

**INTERNATIONAL ENERGY AGENCY
CO-OPERATIVE PROGRAMME ON PHOTOVOLTAIC
POWER SYSTEMS**

Task 1

**Exchange and dissemination of information on PV
power systems**

**National Survey Report of
PV Power Applications in Korea
2008**

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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/m², cell junction temperature of 25°C, AM 1,5 solar spectrum – (also see 'Rated power').

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

PV system: Set of interconnected elements such as PV modules, inverters that convert d.c. current of the modules into a.c. current, storage batteries and all installation and control components with a PV power capacity of 40 W or more.

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 KRW, Korean Won.

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, Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Turkey, the United Kingdom (GBR) and the United States of America (USA). The European Commission and the European Photovoltaic Industry 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.iaepvps.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 Korean National Survey Report for the year 2008. 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.

1 EXECUTIVE SUMMARY

Korea has been making a strong effort to increase the renewable energy portion of "national energy mix". The goal was newly announced in 2008. Korea's renewable energy is targeting to take 4,3% of the total energy consumption by 2015. Currently the renewable energy is estimated to account for about 2,4% of total primary energy consumption. The special feature in Korean PV applications during 2008 was the "quantum jump" in the installation capacity. In addition, the Korean PV programme has strongly supported the R&D investment. PV has emerged as one of the key sector of the government's long-term vision in favour of "Low-Carbon Green Growth".

1.1 Installed PV power

The cumulative installed power of PV system in Korea increased to 357,5 MW by the end of 2008. Annual installed power in 2008 has reached 276,3 MW, which was more than 3,5 times higher than the cumulative installed power by the end 2007. The share of grid-connected centralized system jumped to 83% of the total cumulative installed power, and the grid-connected distributed system accounts for 15% of the total cumulative installed power. On the other hand the share of off-grid non-domestic and domestic system has continued to decrease to about 2% of total cumulative installed power. In reality there was nearly no further installation of the off-grid systems since 2007.

1.2 Costs & prices

The average PV module price of 3 260 KRW/W in 2008 was nearly 18% off compared to that in the previous year. According to the type of the installed PV system, the price of grid-connected systems varied from 6 662 KRW/W to 9 232 KRW/W. The price of the 3 kW rooftop system was 6 662 KRW/W in 2008, which is 20% lower than 8 400 KRW/W in 2007.

1.3 PV production

In 2008, the PV production took shaped from raw materials to all system components with a focus on upstream sectors. One company started the production of polycrystalline silicon feedstock with an annual capacity of 5 000 ton, and seven companies were involved in the silicon ingot and wafer production. For solar cells, four companies including three new entrants produced 59 MW crystalline silicon solar cells. Seven companies produced about 106 MW of crystalline silicon PV module with total annual production capability of 300 MW. In addition, one company launched the production of a-Si thin film PV modules. The production volume was 8.3 MW with a capacity of 20 MW.

1.4 Budgets for PV

In 2008 the total budget for PV was 272 369 million KRW which is two times more than that of 122 191 million KRW in 2007. The budget for R&D in 2008 tripled to 58 159 million KRW, and the budget for market incentives was doubled to 214 210 million KRW respectively.

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 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries.

For the purposes of this report, PV installations are included in the 2008 statistics if the PV modules were installed between 1 January and 31 December 2008, although commissioning may have taken place at a later date.

2.1 Applications for photovoltaics

The year 2008 showed a big jump in the installation capacity. The majority was thanks to the quite favourable feed-in-tariff scheme. As of end 2008, the grid-connected centralized system accounted for 83% of the total cumulative installed power, and the half of them are bigger than 1 MW. The largest system size is 24 MW installed in Shinan county by Dongyang Construction Co. The grid-connected distributed system amounted to 15% of the total cumulative installed power. These systems are mainly installed under the feed-in-tariff scheme and the 100 000 roof-top program. On the other hand the share of off-grid non-domestic and domestic system has continued to decrease to about 2% of total cumulative installed power.

2.2 Total photovoltaic power installed

Table 1 shows the PV power installed in 4 sub-markets during 2008. All the data related to PV installation was provided by the KNREC (Korea New and Renewable Energy Center), the affiliate of the KEMCO (Korea Energy Management Corporation). The individual or the power producers who want to benefit from the government-supported PV demonstration or deployment programme should go through the KNREC.

Table 1: PV power installed during calendar year 2008 in 4 sub-markets.

Sub-market/ application	off-grid domestic	off-grid non- domestic	grid-connected distributed	grid-connected centralized	Total
PV power installed in 2008 (kW)			18 825	257 499	276 324

A summary of the cumulative installed PV Power, from 1992-2008, broken down into four sub-markets is shown in Table 2.

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

Sub-market	Cumulative installed capacity as at 31 December															
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Stand-alone domestic		175	219	256	296	306	316	528	608	608	628	753	853	983	983	983
Stand-alone non-domestic		1 506	1 550	1 757	2 046	2 410	2 855	3 076	3 625	4 041	4 382	4 606	4 810	4 960	4 960	4 960
Grid-connected distributed		0	0	100	133	266	288	356	524	761	971	3 175	6 551	19 522	36 027	54 852
Grid-connected centralised		0	0	0	0	0	0	0	0	0	0	0	1 310	10 381	223	296 722
TOTAL (kW)		1 681	1 769	2 113	2 475	2 982	3 459	3 960	4 757	5 410	5 981	8 534	13 524	35 846	81 193	357 517

- The feed-in-tariff scheme played an absolutely major role in making big jump in PV installation. More than 90 % of installed systems are larger than 100 kW, and the system bigger than 1 MW accounted for 50 %.
- The "One Million Green Home Program" which merged the existing 100 000 PV rooftop program contributed to the wide spread use of small-size distributed PV systems. The government provides 60% of initial installation cost. The application includes the apartments as well as single-family houses. About 10 MW was installed under this program.
- The "Deployment Aid Program" which merged the "Regional Deployment Program" is aiming at PV system for general purpose with a capacity smaller than 50 kW or special purpose demonstration systems. In 2008, about 8 MW was installed under this program.

2.3 PV implementation highlights, major projects, demonstration and field test programmes

The Ministry of Knowledge Economy (MKE) has been implementing, via the KNREC, various deployment initiatives and programs for PV systems. In 2008, the "Third Basic Plan on New and Renewable Energy Sources R&D, D" based on the "National Basic Energy Plan" was made public in order to enhance the level of self-sufficiency in energy supply, to meet the challenging of climate change and to consolidate infrastructure of NRE industry. The goal of NRE deployment is to achieve 4,3 % share of total primary energy supply by 2012. This goal of share is lower than the previously set goal of 5% by 2012. PV still remains as one of the prioritized area. This plan includes the construction of "One Million Green Home" and "200 Green Villages" until 2020. It was also planned that the RPS (Renewable Portfolio Standard) will replace the existing "Feed-in-Tariff" scheme from the year 2012. This plan aims at the grid parity until 2020.

- One Million Green Home Program: This program that merged the 100 000 rooftop PV systems aims at the construction of one million green home utilizing PV as well as solar thermal, fuel cells, wind, bio-energy and geothermal until 2020. In general single-family houses and multi-family houses including apartments can benefit from this program. The government provides 60% of initial PV system cost for single-

family and private multi-family houses, and 100% for public multi-family rent houses. Until the end 2008, a total of 30 MW capacity and 23 640 households benefited from this program.

- Feed-in Tariff Program: Since October 2008, the FIT rate was much reduced as seen in the table. The cap was increased from 100 MW to 500 MW. The beneficiaries can choose the period to be 15 years or 20 years. If the new 500 MW cap is not reached in 2009, the fixed price applicable in 2010 will be announced later. Until 2008, a total of 300 MW was installed under this scheme, and the annual spending in 2008 was 113 144 million KRW.

		Fixed Price (Won/kWh)				
~ 30 Sep. 2008	Period	< 30 kW	> 30 kW			
	15 years	711.25	677.38			
1 Oct. 2008 ~ 2009	Period	< 30 kW	30 kW ~ 200 kW	200 kW ~ 1 MW	1 MW ~ 3 MW	> 3 MW
	15 years	646.96	620.41	590.87	561.33	472.70
	20 years	589.64	562.84	536.04	509.24	428.83

- Deployment Aid Program: The government supports 60% of installation cost for conventional PV systems and 80% for special purpose demonstration and pre-planned systems. Since 2008, this program merged the "General Deployment Program" and "Regional Deployment Program". In 2008, 162 PV systems with a total of 8,3 MW were installed. Various grid-connected PV systems with a power capacity of 5 ~ 200 kW were installed in schools, public facilities, welfare facilities and universities.
- Public Building Obligation Program: New public buildings larger than 3 000 sq meter must spend 5% of total construction budget in installing renewable facility. From the end of 2008, 5% of total energy load should be covered by NRE instead of 5% of construction budget. As the government pursues for "New Administration-Oriented City Plan" and "Plan for Public Enterprise Relocation", new public buildings are planned all over Korea and thus this program will have to contribute a lot to the expansion of Korea PV market.

2.4 Highlights of R&D

The KETEP (Korea Energy Technology Evaluation and Planning) is playing a leading role in Korea's PV R&D program since 2008. With nearly tripled R&D budget compared to the year 2007, the government set up a new R&D strategy. This new initiative is composed of four programs, namely, Strategic Technology Program; Breakthrough Technology; Core Technology; Demonstration & Planning Program. The key is industry-led strategic technology program. About 50~55% of the R&D budget will be allocated to this program. The remaining 10% budget is for breakthrough technology, 25~30% for core technology and 10% for demonstration and R&D planning. The newly launched four big projects under the strategic technology program are as follows.

- Low-cost large-area Si thin film PV modules
- Glass substrate CIGS thin film PV modules
- Low-cost, high-efficiency crystalline silicon solar cells and manufacturing equipment

- Manufacturing equipment for solar grade polycrystalline silicon feedstock

Only the breakthrough technology is led by the university or research institutes. The core technology projects are also led by private industry targeting earlier commercialization. These projects are focusing on developing manufacturing technologies for solar cells, ingot & wafer, BIPV modules and power conditioning systems including inverter.

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

In 2008 the total budget for PV was 272 369 million KRW which is two times more than that of 122 191 million KRW in 2007. The budget for R&D in 2008 tripled to 58 159 million KRW, and the budget for market incentives was doubled to 214 210 million KRW respectively. The market incentives include the budget for FIT scheme and were offered to individuals and private companies that applied for the construction of PV systems through "one Million Green Home", "Deployment Aid Program", "Public Building Obligation Program", etc. The government also provided low-interest loans every year for renewable energy production or PV system application facilities.

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

	R & D	Demo/Field test	Market incentives
National/federal	58 159		214 210
State/regional			
Total (million KRW)	272 369		

3 INDUSTRY AND GROWTH

3.1 Production of feedstocks, ingots and wafers

The Dongyang Chemical Co., (DCC) started the commercial production of polycrystalline silicon feedstock in 2008, with an annual capacity of 5 000 tons. The basic procedure of polycrystalline silicon production is as follows ; Raw material Feed (MG-Si) → Silane Production → TCS Purification → CVD Reactor → Polysilicon. The quality of silicon is to be purer than 9 nine. DCC will expand its production capacity to 15 000 tons per year in 2009.

Woongjin Energy established through a joint venture with Woongjin Group and US- based Sunpower produced 830 tones of single crystalline silicon ingot in 2008.

In wafer area, LG Siltron which has set up 10 MW pilot production line in 2006 using electronic-grade ingot off-spec. produced 7 MW single crystalline silicon wafers in 2008.

In addition, several small size companies such as Rexor, Glosil, Neosemitech, etc. entered into silicon ingot and wafer production in 2007, as can be seen in Table 4.

Table 4: Production and production capacity information for the year for silicon feedstock, ingot and wafer producers

Manufacturers	Process & technology	Total Production	Maximum production capacity	Product destination	Price
DC Chemical	Silicon feedstock	N.A.	5000 ton	N.A.	N.A.
Woongin Energy	sc-Si ingots	830 ton	1400 ton	N.A.	N.A.
Rexor	sc-Si ingots	N.A.	80 ton	N.A.	N.A.
Glosil	mc-Si ingots	N.A.	43 ton	N.A.	N.A.
Neosemitech	sc-Si ingots/wafers	N.A.	120 MW	N.A.	N.A.
Smart Applications	sc-Si ingots/wafers	N.A.	30 MW	N.A.	N.A.
Qualiflow Naratech	mc-Si ingots/wafers	N.A.	15 MW	N.A.	N.A.
LG Siltron	sc-Si wafers	7 MW	10 MW	N.A.	N.A.

3.2 Production of photovoltaic cells and modules

In 2008, four companies including three new entrants produced 59 MW crystalline silicon solar cells with an annual production capacity of 146 MW. The KPE is the largest producer followed by new entrants Hyundai Heavy Industry, Millinet Solar and Shinsung Holdings. These company are expected to expand their production capacity in the coming two years, and new companies including LG Electronics and Hanwha Chemical are also expected to start the production in 2009. The technology will be largely based on single crystalline silicon.

Seven companies produced about 106 MW of crystalline silicon PV module with total annual production capability of 300 MW. Due to PV cell supply shortage, the production was far below the production capacity. Symphony Energy, S-Energy and Hyundai Heavy Industry were major PV module manufacturers. For module production, much of single and multi-crystalline silicon PV cells were imported from Japan and Germany. The S-Energy manufactured several types of conventional modules with a peak output of 80 to 200 W and special BIPV modules for façade and atrium applications. This company is a leading PV system integrator and installer. This company installed large sized laminator for the manufacturing of large sized modules with the R&D program on roof-integrated PV modules with construction material manufacturer. The Hyundai Heavy Industries and Symphony Corp. were very active to export market development and made several supply contracts with foreign customers in 2007. In order to export, some companies have obtained certificate from foreign organization such as TUV.

In addition, the Korea Iron & Steel firstly put its a-Si thin film PV modules on the domestic market. The production volume was 8.3 MW with a capacity of 20 MW. Alti Solar started the installation of a-Si PV module production equipment and will produce its module in 2009.

Total PV cell and module manufacturers together with production capacity information is summarised in Table 5 below.

Table 5: Production and production capacity information for 2008 for each manufacturer

Cell/Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MW)		Maximum production capacity (MW/yr)	
		Cell	Module	Cell	Module
<i>Wafer-based PV manufacturers</i>					
1 KPE	sc-Si, mc-Si	25		36	
2 Hyundai Heavy Industry	sc-Si	20	25	30	70
3 Millinet Solar	sc-Si	12,8		30	
4 Shinsung Holdings.	sc-Si	1,3		50	
5 Symphony Energy	sc-Si, mc-Si		30		100
6 S-Energy	sc-Si		30		80
7 Kyungdong Solar	mc-Si		12		20
8 LS Industrial Systems	sc-Si		5		10
9 Unison	sc-Si, mc-Si		2,5		10
10 Solar Tech	sc-Si, mc-Si		1,6		10
Total		<i>59,1</i>	<i>106,1</i>	<i>146</i>	<i>300</i>
<i>Thin film manufacturers</i>					
1 Korea Iron & Steel	a-Si	8,3	<i>8,3</i>	20	<i>20</i>
<i>Cells for concentration</i>					
1					
TOTALS		67,4	114,4	166	320

3.3 Module prices

The average PV module price was 3 260 KRW/W in 2008, which is nearly 18% off compared to that in the previous year as shown in Table 6.

Table 6: Typical module prices for a number of years

Year	1995	2003	2004	2005	2006	2007	2008
Standard module price(s): Typical (Thousand KRW)	9,4	7,0	4,6	4,6	4,4	4,0	3,26
Best price (Thousand KRW)						3,9	3,02
PV module price for concentration							

3.4 Manufacturers and suppliers of other components

The Hex Power Systems is a leading company in grid-connected inverter business with an annual production capacity of 90 MW. Since 2006, several new companies such as Willings(55 MW/year capacity), Dathtech(15 MW/year capacity) and Hanyang Electric(2,5 MW/year capacity) have entered grid-connected inverter market.

3.5 System prices

Depending on the type of the installed PV system, the price of grid-connected systems varied from 6 662 KRW/W to 9 232 KRW/W. The price of the 3 kW rooftop system was 6 662 KRW/W in 2008, which is 20% lower than 8 400 KRW/W in 2007.

The price of 3 kW-capacity grid-connected systems was 8 400 KRW/W which was slightly reduced from 8 550 KRW/W of the previous year.

Table 7a shows the price trends of a typical 3 kW-capacity residential roof-top system.

Table 7: Turnkey Prices of Typical Applications

Category/Size	Typical applications and brief details	Current prices per W KRW/W
OFF-GRID Up to 1 kW		
OFF-GRID >1 kW		
ON-GRID Specific case	3 kW roof-mounted system	6 662
ON-GRID up to 10 kW	PV power plant, roof-mounted system	9 232
ON-GRID >10 kW	PV power plant, public building, multi-family apartment	9 232
GRID – CONNECTED (centralized, if relevant)		N.A.

Table 7a: National trends in system prices for 3 kW-capacity residential roof-top system

YEAR	1998	2002	2003	2004	2005	2006	2007	2008
Price KRW/W:	18 000	14 300	13 700	12 000	9 800	8 550	8 400	6 662

3.6 Labour places

The labour places estimated are as follows.

- a) Public research and development (not including private companies); 500
- b) Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D; 2 000
- c) All other, including within electricity companies, installation companies etc.; 1 500

Table 8: Estimated PV-related labour places in 2008

Research and development (not including companies)	500
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	
Distributors of PV products	
System and installation companies	3 300
Utilities and government	100
Other	100
Total	4 000

3.7 Business value

The value of PV business in Korea was estimated to be 1 341 105 million KRW. This value was calculated from the PV power installed to which PV module export was added and PV module import was subtracted.

Table 9: Value of PV business

Sub-market	Capacity installed in 2008 (kW)	Price per W (from table 7)	Value (Million KRW)	Totals (Million KRW)
Off-grid domestic				
Off-grid non-domestic				
Grid-connected distributed	18 825	6 662	125 412	
Grid-connected centralized	257 499	7 000	1 802 493	
				1 927 905
Export of PV products (including information from Tables 4 & 5)				156 480
Change in stocks held (including information from Tables 4 & 5)				N.A.
Import of PV products (including information from Tables 4 & 5)				743 280
<i>Value of PV business</i>				1 341 105

4 FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

Table 10 lists the main support measures for PV during 2008.

Renewable Portfolio Agreement (RPA) : Utility companies are asked to adopt renewable energy in their total power supply. The program is not mandatory as is the case with the renewable portfolio standard (RPS).

Table 10: PV support measures

	On-going measures	Measures that commenced during 2008
Enhanced feed-in tariffs	V	
Capital subsidies for equipment or total cost	V	
Green electricity schemes		
PV-specific green electricity schemes		
Renewable portfolio standards (RPS)		
PV requirement in RPS		
Investment funds for PV		
Income tax credits		
Net metering		
Net billing		
Commercial bank activities e.g. green mortgages promoting PV		
Electricity utility activities		
Sustainable building requirements		

4.1 Indirect policy issues

Considering 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 near future. In particular, the PV emerges as one of the key sector for government's long-term vision in favour of "Low-carbon Green growth".

4.2 Standards and codes

There are 17 Korean Standards (KS) related to the qualification of PV components such as solar cells and modules, batteries, and power conditioners. One of them is related to the performance evaluation of stand-alone systems. The certification program for inverter and crystalline silicon PV module has been implemented since 2005. For the government-supported PV systems the use of certified products is obligatory. New standardization and codes are under investigation basically for matching the global standards of IEC TC 82 under the responsibility of KATS(Korea Agency for Technology and Standards). The KATS and KNREC have been working together to prepare guidelines and regulations before starting the massive dissemination of PV system.

5 HIGHLIGHTS AND PROSPECTS

During 2008, the annual installed capacity exceeded 276 MW which are nearly six times more than that installed in 2007. This big jump was mainly due to the construction of a tremendous number of large size PV plants under the feed-in-tariff scheme. In addition, the 100 000 roof-top programmes also played a certain role. It is expected that the Korean government will continue to support the PV R&D and dissemination programmes in order to promote the PV as one of Korea's new growth driving industry.

In accordance with global PV boom and the government's strong drive policy, many companies have already entered into the PV industry and more companies are preparing to enter into PV industry. The Korean PV community is expecting the concrete and massive investment of large companies, which especially have a good technological background in semiconductor and display industry.

ANNEX A: NOTE TO WRITER - METHOD AND ACCURACY OF DATA

All data related to installed power, government budgets were provided by the KNREC. In order to get data related to industry activities, a questionnaire was sent to manufacturers and installers. Some companies, especially feedstock and ingot/wafers manufacturers were quite negative in providing the information, and the provided information was incomplete. The accuracy of data is $\pm 5\%$ for the installed PV capacity and for the cell/module production. Data on R&D, D budget are comparatively correct. Due to the large number of PV players recently participated, the number of labour places were guessed considering the data of previous year, the budget increase and the PV power installation. The PV business value is also estimated using simply the PV installed capacity and the export/import of PV products. The export and import of PV products took only PV modules into consideration.

ANNEX B: COUNTRY INFORMATION

This information is simply to give the reader some background about the national environment in which PV is being deployed. It is not guaranteed to be 100 % accurate nor intended for analysis, and the reader should do their own research if they want more detailed data.

- 1) retail electricity prices (NC) - household, commercial, public institution

Household

Fixed rate per home		Electricity rate per kWh
less than 100kWh	370 KRW	55,10 KRW
101~200 kWh	820 KRW	113,80 KRW
201~300 kWh	1 430 KRW	168,30 KRW
301~400	3 420 KRW	248,60 KRW
401~500	6 410 KRW	366,40 KRW
More than 500kWh	11 750KRW	643,90 KRW

- 2) typical household electricity consumption (kWh) : about 300
- 3) typical metering arrangements and tariff structures for electricity customers (for example , interval metering? time-of-use tariff?) : one month-of-use tariff
- 4) typical household income (NC) : 36 Million KRW/ per year
- 5) typical mortgage interest rate : 6%/yr
- 6) voltage (household, typical electricity distribution network) : 220 Volt (household)
- 7) electricity industry structure and ownership (eg vertically integrated or separate generation, transmission, distribution?; retailers and network businesses – integrated or separate?; state owned or municipal or private etc?; electricity industry regulator?) : generation and transmission & distribution are separated. The generation part consists of several companies.
- 8) price of diesel fuel (NC) : 1 260 KRW per liter
- 9) typical values of kWh / kW for PV systems in parts of your country. : 1 105 (annually)