IEA INTERNATIONAL ENERGY AGENCY

New & Renewable Energy

National Survey Report of PV Power Applications in Korea 2013

PVPS

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

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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 24 participating countries are Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), China (CHN), Denmark (DNK), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Malaysia (MYS), Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Thailand (THA), Turkey (TUR), the United Kingdom (GBR) and the United States of America (USA). The European Commission (EC), the European Photovoltaic Industry Association (EPIA), the US Solar Electric Power Association (SEPA), the US Solar Energy Industries Association (SEIA) and the Copper Alliance are also members.

The overall programme is headed by an Executive Committee composed of one representative from each participating country or organization, while the management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents. Information about the active and completed tasks can be found on the IEA-PVPS website www.iea-pvps.org

Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. 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 country National Survey Report for the year 2013. 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 INSTALLATION DATA

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. Other applications such as small mobile devices are not considered in this report.

For the purposes of this report, **PV installations are included in the 2013 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2013, although commissioning may have taken place at a later date**.

1.1 Applications for Photovoltaics

In Korea, photovoltaic system is mainly applied to the electric power generation.

Since the largest annual installation of 276 MW in 2008, the PV installation during the following three years became stagnant, installing about 156 MW in 2011. This was mainly due to the limited FiT scheme which played an important role in the early stage Korean PV market expansion. However, new installation of 230 MW was recorded in 2012 due mainly to the newly introduced RPS scheme with mandated PV requirement. The RPS scheme was again the main driver for PV installation in 2013, and a remarkable size of 531 MW was recorded. At the end of 2013, the total installed PV capacity is about 1555,0 MW, among them the grid-connected centralized system accounted for 82% of the total cumulative installed power. The grid-connected distributed system amounted to 18% of the total cumulative installed PV power. On the other hand the share of off-grid non-domestic and domestic systems has continued to decrease to less than 1 percent of the total cumulative installed PV power. The total capacity of 1555,0 MW corresponds to 1,79% of total electricity generation capacity of about 86,969 GW, and the installed PV power of 531 MW in 2013 accounts for 10,3% of total power generation capacity newly installed in 2013, as can be seen in Table 3.

1.2 Total photovoltaic power installed

Table 1 show the PV power installed in four sub-markets during 2013.

The annual installation data was obtained from the total capacity of the PV systems approved to install in the year of 2013 by the NREC (New & Renewable Energy Centre) at KEMCO (Korea Energy Management Corporation). Small scale installations for off-grid domestic and non-domestic applications are not accurately monitored by the NREC, introducing some errors in the data of the tables. In Korea, PV installation statistics is categorized into two sectors, PV for “business” or “self-use.” Thus in the tables, “grid-connected distributed” is assumed as “self-use,” and “grid-connected centralized” is assumed as “business.” Data for 2013 is the official value as of November 17, 2014. The electricity statistics data were taken from the “KEPCO (Korea Electric Power Corporation) in Brief 2013,” published on December, 2013.

Table 1: PV power installed during calendar year 2013

AC			**MW installed in 2013 (mandatory)**	**MW installed in 2013 (optional)**	**AC or DC**
Grid-connected	BAPV	Residential	63,3 MW		
		Commercial			
		Industrial			
	BIPV (if a specific	Residential			

	legislation exists)	Commercial			
		Industrial			
	Ground-mounted	cSi and TF	467,4 MW	467,4 MW	
		CPV			
Off-grid		Residential			
		Other			
		Hybrid systems			
		Total		530,7 MW	DC

Table 2: Data collection process:

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	N/A
Is the collection process done by an official body or a private company/Association?	Public body
Link to official statistics (if this exists)	www.kemco.or.kr
	Installation data are mainly collected from KEMCO; electricity data are mainly collected from KEPCO and KEEI; industry data are mainly collected by KOPIA; R&D data are mainly collected by KETEP

Table 3: PV power and the broader national energy market

MW-GW for capacities and GWh-TWh for energy	2013 numbers	2012 numbers
Total power generation capacities (all technologies)	86,969 MW	81,806 MW
Total power generation capacities (renewables including hydropower)	9,973 MW	8,929 MW
Total electricity demand (= consumption)	474,849 GWh	466,593 GWh
New power generation capacities installed during the year (all technologies)	5,163 MW	5,157 MW
New power generation capacities installed during the year (renewables including hydropower)	1,189 MW	652 MW
Total PV electricity production in GWh-TWh	1,605 GWh	1,103 GWh
Total PV electricity production as a % of total electricity consumption	0.34	0.24

*Source: KEMCO, KEPCO, KEEI

Table 4: Other information

	2013 Numbers (optional)
Number of PV systems in operation in your country (a split per market segment is interesting)	Self-use : 278,160 kW (2013, Accumulated) Business : 1,276,875 kW (2013, Accumulated)
Capacity of decommissioned PV systems during the year in MW	Not monitored yet: Plan to keep track of the decommissioned PV systems from 2016
Total capacity connected to the low voltage distribution grid in MW	Self-use : 49 805 MW Business : 107 411 MW Total : 157 216 MW 380 V (3 Phase); 220 V (Single Phase) in <100 kW basis
Total capacity connected to the medium voltage distribution grid in MW	
Total capacity connected to the high voltage transmission grid in MW	Self-use : 13 493 MW Business : 360 011 MW Total : 373 504 MW 22 900 V and above in > 100 kW basis

A summary of the cumulative installed PV Power, from 2002-2013, broken down into four sub-markets is shown in Table 5.

Table 5: The cumulative installed PV power in 4 sub-markets

Sub-market	～2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Stand-alone domestic	0	0	0	0	0	0	0	0	0	0
Stand-alone non-domestic	0	0	0	0	0	0	0	0	0	0
Grid-connected distributed	5,416	5,979	8,294	12,060	25,311	41,818	58,360	82,541	116,847	152,682
Grid-connected centralized	0	0	0,238	1,462	10,533	39,375	298,484	441,141	533,492	576,475
TOTAL (MW)	5,416	5,979	8,532	13,522	35,844	81,193	356,844	523,682	650,339	729,157

Sub-market	2012	2013	2014	2015	2016	2017	2018	2019	2020

Stand-alone domestic	0								
Stand-alone non-domestic	0								
Grid-connected distributed	214,862	278,160							
Grid-connected centralized	809,453	1,276,875							
TOTAL (MW)	1024,316	1,555,035							

*Official Statistics from NREC (2013 NRE Dissemination Statistics, NREC, November, 2014) show different figures in Table 5 when compared with figures reported in Korean NSR 2012. From 2013, the officially reported statistics values are only used in the table, since it is the most reliable data available in Korea.

The increased PV installation in 2013 was mainly due to the newly introduced RPS scheme since 2012 (FiT scheme was terminated at the end of 2011), with mandated PV set-aside requirement. Korean government continued to support strongly the deployment, R&D, infrastructure building and market promotion of PV, which are described in the following sections. Among these, the government-initiated RPS scheme and R&D support played the most important role in boosting the PV deployment and industry development.

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

A summary of typical module and system prices is provided in the following tables. Prices shown in Table 6 are the calculated average values. The price of grid-connected systems varied from 2 400 KRW/W to 3 000 KRW/W depending on the type and size of installations.

Table 6: Typical module prices for a number of years system prices

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Standard module price(s): Typical (KRW/W)	7 000	4 600	4 600	4 400	4 000	3 260	2 600	2 400	1 400	1 000	974
Best price (KRW/W)					3 900	3 020	2 400	2 000	1 200	800	634
PV module price for concentration (if relevant)											

Table 7: **Turnkey prices of typical applications**

Category/Size	Typical applications and brief details	Current prices per W
OFF-GRID Up to 1 kW		
OFF-GRID >1 kW		

Grid-connected Rooftop up to 10 kW (residential)	3 kW for roof-mounted system	3 000 KRW
Grid-connected Rooftop from 10 to 250 kW (commercial)		
Grid-connected Rooftop above 250kW (industrial)		
Grid-connected Ground-mounted above 1 MW		
Other category existing in your country (hybrid diesel-PV, hybrid with battery…)	30 kW field-mounted system	2 400 KRW

Table 8: National trends in system prices (current) for different applications

Price KRW/Wp	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Residential PV systems < 10 KW*	14 300	13 700	12 000	9 800	8 550	8 400	6 662	5 850	5 060	4 000	3 000	3 000
Commercial and industrial**												
Ground-mounted***												2 400

*National trends in system prices for 3 kW-capacity residential roof-top system in Korea.

**National trends in system prices for 10-100 kW-capacity commercial and industrial system in Korea.

***National trends in system prices for RPS related system in Korea.

2.2 Financial Parameters and programs (leasing…)

Table 9: PV financing scheme

Average Cost of Capital	Not available.
Description of a specific PV financing scheme (leasing, renting…)	PV leasing scheme started in 2014.

2.3 Additional Country information

Table 10: Country information

Retail Electricity Prices for an household(low voltage less than 3 kW), (range)	**Fixed rate per home (KRW/household)**		**Electricity rate per kWh (KRW/kWh)**
	less than 100 kWh	410	60,70
	101~200 kWh	910	125,90
	201~300 kWh	1 600	187,90

<table>
<tr><td></td><td colspan="2">301~400 kWh</td><td>3 850</td><td colspan="3">280,60</td></tr>
<tr><td></td><td colspan="2">401~500 kWh</td><td>7 300</td><td colspan="3">417,70</td></tr>
<tr><td></td><td colspan="2">More than 500 kWh</td><td>12 940</td><td colspan="3">709,50</td></tr>
<tr><td rowspan="7">Retail Electricity Prices for a commercial company (Contracted power greater than 4 kW and less than 300 kW), (range)</td><td colspan="2" rowspan="2"></td><td rowspan="2">Basic rate per kW (KRW/kW)</td><td colspan="3">Electricity rate per kWh (KRW/kWh)</td></tr>
<tr><td>Summer 7~8</td><td>Spring Autumn 3~6, 9~10</td><td>Winter 11~2</td></tr>
<tr><td colspan="2">Low Voltage</td><td>6 160</td><td>105,70</td><td>65,20</td><td>92,30</td></tr>
<tr><td rowspan="2">High Voltage A</td><td>Option I</td><td>7 170</td><td>115,90</td><td>71,90</td><td>103,60</td></tr>
<tr><td>Option II</td><td>8 230</td><td>111,90</td><td>67,60</td><td>98,30</td></tr>
<tr><td rowspan="2">High Voltage B</td><td>Option I</td><td>7 170</td><td>113,80</td><td>70,80</td><td>101,60</td></tr>
<tr><td>Option II</td><td>8 230</td><td>108,50</td><td>65,50</td><td>95,30</td></tr>
<tr><td rowspan="7">Retail Electricity Prices for an industrial company (Contracted power greater than 4 kW and less than 300 kW), (range)</td><td colspan="2" rowspan="2"></td><td rowspan="2">Basic rate per kW (KRW/kW)</td><td colspan="3">Electricity rate per kWh (KRW/kWh)</td></tr>
<tr><td>Summer 7~8</td><td>Spring Autumn 3~6, 9~10</td><td>Winter 11~2</td></tr>
<tr><td colspan="2">Low Voltage</td><td>5 550</td><td>81,00</td><td>59,20</td><td>79,30</td></tr>
<tr><td rowspan="2">High Voltage A</td><td>Option I</td><td>6 490</td><td>89,60</td><td>65,90</td><td>89,50</td></tr>
<tr><td>Option II</td><td>7 470</td><td>84,80</td><td>61,30</td><td>83,00</td></tr>
<tr><td rowspan="2">High Voltage B</td><td>Option I</td><td>6 000</td><td>88,40</td><td>64,80</td><td>88,00</td></tr>
<tr><td>Option II</td><td>6 900</td><td>83,70</td><td>60,20</td><td>81,90</td></tr>
<tr><td>Population at the end of 2013 (or latest known)</td><td colspan="6">51 284 774 (as of September, 2014)</td></tr>
<tr><td>Country size (km^2)</td><td colspan="6">100 210 (as of 2013)</td></tr>
<tr><td>Average PV yield (according to the current PV development in the country) in kWh/kWp</td><td colspan="6">1 258 kWh/kW</td></tr>
<tr><td>Name and market share of major electric utilities.</td><td colspan="6">KEPCO (100%)</td></tr>
</table>

*Source: KEPCO, KOSIS

3 POLICY FRAMEWORK

This chapter describes the support policies aiming directly or indirectly to drive the development of PV. Direct support policies have a direct influence on PV development by incentivizing or simplifying or defining adequate policies. Indirect support policies change the regulatory environment in a way that can push PV development.

3.1 Direct support policies

Table 11: PV support measures (summary table)

	On-going measures	Measures that commenced during 2013
Feed-in tariffs (gross / net?)	Ended as of 2012F	
Capital subsidies for equipment or total cost	√	
Green electricity schemes		
PV-specific green electricity schemes		
Renewable portfolio standards (RPS)	√	
PV requirement in RPS	√	
Investment funds for PV	√	
Income tax credits		
Prosumers' incentives (self-consumption, net-metering, net-billing…)		
Commercial bank activities e.g. green mortgages promoting PV		
Activities of electricity utility businesses	√	
Sustainable building requirements	√	

3.2 Direct Support measures

3.2.1 Support measures exiting in 2013

3.2.1.1 Description of support measures excluding prosumers, BIPV, and rural electrification

The Korean Ministry of Trade, Industry and Energy (MOTIE) has been implementing various deployment initiatives and programs for PV systems through the NREC. In 2008, the "Third Basic Plan for the Promotion of Technological Development, Use, and Diffusion of New and Renewable Energy" based on the "First National Energy Basic Plan" was made public in order to enhance the level of self-sufficiency in energy supply, to meet the challenges of global warming and 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 2015. This goal is lower than the previously set value of 5% by 2012. Although the actual outcome of NRE deployment by 2012 was turned out to be 2,6%, falling far below the goal, PV still remains as one of the prioritized area. This plan includes the construction of "One Million Green Homes" and "200 Green Villages" until 2020. Also in this plan, the RPS (Renewable Portfolio Standards) scheme will replace the existing "Feed-in-Tariff (FiT)" scheme from the year 2012. The RPS was launched in 2012 as planed and will be active until 2022. Below are the summaries of PV support measures currently operating in Korea as of 2013.

- **Home Subsidy Programme (One Million Green Homes):** This programme was launched in 2004 that merged the existing 100 000 rooftop PV system installation program, and it aims at the construction of one million green homes 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. The maximum PV capacity allowed for a household is 3 kW. At the end of 2013, more than 150 000 households (total 142,6 MW of PV capacity) benefited from this program. In 2013, the installed capacity was about 20,6 MW.
- **RPS Program:** The RPS is a mandated requirement that the electricity utility business source a portion of their electricity supplies from renewable energies. In Korea, electricity utility business companies exceeding 500 000 kW are required to supply total 10% of their electricity from NRE source by 2022, starting from 2% in 2012. Before starting the formal RPS program from 2012, the Government initiated the RPS demonstration program for three years from 2009 until 2011. Six Korean electricity generation companies have signed the 'RPA (Renewable Portfolio Agreement)' with the Government in order to increase the share of renewable energy electricity generation. The total capacity was fixed to be 101,3 MW. These six electricity companies constructed their own PV power plants or purchased PV electricity from private sources. In 2011, 31,7 MW was approved under this program. Since 2012, the RPS (Renewable Portfolio Standard) scheme began to fully replace the FiT scheme. Total thirteen companies including six electricity generation companies, electricity generation business companies and two other corporates have participated in the RPS since 2012. In order to expand the size of domestic market and boost the PV development, PV has its own set-aside amount in the RPS of total 1,5 GW for the four years covering 2012~2015. The original plan was for five years, but the Government decided to shorten the target year by one year, considering the difficult situation of Korean PV companies. In 2013, the record-breaking 409,4 MW was installed under this program.

<Annual set-aside PV capacity requirement in RPS>

YEAR	2012	2013	2014	2015	2016
Capacity (MW)	220	330	470	480	Not decided yet

Further amendment of RPS scheme was made in 2014 to boost the small-scale installations and use of idle lands. The REC weighting factor scheme was changed from the originally region-dependent (5 different regions) scheme to the capacity-dependent scheme. The new weighting factor scheme is summarized in the table below: Additional 20% weighting factor is given to the lands near the power transmission lines, if more than 30% of the people in the region participate in the project.

<Amended REC weighting factor scheme in RPS>

Type	Small Scale (< 100 kW)	Medium Scale (100 kW ~ 3 MW)	Large Scale (> 3 MW)
General	1.2	1.2+1.0	1.2+1.0+0.7
Building	1.5		1.5+1.0
On-water	1.5		

- **Feed-in Tariff Program**: Until 2011, the total 500 MW was installed under this support measure. In 2011 alone, 79 MW were installed. FiTs in 2010 and 2011 were reduced by 10 to 15% compared with that of the previous year. For BIPV 10% bonus was given. A BIPV system larger than 1 MW is accounted as a ground installed system. The FiT scheme, though, ended at the end of 2011.
- **Building Subsidy Program (Formerly General Deployment Subsidy Program):** The Government supports up to 50% of installation cost for PV systems with a capacity below 50 kW. In addition, the Government supports 80% of initial cost for special purpose demonstration and pre-planned systems in order to help the developed technologies and systems to diffuse smoothly into the market. This is the "Test-period Deployment Subsidy Program." In 2012, 115 PV systems with the total of 2,3 MW were installed by this program. Until the end of 2012, about 16 MW capacity and 690 PV systems benefited from this program. Various grid-connected PV systems were installed in schools, public facilities, welfare facilities as well as in universities.
- **Regional Deployment Subsidy Program:** The government supports 50% of installation cost for PV systems owned and operated by local authorities. Until the end of 2012, about 60 MW benefited from this program with the subsidy of 284 900 million KRW.
- **NRE Mandatory Use for Public Buildings:** The new buildings of public institutions, the floor area of which exceeds 1 000 square meters, are obliged by law to use more than 10% of their total expected energy by the newly installed renewable energy resource systems. Public institutions include state administrative bodies, local autonomous entities, and state-run companies. The building energy mandate percentage is planned to increase up to 30% by 2020. In 2012 alone, approximately 32 MW was installed under this program, the cumulative total capacity reaching about 90 MW at the end of 2012. From 2015, "NRE Mandatory Use for Public Buildings" will be expanded due to recently amended act on NRE deployment promotion. Original 13% by 2015, 14% by 2016, 15% by 2017, 16% by 2018, 18% by 2019, and 20% by 2020 will be changed to 15% by 2015, 18% by 2016, 21% by 2017, 24% by 2018, 27% by 2019, and 30% by 2020.

3.2.1.2 Prosumers' development measures

3.2.1.3 BIPV development measures

3.2.1.4 Rural electrification measures

Rural electrification measures are adopted and implemented mainly by the local authorities in Korea. For example, Incheon city is installing PV power of 250 kW, small size (10 kW) wind power of 40 kW, energy storage of 1 125 kW in Backa island until the end of 2014 to make the island carbon-free. Similarly, PV power of 120 kW and wind power of 30 kW will be installed in Jungma island, which will provide 388 000 kWh electricity annually. 1 200 kWh size ESS (Energy Storage System) is also installed, and the diesel power will now serve as the supplementary power for the island. These types of measures and programs are being gradually expanded by the most local governments in Korea.

3.2.1.5 Other measures including decentralized storage and demand response measures

Korean government (MOTIE) launched the smart grid test-bed project in September, 2012 in Jeju island and invested 76,6 billion KRW (total 249,5 billion KRW including the 172,9 billion KRW investment from the private sector). The project ended in May, 2013, and it aimed at verifying the energy systems integration technology using smart metering devices. The project also aimed at developing business models for commercialization. The 2nd phase smart grid diffusion project is designed in 2014 and expected to be launched since 2015.

3.2.2 New support measures implemented in 2013

- **Convergence and Integration Subsidy Program for NRE:** This is a new NRE subsidy program started in 2013. A consortium led by either local authority or public enterprise with NRE manufacturing companies and privates can apply for this subsidy program. This program is designed to help diffuse the NRE into socially disadvantaged and vulnerable regions and classes such as islands, remote areas (not connected to the grid), long-term rental housing district, etc. Local adaptability is one of the most important criteria, thus the convergence between various NRE resources (PV, wind, electricity and heat) and the complex between areas (home, business and public) are primarily considered to benefit from this program.
- **Solar Lease Program:** In 2013, MOTIE (through NREC) introduced this new scheme to promote PV deployment and launched a few demo projects. The Solar Lease program will fully begin since 2014. It is designed in such a way that the private companies take care of installations and after-services without government support, while consumers pay the PV rental fee. More than 2 000 households using 350 kWh or more electricity per month can benefit from this new program. Rental fee, rental period, REP (Renewable Energy Point) price are properly set to motivate the participation of leasing companies and consumers.
-

<Solar lease program>

	Subsidy Program	Lease Program
Government Subsidy	Certain portion of the Installation cost	No support
Consumer Expense	Certain portion of the installation cost	Rental fee
Leasing Company	Installation cost	Rental fee+REP sales income
Ownership	Household	Leasing company (Transfer of ownership to consumers after the contract period)

- **Environment-friendly Energy Town Program:** A new demo program has been launched by the Korean government (MOTIE, MOE and MSIP) in 2014 for three regions (Gwangju (MOTIE), Hongcheon (MOE) and Jincheon (MSIP)) of deploying the eco-friendly energy generation facilities to the avoiding facilities or sites such as waste incinerators and waste landfill sites. The Korean government has a plan to strengthen and expand this program into whole nation since 2015 by improving the program details from the lessons learned from the demo program.

<Environment-friendly energy town program>

Site	Program Content
Hongcheon, Gangwon Province **(MOE)**	Recycling of animal and food wastes into biogas or fertilizer and reuse & sale; Installation of 340 kW PV and 25 kW small-size hydro power in waste water treatment sites
Woonjeong, Gwangju City **(MOTIE)**	Installation of 20 MW PV in waste landfill sites; Green villages (PV and solar thermal); New & renewable energy experience center

Jincheon, Choongbuk Province (MSIP)	Installation of 950 kW PV and 10 kW fuel cell in waste water treatment sites; Storage and reuse of solar thermal, geothermal and waste water thermal energy as heating source for winter season by using seasonal thermal energy storage system

- **Opening of Negawatt Electricity Market:** MOTIE announced the opening of DRR (Demand Respond Resource) electricity trading market as of November 25, 2014 by approving the revision of 'Electricity Trading Market Operating Rules' on October 3, 2014. This so-called 'Negawatt Electricity Market' was launched as one of 'the Six New Energy Industry Projects for Climate Change Response.' Now a new business for trading saved electricities is expected to grow since 2015.

3.2.3 Measures currently discussed but not implemented yet

- **Bonus-Malus System:** Introduction of the Bonus-Malus system was proposed by Korean Ministry of Environment to launch this new measure in Korea since 2015, but after the strong debate, it was temporarily postponed, considering the global competitiveness of Korean automobile industry.

3.2.4 Financing and cost of support measures

- **New & Renewable Energy Loans:** This loan can be used for funding to construct facilities and production as well as working capital. In 2012, total 34 050 million KRW was used for PV loans.

3.3 Indirect policy issues

3.3.1 International policies affecting the use of PV Power Systems

3.3.2 The introduction of any favourable environmental regulations

- **Cap & Trade System:** The Cap & Trade system will be introduced in Korea since January 1st, 2015. The greenhouse gas (GHG) emissions allowance for the first phase (2015-2017) is set at 1,687 billion CO_2 ton, defined as KAU (Korean Allowance Unit: 1 CO_2 ton). 1,598 billion KAU will be allowed by companies before launching the Cap & Trade system, and 0,89 billion KAU will be allowed during the first phase as spare amount. 573 460 million KAU for 2015, 562 180 million KAU for 2016, and 550 900 million KAU for 2017 will be allowed as the total emissions in Korea. In industry sectors, 730 850 million KAU for power plants and energy industry, 357 600 million KAU for steel industry, 143 700 million KAU for petrochemical industry, and 128 000 million KAU for cement industry will be allowed. The Korean Ministry of Environment announced the total 526 companies including POSCO steel company which will be subjected to the Cap & Trade system for the first phase in September, 2014.

3.3.3 Policies relating to externalities of conventional energy

3.3.4 Taxes on pollution (e.g. carbon tax)

3.3.5 National policies and programmes to promote the use of PV in foreign non-IEA countries

- **KOICA (Korea International Cooperation Agency) Projects:** KOICA has several programs to assist and aid in installing new & renewable energy (NRE) facilities to non-IEA countries.

These programs are launched to participate in the worldwide effort (e.g. UNFCCC) to mitigate and control the world's climate changes. The objective of the programs includes international collaborative actions to promote low-carbon green growth of East-Asian countries and technical support in NRE application sectors for developing countries. The countries benefited from these programs include Mongolia, Ghana, Morocco, Egypt, Tunisia, Bolivia, Ecuador, Uzbekistan and Iraq.

4 HIGHLIGHTS OF R&D

4.1 Highlights of R&D

The national PV R&D budget in 2013 amounted to 213,1 billion KRW. Since 2008, Korean government has promoted the NRE development extensively under the slogan of "Green and Strong Nation," and government-led R&D programs have been consistently initiated. Annual averaged growth of PV R&D budget for the period of 2009-2013 was 8.7%, which was similar to that in other sectors of national R&D. However, after peaking in 2011, PV R&D budget started to decrease slightly each year (annual average decrease of 2.7%) due partly to the recession of worldwide PV market. As of 2013F, the percentage of PV R&D budget with respect to the total national R&D budget was about 1.3%. The average PV R&D budget for a single project was decreased to 350 million KRW in 2013 from 380 million KRW in 2009, which became closer to the average R&D budget for a single project in other sectors of national R&D.

<The national PV R&D budget of Korea (2009-2013)>

(Billion KRW, %)

Year		2009	2010	2011	2012	2013	Average Annual Growth Rate ('09~'13)
PV R&D (A)	Budget	158	208,6	224,9	219,9	213,1	8.7
	No. of Projects	412	564	614	656	604	11.7
	Budget/No. of Projects	0,38	0,37	0,37	0,34	0,35	
National R&D (B)	Budget	12 414,5	13 682,7	14 852,8	15 906,4	16 913,9	9.1
	No. of Projects	39 471	39 179	41 619	49 948	50 865	7.2
	Budget/No. of Projects	0,31	0,35	0,36	0,32	0,33	
Ratio (A/B)	Budget	1.3	1.5	1.5	1.4	1.3	
	No. of Projects	1.0	1.4	1.5	1.3	1.2	

Total eight Korean ministries were involved in planning and managing the national PV R&D projects. In 2013, 86.9% of total PV R&D budget was managed by MOTIE and MSIP (112,0 billion KRW by MOTIE and 73,3 billion KRW by MSIP), and the rest was managed by other six government entities including Small and Medium Business Administration (SMBA) (16,4 billion KRW) and Ministry of Education (MOE) (7,5 billion KRW). The KETEP (Korea Institute of Energy Technology Evaluation and Planning) controls the biggest portion of the MOTIE-led national PV R&D budget and managed total 430 Billion KRW for the period of 2008~2013. About 60 Billion KRW will be invested in PV R&D through KETEP in 2014. Below are the summaries of PV R&D budget allocated to KETEP from 2008 to

2013 and the scope of national PV R&D projects. Major achievements from the national PV R&D projects are also highlighted below.

<The cumulative PV R&D budget of KETEP>

Year		2008	2009	2010	2011	2012	2013	Total
Number of Projects (ea)	Short-term	26	46	63	67	49	39	290
	Mid/Large Scale	13	11	12	13	21	21	91
	Total	39	57	75	80	70	60	381
Government Budget (Billion KRW)	Short-term	11,814	30,833	35,534	29,014	20,707	15,350	143,252
	Mid/Large Scale	44,863	39,806	48,886	47,759	56,577	48,246	286,137
	Total	56,677	70,639	84,420	76,773	77,284	63,596	429,389

The national PV R&D budget managed by KETEP increased dramatically in 2008 to more than 50 billion KRW compared to that of less than 10 Billion KRW in 2007. This increased PV R&D budget concentrated on developing the crystalline Si solar cells (70~80%). The scope of PV R&D then expanded to a broader spectrum, reducing the Si solar cell related R&D, while increasing the thin film related R&D. The objectives of PV R&D also shifted from initially the solar cell focused R&D to a wider spectrum including R&Ds for PV systems, PV electricity generation and various PV applications in order to facilitate the diffusion of PV dissemination.

The government-led PV R&D initiatives generated several noticeable outcomes. Breakthrough and core technologies essential to various types of solar cells were developed, and Korean-made polysilicon manufacturing technology was acquired. Especially, the Korean-made polysilicon manufacturing technology was transferred to the mass production of polysilicon in Korea. Currently the market share of Korean-made polysilicon is among the top 4 in the world, and the export of Korean-made polysilicon is continuously increasing due to its high quality and cost-competitiveness. PV inverters for grid connection was also developed from the national PV R&D, and these inverters are designed and fabricated in Korea and now are being used in the PV system installations in Korea. Below is the summary of major achievements from KETEP's PV R&D.

<Major achievements from KETEP's PV R&D>

Subject	Major Achievement
Polysilicon manufacturing and mass production technology	Acquisition of Korean-made, turn-key polysilicon mass production technology *OCI: World's top 4 in the production capacity - 42,000 ton/yr
Development of 150 ㎛ thick crystalline silicon solar cells	Acquisition of Korean-made fabrication equipment and materials technology *Cell sorter, Laminator, Tabbing & Stringer, EVA film
Development of PV inverters for grid connection	Acquisition of Korean-made design and fabrication technology *Commercialization and entry into both domestic and global market
Development of PV modules for desert applications	100 kW system in demonstration in the middle-eastern countries such as Oman and Saudi Arabia

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

Table 12: Public budgets for R&D, demonstration/field test programmes and market incentives.

	R & D	Demo/Field test
National/federal	213,1 Billion KRW	3 955,4 Million KRW
State/regional	N/A	N/A
Total		

5 INDUSTRY

5.1 Production of feedstocks, ingots and wafers (crystalline silicon industry)

Table 13: Production information for the year for silicon feedstock, ingot and wafer producers

Manufacturers (or total national production)	Process & technology	Production Capacities	Product destination (if known)	Price (if known)
OCI	Polysilicon	42,000 ton (26 391 ton)	Mainly to China	Around USD 18/kg in a spot price
Hankook Silicon	Polysilicon	15,000 ton	-	-
Hanwha Chemical	Polysilicon	10,000 ton	Mainly to China	-
KCC (Ceased Production)	Polysilicon	3,000 ton	-	-
Total	**Polysilicon**			
SKC Solmics	Ingot	150 MW	-	-
Glosil (Ceased Production)	Ingot	100 MW	-	-
Lexor (Under Legal Management)	Ingot	100 MW	-	-
Osung LST	Ingot	350 MW	-	-
Woongjin Energy	Ingot	1 000 MW	Mainly to USA	-
Nexolon	Ingot	1 750 MW	Mainly to China	-
Total	**Ingot**			
SKC Solmics	Wafer	130 MW	-	-
Glosil (Ceased Production)	Wafer	100 MW	-	-
Lexor (Under Legal Management)	Wafer	80 MW	-	-
Osung LST	Wafer	350 MW	-	-
Woongjin Energy	Wafer	500 MW	Mainly to USA	-
Nexolon	Wafer	1 350 MW	Mainly to China	Below USD 1/sheet
Total	**Wafer**			

*Values in parenthesis is the estimated actual production amount.

KCC ceased production of polysilicon in Korea due to the global market situation. However, KCC's joint venture company in Saudi Arabia, PTC, is expected to complete the polysilicon manufacturing plant with 3 000 ton capacity.

Hanwha SolarOne is operating a 800 MW ingot and wafer capacity plant in China.

5.2 Production of photovoltaic cells and modules (including TF and CPV)

Module manufacturing is defined as the industry where the process of the production of PV modules (the encapsulation) is done. A company may also be involved in the production of ingots, wafers or the processing of cells, in addition to fabricating the modules with frames, junction boxes, etc. The manufacturing of modules may only be counted to a country if the encapsulation takes place in that country.

Total PV cell and module manufacture together with production capacity information is summarised in Table 9 below.

Table 14: Production and production capacity information for 2013

Cell/Module manufacturer (or total national production)	**Technology** (sc-Si, mc-Si, a-Si, CdTe)	**Total Production (MW)**		**Maximum production capacity (MW/yr)**	
		Cell	Module	Cell	Module
Wafer-based PV manufactures					
Solar Tech	Sc-Si mc-Si *mc-Si is main				30
Solariver					20
SDN					100
S-Energy			350		500
BJ Power					20
Hyundai Heavy Industries		500	500	600	600
Hae Sung Solar					10
Shinsung Solar Energy			150	350	150
Hansol Technics			250		250
Dayou SE					90
LSIS			120		150
Woori S-tech					50
JSPV					100
Solarpark Korea					600
Topsun					150
EOS Solar					30
LG Electronics		500	500	500	500
E&R Solar		120	60	180	60
T & Solar					50
Luxco					150
Kyung Won (K Solar)					20
Total				*1630*	*3630*
Thin film manufacturers					
None				0	*0*
Cells for concentration					

None				0	*0*
TOTALS				*1630*	*3630*

Most module companies in Korea have been purchasing cells from China and Taiwan manufacturers. LG Electronics is providing total in-house cells to produce its modules, and Hyundai Heavy Industries is utilizing most in-house cells to produce modules, though some cells are sold. Shinsung Solar Energy is using in-house cells, but the ratios of using in-house cells are low. E&R Solar is using in-house cells, but sales of cell is also running parallel.

Around 80% of produced modules in Korea were exported to other countries, and the main export region was Japan.

Solar PV modules for mini PV systems were introduced in 2013.

Modules with thermal benefits were developed for the market targeted for Middle East area.

Hanwha Group is operating cell and module production overseas. Hanwha Chemicals merged with Chinese company (Hanwha Solarone) and German company (Hanwha Q-cells). In 2014, these two companies merged again to form a single company. With this merger and acquisition, Hanwha Q-cells is world's No. 1 in cell production capacity and No. 4 in module production capacity. Hanwha's cells and modules are produced in China, Malaysia and Germany.

5.3 Manufacturers and suppliers of other components

<PV inverters>

Korean manufactures of PV intervers have increased their capacities, and the price for home system is below USD 800/3 kW.

<Storage>

In Korea, LG Chemical, Samsung SDI and SK Innovation are the major developers and suppliers of Energy Storage System (ESS).

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6 PV IN THE ECONOMY

6.1 LABOUR PLACES

Table 15: Estimated PV-related labour places in 2013

Research and development (not including companies)	N/A
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	
Distributors of PV products	
System and installation companies	N/A
Electricity utility businesses and government	N/A
Other	N/A
Total	

6.2 Business value

Table 16: Value of PV business

Sub-market	**Capacity installed *in 2012* (MW)**	**Price per W** *(from table 7)*	**Value**	**Totals**
Off-grid domestic	*X*	*Y*	*a = X x Y x 1 000 000*	
Off-grid non-domestic			*b*	
Grid-connected distributed			*c*	
Grid-connected centralized			*d*	
				a+b+c+d
Export of PV products				*e*
Change in stocks held				*f*
Import of PV products				*g*
Value of PV business				***a+b+c+d+e+f-g***

In Korea, the PV industry value chain for crystalline silicon solar cells is completely established from raw materials (polysilicon), ingot and wafers, cells, modules, systems and power plants. Among these, polysilicon production capacity is currently No. 4 in the world. The Korean-made products are mostly exported to foreign countries including China, EU, Japan and USA.

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

Short description of the electricity industry landscape	- Vertically integrated - Monopoly - Public ownership - Regulated by Government

7.2 Interest from electricity utility businesses

From the year 2012, the RPS (Renewable Portfolio Standards) scheme began to replace the FIT scheme which lasted until 2011. Total thirteen companies including 6 electricity generation companies, electricity generation business companies and two other corporates have participated in the RPS in the first fiscal year of RPS. In 2012, only 64.7% of the first year's RPS duties were attained, while 95.7% of RPS PV set-aside amounts were attained. This caused the cost of REC (Renewable Energy Credit) for PV drop significantly. The electricity utility businesses would like to have more PV to replace the non-PV RPS to lower the cost and fulfil their duties. This trend continued in 2013, and REC cost dropped even more, now the REC is close to 100 KRW/W.

In RPS scheme, REC weighting factor is introduced to balance the utilization/dissemination and promotion of technology development. In determining the PV REC weighting factors, considerations were given to address the following four issues: 1. Influence on environment, technology development and industry revitalization, 2. Cost in electricity generation, 3. Potential amount, 4. Effect on greenhouse gas emission reduction. In practice, however, there exist some mismatches and conflicts to hinder the RPS participants from fulfilling their duties. Some regions with large potential PV source have either low REC weighting factor or under strict regulation. The first year's RPS practice revealed many of these problems encountered by the electricity utility businesses. Thus Korean government decided to simplify the REC weighting factor scheme in 2014 and from 2015, the new REC weighting factor scheme will be in effect.

Electricity utility businesses in general are still hesitant to participate aggressively in the PV deployment and are asking for more support from the Government. Complementary measures are under preparation in 2014 to resolve some of the issues surfaced in 2012 and 2013.

PV rental business (third party ownership) is introduced in 2014 and is expected to grow in near future. A so-called "Negawatt" market was also introduced in 2014 and will be fully operational since 2015. This is a electricity trade scheme not on a production and supply basis but on a saving and peak time trading basis.

7.3 Interest from municipalities and local governments

The Capital city, Seoul has been campaigning "One Less Nuclear Power Plant for Seoul" since 2011 and is conducting many programs to reduce the electricity demand and increase the amount of NRE usage. In this plan, total 320 MW of PV power will be supplied in Seoul by 2014. Seoul recently revived a modified type of FIT scheme to facilitate the PV deployment.

Chungbuk Province's slogan is "A Land of Life and Sun." In this province, more than 50% of Korean-made PV modules are produced. This province met a goal of installing 170 MW of PV power by 2013 and has a

plan to construct a PV R&D hub in the province. KIER (Korea Institute of Energy Research) is located in the neighbouring metropolitan city, Daejeon.

The metropolitan city, Daegu is advocating “Solar City” as its slogan, and hosting many world renowned international meetings, conferences and expos. Recently, Daegu hosted “Solar City Congress,” and has been regularly hosting IGEEC (International Green Energy Expo and Conference) every year. In 2013, the “22nd World Energy Congress” was held in Daegu. Solar Cell/Module RIC (Regional Innovation Centre) is located in Yeungnam University in the neighbouring Gyeonbuk province which also emphasizes Green Energy Industry as its new growth engine industry. Daegyeong PV test-bed located at GERI (Gumi Electronics & Information Technology Research Institute) also resides in Gyeonbuk Province. Gyeongbuk province chose “Energy Parts Industry” as its strategic industry for the future.

Jeonnam Province selected “NRE Industry” as one of its major leading industries of the region and has invested its resources to promote PV industry development and PV deployment. Jeonnam province has the best sun-light source in Korea. Honam PV test-bed at Jeonnam technopark and KITECH (Korea Institute of Industrial Technology) Jeonnam Branch are both located in the neighbouring city, Gwangju. SRIGET (South-western Research Institute of Green Energy Technology) is also located in the neighbouring city, Mokpo.

8 STANDARDS AND CODES

Korea has been adopting IEC TC 82 standards as Korean Standards under the responsibility of KATS (Korea Agency for Technology and Standards). The KATS and KNREC have been working together to prepare guidelines and regulations for massive dissemination of PV system.

The certification program for inverter and crystalline silicon PV module has been implemented since 2005. Under the IECEE scheme, the KNREC is designated as NCB (National Certification Body), and KTL (Korea Testing Laboratory) and KIER (Korea Institute of Energy Research) are designated as CBTL (Certification Body Testing Laboratory) for inverters and crystalline PV modules. KTC is designated as CBTL for high power inverters and PCS in 2013, and KCL is designated as CBTL for BIPV in 2014. TUV Rheinland Yeungnam University Testing Center is designated as CBTL for crystalline PV modules and thin film PV modules. The use of certified products is obligatory for the government-subsidized PV systems.

KNREC governs the “NRE Standardization Programs” and provides service on “Certification of NRE Systems” and “Certification of Buildings Using NRE.”

9 HIGHLIGHTS AND PROSPECTS

Since the record-breaking year of 2008, that saw 276 MW of PV installations, the PV market remained stagnant in Korea during the next three years. This was mainly due to the limited FiT scheme which played initially an important role in the PV market expansion. However, 230 MW in 2012 and 531 MW in 2013, respectively, were installed, reaching the highest level of installations so far, breaking the record of annual installation. Thanks mainly to the newly introduced RPS scheme (with PV set-aside requirement), the market started to react in 2013.

At the end of 2013, the total installed capacity was about 1,56 GW, among them the grid-connected centralized system accounted for around 82% of the total cumulative installed power. The grid-connected distributed system amounted to around 18% of the total cumulative installed PV power.

The share of off-grid non-domestic and domestic systems has continued to decrease and represents less than 1% of the total cumulative installed PV power.

Korean government continued to support strongly the PV deployment, R&D, infrastructure building and market promotion. Among these, the government-driven RPS scheme and R&D support played major roles in boosting PV deployment and industry development.

Various incentives have been used to support PV development. In 2008, the "Third Basic Plan for the Promotion of Technological Development, Use, and Diffusion of New and Renewable Energy" based on the "First National Energy Basic Plan" was issued. This plan includes the construction of "One Million Green Homes" and "200 Green Villages" by 2020. Based on this plan, the RPS (Renewable Portfolio Standards) scheme has replaced the previous "Feed-in-Tariff" scheme in 2012. The RPS was launched in 2012 as planed and will be active until 2020.

In 2014, the "Fourth Basic Plan for the Promotion of Technological Development, Use, and Diffusion of New and Renewable Energy" based on the "Second National Energy Basic Plan" was issued. This new plan will include expansion of yearly PV set-aside requirement, shortening the target year by one year (now 2015 from originally 2016).

Home Subsidy Programme (One Million Green Homes Programme)

This programme was launched in 2004 that merged the existing 100 000 rooftop PV system installation program, and it aims at the construction of one million green homes 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. The maximum PV capacity allowed for a household is 3 kW. At the end of 2013, more than 150 000 households (total 142,6 MW of PV capacity) benefited from this program. In 2013, the installed capacity was about 20,6 MW.

RPS Program

The RPS is a mandated requirement that the electricity utility business source a portion of their electricity supplies from renewable energies. In Korea, electricity utility business companies exceeding 500 MW are required to supply total 10% of their electricity from NRE (New and Renewable Energy) sources by 2022, starting from 2% in 2012. Before starting the formal RPS programme from 2012, the Government initiated the RPS demonstration programme for three years from 2009 until 2011. Six Korean electricity generation companies have signed the 'RPA (Renewable Portfolio Agreement)' with the Government in order to increase the share of renewable energy electricity generation. The total capacity was fixed to be 101,3 MW. The six electricity companies constructed their own PV power plants or purchased PV electricity from the private source. In 2011, 31,7 MW was approved under this program. From the year 2012, the RPS (Renewable Portfolio Standard) scheme fully replaced the existing FiT scheme. PV has its own set-aside amount in the RPS of 1,5 GW for the four years covering 2012 to 2015. The plan was shorten by one year in order to support the local PV industry. In 2013, about 409 MW was installed under this program.

Building Subsidy Programme (Formerly General Deployment Subsidy Program)

The Government supports up to 50% of installation cost for PV systems for systems below 50 kW. In addition, the Government supports 80% of initial cost for special purpose demonstration and pre-planned systems in order to help the developed technologies and systems to diffuse into the market. This is the "Test-period deployment subsidy program." In 2013, a total of 3,7 MW were installed by

this program. Until the end of 2013, about 20 MW benefited from this program. Various grid-connected PV systems were installed in schools, public facilities, welfare facilities as well as universities.

Regional Deployment Subsidy Programme

The government supports 50% of installation cost for PV systems owned and operated by local authorities. Until the end of 2013, about 71 MW benefited from this program.

NRE Mandatory Use for Public Buildings

The new buildings of public institutions, the floor area of which exceeds 1 000 square meters, are obliged by law to use more than 10% of their total expected energy by the newly installed renewable energy resource systems. Public institutions include state administrative bodies, local autonomous entities, and state-run companies. The building energy mandate percentage is planned to increase up to 30% by 2020. In 2012 alone, approximately 32 MW was installed under this program, the cumulative total capacity reaching about 90 MW at the end of 2012. From 2015, “NRE Mandatory Use for Public Buildings” will be expanded due to recently amended act on NRE deployment promotion. Original 13% by 2015, 14% by 2016, 15% by 2017, 16% by 2018, 18% by 2019, and 20% by 2020 will be changed to 15% by 2015, 18% by 2016, 21% by 2017, 24% by 2018, 27% by 2019, and 30% by 2020.

Definitions, Symbols and Abbreviations

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

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

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m^2, cell junction temperature of 25^{o}C, AM 1,5 solar spectrum – (also see 'Rated power').

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

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

CPV: Concentrating PV

Hybrid system: A system combining PV generation with another generation source, such as diesel, hydro, wind.

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 system in a remote area are excluded).

Field Test Programme: A programme to test the performance of PV systems/components in real conditions.

Demonstration Programme: A programme to demonstrate the operation of PV systems and their application to potential users/owners.

Market deployment initiative: Initiatives to encourage the market deployment of PV through the use of market instruments such as green pricing, rate based incentives etc. These may be implemented by government, the finance industry, electricity utility businesses etc.

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

Performance ratio: Ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per kW of installed PV power.

Currency: The currency unit used throughout this report is x

PV support measures:

Feed-in tariff	an explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility business) at a rate per kWh that may be higher or lower 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 business, usually at a premium price
PV-specific green electricity schemes	allows customers to purchase green electricity based on PV electricity from the electricity utility business, usually at a premium price
Renewable portfolio standards (RPS)	a mandated requirement that the electricity utility business (often the electricity retailer) source a portion of their electricity supplies from renewable energies
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

Compensation schemes (self-consumption, net-metering, net-billing…)	These schemes allow consumers to reduce their electricity bill thanks to PV production valuation. The schemes must be detailed in order to better understand if we are facing self-consumption schemes (electricity consumed in real-time is not accounted and not invoiced) or net-billing schemes (the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity account is reconciled over a billing cycle). The compensation for both the electricity self-consumed and injected into the grid should be detailed. Net-metering schemes are specific since they allows PV customers to incur a zero charge when their electricity consumption is exactly balanced by their PV generation, while being charged the applicable retail tariff when their consumption exceeds generation and receiving some remuneration for excess electricity exported to the grid
Commercial bank activities	includes activities such as preferential home mortgage terms for houses including PV systems and preferential green loans for the installation of PV systems
Activities of electricity utility businesses	includes 'green power' schemes allowing customers to purchase green electricity, operation of large-scale (utility-scale) PV plants, various PV ownership and financing options with select customers and PV electricity power purchase models
Sustainable building requirements	includes requirements on new building developments (residential and commercial) and also in some cases on properties for sale, where the PV may be included as one option for reducing the building's energy foot print or may be specifically mandated as an inclusion in the building development