International Energy Agency
CO-OPERATIVE PROGRAM ON PHOTOVOLTAIC POWER SYSTEMS

Task 1
Exchange and dissemination of information on PV power systems

National Survey Report of PV Power Applications in Japan 2010

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Definitions, Symbols and Abbreviations

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

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

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m^2, cell junction temperature of 25^{o}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.

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 systems 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) 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, usually at a premium price
PV-specific green electricity schemes	allows customers to purchase green electricity based on PV electricity from the electricity utility, usually at a premium price
Renewable portfolio standards (RPS)	a mandated requirement that the electricity utility (often the electricity retailer) source a portion of their electricity supplies from renewable energies (usually characterized by a broad, least-cost approach favouring hydro, wind and biomass)
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	in effect the system owner receives retail value for any excess electricity fed into the grid, as recorded by a bi-directional electricity meter and netted over the billing period
Net billing	the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity fed into the grid is valued at a given price
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 2010. 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 2010, as described below, the movement for dissemination of photovolatic power generation has extended. The domestic PV market has grown to the level of close 1/GW of annual installed capacity completely, getting out of the sluggish situation, thanks to the subsidy program for residential PV systems and the start of a new program to purchase surplus PV power based upon the Act on the Promotion of the Use of Nonfossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers.

1) The government established “New Growth Strategy” and “Basic Energy Plan” through the cabinet decision and showed its commitment to putting more emphasis on dissemination of renewable energy
2) The Ministry of Economy, Trade and Industry (METI) plotted out the detailed design of “Gross feed-in tariff program for renewable energy (feed in tariff for entire generated power)” and finished preparations of diet proposal for legislation and increased the budget for the subsidy program for residential PV systems (Subsidy for Installation of Residential Photovoltaic Systems) in order to achieve full-scale dissemination of renewable energy
3) From FY 2010, the New Energy and Industrial Technology Development Organization (NEDO) started a 5-year technological development project titled “R&D of High Performance PV Generation System for the Future” based on the technological development roadmap, PV2010+
4) Over 600 local governments and municipalities implemented their own financial incentive programs to promote dissemination of residential PV systems in conjunction with the national subsidy program for relevant PV systems by METI
5) Japan Photovoltaic Energy Association (JPEA), a PV industrial association, has published “PV OUTLOOK 2030,” as a guideline for the Japanese PV industry, in which a new vision towards 2030 has been formulated
6) Utilities started construction of MW-scale PV power plants across the country. Operation of 100-MW level PV power plants will be started by 2012
7) Growth of the Japanese PV industry has been led by residential PV system market, and along with the expansion of the residential market, many overseas manufacturers entered to the Japanese market, while the emergence of new distribution channels such as electric appliances stores, and new markets for apartments and condominiums has taken place

Installed PV power

Total annual installed capacity of PV systems reached 990 979 kW in 2010, a 105,2% increase

from that of 2009 with 482 976 kW. Over 100% year-on-year increase has continued since 2009. This growth can be attributed to a subsidy program for residential PV systems which has been continued in FY 2010, with its start in January 2009, and a program to purchase surplus PV power, from systems with fewer than 10 kW, at a double amount of retail electricity price which has been started from November 2009.

The breakdown of PV systems installed in 2010 is 739 kW for off-grid domestic application, 3 422 kW for off-grid non-domestic application and 974 225 kW for grid-connected distributed application, mainly residential PV systems. 12 593 kW was newly installed for grid-connected centralized application by utilities and local governments. Cumulative installed capacity of PV systems in Japan in 2010 was 3 618 144 kW.

Cost and Price

In 2010, installed PV capacity significantly increased backed by the restart of a subsidy program for residential PV systems. Consequently, the prices of PV modules and residential PV systems decreased. The average price of PV modules for residential PV systems in 2010 dropped to 375 JPY/W from 402 JPY/W in 2009. Typical price of 3- to 5-kW residential PV systems largely decreased from 613 JPY/W in FY 2009 to 578 JPY/W in FY 2010. Price of PV systems with more than 10-kW generation capacity for public and industrial applications showed an increase from 547 JPY/W in FY 2009 to 615 JPY/W.

PV production

Production volume of solar cells and PV modules in Japan in 2010 increased to 2 311 MW from 1 334 MW in 2009, achieving a year-on-year increase of 73,2%. The import volume in 2010 was 125,6 MW, more than doubled 52 MW in 2009.

The breakdown of production volume was as follows: 785 652 kW of single crystalline silicon (sc-Si) solar cells,1 178 913 kW of multicrystalline silicon (mc-Si) solar cells, 269 480 kW of amorphous silicon (a-Si) solar cells and 77 339 kW of other types of 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 85%. Multicrystalline Si solar cells have been overwhelmingly dominating the solar cell market in Japan over the past 14 years, with supports from the expanding utility markets such as a market for residential application, and growth of exporting amounts. Amorphous Si PV module manufacturers are expanding production capacity to supply mainly to offshore utility markets. CIS/CIGS PV modules, for which commercial production started in 2007, are categorized in other types of solar cells.

National budgets

The national government, with the Ministry of Economy, Trade and Industry (METI) taking charge, has implemented research and development (R&D), demonstrative researches, model projects, dissemination measures and laws and regulations toward further deployment of PV systems.

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 2010. METI also supports the introduction of PV systems by local governments and private entities through “Project supporting acceleration of the local introduction of new energy.” 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.

As a prioritized policy to fully work on creating a low-carbon society, the Ministry of the Environment (MoE) promotes countermeasures for global warming. In FY 2010, MoE implemented project to purchase solar environmental values.

The budgets for major national PV programs implemented in FY 2010 are as follows;

1) Subsidy for measures to support introduction of residential PV systems: 40,15 BJPY + supplementary budget of 14,53 BJPY

2) Technology Development of Innovative Photovoltaic Power Generation: 6,38 BJPY

   - R&D for High Performance PV Generation System for the Future: 4,08 BJPY (new)

   - R&D on Innovative Solar Cells (International Research Center for Innovative Solar Cell Program): 1,9 BJPY + supplementary budget of 0,4 BJPY

3) Field Test Project on New Photovoltaic Power Generation Technology: 0,14 BJPY

4) International Cooperative Demonstration Project for Stabilized and Advanced Grid Connected PV systems: 0,208 BJPY

5) Verification of Grid Stabilization with Large-Scale PV Power Generation Systems: 0,20 BJPY

6) Development of an Electric Energy Storage System for Grid-connection with New Energy Resources: 0,80 BJPY

7) Japan-U.S. Smart Grid Collaborative Demonstration Project : 1,83 BJPY

8) Project supporting acceleration of the local introduction of new energy (New integrated program of FY 2009 Project for Supporting New Energy Operators and Project for Promoting the Local Introduction of New Energy): 34,48 BJPY

9) Project to purchase solar environmental values: 0,45 BJPY

The budgets for item 6) - 8) includes those for PV and other types of new and renewable energy.

Besides METI and MoE, 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.

In 2010, 655 local governments and municipalities have implemented their own subsidy programs for residential PV systems, their budget amounts are unknown.

2 The Implementation of PV systems

2.1 Applications for photovoltaics

The Japanese PV system 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. The PV market development has been driven by residential PV systems with a capacity of 3 - 5 kW, as well as PV systems with a capacity of 10 - 1 000 kW for public facilities, industrial and commercial facilities, and buildings. Residential PV systems account for 81,4% of grid-connected market in Japan, leading Japan's grid-connected distributed PV system market. Installations of medium and large-scale PV systems in public and industrial facilities as well as commercial buildings have been increasing, mainly with the support of the Ministry of Economy, Trade and Industry (METI). PV systems for public facilities introduced by the national and local governments account for 7,4% of the grid-connected market, while PV systems for industrial and commercial use account for 11,1%. 12 593 kW grid-connected centralized PV systems were installed and they account for 1,3% 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 2010 by sub-market. Total installed capacity in 2010 was 990 979 kW, and the annual installed capacity for each application is as follows: 739 kW for off-grid domestic PV systems, 3 422 kW for off-grid non-domestic PV systems and 986 818 kW for grid-connected distributed PV systems mainly for residential houses. In addition, 12 593 kW was installed for large-scale grid-connected centralized PV power application by utilities and local authorities.

Table 1 The installed PV power in 4 sub-markets in 2010

Sub-market/ application	Off-grid domestic	Off-grid non-domestic	Grid-connected distributed	Grid-connected centralized	Total
Installed PV power	739 kW	3 422 kW	974 225 kW	12 593 kW	990 979 kW

Table 1a PV power and the broader national energy market

Total national (or regional) PV capacity (from Table 2) as a % of total national (or regional) electricity generation capacity (2010)	New (2010) PV capacity as a % of new electricity generation capacity (2010)	Total PV energy production as a % of total energy consumption (2010)
1,54%	N.A.	0,33%

Table 2 shows cumulative installed capacity of PV systems by submarket. In 2010, total cumulative installed capacity was 3 618 144 kW. Cumulative installed capacity for each application is as follows: 3 374 kW for off-grid domestic, 95 420 kW for off-grid non-domestic, 3 496 017 kW for grid-connected distributed and 23 333 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
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
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
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
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
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

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 2010. In addition, since the government introduced a new scheme to oblige electric utilities to purchase surplus electricity generated by PV systems (below 10 kW) at a price twice as much as that of the standard electricity price in November 2009, 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. This movement has been spreading from a few major housing manufacturers to a large number of housing manufacturers as well as local housing developers. Intensive introduction of PV systems in residential estates by developers has also started. As a new movement in residential application, introduction of PV systems to collective housings has started. In the newly-built housing market, housing manufacturers are strengthening the sales and marketing of environment-friendly houses with energy saving and carbon-dioxide reducing facilities. As a result, houses equipped with PV systems as standard equipment have been promoted by the housing manufacturers. Major housing manufacturers are providing energy saving houses and environment-friendly houses equipped with PV systems. For existing homes, PV manufacturers are searching for potential customers of residential PV systems across the country by developing and organizing distribution channels through local housing contractors, electronics stores, and roof constructors. Many local authorities have been continuing subsidy programs, and individuals are able to apply for the national subsidy program and local subsidy programs at the same time.

Introduction of PV systems to public, industrial and commercial facilities has been promoted with the support of METI. PV systems for public facilities have been installed at a steady pace every year through the “Project for Promoting the Local Introduction of New Energy” and other projects. Major locations of installation include kindergartens, schools, government office buildings, hospitals, welfare facilities, libraries, parks, community centers and water purification plants, with the systems sized between 10 kW and 1 000 kW. Recently, local authorities have been active in PV system installation and they are expected to continue such efforts.

Introduction of PV systems for industrial and commercial uses has been promoted mainly by the “Project for Supporting New Energy Operators”. Size of the market for PV systems for industrial and commercial uses increased at a steady rate every year along with the increase in introduction of PV systems by companies who are proactive in tackling environmental issues. In addition to the industrial facilities such as factories, warehouses, laboratories, office buildings and commercial buildings, installation of industrial PV systems has been expanded in the following facilities in various forms: 1) agricultural facilities like agricultural greenhouses; 2) commercial facilities including shopping malls, family restaurants, large-scale retail stores; 3) railway facilities such as stations and platforms; 4) road facilities such as parking spaces, expressway toll booths and interchanges; 5) financial facilities like banks; 6) transportation facilities like logistics and distribution centers; and 7) resort facilities. Also, nationwide installation of PV systems by a company having branches and facilities all over Japan, additional installation into the same facilities, and large-scale installation of PV systems are increasing each year.

Kansai Electric Power Co., Inc. (2 850 kW), Shikoku Electric Power Co., Inc. (1 743 kW), Kyushu Electric Power Co., Inc. (3 000 kW) and Okinawa Electric Power Co., Inc. (4 000 kW) have started operation of large-scale PV power plants. Niigata Prefecture also has started the operation of a 1 000-kW PV power plant, thus installation capacity of grid-connected centralized PV systems increased greatly from 2009.

2.3 Major projects, demonstration and field test programs

Field test and dissemination programs implemented in FY 2010 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 “Eco-School Promotion Pilot Model Project” (see Annex C for details). In addition, support for disseminating PV systems and model projects of introduction of PV systems are implemented by the Ministry of the Environment (MoE) as part of the projects to reduce CO_2 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 70 000 JPY/kW for 2010, 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) Maximum nominal output of PV modules should be less than 10 kW in total
iii) Eligible PV modules must be registered as eligible models by J-PEC and have the *JET*PVm certification issued by Japan Electrical Safety & Environment Technology Laboratories (JET)
iv) The products must be not in use (used articles are not covered)
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 650 000 JPY/kW or less (excluding tax)

The number of applications for the subsidy and the installed capacity were approximately 200 000 and 774 MW, respectively in FY 2010. 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 2010, were approximately 800 000 systems and around 2.98GW.

In FY 2010, PV modules produced by 41 manufacturers have been registered as eligible models by J-PEC. This number was 28 in the previous year, and the number of registered manufacturers is increasing yearly. Of them, 12 manufacturers obtained certification from JET, 13 from TÜV Rheinland, 1 from TÜV SUD, 2 from TÜV InterCert, 2 from VDE, 5 from JET and TÜV Rheinland, 1 from JET and VDE, 1 from VDE and TÜV Rheinland, and 2 from JET, TÜV Rheinland and VDE.

(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 2010 has not changed from the previous year and are 48 JPY/kWh (almost double 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 with a capacity below 10kW and other power generation facilities, purchase price is 39 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 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 accelerating introduction of new and renewable energy by 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.

Eligible new and renewable energy sources in FY 2010 projects are PV power generation (PV output capacity of 10 kW and over, or a total of various sites is 10kW and over (provided that the average 2 kW or more for one site,) and 50 kW or more in the case of the Quota of Social System (the quota set aside for private businesses which cooperate with the local government), (the average of 10 kW or more for various sites), wind power generation, use of solar thermal energy, differential temperature energy, natural gas co-generation, fuel cells, biomass power generation, thermal utilization of biomass, biomass-derived fuel production, thermal utilization of ice and snow, hydroelectric power generation (less than 1 000 kW), geothermal power generation (only Binary-Cycle,) and microgrids (with total output capacity of 50 kW or more). Although the term of subsidy is one fiscal year in principle, the recipients of subsidy under this project are allowed to install the systems in multiple fiscal years, since new and renewable energy systems can be introduced for up to 4 years, depending on the processes and the size of the facilities installed. For FY 2010, up to half of the system installation cost (maximum subsidy of 1 BJPY/year) is subsidized for the project of new and renewable energy introduction, depending upon the status of each case. For PV systems, the lower amount of either half of the installation cost or 400 000 JPY/kW is subsidized. Recipients of the subsidy are required to report the utilization status of the systems such as generated electricity for at least 4 years after the start of the full-scale operation of the systems.

In FY 2010, 485 projects were selected including continued projects. Among them, 354 new PV-related projects were selected with total capacity of some 14 500 kW to be installed at social welfare facilities, day care centers and kindergartens, schools, hospitals, city halls, temples, water treatment facilities, office buildings, factories, distribution centers, collective housings, large-scale PV power plants developed by municipalities and utilities and so on. In terms of the system capacity, the majority of the projects had relatively smaller capacity; projects smaller than 20 kW occupied almost the half, and projects smaller than 50 kW occupied approximately 85% of the total. The accumulated capacity of PV systems selected between FY 1997 and FY 2010 is about 115 MW with around 1 300 PV systems in total.

(4) Project for 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, utilization of 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. Along with this project, “System of Debt Guarantee for the Utilization of New Energy” had guaranteed 90% of the debt, however, in FY 2010, the acceptance of new application was suspended.

Among these new and renewable energy sources, 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.

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. In FY 2010, maximum one third of the system installation cost was

subsidized (maximum subsidy of 1 BJPY/year.) For PV systems, the lower amount of either one third of the systems installation cost or 250 000 JPY/kW is subsidized. The term of a subsidized project is a single fiscal year in principle for newly selected projects in FY 2010.

In FY 2010, 494 projects were selected including continued projects. Among them, 401 new PV system projects were selected with total capacity of approximately 22 300 kW. Between FY 1997 and FY 2010, almost 1 800 projects were newly selected. Among them, approximately 1 200 PV projects were selected with the total capacity of around 90 MW. In terms of system capacity, small systems with capacity of less than 50kW were majority; projects smaller than 20 kW occupied almost 45% and projects bigger than 20 kW and smaller than 50 kW occupied approximately 20%. Next come the middle-sized systems, in between 50 to 1 000 kW, which had around 35% share. Some system projects larger than 1 MW were conducted by utilities or enterprises. While these PV systems were mainly installed at office buildings and factories under the project, installation of PV systems at collective housings including all-electrified condominiums is increasing. Distribution centers and social welfare facilities are also included in the installation projects.

(5) Eco-School (environment-conscious school) Pilot Model Project

This project was initiated in FY 1997 through the partnership between METI and the Ministry of Education, Culture, Sports, Science and Technology (MEXT). In FY 2002, the Forestry Agency of the Ministry of Agriculture, Forestry and Fisheries (MAFF) joined the partnership, followed by the Ministry of the Environment (MoE) in FY 2005.

The project aims at implementing pilot model projects in order to promote introduction and demonstration of environment-friendly schools, providing students with environmental education and improving school facilities.

Eligible projects are: 1) PV power generation; 2) utilization of solar thermal energy; 3) utilization of new and renewable energy including wind power generation, geothermal energy and fuel cells; 4) energy conservation and resource saving; 5) symbiosis with nature (greening of buildings and outdoor spaces); 6) utilization of wooden building materials; 7) recycling of resources and 8) others (natural lighting and ventilation).

The MEXT provides the fixed amount of subsidy for investigation of basic planning; half of the cost for new construction and one third of the cost for rebuilding or retrofitting of school buildings. In case of PV system installations at the time of expansion and renovation of schools, METI's subsidies described above will be applied.

1 126 schools were certified as eco-schools between FY 1997 and FY 2010. Total 756 schools were approved to install PV systems; 133 schools in FY 2010, 114 schools in FY 2009, 69 schools in FY 2008, 52 schools in FY 2007, 45 in FY 2006, 59 in FY 2005, 53 in FY 2004, 68 in FY 2003, 49 in FY 2002, 38 in FY 2001, 36 in FY 2000, 16 in FY 1999, 11 in FY 1998, and 13 in FY 1997.

Furthermore, MEXT announced a three-year plan to install PV systems in 12 000 public elementary and junior high schools nationwide as a part of School New Deal initiative formulated in 2009. As part of this initiative, the ministry provides support for building environment-friendly school facilities by public schools and private schools of school corporations. MEXT has developed guidebooks which outline the methods to make schools eco-friendly and utilizations of new and renewable energy at schools, as well as instruction manual and evaluation software which explain the methods to evaluate comprehensive environmental performances at school facilities. Taking advantage of these tools, MEXT has led dissemination and educational campaigns in 2010.

(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. It 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.

In the “Project to support active introduction of technological measures for 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 2010 (10 kW or more for wall and window application.)

In FY 2010, 10 projects were selected, including 1 project to install PV systems and in FY 2009, 46 were selected, including 30 to install PV systems.

As part of the “Project to promote the use of PV and other types of renewable energy”, MoE has been promoting the “Project to purchase solar environmental values”, which supports maintenance of facilities, on condition that Green Power Certificates issued for commercial PV facilities of private institutions are transferred to MoE. MoE is also promoting the “Supporting project for installing renewable energy in residential areas”, which provides subsidy for projects by local governments to support the introduction of renewable energy such as PV systems to residential houses. In the “Project to purchase solar environmental values”, initiated in FY 2009, the fixed amount of subsidy (maximum 300 000 JPY/kW) is provided for those who install PV systems with the capacity ranging from 20 to 500 kW and those who issue Green Power Certificates. In FY 2010, 17 projects with total capacity of 1 465 kW were selected.

With the “Project to Promote Instruments for Local Characteristic Action against Global Warming”, initiated in FY 2010, MoE supports within the range of one third or less of the cost for the projects which introduce advanced renewable energy and energy saving equipment to the houses and offices, in collaboration with community and led as a part of local community council project. Eligible systems for this support include solar light tube systems and PV systems with optical penetration applied to the windows.

Besides, to introduce the redevelopment of the low-carbon city, MoE implements the “Project to Promote Whole Measures for the Construction of Low Carbon Region”, which supports development and implementation of the plan.

Other projects include “Eco-renovation of schools to prevent global warming” (21 schools were selected between FY 2005 and FY 2010,) which provides subsidy to cover a part of the expense to renovate school facilities to reduce CO_2 emissions and to install new and renewable energy facilities. Furthermore, MoE is also conducting projects such as the “Project for developing technology to prevent global warming” which supports development and demonstrative researches on practical use of PV systems and other renewable energy technologies by private sector and public research institutes. Within the framework of this project, engineering development issues, concerning concentrating solar power (CSP,) spherical Si PV modules, and remote failure diagnosis of PV systems, were selected in FY 2010.

In addition, MoE has established “Regional Green New Deal Fund” with the supplementary budget of FY 2009 after the preparation of action plans by local public agencies has become obligatory with the amendment of the “Law Concerning the Promotion of Measures to Cope with Global Warming” in June 2008. 55 BJPY was distributed to 47 prefectures and 18 major cities for the sake of appropriation to the local public agencies, which is aimed at preserving environment in communities, subsidy for private sector, support for paying interests and so forth. Each municipality, taking advantage of this fund, implements the project of energy conservation and green promotion including PV systems. In the same way, MoE has established “Core City/ Special City Green New Deal Fund” which distributes 6 BJPY to the core cities (41 organizations) and special cities (41 organizations.) Both funds are effective for three years till the end of FY 2011.

(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. For the introduction of technologies such as PV systems to reduce CO_2 emissions, MLIT provides subsidy for private institutions who conduct projects which are highly effective as model projects, mainly at collective housings. 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 order to strongly support introduction of PV and other renewable energy facilities in those villages, MAFF implements study on installation of these facilities as well as a demonstrative research on the technology of PV systems with novel structure.

2.4 Highlights of R&D

(1) Research and Development

Four PV-related projects have been conducted by the New Energy and Industrial Technology Development Organization (NEDO.) Out of them, three were completed in the end of FY 2009; i) Research and Development of Next-generation PV Generation System Technologies, ii) Research and Development of Common Fundamental Technologies for Photovoltaic Generation Systems, iii) Development of Technologies to Accelerate the Practical Application of Photovoltaic Power Generation Systems. In FY 2010, “R&D of High Performance PV Generation System for the Future,” has newly started as a 5-year R&D programs for FY 2014, with the aim of achieving the 2020 introduction target of PV power installation (28 GW) set by the Japanese government and strengthening global competitiveness. In addition, for the Research and Development on Innovative Solar Cells (International Research Center for Innovative Solar Cell Program) that has continued since 2008, the mid-term evaluation of the projects was conducted in October 2010 to review research results during the two and a half years since 2008 and to discuss development direction until 2014.

In the field of fundamental research, “Development of Organic Photovoltaics toward a Low-Carbon Society” has been conducted by University of Tokyo from 2009. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) also implements 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, under these programs conducted by MEXT, new research proposals were called.

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

“R&D of High Performance PV Generation System for the Future,” is a 5-year R&D program till 2014, based on the Roadmap PV2030+. This program aims to further improve elemental technologies that had been developed in the previous programs by NEDO, namely Research and Development of Next-generation PV Generation System Technologies and the Development of Technologies to Accelerate the Practical Application of Photovoltaic Power Generation Systems, and lead to commercialization that had been conducted until 2009. R&D targets are; i) PV power generation cost of 14 JPY/kWh; ii) PV module manufacturing cost of 75 JPY/W; and iii) PV module conversion efficiency of 20 %. In order to lower commercial PV cost, academic-industrial consortium-based R&D projects had been initiated including five projects for low-cost PV, such as; i) crystalline silicon PV: low-cost and high-performance PV cell technological development (target module conversion efficiency >20%) mainly led by Toyota Technological Institute, ii) thin-film silicon PV: next-generation multi-junction thin-film silicon PV project (target module conversion efficiency >14%) mainly led by Photovoltaic Power Generation Technology Research Association (PVTEC,) iii) CIGS: advanced technological development of slate and flexible PV (target module conversion efficiency >18%) mainly led by the business enterprises, as well as two projects for commercialization of organic thin-film solar cells. In parallel with the academic-industrial

consortium-based projects, a few technology development projects for low-cost substrate have been initiated by enterprises' proposals. In addition, the R&D on evaluation technologies for PV cell/ module performance that had been conducted until FY 2009 to develop technological infrastructure to support mass deployment of PV systems under the Research and Development of Common Fundamental Technologies for Photovoltaic Generation Systems has continued in the R&D of High Performance PV Generation System for the Future mentioned above. A new project to establish reliability of PV systems and development of related materials has started as well.

2) Other technology development

Following technology development projects are continuously worked out in FY 2010. Research and Development on Innovative Solar Cells (International Research Center for Innovative Solar Cell Program) that has continued since FY 2008 is a seeds-seeking research program aiming at drastically improving performances of solar cells (target conversion efficiency: 40 %) from a long-term perspective towards 2050. Three ongoing projects that will continue until 2014 are as follows; i) research and development project of ultra-high efficiency post-silicon solar cells led by the University of Tokyo as a leading institute, ii) 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) research and development project of thin film full spectrum solar cells with low concentration, led by Tokyo Institute of Technology (TIT.) Interim assessment of the projects was conducted in October 2010, and the approach method beyond 2011 about some fundamental issues or sub-themes will be reviewed.

In the field of fundamental research, Development of Organic Photovoltaics toward a Low-Carbon Society is conducted by University of Tokyo. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) also implements 2 programs: i) Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells which is an individual proposal-oriented project with a research term of 3 to 5 years; and ii) Creative Research for Clean Energy Generation using Solar Energy, a team proposal-oriented project. In 2010, under Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells, researches on 24 subjects including 10 new projects continued aiming to research various PV elemental technologies and develop novel materials. Program of Creative Research for Clean Energy Generation using Solar Energy, has continued with a total of 11 subjects, including 5 new subjects, aiming to develop novel materials for thin-film solar cells.

(2) Demonstrative research

Major demonstration research projects implemented in FY 2010 were: i) Verification of Grid Stabilization with Large-scale PV Power Generation Systems, ii) Development of an Electric Energy Storage System for Grid-connection with New Energy Resources, iii) Verification Test of a Microgrid System for Remote Islands, iv) Demonstration of Next-Generation Energy and Social Systems, v) International Cooperative Demonstration Project for Streamlining of Energy Consumption (Japan-U.S. Smart Grid,) vi) International Cooperative Demonstration Project for Stabilized and Advanced Grid-connection PV System, and vii) International Cooperative Demonstration Project Utilizing Photovoltaic Power Generation Systems.

1) Verification of Grid Stabilization with Large-scale PV Power Generation Systems

With this demonstrative research program, a wide variety of demonstrative operation tests were carried out in the installations of a 5-MW PV power plant in Wakkanai City, Hokkaido Prefecture and a 2-MW PV power plant in Hokuto City, Yamanashi Prefecture. The term of this research project is from FY 2006 to FY 2010. FY 2010 is the final year of the program.

2) Development of an Electric Energy Storage System for Grid-connection with New Energy Resources

This project focuses on development of electricity storage technologies with the aim of minimizing output fluctuations of power generation using new and renewable energy. Research and development of new type nickel hydride batteries and lithium secondary batteries and development of evaluation methods are in operation. This project is a 5-year project between FY 2006 and FY 2010.

3) Verification Test of a Microgrid System for Remote Islands

Verification test on micro grids in remote islands are 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 including 4 000 kW systems in Miyako Island, respectively. The term of this verification test is from FY 2010 to FY 2014.

4) Demonstration of Next-Generation Energy and Social Systems

Demonstration of Next-Generation Energy and Social Systems using PV systems and storage battery are conducted in 4 cities; Yokohama City, Toyota City, Kyoto Prefecture (Kansai Science City) and Kitakyushu City. Objectives of each demonstration site are as follows: i) Yokohama City is for the comprehensive demonstration in a metropolis, ii) demonstration with its focus on the next generation vehicles in Toyota City, iii) Kyoto Prefecture is for the demonstration in an area where housing research institutes are dispersed into relatively large area, iv) Kitakyushu City is for the regionally specific demonstration. The term of this research project is from FY 2010 to FY 2014.

5) Other International Demonstration Projects

Other projects in operation in FY 2010 are: i) Smart Community Demonstration Project in Lyon, France, ii) a collaborative research and demonstration of Smart Grid-related technology with the Centre for the Development of Industrial Technology (CDTI) of Spain, iii) Japan-U.S. Smart Grid Collaborative Demonstrative Project in New Mexico, USA, and iv) a task force of Japan-U.S. Cooperation on Clean Energy Technologies in Hawaii, United States.

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

The FY 2010 budgets for PV system-related R&D, demonstration programs and market incentives are mainly based on national budgets.

The budget for R&D was allocated to “Research and Development on Innovative Solar Cells” and “R&D of High Performance PV Generation System for the Future.” Besides, 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.) However, these budgets are not counted in Table 3.

The budget for demonstration was allocated for: i) “Field Test Project on New Photovoltaic Power Generation Technology” (0.14 BJPY,) ii) “International Cooperative Demonstration Project Utilizing Photovoltaic Power Generation Systems” (0.21 BJPY,) iii) “Verification of Grid Stabilization with Large-scale PV Power Generation Systems” (0.2 BJPY,) and iv) “International Cooperative Demonstration Project for Streamlining of Energy Consumption (Japan-U.S. Smart Grid Collaborative Demonstrative Project in New Mexico, USA)” (1.83 BJPY.) However, PV systems are not newly installed under the “Field Test Project on New Photovoltaic Power Generation Technology” and “Verification of Grid Stabilization with Large-scale PV Power Generation Systems.”

The budget for market incentives are allocated to METI’s “Subsidy for measures to support introduction of residential PV systems” (54.68 BJPY) and “Project to purchase solar environmental values” (0.45 BJPY) implemented by the Ministry of the Environment (MoE.)

Moreover, PV systems can be installed using the budgets for introduction of new and renewable energy such as “Project for Promoting the Local Introduction of New Energy” and “Project for Supporting New Energy Operators.” However, as these budgets also include new and renewable energies other than PV, they are not included in Table 3. 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 2009, 532 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 2008			FY 2009			FY 2010		
	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)	3,7	12,17	10,7	4,16	2,35	43,05	5,98	2,38	55,13
Regional [2] (BJPY)	-	-	-	-	-	-	-	-	-

[1]: Market incentives: PV budgets of METI and MoE.

[2]: 655 municipalities such as prefectures, cities, towns, and villages are implementing their own subsidy programs for residential PV systems in 2010; the budget amount is unknown.

[3]: FY 2008 budget for market incentives includes 9 BJPY of the FY 2008 supplementary budget for subsidy program for residential PV systems.

3 Industry and growth

3.1 Production of silicon feedstock, ingot and wafer for solar cells

In Japan, four companies manufacture polysilicon (semiconductor grade) for the feedstock for solar cells: 1) Tokuyama (production capacity: 9 500 t/year,) 2) Mitsubishi Materials (production capacity: 2 800 t/year,) 3) OSAKA Titanium technologies (production capacity: 900 t/year,) and 4) M.SETEK (production capacity: 3 000 t/year, subsidiary of AU Optronics.) Of them, those manufacture polysilicon for solar cells were Tokuyama (production amount of 4 000t) and M.SETEK (production amount of 2 302,4t.) Tokuyama started construction of its new 6 000 t/year manufacturing plant in Malaysia. M.SETEK, with additional investment from AU Optronics, is planning expansion of its polysilicon business.

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 a 400-t/year production capacity of upgraded metallurgical silicon (UMG-Si.) JSS was planning to start operation of a production facility with an initial capacity of 660 t/year, but it has found an issue about process improvement and decided to postpone the start of commercial production which was scheduled to start by the end of FY 2010 by around one year. In response to the growing demand for monosilane gas for thin-film silicon PV modules, Mitsui Chemicals and Tokuyama are now collaborating on manufacturing technology development. Evonik Degussa Japan is planning to construct a monosilane gas plant which is expected to start operation in 2011.

Five companies, namely M.SETEK, SUMCO, JFE Steel, Dai-ichi Dentsu and Mitsubishi Materials Electronic Chemicals (former Jemco, sales by Mitsubishi Materials) specialize in manufacturing solar Si ingots and wafers. M.SETEK, affected by the economic fluctuation, has cancelled its plan to construct sc-Si wafer plant. SUMCO has announced withdrawal from sc-Si manufacturing in its PV business, and it aims to restore profitability of mc-Si manufacturing with electromagnetic casting process instead. In addition, SANYO Electric operates a solar ingot and wafer plant in USA, Kyocera manufactures solar Si ingots and wafers at its own facilities, and companies like Ferrotec also supply solar Si ingots. Space Energy and Shin-Etsu Film manufacture solar silicon wafers from purchased Si ingots.

With a dramatic expansion of the global demand for solar cells, an increasing number of companies are strengthening their production capacities or newly entering manufacturing of solar Si ingots and wafers. Ishii Hyoki, TKX, Osaka Fuji Corporation, Nakamura Choko, Kitagawa Seiki and others are strengthening their production.

Trading companies are strengthening PV-related business, mainly silicon feedstock, and companies such as Mitsui, Marubeni Corporation, Sumitomo Corporation, CBC, Sojitz Corporation, Chori and Hanwa are planning to expand their business dealing metallic silicon, polysilicon, silicon ingots and wafers.

Table 4 shows the overview of Japanese manufacturers of silicon feedstock, ingots and wafers for solar cells in 2010. Table 4a shows the manufacturing process of each manufacturer. Table 4b shows specifications of silicon 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 the overseas business development by manufacturers.

Table 4 Production and production capacity information for silicon feedstock, ingot and wafer manufacturers (2010)

Manufacturer	Process & technology [1]	Total Production	Maximum production capacity	Product destination
Tokuyama	Polysilicon	ca. 4 000 t	ca. 9 500 t/yr (including Si for semiconductor)	N.A.
M.SETEK	Polysilicon	2 302,4 t	3 000 t/yr	N.A.
	sc-Si ingot (CZ process)	2 175,3 t	3 600 t/yr	N.A.
	sc-Si wafer	43 MW	50 MW	N.A.
Mitsubishi Materials	Polysilicon	None	N.A.	N.A.
Mitsubishi Materials/ Mitsubishi Materials Electronic Chemicals	mc-Si ingot	80 t	136 t/yr	N.A.
	mc-Si wafer	9 MW	17 MW/yr	N.A.
Japan Solar Silicon	Polysilicon for solar cell	0 t	Test Production (not disclosed)	N.A.
NS Solar Material	Polysilicon (UMG-Si)	N.A.	N.A.	N.A.
JFE Steel	Cast mc-Si ingot	1 000 t	1 600 t/yr	N.A.
	Cast mc-Si wafer	160 MW	250 MW/yr	N.A.
SUMCO	Electromagnetic casting mc-Si wafer	232 MW	340 MW/yr	N.A.
	sc-Si ingot	290 t	350 t/yr	N.A.
Covalent Material [2]	sc-Si ingot	None	N.A.	N.A.
Space Energy	sc-Si wafer	200 MW	210 MW/yr	N.A.
Dai-ichi Dentsu	Cast mc-Si ingot	250 t	300 t/yr	N.A.
	Cast mc-Si wafer	25 MW	30 MW	N.A.
Kyocera	mc-Si wafer	N.A.	N.A.	Internal use
OSAKA Titanium technologies	Polysicilon			

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

[2]: No production of solar Si ingots and wafers in FY 2010

* SANYO Electric, the PV manufacturer, produced 100 MW of ingots for wafers of HIT (a-Si on c-Si) in its U.S. plant.

Table 4a Production process and technology for Si feedstock, ingot and wafer manufacturers for solar cells (2010)

Manufacturer	Production process
Tokuyama	- Polysilicon manufacturing using Siemens process
Mitsubishi Materials	- Polysilicon manufacturing using Siemens process
NS Solar Material	N.A.
Japan Solar Silicon	- Silicon tetrachloride + zinc → solar grade silicon
M.SETEK	- Polysilicon：TCS→ distilment/purification → polysilicon - Wafers：sc-Si ingots by CZ process → sc-Si wafers
JFE Steel	- Polysilicon → cast mc-Si ingots → wafers
SUMCO	- Electromagnetic casting → slice blocks → multi-wire saw slicing → washing and testing → shipment
Covalent Material	N.A.
Space Energy	- Purchase of Si feedstock → sc-Si → sc-Si wafers
Mitsubishi Materials /Mitsubishi Materials Electronic Chemicals	- Purchase of Si feedstock → casting mc-Si ingots → mc-Si wafers
Dai-ichi Dentsu	- Purchase of Si feedstock → cast ingot → mc-Si wafers manufacturing
OSAKA Titanium technologies	

Table 4b Specifications of Si feedstock, ingots and wafers for solar cells (2010)

Manufacturer	Product	Specification
Tokuyama	High-purity polysilicon	N.A.
Mitsubishi Materials	Polysilicon	N.A.
Mitsubishi Materials /Mitsubishi Materials Electronic Chemicals	mc-Si ingot (P-type)	680 mm x 680 mm x 300 mm, 0,5-3,0 Ωcm
		550 mm x 550 mm x 300 mm, 0,5-3,0 Ωcm
	mc-Si wafer (P-type)	156 mm x 156 mm, 0,5-3,0 Ωcm, 200 µm
		125 mm x 125 mm, 0,5-3,0 Ωcm, 180 µm
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.
M.SETEK	Wafer (N-type)	125 mm x 125 mm, 0,5-3,0 Ωcm, 180 µm
	Ingot (N-type)	125 mm x 125 mm, 0,5-3,0 Ωcm
	Ingot (N-type)	125 mm x 125 mm, 1,7-12,0 Ωcm
	Ingot (P-type)	156 mm x 156 mm, 0,5-3,0 Ωcm
JFE Steel	mc-Si ingot (P-type)	850 mm x 850 mm, 0,5-2 Ωcm, max. 250 mm in height
	Wafer	160–200 µm
SUMCO	Electromagnetic casting mc-Si wafer	156 mm x 156 mm, 180-200 µm
Covalent Material	N.A.	N.A.
Space Energy	P-type	125 mm x 125 mm/156 mm x 156 mm
	N-type	125 mm x 125 mm/156 mm x 156 mm
Dai-ichi Dentsu	Si feedstock	Polysilicon for solar cells + scrap Si
	mc-Si wafer (P-type)	156 mm x 156 mm (low efficiency 1,0-2,5 Ωcm), 200 µm
OSAKA Titanium technologies		

Table 4c New products or new development of silicon feedstock, ingot and wafer manufacturers for solar cells (2010)

Manufacturer	New product/ new development
Tokuyama	- Conducting tests (ongoing) of a demonstrative manufacturing plant of polysilicon for solar cells with a new VLD manufacturing process - Evaluation of solar cells using the sample product by VLD process.
Mitsubishi Materials/ Mitsubishi Materials Electronic Chemicals	- None
Japan Solar Silicon	- None
NS Solar Material	N.A.
M.SETEK	- 156 mm x 156 mm sc-Si ingots (P-type)
JFE Steel	- None
SUMCO	- None
Covalent Material	N.A.
Space Energy	N.A.
Dai-ichi Dentsu	- Ingots with lowered oxygen density and carbon concentration
OSAKA Titanium technologies	

Table 4d Plans for expansion of production capacity by silicon feedstock, ingot and wafer manufacturers for solar cells (2010)

Manufacturer	Process & Technology	Production capacity in FY 2010	Production capacity in FY 2011	Production capacity in FY 2012 onwards
Tokuyama	Polysilicon	ca. 9 500 t/yr (including Si for semiconductor)	ca. 9 500 t/yr	+ 6 200 t by the fore-end of 2013 (for solar cells) (Malaysia)
M.SETEK	Polysilicon	3 000 t/yr	6 000 t/yr	7 000 t/yr by 2012
	sc-Si ingot	3 600 t/yr	3 600 t/yr	3 600 t/yr
	sc-Si wafer	50 MW/yr	0 (ended)	0
Mitsubishi Materials	Polysilicon	N.A.	N.A.	N.A.
Mitsubishi Materials/Mitsubishi Materials Electronic Chemicals	mc-Si ingot	136 t/yr	146 t/yr	194 t/yr (target year unknown)
	mc-Si wafer	17 MW/yr	18 MW/yr	24 MW/yr (target year unknown)
Japan Solar Silicon	Polysilicon for solar cell	Test Production (N.A.)	Test Production (N.A.)	4 500 t/yr in 2013 onwards
NS Solar Material	Polysilicon (UMG-Si)	N.A.	N.A.	N.A.
JFE Steel	mc-Si ingot	1 600 t/yr	1 600 t/yr	N.A.
	mc-Si wafer	250 MW/yr	N.A.	600 MW/yr expected in a few years
SUMCO	Electromagnetic casting mc-Si wafer	340 MW/yr	400 MW/yr	Not decided
	sc-Si ingot	350 t/yr	N.A.	N.A.
Covalent Material	N.A.	N.A.	N.A.	N.A.
Space Energy	sc-Si wafer	210 MW/yr	N.A.	N.A.
Dai-ichi Dentsu	mc-Si wafer	30 MW/yr	N.A.	No expansion plan
OSAKA Titanium technologies				

Table 4e Overseas Business Development by manufacturers (2010)

Manufacturer	Business activities
Tokuyama	- Preparing for the construction of a polysilicon plant for solar cells in a subsidiary in Malaysia
Mitsubishi Materials	N.A.
Japan Solar Silicon	- None
NS Solar Material	N.A.
M.SETEK	- AU Optronics (AUO), the parent company, and SunPower established a joint venture in Malaysia
JFE Steel	- None
SUMCO	- Nothing special
Covalent Material	N.A.
Space Energy	N.A.
Mitsubishi Materials Electronic Chemicals	- Nothing special
Dai-ichi Dentsu	- Sales of wafers
OSAKA Titanium technologies	

3.2 Production of photovoltaic cells and modules

In 2010, 12 companies were listed as PV cell/ module manufacturers: Sharp, Kyocera, SANYO Electric (Panasonic Group,) Mitsubishi Electric (MELCO,) Kaneka, Mitsubishi Heavy Industries (MHI,) Fuji Electric Systems, Honda Soltec, Solar Frontier (Showa Shell Sekiyu group,) Clean Venture 21, PVG Solutions (sold by Hitachi,) and Choshu Industry (independently developed cells.) Among them, Fuji Electric manufactures flexible a-Si PV modules, Honda Soltec and Solar Frontier manufacture CIGS and CIS PV modules, and Clean Venture 21 manufactures spherical Si PV modules. PVG Solutions has developed bifacial crystalline Si solar cell, and Choshu Industry independently developed crystalline Si solar cell to enter the PV industry. Manufacturers specialized in PV modules are Suntech Power Japan (former MSK,) Fujipream, YOCASOL, and Choshu Industry. In addition, Towada Solar and K-I-S entered the industry. Noritz also is preparing to start operation in 2011. As for production of PV cells and modules, Kansai and Kyushu regions are the two major manufacturing areas in Japan.

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. Table 5d shows the overseas business development by manufacturers. Table 6 shows changes in average prices of residential PV modules.

Table 5 Production volumes and capacities by solar cell and PV module manufacturers (2010)

Cell/Module manufacturer	Technology [1]	Total Production (MW)		Maximum production capacity (MW/year)	
		Cell	Module	Cell	Module
Silicon wafer-based manufacturers					
Sharp	sc-Si, mc-Si	N.A.	1 022 [2]	550	1 055
Kyocera [3]	mc-Si	650	650	720	720
SANYO Electric [4]	HIT (a-Si on c-Si)	400	N.A. [5]	565	680
Mitsubishi Electric [7]	mc-Si	195	195	270	270
	sc-Si	15	15		
Clean Venture 21	light-collecting spherical Si	3,0	0,4	4,5	1,5
Suntech Power Japan	sc-Si	N.A.	5,90	N.A.	100
Fujipream	sc-Si	N.A.	3,6	N.A.	12
	mc-Si	N.A.	1,8	N.A.	12
Choshu Industry	mc-Si	N.A.	4	N.A.	N.A.
	sc-Si	N.A.	20	N.A.	50
YOCASOL	sc-Si	N.A.	8	N.A.	60 [9]
	mc-Si	N.A.	26	N.A.	
Itogumi Motech	mc-Si	N.A.	5	N.A.	20
Thin-film manufacturers					
Sharp	Thin film Si	N.A.	195 [2]	320	320
SANYO Electric [4]	a-Si (for consumer use)	N.A.	5 [6]	N.A.	5
Kaneka	a-Si a-Si/poly-Si hybrid	58	58	95	95
Mitsubishi Heavy Industries (MHI)	Microcrystalline tandem	N.A.	0	N.A.	40
	a-Si	N.A.	5,6 [8]	N.A.	N.A.
Fuji Electric Systems	a-Si	7	7	24	24
Solar Frontier	CIS	60	60	80	80
Honda Soltec	CIGS	17,3	27.5		
YOCASOL	a-Si	N.A.	0,1	N.A.	(60) [9]
Total		1 405,3	2 314,9	2 628,5	3 544,5

[1]: sc-Si: single crystalline silicon, mc-Si: multicrystalline silicon, a-Si: amorphous silicon, μ-Si: microcrystalline silicon
[2]: The numbers are sales volume.
[3]: The amount of wafer production is not countable in MW. All wafers produced are destined for internal cell production.
[4]: The figures of production capacity are as of the end of FY 2010 (March 2011.)
[5]: Module production is not published.
[6]: a-Si (5 MW) is all for consumer products.
[7]: The amount is the production capacity of c-Si PV cell/module because both PV cells and modules can be produced in their manufacturing lines.
[8]: The number is for export.
[9]: Total production capacity is 60 MW/yr including all types of technology; sc-Si, mc-Si, and a-Si.

Table 5a PV module production processes of manufacturers (2010)

Silicon wafer-based manufacturers	Description of main steps in production process
Sharp	<sc-Si/mc-Si> - Purchase of sc-Si/mc-Si wafers → sc-Si or mc-Si cells → modules - Purchase/production of Si feedstock → sc-Si/mc-Si ingots/wafers → cells → modules
Kyocera	- Purchase of Si feedstock → mc-Si wafers[1] → mc-Si cells → modules
SANYO Electric	- Purchase of Si feedstock → sc-Si wafers → HIT cells → modules ↑ Purchase of sc-Si wafers
Mitsubishi Electric	<mc-Si> - Purchase of mc-Si wafers → mc-Si cells → modules <sc-Si> - Purchase of sc-Si wafers → sc-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 → modules
Choshu Industry	- Purchase of sc-Si cells → modules - Purchase of mc-Si cells → modules
YOCASOL	- Purchase of sc-Si/mc-Si cell → modules
Itogumi Motech	- Purchase of mc-Si cells → modules
Thin-film manufacturers	**Description of main steps in production process**
Sharp	- Purchase of gas → cells → modules
Kaneka	- Purchase glass substrates → forming a-Si layers → modules
Mitsubishi Heavy Industries (MHI)	- Purchase of gas → modules
Fuji Electric Systems	- Purchase of silane gas → a-Si cells → modules
Solar Frontier	Purchase of Si feedstock → wafers/ cells→ modules (In the case of CIS solar cells, the manufacturing process is integrated from purchase of Si feedstock to modules. For CIS production, the parts so called cells of c-Si PV are shaped in the process of wafer production.)
Honda Soltec	

[1]: The amount of wafer production is not countable in MW. All wafers produced are destined for internal cell production.

Table 5b New developments and products of manufacturers (2010) (1/2)

Cell/Module manufacturer	New developments and new products
Sharp	- "Sharp to Commercialize a Solar-Powered Mobile Phone <SOLAR HYBRID SH6230C> for the Chinese Market" Sharp Corporation commercializes a mobile phone equipped with a solar cell module for the Chinese market from February 2010. This is the first solar-powered mobile phone by Sharp for the overseas markets. http://sharp-world.com/corporate/news/100127.html - Sharp to start sales of four types of PV modules (for gable roof/hipped roof) applicable for roofit design and 3 types of power conditioner from May 2010. http://www.sharp.co.jp/corporate/news/100316-a.html - "Operation Starts at Solar Cell Plant in GREEN FRONT SAKAI" On March 29, 2010, Sharp Corporation started operations at its new thin-film solar cell plant in GREEN FRONT SAKAI, Sakai City, Osaka Prefecture, Japan. The thin-film solar cell plant in Sakai will serve as a model plant for future Sharp thin-film solar cell plants around the world. Sharp will continue to accumulate and enhance its proprietary production technology and its know-how, to meet the world's growing demand for solar cells. http://sharp-world.com/corporate/news/100329.html - "Sharp's Commercialization and Industrialization of Solar Cells Recognized as IEEE Milestone" Sharp Corporation's achievements in the commercialization and industrialization of solar cells from 1959 to 1983 have been recognized as an IEEE Milestone from the IEEE, the world's largest academic society for electrical, electronics, information, and telecommunications engineering. http://sharp-world.com/corporate/news/100409.html - Sharp to expand number of PV trainees to 10 000 person/yr scale from July 2010 to for the further dissemination of domestic residential PV systems. Sharp was offering training in company's facilities in Tenri (Nara prefecture) and Kita Tokyo (Itabashi, Tokyo,) as well outside facilities. By expanding new meeting rooms in Tenri facilities and increasing number of training sessions in other locations, Sharp expands number of PV trainees to 10 000 person/yr scale. http://www.sharp.co.jp/corporate/news/100722-a.html - "Sharp to Begin Mass Production of New Single Crystalline Solar Cells with High Conversion Efficiency at GREEN FRONT SAKAI with Production Capacity of 200 MW/yr" This single crystalline solar cell with high conversion efficiency uses a Back Contact structure (electrodes are connected on the back-side,) which eliminates the need for electrodes to be set on the front-side. This new structure increases the light-receiving area on the front-side's surface. In addition, a new alignment technology (Alignment Sheet system,) which reduces the connection resistance between adjacent cells, was also developed. http://sharp-world.com/corporate/news/101201.html
Kyocera	- Development of large industrial PV modules - Commercialization of simplified "rackless" construction system for residential PV systems - Commercialization of new "SAMURAI" PV modules for residential application
SANYO Electric	- Commercialization of products which achieved a 21,6% cell conversion efficiency at a mass production level
Mitsubishi Electric	<New products> - Release of "high-output lead-free soldered photovoltaic modules" which adopt four busbar cells with an output capacity of 190W for residential application in Japan - Release of "monocrystalline lead-free soldered photovoltaic modules" which adopt sc-Si solar cells with an output capacity of 200W. Lineup of square and trapezoid modules and increase of installation capacity are available for residential application in Japan - Release of national public/industrial "high-output lead-free soldered photovoltaic modules." Output capacity of 230W with larger modules for public and industrial applications - Release of semiconductor power module "Intelligent Power Modules (IPM) for Solar Power Generation Systems" which is mainly intended for use in power conditioners for residential PV systems <New development> - Achievement of world record conversion efficiency of mc-Si PV cell. mc-Si PV cell, 15cm x 15 cm, 200 μm, achieved conversion efficiency of 19.3%, and ultra-thin mc-Si PV cell with 100 μm achieved conversion efficiency of 18.1% - Silicon thin film triple junction PV module achieved conversion efficiency of 14.8%, the highest level in the industry - Development of maximization of PV generation. New MPPT (maximum power point tracking) control continues automatic measuring of power generating property of PV array, and puts the PV array into operation at the maximum electrical power point of measured power generating property

Table 5b New developments and products of manufacturers (2010) (2/2)

Cell/Module manufacturer	New developments and new products
Clean Venture 21	- Commercialization of light-weight flexible PV module (less than one third of glass module weight) - Development of roof integrated PV systems - Establishment of mass production technology of spherical Si solar cells (80 million spheres/day) - Establishment of mass production technology of spherical Si solar cells with micro reflector cups
Suntech Power Japan	- BIPV module with sc-Si solar cells
Fujipream	- Bifacial thin c-Si glass-glass PV module
Choshu Industry	- Commercialization of sc-Si PV module (215W type) in July 2010 - Commercialization of mc-Si PV module (205W type) in April 2010
Kaneka	- Development of BIPV modules applicable for 12 cm gradient roof - Development of PV modules with snow stop function - Establishment of mass production technology of large-area PV modules
Mitsubishi Heavy Industries (MHI)	- Improvement of conversion efficiency of microcrystalline tandem modules (140W at 1.54m^2)
Fuji Electric Systems	- Development of portable electrical power source - Development of industrial power conditioner (without isolation transformer, 30kW, 50kW) - Development of measurement indicator devices
Solar Frontier	- Establishment of mass production technology of PV modules with large-area; specifically development to enlarge the size of modules in Fab3 from 2011 (641 mm x 1 235 mm → 977 mm x 1 257 mm) - Improvement of conversion efficiency (as of the end of March 2010;) 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)) - Product development such as Frontier Pack 2400 and a pack intended for collective housings: sales of popular style of residential systems aiming for dissemination with simplified rooftop installation - Experimental production and development of see-through PV module: development of prototype of see-through PV module using CIS (ongoing)
Honda Soltec	
YOCASOL	- Modules for residential/hipped roof - Modules for residential/BIPV - BIPV modules
Itogumi Motech	- Commencement of sales of high conversion efficiency modules

Table 5c Plans for future expansion of production capacity (2010)

Manufacturer	FY 2010 (MW/yr)	FY 2011 (MW/yr)	FY 2012 onwards	Technology
Silicon wafer-based manufacturers				
Sharp	550	750	Not announced	sc-Si, mc-Si
Kyocera	720	>= 800	>= 1 000 MW/yr in 2012	mc-Si
SANYO Electric	565	Not announced	Not announced	HIT (a-Si on c-Si)
Mitsubishi Electric [1]	270	270	600 MW/yr in 2012 onwards	sc-Si, mc-Si
Clean Venture 21	4.5	42	250 MW/yr by 2015	Spherical Si
Suntech Power Japan	N.A.	None	None	mc-Si
Fujipream	12	100	180 MW/yr by 2012	sc-Si, mc-Si
Choshu Industry	N.A.	100	150 MW/yr by 2012	mc-Si
YOCASOL	60	100	100 MW/yr (target year unknown)	Mainly sc-Si and mc-Si, including a-Si
Itogumi Motech	20	20	100 MW/yr by 2013	mc-Si
Thin-film manufacturers				
Sharp	320	320	480 MW/yr (target year unknown)	Thin film Si
SANYO Electric	5	Not announced	Not announced	a-Si
Suntech Power Japan	N.A.	None	None	a-Si
Kaneka	95	120	1 GW/yr by 2015	a-Si, a-Si/poly-Si hybrid
Mitsubishi Heavy Industries (MHI)	40	40	13 MW/yr	Microcrystalline tandem
	N.A.	0	0	a-Si
Fuji Electric Systems	24	24	40 MW/yr (target year unknown)	a-Si
Solar Frontier	80	980	Not decided	CIS
Honda Soltec				CIGS

[1]: The amount is the production capacity of c-Si PV cell/module because both PV cells and modules can be produced in their manufacturing lines

Table 5d Overseas business activities of PV manufacturers (1/2)

Manufacturer	New developments and new products
Sharp	- Sharp signed a joint-venture contract about thin film PV module production business with Enel Green Power and STMicroelectronics and another contract about Independent Power Producer (IPP) with Enel on January 4, 2010. Each company, after getting approval from European Commission to set up joint ventures in the fields of production/power generation, plan to found respective joint venture companies by the end of March, 2010. http://www.sharp.co.jp/corporate/news/100104-a.html - "Solar Car Equipped with Sharp Solar Cells to Lead Runners in Kenyan Open Marathon" A solar car equipped with Sharp solar cells will be the lead car in the 2nd Sotokoto*1 Safari Marathon on May 23, 2010 in Nairobi, the Republic of Kenya. The environmentally friendly solar car is driving in support of this open marathon in the equatorial country of Kenya, which boasts one of the highest quantities of solar radiation on earth. http://sharp-world.com/corporate/news/100513.html - "Sharp Supplies Thin-Film Solar Cells for Solar Power Generation Plant in the Kingdom of Thailand" Sharp Corporation has signed an agreement with Natural Energy Development to establish one of the world's largest solar power generation plants with a power generation capacity of 73 MW, and to supply thin-film PV modules and surrounding systems for the plant. The construction of the solar power generation plant will start in July 2010 and the operation is planned to start by the end of 2011. http://sharp-world.com/corporate/news/100701.html - "Sharp to Expand Annual Solar Cell Module Production Capacity in the UK to 500 MW" Sharp Corporation will double its annual production capacity for c-Si PV modules to 500 MW at Sharp Manufacturing Company of U.K. (SUKM,) its production base in the UK (Wrexham, Wales,) starting December 2010. To meet the growing demand for solar cells, SUKM's production capacity will be gradually increased, starting December 2010, from the current level of 250 MW per year to 500 MW by February 2011. http://sharp-world.com/corporate/news/100729.html - "Tokai University's Solar Car Equipped with Sharp Solar Cells Enters a Race in the Republic of South Africa" The "Tokai Challenger" solar car is equipped with Sharp compound solar cells developed for outer space applications. The cells have an output of 1.8 kW and a cell conversion efficiency of 30%, the highest level in the world. The "Tokai Challenger" has won the South African Solar Challenge 2010. http://sharp-world.com/corporate/news/100802_1.html, http://sharp-world.com/corporate/news/101004.html - "Sharp to Acquire Recurrent Energy, a U.S. Developer of Distributed Solar Projects" Sharp hereby announces the completion of acquisition procedures for Recurrent Energy, LLC (hereinafter "Recurrent Energy,") a U.S. developer of distributed solar projects, making Recurrent Energy a wholly-owned subsidiary of Sharp as of November 4, 2010 (U.S. local time.) http://sharp-world.com/corporate/news/100922.html, http://sharp-world.com/corporate/news/101105.html
Kyocera	- Module production in San Diego plant in the USA with production capacity of 30 MW/yr - Module manufacturing Fab2 in Czech is under construction. - Module manufacturing plants in Tianjin, China is under construction (for expansion.)
SANYO Electric	- Manufactures PV modules in plants in Mexico and Hungary with the production capacity of 390 MW/year - Expansion of PV module manufacturing in Hungary with increase of 135 MW - Manufactures ingots and wafers in Oregon and California states in the USA - 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	- Development of light-weight flexible PV module in CSP, Germany
Suntech Power Japan	- As the whole Suntech Power group, the production volume is 1 572 MW and ranked world No.1 (Photon, March 2011.) - With thirteen sales bases in Europe, North America, Middle East, and Asia-Pacific including Japan, production (mainly in China) and R&D bases are present around the world
Fujipream	- Continue sales and marketing activities, but no specific business yet.
Choshu Industry	- Nothing special
Kaneka	- Localized marketing activities based on the overseas offices with expatriate employees in Europe and Americas
Mitsubishi Heavy Industries (MHI)	- To further reinforce cost competitiveness, it is under consideration to finance, provide expertise, and transfer production lines to a Taiwanese thin film PV manufacturer.
Fuji Electric Systems	- Enhancement of sales framework - Expansion of customer base through grouping of products

Table 5d Overseas business activities of PV manufacturers (2/2)

Manufacturer	New developments and new products
Solar Frontier (former Showa Shell Solar)	- Sales of products through branch offices in Europe and USA - Sales of products to RoW (Asia, Middle East, Oceania, etc.) - Marketing alliance with General Electric (GE) - Partnership for R&D with IBM
Honda Soltec	
YOCASOL	- Module export sales to Europe (Germany, France, Italy, etc.) continued. - Development of roof integrated PV systems for European market - Acquisition of module certification for North America
Itogumi Motech	- Nothing special

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
Price	433	436	440	402	375

3.4 Manufacturers and suppliers of other components

While several dozen companies manufacture inverters (power conditioners,) about a dozen companies manufacture inverters for PV systems in Japan. Most of them are PV manufacturers, manufacturers of power supply systems, electric appliances and general electric machine manufacturers. Twelve 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, GS Yuasa, Delta Electronics, Panasonic Electric Works Denro, Shihen Technical, Toshiba Carrier, LS Industrial Systems, Hyundai Heavy Industries and West Holdings Corporation (Ablerex Electronics.) Delta Electronics, LS Industrial Systems, Hyundai Heavy Industries and Ablerex Electronics are non-Japanese manufacturers registered in the JET certification program. The capacity of commercialized 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 production, and size and weight reduction of inverters including islanding prevention devices integrated into the inverters for residential PV systems have been promoted.

10 to 5 000-kW PV systems have been installed in public and industrial facilities as well as power plants. As 10-kW inverters are typically used for PV systems with the capacity ranging from 10 kW to 100 kW, 10-kW inverters are accredited by JET, and seven companies, GS Yuasa, Sanyo Denki, Mitsubishi Electric (MELCO,) Sanken Electric, Ebara Densan, Shindengen Electric Manufacturing and YASKAWA Electric Corporation are registered. Meanwhile, for large-scale PV systems, standardization of 100 to 500-kW inverters has been promoted, and companies such as Sharp, GS Yuasa, Sanyo Denki, Meidensha, Sansha Electric Manufacturing, Nissin Electric, TMEIC, Hitachi, Mitsubishi Electric (MELCO,) YASKAWA Electric Corporation, and Fuji Electric Systems entered this area. Monitoring and controlling functions as well as parallel operation and measurement functions of inverters for public and industrial uses have been improved to be applied to PV systems with larger capacity. Besides, products with new functions like multi-level inverter, for the purpose of improving conversion efficiency, had made an appearance to the market. The upgrading of fault ride-through (FRT) functions at the point of grid defect is expected in the future.

For future applications to micro-grid networks with improved autonomy applicable to PV systems as well as for PV systems that can correspond to leveling electric load, development of new type of storage batteries such as high capacity lithium batteries has been promoted, and it is expected that they will be commercialized 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 application.

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

Size of inverter	FY 2008	FY 2009	FY 2010
10 - 100 kVA	93 600	93 600	89 000
> 100 kVA	83 600	83 600	79 000

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 2010)

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.	578 JPY/W
Grid-connected > 10 kW	Plants, warehouses, commercial buildings, large-scale public facilities, road facilities, railway facilities, etc.	615 JPY/W

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

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
Public & Industrial (>10 kW)	802	640	534	547	615
Residential (3 - 5 kW)	683	696	715	613	566

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 800

b) Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D: about 8 500

c) All other, including those within electric utilities, installation companies, etc.: about 32 000

Estimated PV-related labor places in 2010

Research and development (not including companies)	ca. 800
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	ca. 8 500
Distributors of PV products	
System and installation companies	
Utilities and government	
Other	ca. 32 000
Total	ca. 41 300

3.7 Business value

Table 9 shows business value of the domestic market of PV systems.

Table 9 Business value of PV system market **(BJPY)**

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

* Export value of PV products are not included

4 Framework for deployment (Non-technical factors)

A subsidy program for residential PV systems has been continued in 2010. In November 2009, the new power purchase program for surplus PV power was launched. Other support by taxation also contributed to the growth of the PV market. Table 10 shows measures and schemes for dissemination of PV systems implemented in 2010.

Table 10 PV support measures in 2010 (1/2)

	Ongoing measures implemented by	Measures that commenced in 2010
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	- Legislation of feed-in tariff for all the renewable energy sources is under preparation
Direct subsidy	- "Subsidy for measures to support introduction of residential PV systems" by METI - 655 local governments implement their own subsidy programs	-
Green Power schemes	- Utilities (Green Power Fund, all over Japan)	-
PV-specific green electricity schemes	-	-
Renewables Portfolio Standards (RPS)	- Enforced 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	-	-

Table 10 PV support measures in 2010 (2/2)

	Ongoing measures implemented by	Measures that commenced in 2010
Tax credits	Residential PV systems - Housing tax reduction from income tax for Individuals who buy newly-built house equipped with a PV system with mortgage: 1) 1.0% for year-end debt for general houses, 2) 1.2% for long-life high-quality houses. Maximum period is 10 years, maximum tax deduction amount is 1) 5 MJPY for general houses and 2) 6 MJPY for long-life high-quality houses - Tax credit for energy conservation refurbishment for individuals without mortgage: reduction of 10% of cost from income tax, maximum amount of installation cost: 3 MJPY Non-residential PV systems - Individuals who apply blue return as well as corporate bodies are eligible for special deduction (7%) or special depreciation (max. 30%) - Special depreciation and special deductions of corporate tax (income tax) for acquiring facilities to promote innovation of energy demand supply-structure（Taxation to promote innovation of energy demand-supply structure, national tax）: 1) Tax reduction of 7% of the basis of the acquisition cost (taxation basis designated according to the category of the facilities, the basis for PV power generation facility is 100 %). If the reduction amount exceeds 20% of the corporate tax for the fiscal year, 20% of the corporate tax will be applied. 2) Special measures with the limitation up to 30% of the basis of the acquisition cost	-
Net metering	-	-
Net billing	- Voluntary purchase program for surplus electricity by utilities (until the end of October 2009)	-
Commercial bank activities	- Low-interest loan - Introduction of PV systems to company-owned buildings	-
Electricity utility activities	- Voluntary buyback system for excess electricity by utilities (all over Japan) (until October 2009) - Introduction of PV systems to public and welfare facilities by Green Power Fund - Introduction of PV systems for in-house use	- As mentioned above, a new program to purchase surplus PV power generated by PV systems (< 10kW) at a double price of electricity started
Sustainable building requirements	-	-

4.1 Indirect policy issues

a) International policies influencing the use of PV systems

Global Environment Bureau of the Ministry of the Environment (MoE) deals with the planning, framing and promotion of the basic policies related to the global environmental protection. It also handles the affairs of international organizations, foreign agencies and elsewhere that are associated with its governing matters and fosters environmental cooperation for the developing regions.

On the occasion of the sixteenth Conference of the Parties under the United Nations Framework Convention on Climate Change (COP16) which was held in December 2010, the Japanese government, based on the Copenhagen Accord of COP15, set out to lay down the COP decisions which are well balanced in between the (easing of) emission reduction in the developed countries and the developing countries, and financial supports. This was to promptly adopt the new comprehensive legal documents which construct fair and effective international framework with the participation of all major emitting countries including the United States and China.

Developing countries strongly requested the implementation of the second commitment period of the Kyoto Protocol. However, imposing an obligation only on the developed countries and seeing no prospect of the participation of the U.S., the Kyoto Protocol would not serve for the reduction of the greenhouse gas emission in the global scale. As a result, Japan has opposed to the implementation of the second commitment period.

b) Favorable environmental laws and regulations

The Ministry of Economy, Trade and Industry (METI) approved treatment of PV power generation facilities as “environmental facilities other than green spaces” under the Factory Location Act. Accordingly, PV facilities’ profile area is eligible to be included when securing a certain amount of green and environmental spaces at the time of construction or expansion of factories.

Besides, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) sends notification about “the management of building acts regarding PV facilities” to the main manager of construction administration of prefectural and city governments in order to ease the regulation.

c) Environmental Tax (CO_2 Tax)

The Ministry of the Environment (MoE) is taking the initiative for studying introduction of the Environmental Tax. In November 2009, MoE has announced a specific plan of the tax addressing the global warming.

In December 16th, 2010, in a Cabinet meeting, the introduction of “tax addressing the global warming” from FY 2011 was approved to be included in a large package of tax revisions. Therefore, the Tax Research Commission agreed to introduce the tax addressing the global warming (Environmental Tax) from October 2011. This is the policy, established in the “Basic Energy Plan” in June 2010, to achieve reduction of CO_2 emission caused by energy consumption by more 30% compared to 1990 before 2030. The amount of present petroleum and coal tax, levied on crude oil and petroleum products, coal, and liquefied natural gas (LNG,) will be increased and the increased amount will be the Environmental Tax. As is the case with the petroleum and coal tax, tax payers will be importers and mining operators. The amount of the petroleum and coal tax is 2 040 JPY/kL on crude oil and petroleum products, and 1 080 JPY/t on gaseous hydrocarbon. In addition, 760 JPY/kL on crude oil and petroleum products, 780 JPY/t on gaseous hydrocarbon, and 670 JPY/t on coal are projected to be levied as the Environmental Tax for three and half years through FY 2015. Tax proceeds will be utilized for the measures in a wide range of fields such as industry, commercial, and transportation which can contribute effectively to the action of energy originated CO_2 reduction. In particular, using the tax proceeds to the dissemination of home low-carbon applications, promotion of entire use of unused heat, and implementation of investment on measures to global warming is expected to support the homes and businesses’ action against global warming, alleviate the tax burden, and prompt new demand and innovation. At this stage, the impact of the Environmental Tax introduction on PV systems is unknown.

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

The national government promotes international cooperative activities to disseminate PV systems across the globe, especially in Asia in order to play an active role concerning global warming issues, improvement of living standards in developing countries and contribution to energy security to curb energy consumption overseas. And also, PV power generation is potentially a promising energy technology option for emissions trading through the mechanisms of 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;

- "International Cooperative Demonstration Project for Stabilized and Advanced Grid-connection PV System (New Energy and Industrial Technology Development Organization (NEDO))" is one of the international cooperative demonstration programs which aims at a stable electricity supply constructing micro-grids using PV power generation. 4 projects conducted in Thailand, China, Indonesia, and Malaysia were completed successfully by FY 2009.
- "International Cooperative Demonstration Project Utilizing Photovoltaic Power Generation Systems (NEDO)" verifies PV systems under climate conditions which are usually not available in Japan. From FY 1992 through FY 2010, a total of 19 projects were carried out in various Asian countries. Two projects were implemented in FY 2010: i) "Demonstrative Research Project to Stabilize Output of Hybrid PV Power Generation Systems", using PV and small-scale hydraulic power generation and capacitors in May County of Phongsaly Province, Laos, ii) "Development of Design Support Tools for Photovoltaic Power Generation Systems", developing appropriate design support tools reflecting demonstration results.
- Other International Demonstration Projects conducted by NEDO are; i) Joint projects in the environment and energy efficiency fields with Thai government, ii) Comprehensive Cooperation for Collaborative Projects in the Solar Energy Field with Moroccan government, iii) Feasibility Study of Smart Community for an industrial area in Java Island, Indonesia, and iv) Study on PV system introduction and grid-connection in Mongolia.
- JICA, Japan International Cooperation Agency implements inter-governmental cooperation, through grant aid or loan assistace, as well as technological cooperation projects based on requests from developing countries. JICA supports developing master plans for rural electrification using PV power generation through the study of development for rural electrification. In 2010, JICA installed PV systems in Tonga, Maldives, Zambia and such, 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, Japan Bank for International Cooperation actively provides financing supports to environmental protection businesses as part of its GREEN (Global action for Reconciling Economic growth and Environmental preservation) activities.

4.2 Utilities' perception of PV

From November 2009, a new program to purchase surplus PV power at a fixed rate has begun based on the "New PV Power Purchase Program" and this program has been carried out throughout 2010. As a result, utilities' voluntary programs to purchase surplus PV power were replaced by the national program. With the commencement of this national program, some utilities including Tokyo Electric Power Co., Inc. (TEPCO) scrapped the "Green Power Fund."

Electric utilities introduced 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 facilities. Over the period between FY 2001 and FY 2010, the fund supported PV installations at 1 568 places nationwide, with a total capacity of 27 593,9 kW, mainly at public facilities such as schools and hospitals. In FY 2010, 247 places with a total capacity of 3 530,3 kW were selected as the installation sites.

Electric utilities have also purchased the required amounts of electricity generated from new and renewable energy in FY 2009, based on the Renewable Portfolio Standard (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 2010. The usage volume of electricity generated by new and renewable energy by utilities in FY 2009 was 8 873,2 TWh in total, including 681,2 TWh which completed the obligation amount, and 264,8 TWh from specific PV power plants (facilities intended for “New PV Power Purchase Program”) which is not counted as the obligated amount.

The accredited facilities for power generation using new and renewable energy under the RPS Law were 519 966 systems totaling 6 486 MW cumulatively, of which PV systems accounted for 83 systems and 18 MW and specific PV power accounted for 518 648 systems and 1 919 MW respectively.

Furthermore, utilities formed plans to construct PV power plants located in thirty sites 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. Kansai Electric Power Co., Inc. constructs its 10MW Sakai PV power plant and started its partial operation of 3MW output in September 2010. In total, twelve projects, with a total capacity of 67,25 MW are under construction aiming at their completion in FY 2011.

4.3 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 Optoelectronic 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 submit them to the Japanese Industrial Standards Committee (JISC) for a deliberation based upon the Industrial Standardization Act. After these procedures, the JIS (Japanese Industrial Standards) standards are formulated. Currently, a large number of standards are formulated according to the standardization framework listed in Table 11. 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 of PV modules, “JETPVm certification” in October 2003. This is equivalent to the TÜV certification which is conducted mainly in Europe, covering non-concentrator type PV modules for terrestrial installation or crystalline silicon and thin-film PV modules for sales purposes. Certification is made through product model certification and annual investigation of plants. Labels will be issued for the products which satisfy the standard. Performance tests are conducted in compliance with IEC61215 Ed.2 (JIS C 8990) (for crystalline 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 electrical equipment,) mutual certification procedures can be simplified with certificates of conformity and other documents. At the end of March 2011, the number of certified PV modules from 39 manufacturers that have been

registered is 3 256 models.

JET conducts a certification program for the performance and reliability of grid connection protecting unit (inverter) for small-sized distributed PV systems with 10 kW or less capacity to connect to low-voltage grid. 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, production plants are confirmed and certification labels are issued for the products which satisfy the standards. Certification standards are based on “testing method of equipment for grid connection of PV systems” stipulated by JET. The standards are based on “Electricity Enterprises Law”, as well as METI’s “Ordinance to set technological standards on electrical facilities”, “Interpretation of technological standards on electrical facilities”, “Guideline of Grid Connection Requirement to secure quality of electricity (an instruction issued by the chief of public utility department of Agency for Natural Resources and Energy (ANRE) of METI in August 1986, revised in March 1998)” and so on. As of April 15, 2011, 59 types of inverters by 18 manufacturers have been registered.

Table 11 Standardization Framework for PV Systems (1/2)

Category			JIS No.	Title	Note
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 8911; 2005	Secondary reference crystalline solar cells	
			C 8921, 2008	Photovoltaic devices - Part 2: Requirements for reference solar devices	
		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 8931; 2005	Secondary reference amorphous solar cells	
			C 8932; 2005	Secondary reference amorphous solar submodules	
		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; 2009	Thin-film terrestrial photovoltaic (PV) modules -- Design qualification and type approval	Revision under discussion
	Other types of solar cells	Other types of solar cells	C 8941; 2009	Secondary reference component cells	
			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	

Table 11 Standardization Framework for PV Systems (2/2)

Category		JIS No.	Title	Note
Modules		JIS C 8992-1; 2010	Confirmation of safety eligibility of PV modules - No. 1: Requirements for structure	Formulated in 2010
		JIS C 8992-2; 2010	Confirmation of safety eligibility of PV modules - No. 2: Requirements for testing	Formulated in 2010
		-	Standards for compatibility of module arrays	Under discussion
Other		-	Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data	Under discussion
		-	Method to establish traceability of reference cells	Under discussion
		-	Computation of the spectral mismatch correction for measurements of photovoltaic devices	Under discussion
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
	Power conditioner	C 8980; 2009	Power conditioner for small photovoltaic power generating system	Revised in 2009
		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	
			Environment-friendly design of power conditioner for small photovoltaic power generating systems	Under discussion
		-	Method of testing anti-independent 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 & Prospects

5.1 Highlights

Thanks to the new program to purchase surplus PV power and subsidies for residential PV systems as driving forces, the year 2010 for Japan was a year to step forward for accomplishing 1 GW/year market.

The Japanese government formulated New Growth Strategy, Industrial Structure Vision 2010, and Basic Energy Plan and announced its policy to strategically strengthen dissemination of renewable energy as a high priority issue for Japanese economy and domestic energy supply. Based on this policy, the Ministry of Economy, Trade and Industry (METI) have drawn up the draft of detailed design for the legislation of the new Feed-in Tariff program to achieve full-scale dissemination of PV and other renewable energy. This will set a course for dissemination of renewable energy in Japan, leading to a breakthrough to achieve PV system introduction target. Increased number of other ministries and agencies such as Ministry of Education, Culture, Sports, Science and Technology (MEXT,) Ministry of the Environment (MoE,) Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF) also introduced PV systems in their measures.

More and more local governments started providing their own support programs for the introduction of PV systems, in response to the subsidy program for residential PV systems by the national government. As many as 655 municipalities have their own support programs. In addition to introducing to public facilities, new movement for dissemination of PV system led by the local governments emerged; some started subsidizing installation to industrial facilities, others started introduction of MW-scale PV power plants.

As a driving force of PV system introduction, electric utilities planed MW-scale PV power plants and started construction. As much as 100 MW of the PV plants are scheduled to be operational by 2012.

In the PV industry, 2010 marked a series of strong momentum to enhance PV business development and new entry thanks to global demand expansion and the booming domestic PV markets especially the residential, although suffered severe appreciation of the yen and global competition with emerging overseas companies. Japan Photovoltaic Energy Association (JPEA) announced its new vision towards 2030, JPEA PV OUTLOOK 2030 -- Aiming to be the 100 Billion USD Industry, against the background of the rapidly growing global PV market today. The new vision expected the global PV market to grow by 20 % until 2020, then by 13 % until 2030. The vision presented a powerful stance of the Japanese PV industry, showing that the future image of the Japanese PV industry will be to establish Japanese brand, to promote global business development, and to maintain international competitiveness.

In the area of PV manufacturing, players started to increase their production capacity at home and abroad against the background of domestic and global PV demand expansion. Development of PV cells and modules was strengthened to achieve higher conversion efficiency and higher output for commercialization in order to make a difference with newly emerged companies. Meanwhile, some companies shifted their market strategy from overseas-oriented to domestic-oriented and promoted expansion of distribution channels as well as installation partners in order to cope with the rapidly growing domestic market. On the other hand, a number of overseas PV manufacturers especially from Europe, the US and Asia entered the Japanese market, expecting for the Japanese PV Market to expand again.

In the area of PV system manufacturing, power source manufacturers promoted development of large-sized (100 - 500 kW) PV power conditioners. New entries were also actively seen in this market as well as overseas development. In order to respond to MW-scale PV plant construction by electric utilities and smart community demonstration projects by the national government, heavy electric machinery manufacturers entered PV business. In response to this, new PV system integrators emerged undertaking MW-scale projects.

In the area of distribution of PV systems, there has been an increasing recognition that PV systems will become the new products with mass distribution. Housing industry, construction/ real estate industry and distribution industry started making a significant move into the PV market. In the housing industry, middle-sized housing manufacturers in addition to major pre-fabricated housing manufacturers promoted equipping PV systems as standard equipment for their houses. They strengthened their sales of houses with PV systems. Major pre-fabricated housing manufacturers also started further market cultivation by introducing PV systems in rented apartments. In the construction and real estate industry, developers started introducing PV systems in their condominiums and buildings. In the distribution industry, a number of home electric appliances stores and major supermarkets started sales of residential PV systems, creating new strong distribution channels.

PV system end-users were encouraged to introduce more PV systems as the national government provided subsidy and preferential tax treatment for public and industrial PV systems. Accordingly, more PV systems were installed in public, industrial and commercial facilities as well as electric utility facilities. With the expansion of PV system user population, large-scale industrial PV market of more than 100 kW, such as on the roofs of large factory, is emerging.

5.2 Prospects

Based on the New Growth Strategy, Industrial Structure Vision, and Basic Energy Plan, the government positioned renewable energy as one of the strategic area to grow for the future of the nation. And in order to drastically strengthen dissemination of renewable energy, the government has been promoting the legislation of the new Feed-in Tariff program powerfully.

Under the “Strategy to Become a Clean Energy Superpower by Green Innovation,” which is one of the seven new growth strategy fields, Japan aims to achieve three objectives by 2020 to become “the world’s largest environment and clean energy superpower”: i) create over 50 trillion JPY in new environment-related markets, ii) create 1.4 million new green jobs, and iii) reduce 1.3 billion tons of greenhouse gas emissions across the world (which is equivalent to the total CO_2 emissions in Japan) using technology developed by Japanese private sectors To achieve these goals, promotion of “Rapid expansion of renewable energy” and “Eco-friendly future city” have been deployed as part of national strategic projects to foster the renewable energy market in Japan to reach 10 trillion JPY by 2020, especially putting emphasis on a Feed-in Tariff program to purchase the entire electricity generated by renewable energy resources.

On the other hand, the “Basic Energy Plan” sets the goals and the policy of energy measures toward 2030 in Japan. As for the targets to be achieved by 2030, Japan aims to raise both the energy self-sufficiency ratio and the ratio of zero-emission electric power sources to 70 % according to the plan. Accordingly, Japan will make maximum efforts to introduce non-fossil energy sources such as renewable energy and nuclear energy, employing all possible policy measures. Although renewable energies still have some disadvantages in terms of cost effectiveness and stable supplies at present, Japan is promoting actively to expand the use of renewable energy, expecting to diversify energy sources while at the same time creating new markets and jobs, because most of the electricity from renewable resources can be produced within the country with less burden on the environment. For this purpose, drastic promotion of PV by implementing programs or institutional systems, tightening/ easing of regulation, support measures, technology development and electricity supply system, with a program to purchase the entire electricity generated from renewable resources (Feed-in Tariff) and technology development are the main pillars.

The bill for the new Feed-in Tariff program for renewable energy has been submitted to the Diet. If the bill is enacted, purchase price and period for renewable energy based electricity will be finalized and the Feed-in Tariff program will be started in FY 2012. The future of the renewable energy dissemination in Japan, therefore, hinges on the legislation of this new Feed-in Tariff program.

In the Japanese domestic PV market, the residential PV Market is still a dominant sector. However, in addition to the public and industrial markets, a new market for utility-scale PV power plants is

expected to emerge. The residential PV market, which used to be dominated by individual homes, is now expanding to create new markets such as rented apartment and condominium markets. The expansion of the residential PV market has created new sales network, installation framework, and distribution channels, establishing an expanded distribution framework exceeding 200,000 of annual installation.

Meanwhile, against the background of the governmental support for introduction and expectation for market expansion, the Japanese PV industry, together with many related industries, is starting to prepare for the establishment of production, distribution, and installation framework for PV systems toward the 1-GW or more domestic PV market.

The failures of Fukushima nuclear power plants triggered by the Great East Japan Earthquake have an huge impact not only on the electricity supply issue, but also on the Japanese energy strategy in the future. Therefore, the expectation for further introduction of renewable energy, including PV, is growing. Under such circumstances, the Basic Energy Plan, formulated in 2010, is scheduled to be reviewed and the new expansion of PV systems is anticipated.

Annex A Method and accuracy of data

The work was performed in collaboration with PV modules and BOS components manufacturers, housing manufacturers, and government agencies running PV programs/projects. The data were collected by interviews and questionnaires.

With regards to off-grid PV sector, some PV systems employ PV modules that have a capacity lower than 40 W. In this report, they are included because it is very difficult to distinguish the application types and rated voltages.

The accuracy of data is ±10% for cumulative installed PV power, ± 10% for production and production capacity.

Annex B Country information

This information is provided simply to give the readers 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 readers should do their own research if they require more detailed data.

1) Retail electricity prices (NC) - 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

288,6 kWh/month (FY 2008 average)

(Source: Graphical and Flip-chart of Nuclear & Energy Related Topics 2010)

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 (NC)

- 5,475 MJPY (2008)

(Source: The National Livelihood Survey, The Ministry of Health, Labour and Welfare, according to the survey conducted in 2009)

5) Typical mortgage interest rate

- 2,83 to 3,62% (minimum rate and maximum rate from January to December 2010, 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 (NC)

- High-octane gasoline: 143 - 158 JPY/liter (FY 2010, including 5% consumption tax)
- Regular gasoline: 132 - 147 JPY/liter (FY 2010, including 5% consumption tax)
- Diesel oil: 112 - 127 JPY/liter (FY 2010, 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 C: Table 1 Summary of major projects, demonstration and field test programs (1/4)

Project name	Subsidy for measures to support introduction of residential PV systems (FY 2008 -)				
Technical data/ Economic data	Objectives	Main accomplishments by the end of FY 2010/ problems and lessons learned	Funding	Project Management	Remarks
- Residential PV systems - Object person: Individuals or corporate bodies who have intention to install target system - Target system: - PV systems suitable for roof top installation with 10 kW or less capacity connected to low-voltage grid with reverse power flow - PV system with target cost for subsidy is less than 650 000 JPY (tax not included)/kW - Subsidy: 70 000 JPY/kW of nominal maximum output of PV module (FY 2010)	- Cost reduction of residential PV system and market expansion	- FY 2008 – FY 2010: Application totaling 361 711 (approx. 1.4GW) have been accepted - FY 2008: 21 762 applications (approx. 83MW) have been accepted - FY 2009: 144 601 applications (approx.552MW) - FY 2010: 195 348 applications (approx. 774MW) - Residential support program has halted in FY 2005, shrunk market revived and started to grow rapidly - Cumulative installed systems and capacity are approx. 800,000 systems and 2.98GW - The average residential PV system cost fell down to 607 000 JPY/kW (as of Mar, 2010,) then further 578 000 JPY/kW (as of Dec, 2010)	- ANRE[1], METI[2] - Budget: FY 2008: 9 BJPY FY 2009: 42.05BJPY FY 2010: 54.68BJPY	JPEA/ J-PEC[4]	- FY 1994 - 1996: Residential PV System Monitoring Project, FY 1997- 2001: Project for Residential PV install base development, FY 2002- 2005: implemented as the Project for Promoting Residential PV Installation (completed in FY 2005) - Subsidy project restarted in FY 2008 (January 2009 -)

[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]: Japan Photovoltaic Energy Association (JPEA) / Japan Photovoltaic Expansion Center (J-PEC)

Annex C: Table 1 Summary of major projects, demonstration and field test programs (2/4)

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 2010/ 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 - 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, METI - 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: included number of 34 480 MJPY	- ANRE (FY 1997) - NEDO (- FY 2008) - NEPC[5] (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.

[5] : NEPC: New Energy Promotion Council

Annex C: Table 1 Summary of major projects, demonstration and field test programs (3/4)

Project name	Project for Supporting New Energy Operators (FY 1997 -)				
Technical data/ Economic data	Objectives	Main accomplishments by the end of FY 2010/ 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,) a distribution center (100 kW,) an ironworks (140 kW) and a Japanese-style inn (25 kW) - 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 (17 kW,) a wind farm (10,2 kW) and a condominium for rent (53,38 kW) - FY 2006: 2 PV systems out of 54 qualified systems were installed at a condominium (93,64 kW), and a condominium for rent (66,71 kW) - 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	- 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: included number of 34 480 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 C: Table 1 Summary of major projects, demonstration and field test programs (4/4)

Project name	Eco-school Model Promotion Pilot Project (FY 1997 - FY 2011)				
Technical data/ Economic data	Objectives	Main accomplishments by the end of FY 2010/ 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 1997- FY 2010: PV systems were qualified to a total of 756 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[6] - ANRE, METI - MAFF[7] - MoE[8]	- 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.

[6]: MEXT: Ministry of Education, Culture, Sports, Science and Technology [7] : MAFF: Ministry of Agriculture, Forestry and Fisheries [8] : MoE: Ministry of the Environment