IEA 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 2002

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i Forward

The international Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organization for Economic Co-operation and Development (OECD), which carry out a comprehensive program 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 Program (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 twenty member countries are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Mexico (MEX), The Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), The United Kingdom (GBR) and The United States of America (USA). The European Commission is also a member.

The overall programme is headed by an Executive Committee composed of one representative from each participating country, while the management of individual research projects (tasks) is the responsibility of Operating Agents. Eight tasks have been established, and currently five are active. Information about these tasks can be found on the public website www.iea-pvps.org. A new task concerning urban-scale deployment of PV systems is being developed.

The objective of Task 1 is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems.

ii Introduction

An important deliverable of Task 1 is the annual International Survey Report on PV power applications, and is based on the information provided in the National Survey Reports that are produced annually by each national expert and other participants of Task1.

iii Definitions, symbols and abbreviations

For the purposes of this report, 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 PV array under standard test conditions (STC) – irradiance of 1 000 W/m2, cell junction temperature of 25 , AM 1,5 solar spectrum.

Peak 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 Wp or more.

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

Off-grid domestic PV power system: System installed in households and villages that are not connected to the utility grid. Usually a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'.

Off-grid non-domestic PV power system: Systems used for a variety of 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 (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'.

Grid-connected distributed PV power system: System installed on consumers'premises usually on the demand side of the electricity meter. This includes grid-connected domestic PV systems and other grid-connected PV systems on commercial buildings, motorway sound barriers, etc. These may be used for support of the utility distribution grid.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station.

Turn-key price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid system, the prices associated with battery maintenance/replacement are excluded. If additional costs are incurred for reasons not directly related to the PV system, these should be excluded.

Field Test Program: A program to test the performance of PV systems/components in real conditions

Demonstration Program: A program 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 financing industry, utilities etc.

NC: National Currency

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

1 Executive summary

In 2002, there are the following movement related to the introduction and promotion of photovoltaic power systems.

(1) The Ministry of Economy, Trade and Industry (METI) established the Law Concerning the Use of New Energy by Electric Utilities (Renewables Portfolio Standard (RPS) Law) as new policy to promote and deploy new and renewable energy.
(2) Application number of "Residential Photovoltaic (PV) System Dissemination Program" exceeded 40 000 and installation of total 160 MW of PV systems are expected. METI decided to extend the program for three years.
(3) "Demonstrative Research on Clustered PV systems" was started. PV systems are to be installed in 400 residences in a selected area under the research.
(4) Solar cell and PV module manufacturers significantly increased production capacity to correspond growing demand of solar cells and PV modules.
(5) Electric utilities extended introduction of PV systems through "Green Power Fund".

Installed PV power

PV market in Japan, especially market for grid-connected PV systems, continues to increase satisfactorily in 2002. The breakdown of installed PV systems in 2002 is 50 kW for off-grid domestic application, 5 770 kW for off-grid non-domestic application, and 178 209 kW for grid-connected distributed application, especially in residential sector. No grid-connected centralized application was installed. The total installed capacity in 2002 amounted to 184 029 kW, 50% increase from 2001 (122 587 kW). A primary factor of this significant increase was that the application number of "Residential PV System Dissemination Program" reached on the scale of 40 000.

Costs & prices

The prices of solar cells, PV modules and PV systems are steadily decreasing owing to Government's financial support policies on R&D and introduction for PV systems, and ambitious effort by PV manufacturers. Average prices of PV modules decrease to 463 JPY/W in 2002 from 484 JPY/W in 2001 (about 10% decrease). In addition, typical prices of PV systems decrease to about 850 JPY/W in 2002 from 950 JPY/W in 2001 (about 9% decrease) for PV systems with more than 10 kW capacity for public and industrial facilities use, and to 720 JPY/W in 2001 from 770 JPY/W in 2002 (about 10% decrease) for 3-5 kW PV systems for residential use.

PV production

2002 production of solar cells and PV modules in Japan recorded 258,0 MW, and increased substantially for 6 consecutive years. The production of solar cells and PV modules in 2001 was 173,4 MW. Since Japan became the largest PV production country in the world in 1999, overtaking USA, and the share of Japan in worldwide PV production exceeded 40%.

The breakdown of production was 62,4 MW of single crystalline silicon (sc-Si) solar cells, 184,0 MW of multicrystalline (mc-Si) solar cells, 11,5 MW of amorphous silicon (a-Si) solar cells, and 0,0 MW of other solar cells. The market share of crystalline Si solar cells is about 95%. Multicrystalline silicon solar cells have overwhelmingly dominated over the solar cell market in Japan for the last 8 years and kept up with the growing solar cell market in Japan. Crystalline Si solar cells have been significantly growing in quantity, with the backing of expansion of PV market for electric power use owing to the Government's

“Residential PV System Dissemination Program” and “PV Field Test Project for Industrial Use”, Introduction of PV systems by electric utility companies with “Green Power Fund”, demand of professional applications, such as traffic sign, telecommunication, as well as expansion of export. Amorphous silicon solar cells are turning to increase the production, because a-Si solar cells began to be used for electric power application.

Budgets of PV

2002 national budgets for photovoltaics of the Ministry of Economy, Trade and Industry (METI) totaled 35 000 MJPY (31 930 MJPY in 2001), of which was 7 300MJPY (6 360 MJPY in 2001) for R&D, 4 500 MJPY (2 060 MJPY in 2001) for demonstration/field programs, and 23 200 MJPY (23 510 MJPY in 2001) for market incentives. 2002 budgets were increased in all the areas, PV market incentives, R&D and demonstration/field programs, and especially focused on dissemination, compared with 2001 budgets.

The budgets for major 2002 national programs of METI are as follows;

1) Photovoltaic Power Generation Technology R&D: 7 300 MJPY
2) Residential PV System Dissemination Program: 23 200 MJPY
3) PV Field Test Project for Industrial Use: 4 500 MJPY
4) Financial Support for Entrepreneurs Introducing New Energy: 23 620 MJPY
5) Introduction and Promotion of New Energy at the Regional Level: 12 700 MJPY
6) Project for Introduction and promotion of New Energy at the Regional Level: 1 020 MJPY
7) Support Project for Local Efforts to Introduce New Energy: 1 230 MJPY
8) Support Program to Arrest Global Warming: 470 MJPY

The budgets for items 4, 5, 6, 7, and 8 include other new energies as well as PV.

In addition to METI, the Ministry of Land, Infrastructure and Transport, the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of the Environment, the Cabinet Office and the Postal Service Agency are promoting the introduction of PV systems, but the detailed budgets do not published.

Many local governments and municipals have implemented their own subsidy programs that can be added to the Government’s subsidy, but their budgets are unknown.

2 The Implementation of PV systems

2.1 Applications for photovoltaics

The amount of solar cells introduced to PV systems in 2002 for the second year running has been increasing by growing the market in the sector of PV systems for private houses, public facilities, industrial facilities and commercial buildings by financial support of METI. Especially residential PV systems are increasing on a scale of annually more than 40 000 systems, mainly in range of 3-5 kW per house. As the new trends in residential PV systems, introduction of PV systems in public housings by local governments, concentrative mass introduction of PV systems in newly developed residential districts by developers, and introduction of PV systems in collective housings also started. In 2002, the demand of residential PV systems was accounted for 87% of total PV demand in Japan. PV systems for public facilities, accounted for about 2,8%, steadily installed year after year. 10-50 kW PV systems were installed mainly to kindergartens, schools, governmental offices, hospitals,

welfare facilities, libraries, parks, public halls and filtration plants. Furthermore, 10-100 kW PV systems for industrial use are installed to rooftops and roofs of factories, warehouses, laboratories and so on. 10-100 kW PV systems for commercial buildings are installed to rooftops, roofs and exterior walls of head offices, business offices, branch offices. PV systems for service stations and railroad facilities use were newly developed and introduced. Installation of PV systems for industrial buildings, commercial buildings and other industrial facilities is 6,9% in total and is increasing every year. For new buildings, building integrated PV systems, are applied to roofs, rooftops, outer walls, canopies, louvers and so on. Besides, off-grid non-domestic PV systems without governmental support are utilized as power supplies for telecommunication, traffic sign, remote monitoring, ventilating fan, lighting and the like.

2.2 Total photovoltaic power installed

Table 1 shows the cumulative installed PV power in 4 sub-markets. Grid-connected distributed PV application dominates over the PV market in Japan. As off-grid domestic market, there are PV application for mountain cottages, remote area and island, but the market scale is very small. Main PV applications in off-grid non-domestic market include power supplies for streetlight, telecommunication, pumping, remote measurement emergency measure for disaster, agriculture, traffic sign, ventilating fan and the like. Off-grid non-domestic market has already been built up as the commercial market in Japan. PV systems for demonstration have been installed so far to promote grid-connected centralized market, but no PV system has been installed since 1995. Grid-connected distributed market has remarkably expanded year after year mainly because PV system installations to private houses, apartment houses, public utilities, industrial facilities, commercial buildings have increased by financial support of METI, and other ministries, government offices and local governments are taking the lead in installing PV systems to their own facilities. The development of PV market has been focused on 3-5 kW residential PV systems and 10-100 kW PV systems for public facilities, industrial facilities, commercial buildings. The ripple effect extends to housing manufacturers, battery manufacturers, building material manufactures and construction companies as well as PV cell manufacturers. As a result, user-oriented PV markets in Japan are developed and activated.

Table 1: 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
off-grid domestic	150	200	250	300	350	400	450	500	550	600	650
off-grid non-domestic	15 260	19 170	23 260	29 360	35 890	44 900	52 300	56 200	63 000	66 227	71 997
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
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
TOTAL	19 000	24 270	31 240	43 380	59 640	91 300	133 400	208 600	330 220	452 813	636 842

2.3 Major projects, demonstration and field test programs

Main demonstration programs that were implemented in 2001 were “Residential PV System Dissemination Program”, ”PV Field Test Project for Industrial Use”, “Introduction and Promotion of New Energy at the Regional Level”, “Financial Support Project for Entrepreneurs Introducing New Energy”, “Support Project for Local Efforts to Introduce New Energy”, “Support Program to Arrest Global Warming” and “Eco-School Promotion Pilot Model Project”.

(1) Residential PV System Dissemination Program

“Residential PV System Dissemination Program” started on April 1997 to enlarge further the scale of PV promotion in “Residential PV System Monitor Program”.

“Residential PV System Dissemination Program” aims to subsidize the PV installation cost for individuals on the condition that they understand the significance of PV introduction and provide the operation data of their PV systems. The subsidy is given three categories, (i) an individual who is going to install PV systems to his own house, (ii) housing supplier of housing development complex or supplier of houses built for sale and (iii) local public organization who is going to introduce PV systems to public house. Less than 10 kW PV systems with reverse power flow connected to low voltage line is subsidized. Subsidy per 1 kW in 2002 is provided 100 000 JPY plus sales tax.

In 2002, 42 837 applicants (161,8 MW) were accepted. The application number significantly increased from the previous year. In 2001, 25 151 applicants (91,0 MW) were accepted. Residential PV systems have been installed to 20 877 houses, 74,4 MW in 2000; 15 879 houses, 57,7 MW in 1999; 6 352 houses, 24,1 MW in 1998; to 5 654 houses, 19,5 MW in 1997; to 1 986 houses, 7,5 MW in 1996; to 1 065 houses, 3,9 MW in 1995 and to 539 houses, 1,9 MW in 1994. Residential PV systems have been installed to 77,503 houses and cumulative installed capacity reached 280,0 MW at the end of 2001.

(2) PV Field Test Project for Industrial Use

This program started in 1998. The aim is; (i) to install in trial PV systems using new technology effective to introduce to industrial sector, such as industrial facilities, (ii) to demonstrate availability for introduction of PV systems by collecting data and analyzing a long-term operation under demonstration test and (iii) further standardization and diversified introduction applications toward full scale deployment of PV systems. Eligible for subsidy are private company, local public organizations and other organizations, which are going to install modular type PV systems and novel application of PV systems.
Half of PV installation cost is subsidized.

PV systems, especially 10-100 kW PV systems, have been installed to schools, welfare facilities, manufacturing plants, warehouse, office buildings, private facilities, and so on.

In 2002, 207 systems, 4 800 kW in total were installed. The breakdown of installations in 2002 was 184 systems, 4 200 kW for modular type and 23 systems, 600 kW for novel application type. 218 PV systems, 4 890 kW were installed in 2001, 149 systems, 3 680 kW in 2000, 93 PV systems, 2 790 kW in 1999, 73 PV systems, 1 940 kW in 1998. Cumulative installed PV systems will be total 740, 18 100 kW at the end of 2002.

(3) Support Project for Local Efforts to Introduce New Energy

This project aims at accelerating new energy introduction by supporting the regional projects that governments established for new energy.

Eligible for subsidy are local public organizations who are going to introduce and promote PV, wind power, solar thermal, differential temperature energy, natural gas co-generation, fuel cells, wastes generation, use of waste thermal, production of wastes fuel, clean energy car, energy saving measurements. PV systems with 50 kW output and over are subsidized.

In addition, PV system with 10 kW output and over for Eco-School Promotion Pilot Model Project are also subsidized. Up to half or one third of system installation cost is subsidized for the project of new energy introduction, depending upon cases, and fixed amount (up to 20 MJPY) is subsidized for PV recognition and introduction projects.

In 2002, 66 systems in total were subsidized and 26 PV systems (2 676 kW) out of them were installed. In 2001, PV systems (3 160 kW in total) were 15 out of 37 qualified systems, and were subsidized. In 2000, 14 PV systems (2 124 kW) out of 28 qualified systems, and in 1999, 19 PV systems (1 554 kW) out of 37 qualified systems were subsidized. In 1998, 16 systems were subsidized and 4 systems (500 kW) out of them were PV systems installed to elementary schools and city halls. The accumulated capacity and system installed and planned to be installed from 1998 to 2005 will be 10 014 kW, 78 systems in total.

(4) Financial Subsidy Project for Entrepreneurs Introducing New Energy

This project aims at accelerating new energy introduction by supporting the industrialists who set about introducing new energy, such as PV, wind power, solar thermal, differential temperature energy, natural gas co-generation, fuel cells, wastes generation, use of waste thermal, production of wastes fuel, from a viewpoint of energy security and global environmental protection.

Eligible for guaranteed debt or subsidy are private entrepreneurs who set about new energy business. A third of system installation cost is subsidized and guaranteed debt is 90% of a debt.

In 2002, PV system was 1 out of 25 qualified systems and its capacity was 25 kW. In 2001, a 140 kW PV system out of 32 qualified systems was subsidized. In 2000, 26 systems were qualified, but there was no eligible PV system. In 1999, a 100 kW PV system out of 32 systems and in 1998, a 116 kW PV system out of 18 qualified systems were qualified.

(5) Support Program to Arrest Global Warming

The program was established in 2001 aiming at supporting the activity of prevention against global warning at regional level. The targeted sectors are local governments, local communities, environmental NPOs and so on, and are provided the subsidy of less than half or one third of facility installation cost for power generation, utilization of heat and energy efficiency, depending on cases. In 2002, PV systems were 10 out of 34 projects in 14 areas and qualified. In 2001, PV systems were 14 out of 34 projects in 15 areas and qualified.

(6) Project for Introduction and Promotion of New Energy at the Regional Level

This project established in 2000 aims at promoting new energy introduction by assisting the support project that NGOs, and the like help the introduction of new energy facilities by third parties. The subsidy is provided half of eligible cost. In 2002, 82 PV systems, 776 kW in total were qualified. In 2001, 25 PV systems, 211 kW in total were qualified.

(7) Eco-school Infrastructure Promotion Pilot Project

This Project initiated in 1997 with the partnership of METI and Ministry of Education, Culture, Sports, Science and Technology (MEXT). The project aims at implementing pilot model projects to demonstrate and promote environmental-friendly schools, providing students with environmental education, and further improving school facilities.

Eligible projects are (a) new energy utilization, including PV, solar thermal, wind power, geothermal and fuel cells, (b) tree planting promotion (c) waste water utilization, and (d) energy efficiency.

The MEXT provides the subsidy of fixed cost with investigation for fundamental planning, the subsidy of half of cost with new school building and one-thirds of cost with rebuilding and retrofitting. METI's subsidy is available for PV system installation.

PV systems were installed to 47 schools (460 kW) in 2002. 38 schools (620 kW) in 2001, and 36 schools (770 kW) in 2000, 16 schools (370 kW) in 1999, 11 schools (350 kW) in 1998, and 13 schools (450 kW) in 1997 were qualified to install PV systems.

From 1998 to 2001, 275 PV systems were introduced to 133 national universities under "Eco-Campus Project". Total installation capacity was 3 865 kW.

Table 2: Summary of major projects, demonstration and field test programs (continued)

Project Data plant start up	Technical data/ Economic data	Objectives	Main accomplishments until the end of 2002/ problems and lessons learned	Funding	Project Manage-ment	Remarks
Residential PV System Dissemination Program (1994~)	- Grid connected, residential - Eligible system rate 1994~1996: ≤4~5 kW 1997 : ≤4 kW 1998~1999: ≤10 kW 2000 : ≤4 kW 2001 :≤10kW 2002 :≤10 kW - Subsidy: see NOTE 4	- Perception to PV - Dissemination of PV - Collection of PV operation data	- 31 475 residential PV systems were installed in total from 1994 to 1999 (114,6 MW). - 20 877 PV systems were installed in 2000 (74,4 MW). - 25 151 PV systems were installed in 2001 (91,0 MW). - 42 837 PV systems were accepted in 2002 (161,8 MW). - Better understanding to PV has been promoted. - Cost of systems reduced to 712 000 JPY/kW - Novel types of building integrated PV modules such as roof material integrated and triangular-shaped PV modules were developed. - Commercialization of Housings equipped PV systems as standard equipment was promoted. - Education for installers of residential PV systems was advanced.	- METI[1], ANRE[2] - Budget: 1994 2 030 MJPY 1995 3 310 MJPY 1996 4 056 MJPY 1997 11 110 MJPY 1998 14 700 MJPY 1999 16 040 MJPY 2000 14 500 MJPY 2001 23 510 MJPY 2002 23 200 MJPY	- NEF[3]	- Applications for residential PV system subsidy have been increased year by year. - Total budget 1994 to 2002 was 112 456 MJPY. - Title of "Residential PV System Monitor Program" changed to" Residential PV System Dissemination Program" in 1997.

NOTE)

1. ANRE: Agency of Natural Resources and Energy
2. METI: Ministry of Economy, Trade and Industry
3. NEF: New Energy Foundation
4. Subsidy for 2002

   100 000 JPY/kW + sales tax

Table 2: Summary of major projects, demonstration and field test programs (continued)

Project Data plant start up	Technical data/ Economic data	Objectives	Main accomplishments until the end of 2002/ problems and lessons learned	Funding	Project Manage-ment	Remarks
PV Field Test Project for Industrial Use (1998~)	- Grid connected, residential (10 kW and more) - Industrial facilities, such as factory, warehouse, commercial building - Subsidy: 50% of installation cost - Eligible systems Modular type: combined systems with 10 kW PV unit Novel application type: systems with thin film solar cells, building integrated PV systems.	- Collection and dissemination of operational data - Cost reduction - Standardization of PV systems - Demonstration of new type PV system	- From 1998 to 2002, 15 610 kW of 644 modular type PV systems and 2 490 kW of 96 novel application types were installed to factories, warehouses, laboratories, commercial buildings, schools and so on. 1998: 73 cases (1 940 kW) 1999: 93 cases (2 790 kW) 2000: 149 cases (3 680 kW) 2001: 218 cases (4 890 kW) 2002: 207 cases (4 800 kW) - Perception of industries is being spread. - Cost of PV systems for public facilities and industrial use reduced to 820 000 JPY/kW - Better understanding to PV has been promoted in the local residents - Variety of novel types of PV systems were installed	- ANRE, METI - Budget: 1998 2 400 MJPY 1999 2 410 MJPY 2000 4 000 MJPY 2001 1 990 MJPY 2002 4 500 MJPY	- NEDO	- Total budget 1998 to 2002 was 15 300 MJPY. - Installed capacity 1998 to 2002 by sector Private companies: 295 cases 7 760 kW Public-service corps.:123 cases 3 750 kW Local governments: 322 cases 6 590 kW Total: 740 cases 18 100 kW

Table 2: Summary of major projects, demonstration and field test programs (continued)

Project Data plant start up	Technical data/ Economic data	Objectives	Main accomplishments until the end of 2002/ problems and lessons learned	Funding	Project Manage-ment	Remarks
Support Project for Local Efforts to Introduce New Energy (1997~)	- New energy in general - Eligible PV systems: grid-connected (50 kW and more) - Subsidy: 50% or one third of installation cost - Eligible: Local governments	- Enhancement of promotion of new energy to public facilities - Education and promotion of new energy to local inhabitants	- 37 systems (4,178 kW) were installed in from 1997 to 2000 - 15 systems (3 160 kW) out of 37 qualified systems were PV in 2001 - 26 systems (2 676 kW) out of 66 qualified systems were PV in 2002 - 10 014 kW of 78 PV systems will be installed during 1998~2005 - Installation of multiple numbers of PV systems in local governmental offices, schools, libraries, water purification plants, etc. can be qualified - Qualification of larger-scale PV systems with more than 100 kW output was started	- ANRE, METI - Budget: 1997 2 200 MJPY 1998 4 380 MJPY 1999 6 760 MJPY 2000 6 430 MJPY 2001 11 500 MJPY 2002 12 700 MJPY	- NEDO	
Financial Support Project for Entrepreneurs Introducing New Energy (1997~)	- New energy in general - Eligible PV systems: grid-connected (100 kW) - Subsidy: a third of installation cost or guaranteed debt	- Support of private industries who introduce new energy - Encouragement of introduction of new energy by private industries	- 2 PV systems were installed in a commercial building (118 kW) and a delivery center (100 kW) from 1997 to 2000 - One 140 kW PV system out of 34 qualified systems was installed to a steelworks facility in 2001 - One 25 kW PV system out of 25 qualified systems was installed in 2002	- ANRE, METI - Budget: 1997 1 120 MJPY 1998 5 390 MJPY 1999 10 340 MJPY 2000 11 490 MJPY 2001 14 040 MJPY 2002 23 620 MJPY	- NEDO	

Table 2: Summary of major projects, demonstration and field test programs (continued)

Project Data plant start up	Technical data/ Economic data	Objectives	Main accomplishments until the end of 2002/ problems and lessons learned	Funding	Project Management	Remarks
Eco-school Infrastructure Promotion Pilot Project (1997~)	- New energy use school (PV, solar thermal, etc.) energy efficient school etc. - Eligible Energy: New energy including PV - Subsidy: Investigation; fixed cost (METI's subsidy is available for PV system installation) - Eligible: Local government	- Demonstration and promotion of environment-friendly school - Environmental education to students	- PV systems (1 940 kW) were installed to 76 schools in 1997 to 2000 - PV systems (620 kW) were qualified to 38 schools in 2001 - PV systems (460 kW) were qualified to 47 schools in 2002 - Schools introduced PV systems were expanded to 161. - Students understand PV system were increased - Environmental education was implemented and enhanced	- METI: METI's subsidy is available for PV systems installed under Eco-school Infrastructure Promotion Pilot Project (Reference) - Budget of MEXT[1]: 1998 28 MJPY 1999 28 MJPY 2000 28 MJPY	- MEXT - ANRE	- The project will be continued by 2006 - PV systems (3 865 kW) were installed to 275 sites in 133 national universities and technical colleges in 1998 to 2001

Note)

1. MEXT: Ministry of Education, Culture, Sports, Science and Technology

Table 2: Summary of major projects, demonstration and field test programs

Project Data plant start up	Technical data/ Economic data	Objectives	Main accomplishments until the end of 2002/ problems and lessons learned	Funding	Project Management	Remarks
Support Program to Arrest Global Warming (2001~)	- Eligible Project: Multiple businesses that plan to introduce new energy facilities or energy-efficiency facilities during single fiscal year - Subsidy: Up to 1/2 or 1/3 of installation cost - Eligible entrepreneurs: Local governments, local communities, environmental protection NPOs, entrepreneurs, etc.	- To establish model cases to arrest global warming by leadership of regions - To promote businesses to wider regions	- 2001: 14 PV systems out of 34 projects in 15 regions were qualified - 2002: 15 PV systems out of 34 projects in 14 regions were qualified	- METI Budget: 2001 466 MJPY 2002 466 MJPY	- NEDO	

2.4 Highlights of R&D

2002 was the second year of the new 5-year plan on technical R&D for photovoltaic power systems, which was initiated in 2001. The R&D sectors of the new 5-year plan are categorized the following four areas; R&D on advanced solar cell technologies; R&D and investigation on common basic technologies toward full-scale PV introduction; R&D on innovative next generation photovoltaic power technologies, R&D of advanced manufacturing technology of PV systems.

R&D on advanced solar cell technologies aims at “establishing the technologies that can secure lower PV generation cost level than the electricity charge for household” and developing manufacturing technologies of thin film solar cells and the like that can be expected further cost reduction. Specific R&D themes include (1) development of manufacturing technologies for thin film c-Si modules (improvement of the quality by VHF plasma CVD, development of light-trapping structure for hybrid cells), (2) development of manufacturing technologies for thin film CIS cells (improvement of the quality by selenization, improvement of productivity by vapor deposition), (3) development of manufacturing technologies for super-high efficiency crystalline compound cells (GaAs cells with 40% conversion efficiency, development of solar concentrator modules), and (4) R&D of processing technology of high efficiency multicrystalline silicon solar cells (improvement of the quality of silicon ingot, super-thin slicing of silicon ingot, improvement of efficiency (20%) in multycrystalline silicon solar cell.

R&D and investigation on common basic technologies toward full-scale PV introduction focus on evaluation technique R&D on the performance, reliability, durability and safety of solar cells, modules and PV systems in consideration of full-scale PV introduction, and R&D on effective use of limited resources and reduction of environmental burden. Specific R&D themes include (1) R&D on solar cell evaluation technologies, (2) R&D on PV system evaluation technologies, (3) R&D on processing technologies of reusing and recycling of PV systems, and (4) R&D on electromagnetic immunity (EMI) of PV systems.

R&D on innovative next generation photovoltaic power technologies promote to make innovative PV systems practicable, which are expected to realize substantial cost reduction through new materials, new structures and new processing based on innovative concepts in order to achieve mass deployment of PV systems after 2010. R&D topics are as follows: (1) new materials for solar cells (multicrystalline SiGe, FeSi2, carbon-based thin-film, organic thin solid film, and chalcogenide), (2) solar cells with new structure (nanostructure Si (amorphous Si + multycrystalline Si), concentrated spherical micro silicon, high light-trapping thin-film silicon, wide bandgap microcrystalline SiC, dye-sensitized cells for high performance), and (3) New process (thin-film Si Cat-CVD deposition, thin-film CIS plating deposition, thin-film Si prepared by lateral-crystallization).

R&D of advanced manufacturing technology is aiming at applying the established manufacturing technology of PV system at 250 JPY/W into mass production within a few years. Earlier realization of mass production and cost reduction is expected. Specific R&D topics are as follows: (1) mass production of multicrystalline silicon substrate (wafer), (2) production of low-cost silicon for solar cells, and (3) production of amorphous silicon solar cells on plastic film.

In addition, demonstrative research on clustered PV systems was started as a new R&D topic in 2002. The power system in a district where PV systems are clustered tends to induce over-voltage obstacle has possibility to restrict the dissemination of PV systems. Thus, this research is programmed to develop the technology to resolve these problems. The research is aiming at demonstrating a general power system, where PV systems are intensively grid-connected. The specific research topics are (1) development of technology to avoid restriction of PV system output, (2) analyses and evaluation of higher harmonics, (3) analyses of mis-actuation of function to prevent islanding operation, and (4) development of applied simulations.

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

The 2002 national budgets for PV systems focus on R&D, demonstration programs and market incentives. The budgets by local governments are complementarily appropriated for market incentives. The number of local governments with complementary budgets is increasing year by year. The budget for PV System Technology R&D and Technology Development of Promotion for PV Systems are integrated into Photovoltaic Power Generation Technology R&D from 2002. The budget for demonstration is allocated for PV Field Test Project for Industrial Use, in which new installation of the system was completed in 2002. The budget for market initiatives is put emphasis on Residential PV system Dissemination Program. Moreover, PV systems can be installed using the budgets of Introduction and Promotion of New Energy at the Regional Level and Financial Support for Entrepreneurs Introducing New Energy. However, as these budgets include other new energies than PV, they are not included in Table 3. Also the budget for International Joint Project for Development and Demonstration (800 MJPY) and the budget for PV system introduction by other ministries and government offices except METI are not included Table 3.

Table 3: Budgets (in National Currency) for R&D, demonstration programs and market incentives.

	2000			2001			2002		
	R&D	Demo	Market	R&D	Demo	Market	R&D	Demo	Market
National*[1] (MJPY)	9 610	4 100	14 500	6 360	2 060	23 510	7 400	4 500	23 200
Regional (MJPY)	-	-	*[2]	-	-	*[2]			*[2]

*[1]The figures in Table 3 shows METI's budget. The budgets of other ministries and government offices except METI are unknown.

*[2] 229 municipals are enforcing additional subsidy program on residential PV systems, but the amount of subsidy is unknown.

3 Industry and growth

3.1 Production of photovoltaic cells and modules

Tables 4a shows the outline of PV cell and module manufacturers in Japan. In 2002, PV cell and module manufacturers are 9, i.e. Sharp, Kyocera, Sanyo Electric, Mitsubishi Electric, Kaneka, Canon, Matsushita Battery, and Matsushita Ecology Systems (former Matsushita Seiko) and Mitsubishi Heavy Industries. Matsushita Battery, which was manufacturing consumer CdTe cells decided to withdraw in 2002. Mitsubishi Heavy Industries completed the plant for amorphous silicon solar cell in October 2002 and started commercial production. As for module manufacturers, Showa Shell Sekiyu, MSK, and Nisshin A&C are manufacturing mass production modules for residential and industrial applications. In addition, Asahi Glass, Kobe Steel, and FujiPream newly entered the module market as module manufacturers specialized in building-integrated PV modules. Mitsubishi Sumitomo Silicon and M.SETEC are manufacturing only Si substrate for solar cells. Kawasaki Steel started commercial production of silicon ingots for PV cell use from 2001. Metal Reclaim is planning to manufacture Si substrate from 2003.

Table 4b shows PV module production processes of the manufacturers in Japan. Table 4c shows technical data of typical modules for residential and power uses. Table4d shows the present status of PV module certification of module manufacturers. Table4e shows typical new developments and products of PV cell and module manufacturers in Japan. Table 4f shows plan for future expansion in module production capacity. Table 4g shows average prices of residential PV modules.

Table 4a: Production and production capacity information for each module manufacturer in 2002

Cell/Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MWp)		Maximum production capacity (MWp)	
		Cell	Module	Cell	Module
Sharp	sc-Si mc-Si	22,56 100,50	13,95 93,59	200	200
Kyocera	mc-Si	62,0	60,0	70	70
Sanyo Electric	a-Si/sc-Si	26	26	30	30
Mitsubishi Electric	mc-Si	24	24	26	26
Matsushita Ecology Systems	sc-Si	1	1	3	3
MSK	mc-Si sc-Si		8 23		10 25
Showa Shell Sekiyu	sc-Si		1,2		6,0
Thin film manufacturers					
Kaneka	a-Si a-Si/poly-Si	4 3,5	4 3,5	10 10	10 10
Canon	a-Si/ c-Si	0,72	0,72	10	10

Mitsubishi Heavy Industries	a-Si	0,1	0,1	2	2
Sharp	a-Si	0,01	0,01		
MSK	a-Si		0,5		3
TOTAL		244, 39	259,57	361	405

mc: multicrystalline, sc: single crystalline, c: micro-crystalline, poly: polycrystalline: (thin-film mc)

Table 4b: PV module production processes of manufacturers (2002)

Module manufacturer	Description of main steps in production process
Sharp	- Purchase of sc-Si substrate → sc-Si cells → Modules - Purchase of mc-Si substrate → mc-Si cells → Modules - Purchase of feedstock → mc-Si wafer → Cells → Modules
Kyocera	- Purchase of Si scraps → mc-Si substrate → mc-Si cells → Modules
Sanyo Electric	- Purchase of Si substrate → a-Si/sc-Si cells → a-Si/sc-Si Modules
Mitsubishi Electric	- Purchase of mc-Si substrate → mc-Si cells → Modules
Matsushita Ecology Systems	- Purchase of sc-Si substrate → sc-Si cells → Modules
MSK	- Purchase of mc-Si & sc-Si cells → Modules
Showa Shell Sekiyu	- Import of sc-Si cells → Modules
Thin film manufacturers	
Kaneka	- Purchase of SiH_4 gas & substrate (with TCO) → Thin-film cells → Modules
Canon	- Purchase of stainless steel substrate & SiH_4 gas → a-Si cells → Modules
Mitsubishi Heavy Industries	- Purchase of SiH_4→ a-Si cells → Modules
MSK	- Purchase of a-Si cells → Modules

Table 4c: PV modules for residential and power uses (2002)

Module Manufacturer	Typical module data						Residen-tial use	Power use
	cell technology	W x L x D (mm)	Weight (kg)	P_{max} (W)	V_{op} (V)	I_{op} (A)		
Sharp	sc-Si	802×1 200×46	12,5	143	27,77	5,15		
	mc-Si	802×1 200×46	12,5	130	26,75	4,86		
	sc-Si	802×945×46	9,9	102	20,78	4,91		
	mc-Si	802×945×46	9,9	98	20,10	4,66		
	mc-Si	1019×1 168×45	16,0	145	20,42	7,11		
	sc-Si	826×1 573×46	17,0	175	35.36	4,95		
	mc-Si	826×1 573×46	17,0	160	34,50	4,64		
	sc-Si	802×1 200×46	12,5	120	26,70	4,67		
	mc-Si	802×1 200×46	12,5	120	25,70	4,67		
	sc-Si	530×1 200×35	8,5	85,5	17,42	4,91		
	mc-Si	530×1 200×35	8,5	80,0	17,14	4,67		
Kyocera	mc-Si	1 290×990×56	16,0	167	23,2	7,20		
	mc-Si	1 290×990×36	15,0	158	23,2	6,82		
	mc-Si	1 120×971×36	14,0	136	20,3	6,70		
	mc-Si	1 425×652×56	12,2	125	21,7	8,00		
Sanyo Electric	a-Si/sc-Si	1 320×895×35	14,0	190	54,8	3,47		
Mitsubishi Electric	mc-Si	1 271×827×37	13	130	19,3	6,74		
	mc-Si	1 338×539×40	8,5	75	11,4	6,56		
	mc-Si	1 248×803×46	12,5	130	19,3	6,74		
	mc-Si	1 270×675×37	11,0	100	15,3	6,56		
	mc-Si	1 271×827×37	13,0	126	19,2	6,56		
	mc-Si	1 248×803×46	12,5	126	19,2	6,56		
	mc-Si	1 889×1 045×12	60,0	186	30,5	6,10		
Matsushita Ecology Systems	Sc-Si	645×1 185×36	14	111	41	3,4		
MSK	sc-Si	1 580×802×50	18	177	44,6	5,59		
	sc-Si	1 195×802×50	14	132	33,5	5,59		
	sc-Si	815×802×50	9	88	22,3	5,59		
	mc-Si	1 195×802×50	14	120	32,3	5,3		
	mc-Si	1 580×802×50	18	160	43,0	5,3		
	mc-Si	939×502×50	6,3	50	21	3,23	×	
Showa Shell Sekiyu	sc-Si	869×982×35	11	109	43,2	3,50		
	mc-Si	1 012×1 290×36	16,5	150	28,5	7,26		
TF manufacturers								
Kaneka	a-Si/poly-Si	918×350×34	4,6	17,5	97,2	0,181		

	a-Si/poly-Si	939×465×25,5	5,4	36,5	48,6	0,751		
	a-Si/poly-Si	950×465×38	5,9	36,5	48,6	0,751		
	a-Si	920×920×40	12,5	58	63	0,92		
	a-Si	950×465×38	5,5	26	16,5	1,58		
	a-Si	544×320×25	5	6,7	29,8	0,23		
Mitsubishi Heavy Industries	a-Si	1 408×1 108×35	20	97	109	0.89		
	a-Si	708×1 108×35	10	47	109	0.43		

Table 4d: Present status of certification of module manufacturers (2002)

Module manufacturer	Certification of modules	Certification of plant
Sharp	IEC 61215 UL 1703 TUV Safety Class ll	ISO 9000 ISO 14001 UL 1703
Kyocera	IEC 61215 UL 1703 TUV Safety Class ll	ISO 9000
Sanyo Electric	IEC 61215 UL 1703	ISO 9000
Mitsubishi Electric	IEC 61215 UL 1703 TUV Safety Class ll	ISO 9000 ISO 14001
Matsushita Ecology Systems		
MSK	IEC 61215[*1]	ISO 9000
Showa Shell Sekiyu	UL 1703	
Thin film manufacturers		
Kaneka	IEC 61646 UL 1703[*2]	IEC 61646 UL 1703[*2]
Mitsubishi Heavy Industries	IEC 61646 TUV Safety Class ll	ISO 9001 2000

Note) [*1] for sc-Si and mc-Si
[*2] for a-Si

Table 4e: New developments and new products of manufacturers (2002)

Cell/Module manufacturer	New developments an new products
Sharp	- Commercialization of residential PV systems with PV modules smaller than the conventional model - Increase of annual production capacity to 200 MW - Production of modules in the USA was started - Organized design competition for housings, buildings and products utilizing PV system - Development of reuse and recycle technology of used PV modules
Kyocera	- Commercialization of automatic booster unit (device for increasing the voltage of the serially connected arrays) - Development of rack-less installation method - Commercialization of 150 W cell, 'R167' for residential PV systems - Commercialization of a diffusion type cell ,'R158' for residential PV systems improved by cell processing technology
Sanyo Electric	- Commercialization of 190 W PV module - Commercialization of aluminum mount for slate-covered roof
Mitsubishi Electric	- Commercialization of modules for hipped roof use (small surface area) - Commercialization of a power monitor, "Echo Guide" - Commercialization of power conditioner (4 kVA) - Commercialization of a junction box with a built in booster unit
MSK	- Commercialization of a flat tile integrated PV system, 'Re Roof' - Development of see-through modules and its application - Commercialization of 'Energy-Gear' (products for PC backup) - Development of 'Melty-Roof' (snow melting system)
Showa Shell Sekiyu	- Commercialization of 150 W mc-Si modules for residential use - Commercialization of 120 W mc-Si modules for industrial use
Thin film manufacturers	
Kaneka	- Development of see-through modules with large surface area - Development of PV systems for rooftop of buildings using flat roof construction method - Development of PV modules with thermal benefit for rooftop - Development of hybrid system for rooftop greening
Canon	- Development of a-Si/ c-Si/ c-Si cell
Mitsubishi Heavy Industries	- Commercialization of a-Si modules
Showa Shell Sekiyu	- Development of thin-film $CuInSe_2$ (CIS) modules (conversion efficiency: 13.52%, surface area:3 459 cm^2)

Table 4f: Plans for future expansion in module production capacity

Module Manufacturer	Production capacity in 2002 (MW)	Production capacity in 2003 (MW)	Production capacity from 2004 onwards (MW)	Module technology
Sharp	200			sc-Si & mc-Si
Kyocera	70	100		mc-Si
Sanyo Electric	30	60	120 (~2005)	a-Si/sc-Si
Mitsubishi Electric	26	50		mc-Si
Matsushita Ecology Systems	1	1		sc-Si
MSK	25 10	60 30	100 (2006) 50 (2006)	sc-Si mc-Si
Showa Shall Sekiyu	6,0	6,0	6,0	sc-Si
Thin film manufacturers				
Kaneka	10 10	12 10	12 15	a-Si a-Si/poly-Si
Canon	10	10	10	a-Si/ c-Si
Mitsubishi Heavy Industries	2	10	15 (~2005)	a-Si
Showa Shall Sekiyu			20(~2010)	CIS
MSK	3	10	30 (2007)	a-Si

Table 4g: Typical module prices (JPY/W) for residential use for a number of years

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Module prices: current	966	950	927	764	646	656	670	600	548	484	463

3.2 Manufacturers and supplies of other components

There are more than 20 large and small inverter manufacturers for PV systems in Japan, who are divisions or affiliates of electric appliance manufacturers, power supply manufacturers, electric component manufacturers and general electric machinery manufacturers. Sharp, Sanyo Electric, Mitsubishi Electric, Omron, Japan Storage Battery and Matsushita Electric Works are mainly producing 3-5 kW inverters for residential use. Some of these manufacturers standardize their own inverter and are mass-producing. The production amount of inverters has been increasing year by year and the cost has been reduced. Furthermore, on commercializing inverter, development of compact and lightweight inverter is under way. 10-100 kW inverters for public facilities and industrial uses are also manufactured. The manufactures of these types are as follows: Japan Storage Battery, Kyocera, Sanyo Denki, Nichicon, Furukawa Electric, Yuasa Corporation, Nissin Electric, Fuji Electric and SanRex Corporation. As a result of implementation of PV Field Test Project for Public Facilities and PV Field Test Project for Industrial Use, the standardization of 10 kW unit for public facilities and industrial uses has been developing and the production of inverter is remarkably increasing. In Japan, as the demand of batteries for PV use and inverters for stand-alone system use are limited to special

use, the standardization is not in progress. Table 5 shows the price of inverter sold for grid-connected PV application.

Table 5: Price of inverter for grid-connected PV applications.

Size of inverter	Average price per kVA in 2001 (JPY)	Average price per kVA in 2002 (JPY)
<1 kVA		
1-10 kVA*[1]	90 000 ~ 95 000	75 000 ~ 90 000
10-100 kVA*[2]	150 000 ~ 170 000	130 000 ~ 150 000
>100 kVA	200 000	200 000

Note) *[1] single phase, 3-5 kW for residential use
*[2] 10~100 kVA. In case of > 100 kVA, three phase 10 kW unit is used.

3.3 System prices

Table 6 shows the typical application by category and the system price and Table 6a shows the trends in system prices from 1992. The standardization of grid-connected systems has progressed as the PV market in Japan is expanding, and the prices have been reducing. On the other hand, the off-grid system prices are determined case by case because there are various type of application areas and each market scale is small.

Table 6: Prices of typical applications (2002)

Category / Size	Typical applications and brief details	Typical price per W in current JPY
OFF-GRID*[1] Up to 1 kWp	Telecommunications, lighting, traffic and road signs, pumps, ventilating fans, remote measurements, navigation signs, clock towers, etc.	Depending on cases
OFF-GRID >1 kWp	Agricultural facilities, communication facilities, disaster prevention facilities, mountain cottages, park facilities, remote area housing, lighthouses, etc.	Depending on cases
GRID-CONNECTED Up to 10 kWp	Residences, park facilities, small public facilities, etc.	720 JPY/W
GRID-CONNECTED >10 kWp	Plants, warehouses, commercial buildings, larger public facilities, road buildings, railway facilities, etc.	850 JPY/W

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

Table 6a: National trends in system prices

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Public & Industrial (>10 kWp) JPY/W	4 300	3 400	2 800	2 400	1 500	1 300	1 190	1 040	1,010	950	850
Residential (3 ~ 5 kWp) JPY/W		3 500	1 920	1 510	1 090	1 060	1 070	940	860	770	720

3.4 Labor places

Estimated labor places are as follows;

a) Research and development (not including companies): about 300
b) Manufacturing of PV systems components, including company R&D: about 2 500
c) All other, including within electricity companies, installation companies etc.: about 7 000

3.5 Business value

Table 7 shows business value of the domestic market of PV systems.

Table 6a: Business value of PV system market

1999	2000	2001	2002
76 500 MJPY	84 900 MJPY	110 000 MJPY	150 000 MJPY

4 Framework for deployment (Non-technical factors)

4.1 New initiatives

(1) Promotion initiatives

Through the ongoing promotion programs on PV systems, such as “Residential PV System Dissemination Program”, “PV Field Test Project for Industrial Use”, “Introduction and Promotion of New Energy at the Regional Level”, “Financial Support Project for Entrepreneurs Introducing New Energy”, and “Support Program to Arrest Global Warming”, expansion of introduction volume of PV systems has been promoted. There were no government-led initiatives newly started in 2002.

On the other hand, Japan Photovoltaic Energy Association (JPEA) has developed and announced a vision, “Vision of the Future of the Photovoltaic Industry in Japan: Creation of a New Industry that Will Contribute to the Solution of Energy and Environmental Problems”. It indicates a future perspectives and the roadmap of PV promotional means for next 30 years up to 2030. The Vision visualizes that PV market scale will reach 473 000 MJPY by 2010, 1 250 000MJPY by 2020 and 2 250 000 MJPY.

(2) New plan of PV system introduction

New Energy and Industrial Technology Development Organization (NEDO) started a new demonstration project of the intensively installed PV systems. Under the project, PV systems, 1 200 kW in total will be installed in 400 residences in a selected site. Local governments promote installation of PV systems utilizing “Introduction and Promotion of New Energy at the Regional Level”. For example, Iwaki City of Fukushima Prefecture planned to introduce total 370 kW of PV systems in a school and other 6 public facilities. Fukushima Prefecture planned to introduce total 233kW of PV systems in 4 sites. Hirakata City of Osaka Prefecture also decide to install total 216 kW of PV systems in 5 sites. In addition, The Ministry of Land, Infrastructure and Transport (MLIT) promotes to introduce PV systems following “the Guidelines for Planning Environmentally-Friendly Government Building (Green Government Office Buildings)”.

(3) Utility perceptions to PV

Electric power companies adopted net metering system and have bought back the surplus power by PV from their customers at the selling price since 1992. Other initiatives, such as green pricing, rate-based incentives have not been studied in Japan. During April 2001 to March 2002, electric power companies bought surplus PV power of 124 138 MWh.

Electric power companies have been interested in PV systems earlier, and introduce PV systems to their own facilities every year. As of the end of March 2002, accumulative introduction of PV systems by 10 electric power companies and Power Resources Development reached 318 systems. The accumulated capacity installed was 4 548 kW.

In October 2000, electric power industry introduced “Green Power Fund” to promote utilization of natural energy. Electric power companies contribute to the Fund the same amount as the total sum collected on the basis of 500 JPY per share per month from their customers who support the purpose of “Green Power Fund”. The Fund is utilized as the introductory fund of PV power plants and wind power plants. The number of subscribers to “Green Power Fund” as of the end of 2002 totaled about 56 000 shares. In 2002, 87 PV systems, 1 431 kW in total were qualified through “Green Power Fund” and installed to schools, hospitals and other public facilities. In 2001, 39 PV systems totaled 830 kW were installed through “Green Power Fund”.

(4) Public perceptions to PV

Public perception to PV and awareness for introduction of PV system in Japan is getting positive through ambitious and strong policies, programs on PV introduction and promotion, and publicities via television and news papers. For example, in case of “Residential PV System Dissemination Program”, the number of applicants has been growing year by year, especially since the number of introduced PV systems broke through 10 000 in 1999. The application number for “Residential PV System Dissemination Program” in 2002 exceeded 40 000 and reached 42 837 (161,8 MW). Furthermore, contribution consciousness to environment by businesses is increasing, and introduction of PV systems by businesses has been increasing through “PV Field Test project for Industrial Use”.

In 2000, as the Program for Introduction and Promotion of New Energy at Regional Level was introduced to support NPOs who tackle the introduction of new energy facilities at regional level. Under the program, NPOs can introduce PV systems into regions. Grass-root movement for PV introduction has started.

(5) Others

Housing manufacturers, building material manufacturers, construction companies and power supply equipment manufacturers set about developing houses and components with PV systems, and are playing a role of PV promotion. In addition to this, local electric equipment stores, electric appliance stores, roofers, etc. started sales and installation of PV systems, and the distribution chain of residential PV systems is being formed.

4.2 Indirect policy issues

In 2002, the House of Councilors enacted Energy Policy Basic Law. The Law guides the nation under 3 energy policy principles: (1) stable energy supply, (2) environmental harmony and (3) market mechanism. PV is on the list as a measure to the environmental harmony.

The government revised the environmental guideline, “the Guideline of Measures to Prevent Global Warming”. It determines the national target and measures for the greenhouse gas emission reduction. The targets of CO_2 reduction in particular, are 7% decrease in the industrial sector, 2% decrease in the residential and commercial sector and 17% increase in the transportation sector. The guideline also includes PV system R&D and promotion support as an additional measure.

The Ministry of Economy, Trade and Industry (METI) established the Law Concerning the Use of New Energy by Electric Utilities (Renewables Portfolio Standard (RPS) Law) as a new energy measure in order to promote further dissemination of new and renewable energy. The RPS Law obliges electric power companies to set a minimum ration of electricity generated from new energy. The target minimum ration of renewable energy usage in 2010 is 12 200 GWh, which accounts for 1.35% of net system energy demand. The law is to accelerate promotion of procurement and distribution of new energy by electric utilities

4.3 Standards and codes

In 2002, new standards, code and guideline were not published. The following Japanese Industrial Standards (JIS) are at the stage of discussion and will be published in the near future; “Design guide on structures for photovoltaic array”, “Structural design and installation for residential photovoltaic array (roof mount type)”, “Standards for safety design of electrical circuit in photovoltaic power generating systems” and “Design guide on electrical circuits for photovoltaic arrays”.

5 Highlights & Future trends

In order to achieve the national target introduction volume of PV system, 4 820 MW in 2010, the Japanese Government continues to create a better condition for R&D, market incentive measures, and promotion of introduction of PV systems by watching the trend of dissemination status and cost reduction of PV systems. In the policies on R&D, technological development supporting cost reduction and mass deployment of PV systems are enhanced. As for dissemination measures, subsidy programs for introduction of PV systems for residence, public facilities and industrial uses are continued to establish and expand the initial market. The RPS Law established in 2002 was enforced in April 2003 in order to promote use of new energy as a measure to create more favorable condition for dissemination of PV systems. In addition, the Government takes the lead in installation of PV systems in governmental facilities, aiming at CO_2 reduction in response to “Law concerning the promotion of procurement of eco-friendly goods and services by the state and other entities (Law on promotion of green procurement)” and “Law Concerning the Promotion of the Measures to Cope with Global Warming”

Electric utilities will promote introduction of PV systems into public facilities through “Green Power Fund”.

In sector of industry, PV manufacturers are planning to increase their production capacity, extend production sites, reduce manufacturing cost, commercialize various types of PV modules and PV systems, which can meet the users’ demand, and improve conversion efficiency of solar cells in order to enlarge PV market. Moreover, the PV industry will create a new industrial structure in corporation with peripheral industries.

Annex A Method and accuracy of data

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

As regards off-grid sector, some of these systems implement 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, production and production capacity.