testing and Certification of Electrotechnical Equipment and Components), mutual certification procedures can be simplified with certificates of conformity and other documents. At the end of March 2013, 6 806 models of PV modules from 60 manufacturers have been certified and registered.

A new standard “JIS Q 8901” providing the requirement of PV modules for terrestrial installation - reliability assurance system (designing, manufacture and performance) was established in February 2012. This standard aims at improving reliability of PV systems and achieving its dissemination and user protection by requiring business operators of distribution of PV modules which were recognized their long-term reliability in terms of designing and manufacture and combination of long-term product assurance system. Four organizations including JET, TÜV Rheinland Japan, UL Japan and VDE offer reliability certifications based on JIS Q 8901. 1 074 models from five manufacturers are registered in the JET certification program.

JET conducts a certification program for “Grid-connected Protective Equipment etc. for Small Distributed Generation Systems” to certify inverters with the capacity of below 20 kW for small-sized distributed PV systems to connect to low-voltage grids. This certification program aims at smooth “preliminary technological discussions” at the time of connection to electricity grids of utilities. Similar to certification of PV modules, product models are certified, factories are inspected and certification labels are issued for the products which satisfy the standards. Certification standards are based on the “Individual Test Method of Grid-connected Protective Equipment etc. for Grid-connected PV Power Generating Systems (for PV Power Generating Systems) stipulated by JET. The standards are based on “Electricity Utilities Industry Law”, as well as METI’s “Ordinance to set technological standards on electrical facilities”, “Official Interpretation of Technical Requirement of Electric Facilities under the Electricity Utilities Industry Law”, “Grid-interconnection Technical Requirement Guidelines on Quality of Electricity” and so on. As of April 2, 2013, 359 models of inverters by 23 manufacturers have been certified and registered.

JET started a new certification program for inverters for multiple grid-interconnection for PV systems in 2011. An inverter manufactured by Omron using ”AICOT ®” technology was certified. “AICOT” is a technology to prevent islanding operation in case of installations of multiple number of inverters for PV systems. In 2012, inverters from Kyocera, SANYO Electric (Panasonic) and YASKAWA Electric were certified and registered. “JEM1498: frequency feedback system with step reactive power injection (system to detect standard active islanding operation of PV inverters)” was formulated in August 2012 as a related standard. As of April 2, 2013, 91 models of inverters by four manufacturers have been certified and registered.

Table 14 Standardization Framework for PV Systems (1/2)

Category			JIS No.	Title	Remark
Terms and symbols			C 0617	Graphical symbols for diagrams	Revised in 2011
			C 8960; 2004	Glossary of terms for photovoltaic power generation (incl. solar cells)	Revised in 2012
System			C 8905; 1993	General rules for stand-alone photovoltaic power generating system	
			C 8906; 2000	Measuring procedure of photovoltaic system performance	
			C 8981; 2006	Standards for safety design of electrical circuit in photovoltaic power generating systems for residential use	
			C 8907; 2005	Estimation method of generating electric energy by PV power system	
			TS C 0055	Electromagnetic compatibility testing and measuring procedure of power conditioner for photovoltaic systems	Formulated in 2011
			JEM-TR 228	Guideline for maintenance and review of small output PV power systems	Revised in 2012
			-	Electromagnetic compatibility standard of PV power systems	Under discussion
			-	Guideline for field test of PV power systems	Under discussion
Solar Cell	Crystalline Solar Cell	Reference	C 8910; 2005	Primary reference solar cells	
			C 8904-2	Requirements for reference solar devices	Formulated in 2011
			C 8904-3	Measurement principles for photovoltaic(PV) solar devices with reference spectral irradiance data	Formulated in 2011
		Solar simulator	C 8912; 2011	Solar simulators for crystalline solar cells and modules	Revised in 2011
		Crystalline solar cells	C 8913; 2005	Measuring method of output power for crystalline solar cells	
			C 8915; 2005	Measuring method of spectral response for crystalline solar cells and modules	
			C 8920; 2005	Measuring method of equivalent cell temperature for crystalline solar cells by the open-circuit voltage	
		Crystalline solar PV modules	C 8918; 2005	Crystalline solar PV modules	
			C 8916; 2005	Temperature coefficient measuring methods of output voltage and output current for crystalline solar cells and modules	
			C 8914; 2005	Measuring method of output power for crystalline solar PV modules	
			C 8917; 2005	Environmental and endurance test methods for crystalline solar PV modules	
			C 8919; 2005	Outdoor measuring method of output power for crystalline solar cells and modules	
			C8990; 2009	Crystalline silicon terrestrial photovoltaic (PV) modules -- Design qualification and type approval	
	Amorphous Solar Cell	Reference cell/ module	C 8904-2	Requirements for reference solar devices	Formulated in 2011
			C 8904-3	Measurement principles for photovoltaic(PV) solar devices with reference spectral irradiance data	Formulated in 2011
		Solar simulator	C 8933; 1995	Solar simulators for amorphous solar cells and modules	
		Amorphous solar cell	C 8934; 2005	Measuring method of output power for amorphous solar cells	
			C 8936; 2005	Measuring methods of spectral response for amorphous solar cells and modules	
		Amorphous solar PV modules (thin-film solar PV modules)	C 8939; 2005	Amorphous solar PV modules	
			C 8937; 2005	Temperature coefficient measuring methods of output voltage and output current for amorphous solar cells and modules	
			C 8935; 2005	Measuring method of output power for amorphous solar modules	
			C 8938; 2005	Environmental and endurance test methods for amorphous solar cell modules	
			C 8940; 2005	Outdoor measuring method of output power for amorphous solar cells and modules	
			C8991; 2011	Thin-film terrestrial photovoltaic (PV) modules -- Design qualification and type approval	Revised in 2011

Source: The Japan Electrical Manufacturers' Association (JEMA)

Table 14 Standardization Framework for PV Systems (2/2)

Category		JIS No.	Title	Remark
Solar Cell	Other types of solar cells	C 8904-7	Computation of the spectral mismatch correction for measurements of photovoltaic devices	Formulated in 2011
		C 8944; 2009	Measuring methods of spectral response for multi-junction solar cells	
		C 8942; 2009	Solar simulator for multi-junction solar cells and modules	
		C 8943; 2009	Indoor measuring method of output power for multi-junction solar cells and modules (Component reference cell method)	
		C 8945; 2009	Temperature coefficient measuring methods of output voltage and output current for multi-junction solar cells and modules	
		C 8946; 2009	Outdoor measuring method of output power for multi-junction solar cells and modules	
		TS C 0052	Measuring methods of spectral response for CIS solar cells	Published in 2010
		TS C 0049	Secondary reference CIS solar cells	Published in 2010
		TS C 0051	Measuring method of output power for CIS solar cells and modules	Published in 2010
		TS C 0053	Temperature coefficient measuring methods of output voltage and output current for CIS solar cells	Published in 2010
		TS C 0050	Solar simulator for CIS solar cells	Published in 2010
		OITDA PV01	Evaluation method of performance for dye-sensitized solar devices	Formulated in 2009
	Modules	JIS C 8992-1; 2010	Confirmation of safety eligibility of PV modules - No. 1: Requirements for structure	Formulated in 2010
		JIS C 8992-2; 2010	Confirmation of safety eligibility of PV modules - No. 2: Requirements for testing	Formulated in 2010
		-	Standards for compatibility of module arrays	Under discussion
		JIS Q 8901	Requirement of PV modules for terrestrial installation - reliability assurance system (designing, manufacture and performance)	Formulated in 2012
	Other	JIS C 8904-3	Measurement principles for photovoltaic(PV) solar devices with reference spectral irradiance distribution data	Formulated in 2011
		-	Method to establish traceability of reference cells	Under discussion
		JIS C 8904-7	Computation of the spectral mismatch correction for measurements of photovoltaic devices	Formulated in 2011
Components	Array	C 8951; 2011	General rules for photovoltaic array	Revised in 2011
		C 8952; 2011	Indication of photovoltaic array performance	Revised in 2011
		C 8954; 2006	Design guide on electrical circuits for photovoltaic arrays	
		C 8955; 2011	Design guide on structures for photovoltaic array	Revised in 2011
		C 8953; 2006	On-site measurements of crystalline photovoltaic array I-V characteristics	
		C 8956; 2011	Structural design and installation for residential photovoltaic array (roof mount type)	Revised in 2011
	Inverter (power conditioner)	C 8980; 2009	Power conditioner for small photovoltaic power generating system	Revision under discussion
		C 8961; 2008	Measuring procedure of power conditioner efficiency for photovoltaic systems	
		C 8962; 2008	Testing procedure of power conditioner for small photovoltaic power generating systems	To be integrated with C 8980
		JEM 1498	JEM1498: frequency feedback system with step reactive power injection (system to detect standard active islanding operation of PV inverters)	Formulated in 2012
		-	Method of testing anti-islanding operation of power conditioners	Formulated in 2010
		-	Safety standards of power conditioners	Under discussion
		-	Environment-friendly design of power conditioner for small photovoltaic power generating systems	Under discussion
	Terminal box	JEM 1493	Terminal box for PV systems and junction box	Under discussion
Lead acid battery for PV		C 8971; 1993	Measuring procedure of residual capacity for lead acid battery in photovoltaic system	
		C 8972; 1997	Testing procedure of long discharge rate lead-acid batteries for photovoltaic systems	

* TS: Technical Specifications (standard specification sheet)

* TR: Technical Report (standard information)

Source: The Japan Electrical Manufacturers' Association (JEMA)

5 Highlights and prospects

5.1 Highlights

Japanese PV market entered a new stage of dissemination installing GW-scale annually with the start of the Feed-in Tariff (FIT) program under the Renewable Energy Law. In 2012, the framework for PV dissemination shifted significantly from initiative of supply side to initiative of user side. To date, Japanese PV market has been growing mainly in the residential application. Now the formation of new core market started including public, industrial and utility-scale applications. PV industry is expanding to the downstream sector with the inclusion of industry of PV utilization, system integrator, construction and installation in addition to the upstream sector surrounding PV systems. Also, taking advantage of the opportunity to newly invest in the dissemination of PV systems, financial institutions such as major banks, local banks, leasing business, investment funds and insurance business entering into the PV market appeared one after another.

Under these circumstances, ministries and agencies conducted the revision of the law which is under the jurisdiction of each ministries and agencies and the regulation reforms to eliminate the obstacles for the dissemination of PV systems. For instance, the Ministry of Economy, Trade and Industry (METI) conducted the regulation reform by amending the Factory Location Act and the Electric Utility Industry Law in order to support the growth of PV installation.

Local governments and municipalities extended subsidy programs to PV systems for industrial use and MW-scale PV power plants in addition to residential PV systems. Besides, they are playing a leading role in dissemination of PV systems by conducting the following activities; i) enter into the PV power generation business by constructing MW-scale PV power plants; ii) attract PV power provider to their own land; and iii) launch a roof-leasing project utilizing the public facilities.

Amid the rapidly worsening business environment, PV manufacturers made various efforts, in addition to selling PV cells, modules and systems. While some of them entered the EPC or power generation business and started PV production overseas, others launched high performance and high function PV modules such as high output capacity and lightweight PV modules for differentiation of the products. Some enhanced their efforts to address PID issues and drastically reformed their PV business to survive. A series of manufacturers entered PV cell and module production in expectation of continued growth of the Japanese PV market. In parallel, overseas manufacturers mainly from emerging countries entered the non-residential PV market in Japan one after another. The market share of foreign-made PV modules exceeded 30 %.

Manufacturers of silicon feedstock and PV module materials in particular faced difficulties in continuing their business due to a decline in the price of PV cells and modules they could not expect and a forecast that the market would not recover on a short-term basis. A number of such manufacturers went bankrupt or dissolved, withdrew from or downsized the PV business, or postponed their business plans. Despite these circumstances, some manufacturers of manufacturing equipment and PV module components acquired other companies and increased their production capacity.

In the PV inverter industry, manufacturers enhanced their production facilities to respond to the steadily growing residential PV market and the rapidly growing non-residential PV market. A large number of new comers including overseas manufacturers entered the PV inverter industry.

In the supporting structure manufacturing business, a number of newcomers entered, including those from the steel industry, the cement industry and the aluminum industry. They expect that the market for ground-mounted PV systems taking advantage of unused land will expand. EPC and power generation business of PV are considered to be new business opportunities among the expectation that the PV market will largely grow to a GW-scale market, therefore, various industries entered into the PV market including heavy electric industry, electrical equipment industry, general constructors, gas industry, telecom industry, trading business, construction and sales of PV systems. It is remarkable that newcomers are entering the power sales business by making the use of unused land and rooftops of factories and buildings owned by private companies. They became pillar of the growth of Japanese PV market.

Also, in order to support the PV power generation business over a long period, new business sectors exclusively engaged in supporting power generation business have emerged, including

maintenance of power plants, measurement and monitoring of generation volume, and consulting for the PV power generation business.

In the housing sector, which used to be a major PV application, over 300,000 houses were equipped with PV systems annually, which is a sign of a new development in the industry. PV system installation in houses, which was started by major housing manufacturers, has been expanding and medium-sized housing manufacturers and those in rural areas started installing PV systems in their houses. Major housing manufacturers are trying to increase the installed capacity of a PV system to over 5 kW/ house, while working on increasing the installation ratio. They also started promoting smart houses by installing PV systems in combination with HEMS, fuel cells and storage batteries, in order to realize energy self-sufficient houses. Installation of PV systems in newly-built houses has been increasingly becoming a standard. Also, since the start of the FIT program, more apartments for rent were installed with PV systems with the capacity of over 10 kW without depending on the subsidy limiting the capacity up to 10 kW, since 100 % of the generated power will be purchased for 20 years under the FIT program. In the condominium industry, installation of PV systems has finally become common and an increasing number of condominiums are installing PV systems. In some cases, PV systems are installed in each unit of the condominium. New formats of PV installation emerged, including PV systems combined with a high voltage power receiving equipment.

5.2 Prospects

In 2013, the second year of the FIT program, it is expected that Japanese PV market will grow significantly. As of the end of December 2012, under the FIT program, total capacity of approved PV projects was 4 704 MW equivalent to 224 456 systems. A large part of these approved projects are expected to secure the tariff of 42 JPY/kWh for FY 2012 and they will be installed within 1 to 3 years. This rate is applied for the PV projects approved from January to March 2013.

The tariffs under FIT program from April 2013 are set as follows: 1) 37.8 JPY/kWh (incl. tax) for PV systems with the capacity of 10 kW or more; and 2) 38 JPY/kWh for PV systems with the capacity below 10 kW. In 2013, the annual PV market is predicted to be more than 3 GW level if the installations are carried out steadily.

Under the FIT program, total capacity of approved PV systems was 847 MW with the capacity below 10 kW (for residential application), 1 681 MW with the capacity between 10 kW and below 1 MW and 2 176 MW with the capacity of 1 MW or above as of December 31, 2012. Japanese PV market is shifting from the one dominated by the residential applications to the one consisting of public, industrial and utility-scale applications in addition to the residential applications to form more balanced market.

Besides, full-scale dissemination of PV system is foreseen with the help of ministries and agencies to introduce PV system under the FIT program as well as to continue regulation reforms for dissemination. In this situation, manufacturing industry surrounding solar cells and PV systems are expected to create new employment establish and growth industries involving BOS and components manufacturers of inverters and supporting structures as well as electric facilities company and construction company in charge of design and installation of PV systems.

Annex A: COUNTRY INFORMATION

This information is simply to give the reader some background about the national environment in which PV is being deployed. It is not guaranteed to be 100 % accurate nor intended for analysis, and the reader should do their own research if they require more detailed data.

1) Retail electricity prices - household, commercial, public institution

Typical electricity price is the total of basic fees depending on contract size of ampere and the charge for the volume of usage.

- Household: < 120 kWh/month: 18,89 JPY/kWh
  120 - 300 kWh/month: 25,19 JPY/kWh
  > 300 kW/month: 29,10 JPY/kWh (type B, typical ampere for general household: 10 - 60 A)
  Three-phase pricing system with prices varying depending on the volume of usage

  (Source: Tokyo Electric Power Co., Inc. (TEPCO,) September 1, 2012)
- Commercial: 16,65 JPY/kWh (summer,) 15,55 JPY/kWh (other seasons) (high-voltage, business use) (Source: Tokyo Electric Power Co., Inc. (TEPCO,) September 1, 2012)
- Industrial: high-voltage, ≥ 500 kW : 15,34 JPY/kWh (summer,) 14,37 JPY/kWh (other seasons)
- Industrial: high-voltage, < 500 kW : 16,49 JPY/kWh (summer,) 15,41 JPY/kWh (other seasons)

  (Source: Tokyo Electric Power Co., Inc. (TEPCO,) September 1, 2012)

2) Typical household electricity consumption

302,2 kWh/month (FY 2010 average)

(Source: The Federation of Electric Power Companies of Japan, Graphical and Flip-chart of Nuclear & Energy Related Topics 2012)

3) Typical metering arrangements and tariff structures for electricity customers (for example, interval metering, time-of-use tariff)

- Interval Metering (30 minutes)
- Time-of-use tariff is available (Source: websites of electric utilities)

4) Typical household income

- 5,380 MJPY (2011)

(Source: The National Livelihood Survey, The Ministry of Health, Labour and Welfare, according to the survey conducted in 2011)

5) Typical mortgage interest rate

- 2,41 to 2,89 % (minimum rate and maximum rate from January to December 2012, standard)

  (Source: website of Japan Housing Finance Agency: trends of standard loan interest rates of the former Government Housing Loan Corporation)

6) Voltage (household, typical electricity distribution network)

- Household: 100 V
- Distribution network: single phase 3 lines 100/200 V

7) Electricity industry structure and ownership

- All the major utilities are investor-owned; generation, transmission and distribution are vertically integrated
- Independent power producers (IPPs) also generate electricity
- Regulator of the electricity industry: Agency for Natural Resources and Energy (ANRE) of the Ministry of Economy, Trade and Industry (METI)

8) Retail prices of oil

- High-octane gasoline: 150,2 - 169,1 JPY/liter (FY 2012, including 5% consumption tax)
- Regular gasoline: 139,4 - 158,3 JPY/liter (FY 2012, including 5% consumption tax)
- Diesel oil: 121,1 - 137,1 JPY/liter (FY 2012, including 5% consumption tax)

(Source: Agency for Natural Resources and Energy (ANRE) of the Ministry of Economy, Trade and Industry (METI))

9) Typical values of kWh/kW for PV systems

1 000 to 1 100 kWh/kW/year