

KOREA

PHOTOVOLTAIC TECHNOLOGY STATUS AND PROSPECTS
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Fig. 1 - The 13 kW grid-connected BIPV systems installed on the KIER research building in 2007.



Fig. 2 - 3 ~ 5kW grid-connected PV systems on residential houses under the 100 000 roof-top program.

GENERAL FRAMEWORK

Korea has been making a strong effort to increase the new and renewable energy (NRE) portion of "energy mix" to achieve the goal that was announced in December 2003. Korea's renewable energy is targeting to take 5 % of the total energy consumption by 2012. Currently the renewable energy is estimated to be about 2,1 % of total energy. The Korean government increased the renewable energy budget steadily from 196 BKRW in 2004, 324 BKRW in 2005 and 409,5 BKRW in 2006. In 2006, budget was allocated as 124,4 BKRW for R&D, 137,5 BKRW for deployment, 121,3 BKRW for long-term loan and 2,3 BKRW for Feed-in Tariff program. As of the third year of implementing the 10-year Plan, the Korean Photovoltaic Program has made great progress in the areas of system installation, R&D investment, standards and accreditation. The Feed-in Tariff (FIT) rate per kW-hr changed from 716,40 to 677,38 KRW for systems larger than 30 kW with a ceiling of cumulative 100 MW since Oct. 2006. Korean PV industry attracted international attention when DCC announced to jump into the poly-silicon feedstock manufacturing business in order to tackle the silicon shortage issue.

NATIONAL PROGRAM

The Ministry of Commerce, Industry and Energy (MOCIE) has been implementing, via KEMCO (Korea Energy Management Corporation), demonstration and field test of various renewable energy technologies. In 2003, the 2nd 10-year basic plan for NRE R, D&D was established 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 the plan is to achieve 3,0 % share of total primary energy supply with NRE by 2006 and 5,0 % by 2012. PV was selected as one three major areas as well as wind power and hydrogen & fuel cell. The government appointed Korea University as an organization for planning and managing PV R&D programs and established the Korea Photovoltaic

Development Organization (KPVDO) in 2004. Korea plans to secure 7 % of world PV market share through utilizing the infrastructure and the resources of semiconductor and display industries where Korea has a world-class leadership and also has plans to install 1,3 GW of PV by 2012.

RESEARCH AND DEVELOPMENT

The government budget in 2006 for PV R&D was 124,4 billion KRW, which is a 25 % increase from previous year. Korea's PV R&D Program is led by the KPVDO since 2004. The program mostly consists of industry-oriented research works. The 25 projects have been running with participation from 35 companies, 8 national institutes and 21 universities. The projects implemented in 2005 and 2006 included various categories. For the short-term commercialization, 9 projects have been implemented with the subjects of high efficiency and low cost bulk silicon solar cell, Si ingot and wafer, transformer-less PCS, BIPV and roof-integrated module. For long-term and innovative goal, three projects have been implemented in the area of a-Si and CIGS thin-film and dye-sensitized solar cells. Especially two new important projects have been initiated for poly-Si feedstock production and 130 μm wafer-based silicon solar cell development in 2006 to counteract the Si shortage issue. In addition, for demonstration and infrastructure areas, 11 programs have been carried out. The main subjects are the Road Map for Standardization and Certification, the 1 MW PV Power Plant Demonstration, the Solar Cell Evaluation Facility, a PV demonstration site infrastructure and a public building demonstration, etc.

DISSEMINATION PROGRAMS

General Deployment Program: The government supports 70 % of the installation cost. In 2006, 77 PV systems with a total of 2,255 kW were installed. The installed capacity was not much changed compared to 71 PV systems with a total capacity of 2,025 kW in

2005. Various grid-connected PV systems with a power capacity of 5-200 kW were installed in schools, public facilities, welfare facilities and universities.

Rooftop Program: In 2006, under the 100 000 roof-top program, 2 452 systems with a total capacity of 6,469 kW were for single-family houses; the average capacity being 2,47 kW. In addition, 120 kW systems for apartment buildings with 550 households and 3 kW for public rental apartment buildings with 2 962 households were installed. PV system applications for multi-family apartment buildings were new in 2006 and this kind of installation will be more encouraged by the Korean residential situation. The beneficiary paid only 30 % of total system price of 8,55 MKRW per kW.

The Public Building Obligation Program: This program was implemented in 2004 and was applied to newly installed public buildings larger than 3 000 sq. meter and obliged to invest renewable energy equipments such as PV more than 5 % of the total building construction cost. Up to November 2006, a total of 349,1 kW PV systems were installed under the program. As the central government pursues the "New Administration-Oriented City Plan" and "Plan for Public Enterprise Relocation," new public buildings are planned all over Korea and thus the Program should contribute a great deal to the expansion of the Korea PV market.

Feed-in Tariff Program: The Feed-in Tariff (FIT) rate per kW-hr changed from 716,40 KRW to 677,38 KRW for systems larger than 30 kW with a ceiling of cumulative 100 MW since Oct. 2006 guaranteed for 15 years for the PV system over 3 kW. 52 commercial PV power plants of 9,157 kW in total ranging 3 kW-1 MW were newly installed and operating. Four 1 MW PV plants were installed such as Donghae PV Power owned by the Dongseo Utility; Youngheung PV Power owned by the Namdong Utility; Kangjin PV Power owned by Namhae Energy; and Hanra PV Power owned by the Hanra Electric Co., LTD. Several projects of multi-MW scale are in the planning stage with local government and local utilities or foreign companies. Annual spending for the PV Feed-in-Tariff program was 3,478 MKRW and the annual PV Power generation was 5,474 MWh in 2006.

Local Deployment Program: Under the local energy development project, a wide variety of PV systems including off-grid domestic, non-domestic and grid-connected systems were constructed. In 2006, 27 PV systems of 1,831 kW were installed; a two-fold increase compared to 24 PV systems of 883,7 kW in 2005. This program aims at increasing public awareness on PV and developing PV as an indigenous renewable energy source for their region. It is worthy to note that several local authorities finished 9 "Green Village" projects which were mainly composed of PV, solar thermal, geothermal and wind power until the end of 2006. In 2006, two new green village projects were accomplished, which are Buyeo of Chungchung nam-do province and Suncheon of Chunla nam-do province.



Fig. 3 - The 310kW PV power plant installed at water purification sites from Seoul Metropolis in 2007.



Fig. 4 - The 2,2 MW PV power plant installed at Munkyeong, Kyungpook Province in 2007.

DISSEMINATION PROGRAM OUTCOME

The total cumulative installed PV power for each sub-market as of the 31 December of each year, from 1992 to 2006 is shown in Figure 3. The total installed power of PV systems in Korea was 34,733 kW at the end of 2006. The total PV power installed during the year 2006 was 21,209 kW, which is over four times higher than that achieved in the previous year (4,990 kW). The major increase came from PV power plants supported by the Feed-in-Tariff Program and 3 kW residential roof-top applications under the 100 000 solar roof program. The share of grid-connected distributed system increased to 83 % of the total cumulative installed power from 58 % in the previous year. The annual installed power of this sector in 2006 reached 20,930 kW; representing over 98 % of the total Korean PV market. Following rapid increase of commercial PV power and residential roof-top installations, off-grid non-domestic and domestic sectors are not interested by Korea PV industry and the cumulative share decreased year by year; occupying only 17 % of total cumulative installed power.

INDUSTRY STATUS

Production of Feedstock and Wafers: There was no production of feedstocks but single crystalline wafers were produced by Siltron Corp. which has 10MW pilot production line using electronic-grade ingot off-spec. In 2006, Dongyang Chemical Co., (DCC) announced to invest for 3,000 ton annual production facility of poly-silicon feedstock; scheduled for commercial production in 2008. In the wafer area, Woongjin established a joint venture, Woongjin Energy, with US-based Sunpower for single crystalline silicon ingot production.



Fig. 5 - The PV gardening systems: PV Tree.

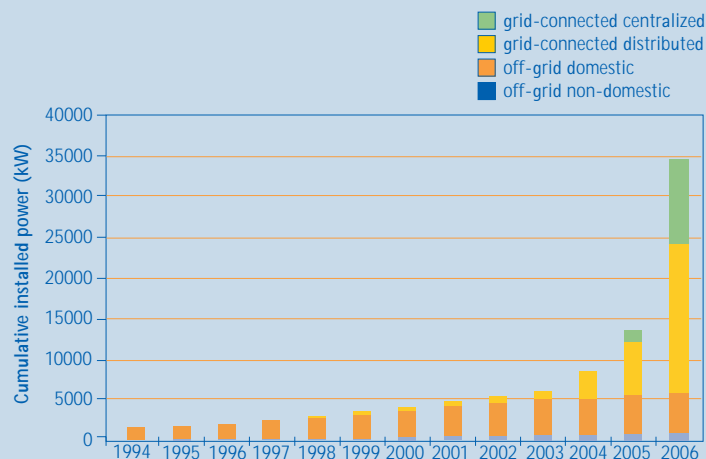


Fig. 6 - The Cumulative Installed PV Power in Korea.

Production of Photovoltaic Cells and Modules: In 2006, KPE completed the second manufacturing line of 30 MW which has a capability of handling both single and multi crystalline Si wafer at the size of 125 mm and 156 mm and had a total production capacity of 35 MW, as of May 2006. As a new company, Millinet Solar, is constructing 30MW solar cell line scheduled for operation in middle of 2007. Sinseong ENG and Hyundai Heavy Industry Co. Ltd., are constructing a production line with capacity ranging from 30 to 50MW with a target for production within 2008. Eight companies produced only 16,9 MW of PV modules with total annual production capability of 130 MW, due to the PV cell supply problem. In spite of limited operation of the production line, Symphony Energy and Hyundai Heavy Industries successfully entered into the European module market in 2006 and these two companies are expected to increase their production in 2007. Korean module manufacturers plan to produce more than 60 MW in 2007. The module price was in the range of 4,200 to 4,600 KRW/W depending on the manufacturing company and the order volume. The average PV module price of 4,400 KRW/W in 2006 was a little less than that in the previous year.

Manufacturers and Suppliers of other Components: In 2006, several new companies entered the grid-connected inverter market with the leading company - Hex Power Systems. Active new companies were Willings, Hanyang Electric, Hyundai Heavy Industries and Dattech. Due to new suppliers and imported products from SMA and Fronius, the price of PV inverters decreased very sharply in 2006. These trends expect to continue in 2007. Domestic manufacturers supplied mainly for residential PV systems less than 10kW and foreign companies were actively supplying over 100 kW for PV power systems for the Feed-in-Tariff program. SMA was a leading supplier for larger inverters in the Korean market.

FUTURE OUTLOOK

The year 2006 was a year that the annual installed PV capacity in Korea exceeded 20 MW. In 2007, the annual PV market will increase to about 50 MW based on the government dissemination budget and PV power plant under feed-in Tariff program. Under the new Korea's national PV plan, the goal increased to 100 000 roofs and 70 000 buildings for a total capacity of 1,3 GW by the year 2012. An explosive market growth is expected between 2006 and 2012. The foundation for mass deployment was set into place in the year

2006 especially for roof-top and feed-in tariff market. In the future, the BIPV market is expected to play an important role due to the "New Administration-Oriented City" and "Many Innovation Cities" programs under which the Korean government will construct public buildings throughout Korea until 2012. The Korean government recognizes that the PV industry will grow and take up to 10 % of the world market by 2012, with exports amounting to 3 BUSD and employing 50 000 people. The strategies for promoting the distribution of PV systems are described below. The whole program will be managed and monitored by the experts group organized solely for PV technology distribution.

- Establish the foundation for mass distribution through developing PV systems for the distributed electricity system. During 2001-2006, focus on developing the standardized systems for residential homes and for commercial buildings that have large potential demands.
- Set up the test sites and villages for demonstration. Establish more "green villages" throughout Korea starting from Daegu and Gwangju. For new buildings, encourage the installation of 10 kWPV systems and multi-hundreds kW PV systems for factory buildings with removal of administrative and legal barriers.
- Maximize the subsidy program that has a strong short-term effect. Further promotion should be pursued by "green pricing" and other tax incentives.

To fuel the plans and strategies mentioned above, Korea will have to spend about 2,3 BUSD during 2004-2012. The fund will be provided by the Government. As the PV world market rapidly grows, investment from industry is expected to increase accordingly.