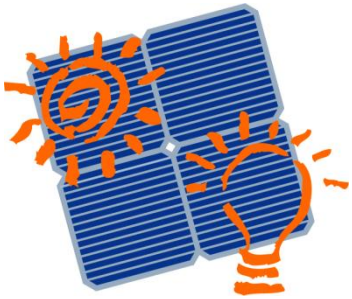

INTERNATIONAL ENERGY AGENCY

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 2011

Prepared by

Hiroyuki YAMADA

New Energy and Industrial Technology
Development Organization (NEDO)
Muza Kawasaki Building, 1310, Omiya-cho, Saiwai-ku,
Kawasaki City, Kanagawa 212-8554, Japan

Osamu IKKI

RTS Corporation
2-3-11 Shinkawa, Chuo-ku, Tokyo 104-0033, Japan

May 31, 2012

TABLE OF CONTENTS

Foreword 4
Introduction 5
1 Executive Summary 5
1.1 Installed PV power 5
1.2 Costs & prices 6
1.3 PV production 6
1.4 Budgets for PV 6
2 The implementation of PV systems 8
2.1 Applications for photovoltaics 8
2.2 Total photovoltaic power installed 8
2.3 Major projects, demonstration and field test programs 10
2.4 Highlights of R&D 13
2.5 Public budgets for market stimulation, demonstration / field test programmes and R&D 15
3 Industry and growth 17
3.1 Production of feedstocks, ingots and wafers 17
3.2 Production of photovoltaic cells and modules 24
3.3 Module prices 31
3.4 Manufacturers and suppliers of other components 31
3.5 System prices 32
3.6 Labor places 33
3.7 Business value 33
4 Framework for deployment (Non-technical factors) 34
4.1 Indirect policy issues 36
4.2 Interest from electricity utility businesses 38
4.3 Interest from municipalities and local governments 39
4.3 Standards and codes 39
5 Highlights and prospects 43
5.1 Highlights 43
5.2 Prospects 44
Annex A: Country information 46

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:

Enhanced 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 somewhat higher 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 balanced by their PV generation, to be charged the applicable retail tariff when electricity is imported from the grid and to receive some remuneration for PV 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 22 participating countries are Australia (AUS), Austria (AUT), 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.

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 2011. 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 2011, the annual PV installed capacity in Japan exceeded 1 GW along with the enactment of Renewable Energy Law.

1) The government newly established the Energy and Environment Council to start the revision of the energy strategy with the aim to lower the dependence on the nuclear power and to expand the use of renewable energy. In addition, the government enacted “the Renewable Energy Law” and decided the launch of Feed-in Tariff Scheme for Renewable Energy from July 2012
2) The Ministry of Economy, Trade and Industry (METI) undertook the development of new Basic Energy Plan in tandem with the newly-established Energy and Environment Council and enhanced the aid budgets in order to disseminate and expand the introduction of residential PV systems
3) The New Energy and Industrial Technology Development Organization (NEDO) started Smart Grid Demonstration Projects with USA, France, Spain, India, China and other countries to launch the international operation of Smart Grid projects
4) 875 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
5) The PV industry strengthened the approach to the domestic market in order to realize the huge expansion of domestic market led by residential field and the development of non-residential market including MW-scale solar power plant which is expected to boost its implementation from 2012
6) Utilities completed construction of MW-scale solar power plants across the country and many of them started operation
7) The Japanese PV market, driven by the residential market, achieved the annual installed capacity of 1 GW

1.1 Installed PV power

Total annual installed capacity of PV systems reached 1 295 804 kW in 2011, a 31 % increase from that of 2010 with 990 979 kW. The annual PV installed capacity in Japan exceeded 1 GW for the first time. PV market is 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. The breakdown of PV systems installed in 2011 is 2 172 kW for off-grid domestic application, 2 308 kW for off-grid non-domestic application and 1 245 447 kW for grid-connected distributed application,

mainly for residential PV systems. 45 877 kW was newly installed for grid-connected centralized application mainly by utilities. Cumulative installed capacity of PV systems in Japan in 2011 was 4 913 948 kW.

1.2 Costs & prices

In 2011, the average price of PV modules for residential PV systems dropped to 335 JPY/W from 375 JPY/W in 2010. Typical price of residential PV systems continued decreasing from 565 JPY/W in FY 2010 to 521 JPY/W in FY 2011. Price of PV systems with more than 10 kW generation capacity for public and industrial applications decreased from 576 JPY/W in FY 2010 to 518 JPY/W in FY 2011.

1.3 PV production

Total production of solar cells and PV modules in Japan in 2011 increased to 2 496 MW from 2 311 MW in 2010, achieving a year-on-year increase of 8%. The import volume in 2011 was 262,5 MW, more than doubled the amount of 125,6 MW in 2010.

The breakdown of shipping volume was as follows: 951 MW of single crystalline silicon (sc-Si) solar cells, 1 153 MW of multicrystalline silicon (mc-Si) solar cells and 655 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 76 %. 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, model projects, dissemination measures, laws and regulations. METI restarted the subsidy program for residential PV systems from January 2009 with the supplementary budget of FY 2008 and continued the program in FY 2011 with a budget of 34,9 BJPY. 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 offered subsidy for interest rate to eco-friendly leasing businesses leasing PV modules and other low-carbon equipment in FY 2011.

In the 3rd supplementary budget passed the Diet on November 21, 2011, the government allocated the budgets for the programs or projects promoting PV power generation. “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) were established as funds and will be utilized this fiscal year (FY 2011) and until FY 2013 to promote installation of residential PV systems. METI established “Subsidy for introducing renewable energy systems as part of restoration measures” as a measure to subsidize introduction of renewable energy power generation systems including PV systems and wind power generators as well as storage batteries for these equipment in the areas damaged by the Great East Japan Earthquake occurred on March 11, 2011. In addition, budgets were requested to establish an R&D base for renewable energy in Fukushima Prefecture responding to Fukushima nuclear power plant failures. MoE allocated “support fund for local governments to introduce renewable energy” (84 BJPY).

The budgets for major national PV programs implemented in FY 2011 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: 34,9 BJPY
2) Technology Development of Innovative Photovoltaic Power Generation: 8,04 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): 2,06 BJPY

3) Demonstration project on developing forecasting technology of PV power generation: 0,10 BJPY
4) Development of electric energy storage system for grid-connection with new and renewable energy resources: 2,0 BJPY
5) International collaboration project on efficient use of energy consumption (Japan-U.S. Smart Grid Collaborative Demonstration Project in New Mexico, USA): 1,0 BJPY
6) Project supporting acceleration of the local introduction of new energy: 13,0 BJPY
7) 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)): 2,0 BJPY

Major national PV programs implemented in the FY 2011 3rd supplementary budget are as follows (the budget for item 3) - 5) includes those for PV and other types of new and renewable energy);

1) Subsidy for introducing residential PV systems as restoration measures: 86,99 BJPY
2) Projects for establishing a fund for high penetration of residential PV systems as restoration measures: 32,39 BJPY
3) Project to establish an R&D center on renewable energy in Fukushima Prefecture: 5,0 BJPY
4) Project for R&D on renewable energy in Fukushima Prefecture: 5,1 BJPY (3,0 BJPY is allocated for photovoltaics)
5) Subsidy for introducing renewable energy systems as part of restoration measures: 32,6 BJPY
6) Support fund for local governments to introduce renewable energy: 84 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.

875 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 distributed PV systems, mainly for private housings, collective housings or apartment buildings, public facilities, industrial and commercial facilities, and buildings. Residential PV systems account for 85,4 % of grid-connected market in Japan in 2011, leading Japan's grid-connected distributed PV system market. PV systems for public facilities introduced by the national and local governments account for 2,1 % of the grid-connected market, while PV systems for industrial and commercial use account for 8,6 %. 45 877 kW grid-connected centralized PV systems were installed and they account for 3,6 % of grid-connected market in Japan.

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 2011 by sub-market. Total installed capacity in 2011 was 1 295 804 kW, and the annual installed capacity for each application is as follows: 2 172 kW for off-grid domestic PV systems, 2 308 kW for off-grid non-domestic PV systems and 1 245 447 kW for grid-connected distributed PV systems mainly for residential houses. 45 877 kW was installed for large-scale grid-connected centralized PV power application mainly by utilities.

Table 1 The installed PV power in 4 sub-markets in 2011

Sub-market/ application	Off-grid domestic	Off-grid non-domestic	Grid-connected distributed	Grid-connected centralized	Total
Installed PV power	2 172 kW	2 308 kW	1 245 447 kW	45 877 kW	1 295 804 kW

Analyzed by RTS Corporation

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 (2011)	New (2011) PV capacity as a % of new electricity generation capacity (2011)	Total PV energy production as a % of total energy consumption (2011)
2,1 %	N.A.	0,48 %

Analyzed by RTS Corporation

Table 2 shows cumulative installed capacity of PV systems by submarket. In 2011, total cumulative installed capacity was 4 913 948 kW. Cumulative installed capacity for each application is as follows: 5 546 kW for off-grid domestic, 97 728 kW for off-grid non-domestic, 4 741 464 kW for grid-connected distributed and 69 210 kW for grid-connected centralized application.

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
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
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
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
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

Source: National Reports Japan, 2011 figure is analyzed by RTS Corporation

The Ministry of Economy, Trade and Industry (METI) resumed the Subsidy for Installation of Residential Photovoltaic Systems in 2009 and that subsidy program was continued in 2011. In addition, with the extension of the scheme to oblige electric utilities to purchase surplus electricity generated by PV systems (below 10 kW) at a preferential price, the market demand for residential PV systems has been continuously increasing. A trend of houses equipped with PV systems as standard equipment was promoted by major pre-fabricated housing manufacturers, as the actions for reducing CO_2 emissions and promoting all-electrified housing. The increasing interest for electric power facility in houses contributed to the demand increment because the planned blackouts were implemented in some places amid concerns that the power shortage may have occurred after the Great East Japan Earthquake in March 11, 2011. The development of smart house which enables energy-independence is also accelerated with the introduction of storage batteries and HEMS.

As for medium- to large-sized PV systems for public and industrial facilities, there were no more new calls for proposals under the Project for Promoting the Local Introduction of New Energy and the Project Supporting New Energy Operators, which means there was no national support program in FY 2011. However, the nation-wide response to power shortage and disaster prevention after the nuclear power plant accident enhanced the willingness of local authorities and industries to install PV systems and brought the installation of approximately 140 MW in public, industrial, commercial, and power generation business facilities.

Hokkaido Electric Power, Tohoku Electric Power, Tokyo Electric Power, Chubu Electric Power, Kansai Electric Power, Hokuriku Electric Power, Shikoku Electric Power, Kyushu Electric Power, and Okinawa Electric Power have started operation of large-scale PV power plants, thus installation capacity of grid-connected centralized PV systems increased greatly from 2010.

2.3 Major projects, demonstration and field test programs

Field test and dissemination programs implemented in FY 2011 were “Subsidy for measures to support introduction of residential PV systems”, “Program to purchase surplus PV power”, “Project for Promoting the Local Introduction of New Energy”, “Project for Supporting New Energy Operators” and “Project for development of stable power supply facility for emergency case” (see Annex B for details). Besides, 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 is 48 000 JPY/kW for FY 2011, and 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: 13,5 % or higher for crystalline silicon solar cells, 7,0 % or higher for thin-film silicon solar cells, 8,0 % or higher for compound solar cells)
ii) Grid-connected to low-voltage power distribution line with reverse power flow. Maximum nominal output of PV modules should be less than 10 kW in total and in case of system expansion, 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) 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 600 000 JPY/kW or less (excluding tax)

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 FY 2011, were approximately 1 040 000 and around 4 GW.

With the FY 2011 3rd supplementary budget, passed in the diet on November 21, 2011, the budget was also allocated to the programs related to the dissemination support of PV systems. “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)” were both formulated as foundations within the 3rd supplementary budget. They will be utilized as “Subsidy for measures to support introduction of residential PV systems” during FY 2011 - FY 2013.

In FY 2011, PV modules produced by 75 manufacturers have been registered as eligible models by J-PEC. This number was 41 in the previous year, and the number of registered manufacturers is increasing considerably. Of them, 26 from TÜV Rheinland, 18 manufacturers obtained certification from JET, 6 from JET and TÜV Rheinland, 6 from VDE, 5 from TÜV SUD, 5 from TÜV Rheinland and VDE, 2 from TÜV Rheinland and TÜV SUD, 2 from INTERTEK, 1 from INTERTEK and JET, 1 from JET and TÜV InterCert, 1 from JET, TÜV Rheinland and VDE, 1 from JET and VDE, and 1 from TÜV InterCert.

(2) Program to purchase surplus PV power

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’’ legislated in July 2009, METI has been implementing the program to purchase surplus PV power since November 2009. Electricity generated from PV systems with the capacity of below 500 kW is eligible for the purchase and the term is for 10 years. Purchase prices under this program in FY 2011 has not changed from the previous year and are 42 JPY/kWh (almost 1.7 times of retail electricity charge for households) for residential PV systems with the capacity of below 10 kW. In case of the combination of PV system (capacity below 10kW) with other power generation facilities, purchase price is 34 JPY/kWh. For non-residential PV systems and PV systems with a capacity of 10 kW or more without other power generation facilities and with combination of them, the purchase prices are 40 JPY/kWh and 32 JPY/kWh respectively. For non-residential PV systems and PV systems with a capacity of 10 kW or more installed before FY 2010 without other power generation facilities and with combination of them, the purchase prices are 24 JPY/kWh and 20 JPY/kWh respectively. These prices are reviewed annually. All the users of electricity will evenly share the purchase costs.

(3) Project for Promoting the Local Introduction of New Energy

METI has initiated “Project for Promoting the Local Introduction of New Energy” in FY 1997 with the aim of supporting regional projects established by local authorities for introduction of new and renewable energy and nonprofit projects for introducing new and renewable energy facilities by nonprofit organizations (NPOs). Since FY 2008, private institutions who conduct projects in collaboration with local authorities are also eligible for the subsidy of this project inside the frame of social system. As for PV, 4 projects continued in FY 2011, however, a call for new application was not conducted for PV system in FY 2011. From the initiation of the program in FY 1997, the cumulative number of qualified systems and installed capacity were 1 300 systems and 116 MW respectively.

(4) Project Supporting New Energy Operators

METI has initiated “Project for Supporting New Energy Operators” in 1997 with the aim of accelerating introduction of new and renewable energy by supporting private institutions who introduce new and renewable energy such as PV power generation, wind power generation, solar thermal energy, utilization of differential temperature energy, natural gas co-generation, fuel cells,

thermal utilization of ice and snow, biomass power generation, thermal utilization of biomass, biomass-derived fuel production, hydroelectric power generation, geothermal power generation, mirogrids, etc. from the viewpoint of energy security and preservation of the global environment. Eligible recipients of the subsidy or the debt guarantees are private institutions who plan to install new and renewable energy facilities. In 2009, sole proprietors started installations of such energy facilities in collective housing. Designated output capacity of eligible PV systems is 50 kW or more. However, in case of installations by small- and medium-sized enterprises (SMEs,) installations in remote islands as well as installations of non-PV energy systems combined with PV systems by a single operator, the PV systems with the capacity of 10 kW or more are also eligible. As for PV, 5 projects continued in FY 2011, however, a call for new application was not conducted for PV system in FY 2011.

(5) Project for development of stable supply base for emergency case

From FY 2011, METI started “Project for development of stable supply base for emergency case” with the purpose of stabilizing the supply of petroleum products even in emergency situations such as disasters, by installing PV systems, off-grid power systems with cogeneration, and water supply facilities in gas stations. Eligible recipients of the subsidy are gasoline distributors (business operator which is recommended for this project by local governments or associate partners of Oil Association who have agreement on disaster with local governments). Eligible facilities include PV system, power generation facility with internal-combustion engine, water storage facility, and water well. To be eligible, PV system should have the output capacity of 10 kW and under. Also, the eligible PV system should be attached to power generation facility with internal-combustion engine or power generation facility with internal-combustion engine is already owned. The grant rate is one-half for insecure supply area (gas stations in the municipality where the number of gas stations per each 100 m^2 is 8 and under, or the area where the number of gas stations within 5 km of the applying station in road distance is 1 and under) , and one-quarter for other areas. The amount limit of grant per each site is 5 MJPY for the cost of PV system and installation. In FY 2011, 70 gas stations (20 sites of them with PV) were selected as eligible recipients of the subsidy.

(6) 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 CO_2 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 CO_2 emissions to local authorities’ facilities, industrial facilities, local communities, cities, and schools. It also offers support for technology development.

From FY 2011, “Eco lease business promotion project for household and business” was launched which grants subsidy for entities who lease and introduce low-carbon devices to meet certain requirements. Eligible recipients of the subsidy are private business (entities who deal with leasing business), and the eligible lease will be provided to houses (individuals), sole proprietors, small and medium-sized companies, and leading medium-sized firm. Grant rate is 3 % of the leasing price to introduce low-carbon devices by lease, and the rate was increased to 10 % for the entities in Iwate Prefecture, Miyagi Prefecture, and Fukushima Prefecture in the Tohoku region from November 1, 2011.

In the “Project to support active introduction of technological measures for small local authorities”, MoE has been providing subsidy for the introduction of alternative energy and enhancement of energy conservation by local authorities and private institutions who are engaged in energy conservation of facilities owned by local authorities. The amount of subsidy is the lower amount of either up to half of the cost, or 0,1 BJPY, and the required output capacity of eligible PV systems is 50 kW or more for FY 2011 (10 kW or more for wall and window application). In FY 2011, 20 projects were selected, including 2 project to install PV systems and in FY 2009, 10 were selected, including 1 to install PV systems.

Also, under the “Project for developing technology to prevent global warming (competitive funds)”, MoE calls for proposals from private businesses, public research facilities, and universities and selects proposed projects to conduct by means of commission or subsidy to deal with the development and demonstration research of the technology which has necessity and possibility to

become practical in short term to control CO_2 emission from energy. The budget for FY 2011 was 6,2 BJPY. MoE provides grant for the technology development of low carbon transportation and technology development of low carbon houses and offices utilizing new and renewable energy including PV.

In addition, MoE implements “Promotion project of measures for low-carbon community development” to support planning and operation with the aim of leading urban redevelopment of low-carbon model.

(7) 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) at buildings for central ministries and agencies and local government offices. 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 CO_2 reduction at houses and buildings. MLIT also considers 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 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.

2.4 Highlights of R&D

(1) Research and Development

“R&D on Innovative Solar Cells (FY 2008 - FY 2014)” and “R&D for High Performance PV Generation System for the Future (FY 2010 - FY 2014)” are ongoing PV-related projects by the New Energy and Industrial Technology Development Organization (NEDO). The Ministry of Education, Culture, Sports, Science and Technology (MEXT) continues to call for additional proposals with new topics regarding following 2 programs: i) Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells, and ii) Creative Research for Clean Energy Generation using Solar Energy. In addition, “Development of Organic Photovoltaics toward a Low-Carbon Society (FY 2009 - FY 2013)” has been continuously conducted by the University of Tokyo.

Research Center for Photovoltaics (RCPV) at the National Institute of Advanced Industrial Science and Technology (AIST) completed 7 years of activity period in the end of FY 2010 and revaluation and restructuring were undertaken. The center was reorganized as Research Center for Photovoltaic Technologies (RCPVT) and will continue research activities until FY 2018.

In the 3rd supplementary budget passed in the Diet on November 2011, the foundation of new research facilities in Koriyama, Fukushima Prefecture was decided with the principal aim of industrial support related to renewable energy, in connection with the reconstruction after the Great East Japan Earthquake. Preparation work for the foundation of the new facilities mainly led by AIST is under way. Technological development projects (budget of 3 BJPY) including crystalline silicon PV cells and system demonstration research will be focused, as well as wind energy and fuel cells. Also, exploratory research of high-performance PV cells (budget of 4 BJPY for 5 years) at the new research facilities is planned as part of R&D program on next-generation energy for reconstruction of Tohoku (quake-stricken) area, so the preparation for 5-year project is in process principally led by the Japan Science and Technology Agency (JST).

1) R&D for High Performance PV Generation System for the Future

A total of 7 academic-industrial consortium-based development projects, 6 technological

development projects initiated by enterprises' proposals, and development of common fundamental technologies related to performance evaluation and reliability of PV cells are conducted under this program, a 5-year R&D program till 2014, regarding crystalline silicon PV cells, thin-film silicon PV cells, CIGS PV cells and organic thin-film PV cells with the principal R&D target of "PV power generation cost of 14 JPY/kWh" following 2010.

For the crystalline silicon PV, high-performance PV cell technological development (target module conversion efficiency >20%) using 100 μm thick thin wafer academic-industrial alliance project was conducted mainly by Toyota Technological Institute. And relevant developments including slicing technology and silicon feedstock technology were conducted. For thin-film silicon PV modiles, next-generation multi-junction thin-film silicon PV project (target module conversion efficiency >14%) and development of high speed deposition technologies for large area and optical confinement structure are mainly led by Photovoltaic Power Generation Technology Research Association (PVTEC). For CIGS PV cells, 3 technology development projects are ongoing including advanced technological development of flat and flexible PV (module conversion efficiency >18%) mainly led by the business enterprises. In addition, as for organic PV cells, development of production model technology of PV module with high durability and low-cost film modules for dye-sensitized solar cell (DSSC) are conducted. As for organic thin-film PV cells, technological development of material and module is ongoing.

Technological developments including PV power generation evaluation/ forecasting technology, reliability assessment technology, modules, and recycling technology were conducted in the field of common fundamental technologies for PV systems. The mid-term evaluation of achievement and progress of these technological developments is planned in the middle of 2012. Responding to the recent development of PV cells, proposals with new topics were called in the beginning of FY 2012.

2) R&D on Innovative Solar Cells

"R&D on Innovative Solar Cells", continued from FY 2008, is a research project of search for seeds, with the aim of fundamental advancement of PV cells (target conversion efficiency: 40%) with long-term perspective. R&D activities were ongoing, including i) technological development focusing on the multi-junction solar cells built from III–V semiconductors and quantum dot superlattice solar cells under the research and development project of ultra-high efficiency post-silicon solar cells led by the University of Tokyo, ii) development of mechanical stack technology for multi-junction solar cells and new thin-film materials under the research and development project for thin film multi-junction solar cells with highly ordered structure, led by National Institute of Advanced Industrial Science and Technology (AIST); and iii) development of optical management technology for multi-junction cells and wide-gap thin-film materials under the research and development project of thin film full spectrum solar cells with low concentration, led by Tokyo Institute of Technology (TIT). One of the objectives of this project is the promotion of international technology exchange, therefore, a symposium is held once a year inviting researchers from abroad.

3) R&D on fundamental research area

Under the "Development of Organic Photovoltaics toward a Low-Carbon Society" project conducted by the University of Tokyo, research activities are conducted and projected to end in 2013, with the themes including highly-durable organic PV cells, advancement of optical energy efficiency, large-area printing technology, organic thin film tandem solar cells, and PV cells with storage function.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) have been continued the projetcs: i) Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells (an individual proposal-oriented program with a research term of 3 to 5 years); and ii) Creative Research for Clean Energy Generation using Solar Energy (a team proposal-oriented program). 2011 was the final year to call for proposals of new themes. Under "Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells", 36 projects including 12 new projects have been conducted to study various PV elemental technologies and develop novel materials. "Creative Research for Clean Energy Generation" using Solar Energy has been conducted with a total of 14 projects, including 3 new projects such as a project on optical

management technology.

(2) Demonstrative research

Demonstration projects were implemented in Japan and overseas mainly on smart community in FY 2011, and PV systems were installed for those projects in a large volume. Overseas, smart community demonstration projects have been planned and implemented in New Meixco and Hawaii in the USA, Lyon in France, Malaga in Spain, Gongqingcheng, Jiangxi Province in China and Java Island in Indonesia. In addition, a comprehensive joint project in solar energy area has been promoted in Morocco.

1) Demonstration Project of Next-Generation Energy and Social Systems

Demonstrative research on a next-generation energy and social system with the installation of PV, storage battery and other systems has been conducted in 4 cities: Yokohama City, Kanagawa Prefecture; Toyota City, Aichi Prefecture; Keihannna Science City, Kyoto Prefecture and Kitakyushu City, Fukuoka Prefecture. The objectives of the demonstration projects in each city are as follows: i) Yokohama City aims for the comprehensive demonstration in a metropolis, ii) Toyota City is for the demonstration focusing on next generation vehicles, iii) Keihannna Science City is for the demonstration in an area where homes and research institutes are dispersed into relatively large area, iv) Kitakyushu City is for the regionally-specific demonstration. The term of these project is from FY 2010 to FY 2014.

2) Verification Test of a Micro Grid System for Remote Islands

Verification tests on a micro grid in remote islands have been conducted by Kyushu Electric Power and Okinawa Electric Power. Installed PV capacity of Kyushu Electric Power and Okinawa Electric Power are 120 kW and 4 500 kW, respectively, including a 4 000 kW system in Miyako Island in Okinawa Prefecture. The term of this verification test is from FY 2010 to FY 2014.

3) Japan-U.S. Smart Grid Collaborative Demonstration Project in New Mexico, USA

This is a Japan-US joint demonstrative research conducted in Los Alamos County and Albuquerque City in the State of New Mexico. Demonstrative project on smart grid, smart house and others has been conducted in residential and commercial areas. The term of the project is from FY 2009 to FY 2013, and the budget for FY 2011 was 1 BJPY.

4) Verification Test of a Smart Grid System for Remote Islands in Hawaii, USA

Verification tests on smart grid in remote islands using renewable energy and electric vehicles (EVs) have been implemented in Maui Island in the State of Hawaii. The term of this project is from FY 2011 to FY 2014, and the overall budget scale is approximately 3 BJPY.

5) Other International Demonstration Projects

Other projects in operation in FY 2011 include “Smart Community Demonstration Project” in Lyon, France and “Demonstration Project for Smart Grid-related Technology” in Malaga, Spain.

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

The FY 2011 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” and “R&D for High Performance PV Generation System for the Future” and “Demonstration project on developing forecasting technology of PV power generation”. In the FY 2011 3rd supplementary budget, created for the reconstruction and development of damaged areas after the Great East Japan Earthquake occurred on March 11, 2011, the government allocated the budget for the development of renewable energy R&D facilities in Fukushima Prefecture. However, that budget is not counted in table 3 (Project to establish an R&D center on renewable energy in Fukushima Prefecture: 5,0 BJPY, Project for R&D on renewable energy in Fukushima Prefecture: 5,1 BJPY) because the budget includes other renewable energy research. 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” (80 MJPY) and “International Cooperative Demonstration Project for Streamlining of Energy Consumption (Japan-U.S. Smart Grid Collaborative Demonstrative Project in New Mexico, USA)” (1 BJPY). However, PV systems are not newly installed under the “Field Test Project on New Photovoltaic Power Generation Technology”.

The budget for market incentives are allocated to METI’s “Subsidy for measures to support introduction of residential PV systems” (36,9 BJPY) and “Eco lease business promotion project for household and business (Subsidy for lease interests by entities who lease low-carbon devices such as PV modules)” (2 BJPY). 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) were allocated in the FY 2011 3rd supplementary budget. However, these budgets are not counted in Table 3 because they will be spent as funds for multiple-fiscal-year. Subsidy for introducing renewable energy systems as part of restoration measures (32,6 BJPY) and Support fund for local governments to introduce renewable energy (84 BJPY) were also budgeted for the measures of reconstruction of the area damaged by the Great East Japan Earthquake in March 11, 2011. Neither of these budgets are not included in Table 3 because they also cover new and renewable energies as well as PV power generation.

Other ministries and agencies such as MLIT, the Ministry of Land, Infrastructure and Transportation and MEXT are also promoting introduction of PV systems, but the budget amounts are unknown.

The budgets of local governments are complementarily appropriated for market incentives, mainly for residential PV systems. In FY 2011, 875 municipalities implemented their own subsidy programs. The amount of subsidy varies by municipality (e.g. approximately 20 000 JPY/kW to 100 000 JPY/kW,) and the total amount is unknown.

Table 3 Public budgets for R&D, demonstration/ field test programs and market incentives

	FY 2009			FY 2010			FY 2011		
	R&D	Demo/ Field Test	Market Stimulation	R&D	Demo/ Field Test	Market Stimulation [3]	R&D	Demo/ Field Test	Market Stimulation
National [1] (BJPY)	4,16	2,35	43,05	5,98	2,38	55,13	8,14	1,08	36,9
Regional [2] (BJPY)	-	-	-	-	-	-	-	-	-

[1]: Market incentives: PV budgets of METI and MoE. The 3rd supplementary budget not included.

[2]: 875 municipalities such as prefectures, cities, towns, and villages are implementing their own subsidy programs for residential PV systems in 2011; the budget amount is unknown.

Souce: METI, NEDO and MoE compiled bv RTS Corporation

3 Industry and growth

3.1 Production of feedstocks, ingots and wafers

In Japan, four companies manufacture polysilicon (semiconductor grade) for the feedstock for solar cells: 1) Tokuyama (production capacity: 3 000 t/year (production capacity including for semiconductor: 9 200t/year)), 2) Mitsubishi Materials (production capacity: 2 800 t/year), 3) OSAKA Titanium technologies (production capacity: 3 600 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 (production amount of 3 000 t) and M.SETEK (production amount of 754 t). Tokuyama started construction of polysilicon plant in Malaysia for the 2nd phase production capacity expansion ahead of schedule, aiming to achieve 20 000 t/year of production capacity by the end of 2013. M.SETEK, though suffered from the Great East Japan Earthquake in March 2011, recovered from the damage and increased production capacity.

In addition, several manufacturers conduct research and development (R&D) of solar grade silicon (SoG-Si): Tokuyama on vapor to liquid deposition (VLD) process; Japan Solar Silicon (JSS) on Zn reduction process; NS Solar Material and others. JFE Steel has 400 t/year of production capacity of upgraded metallurgical silicon (UMG-Si). Due to the damage from the Great East Japan Earthquake and deteriorated market condition, JSS again postponed the start of commercial production.

Four companies, namely M.SETEK, SUMCO, JFE Steel and Dai-ichi Dentsu specialize in manufacturing Si ingots and wafers for solar cells. In addition, Kyocera and Choshu Industry manufacture solar Si ingots and wafers in their own facilities, and SANYO Electric operates a solar Si ingot/ wafer plant in Oregon, the USA. Ferrotec also supplies solar Si ingots and increased production capacity of Si wafers in its factory in China. Major company manufacturing solar Si wafers from purchased Si ingots for solar cells is Space Energy.

With expanded production of solar cells globally, companies such as TKX, Osaka Fuji, Space Energy, Shinko Manufacturing, Kitagawa Seiki and Ishii Hyoki are conducting manufacturing business of silicon wafers. Due to the weakening market and exchange rate fluctuations, however, some companies ended in making decisions to downsize or withdraw from the business.

In addition, Evonik Monosilane Japan and Taiyo Nippon Sanso completed a new monosilane manufacturing plant with a production capacity of 1 000 t/year. Due to the global production expansion of compound semiconductor solar cells, metal resources manufacturers dealing indium, selenium, tellurium and others are increasing transaction volume for solar cells. Air Water, Showa Denko, Taiyo Nippon Sanso and other companies are increasing production of hydrogen selenide. Shinko Chemical also increased its production capacity of high purity selenium.

Table 4 shows an overview of Japanese manufacturers of Si feedstock, ingots and wafers for solar cells in 2011. Table 4a shows manufacturing process of each manufacturer. Table 4b shows specifications of Si ingots and wafers for solar cells. Table 4c shows new developments and products, Table 4d shows production expansion plans of manufacturers, and Table 4e shows overseas business development by the manufacturers.

Table 4 Production and production capacity information for silicon feedstock, ingot and wafer manufacturers (2011)

Manufacturer	Process & technology [1]	Total Production	Maximum production capacity	Product destination
Tokuyama	Polysilicon	3 000 t (excl. for semiconductor)	3 000 t/yr (excl. for semiconductor)	
M.SETEK	Polysilicon	754 t	7 000 t/yr	
	sc-Si ingot	2 446 t	3 600 t/yr	
Mitsubishi Materials	Polysilicon	N.A.		
Mitsubishi Materials/ Mitsubishi Materials Electronic Chemicals [2]	mc-Si ingot	0 t	0 t/yr	
	mc-Si wafer	0 MW	0 MW/yr	
Japan Solar Silicon	Polysilicon for solar cell	0 t	Test Production (not disclosed)	
NS Solar Material	Polysilicon (UMG-Si)	N.A.	N.A.	
JFE Steel	Cast mc-Si ingot			
	Cast mc-Si wafer			
SUMCO	mc-Si wafer	175 MW	400 MW/yr	
Covalent Material [3]	sc-Si ingot	None	None	
Space Energy	sc-Si wafer	60 MW	219 MW/yr	
Dai-ichi Dentsu	Cast mc-Si ingot	250 t	330 t/yr	
	Cast mc-Si wafer	26 MW	33.7 MW/yr	
Kyocera [4]	mc-Si wafer	N.A.	N.A.	
OSAKA Titanium technologies				
Ferrotec				
Shin-Etsu Chemical[7]				
SANYO Electric [6]	Si wafer for HIT (a-Si on c-Si)	100 MW	100 MW/yr	

[1]: mc-Si: multicrystalline silicon, sc-Si: single crystalline silicon

[2]: PV-related business was suspended in April 2011 (diverted for the manufacturing of products with other purpose)

[3]: No production in FY 2011

[4]: Can not be counted by MW. All products are for internal use

[5]: Polysilicon production is specialized for semiconductor use and no production for PV

[6]: As for Si wafer, other company's production on commission basis, included in the ingot production amount by affiliate company, is also counted

Source: answers from each company for the questionnaire by NEDO

Table 4a Production process and technology for Si feedstock, ingot and wafer manufacturers for solar cells (2011)

Manufacturer	Production process
Tokuyama	- Metallic silicon + chlorine + hydrogen → deposition using Siemens process → Polysilicon
M.SETEK	- Production of Si feedstock → sc-Si ingots by CZ process
Mitsubishi Materials	- Polysilicon manufacturing using Siemens process
NS Solar Material	N.A.
Japan Solar Silicon	- Zinc reduction method process
JFE Steel	- Polysilicon → cast mc-Si ingots → wafers
SUMCO	- Purchase of Si feedstock →mc-Si by electromagnetic casting process (EMC) → mc-Si wafer
Covalent Material	
Space Energy	- Purchase of Si feedstock → sc-Si ingot by subcontracting → sc-Si wafers - sc-Si ingot from market → sc-Si wafers
Mitsubishi Materials /Mitsubishi Materials Electronic Chemicals	- Purchase of Si feedstock → casting mc-Si ingots → mc-Si wafers
Dai-ichi Dentsu	<Cast mc-Si production> - Ingot <Wafer process (by subcontracting)> - Cutting into blocks, polishing, slicing, cleaning
OSAKA Titanium technologies	- Metallic silicon (imported) → polysilicon manufacturing using Siemens process (only for semiconductor)
Ferrotec	
Shin-Etsu Chemical	
Kyocera	- Purchase of feedstock → integrated manufacturing to modules
SANYO Electric	- Purchase of feedstock → c-Si wafer → HIT cells → modules - Purchase of c-Si wafer → HIT cells → modules

Source: answers from each company for the questionnaire by NEDO

Table 4b Specifications of Si feedstock, ingots and wafers for solar cells (2011)

Manufacturer	Product	Specification
Tokuyama	High-purity polysilicon of 11N	
M.SETEK	sc-Si ingot (N-type)	125 mm x 125 mm, 0,5-3,0 Ωcm
	sc-Si ingot (N-type)	125 mm x 125 mm, 1,7-12,0 Ωcm
	sc-Si ingot (N-type)	156 mm x 156 mm, 1,0-13,0 Ωcm
	sc-Si ingot (P-type)	156 mm x 156 mm, 0,5-3,0 Ωcm
Mitsubishi Materials	Polysilicon	N.A.
Mitsubishi Materials /Mitsubishi Materials Electronic Chemicals	Ingot	None for PV
	Wafer	None for PV
Japan Solar Silicon	Polysilicon for solar cell	Polysilicon for sc-Si ingot and mc-Si ingot for solar cell
NS Solar Material	Polysilicon (UMG-Si)	N.A.
JFE Steel	mc-Si ingot (P-type)	
	Wafer	
SUMCO	mc-Si wafer (P-type)	156 mm x 156 mm (0,5-3,0 Ωcm), 180μm, 200 μm
Covalent Material		No production
Space Energy	N-type	125 mm x 125 mm (0,5-12 Ωcm), 170 μm
	P-type	156 mm x 156 mm (0,5-6 Ωcm), 180 μm
Dai-ichi Dentsu	mc-Si wafer	156 mm x 156 mm, 200 μm
OSAKA Titanium technologies		None
Ferrotec		
Shin-Etsu Chemical		
Kyocera		
SANYO Electric		

Source: answers from each company for the questionnaire by NEDO

Table 4c New products or new development of silicon feedstock, ingot and wafer manufacturers for solar cells (2011)

Manufacturer	New product/ new development
Tokuyama	- None
M.SETEK	- 156 mm x 156 mm sc-Si ingots (N-type)
Mitsubishi Materials	N.A.
Mitsubishi Materials/ Mitsubishi Materials Electronic Chemicals	- None
Japan Solar Silicon	- None
NS Solar Material	N.A.
JFE Steel	
SUMCO	- 156 mm x 156 mm high conversion efficiency mc-Si wafer (180μm, 200 μm)
Covalent Material	- No new development plan
Space Energy	- sc-Si wafer using fixed abrasive slicing
Dai-ichi Dentsu	- mc-Si high efficiency ingot - Ingots with lowered oxygen density and carbon concentration
OSAKA Titanium technologies	- None
Ferrotec	
Shin-Etsu Chemical	
Kyocera	
SANYO Electric	

Source: answers from each company for the questionnaire by NEDO

Table 4d Plans for expansion of production capacity by silicon feedstock, ingot and wafer manufacturers for solar cells (2011)

Manufacturer	Process & Technology	Production capacity in FY 2011	Production capacity in FY 2012	Production capacity in FY 2013 onwards
Tokuyama	Polysilicon	3 000 t/yr (excl. for semiconductor)	3 000 t/yr (excl. for semiconductor)	9 200t/r in 2013 23 000t/yr in 2014
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.
Mitsubishi Materials/Mitsubishi Materials Electronic Chemicals	mc-Si ingot	0 t/yr	0 t/yr	0 t/yr
	mc-Si wafer	0 MW/yr	0 MW/yr	0 MW/yr
Japan Solar Silicon	Polysilicon for solar cell	Test Production (not disclosed)	Test Production (not disclosed)	4 500 t/yr (target year not disclosed)
NS Solar Material	Polysilicon (UMG-Si)	N.A.	Shut off the production in September 2012	
JFE Steel	mc-Si ingot			
	mc-Si wafer			
SUMCO	mc-Si wafer	400 MW/yr	300 MW/yr	Not decided
Covalent Material		N.A.	N.A.	N.A.
Space Energy	sc-Si wafer	219 MW/yr		
Dai-ichi Dentsu	Cast mc-Si ingot	330 t/yr	330 t/yr	Not decided
OSAKA Titanium technologies				
Ferrotec				
Shin-Etsu Chemical				
Kyocera				
SANYO Electric			Not disclosed	Not disclosed

Source: answers from each company for the questionnaire by NEDO

Table 4e Overseas Business Development by manufacturers (2011)

Manufacturer	Business activities
Tokuyama	- Polysilicon production plant is under construction in Sarawak, Malaysia. The first-phase plant will start commercial production in June 2013 with production capacity of 6 200t/yr. The second-phase plant will start commercial production in April 2014 with production capacity of 13 800t/yr
M.SETEK	- AU Optronics (AUO), the parent company, constructs sc-Si ingot plant in Taiwan.
Mitsubishi Materials	N.A.
Japan Solar Silicon	- None
NS Solar Material	N.A.
JFE Steel	
SUMCO	- Nothing special
Covalent Material	- No overseas business for wafers
Space Energy	- Nothing special
Mitsubishi Materials Electronic Chemicals	- None
Dai-ichi Dentsu	- Sales of wafers
OSAKA Titanium technologies	- None
Ferrotec	
Shin-Etsu Chemical	
Kyocera	
SANYO Electric	- Ingot/wafer production in Oregon, USA

Source: answers from each company for the questionnaire by NEDO

3.2 Production of photovoltaic cells and modules

In 2011, 13 companies were listed as PV cell/ module manufacturers: Sharp, Kyocera, SANYO Electric (current name is Panasonic by M&A), Mitsubishi Electric (MELCO), Kaneka, Mitsubishi Heavy Industries (MHI), 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 type c-Si solar cells and thin-film Si PV modules. Kaneka and MHI manufacture tandem type a-Si PV modules, Fuji Electric manufactures flexible a-Si PV modules, Honda Soltec manufactures CIGS PV modules and Solar Frontier manufactures CIS PV modules, and Clean Venture 21 manufactures spherical Si solar cells. PVG Solutions and Hi-nergy independently developed bifacial c-Si solar cells, and Choshu Industry also independently developed c-Si solar cells and entered the PV industry. Manufacturers specialized in PV modules are Suntech Power Japan, Fujipream, YOCASOL, Choshu Industry, K-I-S, Itogumi Motech and Towada Solar. In addition, Noritz entered the industry. 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. Furthermore, some companies have begun activities aiming to start overseas manufacturing from solar cells, with Sharp starting production of thin-film silicon PV modules in Italy through joint venture as well as Panasonic's decision to newly construct a manufacturing plant for HIT solar cells in Malaysia with a production capacity of 300 MW/year.

Table 5 shows production volumes and capacities reported by solar cell and PV module manufacturers. Table 5a shows PV module production processes of manufacturers in Japan. Table 5b shows new developments and products of PV module manufacturers in Japan. Table 5c shows plans for future expansion of cell/ module production capacity by PV manufacturers. And Table 5d shows the overseas business development by manufacturers.

Table 5 Production volumes and capacities by solar cell and PV module manufacturers (2011)

Cell/Module manufacturer	Technology [1]	Total Production (MW)		Maximum production capacity (MW/year)	
		Cell	Module	Cell	Module
Silicon wafer-based manufacturers					
Sharp	c-Si	637	927	N.A.	1 495
Kyocera [2]	mc-Si	660	660	800	800
SANYO Electric	HIT (a-Si on c-Si)	490	N.A. [3]	565	680
Mitsubishi Electric [4]	c-Si	190	190	270	270
Clean Venture 21 [5]	light-collecting spherical Si	1,0	0,5	5	2
Suntech Power Japan [6]	sc-Si	N.A.	1	N.A.	100
Fujipream	sc-Si	N.A.	4,4	N.A.	100
	mc-Si	N.A.	1,1	N.A.	100
Choshu Industry					
YOCASOL	sc-Si	N.A.	1	N.A.	60 [7]
	mc-Si	N.A.	11	N.A.	
Itogumi Motech [8]	mc-Si	N.A.	3	N.A.	20
PVG Solutions [9]	sc-Si	3,5	N.A.	15	N.A.
Towada Solar	mc-Si	N.A.	0,05	N.A.	10
Thin-film manufacturers					
Sharp	Thin film Si	220	220	N.A.	320
SANYO Electric	a-Si (for consumer use)	N.A.	5 [10]	N.A.	5
Kaneka [11]	a-Si a-Si/poly-Si hybrid	64	64	120	120
Mitsubishi Heavy Industries (MHI) [12]	Microcrystalline tandem				
	a-Si				
Fuji Electric	a-Si	5	5	24	24
Solar Frontier [13]	CIS	450	450	980	980
Honda Soltec	CIGS	5	5	27,5	27,5
YOCASOL	a-Si	N.A.	0,1	N.A.	60 [7]
Towada Solar	a-Si	N.A.	0,01	N.A.	0,2
Total		2 725,5	2 548,16	2806,5	5 113,7

[1]: c-Si:crystalline silicon ,sc-Si: single crystalline silicon, mc-Si: multicrystalline silicon, a-Si: amorphous silicon, μc-Si: microcrystalline silicon [2]: Listed production capacity is the commercial production capacity（実生産能力）, not plant facility capacity, as of the end of December. Approximately 55- 60 % of the shipping volume (MW) is for export.

[3]: Total production of modules is not disclosed. [4]: The amount is the total production and production capacity of c-Si PV cell/module. [5]: For 2011, production amount of Spherical Si was 5 MW, production capacity was 10 MW/yr. Export amount was 0,2 MW of cells and 0,1 MW of modules. [6]: Module export amount in 2011 was 0 MW.

[7]: Total production capacity is 60 MW/yr including all types of technology; sc-Si, mc-Si, and a-Si.

[8]: No export in 2011. [9]: No production (no data). [10]: All a-Si (5 MW) is for consumer products. [11]: Module export amount in 2011 was 10 MW. [12]: Listed total production and production capacity is in the period of July 2011 - December 2011. Export amount of sc-Si cell in 2011 was 0,1 MW.

[13]: Production capacity is the sum of 80 MW/yr in the first/second-phase plant and 900 MW/yr in the third-phase plant. Export amount of cells and modules in 2011 was 270 MW.

Source: answers from each company for the questionnaire by NEDO

Table 5a PV module production processes of manufacturers (2011)

Silicon wafer-based manufacturers	Description of main steps in production process
Sharp	<c-Si> - Purchase of Si feedstock → production of ingot/wafers → c-Si cells → modules - Purchase of wafers → c-Si cells → modules
Kyocera	- Purchase of feedstock → integrated manufacturing to modules
SANYO Electric	- Purchase of Si feedstock → c-Si wafers → HIT cells → modules ↑ Purchase of c-Si wafers
Mitsubishi Electric	- Purchase of c-Si wafers → c-Si cells → modules
Clean Venture 21	- Purchase of Si feedstock (Si powder) →spherical Si → spherical Si cells → micro light-collecting spherical Si solar cells → modules
Suntech Power Japan	- Purchase of sc-Si → modules
Fujipream	- Purchase of sc-Si and mc-Si cells → module production
Choshu Industry	
YOCASOL	- sc-Si/mc-Si cell → modules
Itogumi Motech	- Purchase of mc-Si cells → modules
PVG Solutions	- Purchase of sc-Si wafers → production of sc-Si cells
Towada Solar	- Purchase of mc-Si cells → module
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
Mitsubishi Heavy Industries (MHI)	
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 maerials → CIGS sub-modules → modules
Towada Solar	- Purchase of a-Si cells → modules

Source: answers from each company for the questionnaire by NEDO

Table 5b New developments and products of manufacturers (2011) (1/2)

Cell/Module manufacturer	New developments and new products
Sharp	- Sharp develops intelligent power conditioner that enables electric Vehicle batteries to be Used as storage batteries for home power (February 22, 2011) (http://sharp-world.com/corporate/news/110222.html) - Sharp to begin mass production of new single crystalline solar cells with high conversion efficiency. Production starts on new line for single crystalline solar cells at GREEN FRONT SAKAI (March 31, 2011) (http://sharp-world.com/corporate/news/110331.html) - Sharp to start evaluating Sharp Eco House, aiming to minimize energy consumption (June 8, 2011) (http://sharp-world.com/corporate/news/110608.html) - Sharp to develop “electricity visualization system” to contribute to saving electricity utilizing specialized tablet terminal and check the electricity consumption of household electrical appliance quickly (September 2, 2011) - Sharp Develops Solar Cell with World ‘s Highest conversion efficiency of 36.9 %. Achieved with triple-junction compound solar cell (November 4, 2011) (http://sharp-world.com/corporate/news/111104.html) - Sharp to start sales of back-up power supply system which enables the use of electricity even in the event of a power outage with attached storage batteries (November 17, 2011)
Kyocera	- Commercialization of power generation monitor “ECONONAVIT” - Commercialization of “ECONOROOTS ® ADVANCE” for residential application - Commercialization of new “HEYBAN” PV modules for residential application
SANYO Electric	- Upgraded output of 240/233 W modules from conventional modules
Mitsubishi Electric	<New products> - Release of “210 W monocrystalline lead-free soldered photovoltaic module series” for residential application in Japan ; Achieved high output of 210 W by thinning grid electrode and using low-reflection glass ; Upgraded installation capacity per household by providing quadrate modules (half) and trapezoid modules in addition to standard modules - Release of “full black monocrystalline PV module” for residential application in Japan ; Upgraded designing quality adopting “black” design, responding to the diversification of market demand from performance to design - Release of “high-output 250 W modules using monocrystalline half-cut cell” for public and industrial application in Japan ; Achieved high efficiency while reducing internal loss by cutting the traditional cell (156 mm x 156 mm) in half ; Enabled optimal design while upgrading the output to 250 W and constructing 10 kW system with 40 modules <Demonstration research> - Started full operation of smart grid/ smart community demonstration experimental facilities ; By installing PV systems (4 200 kW) and smart grid demonstration experimental facilities (total investment cost: 7 BJPY) in the captive factory, simulation of the environment with high penetration of renewable energy systems and verification of challenges and measures for the energy management system in whole power system are conducted
Clean Venture 21	- Commercialization and acquisition of certification of light-weight flexible PV module attached with aluminum frame - Development of wall installation style PV modules - Technology development of commercial production of Si sludge recycled spherical Si - Commercialization of PV module and AC charger system with storage batteries (1,2 kWh)
Suntech Power Japan	- Large-size multicrystalline silicon PV module for industrial application
Fujipream	- Ultralight PV module - Bifacial thin c-Si glass-glass PV module
Choshu Industry	

Source: answers from each company for the questionnaire by NEDO

Table 5b New developments and products of manufacturers (2011) (2/2)

Cell/Module manufacturer	New developments and new products
Kaneka	- Development of large-area PV modules - Technology development of glass encapsulation - Development of low-angle installation method for large-area PV modules - Development of roof rafter stopper method for decorative slates specific PV modules
Mitsubishi Heavy Industries (MHI)	
Fuji Electric	- Portable electrical power source (end article already placed on the market as client's product) - Power generating anti-grass cloth (end article already placed on the market as client's product)
Solar Frontier	- Succeeded in the production of large modules in the third-phase plant from 2011 (traditional size: 641mm x 1 235 mm → new larger size: 977 mm x 1 257 mm) - Improvement of conversion efficiency; improvement of conversion efficiency on slate (30 cm) which will be a standard for development of the end product of slate (achievement of conversion efficiency of 17.2 % (aperture area) in March 2011, 17,8 % in February 2012) - Development of "Frontier-Monitor"; development of "Frontier-Monitor" in order to support visualization and energy saving in the use of residential PV systems - Introduction of CIS PV systems in 290 gas stations owned by Showa Shell Sekiyu in the service area of Tohoku Electric Power, Tokyo Electric Power, Kansai Electric Power, and Kyushu Electric Power - Development of simple installation system for canopies of gas stations
Honda Soltec	- Development of high-efficiency CIGS thin-film PV modules (130 W modules)
YOCASOL	- Residential/roof integrated modules - BIPV modules - Carport
Itogumi Motech	- Development of large-size PV modules (modules with 60 cells (6 inches), modules with 72 cells (6 inches) - Mounting structure of PV systems for special roofs in Hokkaido from which snow does not fall down - PV system with different types of PV modules (e.g. hybrid system of modules with 54 cells and modules with 72 cells)
PVG Solutions	- Development of high-efficiency bifacial light-receiving cells
Towada Solar	- Application for TÜV certification → acquisition of certification for 32 models - Planning to apply for JET certification - Planning to apply for J-PEC certification - Modules correspondent to snow covering - Stand-alone storage system - Street lights - Amorphous modules

Source: answers from each company for the questionnaire by NEDO

Table 5c Plans for future expansion of production capacity (2011)

Manufacturer	FY 2011 (MW/yr)	FY 2012 (MW/yr)	FY 2013 onwards	Technology
Silicon wafer-based manufacturers				
Sharp [1]	1 495	1 495	Not announced	c-Si
Kyocera	800	900 - 1 000	>= 1 000 MW/yr in 2013	mc-Si
SANYO Electric	565	Not announced	Not announced	HIT (a-Si on c-Si)
Mitsubishi Electric [2]	270	270	Will be planned considering market trends	c-Si
Clean Venture 21	5	25	570 MW/yr by 2015	Spherical Si
Suntech Power Japan	N.A.	None	None	mc-Si
Fujipream	100	100	180 MW/yr by 2013	sc-Si, mc-Si
Choshu Industry				
YOCASOL [3]	60	60	100 MW/yr (will be decided considering market trends)	mc-Si
Itogumi Motech	20	20	60 MW/yr by 2013	mc-Si
PVG Solutions	15	30	No plans	sc-Si
Towada Solar	10	10	30 MW/yr by 2013	mc-Si
Thin-film manufacturers				
Sharp	320	320	Not announced	Thin film Si
SANYO Electric	5	Not announced	Not announced	a-Si
Suntech Power Japan	N.A.	N.A.	N.A.	a-Si
Kaneka	120	120	120 MW/yr	a-Si, a-Si/poly-Si hybrid
Mitsubishi Heavy Industries (MHI)	N.A.	N.A.	N.A.	
Fuji Electric	24	24	27 MW/yr by 2014	a-Si
Solar Frontier	980	980	980 [4]	CIS
Honda Soltec	27,5	27,5	30 MW/yr by FY 2013	CIGS
YOCASOL [3]	60	60	100 MW/yr (will be decided considering market trends)	a-Si
Towada Solar	0,2	0,2	0,4 MW/yr	a-Si

[1]: Production capacity of module. [2]: The amount is the production capacity of c-Si PV cell/module.
[3]: Listed amount is the total of mc-Si and a-Si. [4]: Introduction of new production facilities in Miyagi Prefecture in 2014 is under discussion and will be decided within FY 2012.

Source: answers from each company for the questionnaire by NEDO

Table 5d Overseas business activities of PV manufacturers

Manufacturer	New developments and new products
Sharp	- Sharp and Enel Green Power complete construction of power generation plant in southern Italy. (January 20, 2011) (http://sharp-world.com/corporate/news/110120.html) - U.S. and Japan companies collaborate on smart grid project in Hawaii. Hitachi to serve as project leader. (May 17, 2011) (http://sharp-world.com/corporate/news/110517.html) - Sharp begins solar maintenance business in Asia. Agreement Signed with NED to Provide Maintenance service for large solar power generation plant. (September 9, 2011) (http://sharp-world.com/corporate/news/110909.html)
Kyocera	- Passed the “Long-Term Sequential Test” of TÜV Rheinland for the first time in the world - Completed construction of module manufacturing plants in Tianjin, China - Supplied the largest PV system in Palau (226,8 kW)
SANYO Electric	- Manufacture of PV modules in plants in Mexico and Hungary with the production capacity of 390 MW/year - Manufacture of ingots and wafers in Oregon states in the USA - Construction of new plant in Malaysia - Worldwide sales activities for PV modules
Mitsubishi Electric	- Expands sales activities in Europe, the USA and Asia based on the global sales framework
Clean Venture 21	- Supported for CSP, Germany to acquire TÜV certification with light-weight flexible modules - Supplied light-weight modules for application in exhibition to GSC, Korea - Supported for a Chinese company to construct spherical Si PV module plant
Suntech Power Japan	- As the whole Suntech Power group, the shipping volume is 2 066 MW and ranked world No.1 for the second year in a row (IMS Research, April 2011, February 2012) - With thirteen sales bases in Europe, North America, Middle East, and Asia-Pacific including Japan, 13 sales bases, production bases (mainly in China) and R&D bases are present around the world
Fujipream	
Choshu Industry	
Kaneka	- Marketing activities mainly in Europe - Sales of modules - Measurement of production of electricity by Kaneka’s PV systems all over the world
Mitsubishi Heavy Industries (MHI)	
Fuji Electric	- Enhancement of sales framework
Solar Frontier	- Sales of products through overseas offices (Europe: Germany, USA: California) - Sales of products to RoW (Asia, Middle East, Oceania, etc.) - Sales of products through sales contracts with overseas system integrators
Honda Soltec	- Nothing special
YOCASOL	- Module export sales to Europe (Germany, France, Italy, etc.) - Development of roof integrated PV systems for European market
Itogumi Motech	- Nothing special
PVG Solutions	- Consulting on PV-related technology - Sales of PV-related materials
Towada Solar	- Business collaboration with overseas cell/module manufacturers

Source: answers from each company for the questionnaire by NEDO

3.3 Module prices

Table 6 shows trends of typical module prices.

Table 6 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
Price	433	436	440	402	375	335

Source: Previous Natrional Survey Report Japan, 2011 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. 14 residential PV inverter manufacturers are registered to the voluntary certification program of the Japan Electrical Safety & Environment Technology Laboratories (JET): Sharp, SANYO Electric, Mitsubishi Electric (MELCO), Omron, Panasonic, Shihen Technical, Tabuchi Electric, IDEC, Diamond Electric Mfg., LS Industrial Systems, Hyundai Heavy Industries, West Holdings (Ablerex Electronics), SAMHWA and SMA Solar Technology. Five companies, namely LS Industrial Systems, Hyundai Heavy Industries, Ablerex Electronics, SAMHWA and SMA Solar Technology, are non-Japanese manufacturers registered to the JET certification program. As a non-Asian company, SMA is registered for the first time. 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 promoted. Certification program for residential PV inverters has started shifting to be applicable to multiple grid-interconnection for PV systems, and Omron acquired the certification for PV inverters for multiple grid-interconnection. 10 to 13 000-kW PV systems have been installed in 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 promoted, 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 Systems and Daihen entered this area. Currently in Japan, functions of inverters for public and industrial applications including parallel operation, 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.

With the launch of the new Feed-in Tariff program to be enforced on July, 1, 2012, production of inverters is expected to increase. 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 7 shows the prices of inverters for grid-connected PV systems.

Table 7 Price of inverter for grid-connected PV application (average price per kVA in JPY)

Size of inverter	FY 2009	FY 2010	FY 2011
10 - 100 kVA	93 600	89 000	82 000
> 100 kVA	83 600	79 000	68 000

Source: Previous Natrional Survey Report Japan, 2011 figure : RTS Corporation

3.5 System prices

Table 8 shows typical applications and prices of PV systems by category. Table 8a 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 8 Turnkey prices of typical applications (FY 2011)

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.	521 JPY/W
Grid-connected > 10 kW	Plants, warehouses, commercial buildings, large-scale public facilities, road facilities, railway facilities, etc.	518 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, 2011 figure : RTS Corporation

Table 8a 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
Public & Industrial (>10 kW)	802	640	534	547	576	518
Residential (3 - 5 kW)	683	696	715	613	565	521

Source: Previous Natrional Survey Report Japan, 2011 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 9 000

c) All other, including those within electric utilities, installation companies, etc.: about 35 000

Table 9 Estimated PV-related labor places in 2011

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. 9 000
Distributors of PV products	
System and installation companies	
Utilities and government	
Others	ca. 35 000
Total	ca. 45 000

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

3.7 Business value

Table 10 shows business value of the domestic market of PV systems.

Table 10 Business value of PV system market **(BJPY)**

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

* 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 2011. A program to purchase surplus PV power at preferential rates as well as support through a taxation system were also continued. Table 11 shows support measures and schemes for dissemination of PV systems implemented in 2011.

Table 11 PV support measures in 2011 (1/2)

	Ongoing measures	Measures that commenced in 2011
Enhanced feed-in tariffs	- Established the "Act on the Promotion of the Use of Nonfossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers" and enacted a scheme which obligates utilities to purchase surplus PV power in November 2009	- As the "Bill on Special Measures Concerning Procurement of Renewable Energy Sourced Electricity by Electric Utilities" was enacted in August 2011, a Feed-in Tariff (FIT) program for renewable energy is scheduled to be enforced in July 2012.
Direct subsidy	- "Subsidy for measures to support introduction of residential PV systems" by METI - 875 local governments implement their own subsidy programs	-
Green Power schemes	- Utilities (Green Power Fund, all over Japan)	- It was announced that Green Power schemes will be terminated at the start of the FIT program.
PV-specific green electricity schemes	-	-
Renewable portfolio standards (RPS)	- Implemented by the national government, setting a target amount of new and renewable energy use in FY 2014 at 16 billion kWh	-
PV requirements in RPS	- No requirements for PV, but implemented a preferential treatment which double-counts the amount of RPS-equivalent electricity for PV power	-
Funds for investment in PV	-	- Some financial institutions announced plans to establish investment funds for large-scale PV power plants in preparation for taking advantage of the FIT program.

Source: METI, J-PEC, etc.

Table 10 PV support measures in 2011 (2/2)

	Ongoing measures	Measures that commenced in 2011
Tax credits	Residential PV systems - Tax credit for energy conservation refurbishment for individuals without mortgage: reduction of 10 % of cost from income tax is applicable for the maximum installation cost of 3 MJPY to install residential PV systems Non-residential PV systems - For the installation of PV systems, standard taxable value for fixed property tax will be reduced to seven-eighths (7/8) for three years. For PV systems installed with the subsidy of the national government, the value will be reduced to two-thirds (2/3) for three years. - Tax reduction for green investment: Small- and medium-sized enterprises (SMEs) who install PV systems are eligible for special tax deduction (7 %) or special depreciation (30 %) - Special depreciation or special deduction of corporate tax (income tax) for acquiring facilities to promote innovation of energy demand supply-structure (Taxation to promote innovation of energy supply-demand structure, national tax): Special depreciation for 30 % of the basis of the acquisition cost or tax reduction of 7 % of the basis of the acquisition cost (for SME only), or 100 % immediate depreciation.	-
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	- Introduction of PV systems to public and welfare facilities by Green Power Fund - 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 note.

4.1 Indirect policy issues

a) International policies influencing the use of PV systems

Based on the Cancun Agreements of the sixteenth session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP16) which took place from November 29 to December 10, 2010 in Cancun, Mexico, 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. On the occasion of the seventeenth session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP17) which was held in November 2011, the Japanese government announced “Japan’s Vision and Actions toward Low-Carbon Growth and Climate-Resilient World”. This vision represents Japan’s recognition that, in order to effectively address global warming, developed and developing nations must join hands to promote low-carbon growth of the world as a whole, in addition to the establishment of a comprehensive international framework. With the vision, Japan will take initiative in implementing measures to tackle global warming and encourage the global society to join the efforts through the following three approaches: 1) efforts to achieve innovation for further reduction of greenhouse gas emissions; 2) dissemination and promotion of low-carbon technologies as well as establishment of a new market mechanism and 3) considerations of fragile states. Japan presented its stance that it will continue actively contributing to achieving the low-carbon growth of the world by utilizing all the possible measures including technology, market and funds.

b) Favorable environmental laws and regulations

The Ministry of Economy, Trade and Industry (METI) excluded PV systems from the power generation facilities which are governed by the Factory Location Act. This eliminated some regulations for PV systems and PV power generation facilities can be treated as environmental facilities under this act.

METI defined PV systems with the capacity of below 50 kW (formerly below 20 kW) which are connected to low-voltage grids as general electrical facilities. Under this eased the regulations and assignment of senior electricians for operation and maintenance and notification of safety documents are not required.

Act on the Rational Use of Energy (Energy Saving Act) requires notification of energy-saving measures introduced to buildings at the time of new construction and renovation. Buildings in the size larger than a certain level are required to report the amount of energy use on a regular basis. As the efficiency in energy usage must be improved, installations of PV systems which contribute to reducing the use of electricity are effective. In a bill concerning energy conservation which is currently under study for revision, it has been discussed to count the amount of peak time electricity usage 1.5 times larger than the actual amount. Since the electricity peak time is in the daytime in summer in Japan, it is expected that installations of PV systems will be beneficial.

For housing, energy conservation standards are set and when a house meets above the standards by a certain margin through such measures as installation of a PV system, there are preferential treatments such as additional reduction of tax on mortgages. Establishment of a system to certify energy-saving performances is also planned. Furthermore, establishment of next-generation energy conservation standards is discussed, under which newly-built houses might be obliged to conform to the standards.

Besides, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) sent a notice regarding the handling of PV facilities under the Building Standards Law titled “excluding PV systems from the regulation on the height under the Building Standards Law” to managers of prefectural governments in charge of construction administration and the regulation on the height of PV systems was eased.

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, power generation costs of various power sources were estimated in two time frames, as of 2010 and as of 2030. In the calculation, social costs of various power sources were estimated as they are essential for formulating an energy strategy after the nuclear power plant failures in Fukushima Prefecture in March 2011. External costs such as a cost to reduce CO_2 emissions are not included. All the calculation bases were disclosed and comments from various sectors were taken into consideration for making the estimate.

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

The Ministry of the Environment (MoE) is taking the initiative in studying introduction of the Environmental Tax. At the Cabinet meeting held on December 16, 2010, it was approved that the introduction of “the tax addressing global warming” would be included in a large package of tax revisions for FY 2011. Accordingly, the Tax Research Commission of the national government agreed to introduce the tax addressing global warming (“Environmental Tax”) from October 2011. However, the tax was not introduced in the tax revision in FY 2011 due to objections by the opposition parties. The national government aims to introduce the tax in the tax revision in FY 2012. The Environmental Tax is planned to be added on to the petroleum and coal tax imposed on petroleum and other fossil fuels which emit CO_2, effective in October 2012. While corporations will be responsible for tax payments, it is assumed that the tax burden will be passed on to consumers through the increases in gasoline prices. It is stipulated that revenues from the Environmental Tax will be used for curbing CO_2 emissions including measures to disseminate PV power generation. However, specific measures have not been announced and effects of the Environmental Tax on the dissemination of PV systems are unknown at this moment.

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, PV power generation is potentially a promising energy technology option for emissions trading through the mechanisms of the Kyoto Protocol such as CDM (Clean Development Mechanism) and JI (Joint Implementation). In the non-IEA PVPS countries, the following PV-related projects are conducted by the New Energy and Industrial Technology Development Organization (NEDO).

- Smart Community demonstration research project in India: This project was agreed in a Japan-India 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 China: A demonstrative research on Smart Community started in GongQing City, Jiangxi Province, China. In small- and medium-sized cities in inland China where the population has been rapidly increasing, this project 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. Total budget for the project is approximately 3 BJPY for the scheduled project period from FY 2011 to FY 2013.
- Smart Community Demonstration Project in an Industrial Complex in Java Island, Indonesia: 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. Under the plan, total 2 000 MW of solar power generation facilities will be installed 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 2011, JICA installed PV systems in Egypt 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

In November 2009, “Program to purchase surplus PV power” started and surplus power generated from PV systems with the capacity of below 500 kW has been purchased at fixed rates. Also, Feed-in Tariff (FIT) program for renewable energy is scheduled to be enforced by the national government in July 2012. Under the FIT program, surplus power generated from PV systems with the capacity of below 10 kW will be purchased while 100 % of electricity generated from those with the capacity of 10 kW or larger will be purchased. Utilities’ voluntary programs to purchase surplus PV power until October 2009 were replaced by the national program. Also, some utilities terminated the “Green Power Fund” as the FIT program will be enforced.

Electric utilities established the “Green Power Fund” in October 2000 to promote the dissemination of natural energy. They contribute to the fund the same amount as the total sum collected on the basis of 500 JPY/month per share from their customers who support the purpose of the Green Power Fund. The fund is managed as a financial source to install PV and wind power generation systems. Over the period between FY 2001 and FY 2011, the fund supported PV installations at 1 724 places nationwide, with a total capacity of 29 706,7 kW, mainly at public facilities such as schools and hospitals. In FY 2011, 151 places with a total capacity of 2 005,9 kW were selected as the installation sites.

Furthermore, electric utilities purchased the required amounts of electricity generated from new and renewable energy in FY 2010, based on the Renewable portfolio standards (RPS) Law that was enforced in FY 2003, while strengthening their efforts to expand the use of new and renewable energy in order to achieve the required purchase amounts set for FY 2011. The usage of electricity generated from new and renewable energy by utilities in FY 2010 was 10 246,0 TWh in total, including 16,6 TWh by PV systems which achieved the required amount, and 1 336,9 TWh from specific PV power plants (facilities qualified for the “Surplus PV Power Purchase Program”) which is not counted as the required amount.

The accredited facilities for power generation using new and renewable energy were 720 587 systems totaling 7 594,9 MW on a cumulative basis, of which 114 systems were PV systems totaling 49,718 MW. There were 719 188 specific PV systems totaling 2 728 MW.

Furthermore, 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. In FY 2011, total 11 PV power plants with a total capacity of 56 MW started operation.

4.3 Interest from municipalities and local governments

An increasing number of local governments (prefectures) and municipalities are actively addressing environmental issues year after year. As of December 16, 2011, 875 local governments and municipalities have implemented subsidy programs to support installation of residential PV systems. Among them, Hokkaido, Saitama and Aichi prefectures have larger

numbers of municipalities conducting such subsidy programs, with 53 municipalities, 52 and 49, respectively. Majority of municipalities provide the subsidy ranging from 20 000 JPY/kW to 50 000 JPY/kW.

Tokyo Metropolitan Government (TMG) set a target of reducing CO_2 emissions by 25 % by 2020 from the 2000 levels in its plan so-called “Tokyo in 10 years”. TMG announced its plan to introduce 1 GW of solar energy and decided to provide a subsidy of 100 000 JPY/kW in FY 2009 and FY 2010. TMG continued this subsidy in FY 2011 with the same grant amount in support of securing electricity after the Great East Japan Earthquake in March 2011.

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 12. 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.

(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. Certification is made through product model certification and annual investigation of factories. Labels will be issued for the products 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 2012, 4 286 models of PV modules from 39 manufacturers have been certified and registered.

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 March 30, 2012, 355 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. Related standards are currently under formulation. As of March 30, 2012, 29 models of inverters by 1 manufacturer have been certified and registered.

Table 12 Standardization Framework for PV Systems (1/2)

Category			JIS No.	Title	Remark
Terms and symbols			C 0617	Graphical symbols for diagrams	
			C 8960; 2004	Glossary of terms for photovoltaic power generation (incl. solar cells)	Revised in 2011
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	Electromagnetic compatibility testing and measuring procedure of power conditioner for photovoltaic systems	Published in 2010
Solar Cell	Crystalline Solar Cell	Reference	C 8910; 2005	Primary reference solar cells	
			C 8904-2;2011	Requirements for reference solar devices	Formulated in 2011
			C 8904-3;2011	Measurement principles for photovoltaic(PV) solar devices with reference spectral irradiance data	Formulated in 2011
		Solar simulator	C 8912; 2005	Solar simulators for crystalline solar cells and modules	
		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;2011	Requirements for reference solar devices	Formulated in 2011
			C 8904-3;2011	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
	Other types of solar cells	Other types of solar cells	C 8904-7;2011	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	

Source: The Japan Electrical Manufacturers' Association (JEMA)

Table 12 Standardization Framework for PV Systems (2/2)

Category		JIS No.	Title	Remark
Modules		C 8992-1;2010	Confirmation of safety eligibility of PV modules - No. 1: Requirements for structure	Formulated in 2010
		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
Other		C 8904-3;2011	Measurement principles for photovoltaic(PV) solar devices with reference spectral irradiance data	Formulated in 2011
		-	Method to establish traceability of reference cells	Under discussion
		C 8904-7;2011	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
		-	Environment-friendly design of power conditioner for small photovoltaic power generating systems	Under discussion
		-	Method of testing anti-islanding operation of power conditioners for grid-connected PV systems	Formulated in 2010
		-	Safety of power conditioner for photovoltaic power generating systems No. 1: General requirements	Under discussion
		-	Safety standards of power conditioners	Under discussion
	Terminal box	JEM	Relay terminal box for PV systems	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

In 2011, Japan's PV installed capacity reached 1 GW annually, driven by the program to purchase surplus PV power and subsidies for residential PV systems. As the Law on Special Measures Concerning Procurement of Renewable Energy Sourced Electricity by Electric Utilities ("the Renewable Energy Law") was enacted in August 2011, the PV market in Japan made a significant step in 2011 toward a full-fledged dissemination of PV systems. Meanwhile, Japanese PV manufacturers were facing a tough business environment amid stricter-ever competitions in the global PV market, influenced by progressing yen's appreciation, significant price reduction of PV products globally, full-fledged entries by overseas manufacturers, mainly emerging manufacturers into the Japanese market. The Japanese PV manufacturers sought for a new business development in 2011.

In the aftermath of Tokyo Electric Power Company (TEPCO)'s Fukushima No. 1 Nuclear Power Plant failures following the Great East Japan Earthquake, the Energy and Environment Council of the national government started reviewing Japan's energy strategy. The review focuses on reducing dependence on nuclear power generation and expansion of energy conservation and the use of renewable energy. The council decided a basic direction of the strategy in preparation for formulating "Innovative Energy and Environment Strategy" scheduled in the summer of 2012. Furthermore, in August 2011, the government enacted the Renewable Energy Law for which preparations had been made since 2009. With the enactment of the law, Japan's Feed-in Tariff (FIT) program is scheduled to be enforced in July 2012.

The Ministry of Economy, Trade and Industry (METI), coupled with the Energy and Environment Council, thoroughly reviewed the current Basic Energy Plan which was amended in June 2010 and started formulating a new basic energy plan covering a new energy mix and measures to realize it. Regarding dissemination of residential PV systems, METI secured 119,4 BJPY in the FY 2011 Third Supplementary Budget and decided to continue the current subsidy program for residential PV systems until FY 2013.

An increasing number of local governments provided subsidy for residential PV systems in conjunction with the national subsidy program. Total 875 municipalities had the subsidy program as of December 16, 2011. In expectation for the enforcement of the FIT program in July 2012, some local authorities started construction of MW-scale PV power plants. They disclosed candidate sites for these large-scale PV power plants one after another. Those with their own support programs for PV systems are on the rise.

Electric utilities constructed MW-scale PV power plants ahead of schedule and a great number of such PV power plants were completed in 2011 across the nation, from Hokkaido to Okinawa. Some utilities started on-site PV power generation business through their subsidiaries, by installing PV systems on the rooftops of properties owned by their customers.

The Japanese PV industry faced a severe business environment caused by long-lasting extraordinary yen's appreciation, substantial declines in prices of PV products, as well as intensifying competitions with emerging non-Japanese manufacturers. Meanwhile, with the rapid expansion of domestic PV market mainly driven by the residential PV market as well as non-residential PV market which is expected to expand in 2012, many companies reviewed their PV business and many others entered the PV market.

In the area of manufacturing PV products, manufacturers focused on the domestic PV market and advanced their own business development through enhancement of production capacity, manufacturing of high-efficiency PV products and cultivation of non-residential PV market, while facing a fierce international competition. In the area of manufacturing PV components, some manufacturers enhanced their production capacity of backsheets, encapsulants and other PV components, promoted construction of overseas manufacturing plants as they positioned the market to continue growing on a mid- to long-term basis. There were also a number of new

entrants and introduction of novel materials was advanced.

In the area of manufacturing PV systems, some power source suppliers entered markets of large-sized power conditioners and storage batteries. Others from various industries entered the power generation business with MW-scale PV power plants. Metal and steel manufacturers entered the business of manufacturing supporting structures for MW-scale PV power plants. Some heavy electric machinery manufacturers entered the smart city business home and abroad.

In the area of distribution of PV systems, more companies introduced PV systems in their business in various industries from housing, construction and real estate, sales and installation, as well as leasing industries against the backdrop of lowering prices of PV systems and power shortage.

In the housing industry, an increasing number of manufacturers from major prefabricated housing manufacturers to local house builders installed PV systems in newly-built houses for sale as standard equipment. Ratio of PV system installation and installed capacity increased. Furthermore, development of smart houses has been accelerated. These houses are equipped with storage batteries and HEMS and will possibly be energy self-sufficient. In the construction and real estate industry, installation of PV systems in condominiums increased. In the sales and installation industry, more distributors such as large-scale electric appliances stores, major supermarkets and mail order businesses entered the PV business, in addition to local electric appliances stores which have been organized by PV manufacturers. Sales of residential PV systems were put the strong focus as the major product and promoted. In these industries, companies are expanding business across the nation through partnerships with PV manufacturers and local installers. A new distribution channel that enables mass sales of PV systems was established.

With subsidy programs for residential PV systems by the national government and local authorities, a program to purchase surplus PV electricity as well as reduction of prices of PV systems, individuals are increasing their interest in installing PV systems at their homes. Moreover, efforts to deal with power shortage and disaster prevention measures after the nuclear power plant failures accelerated interest in installing PV systems not only by individuals but also by municipalities and industries. PV installation in public, industrial and commercial facilities as well as power generation facilities is about to expand.

5.2 Prospects

Following the nuclear power plant failures after the Great East Japan Earthquake in March 2011, the Japanese government started formulating a new energy strategy from scratch. The new energy strategy aims to focus on expanding the use of renewable energy and strengthening the energy-saving society, while reducing dependence on nuclear power generation. In 2012, a new strategy called “Innovative Energy and Environment Strategy” is scheduled to be formulated. Consequently, target installed capacity of renewable energy will be revised and reestablished.

With the start of the Feed-in Tariff (FIT) program scheduled to be enforced in July 2012 based on the Renewable Energy Law, the Japanese PV market is expected to be accelerated toward a full-scale dissemination of PV systems. With the FIT program initiated, non-residential PV markets such as public, industrial and commercial markets as well as power generation market will be newly established. Combined with the main residential PV market, these markets will contribute to creating a well-balanced GW-level PV market.

For the entire electricity generated by PV systems with the capacity of 10 kW or larger, the feed-in tariff is expected to be 42 JPY/kWh including consumption tax for the period of 20 years. For PV systems with the capacity of below 10 kW, surplus electricity will be purchased at 42 JPY/kWh including consumption tax for the period of 10 years. These tariffs will be set as they are considered to be profitable. It is expected that the FIT program will bring about new business opportunities along with the increase in installation of PV systems. As the commercial and industrial PV markets expand on top of the residential PV market, Japan’s industrial structure surrounding PV power generation will be expanded and enhanced. A large number of PV-related

industries will join the used-to-be limited market including BOS industry covering large-capacity inverters, components industry including supporting structures, as well as electric facilities and construction industries in charge of design and installation of PV systems. Japan's PV industry is assumed to grow differently from the past, from a subsidy-based to a FIT-based growth. It is expected to broaden its horizon while creating employment and will be further developed into a new industry as one of the integral parts of the energy industry. Against the backdrop of power outage following the suspension of nuclear power plants across the nation, movement toward increasing electric bills, heightening demand for clean energy and accelerating price reduction of PV systems, individuals, private entities, local governments and municipalities are getting more eager to install PV systems. It is also expected that the PV market will be expanded from the users' side through the increased installations.

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: 17,87 JPY/kWh
  120 - 300 kWh/month: 22,86 JPY/kWh
  > 300 kW/month: 24,13 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,) April 1, 2009)
- Commercial: 13,75 JPY/kWh (summer,) 12,65 JPY/kWh (other seasons) (high-voltage, business use) (Source: Tokyo Electric Power Co., Inc. (TEPCO,) April 1, 2008)
- Industrial: high-voltage, ≥ 500 kW : 12,44 JPY/kWh (summer,) 11,47 JPY/kWh (other seasons)
- Industrial: high-voltage, < 500 kW : 13,59 JPY/kWh (summer,) 12,51 JPY/kWh (other seasons)

  (Source: Tokyo Electric Power Co., Inc. (TEPCO,) April 1, 2008)

2) Typical household electricity consumption

283,6 kWh/month (FY 2009 average)

(Source: The Federation of Electric Power Companies of Japan, Graphical and Flip-chart of Nuclear & Energy Related Topics 2011)

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

- 5,496 MJPY (2010)

(Source: The National Livelihood Survey, The Ministry of Health, Labour and Welfare, according to the survey conducted in 2010)

5) Typical mortgage interest rate

- 2,88 to 3,37% (minimum rate and maximum rate from January to December 2011, 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: 153.3 - 163.5 JPY/liter (FY 2011, including 5% consumption tax)
- Regular gasoline: 142.5 - 157.6 JPY/liter (FY 2011, including 5% consumption tax)
- Diesel oil: 122.8 - 136.6 JPY/liter (FY 2011, including 5% consumption tax)

(Source: The Oil Information Center)

9) Typical values of kWh/kW for PV systems

1 000 to 1 100 kWh/kW/year

Annex B: Table 1 Summary of major projects, demonstration and field test programs (1/3)

Project name	Project for Promoting the Local Introduction of New Energy (FY 1997 -)				
Technical data/ Economic data	Objectives	Main accomplishments by the end of FY 2011/ problems and lessons learned	Funding	Project Management	Remarks
- New energy in general - Eligible PV systems: grid-connected (≥ 10 kW) - Subsidy for PV: up to half of the PV installation cost: the lower amount of either up to half of the installation cost or 400 000 JPY/kW, maximum amount of 1 BJPY/ system - Eligible: Local governments, Non-profit organizations (NPOs,) private institutions who are engaged in projects for local production and local consumption of new and renewable energy in collaboration with local authorities	- Enhancement of promotion of new and renewable energy to public facilities - Education and promotion of new and renewable energy to local residents	- FY 1998 - FY 2003: 148 PV systems (18 296 kW) were installed - FY 2004: 45 PV systems (3 433 kW) out of 71 qualified systems - FY 2005: 33 PV systems (870 kW) out of 103 qualified systems - FY 2006: 35 PV systems (1 078,8 kW) out of 111 qualified systems - FY 2007: 49 PV systems (945,4 kW) out of 119 qualified systems - FY 2008: 121 PV systems (3 117 kW) out of 229 qualified systems - FY 2009: 547 PV systems (73 480 kW) out of 676 qualified systems, including continued projects - FY 2010: 354 PV systems (14 527 kW) out of 397 qualified systems - FY 2011: 4 PV systems (41 009 kW) out of 23 qualified systems (all projects are continued) - 1 300 PV systems totaling 115 MW will be installed from the initiation of the project until FY 2013. - Planned installation of multiple numbers of PV systems in local governmental offices, schools, libraries, water purification plants, kindergartens etc., which NPOs operate, as well as factories and large-scale PV power plants engaged in local production/ consumption of new and renewable energy became available. - Installation of larger-scale PV systems with more than 100 kW output became available.	- ANRE[1], METI[2] - Budget: FY 1997: 2 430 MJPY FY 1998: 4 380 MJPY FY 1999: 6 760 MJPY FY 2000: 6 430 MJPY FY 2001: 11 502 MJPY FY 2002: 12 702 MJPY FY 2003: 12 710 MJPY FY 2004: 11 031 MJPY FY 2005: 7 602 MJPY FY 2006: 5 181 MJPY FY 2007: 4 500 MJPY FY 2008: 4 151 MJPY FY 2009: 22 370 MJPY FY 2010: 34 480 MJPY FY 2011: included number of 13 000 MJPY	- ANRE (FY 1997) - NEDO[3] (- FY 2008) - NEPC[4] (FY 2009 -)	Total budget from FY 1997 to FY 2009 is 111 749 MJPY, included number of 34 480 MJPY for FY 2010 would be added.

[1] : Agency for Natural Resources and Energy (ANRE), [2]: Ministry of Economy, Trade and Industry (METI),[3]: New Energy and Industrial Technology Development Organization (NEDO), [4] : NEPC: New Energy Promotion Council

Annex B: Table 1 Summary of major projects, demonstration and field test programs (2/3)

Project name	Project for Supporting New Energy Operators (FY 1997 -)				
Technical data/ Economic data	Objectives	Main accomplishments by the end of FY 2011/ problems and lessons learned	Funding	Project Management	Remarks
- New energy in general - Eligible PV systems: grid-connected (≥ 50 kW) (≥ 10 kW PV systems are also eligible in case of installation of multiple types of new and renewable energy systems) - Subsidy: Up to one-third of installation cost (for PV systems, the lower amount of either up to one-third of installation cost or 250 000 JPY/kW,) maximum 1 BJPY/ system - Object person: private business	- Support for private businesses who introduce new and renewable energy - Encouragement of introduction of new and renewable energy by private businesses	- FY 1997 - FY 2002: 4 PV systems out of 135 qualified systems were installed at a commercial building (118 kW) and a distribution center (100 kW) and others - FY 2003: 2 PV systems out of 39 qualified systems were installed at a factory (200 kW) and a wind power plant (17 kW) - FY 2004: 3 PV systems out of 67 qualified systems were installed at a wind farm (10,8 kW,) a factory (70 kW) and a condominium (66,5 kW) - FY 2005: 3 PV systems out of 90 qualified systems were installed at a golf course and a wind farm - FY 2006: 2 PV systems out of 54 qualified systems - FY 2007: 3 PV systems out of 51 qualified systems - FY 2008: 162 PV systems out of 211 qualified systems - FY 2009: 561 PV systems (52 139 kW) out of 660 qualified systems, including continued projects - FY 2010: 401 PV systems(22 258 kW) out of 422 qualified systems - FY 2011: 5 PV systems(11 110 kW) out of 27 qualified systems (all projects are continued)	- ANRE, METI - Budget: FY 1997: 1 123 MJPY FY 1998: 5 393 MJPY FY 1999: 10 340 MJPY FY 2000: 11 490 MJPY FY 2001: 14 040 MJPY FY 2002: 23 618 MJPY FY 2003: 38 818 MJPY FY 2004: 48 255 MJPY FY 2005: 34 504 MJPY FY 2006: 35 272 MJPY FY 2007: 31 600 MJPY FY 2008: 33 580 MJPY FY 2009: 30 070 MJPY FY 2010: 34 480 MJPY FY 2011: included number of 13 000 MJPY	- NEDO (- FY 2002) - METI (FY 2003 -) - METI, NEDO (FY 2007 -) - NEPC, NEDO (FY 2009 -) - NEPC (FY 2010)	- The total budget between FY 1997 and FY 2009: 318 103 MJPY, included number of 34 480 MJPY for FY 2010 would be added. - NEDO implemented 90% debt guarantee until FY 2009

Annex B: Table 1 Summary of major projects, demonstration and field test programs (3/3)

Project name	Eco-school Model Promotion Pilot Project (FY 1997 - FY 2011)				
Technical data/ Economic data	Objectives	Main accomplishments by the end of FY 2011/ problems and lessons learned	Funding	Project Management	Remarks
- Schools using new and renewable energy (PV, solar thermal, etc.,) energy efficient schools, etc. - Eligible energy: All sources of new and renewable energy including PV - Subsidy: Expenses for investigation of basic planning: fixed cost (subsidized by MEXT) (METI's subsidy is available for installation cost of PV systems) - Eligible: Local governments and municipalities	- Demonstration and promotion of environment-friendly school facilities - Environmental education to students	- FY 1997 - FY 2004: PV systems were qualified to 284 schools - FY 2005: PV systems were qualified to 59 schools - FY 2006: PV systems were qualified to 45 schools - FY 2007: PV systems were qualified to 52 schools - FY 2008: PV systems were qualified to 69 schools - FY 2009: PV systems were qualified to 114 schools - FY 2010: PV systems were qualified to 133 schools - FY 2011: PV systems were qualified to 62 schools - FY 1997- FY 2011: PV systems were qualified to a total of 818 schools - A larger number of schools introduced PV systems and more students understand PV systems. - Environmental education was implemented and enhanced.	- METI: METI's subsidy is available for PV systems installed under Eco-School Promotion Pilot Model Project (Reference) - Budget of MEXT: Expenses for investigation of basic planning FY 1998: 28 MJPY FY 1999: 28 MJPY FY 2000: 28 MJPY	- MEXT[5] - ANRE, METI - MAFF[6] - MoE[7]	- Under FY 1998 supplementary budget, PV systems with total capacity of 3 590 kW were installed at 250 locations of 85 schools by MEXT (national universities, high/ junior high and elementary schools.) - MEXT announced a 3-year plan to install PV systems at 12 000 public elementary/ junior high schools nationwide under the School New Deal initiative formulated in 2009 - Under the initiative, PV introduction for public schools is conducted besides motel projects - As Eco-Campus Project, Environment-friendly school facilities by private schools (school corporations) will also be supported as part of the initiative.

[5]: MEXT: Ministry of Education, Culture, Sports, Science and Technology [6] : MAFF: Ministry of Agriculture, Forestry and Fisheries [7] : MoE: Ministry of the Environment