International Energy Agency

CO-OPERATIVE PROGRAMME

ON

PHOTOVOLTAIC POWER SYSTEMS (IEA-PVPS)

Task 1

Exchange and dissemination of information on PV power systems

National Survey Report of PV Power Applications in Korea 2003

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i 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 twenty participating 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. Nine tasks have been established, and currently six are active. Information about the active and completed tasks can be found on the IEA-PVPS website www.iea-pvps.org. The new task concerning urban-scale deployment of PV systems is now underway.

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

This 2003 National Survey Report gives an overview of the key developments and achievements in the field of PV in Korea during the year 2003. All the information in this report was provided by various organizations involved in the photovoltaic power systems in Korea. These organizations include industry, government organizations, research institutes and academia. This report is prepared every year for information dissemination and for International Survey Report (ISR) on PV power applications.

iii Definitions, symbols and abbreviations

For the purposes of the 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 Wp 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/m2, cell junction temperature of 25oC, AM 1,5 solar spectrum – (also see 'Peak power').

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

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 organisation 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: System 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. 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.

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 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.

NC: National Currency (KRW : Korean Won)

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.

KERI: Korea Electrotechnical Research Institute

KEMCO: Korea Energy Management Corporation

KEPCO: Korea Electric Power Corporation

KIER: Korea Institute of Energy Research

KOPRA: Korean Photovoltaic Research Association

MOCIE: Ministry of Commerce, Industry and Energy

MOST: Ministry of Science and Technology

NRSE: New and Renewable Sources of Energy

1 Executive summary

- Installed PV power

The total installed power of PV systems in Korea was 6,43 MW at the end of 2003. For the first time the installed power in 2003 exceeded 1 MW with a figure of 1 028 kW, which are 60 % more than that achieved in the previous year (653 kW).

The PV market was still dominated by off-grid non-domestic sector that occupied about 71 % of total cumulative installed power. For off-grid domestic application, no system was installed in 2003. The share of this sector is decreased to about 7 % of the total cumulative installed PV power. Among the various off-grid non-domestic applications, telecommunication was still the largest sector of application, followed by marine applications such as lighthouses and street lighting. In the year 2003, marine applications were the largest sector of application, followed by highway emergency call box and street light lamps.

In 2003, several dozens of grid-connected distributed systems with a capacity in the range 3 kW to 200 kW were installed. The share of grid-connected distributed system was raised to 22 % of the total cumulative installed power from 14% in the previous year. In 2003, the total installed power of this sector was 667 kW, representing 65 % of the total PV market.

- Costs & prices

The PV module prices was in the range of 5 700 to 8 000 KRW/W depending on the manufacturing company and the order volume. The average PV module price of 6 500 KRW/Wp in 2003 was 10 % lower than that in the previous year. Depending on the PV system type installed, system prices ranged between 22 300 and 23 300 KRW/kW in the case of stand-alone systems. The price of grid-connected systems varied between 13 700 KRW/kW and 15 000 KRW/kW. The price of the 3 kW rooftop system was 15 000 KRW/W, the price remained nearly unchanged. .

- PV production

In 2003, two companies produced 540 kW of PV cells. One of these companies completed its new production line with a capacity of 6,0 MW in the year 2003, thus raising total production capacity to 6,6 MW. Five companies including one completed its new production line in the end 2002 produced about 2,29 MW of PV modules. The production volume was nearly three times more than that of the year 2002 (0,78 MW). Most of single and multi-crystalline silicon PV cells for module production were imported from foreign manufacturers in USA, Japan and Germany,

- Budgets for PV

The total budgets for Demonstration was remarkably increased in 2003, largely thank to the budget increase of ‘Local Energy Development Program”. The amount is two times more than that of the year 2002. The government budgets in 2003 for R&D and demonstration/field test programme were 4 802 MRKW and 13 414 MRKW, respectively. The public budget allocated for market incentives was 978 MKRW in 2003.

2 The implementation of PV systems

The PV power system market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 Wp or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries.

2.1 Applications for photovoltaics

The PV market was still dominated by off-grid non-domestic sector that occupied about 71 % of the cumulative installed PV power. However, the market share of this sector has been decreasing year by year. Among the various off-grid non-domestic applications, telecommunication was still the largest sector of application, followed by marine applications such as lighthouses and street lighting. In the year 2003, marine applications were the largest sector of application, followed by highway emergency call box and street light lamps. Another important applications include PV systems for river flood warning systems, the aviation warning lamps of the high-voltage transmission tower, environment- monitoring equipment such as water-borne pollution, sewage, forest fire monitoring and traffic signaling.

For off-grid domestic application, no system was installed in 2003. The share of this sector is decreased to about 7 % of the total cumulative installed PV power.

In 2003, several dozens of grid-connected distributed systems with a capacity in the range 3 kW to 200 kW were installed. Among them 16 systems were for public office building and 5 systems were rooftop systems for residential houses. The share of grid-connected distributed system was raised to 22 % of the total cumulative installed power from 14% in the previous year. In 2003, the total installed power of this sector was 667 kW, representing 65 % of the total PV market. In 2002 a total capacity of 237 kW were installed, and the share was 36 %. This sector has been intensively promoted under the framework of “Renewable Energy Demonstration Program” or “Local Energy Development Program” supported by the government and local authorities.

Figure 1 shows the share of 3 sub-markets during the year 2003 and in total.

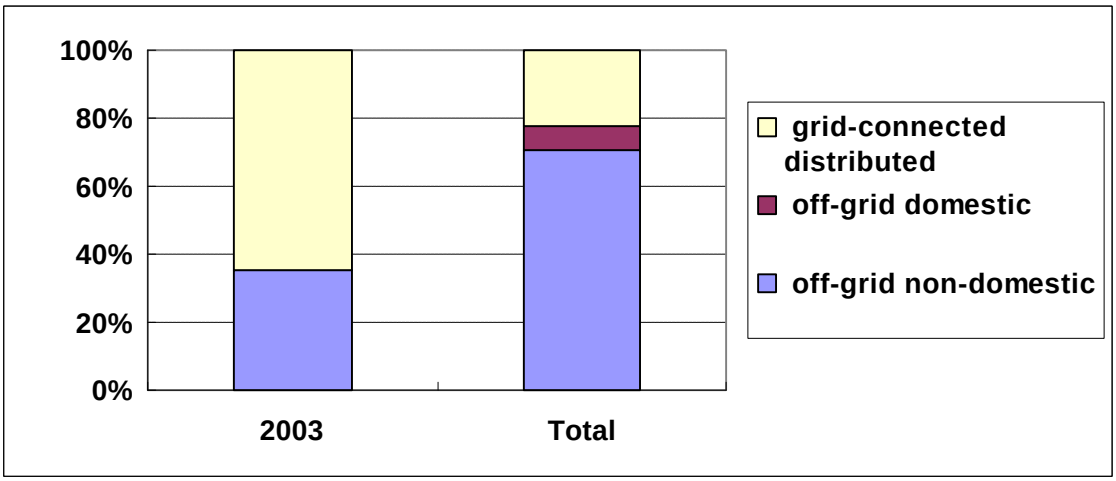

Figure 1: The share of sub-markets during 2003 and in total cumulative power

2.2 Total photovoltaic power installed

The total cumulative installed PV power for each sub-market on the 31 December of each year from 1992 is shown in Table 1 and Figure 2.

The total installed power of PV systems in Korea was 6 438 kW at the end of 2003. The total PV power installed during the year 2003 was 1 028 kW, which is about 60 percent higher than that achieved in the previous year (653 kW). For the first time the annual installation exceeded 1 MW.

Table 1 : The cumulative installed PV power in 4 sub-markets.

Sub-market/ application	31 Dec 1992 kWp	31 Dec. 1993 kWp	31 Dec. 1994 kWp	31 Dec. 1995 kWp	31 Dec. 1996 kWp	31 Dec. 1997 kWp	31 Dec. 1998 kWp	31 Dec. 1999 kWp	31 Dec 2000 kWp	31 Dec 2001 kWp	31 Dec 2002 kWp	31 Dec 2002 kWp
off-grid domestic	59	149	175	219	256	296	306	316	316	376	461	461
off-grid non-domestic	1 412	1 482	1 506	1 550	1 757	2 046	2 410	2 855	3 288	3 857	4 188	4 549
grid-connected distributed	0	0	0	0	100	133	266	288	356	524	761	1 427
grid-connected centralized	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1 471	1 631	1 681	1 769	2 113	2 475	2 982	3 459	3 960	4 757	5 410	6 438

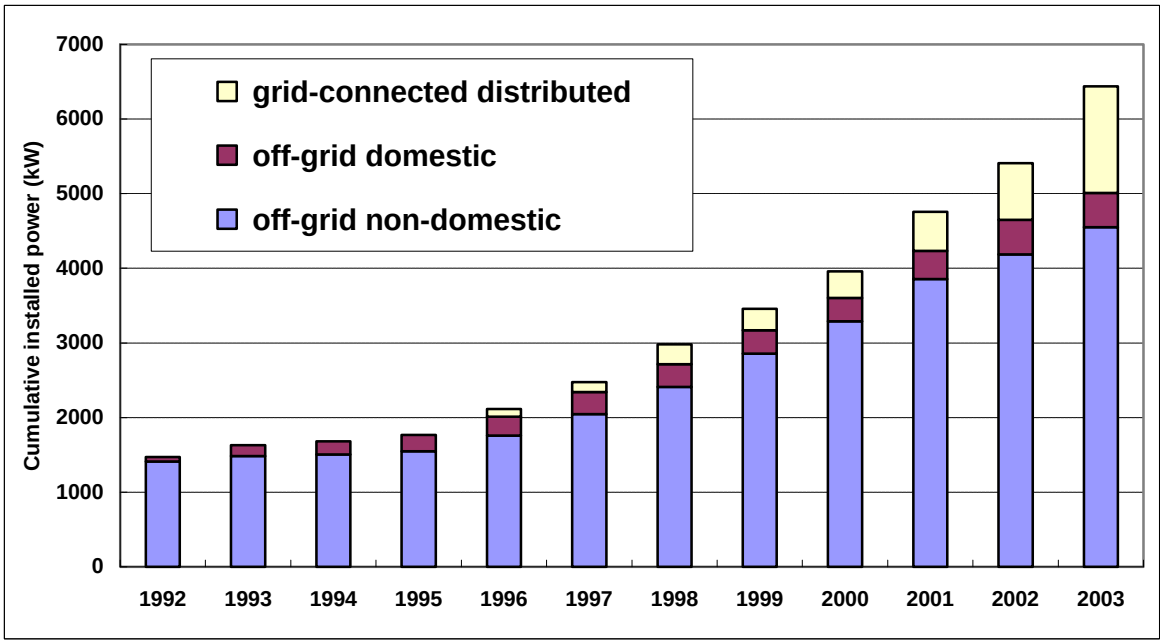

Figure 2 : The cumulative installed PV power in 3 sub-markets

2.3 Major projects, demonstration and field test programmes

Since 1993 the MOCIE (Ministry of Commerce, Industry and Energy) has been implementing, via the KEMCO, demonstration and field test of various renewable energy technologies. In addition, the government has been encouraging and supporting local authorities to implement their own demonstration or field test projects under the framework of "Local Energy Development Program". This program in part aims to raise public awareness on renewable energy technologies and to develop indigenous renewable energy sources for each region. In both of these projects, the PV technology has always been at the top priority.

- Renewable Energy Demonstration Program: Among a total of 33 projects implemented under this program, the number of projects related to PV amounted to 21 in the year 2003. Various grid-connected PV systems with a power capacity of 5-30 kW were installed in schools and universities. In addition, fifteen individuals had PV arrays on their rooftops. All the rooftop PV system has a same capacity of 3kW. A total of 1,3 billion won was invested on PV power systems. The beneficiary paid only 30 % of initial investment.

- Renewable Energy Field Test Program: Several PV rooftop systems have been testing at the "Solar Energy Field Test Site" at Chosun University in Gwangju metropolitan city. System performances and reliability are tested and evaluated.

- Local Energy Development Program: Under the local energy development project, a wide variety of PV systems including off-grid domestic, non-domestic and grid-connected systems were constructed. In 2003 the government allocated more than 25,7 billion won for this program, PV accounted for more than 47 %. Local authorities, in cooperation with the MOCIE, implemented a variety of PV system installation aiming at increasing public awareness on PV and to develop PV as indigenous renewable energy sources for their region. It is worthy to note

that several local authorities started the planning of “Green Village” projects. The objective of this project is to construct a small-size solar village by using photovoltaic power systems and solar thermal systems as much as possible. In 2003 two local authorities - Gwangju and Daegu metropolitan cities - were beneficiaries of “Green Village” projects. In 2004 more local authorities will be designated as the target of this project.

2.4 Highlights of R&D

The PV R&D projects are mainly supported by the MOCIE, and some basic research projects are supported by the MOST. The KEMCO is a leading organisation in management of R&D projects as well as demonstration and field test projects. At the end of 2003 the KEMCO has established the ‘R&D Center for Photovoltaics” in order to carry out more efficiently R&D activities and promote the cooperation among the government organizations, research institutes, universities and industries. This center is carrying out planning on R&D and commercialization and widespread deployment scenario of PV power systems.

The R&D projects implemented in 2003 included various categories. In short term covering the period 2001-2004, the key project has been to develop solar cells mass production technology and BOS systems for 3-kW residential rooftop system. In the mid- and long-term, two projects have been implemented. One was related to BIPV, the other one aimed to develop polycrystalline thick-film silicon using solution growth.

In addition, research institutes and university laboratories have been carrying out some basic R&D projects on thin-film solar cells. The materials included CIGS, amorphous silicon (a-Si), polycrystalline silicon (p-Si), organic materials and TiO_2 for dye-sensitized PV cells. The KIER is very active in R&D on CIGS chemical compound and polycrystalline silicon thin film solar cells in order to develop low-cost and high-efficiency solar cells. Recently, dye-sensitized solar cells and organic solar cells attracted much interest from university research teams.

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

The R&D budget increased about 20 % over the previous year’s budget. The total budgets for Demonstration was remarkably increased in 2003, largely thank to the increase of ‘Local Energy Development Program” budget. The amount is two times more than that of the year 2002. The government budgets in 2003 for R&D and demonstration/field test programme were 4 802 MRKW and 13 414 MRKW, respectively, as shown in Table 2. In addition, local authorities provided 5 110 MKRW for the implementation of ‘Local Energy Development Program”. In general, the government provides up to 70 % for of the total initial investment of the installations on the basis of cost-share projects.

The public budget allocated for market incentives was 978 MKRW in 2003. The incentives were offered to individuals and private companies that applied for the construction of rooftop or BIPV systems through “Demonstration Program”. Besides, the government provided every year low-interest loans for renewable energy production or application facilities. However, its conditions were not favorable for PV, and mainly applied to solar water heater or waste incineration facilities.

Table 2: Public budgets (in Million KRW) for R&D, demonstration/field test programmes and market incentives.

	R & D	Demo/ Field test	Market
National/federal	4 802	13 414	978
State/regional		5 110	
Total	4 802	18 524	978

3 Industry and growth

3.1 Production of feedstocks and wafers

There was no production of feedstocks and wafers in Korea in the year 2003.

3.1 Production of photovoltaic cells and modules

The status of PV cells and module production in 2003 is summarized in Table 3. Until 1999, High Solar Company (independent from former LG Siltron Co. in May 1999) continued to manufacture PV cell, but this company stopped its operation in the year 2000. In 2001, there was no PV cell manufacturer in Korea. In the year 2002, two new companies entered into PV cell production. Neskor Solar Co. produced 0,24 MW and Photon Semiconductor & Energy Co. 0,3 MW in 2003. The latter increased significantly its production capacity from 0,5 MW to 6,0 MW in the year of 2003. These two companies provided a part of its production to domestic module manufacturers and some to foreign companies. These two companies import wafers from foreign companies.

In 2003, five companies including one started its operation at the end of 2002 produced about 2,29 MW of PV modules. This figure nearly tripled the production in the previous year. This remarkable expansion of PV module production was thanked to the newly established company “ATS Solar Co.”. This company produced about 1,4 MW PV modules with a production capacity of 3,0 MW. This production line is the largest one in Korea. The total production capacity was also tripled, compared with that of the year 2002. Most of single and multi-crystalline silicon PV cells were imported from foreign countries.

S-Energy (independent from former Samsung Electronics Co.) manufactured four types of modules with a peak output of 50 to 80 W using mc-Si PV cells imported from BP Solar. The 75 W has a dimension 1 204 L x 538 W x 38 mm D, and a structure glass/EVA/solar cells/EVA/tedlar. This company announced the completion of development of rooftop PV modules and started field test of these modules in 2003. This company is planning to install large size laminator for the manufacturing of large size module.

LG Industrial System Co. produced a various types of PV modules with a peak output power in the range of 43 to 100 W using sc-Si PV cells imported from Shell Solar in USA. The module has a typical structure glass/EVA/solar cells/EVA/back sheet, which is similar to that of S-Energy. Solartech Co. also produces similar type of modules using sc-Si cells purchased from Shell Solar.

Haesung Solar manufactures small PV modules with an output power ranging 1 to 50 W using sc-Si PV cells provided by Neskor Solar Co. The module manufacturing process is also similar to that of the former two companies.

ATS Solar Co. manufactures a variety of PV modules with an output power ranging 75 to 175 W using single and mc-Si cells imported from Germany, Japan, etc. The 175 W has a dimension 1 580 L x 785 W x 38 mm D, and a structure glass/EVA/solar cells/EVA/tedlar.

The average PV module prices in 2003 decreased about 10 % compared with that in the previous year, as shown in the Table 4a. The prices was in the range of 5 700 to 8 000 KRW/W depending on the manufacturing company and the order volume.

Table 4: Production and production capacity information for the year for each manufacturer

Cell/Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MWp)		Maximum production capacity (MWp)	
		Cell	Module	Cell	Module
1. Neskor Solar Co.	sc-Si	0,24		0,6	
2. Photon Semiconductor & Energy Co.	sc-Si	0,30		6,0	
3. S-Energy Co	mc-Si		0,35		1,0
4. LG Industrial System Co.	sc-Si		0,25		0,5
5. Haesung Solar Co	sc-Si, mc-Si		0,07		0,5
6. SolarTech Co.	sc, mc-Si		0,2		1,0
7. ATS Solar Co.	sc, mc-Si		1,42		3,0
TOTALS		0,54	2,29	6,6	6,0

Table 4a: Average module prices in current kilo KRW/W between 1994 and 2003.

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Module price(s): Current	9,4	9,4	8,2	8,5	9,2	7,5	7,1	7.2	7,2	6,5

3.3 Manufacturers and suppliers of other components

In 2003 only one company - Hex Power Systems - manufactured the inverters for grid-connected system. This company produced various products with a capacity 1 – 50 kW. The price was ranged between 2,83 MKRW/kVA for a size smaller than 1 kVA and 1,57 MKRW for larger than 100 kVA depending on the inverter size.

Two companies were involved in producing the inverters for stand-alone systems. In the case of inverters for stand-alone systems, the average price was about 2,2 MKRW/kVA for a size larger than 10 kVA. There is one PV battery manufacturer, Global High-tech Co. that produces lead-acid batteries of tubular plate stationary type. The unit price of the battery with a capacity 2 000Ah/100hr is about 1 000 kKRW. Concerning the supporting structures, PV system installers used their own type of support structures made from anodised aluminium or galvanized steel. That is why the price of the supporting structures is so multifarious.

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

Size of Inverter	<1 KVA	1-10 KVA	10-100 KVA	>100 KVA
Average Price per kVA (KRW)	2,83 MKRW	2,13 MKRW	1,93 MKRW	1,57 MKRW

3.4 System prices

Depending on the installed PV system type, system prices ranged between 22 300 and 23 300 KRW/Wp in the case of stand-alone systems, as shown in Table 6. The price is 23 300 KRW/W for a street lighting PV system with a unit power capacity of 200 W. The price of grid-connected systems varied between 13 700 KRW/Wp and 15 000 KRW/Wp. The price of the 3 kW rooftop system was 15 000 KRW/Wp which remained unchanged.

Table 6a shows the price trends of a typical 10 kW-capacity PV rooftop system for building. The price reduction is nearly negligible.

Table 6: Turnkey Prices of Typical Applications

Category/Size	Typical applications and brief details	Current prices per Wp in KRW
OFF-GRID Up to 1 kWp	Forest fire warning, Street lighting 200 W	23 300
OFF-GRID >1 kWp	Remote island	22 300
GRID-CONNECTED Specific case	3 kW roof-mounted system	15 000
GRID-CONNECTED Up to 10 kWp	Building rooftop 10 kW	15 000
GRID-CONNECTED >10 kWp	Building rooftop 30 kW	13 700

Table 6a: National trends in system prices (KRW/W) for 10 kW-capacity building rooftop system.

YEAR	1997	1998	1999	2000	2001	2002	2003
Price : KRW/W	17 330	18 000	16700	15700	14 700	14 300	13 700

3.5 Labour places

The estimated full time labour place equivalents in PV related activities are as follows:
a) Research and development (not including companies); 52
b) Manufacturing of PV system components, including company R&D; 122
c) All other, including within electricity companies, installation companies etc.; 49

c) All other, can be broken down into:
c1) Distributors, system and installation companies; 39
c2) Utilities and government; 10

3.6 Business value

The value of PV business in Korea was estimated to be 18 704 MKRW. This value was calculated from the module shipments plus PV power installed to which PV cell export was

added and from which the value for PV cell and module import was subtracted.

4. Framework for deployment (Non-technical factors)

4.1 New initiatives

- Utility perception of PV

The KEPCO separated its power generation unit in 2001, and is planning to privatize these units in the near future. The KEPCO and power generation companies have continuously had an interest in the PV, through the direct involvement in the construction of PV plant in remote islands and the related technology development on grid-connection of PV. There was no noticeable change of policy or attitude during the year 2003.

- Change in public perceptions of PV

The public acceptance for the PV has been slowly increasing due to its environment friendliness. The number of individuals who apply for the installation of rooftop PV systems with financial support from the government and local authorities is much increased. The KEMCO and the KIER have been providing useful information to all the parties including the general public. During the year 2003, several conferences, exhibitions and other events held in Korea contributed to raise the public perception of PV. Among them, the solar toy car and BIPV design competition targeted for high school boys and university students, respectively, attracted much attention from mass media. Several NGOs, which have main activities in energy and environment sector, are expected to play an important role in raising public acceptance on renewable energy technologies including PV.

- Major new projects or initiatives

In July 2002, the Korean Ministry of Commerce, Industry and Energy (MOCIE) opened to the public “Solar Land 2010 Program” which aimed at the acceleration of R&D and dissemination of PV power systems in Korea and fostering PV as a new exporting industry as well. The key of the program was to install 30,000 rooftop PV systems of 3 kW capacity until the year 2010.

. In 2002, the Korean Ministry of Commerce, Industry and Energy (MOCIE) raised the target share of NRSE to 3% until 2006, and to 5% until 2011 through the second “National Basic Plan for Energy”. According to this revised basic plan, the Government is setting up concrete action plan for new and renewable energy technology development and dissemination. Related to PV technology, the Government is planning to install about 1.3 GW PV systems until the year 2012. The installation target includes 100,000 3-kW rooftop system for residential houses, 10-kW 40,000 systems for public buildings and 20-kW 30,000 systems for commercial buildings. This plan includes not only dissemination program and various incentive schemes but also PV research and technology development program. The rooftop systems program for residential houses is scheduled to start from the year 2004.

4.2 Indirect policy issues

International environmental issue such as “The Framework Convention on Climate Change” has, until now, no tangible effects on the PV market. Taken into consideration the reality that the energy sector is responsible for the major part of the greenhouse gas emissions in Korea, it is inevitable to accelerate the use of clean energy. Therefore, these issues will undoubtedly have a great impact on the promotion of PV market in the near future.

4.3 Standards and codes

There are 17 Korean Standards (KS) related to the qualification of PV components such as solar cells and modules, battery, power conditioner, and one of them is related to the performance evaluation of stand-alone systems. However, there are no specific standards or technical regulations available for grid-connected PV system construction and operation including interconnection with grid line. The KEMCO and relevant organizations have been working together to prepare necessary guidelines and regulations before starting the dissemination of 3-kW rooftop PV system.

5 Highlights and prospects

The year 2003 marked the first year in that annual installed capacity exceeded 1 MW. In accordance with the release of the government's concrete R&D and dissemination program, the Korean PV industry was also busy in expanding PV cells and modules production capacity. One PV cells company constructed a new production line with a capacity of 6 MW, and a PV module company completed module manufacturing line with an annual production capacity of 3,0 MW/shift.

Annex A Method and accuracy of data

All data on installed power, industry status and budgets were obtained from manufacturers, installers, the government and local authorities. To manufacturers and installers a questionnaire was sent. Until 2002, there was nearly little possibility of data missing or double counting because the data to collect and the data sources were limited. However during the year 2003 quite a lot of small-sized installers were involved in the PV system construction. Therefore module manufacturers were not able to provide us the information about the concrete application of the modules, etc. So, it seems that there must be a bit of data missing or some error in counting the date of construction completion, etc. The accuracy of data is ± 7 % for the installed PV capacity and ± 2 % for the cell/module production. Data on R, D & D funding are correct. The number of labour places was estimated from the information collected from many sources.