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 2009

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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, utilities 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

Electricity utility activities	includes ‘green power’ schemes allowing customers to purchase green electricity, large-scale utility 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 21 participating countries are Australia (AUS), Austria (AUT), Canada (CAN), 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 and the US Solar Electric Power Association are also members.

The overall programme is headed by an Executive Committee composed of one representative from each participating country, 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 2009. 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 2009, as described below, the Japanese domestic PV market recovered thanks to the restart of a 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. The domestic PV market, which had been sluggish since 2006 picked up and started moving towards full-fledged dissemination of PV power generation.

1) The government enacted the Act on the Promotion of the Use of Nonfossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers and obliged electric utilities to purchase surplus PV power at a double price of conventional electricity. Moreover, the government increased the target PV installed capacity by FY 2020 from 14 GW to 28 GW.
2) The Ministry of Economy, Trade and Industry (METI) resumed the subsidy program for residential PV systems (Subsidy for Installation of Residential Photovoltaic Systems) and started a new 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. The ministry's efforts on dissemination of PV systems have been enhanced.
3) The New Energy and Industrial Technology Development Organization (NEDO) reviewed its PV technology roadmap titled "PV 2030", which was formulated in 2004 and revised it as the new roadmap called "PV 2030+". PV 2030+ has set the target year by three to five years ahead of schedule originally set in PV 2030, looking towards 2050.
4) In response to the resumption of the subsidy program for residential PV systems by METI, over 500 municipalities started implementing their own support programs for residential PV systems.
5) In the PV industry, a number of businesses enhanced their PV-related activities in all the PV-related sectors, through production capacity increases, expansion of businesses in overseas markets and entries into new markets, in response to the growing PV markets both home and abroad.
6) Electric utilities have plans to construct PV power plants with the total capacity of 140 MW at 30 locations across Japan by 2020. So far, utilities announced specific plans for the construction of 18 PV power plants with total power generation capacity of the scale of 100 MW nationwide.

Installed PV power

Total annual installed capacity of PV systems reached 482 976 kW in 2009, a 114,4% increase from or more than double that of 2008 with 225 295 kW. This growth can be attributed to the

restart of a subsidy program for residential PV systems in January 2009.

The breakdown of PV systems installed in 2009 is 712 kW for off-grid domestic application, 3 112 kW for off-grid non-domestic application and 477 712 kW for grid-connected distributed application, mainly residential PV systems. 1 440 kW was newly installed for grid-connected centralized application, as demonstrative research projects of large-scale PV power plants continued and electric utilities constructed PV power plants. Cumulative installed capacity of PV systems in Japan in 2009 was 2 627 165 kW.

Cost and Price

In 2009, 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 FY 2009 dropped to 402 JPY/W from 440 JPY/W in FY 2008. Typical price of 3- to 5-kW residential PV systems largely decreased from 715 JPY/W in FY 2008 to 613 JPY/W in FY 2009. Price of PV systems with more than 10-kW generation capacity for public and industrial applications showed a small increase from 534 JPY/W in FY 2008 to 547 JPY/W.

PV production

2009 production volume of solar cells and PV modules in Japan increased to 1 334 MW from 1 150,7 MW in 2008, achieving a year-on-year increase of 13,7%.
The breakdown of production volume was as follows: 395,2 MW of single crystalline silicon (sc-Si) solar cells, 630,6 MW of multicrystalline silicon (mc-Si) solar cells, 114,4 MW of amorphous silicon (a-Si) solar cells and 10,5 MW of other types of solar cells.
(Note: This figure is different from total reported figure by PV manufacturers in Table 5)

The market share of crystalline Si solar cells is 89%. Multicrystalline Si solar cells have been overwhelmingly dominating the solar cell market in Japan over the past 14 years and, as a major solar cell technology, kept the status with the continuously growing solar cell market in Japan. Crystalline Si solar cell market has been supported by domestic demand, mainly by the subsidy program for residential PV systems by the government and increase of PV power generation application by “Project for Promoting the Local Introduction of New Energy”, demand from general applications such as traffic lights and communication power sources as well as expansion of exports for overseas market.

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 FY 2009 national budgets for PV power generation for the Ministry of Economy, Trade and Industry (METI) totaled 49 560 MJPY, significantly increased from 26 570 MJPY in FY 2008. 4 160 MJPY was allocated for R&D related to PV power generation (3 700 MJPY allocated in FY 2007), 2 170 MJPY for demonstration (12 170 MJPY in FY 2008), and 43 050 MJPY was allocated for market revitalization (10 700 MJPY in FY 2008). In addition, budget for supporting dissemination of PV and other types of new and renewable energy was also allocated.
Major projects and budgets in FY 2009 for new and renewable energy mainly PV by METI and the Ministry of the Environment (MoE) are described below.

1) Subsidy for Installation of Residential Photovoltaic Systems (FY 2008 supplementary budget): 9 000 MJPY
2) Subsidy for Installation of Residential Photovoltaic Systems: 42 050 MJPY (FY 2009 budget: 20 050 MJPY + FY 2009 supplementary budget: 22 000 MJPY)

3) Technology Development of Photovoltaic Power Generation: 3 590 MJPY
   - Development of Technologies to Accelerate the Practical Application of Photovoltaic Power Generation System: 310 MJPY
   - Research and Development of Next-generation PV Generation System Technologies: 1 100 MJPY
   - Research and Development on Innovative Solar Cells (International Research Center for Innovative Solar Cell Program): 2 400 MJPY (FY 2009 budget: 1 500 MJPY + FY 2009 supplementary budget: 900 MJPY)
   - Research and Development of Common Fundamental Technologies for Photovoltaic Generation Systems: 350 MJPY
4) Field Test Project on New Photovoltaic Power Generation Technology: 330 MJPY
5) Verification of Grid Stabilization with Large-Scale PV Power Generation Systems: 2 020 MJPY
6) Development of an Electric Energy Storage System for Grid-connection with New Energy Resources: 1 700 MJPY (new)
7) Project for Supporting New Energy Operators: 3 007 MJPY
8) Project for Promoting the Local Introduction of New Energy: 6 260 MJPY
9) Project to Introduce and Promote New Energy Measures: 110 MJPY
10) Project for Establishing New Energy and Energy Conservation Visions at the Local Level: 540 MJPY
11) Project for developing technology to prevent global warming: 3 805 MJPY
12) Project to promote comprehensive measures to create low-carbon local communities: 990 MJPY
13) Project to promote the use of PV and other types of renewable energy: 1 000 MJPY

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 2009, 532 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. 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. Residential PV systems account for 89,5% 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 account for 2,8% of the entire PV market, while PV systems for industrial and commercial use account for 7,4%. Grid-connected centralized PV systems had been installed for the purposes of demonstrative researches and no new systems had been installed since FY 1995. However, national demonstrative research projects for large-scale PV systems were launched in FY 2007 with the constructions of approximately 2-MW and 5-MW PV plants. The plant operations started in 2007 and through the additional installations in FY 2008, the plant expansion was completed in FY 2009.

The off-grid residential PV system market is small in size, and mainly for residences in remote areas including mountain lodges and huts, 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 2009 by sub-market. Total installed capacity in 2009 was 482 976 kW, and the annual installed capacity for each application is as follows: 712 kW for off-grid domestic PV systems, 3 112 kW for off-grid non-domestic PV systems and 477 712 kW for grid-connected distributed PV systems mainly for residential houses. In addition, 1 440 kW was installed for grid-connected centralized application for demonstrative researches of large-scale PV power plants.

Table 1 The installed PV power in 4 sub-markets in 2009

Sub-market/ application	Off-grid domestic	Off-grid non-domestic	Grid-connected distributed	Grid-connected centralized	Total
Installed PV power [kW]	712	3 112	477 712	1 440	482 976

Table 2 shows cumulative installed capacity of PV systems by submarket. In 2009, total cumulative installed capacity was 2 627 165 kW. Cumulative installed capacity for each application is as follows: 2 635 kW for off-grid domestic, 91 998 kW for off-grid non-domestic, 2 521 792 kW for grid-connected distributed and 10 740 kW for grid-connected centralized application.

Table 2 The cumulative installed PV power in 4 sub-markets

Sub-market/ application	31 Dec. 1992 kW	31 Dec. 1993 kW	31 Dec. 1994 kW	31 Dec. 1995 kW	31 Dec. 1996 kW	31 Dec. 1997 kW	31 Dec. 1998 kW	31 Dec. 1999 kW	31 Dec. 2000 kW	31 Dec. 2001 kW	31 Dec. 2002 kW	31 Dec. 2003 kW	31 Dec. 2004 kW	31 Dec. 2005 kW	31 Dec. 2006 kW	31 Dec. 2007 kW	31 Dec. 2008 kW	31 Dec. 2009 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
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
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
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
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

The annual installed capacity increased along with the significant growth in the Japanese residential PV market because the Ministry of Economy, Trade and Industry (METI) resumed the Subsidy for Installation of Residential Photovoltaic Systems in 2009. 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 been increasing. As a new movement in residential application, introduction of PV systems to collective housings has started. In the newly-built residential 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 having PV systems as standard equipment have been promoted by the housing manufacturers. Major housing manufacturers are aggressively providing energy saving houses and environment-friendly houses equipped with PV systems. For already-built homes, PV manufacturers are searching for potential customers of residential PV systems by developing and organizing distribution channels through local housing contractors, electronics stores, roof constructors. Some local authorities have been continuing subsidy programs to prop up dissemination of residential PV systems, and individuals are able to apply for the national subsidy program and local subsidy programs at the same time. 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 increasing.

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”. Demand for PV systems for industrial and commercial uses increased at steady growth rate in 2009 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, commercial buildings, etc., 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) train facilities such as stations, platforms; 4) road facilities such as parking areas, expressway toll booths, interchanges; 5) financial facilities like banks; 6) transportation facilities like logistics and distribution centers; 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.

Through the continuation of the Project on “Verification of Grid Stabilization with Large-Scale PV Power Generation Systems”, 1 440 kW of grid-connected centralized PV systems were newly installed in FY 2009. Under the Project which was launched in FY 2007, constructions of large-scale PV power plants with generation capacities of 5 000 kW and 1 840 kW were completed in Wakkanai City of Hokkaido Prefecture and Hokuto City of Yamanashi Prefecture, respectively.

2.3 Major projects, demonstration and field test programs

Field test and dissemination programs implemented in FY 2009 were “Subsidy for Installation of Residential Photovoltaic Systems”, “Program to purchase surplus PV electricity at fixed rates”, “Field Test Project on New Photovoltaic Power Generation Technology”, “Project for Promoting the Local Introduction of New Energy”, “Project for Supporting New Energy Operators” and “Eco-School Promotion Pilot Model Project” (see also Annex C). 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 Installation of Residential Photovoltaic Systems

In January 2009, the Ministry of Economy, Trade and Industry (METI) restarted a subsidy program to install residential PV systems (70 000 JPY/kW). Requirements for the subsidy include the following:

1) Conversion efficiency of PV modules exceeds a certain conversion efficiency after modularization: 13.5% or higher for crystalline silicon solar cells, 7.0% or higher for thin-film silicon solar cells, and 8.0% or higher for polycrystalline compound solar cells)
2) PV systems which have total nominal maximum output capacity of PV modules of below 10 kW
3) PV modules are certified by the Japan Electrical Safety & Environment Technology Laboratories (JET) or have equivalent certification such as TÜV and are registered by the Japan Photovoltaic Expansion Center (J-PEC)
4) Performances of PV modules and support after installation are guaranteed by PV manufactures or relevant organizations
5) Maximum output capacity is below 10 kW and the price of a PV system is 700 000 JPY/kW (excluding tax) or lower

With the restart of this subsidy program, the residential PV market revived. The number of applications submitted between January and December 2009 exceeded 117 000, which has been steadily increasing. This program is scheduled to continue in FY 2010. When the number of projects approved in FY 2009 are added to the actual number of installed projects up to FY 2008, cumulative number of installation and installed capacity at the end of FY 2009 which received subsidy are expected to reach approximately 600 000 projects and 2 200 MW, respectively.

PV modules by 28 PV manufacturers have been registered as eligible models by J-PEC. PV modules by 28 manufacturers are certified by different certification organizations as follows: 12 manufacturers by JET, 13 by TÜV, 1 by VDE, 1 by JET/ TÜV, and 1 by JET/TÜV/VDE.

(2) Program to purchase surplus PV electricity at fixed rates

In July 2009, the Ministry of Economy, Trade and Industry (METI) enacted the “Act on the Promotion of the Use of Nonfossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers”, which obliges electric utilities to purchase surplus PV power. Accordingly, a program to purchase electricity at fixed rates was initiated in November 2009. Electricity generated from PV systems with the capacity of below 500 kW are eligible for the purchase. Purchase prices under this program in FY 2009 are 48 JPY/kWh (almost double electricity charge for domestic use) for residential PV systems with the capacity of below 10 kW. In case of the combination of a PV system with a capacity below 10kW and other power generation facilities (e.g. fuel cells), the purchase price is 39 JPY/kWh. For non-residential PV systems and PV systems with the capacity of 10 kW or more, the purchase price is 24 JPY/kWh. With other generation equipment, the purchase price is also 24 JPY/kWh. These prices are expected to be reviewed annually. All the users of electricity will evenly share the purchase costs.

(3) Field Test Project on New Photovoltaic Power Generation Technology

This field test program started in FY 2003 as a successor of the Field Test Project on Photovoltaic Power Generation Systems for Industrial and Other Applications, aiming at promoting further introduction of middle- and large-scale PV systems, improving the performance and reducing the cost through adopting new technologies into PV systems for public and industrial facilities and accelerating potential of further development. Under the FY 2008 program, five types of PV

systems were defined as the models adopting new technologies as follows: 1) PV systems with new type modules (next generation PV modules with solar cells using new materials and new type PV modules with improved functions and performance, total generation capacity: 4 kW or more); 2) PV systems with building materials integrated PV (BIPV) modules such as roof-integrated and wall-integrated PV modules, which have functions of building materials, total generation capacity: 4 kW or more); 3) PV systems with new control system (PV systems with storage equipment and PV systems adopting balance of system (BOS) with improved functions and performance compared to the conventional ones, total generation capacity: 4 kW or more); 4) PV systems using small-sized multiple grid-connection systems (PV systems aimed at confirming impacts on multiple grid-connection systems such as installations at each unit of collective housing, total generation capacity: 3 kW or below, 2 systems or more); and 5) PV systems aiming at higher efficiency (PV systems with higher system efficiency by improving components, design and installation methods by modifying conventional PV systems, total generation capacity: 10kW or more).

Eligible applicants for the projects are private businesses, local authorities and organizations. As co-researchers, they collect and analyze operational data of PV systems for 4 years to demonstrate the performances of these systems. For PV systems categorized in 1) to 3) described above, half of the introduction cost is subsidized. For those categorized in 4) and 5), the lower amount of either up to half of the introductions cost or 300 000 JPY/kW is subsidized. Under the Field Test Project, 148 PV systems totaling 4 480 kW were installed in FY 2003, 262 PV systems totaling 7 161 kW in FY 2004, 457 PV systems totaling 17 672 kW in FY 2005, 662 PV systems totaling 21 707 kW in FY 2006, 329 PV systems totaling 16 292 kW in FY 2007 and 182 PV systems totaling 11 484 kW were installed in FY 2008.

Accepting new applications for the Field Test Project on New Photovoltaic Power Generation Technology was closed in FY 2008. Currently, only collection of data for existing projects has been continued. Cumulative installed capacity of PV systems introduced by the Field Test Projects between FY 1992 and FY 2008 is expected to be around 100 MW.

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

The project started 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.

Eligible new and renewable energy sources in FY 2009 projects are PV power generation (output power of 10 kW or more), 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, geothermal power generation and microgrids (with output capacity of PV systems 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 for up to 4 years, so that new and renewable energy systems can be introduced in multiple fiscal years, depending on the processes and the size of the facilities installed. Up to half of the system installation cost is subsidized for the projects of new and renewable energy introduction, depending upon the status of each case. For PV systems, the lower amount of either up to 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 2009, 676 projects were newly selected. Among them, 547 PV system projects were selected with total capacity of 73 480 kW to be installed at city halls, water treatment facilities, schools, kindergartens, hospitals, social welfare facilities, temples, factories, large-scale PV power plants and so on. The accumulated capacity of PV systems selected between FY 1998 and FY 2009 is 101 220 kW with 978 PV systems in total.

(5) Project for Supporting New Energy Operators

This project started 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. 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 guarantee include private institutions who plan to install new and renewable energy facilities. In 2009, sole proprietors started installations of such energy facilities in collective housing. Maximum one third of the system installation cost is subsidized (maximum subsidy for a PV system is 1 BJPY/year). For PV systems, the lower amount of either up to one third of the system installation cost (maximum subsidy of 1 BJPY/year/system) or 250 000 JPY/kW is subsidized. 90% of the debt is guaranteed. The term of a subsidized project is a single fiscal year in principle, but it can be extended to maximum 4 years depending on the processes of the project.

In FY 2009, 660 projects were newly selected. Among them, 548 PV system projects were selected with total capacity of 50 661 kW.

Between FY 1998 and FY 2009, 1 415 projects were newly selected. Among them, 740 PV projects were selected with the total capacity of 66 369 kW. While the PV systems were mainly installed in factories under the project, some PV systems were installed at all-electrified condominiums.

(6) 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.

951 schools were certified as eco-schools between FY 1997 and FY 2009. Total 623 schools were approved to install PV systems; 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 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 school corporations.

(7) 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. In the “Project to support active introduction of technological measures for local authorities”, MoE has been providing subsidy for the introduction of alternative energy including PV systems with the capacity of 20 kW or more and enhancement of energy conservation by local authorities and private institutions who are engaged in energy conservation of facilities owned by local authorities. In FY 2009, 46 projects were selected, including 30 projects 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”, 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 2009, 29 projects with total capacity of 1 947 kW were selected.

For the “Model project to create demand for Green Power Certificates in local communities” for local governments, 12 local authorities (prefectures and municipalities) were selected in FY 2009. The project is boosting independent dissemination of residential PV systems in local communities.

Furthermore, in the “Challenge 25 - project to create local communities”, which provides subsidy for private institutions and local authorities who formulate plans and provide subsidy to promote creation of low-carbon communities and who conduct demonstrative projects, total 29 projects were selected in FY 2009 including 8 PV-related projects. Other projects include “Eco-renovation of schools to prevent global warming” (21 schools were selected between FY 2005 and FY 2009), which provides subsidy to cover 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 implements development and demonstrative researches on practical use of PV systems and other renewable energy technologies.

2.4 Highlights of R&D

(1) Research and Development

Four PV-related projects under the control of the Ministry of Economy, Trade and Industry (METI) were conducted by the New Energy and Industrial Technology Development Organization (NEDO) in 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, and iv) Research and Development on Innovative Solar Cells (International Research Center for Innovative Solar Cell Program).

Research and development to tackle technical issues on the grid connection of PV systems has also been continued in 2009 and development of electricity storage technologies has been promoted under the plan towards 2010. Among the PV-related projects listed above, the first three projects were completed in FY 2009. Against this backdrop, NEDO reviewed the PV Roadmap Toward 2030 (PV2030) to establish new projects from FY 2010 and released a new roadmap, PV2030+ (Plus) in June 2009.

In the field of basic research, two new projects started aiming to make breakthrough for the next generation solar cells under the control of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the promotion of the Japan Science and Technology Agency (JST); i) Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells, and ii) Creative Research for Clean Energy Generation Using Solar Energy. Furthermore, Development of Organic Photovoltaics toward a Low-Carbon Society was selected as one of the 30 themes of advanced researches under the government's Funding Program for World-Leading Innovative Research and Development on Science and Technology.

1) Research and Development of Next-generation PV Generation System Technologies

This project aims at realizing higher conversion efficiency, further cost reduction and improved durability of solar cells for the establishment of elemental technologies to achieve the targeted PV power generation cost set in the PV2030 Roadmap: 14 JPY/kWh in 2020 and 7 JPY/kWh in 2030. FY 2009 was the final year of the project. Based on interim evaluations conducted in 2007, project details were adjusted and 19 themes (cf. 21 themes in FY 2008) were continued in the field of thin-film CIS, thin-film silicon, dye-sensitized, next-generation ultra-thin crystalline silicon, and organic thin-film solar cells as well as next-generation elemental technologies. All in all, anticipated results were achieved at lab level, including 18.9% conversion efficiency of multicrystalline silicon solar cells.

2) Research and Development of Common Fundamental Technologies for Photovoltaic Generation Systems

This project is aimed at developing technological infrastructure to support mass deployment of PV systems. Just as last year, various researches including development of evaluation technologies for PV cell/ module performance and reliability and for PV-generated electricity, technological development including highly-recyclable new module structures, support for standardization of Balance-of-Systems (BOS) components, survey on PV technology trend, and PV life cycle assessment (LCA) have been continued. FY 2009 was the final year of the project and the project successfully achieved the original target.

3) Development of Technologies to Accelerate the Practical Application of Photovoltaic Power Generation Systems

This is a support project for industry players to pursue technological development. As selected in FY 2008, four technological development programs have been supported under this project; i) Thin-film amorphous silicon solar cells fabricated on plastic film substrates (by Fuji Electric Advanced Technology), ii) Slicing techniques for ultra-thin multicrystalline silicon solar cells (by Komatsu NTC), iii) Enhanced production technologies for thin-film silicon solar cells (including super large-area cell production and high-speed production) (by Mitsubishi Heavy Industries (MHI)), and iv) Selenization process optimization techniques for CIS thin-film solar cells (by Showa Shell Sekiyu).

4) Research and Development on Innovative Solar Cells (International Research Center for Innovative Solar Cell Program)

This project is a seeds-seeking research project aiming at drastically improving performances of solar cells (target conversion efficiency: 40%) from a long-term perspective looking towards 2050. Just as in FY 2008, three groups (34 organizations) have been conducting technological development projects as follows:

I) The University of Tokyo with 9 organizations conducts a research and development project of ultra-high efficiency post-silicon solar cells. Subjects are; i) high efficiency quantum dot tandem solar cell manufacturing process technology, ii) ultra-high efficiency quantum dot superlattice solar cells, iii) ultra-high efficiency hybrid, multi-junction solar cells, and iv) high efficiency multi-junction CPV cells.

II) National Institute of Advanced Industrial Science and Technology (AIST) with 13 organizations conducts a research and development project for thin-film multi-junction solar cells with a highly ordered structure. Subjects are; i) Silicon-based triple-junction thin-film solar cells, ii) compound-based quadruple junction thin-film solar cells, iii) Study for novel materials and concepts, and iv) Advanced photoenergy application technology.

III) Tokyo Institute of Technology (TIT) with 14 organizations conducts a research and development project of thin-film full spectrum CPV cells with low concentration. Subjects are; i) Band engineering technology, ii) Thin-film full spectrum solar cells, and iii) Light-management and transparent-conducting-oxide (TCO) technology.

Each group plays a role of an international joint research center, and as part of this project, the Second International Symposium on Innovative Solar Cells was held in Tsukuba City, Ibaraki Prefecture in December 2009.

5) Research and Development of Islanding Detection Testing Technology for Clustered Photovoltaic Power Generation Systems

This R&D project aims at establishing testing technology that will contribute to the certification of islanding detection systems for grid-connected PV systems. It has been continued in 2009 in order to address the issues of increased grid connection of PV systems (Details of this project; see the section of Demonstrative research).

6) Projects for basic researches

In the field of basic researches on solar cells, two new R&D projects started in FY 2009 under the control of MEXT as follows:

I) Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells

This is an individual proposal-oriented project through participation of mainly young postdoctoral researchers. The research started with the selection of 14 themes aiming to make proposals for next generation solar cells such as elemental technologies and development of novel materials (research term: 3 - 5 years) for various types of solar cells.

II) Creative Research for Clean Energy Generation Using Solar Energy

This team-based project started aiming to establish breakthrough technology to improve conversion efficiency and overcome degradation and deterioration issues with the following seven themes selected in FY 2009 as follows:

i) New Formation Process of Solar-Grade Si materials

ii) Complete Utilization of "Light" and "Carrier" by the Control of Interface

iii) Hydrogenated Amorphous Silicon Free from Light-Induced Degradation

iv) High Efficiency Thin Film Solar Cells with Enhanced Optical Absorption by Excitons

v) Device Physics of Dye-sensitized Solar Cells (DSCs)

vi) Bandgap Science for Organic Solar Cells

vii) Efficient Visible Light-Sensitive Photocatalysts for Water Splitting

7) Revision of PV2030 Roadmap

Circumstances have radically changed surrounding PV utilization and the PV industry since PV Roadmap Toward 2030 (PV2030) was formulated in 2004. Against this backdrop, NEDO reviewed PV2030 to establish next phase R&D projects and released a new roadmap, PV2030+ (Plus) in June 2009. In the revised roadmap, the target year has been extended from 2030 to 2050 and various targets have been set including the followings; i) covering about 10% of domestic primary energy demand by PV power generation by 2050, ii) developing solar cells with a conversion efficiency of 40%, iii) achieving the 2030 technological development target in 2025 or five years ahead of the schedule set in PV2030, and v) enhancing system utilization technology development toward mass dissemination of PV systems in harmony with the PV utilization environment.

(2) Demonstrative research

Major demonstration research projects implemented in FY 2009 were: i) Field Test Project (details are described in 2.2), ii) Verification of Grid Stabilization with Large-scale PV Power Generation Systems, iii) Development of an Electric Energy Storage System for Grid-connection with New Energy Resources, iv) Research and Development of Islanding Detection Testing Technology for Clustered Photovoltaic Power Generation Systems, v) International Cooperative Demonstration Project for Stabilized and Advanced Grid-connection PV Systems and vi) International Cooperative Demonstration Project Utilizing Photovoltaic Power Generation Systems.

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

This demonstrative research project aims at establishing a system to stabilize power output of MW-scale PV systems without giving negative impacts on the quality of grid electricity and validating its effectiveness and usefulness. In addition to these objectives, the final goal of this research is to develop technologies to make MW-scale PV power plant businesses feasible. Installations of a 5-MW scale PV power plant in Wakkanai City, Hokkaido Prefecture and a 2-MW level PV power plant in Hokuto City, Yamanashi Prefecture were completed and both of the two power plants were connected to the grid. In the Hokuto site, three 400-kW power conditioners with a function to control grid stabilization were installed. Grid connection to a high-voltage transmission system from the previous medium-voltage transmission system was demonstrated, and the demonstrative research has continued. The term of this research project is from FY 2006 to FY 2010.

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

This project is a 5-year project between FY 2006 and FY 2010 on development of electricity storage technologies with the aim of minimizing output fluctuations of power generation using new and renewable energy. Technological development covers three themes as follows: i) development of technologies for practical applications to establish a safe electric energy storage system with the capacity of around 1 MW, at the mass production cost of 40 000 JPY/kWh and the life span of 10 years, ii) development of next-generation technologies aiming at reaching 20 to 30 MW of capacity with mass production cost of 15 000 JPY/kWh and the lifespan of 20 years in 2030, iii) development of common fundamental technologies to select charge/ discharge test patterns and development of evaluation methods. Under this program, developments of large-capacity lithium ion batteries and nickel hydride batteries have been conducted. In FY 2009, evaluation of performances of 100-kWh lithium ion batteries has been conducted.

3) Research and Development of Islanding Detection Testing Technology for Clustered Photovoltaic Power Generation Systems

This project was associated with the Demonstrative Project on Grid-Interconnection of Clustered Photovoltaic Power Generation Systems which was conducted over the period from FY 2002 to FY 2007. Aiming at establishing certification and testing technologies which contribute to certification of devices to detect islanding operations at the time of grid-connection of multiple PV systems, the project was conducted from FY 2008 to FY 2009.

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

The FY 2009 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 “Development of Technologies to Accelerate the Practical Application of Photovoltaic Power Generation Systems”, “Research and Development of Next-generation PV Generation System Technologies”, “Research and Development on Innovative Solar Cells (International Research Center for Innovative Solar Cell Program)” and “Research and Development of Common Fundamental Technologies for Photovoltaic Generation Systems”. In addition, two R&D projects, “Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells” and “Creative Research for Clean Energy Generation Using Solar Energy” under the control of MEXT, the Ministry of Education, Culture, Sports, Science and Technology and the promotion of the Japan Science and Technology Agency (JST), and “Development of Organic Photovoltaics toward a Low-Carbon Society” under the government initiative of “Funding Program for World-Leading Innovative R&D on Science and Technology” also have been conducted, but the budget for these projects are not included in Table 3.

The budget for demonstration was allocated for “Field Test Project on New Photovoltaic Power Generation Technology” and “Verification of Grid Stabilization with Large-scale PV Power Generation Systems”. Installation of PV systems was implemented under “Verification of Grid Stabilization with Large-Scale PV Power Generation Systems”.

The budget for market initiatives are allocated to “Subsidy for Installation of Residential Photovoltaic Systems”, a residential PV system dissemination program which METI has re-launched “Subsidy for Installation of Residential Photovoltaic Systems”, and “Promotional project for renewables including PV power generation” initiated by MoE, the Ministry of the Environment.
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”, “Project for Supporting New Energy Operators” and “Demonstrative Project of Regional Power Grids with Various New Energies”. 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 2007			FY 2008			FY 2009		
	R&D [3]	Demo/ Field Test	Market	R&D	Demo/ Field Test	Market [4]	R&D	Demo/ Field Test	Market
National [1] (BJPY)	4,58	14,6	4,8	3,7	12,17	10,7	4,16	2,35	43,05
Regional [2] (BJPY)	-	-	-	-	-	-	-	-	-

[1]: The figures in Table 3 show PV budgets of METI and MoE only. The budgets of other government ministries and agencies are unknown.

[2]: More than 500 municipalities such as prefectures, cities, towns, and villages are implementing their own subsidy programs for residential PV systems.

[3]: FY 2007 budget includes budget for new and renewable energy besides PV.

[4]: FY 2008 budget for market initiatives includes 9 BJPY of the FY 2008 supplementary budget for “Subsidy for Installation of Residential Photovoltaic System”.

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: 9 200 t/year), 2) Mitsubishi Materials (production capacity: 1 800 t/year), 3) OSAKA Titanium technologies (production capacity: 1 400 t/year), and 4) M. SETEK (production capacity: 3 000 t/year). Tokuyama started operation of its new 3,000 t/year manufacturing plant. AU Optronics, Taiwan, invested in M. SETEK to make it a subsidiary. Producers of polysilicon for solar cells in 2009 was Tokuyama (3 000 t), M.SETEK (1,900 t), and Mitsubishi Materials. Tokuyama announced a plan to construct a manufacturing plant in Malaysia with a production capacity of 6 000 t/year, while Osaka Titanium technologies and Mitsubishi Materials announced construction of new plants with production capacity of 2 200 t/year (additional increase through efficiency improvement) and 1 000 t/year, respectively.

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 plans to start operation of a production facility with an initial capacity of 660 t/year, and aims to expand it to 4 500 t/year in the future. JSS aims to reinforce its business through management integration of its parent company Nippon Mining Holdings and Nippon Oil. In response to the growing demand for monosilane gas due to production increases of thin-film silicon PV modules, Mitsui Chemicals and Tokuyama are now collaborating on manufacturing technology development. Taiyo Nippon Sanso and Evonik Degussa Japan announced a plan to construct a monosilane gas plant for solar cells in Yokkaichi City, Aichi Prefecture in Japan.

Five companies, namely M.SETEK, SUMCO, JFE Steel, Dai-ichi Dentsu and Mitsubishi Materials Electronic Chemicals (former Jemco) specialize in manufacturing solar Si ingots and wafers. SUMCO will increase production of mc-Si ingots which have been produced at its subsidiary SUMCO Solar with electromagnetic casting process, aiming to achieve a production capacity of 400 MW/year, and then expanding to 1 GW/year level in the future. SUMCO also entered sc-Si solar wafer production by shifting part of EG Si wafer production capacity. In addition, SANYO Electric started operation of a new solar ingot and wafer plant in Oregon, USA, Kyocera manufactures solar Si ingots and wafers at its own facilities, and companies like Mitsubishi Materials Electronic Chemicals and Ferrotec also supply solar Si ingots. Space Energy and Shin-Etsu Film manufacture solar silicon wafers from purchased Si ingots. Nippon Oil Corporation increased its investment in Space Enegy to strengthen solar business and plans to establish an integrated holding company with Nippon Mining Holdings in April 2010. Since Nippon Mining Holdings has been developing its polysilicon business, they both expect synergy effects.

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 and others will strengthen their production. Celco Japan Group entered solar Si wafer business by newly establishing a slicing facility. Procurement of silicon metal remains a task for polysilicon manufacturers, and Shin-Etsu Chemical plans to double the metallic silicon production capacity to 64 000 t/year including production for non-PV applications at its Australian subsidiary, Simcoa.

Trading companies are strengthening solar-related business, mainly silicon feedstock, and companies such as Marubeni Corporation, Sumitomo Corporation, CBC, Sojitz Corporation and Chori are planning to expand their business dealing metallic silicon, polysilicon, silicon ingot and wafer.

Table 4 shows the overview of Japanese manufacturers of silicon feedstock, ingots and wafers for solar cells in 2009. 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 and Table 4d shows production expansion plans of manufacturers. Table 4e shows the overseas business development by companies.

Table 4 Production and production capacity information for silicon feedstock, ingot and wafer manufacturers (2009)

Manufacturer	Process & technology [1]	Total Production	Maximum production capacity	Product destination
Tokuyama	Polysilicon	ca. 3 000 t	ca. 9 200 t/yr (including Si for semiconductor)	N.A.
M.SETEK	Polysilicon	1 900 t	2 300 t/yr	N.A.
	sc-Si ingot (CZ process)	1 220 t	3 000 t/yr	N.A.
Mitsubishi Materials	Polysilicon	N.A.	N.A.	N.A.
Mitsubishi Materials/ Mitsubishi Materials Electronic Chemicals	mc-Si ingot	90 t	165 t/yr	N.A.
	mc-Si wafer	N.A.	17 MW/yr	N.A.
Japan Solar Silicon	polysilicon	0 t	0 t/yr	N.A.
NS Solar Material	polysilicon	-	-	-
JFE Steel	Cast mc-Si ingot (Directional solidification process)	500 t	1 000 t/yr	N.A.
	Cast mc-Si wafer	75 MW	150 MW/yr	N.A.
SUMCO	Electromagnetic casting mc-Si wafer	106 MW	210 MW/yr	N.A.
	sc-Si ingot	350 t	350 t/yr	N.A.
Covalent Material	sc-Si ingot	70 t	N.A.	N.A.
Shin-Etsu Film	mc-Si wafer	-	-	-
Space Energy	sc-Si wafer	200 MW	240 MW/yr	N.A.
Dai-ichi Dentsu	mc-Si ingot	-	-	-
	mc-Si wafer	-	-	-
Kyocera	mc-Si wafer	N.A.	500 MW/yr.	Internal use

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

Table 4a Production process and technology for Si feedstock, ingot and wafer manufacturers for solar cells (2009)

Manufacturer	Production process
Tokuyama	- Polysilicon manufacturing using Siemens process
Mitsubishi Materials	- Polysilicon manufacturing using siemens process
NS Solar Material	- Purchase of Si feedstock → polysilicon using metallurgical process
Japan Solar Silicon	Polysilicon for solar cell by Zinc reduction method
M.SETEK	- Polysilicon : TCS→ distilment/purification → polysilicon - Wafers : sc-Si ingots by CZ process[1] → sc-Si wafers
JFE Steel	- Purchase of Si feedstock (partly by in-house production) → manufacture cast mc-Si ingots → wafers
SUMCO	- Electromagnetic casting → slice blocks → multi-wire saw slicing → washing and testing → shipment
Covalent Material	- Purchase of Si feedstock → manufacture sc-Si ingots by CZ process
Shin-Etsu Film	- Purchase of cast mc-Si → mc-Si wafers
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

[1]: Czochralski process

Table 4b Specifications of Si feedstock, ingots and wafers for solar cells (2009)

Manufacturer	Product	Specification
Tokuyama	High-purity polysilicon	N.A.
Mitsubishi Materials	Polysilicon	-
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
Japan Solar Silicon	N.A.	N.A.
NS Solar Material	Polysilicon	-
M.SETEK	Wafer (P-type)	125 mm x 125 mm, 0,5-3,0 Ωcm, 200μm
	Wafer (N-type)	125 mm x 125 mm, 0,5-3,0 Ωcm, 190μm
	Ingot (P-type)	156 mm x 156 mm
	Ingot (N-type)	125 mm x 125 mm
JFE Steel	mc-Si ingot (P-type)	850 mm x 850 mm, 1,0 Ωcm, max. 250 mm in height, 160 – 200 μm
SUMCO	Electromagnetic casting mc-Si wafer	156 mm x 156 mm, 180 - 200 μm
Covalent Material	P-type 8” ingot	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	mc-Si ingot	N.A.
	mc-Si wafer	N.A.

Table 4c New products or new development of silicon feedstock, ingot and wafer manufacturers for solar cells (2009)

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	- P-type 156 mm x 156 mm, 0,5～3,0 Ωcm, 200 μm P-type 125 mm x 156 mm, 0,5～3,0 Ωcm, 180 μm
Japan Solar Silicon	- N.A.
M.SETEK	- 156 mm x 156 mm, 200 μm mc-Si wafers
JFE Steel	- None
SUMCO	- None
Covalent Material	- N-type crystalline Si
Space Energy	- None

Table 4d Plans for expansion of production capacity by silicon feedstock, ingot and wafer manufacturers for solar cells (2009)

Manufacturer	Process & Technology	Production capacity in FY 2009	Production capacity in FY 2010	Production capacity in FY 2011 onwards
Tokuyama	Polysilicon	ca. 9 200 t/yr (including Si for semiconductor)	ca. 9 200 t/yr	+ 6 000 t by the fore-end of 2013 (for solar cells) (Malaysia)
M.SETEK	Polysilicon	2 300 t/yr	2 800 t/yr (including 2nd Phase Plant)	6 500 t/yr (2014)
	sc-Si ingot	3 000 t/yr		
Mitsubishi Materials	Polysilicon	-	-	-
Mitsubishi Materials/Mitsubishi Materials Electronic Chemicals	mc-Si ingot	165 t/yr	165 t/yr	165 t/yr by 2011
	mc-Si wafer	17 MW/yr	17 t/yr	17 t/yr by 2011
Japan Solar Silicon	Polysilicon	0 t	660 t/yr	4 500 t/yr In FY 2013
JFE Steel	mc-Si ingot	1 000 t/yr	1 600 t/yr	Under consideration
	mc-Si wafer	150 MW/yr		
SUMCO	Electromagnetic casting mc-Si wafer	210 MW/yr	340 MW/yr	Not decided
	sc-Si ingot	350 t/yr	350 t/yr	Not decided
Covalent Material	N.A.	N.A.	N.A.	N.A.
Space Energy	sc-Si wafer	240 MW/yr	N.A.	N.A.

Table 4e Overseas Business Development by manufacturers (2009)

Manufacturer	Business activities
Tokuyama	- Established a subsidiary in Malaysia
Mitsubishi Materials	- Nothing special
Japan Solar Silicon	- Nothing special
M.SETEK	- Acquired by AU Optronics (AUO), Taiwan
JFE Steel	- N.A.
SUMCO	- Nothing special
Covalent Material	- Nothing special
Space Energy	- N.A.
Mitsubishi Materials Electronic Chemicals	- Nothing special

3.2 Production of photovoltaic cells and modules

In 2009, 11 companies were listed as PV cell/ module manufacturers: Sharp, Kyocera, SANYO Electric, Mitsubishi Electric (MELCO), Kaneka, Mitsubishi Heavy Industries (MHI), Space Energy, Fuji Electric Systems, Honda Soltec, Showa Shell Solar (now Solar Frontier) and Clean Venture 21. Among them, Space Energy manufactures bifacial silicon solar cells, Fuji Electric manufactures flexible a-Si PV modules, Honda Soltec and Showa Shell Solar manufacture CIGS and CIS PV modules respectively, and Clean Venture 21 manufactures spherical Si PV modules. SANYO Electric established a joint venture company, “Sanyo ENEOS Solar” with Nippon Oil Corporation, while Sanyo itself has become a subsidiary of Panasonic through a takeover bid. In addition to the existing manufacturers specialized in PV modules, namely Suntech Power Japan (former MSK), Fujipream, and YOCASOL, Choshu Industry entered this business in 2009. As for production of PV 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 characteristics of PV modules for residential and utility use, which are typical module applications in Japan. Table 5c shows the present status of PV module certification of PV manufacturers. Table 5d shows new developments and products of PV module manufacturers in Japan. Table 5e shows plans for future expansion of cell/ module production capacity by PV manufacturers. Table 5f shows the overseas business development by manufacturers. Sharp manufacturers crystalline Si PV modules in Memphis, USA (60 MW/year) and Wrexham, UK (220 MW/year). Kyocera has PV module manufacturing facilities in Tianjin, China (30 MW/year), Tijuana, Mexico (25 MW/year) and Kadan, Czech Republic (25MW/year). Kyocera also is planning to establish a PV module factory in San Diego, CA, USA in 2010. SANYO Electric manufactures PV modules in Monterrey, Mexico (75 MW/year) and Dorog, Hungary (165 MW/year). Kaneka has a PV module plant in Olomouc, Czech Republic (30 MW/year). Table 6 shows changes in average prices of residential PV modules.

Table 5 Production volumes and capacities by solar cell and PV module manufacturers (2009)

Cell/Module manufacturer	Technology [1]	Total Production (MW)		Maximum production capacity (MW/year)	
		Cell	Module	Cell	Module
Silicon wafer-based manufacturers					
Sharp	sc-Si	221		550	-
	mc-Si	280			-
Kyocera	mc-Si	400	400	500	500
SANYO Electric	a-Si/sc-Si (HIT)	255	-[2]	340	135[3]
	a-Si	5	5[4]	5	5
Mitsubishi Electric	mc-Si	120	120	220	220
Space Energy	Bifacial sc-Si	-	-	-	-
Clean Venture 21	light-collecting spherical Si	-	-	-	-
MSK (Suntech Power Japan)	c-Si	-	-	-	-
Fujipream	sc-Si	-	1,0	-	12
	mc-Si	-	4,0	-	12
Choshu Industry	mc-Si		2,4		5
	sc-Si		25 (OEM)		N.A.
Thin-film manufacturers					
Sharp	a-Si/µ-Si	94		160	a-Si/µ-Si
Kaneka	a-Si a-Si/poly-Si hybrid	40	40	70	70
Mitsubishi Heavy Industries (MHI)	Other[5]	17	17	40	40
	a-Si	4,8	4,8	28	28
Fuji Electric Systems	a-Si	7	7	17	17
Solar Frontier	CIS	43	43	80	80
Honda Soltec	CIGS	N.A.	N.A.	27,5	27,5
Total		1 486,8	1 291,6	2 037,5	1 316,5

[1]: sc-Si: single crystalline silicon, mc-Si: multicrystalline silicon, a-Si: amorphous silicon, µ-Si: microcrystalline silicon

[2]: Production breakdown of modules in or outside of Japan is not available

[3]: Production capacity in Japan: 135 MW/year, overseas: 215 MW/year

[4]: All of 5 MW a-Si PV modules is for consumer products

[5]: Microcrystalline tandem

Table 5a PV module production processes of manufacturers (2009)

Silicon wafer-based manufacturers	Description of main steps in production process
Sharp	- Purchase of mc-Si or sc-Si wafers → mc-Si or sc-Si cells → modules - Purchase of Si feedstock → sc-Si/mc-Si wafers → cells → modules
Kyocera	- Purchase of Si feedstock → mc-Si wafers[1] → mc-Si cells → modules
Choshu Industry	- Purchase of solar cells → modules
SANYO Electric	- Purchase of Si feedstock → sc-Si wafers → HIT cells → modules ↑ Purchase of sc-Si wafers
Mitsubishi Electric (MELCO)	- Purchase of mc-Si wafers → mc-Si cells → modules
Clean Venture 21	- Purchase of Si feedstock →spherical Si → light-collecting spherical Si solar cells
MSK (Suntech Power Japan)	-
Fujipream	- Purchase of sc-Si and 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 → amorphous/μ-Si thin-film sub modules → modules
Fuji Electric Systems	- Purchase of silane gas → a-Si cells → modules
Solar Frontier	Purchase of Si feedstock → back contact formation → conversion layer (CIS layer) process → Buffer layer process → TCO process → lamination → modules
Honda Soltec	- N.A.

[1]: US manufacturing base (2009 production: 30 MW, production capacity: 100 MW/yr)

Table 5b PV modules for residential and utility use (2009) (1/2)

Module Manufacturer	Typical module data						Residential use	Utility use
	Cell technology	W x L x D (mm)	Weight (kg)	Pmax (W)	Vop (V)	Iop (A)		
Silicon wafer-based manufacturers								
Sharp	mc-Si	1 318 × 1 004 × 46	16,0	191	24,31	7,86	√	
	mc-Si	1 165 × 990 × 46	14,5	160	21,28	7,52	√	
	mc-Si	1 165 × 990 × 46	14,5	153	20,3	7,54	√	
	mc-Si	990 × 856 × 46	11,0	114	15,16	7,52	√	
	mc-Si	990 ×856 × 46	8,5	60,5	8,05	7,52	√	
	mc-Si	1 165 × 990 × 46	14,5	142	19,92	7,13	√	
	mc-Si	1 165 × 990 × 46	10,5	71	9,96	7,13	√	
	mc-Si	1 535 × 280× 29,7	7,8	52,5	10,7	4,91	√	
	mc-Si	1 228 × 280× 29,7	6,5	38	7,74	4,91	√	
	mc-Si	1 652 × 994 × 46,5	21	210	28,5	7,37		√
	sc-Si	1 318 × 1 004 × 46	17	180	23,69	7,6		√
	mc-Si	1 318 × 1 004 × 46,5	17	180	24,2	7,44		√
	sc-Si	1 200 x 530 x 35	8,5	84	17,42	4,83		√
Kyocera	mc-Si	1 138 × 1 012 × 36	16,5	183	29,5	8,49	√	
	mc-Si	1 500 × 990 × 36	18,5	208,4	33,2	8,50		√
Sanyo Electric	HIT	1 580 × 812 × 35	15,0	210	41,3	5,09	√	√
	HIT	1 424 × 894 × 35	15,5	210	59,7	3,52	√	√
	HIT	1 319 × 894 × 35	14,0	200	55,8	3,59	√	√
	HIT	1 580 × 812 × 35	15,0	200	40,0	5,00		√
	a-Si							
Mitsubishi Electric (MELCO)	mc-Si	1 658 × 834 × 46	17,0	190	24,7	7,71	√	√
	mc-Si	1 657 × 858 × 46	17,0	190	24,8	7,66	√	√
	mc-Si	1 657 × 858 × 46	17,0	185	24,6	7,52	√	√
	mc-Si	843 × 858 × 46	9,0	92,5	12,3	7,52	√	√
	mc-Si	1 297 × 858 × 46	11,0	92,5	12,3	7,52	√	√
	mc-Si	1 495 x 674 x 46	13,5	130	17,4	7,47	√	√
	mc-Si	559 × 674 × 46	5,5	52	18,7	2,78	√	
Fujipream	mc-Si	1 482 x 995 x 35	17,1	200	26,8	7,47	√	√
	mc-Si	1 164 x 995 x 35	13,6	156	20,9	7,46	√	√
	sc-Si	1 482 x 995 x 35	17,1	212	27,7	7,66		√
	sc-Si	1 164 x 995 x 35	13,6	164	21,5	7,63		√
Choshu Industry	mc-Si	1 634 × 668 × 40	13,5	150	19,6	7,55	√	
	mc-Si	1 476 × 984 ×40	17,0	200	26,3	7,56	√	
	mc-Si	1 634 × 668 ×40	13,5	145	19,4	7,47	√	
	mc-Si	1 476 × 984 ×40	17,0	195	26,2	7,44	√	
	sc-Si (OEM)	1 580 × 812 × 35	15,0	210	41,3	5,09	√	
	sc-Si (OEM)	1 580 × 812 × 35	15,0	205	40,7	5,05	√	
	sc-Si (OEM)	1 453 × 812 × 35	14,0	190	37,6	5,05	√	

Table 5b PV modules for residential and utility use (2009) (2/2)

Module Manufacturer	Typical module data						Residential use	Power use
	Cell technology	W x L x D (mm)	Weight (kg)	P_{max} (W)	V_{op} (V)	I_{op} (A)		
Thin-film manufacturers								
Sharp	a-Si/µ-Si	1 129 x 934 x 46	18	90	48	1,88		√
	a-Si/µ-Si	1 180 x 985 x 14	39	67	-	-		√
	a-Si/µ-Si	1 180 x 985 x 27	63	67	-	-		√
Kaneka	a-Si	960 × 990 × 40	13,7	60	67	0,90	√	√
	a-Si	1 210 × 1 008 × 40	18,3	75	91,8	1,40	√	√
	HB[1]	918 × 350 × 34[2]	4,6	17,5	97,2	0,181	√	
	HB	950 × 465 × 38	5,9	36,5	48,6	0,751	√	√
	HB	1 210 × 1 008 × 40	18,3	110	54,0	2,04	√	√
	HB	1 039 × 349 × 64[3]	5,3	20	117,6	0,171	√	
Mitsubishi Heavy Industries (MHI)	Microcrystalline tandem	N.A.	21	130	101	1,29	√	√
	a-Si	N.A.	21	100	105	0,96	√	√
Fuji Electric Systems	a-Si	3 700 × 466 × 20	14,5	110	157	0,702		√
	a-Si	1 965 × 494 × 1,5	2	55	78,5	0,702		√
Solar Frontier	CIS	671 x 1 235 x 35	12,4	85	42,5	2	√	√
	CIS	671 x 1 235 x 35	12,4	80	41	1,95	√	√
Honda Soltec	CIGS	1 417 × 791 × 37	14,3	125	71,7	1,74	√	
	CIGS	1 417 × 791 × 37	14,3	115	70,0	1,65	√	
	CIGS	1 417 × 791 × 37	14,3	125	215	0,58		√
	CIGS	1 417 × 791 × 37	14,3	115	210	0,55		√

[1] : a-Si/poly-Si hybrid

[2] : working dimensions: 918 mm × 280 mm

[3] : working dimensions: 1 000 mm × 280 mm

Table 5c Present status of certification of module manufacturers (2009)

Module manufacturer	Certification of modules	Certification of plants
Sharp	IEC 61215（VDE, JET）[1] IEC 61646（VDE, JET）[1] IEC 61730-1,-2（VDE, JET）[1] UL1703（UL）[1]	IEC 61215（VDE, JET）[1] IEC 61646（VDE, JET）[1] IEC 61730-1,-2（VDE, JET）[1] ISO 9000-2000（JACO） ISO 14001（JACO） UL1703（UL）[1]
Kyocera	IEC 61215, IEC 61646 ISO 9000 UL 1703	IEC 61215, IEC 61646 ISO 9000 UL 1703
SANYO Electric	IEC 61215 (HIT module) UL 1703 (HIT module) IEC 61730 (HIT module)	IEC 61215 (HIT module) ISO 9000 (HIT module) ISO14001 (HIT module) UL 1703 (HIT module) IEC 61730 (HIT module)
Mitsubishi Electric (MELCO)	IEC 61215 UL 1703 TÜV Class 2 JET PVm	ISO 9000 ISO 14001
Fujipream	IEC 61215 (sc-Si, mc-Si cells), IEC 61730-1, IEC 61730-2	IEC 61215 (sc-Si, mc-Si cells)
Choshu Industry	IEC 61215 IEC 61730	ISO 9001
Kaneka	IEC 61646 (new products also acquired IEC 61730 at the same time) UL 1703 (some of the products) IEC 61730 (acquired IEC 61646 at the same time)	ISO 9001 (the company and its manufacturing subsidiary)
Mitsubishi Heavy Industries (MHI)	IEC 61646(Microcrystalline tandem, a-Si) IEC 61730	ISO 9001
Fuji Electric Systems	IEC 61646 (a-Si)	ISO 9000
Solar Frontier	IEC 61730 (CIS/JET,TÜV) IEC 61646 (CIS/JET,TÜV) UL1703 (CIS/UL)	IEC 61730 (CIS/JET,TÜV) IEC 61646 (CIS/JET,TÜV) ISO 9001(CIS/ Miyazaki Factory, Atsugi Lab.) UL 1703 (CIS/UL)
Honda Soltec	IEC 61646	ISO 9000 2008

Table 5d New developments and products of manufacturers (2009) (1/3)

Cell/Module manufacturer	New developments an new products
Sharp	- To launch a new colored power monitor for PV power generation - Colored power monitor “JH-RWL1” is to be launched, equipped with a “broadband communication function” for the first time for a PV system in Japan. Eligible for trading of Green Power Certificates - http://www.sharp.co.jp/corporate/news/090210-a.html - To introduce into the Japanese market residential solar power generation systems compatible with “Roofit Design” - To introduce into the Japanese market residential solar power generation systems compatible with “Roofit Design” that adopt a new design system that enables efficient installation of photovoltaic modules on a wide range of roof shapes with various roof surface areas. Sales of these systems will begin first in Tokyo. - http://www.sharp.co.jp/corporate/news/090303-a.html - To introduce a new lineup of ten LED-based outdoor lighting products including four models of solar-powered LED lights - Has developed a new line-up of ten LED-based outdoor lighting products (four solar-powered LED lights, two LED security (crime deterrence) lights and four LED lighting fixtures) and will introduce them in succession into the Japanese market over the coming months. Solar-powered LED lights combine solar panels with newly developed high-intensity, long-life LEDs to achieve industry-leading brightness (instrument-measured luminous flux = 1,800 lumens). - http://sharp-world.com/corporate/news/090327.html - Achieved the world’s highest solar cell conversion efficiency of 35,8% - Achieved the world’s highest solar cell conversion efficiency of 35,8% using a triple-junction compound solar cells - http://sharp-world.com/corporate/news/091022.html
Kyocera	- PV modules using high-efficiency back contact technology - Large-sized module with 60 cells
SANYO Electric	- Achieved the world’s highest solar cell conversion efficiency of 23% at a research level for its proprietary HIT solar photovoltaic cells - Achieved a 22,8% cell energy conversion efficiency, for a research-level HIT solar cell using a cell thickness of 98 µm - Achieved a solar cell conversion efficiency of 20% at a mass production level

Table 5d New developments and products of manufacturers (2009) (2/3)

Cell/Module manufacturer	New developments an new products
Mitsubishi Electric	High Efficiency Solar Cell Technology Development (1) Set two world records for photoelectric conversion efficiency in polycrystalline silicon PV cells on a 15 cm x 15 cm x 200 micrometers polycrystalline silicon PV cell, the world's highest photoelectric conversion efficiency of 19,3%[1] was achieved, up by 0,2 percentage point from the previous world's record of 19,1% achieved by Mitsubishi Electric in 2009. The company has renewed the world record[2] for the third consecutive year. The second world record, achieved with the same technologies in an ultra-thin polycrystalline silicon PV cell measuring approximately 15 cm x 15 cm x 100 micrometers, is an efficiency rating of 18,1%[1]. [1]: The conversion efficiency rates have been confirmed by the National Institute of Advanced Industrial Science and Technology (AIST) [2]: Investigated by Mitsubishi Electric as of February 16, 2010 (2) Achieved an industry-leading photoelectric conversion efficiency of 14,8%[3] in a 5 mm x 5 mm thin-film silicon photovoltaic (PV) cell. The thin-film silicon PV cell developed by Mitsubishi Electric has a triple junction structure that utilizes a majority of the solar spectrum for higher efficiency and achieved an industry-leading photoelectric conversion efficiency of 14,8%. [3]: Measured by Mitsubishi Electric on a 5 mm x 5 mm PV cell, initial efficiency Product Development of Modules (1) To launch new high-output modules that use lead-free solder To launch ten new models of photovoltaic (PV) modules for overseas markets. The new high-output modules use lead-free solder and incorporate PV cells with four bus bars. Using the new cells in combination with an increased module size achieves a power output of up to 235 W/module. Shipments will begin on January 15, 2010. Product Development of Inverters (1) To introduce large-scale PV inverters for North American market (Press Release on October 1, 2009) To introduce two photovoltaic (PV) inverters to the North American market. Mitsubishi Electric has already announced the development of new technologies that will help achieve a conversion efficiency rate of 97,5%, the highest rate in 100kW-480V PV inverters at a load of 75% (Press Release on February 18, 2009). 100-kW inverters will be launched in October 2010 and 250-kW inverters in April 2011, respectively for industrial and large-scale power generation in North America. (2) Has developed the world's first technology to maximize output power in photovoltaic (PV) systems (Press Release on February 16, 2010) Has developed the world's first technology to maximize output power in photovoltaic (PV) systems by incorporating a new maximum power-point tracking (MPPT) system in PV inverters. With the MPPT system, power generation properties of PV arrays are continuously and automatically calculated, to operate the PV arrays at the maximum power point of the calculated power generation properties. The technology, which works with a single PV inverter, achieves the maximum power point even when part of a PV array in series-parallel connection is hidden by shadow or dust. (3) To launch new package "IPM[4] for PV power generation" power semiconductor module (Press Release on March 18, 2010) To launch in May 2010 six new models of "IPM for PV power generation" power semiconductor modules, which are used for inverters for residential PV modules, in a smaller package size [4]: Intelligent Power Module: Semiconductor element which has power chip using IGBT, its drive circuits and various protection circuits in one package
Fujipream	- Monocrystalline silicon PV modules using square-shaped monocrystalline silicon solar cells - Light-weight building material-integrated PV (BIPV) module
Choshu Industry	- In-house production of multicrystalline silicon PV modules
Kaneka	- Developed an installation method for PV modules (13 methods for different roof types) which fit 12% hybrid PV modules and glazed slate roof tiles
Mitsubishi Heavy Industries (MHI)	- Commercialization of small- and medium-sized package products for home use

Table 5d New developments and products of manufacturers (2009) (3/3)

Cell/Module manufacturer	New developments an new products
Fuji Electric Systems	- Start of a PV system integration business - Development of light-weight PV modules (55 W, 2 kg/ m^2) - Development of inverters for industrial use (50, 100, 200, 300, 400, 500, 600 kW)
Solar Frontier	- N.A.
Honda Soltec	- Commercialization of PV modules with specifications for European markets - Commercialization of PV modules with artistic designs for residential application - Commercialization of pressure-resistant PV modules - Commercialization of high output models (130 W for industrial use)

Table 5e Plans for future expansion of production capacity

Manufacturer	FY 2009 (MW/yr)	FY 2010 (MW/yr)	FY 2011 onwards	Technology
Silicon wafer-based manufacturers				
Sharp	550	550	Not announced	mc-Si, sc-Si
Kyocera	500	600	1 000 MW/yr by 2010	mc-Si
SANYO Electric[1]	340	565 by the end of FY 2010	Not announced	HIT
	5[1]	5	Not announced	a-Si
Mitsubishi Electric (MELCO)	220	270	600 MW/yr in 2011 onwards	mc-Si
Clean Venture 21	-	-	-	Light-collecting spherical Si
MSK	-	-	-	mc-Si
	-	-	-	a-Si
Fujipream	12	32	100 MW/yr by 2011	mc-Si
Choshu Industry	5	5 - 10	110 MW/yr +30 MW/yr (OEM) by 2011	mc-Si
	N.A.	40 – 50 (in-house) + 30 (OEM)		a-Si
Thin-film manufacturers				
Sharp	160	320	480 MW/yr at the beginning of 2011	a-Si/ μ -Si
Kaneka	70	150	1 GW/yr by summer 2015	a-Si, a-Si/poly-Si hybrid
Mitsubishi Heavy Industries (MHI)	40	40	118 MW/yr	Microcrystalline tandem
	28	28	N.A.	a-Si
Fuji Electric Systems	17	24	40 MW/yr	a-Si
Solar Frontier	80	80	980 MW/yr in the middle of 2011	CIS
Honda Soltec	Max. 27,5	Max. 27,5	N.A.	CIGS

[1] : For consumer products

Table 5f Overseas business activities of PV manufacturers

Manufacturer	New developments an new products
Sharp	- To provide solar cells to the Tokai University team taking part in one of the world's largest solar car races - To provide solar cells to the Tokai University team taking part in the solar car category of the Global Green Challenge - Construction has been completed on Tokai University's solar car equipped with Sharp solar cells - Construction has been completed on Tokai University's solar car equipped with Sharp solar cells boasting the highest level of conversion efficiency in the world. A team from Tokai University will use this solar car in the Global Green Challenge, one of the world's largest solar car races, to be held from October 24 to 31, 2009. - The Tokai University team won the Global Green Challenge - Driving a solar car equipped with Sharp compound solar cells, the Tokai University team won the Global Green Challenge, one of the world's largest solar car races.
Kyocera	- Expanded sales channels in Europe and the USA - Introduced PV modules to large-sized power generation systems - Expansion of PV modules to unelectrified areas
SANYO Electric	- Manufactures PV modules in plants in Mexico and Hungary with the production capacity of 240 MW/year - Expansion of a PV module manufacturing plant in Hungary is underway for increasing production - 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 strategies
Fujipream	- Participated in the exhibition of the Solar Power International 2009
Choshu Industry	- Nothing special
Kaneka	- Localized marketing activities based on the overseas offices with expatriate employees in Europe and Americas
Mitsubishi Heavy Industries (MHI)	- Focused on sales in the Middle East and Europe
Fuji Electric Systems	- Enhancement of sales framework - Expansion of customer base through grouping of products
Solar Frontier (former Showa Shell Solar)	- Established local corporations in Europe and North America as bases of overseas sales activities - Sales activities in Europe, North America and Asia including Australia to expand sales channels - Started sales of products for Europe (Germany) - Agreed with Saudi Aramco to start a joint feasibility study on a small-scale distributed power generation business utilizing solar energy in the Kingdom of Saudi Arabia and conducted a basic research. Based on the feasibility study, a pilot plant is planned to be constructed, to start a full-fledged business after studying technologies for commercialization
Honda Soltec	- Test sales of products in Europe (Germany) - Sample shipments to Asia and North America

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
Price	433	436	440	402

3.4 Manufacturers and suppliers of other components

While several dozen companies manufacture inverters (power conditioners), over ten 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. Eleven 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, and Hyundai Heavy Industry. Delta Electronics, LS Industrial Systems and Hyundai Heavy Industry 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 five companies, GS Yuasa, Sanyo Denki, Mitsubishi Electric (MELCO), Sanken Electric and Ebara Densan are registered. Meanwhile, for large-scale PV systems, standardization of 100 to 250-kW inverters has been promoted, and companies such as Sharp, GS Yuasa, Sanyo Denki, Meidensha, Sansha Electric Manufacturing, and Nissin Electric entered this area. In addition, 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.

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 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. If stand-alone PV systems with micro-grid are commercialized with further price reduction of solar cells, it is expected that standardization of inverters and storage batteries for these applications will be promoted.

Table 7 shows the prices of inverters sold 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 2007	FY 2008	FY 2009
10 - 100 kVA	96 500	93 600	93 600
> 100 kVA	88 000	83 600	83 600

3.5 System prices

Table 8 shows typical applications and the price 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 2009)

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.	613 JPY/W
Grid-connected > 10 kW	Plants, warehouses, commercial buildings, large-scale public facilities, road facilities, railway facilities, etc.	547 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
Public & Industrial (>10 kW)	802	640	534	547
Residential (3 - 5 kW)	683	696	715	613

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 700

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

c) All other, including those within electric utilities, installation companies, etc.: about 18 000

Estimated PV-related labor places in 2008

Research and development (not including companies)	ca. 700
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	ca. 8 000
Distributors of PV products	
System and installation companies	
Utilities and government	
Other	ca. 18 000
Total	ca. 26 700

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
Business value	84,9	110	150	170	200	215	205	150	152,3	290,4

4 Framework for deployment (Non-technical factors)

a) Support measures and new initiatives

Table 10 shows measures and schemes for dissemination of PV systems implemented in FY 2009. In 2009, a subsidy program for residential PV systems started. 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 PV support measures in 2009 (1/2)

	Ongoing measures implemented by	Measures that commenced in 2009
Enhanced feed-in tariffs	-	Established the "Bill 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 to purchase surplus PV power. In November 2009, a new program to purchase surplus PV power generated by PV systems (< 10kW) at a double price of electricity started.
Direct subsidy	- 532 local governments	-
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, but implemented a preferential treatment which double-counts the amount of RPS-equivalent electricity for PV systems	-
Funds for investment in PV	-	-
Tax credits	Non-residential PV systems - Corporate bodies or individuals to introduce PV system (100 kW or more) are eligible for 3-year reduction of property tax (7/8) - Individuals who apply blue return as well as corporate bodies are eligible for special deduction (7%) or special depreciation (max. 30%)	Residential PV systems - Housing tax reduction from income tax for Individuals who buy newly-built house equipped with 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 mortage: reduction of 10% of cost from income tax, maximum amount of installation cost: 3 MJPY
Net metering	-	-

Table 10 PV support measures in 2009 (2/2)

Net billing	- Voluntary purchase program for excess electricity by utilities (until the end of November 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) - 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	-	-

b) New plans of PV system introduction

Based upon the “Fukuda Vision”, a vision by the former Japanese Prime Minister Yasuo Fukuda, presenting how Japan should be in the future, the government at that time made a cabinet decision on the “Action Plan for Achieving a Low-Carbon Society” in July 2008. In the vision, the government set a national goal of increasing installed PV capacity tenfold by 2020 to 14 GW and forty-fold by 2030 to 53 GW from current level. Then, in April 2009, the government announced the J-Recovery Plan (formulated in 2009), with which the target PV installed capacity by 2020 was doubled to 28 GW. In the FY 2008 supplementary budget, METI decided to restart a program to provide subsidy to residential PV systems in January 2009. This program has been continued in FY 2009 and will be implemented in FY 2010. The government also enacted the Bill on the Promotion of the Use of Nonfossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers and legalized the program to purchase surplus PV power. The new power purchase program started on November 1, 2009 for a duration of ten years. The initial purchase price of 48 JPY/kWh will be reviewed and reduced on a yearly basis. Through the new surplus power purchase program and the renewed subsidy program, METI aims to reduce the price of residential PV systems to almost half of the current level within three to five years.

The introduction of new stimulus measures for dissemination of PV power generation has given a great impact on the PV industry and the distribution industry, accelerating the installation of PV systems.

The Ministry of the Environment (MoE) is promoting projects to reduce CO_2 emissions by the use of natural energy under the “Law Concerning the Promotion of Measures to Cope with Global Warming”. In FY 2008, MoE focused on full-fledged efforts to create a low-carbon society based on the “21st Century Environmental Nation Strategy” and has been accelerating measures against global warming in a wide variety of sectors including commercial and residential sectors. For achieving a low-carbon society, MoE started the “Model project to create demand for Green Power Certificates in local communities” and “Project to promote the use of PV and other types of renewable energy” in FY 2009 to promote dissemination of PV power generation.

Based on the “Standards for environmental conservation of government office buildings” and the “Kyoto Protocol Target Achievement Plan”, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has been promoting introduction of green government office buildings using new and renewable energy such as PV systems at ministries and agencies-related office buildings both in central Tokyo and other parts of Japan. In July 2008, the ministry formulated the “Program to reduce environmental burdens at facilities owned by ministries and agencies (Green building program)”. “Model Project to promote eco-CO_2 at residential houses and buildings” was established and subsidy is provided for introduction of technologies such as PV systems to reduce CO_2 emissions. In the “Model project for residential areas co-existing with the environment”,

subsidy has been continuously provided to install PV systems.

Furthermore, the four ministries, namely METI, MEXT, MLIT and MoE announced the “Action plan for the dissemination of PV power generation” in 2008, which was joined by the Ministry of Agriculture, Forestry and Fisheries (MAFF), the Ministry of Internal Affairs and Communications (MIC), the Ministry of Health, Labour and Welfare (MHLW), the National Police Agency (NPA) and the Cabinet Secretariat in 2009. Currently, these nine governmental organizations are working on this action plan.

c) Utilities’ perception of PV

Electric utilities have been supporting deployment of PV systems through 1) net billing system for surplus electricity generated by PV systems, 2) management of the Green Power Fund and 3) fulfillment of the requirements set under the "Law on Special Measures Concerning New Energy Use by Electric Utilities" (Renewables Portfolio Standard Law (RPS Law)). Electric utilities have consistently continued offering the net billing system since FY 1992 and have voluntarily bought back surplus electricity generated by PV power generation at the selling price of electricity across the country.

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 2009, the fund supported PV installations at 1 323 places nationwide, with a total capacity of 24 063,87 kW, mainly at public facilities such as schools and hospitals. In FY 2009, 247 places with a total capacity of 3 387,6 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 2008, 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 2009. The usage volume of electricity generated by new and renewable energy by utilities in FY 2008 was 7 918,1 TWh in total, including 762,8 TWh from PV power generation. The accredited facilities for power generation using new and renewable energy under the RPS Law were 437 203 systems, or a total of 5 854 MW as of March 2009. Among them, PV systems were 436 034, accounting for 1 619 MW of total generation capacity.

Electric utilities also announced that they will accept approximately 10 million kW of electricity generated by PV systems fed into the grid, and strengthened activities on PV power generation. Specifically, the electric utilities, regarding themselves as leading introducers of PV power generation, plan to construct 30 PV power plants with a total capacity of 140 MW nationwide by 2020. Of these plans, specific plans have been announced for the construction of 18 PV power plants with total power generation capacity of the scale of 100 MW nationwide

d) Changes in public perceptions of PV

Since the subsidy program for residential PV systems (70 000 JPY/kW) restarted in January 2009, public awareness and understandings of PV in Japan has been significantly growing. Furthermore, a new program to purchase power at fixed rates was launched in November 2009, under which surplus power generated by residential PV systems is purchased for 48 JPY/kWh. As for PV systems for non-residential applications, types of applications have become more diverse, other than public and industrial applications, along with the expansion of national support programs. Construction of PV power plants as well as multi-family housings equipped with PV systems by individuals are on the rise.

e) Local governments, private businesses and others

532 local governments have been supporting installation of residential PV systems in 2009. In April 2009, Tokyo Metropolitan Government (TMG) established a support program to provide its

residents who install PV systems with the subsidy of 100 000 JPY/kW, which resulted in some 8 000 applications. TMG also has a program to make the amount of generated PV electricity for home consumption into Green Power Certificates.

Housing manufacturers have been increasing its efforts to sell residential houses equipped with PV systems. They are competing in the promotional campaigns via TV and other forms of media. Building materials manufacturers and energy suppliers have been enhancing product development and sales activities for their products employing PV systems, contributing to the dissemination of PV systems. Moreover, large-scale home electric appliances stores who have nationwide distribution networks started the sales of PV systems. Local electric equipment stores, home electric appliances stores, builders and roofers entered the sales and installation of residential PV systems for local residents. Thus, distribution networks of residential PV systems covering from PV manufacturers to end users have been established.

4.1 Indirect policy issues

a) International policies influencing the use of PV systems

In 2005, the government established the Kyoto Protocol Target Achievement Plan to fulfill the obligatory greenhouse gas reduction target designated by the Kyoto Protocol. In the plan, the government recognizes that PV and wind power generation and biomass, etc. significantly contribute to reinforcing measures against global warming and help improve energy self-sufficiency, which will consequently promote introduction of new and renewable energy. In addition, aiming to facilitate multifaceted introduction of new and renewable energy and secure the flexibility of energy use, the government stated in the plan that it would introduce microgrids utilizing PV and wind power generation, biomass, fuel cells and other types of new and renewable energy and would promote implementation, technological development and demonstration of advanced model projects.

The new administration by the Democratic Party of Japan (DPJ) was born after winning the general elections at the end of August 2009. Right after that, in September 2009, the U.N. Summit on Climate Change was held in New York, where the new Japanese Prime Minister Yukio Hatoyama declared that Japan would reduce its greenhouse gas emissions by 25% by 2020 from the 1990 level as a national target. Having set the target of reducing its greenhouse gas emissions by 80% by 2050 and 25% by 2020 from the 1990 level, the government has been negotiating for establishing an international framework after the Kyoto Protocol. In 2009, the government solicited public comments to establish “the Basic Act on Global Warming Countermeasures”, which clarifies the position and the basic direction of policies to achieve the target. The government made a cabinet approval on this act in March 2010. The act carries the following as mid- to long-term targets for reducing greenhouse gas emissions: 1) to reduce greenhouse gas emissions by 25% by 2020 from the 1990 level, assuming that all major countries agree to establish a fair and effective international framework and set aggressive targets; 2) to reduce greenhouse gas emissions by 80% by 2050 from the 1990 level; and 3) to increase the ratio of renewable energy in the supply of primary energy to 10% by 2020. Since June 2009, the government officially participates in the International Renewable Energy Agency (IRENA), which aims to disseminate renewable energy such as PV and wind power generation. Japan signed the Charter at the preparatory meeting of IRENA. IRENA’s annual budget is estimated to be approximately 2.5 BJPY and Japan is expected to allocate the budget for IRENA.

b) Favorable environmental laws and regulations

In April 2009, the national government announced so-called the “J-Recovery Plan” with a target to achieve the national PV installed capacity of 28 GW by 2020.

The Ministry of Economy, Trade and Industry (METI) enacted the Bill on the Promotion of the Use of Nonfossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers in July 2009, and decided to oblige electric utilities to purchase surplus PV power. Under the new bill, a new program to purchase electricity at fixed rates was launched. Along with the start of the new program, the amount of electricity for purchase at fixed rates was excluded from the amount of electricity generated from new and renewable energy sources which electric utilities

have been obliged to use under the Special Measures Law Concerning the Use of New Energy by Electric Utilities ("RPS Law"). Furthermore, METI positioned PV power generation facilities as “environmental facilities other than green spaces” under the Factory Location Act and decided to deregulate the ratio of green spaces in these facilities.

c) Environmental Tax (CO_2 Tax)

The Ministry of the Environment is taking the initiative for studying introduction of the Environmental Tax. In the Kyoto Protocol Target Achievement Plan which was approved at the Cabinet meeting in April 2005, the national government defines the Environmental Tax as “a challenge that needs to be carefully and comprehensively studied” and continues studying by the entire government along with the plan. However, MoE’s proposal to establish the Environmental Tax in FY 2007 was put on the shelf. The “Mid-term program to establish a sustainable social security and to secure stable financial resources” was approved at the Cabinet meeting in December 2008. In the program, it was stated that, as the basic direction of the drastic tax reform, the entire taxation system would be changed to a greener one, from the perspective of promoting reduction of carbon emissions. In November 2009, the Ministry of the Environment announced a specific plan of the tax addressing the global warming. Effects and impacts of introduction of the Environmental Tax are under study. Also, effects of introduction of the Environmental Tax on dissemination of PV systems are unknown at this moment.

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. 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). The Ministry of the Environment (MoE) and the New Energy and Industrial Technology Development Organization (NEDO) have been conducting specific researches on these activities. In India, they are scheduled to start a demonstrative research project on technologies at large-scale PV power plants with the assumption of implementing CDM.

In cooperation with developing countries which have natural conditions and social systems that are not seen in Japan, the New Energy and Industrial Technology Development Organization (NEDO) have implemented International Cooperative Demonstration Project Utilizing Photovoltaic Power Generation Systems in Thailand, China, Malaysia, Vietnam, Nepal, Mongolia, Myanmar, Cambodia, Laos and Indonesia in order to develop technologies for practical use of PV systems and promote introduction and dissemination. In addition, NEDO started “International Cooperative Demonstration Project for Stabilized and Advanced Grid connection PV Systems” in FY 2006, which is an international demonstration and development program using PV power generation. Aiming at stable supply of electricity by establishing a microgrid mainly with a higher usage ratio of PV power generation, joint demonstrative projects have been conducted in China, Thailand, Indonesia and Malaysia. NEDO have also been working on capacity building utilizing PV and other technologies in Asian countries.

NEDO also has a plan to implement an US-Japan cooperative demonstration project on smart grid in New Mexico, USA. After hosting workshops, NEDO will participate in 2 of 5 projects conducted in Los Alamos and Albuquerque. In the Loas Aramos Projet, demonstration of 2-MW PV plant and 1 MW storage batteries and installation of residential PV systems and storage batteries in 200 residential houses. Autonomous operation in the distribution grid is also planned. NEDO selected contracting companies and start establishment of the system from FY 2010 and demonstration research in the site in FY 2011.

JICA, Japan International Cooperation Agency implements inter-governmental free-of-charge cooperation, paid cooperation 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 2009, JICA installed PV systems in island nations in the South Pacific and Yemen, while 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 provides finances for business development and trading to the governments of developing countries.

PV power generation is an effective energy technology to improve living standards in developing. In 2009, the national government re-announced its policy to actively promote technical support for developing countries in order to take initiative in negotiations over the establishment of an international framework to reduce greenhouse gas emissions from 2013 onwards, after the Kyoto Protocol. As a new support measure, the government will make an investment in the environment of developing countries in Asia and other regions with 5 BUSD over 2 years, through the Japan Bank for International Cooperation (JBIC). The government plans to supply electricity generated from PV systems through a grant aid for environmental programs with 27,4 BJPY.

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 system

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 system which is conducted mainly in Europe, covering non-concentrator type PV modules for terrestrial installation or crystalline 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 (for crystalline PV modules) and IEC61646 (for thin-film PV modules).

Furthermore, the following safety standards were added in 2006:

- TS C8992-1 (2006) (IEC61730-1 Ed.1 2004): Certification of safety conformity of PV modules - Part 1: Structure requirements

- TS C8992-2 (2006) (IEC61730-2 Ed.1 2004): 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 2009, the number of certified PV modules from 24 manufacturers that have been registered is 1 683 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 1, 2009, 48 types of inverters by 14 manufacturers have been registered.

Table 11 Standardization Framework for PV Systems

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)	Revision under discussion
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	
			-	Standards for electromagnetic compatibility of PV systems	Under discussion
Solar Cell	Crystalline Solar Cell	Reference	C 8910:2001	Primary reference solar cells	
			C 8911; 1998	Secondary reference crystalline solar cells	
			C 8921, 2008	Photovoltaic devices - Part 2: Requirements for reference solar devices	
		Solar simulator	C 8912; 1998	Solar simulators for crystalline solar cells and modules	
		Crystalline solar cells	C 8913; 1998	Measuring method of output power for crystalline solar cells	
			C 8915; 1998	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; 1998	Crystalline solar PV modules	
			C 8916; 1998	Temperature coefficient measuring methods of output voltage and output current for crystalline solar cells and modules	
			C 8914; 1998	Measuring method of output power for crystalline solar PV modules	
			C 8917; 1998	Environmental and endurance test methods for crystalline solar PV modules	
			C 8919; 1995	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; 1995	Secondary reference amorphous solar cells	
			C 8932; 1995	Secondary reference amorphous solar submodules	
		Solar simulator	C 8933; 1995	Solar simulators for amorphous solar cells and modules	
		Amorphous solar cell	C 8934; 1995	Measuring method of output power for amorphous solar cells	
			C 8936; 1995	Measuring methods of spectral response for amorphous solar cells and modules	
		Amorphous solar PV modules (thin-film solar PV modules)	C 8939; 1995	Amorphous solar PV modules	
			C 8937; 1995	Temperature coefficient measuring methods of output voltage and output current for amorphous solar cells and modules	
			C 8935; 1995	Measuring method of output power for amorphous solar modules	
			C 8938; 1995	Environmental and endurance test methods for amorphous solar cell modules	
			C 8940; 1995	Outdoor measuring method of output power for amorphous solar cells and modules	
			C8991; 2004	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	
			-	Measuring methods of spectral response for CIS solar cells	Under discussion
			-	Secondary reference CIS solar cells	Under discussion
			-	Measuring method of output power for CIS solar cells and modules	Under discussion
			-	Measuring methods of spectral response for CIS solar cells	Under discussion
			-	Solar simulator for CIS solar cells	Under discussion
			OITDA PV01	Evaluation method of performance for dye-sensitized solar devices	
Modules			TS C 8992-1	Confirmation of safety eligibility of PV modules - No. 1: Requirements for structure	
			TS C 8992-2	Confirmation of safety eligibility of PV modules - No. 2: Requirements for testing	
			-	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; 1996	General rules for photovoltaic array	
		C 8952; 1996	Indication of photovoltaic array performance	
		C 8956; 2004	Structural design and installation for residential photovoltaic array (roof mount type)	Revision under discussion
		C 8954; 2006	Design guide on electrical circuits for photovoltaic arrays	
		C 8955; 2004	Design guide on structures for photovoltaic array	Revision under discussion
		C 8953; 2006	On-site measurements of crystalline photovoltaic array I-V characteristics	
		C 8956; 2004	Structural design and installation for residential photovoltaic array (roof mount type)	
	Power conditioner	C 8980; 2009	Power conditioner for small photovoltaic power generating system	
		C 8961; 1993	Measuring procedure of power conditioner efficiency for photovoltaic systems	
		C 8962; 1997	Testing procedure of power conditioner for small photovoltaic power generating systems	
		-	Method of testing anti-independent operation of power conditioners for grid-connected PV systems	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	

[1]: TR: Technical Report (standard information)

Source: The Japan Electrical Manufacturers' Association (JEMA)

5 Highlights & Prospects

5.1 Highlights

The government enacted the “Act on the Promotion of the Use of Nonfossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers” to legislate a framework to strongly promote introduction of PV systems. In order to take the initiative in introducing PV systems as the government and promote collaboration among ministries and agencies, the government increased the number of ministries and agencies which implement action plans for introduction of PV power generation from four to nine. The Ministry of Economy, Trade and Industry (METI) resumed a subsidy program for residential PV systems, which was terminated in 2005 and started supporting dissemination of PV systems. In addition, 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”, which was enacted in July 2009, the ministry doubled the purchase price of surplus PV power from 24 JPY/kWh to 48 JPY/kWh and started the new PV power purchase program on November 1, 2009. METI also formulated the “Industrial Strategy for PV Power Generation” and showed significance of PV power generation not only from the perspective of energy and environmental policies, but also from the perspective of industrial policy.

Local governments have started providing their own support programs for residential PV systems one after another, in response to the restart of the subsidy program for residential PV systems by the national government. As many as 532 municipalities have implemented their own support programs.

Electric utilities also have a series of plans to construct MW-scale PV power plants with the total capacity of 140 MW at 30 locations across Japan by 2020, to show themselves as taking initiative in PV introduction. Specific plans have been made for the construction of 18 PV power plants including an 18-MW PV power plant planned by Kansai Electric Power Co., Inc. in Sakai City, Osaka Prefecture. Plans for PV power plants with total power generation capacity of the scale of 100 MW nationwide were announced.

In the PV industry, a number of businesses enhanced their PV-related activities or entered a variety of PV-related sectors, against the backdrop of estimated significant growth on a mid-term basis despite the short-term slump of overseas markets, and expected recovery of demand backed by the restart of the national subsidy program. In the area of silicon feedstock and wafer manufacturing, some PV players enhanced their production capacity, expanded businesses in overseas markets and advanced their entry plans. Meanwhile, there were other events in the PV industry. A Taiwanese manufacturer acquired a Japanese manufacturer. A Japanese manufacturer advanced its plan to construct a new plant under the joint venture with a European partner. In the area of solar cell manufacturing, some PV players announced their plans to increase their production capacity to GW-level production. A manufacturer announced a plan to manufacture thin-film silicon PV modules under the joint venture with a petroleum company. Some manufacturers entered the manufacturing of PV modules. Under such circumstances, conversion efficiency of solar cells has been improved. Some Chinese manufacturers started entering the Japanese market. In the area of manufacturing components for PV modules, some manufacturers increased their production capacity of various components including backsheets and encapsulants. A number of manufacturers newly entered the PV components market. In the area of manufacturing systems, power source manufacturers started development of large-sized power conditioners, while heavy electric machinery manufacturers entered the MW-scale power generation business. In the area of manufacturing equipment for solar cells, manufacturers promoted sales alliances with overseas manufacturers and increased their production capacity. 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 distribution industry, an increasing number of home electric appliances stores and major supermarkets started the sales of residential PV systems and expanded their sales networks. PV system users got to have higher awareness of dissemination of PV systems and were encouraged to introduce more PV systems as the national government provided subsidy and preferential tax treatment for PV systems for public and industrial applications. Accordingly, more PV systems

were installed in public, industrial and commercial facilities as well as electric utility facilities.

In 2009, the Japanese domestic PV market was revitalized thanks to the efforts to expand dissemination of PV systems which have been promoted since 2008. So far, the installed capacity in the Japanese PV market hovered around 200 - 300 MW. In 2009, it was expanded to nearly 500 MW. A new program to purchase surplus PV power based on the legislation and the restart of a subsidy program for residential PV systems have been a significant driving force for the Japanese PV market to make a step forward to achieve full-fledged dissemination of PV systems. This driving force is motivating a variety of industries required for a full-scale dissemination of PV systems and started creating a large number of jobs across the nation.

5.2 Prospects

Based upon the “Action Plan for Achieving a Low-Carbon Society” formulated in 2008 and the “J-Recovery Plan” formulated in 2009, establishment of the environment for dissemination of PV systems has been promoted with the restart of the subsidy program for residential PV systems and a new program to purchase surplus PV power at a double price of that of conventional electricity. With these support measures, Japan’s PV market returned to a growth trajectory. The new administration was born in October 2009, consisting of the Democratic Party of Japan (DPJ) as a majority and two other parties. Aiming to further expand dissemination of renewable energy, the Hatoyama administration reviewed the former energy strategy of the government and has been formulating basic principles of its energy policy towards 2030. As its basic standpoint, the new administration plans to promote nuclear power and renewable energy to a maximum extent, focusing on the following: 1) enhancement of comprehensive energy security; 2) strengthening of measures against global warming; 3) realization of energy-oriented economic growth; 4) securing of safety and public understanding; 5) securing of efficiency with the use of market functions; and 6) structural reform of energy industries. The government recognizes the need to promote dissemination of renewable energy as a significant energy source from the viewpoints of measures against global warming, improvement of energy self-sufficiency ratio, diversification of energy sources, cultivation of environment-related industries, and so on. For the dissemination of renewable energy, the government plans to implement necessary measures including establishment of a program to purchase the entire electricity generated from renewable energy sources at fixed rates, promotion of installation of renewable energy facilities, improvement of electric grids and appropriate review of regulations. As for dissemination of PV systems, a program to purchase the entire electricity generated from renewable energy sources at fixed rates has been deliberated to enact it into law. It is expected that this program will contribute to expanding introduction of renewable energy not only in the residential sector but also in non-residential sectors. In order to promote dissemination of renewable energy including PV power generation, the government is also working on the following issues, in addition to establishing a program to purchase electricity at fixed rates: 1) measures for grid stabilization; 2) measures for supporting introduction of renewable energy; 3) promotion of technology development and demonstrative researches; and 4) promotion of deregulation. To implement these measures and activities, the government plans to utilize all the necessary policy measures such as regulations, budgets, tax systems and financial measures. The PV industry will also continue strengthening efforts to achieve full-fledged dissemination of PV power generation through technology development, enhancement of production capacity and collaboration with industries using PV power generation. Through these activities, the PV industry will promote cost reduction of PV systems, expansion of markets, as well as development of new markets. In addition to these activities, dissemination of PV power generation in Japan is expected to make progress toward achieving the near-term target domestic market size of 1 GW or more at an early date, with the mutual understanding with the nation, as well as with the support by users such as ministries and agencies, local governments, private businesses and individuals.

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)

- 5,562 MJPY (2007)

(Source: The National Livelihood Survey, The Ministry of Health, Labour and Welfare, according to the survey conducted in 2008)

5) Typical mortgage interest rate

- 3,37 to 4,07% (minimum rate and maximum rate from January to December 2009, 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: 125 - 141 JPY/liter (FY 2009, including 5% consumption tax)
- Regular gasoline: 114 - 130 JPY/liter (FY 2009, including 5% consumption tax)
- Diesel oil: 100 - 110 JPY/liter (FY 2009, 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 (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 2009/ problems and lessons learned	Funding	Project Management	Remarks
- New energy in general - Eligible PV systems: grid-connected (≥ 10 kW) - Subsidy for PV: the lower amount of either up to half of the installation cost or 400 000 JPY/kW - 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 2002: 78 PV systems (9 995 kW) were installed - FY 2003: 70 PV systems (8 301 kW) out of 101 qualified systems - 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 - 978 PV systems totaling 101 220 kW will be installed between FY 1998 and 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	- NEDO (- FY 2008) - NEPC[1] (FY 2009 -)	Total budget from FY 1997 to FY 2009 is 111 749 MJPY

[1] : 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 2009/ 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) or 90% of debt guarantee	- 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	- 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	- NEDO (- FY 2002) - METI (FY 2003 -) - METI, NEDO (FY 2007 -) - NEPC, NEDO (FY 2009 -)	The total budget between FY 1997 and FY 2009: 318 103 MJPY

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 2009/ 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 2002: PV systems were qualified to 163 schools - FY 2003: PV systems were qualified to 68 schools - FY 2004: PV systems were qualified to 53 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 - A larger number of schools introduced PV systems. - 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[1]: Expenses for investigation of basic planning FY 1998: 28 MJPY FY 1999: 28 MJPY FY 2000: 28 MJPY	- MEXT[1] - ANRE, METI - MAFF[2] - MoE[3]	- 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 -Environment-friendly school facilities by private schools (school corporations) will also be supported as part of the initiative.

[1]: MEXT: Ministry of Education, Culture, Sports, Science and Technology [2] : MAFF: Ministry of Agriculture, Forestry and Fisheries [3] : MoE: Ministry of the Environment