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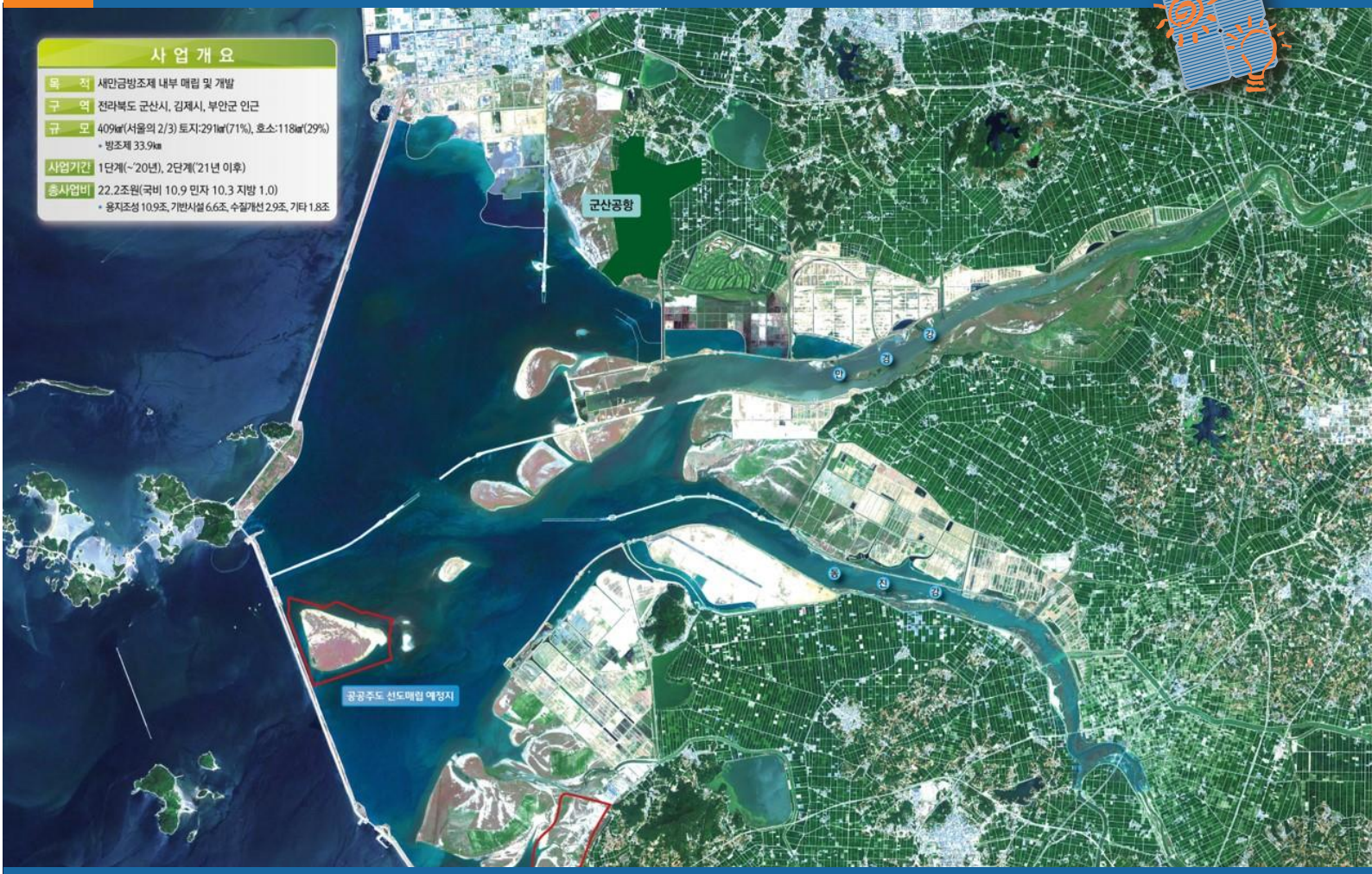

Task 1 Strategic PV Analysis and Outreach

PVPS

National Survey Report of PV Power Applications in Korea 2018

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PHOTOVOLTAIC POWER SYSTEMS
TECHNOLOGY COLLABORATION PROGRAMME

KOREA ENERGY AGENCY

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WHAT IS IEA PVPS TCP

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The IEA carries out a comprehensive programme of energy cooperation among its 30 member countries and with the participation of the European Commission. The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the collaborative research and development agreements (technology collaboration programmes) within the IEA and was established in 1993. The mission of the programme is to "*enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems.*"

In order to achieve this, the Programme's participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct 'Tasks,' that may be research projects or activity areas. This report has been prepared under Task 1, which deals with market and industry analysis, strategic research and facilitates the exchange and dissemination of information arising from the overall IEA PVPS Programme.

The IEA PVPS participating countries are Australia, Austria, Belgium, Canada, Chile, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Mexico, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, and the United States of America. The European Commission, Solar Power Europe, the Smart Electric Power Alliance (SEPA), the Solar Energy Industries Association and the Copper Alliance are also members.

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WHAT IS IEA PVPS task 1

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 2018. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

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DISCLAIMER:

Data for non-IEA PVPS countries are provided by official contacts or experts in the relevant countries.
Data are valid at the date of publication and should be considered as estimates in several countries due to the publication date.

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1 INSTALLATION DATA

The PV power systems 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 2018 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2018, 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 record-breaking year of 2008, that saw 276 MW of PV installations, the PV market remained stagnant in the next three years. This was mainly due to the limited Feed-in Tariff (FiT) scheme which played initially an important role in the PV market expansion. Since 2012, Renewable Portfolio Standard (RPS) was introduced as a flagship renewable energy program, replacing FiT. Thanks to the new RPS scheme (initially with PV set-aside requirement), significant PV deployment has been achieved, 295 MW in 2012, 531 MW in 2013, 926 MW in 2014, 1 134 MW in 2015, 909 MW in 2016, 1 362 MW in 2017, and 2 367 MW in 2018, respectively. At the end of 2018, the total installed PV capacity was about 8,1 GW, among those the grid-connected centralized system accounted for around 90% of the total cumulative installed power. The grid-connected distributed system amounted to around 10% 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. The total capacity of 8 099 MW corresponds to 6,7% of total electricity generation capacity of about 121 592 MW, and the installed PV power of 2 367 MW in 2018 accounts for 50,5% of total power generation capacity newly installed (4 684 MW) in 2018, as can be seen in Table 5.

PV in buildings is getting more interest in urban environment, and recent zero-energy complex project in Nowon-gu, Seoul demonstrated successful results, receiving many visitors. Floating PV on the lakes is also getting popular in Korea (with potential of ~10 GW). In July 2017, Korea Rural Community Corporation conducted a study about South Korea's potential of on-water PV and estimated 3,26 GW from water reservoir (10% of the total reservoir), 2,633 GW from fresh-water lakes (20% of the total) and 73 MW from irrigation and drain channels (2% of the total). In addition, K-Water can utilize 8% of the dams, which sums up to 3,7 GW. Therefore, the total on-water PV potential in Korea is estimated to be about 9,7 GW. Agricultural PV (in short agri-PV) is getting higher attention, since the new government announced 'RE3020 plan,' and many demonstration projects are being undertaken by power producing companies collaborating with local authorities. BIPV and VIPV are also being developed through government-led R&D projects which focus on the compatibility of PV modules to design, esthetic appearance as well as functional flexibility. Hyundai-Kia motor company demonstrated a passenger car with VIPV attached in 2018.

1.2 Total photovoltaic power installed

The annual installation data was obtained from the total capacity of the PV systems approved to be installed in the year of 2018 by the NREC (New & Renewable Energy Centre) at KEA (Korea Energy Agency). In Korea, PV installation statistics is categorized into two sectors, PV for 'business' and PV for 'self-use.' Thus in the tables, 'Decentralized' is assumed as 'self-use' which includes PV installations in households, public facilities, education facilities, welfare facilities, industrial facilities, commercial facilities and others (off-grids), and 'Centralized' is assumed as 'business' which include all the PV installations under RPS scheme. 2018 data were taken from the '2018 NRE Deployment Statistics' published by KEA in November 2019.

Table 1: Annual PV power installed during calendar year 2018.

		Installed PV capacity in 2018 [MW]	AC or DC
PV capacity	Off-grid	-	DC
	Decentralized	176	DC
	Centralized	2 191	DC
	Total	2 367	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?	Korea Energy Agency
Link to official statistics (if this exists)	www.kemco.or.kr
	within ±1% data accuracy

Table 3: The cumulative installed PV power in 4 sub-markets.

Year	Off-grid [MW]	Grid-connected distributed [MW]	Grid-connected centralized [MW]	Total [MW]
1998		0,6	-	0,6
1999		3,6	-	3,6
2000		4,1	-	4,1
2001		4,9	-	4,9
2002		5,4	-	5,4
2003		6,0	-	6,0
2004		8,3	0,2	8,5
2005		12,1	1,4	13,5
2006		25,3	10,5	35,8
2007		41,8	39,4	81,2
2008		58,4	298,5	356,9
2009		82,6	441,1	523,7
2010		116,8	533,5	650,3
2011		152,7	576,5	729,2
2012		214,9	809,4	1 024,3
2013		278,1	1 276,9	1 555,0

2014		347,1	2 134,2	2 481,3
2015		440,9	3 174,3	3 615,2
2016		551,1	3 950,6	4 501,7
2017		665,0	5 169,5	5 834,5
2018		840,4	7 258,8	8 099,1

Table 4: Other PV market information.

	2018 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	unknown
Capacity of decommissioned PV systems during the year [MW]	103 MW
Capacity of repowered PV systems during the year [MW]	unknown
Total capacity connected to the low voltage distribution grid [MW]	-
Total capacity connected to the medium voltage distribution grid [MW]	-
Total capacity connected to the high voltage transmission grid [MW]	-

Table 5: PV power and the broader national energy market.

	2017 numbers	**2018 numbers**
Total power generation capacities [GW]	116,908 GW	121,592 GW
Total renewable power generation capacities (including hydropower) [GW]	15,767 GW	19,027 GW
Total electricity demand [TWh]	507,746 TWh	526,149 TWh
Total energy demand [TWh]	233 901 ktoe* (= 2 720 TWh)	237 930 ktoe (= 2 767 TWh)
New power generation capacities installed in 2018 [GW]	11,042 GW	4,684 GW
New renewable power generation capacities installed in 2018 (including hydropower) [GW]	1,805 GW	3,533 GW
Estimated total PV electricity production (including self-consumed PV electricity) in [GWh]	7 056 GWh	9 208 GWh
Total PV electricity production as a % of total electricity consumption	1,4%	1,8%

*1 ktoe= $10*10^9$ kcal; 1 TWh= $860*10^9$ kcal; 1 TWh= 86 ktoe

1.3 Key enablers of PV development

Table 6: Information on key enablers.

	Description	Annual Volume	Total Volume	Source
Decentralized storage systems In [MW, MWh or #]				
Residential Heat Pumps [#]				
Electric cars [#]	EV & FCEV	32 408 (EV 31 696, FCEV 712)	58 178 (EV 57 289, FCEV 889)	Ministry of Environment
Electric buses and trucks [#]	EV & FCEV	140 (EV 138, FCEV 2)	281 (EV 279, FCEV 2)	Ministry of Land, Infrastructure & Transportation
Other				

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

A summary of typical module and system prices is provided in the following tables. All the prices shown in Table 8 and Table 10 are the calculated average values.

Table 7: Typical module prices for a number of years.

Year	Lowest price of a standard module crystalline silicon	Highest price of a standard module crystalline silicon	Typical price of a standard module crystalline silicon
2005			
2006			
2007			
2008			
2009			
2010			
2011	1 200		1 400
2012	800		1 000
2013	634		974
2014	634		974
2015	634		974
2016	456		646
2017	450 (import)	800 (import)	500
2018	360 (import)	900 (import)	410

2.2 System prices

The price of grid-connected systems varied from 1 204 KRW/W to 3 000 KRW/W depending on the type and size of installations. Most of the installations (more than 80%) were made under the RPS scheme.

Table 8: Turnkey PV system prices of different typical PV systems.

Category/Size	Typical applications and brief details	Current prices [KRW/W]
Off-grid 1-5 kW	A stand-alone PV system is a system that is installed to generate electricity to a device or a household that is not connected to the public grid.	-
Residential BAPV 5-10 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected households. Typically roof-mounted systems on villas and single-family homes.	1 309 - 1 760
Residential BIPV 5-10 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected households. Typically, on villas and single-family homes.	-
Small commercial BAPV 10-100 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	1269 - 1 707
Small commercial BIPV 10-100 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	-
Large commercial BAPV 100-250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected large commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	1 244 - 1 672
Large commercial BIPV 100-250 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	-
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	1 204 - 1 619
Small centralized PV 1-20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	1 405 – 1 935
Large centralized PV >20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	1 264 - 1 741
Floating Centralized PV	Grid-connected, mounted on a structure that floats on the surface of the water, distributed PV systems installed to produce electricity using public waters, such as reservoirs, artificial basins, lakes, etc.	1 550 - 1 900
Agricultural PV	Grid-connected, farming land-mounted, centralized PV systems that work as a central power station. The electricity generated in this type of facility is not tied to a specific customer, and the purpose is to produce electricity for sale.	2 057 - 3 000

Table 9: National trends in system prices for different applications

Year	Residential BAPV Grid-connected, roof-mounted, distributed PV system 5-10 kW **[KRW/W]**	Small commercial BAPV Grid-connected, roof-mounted, distributed PV systems 10-100 kW **[KRW/W]**	Large commercial BAPV Grid-connected, roof-mounted, distributed PV systems 100-250 kW **[KRW/W]**	Small centralized PV Grid-connected, ground-mounted, centralized PV systems 10-20 MW **[KRW/W]**
2005				
2006				
2007				
2008				
2009				
2010				
2011	4 000			
2012	3 000			
2013	3 000			
2014	3 000	2 900	2 900	2 250
2015	1 750	2 250	2 250	1 700
2016	1 600	1 550	1 500	1 500
2017	1 520	1 500	1 450	1 500
2018	1 474	1 430	1 400	1 582

2.3 Cost breakdown of PV installations

The cost breakdown of a typical 5-10 kW roof-mounted, grid-connect, distributed PV system on a residential single-family house and a typical >10 MW Grid-connected, ground-mounted, centralized PV systems at the end of 2018 is presented in Table and Table , respectively.

The cost structure presented is from the customer's point of view. I.e. it does not reflect the installer companies' overall costs and revenues. The “average” category in Table and Table represents the average cost for each cost category and is the average of the typical cost structure. The average cost is taking the whole system into account and summarizes the average end price to customer. The “low” and “high” categories are the lowest and highest cost that has been reported within each segment. These costs are individual posts, i.e. summarizing these costs do not give an accurate system price.

The cost information below was collected from the interviews with a few major PV system installation companies in Korea, and the level of reliability is within ±15%.

Table 10: Cost breakdown for a grid-connected roof-mounted, distributed residential PV system of 5-10 kW.

Cost category	Average [KRW/W]	Low [KRW/W]	High [KRW/W]
Hardware			
Module	420	380	550
Inverter	200	180	250
Mounting material	270	230	310
Other electronics (cables, etc.)	150	120	170

Subtotal Hardware	**1 040**		
Soft costs			
Planning	-	-	-
Installation work	200	180	220
Shipping and travel expenses to customer	50	50	50
Permits and commissioning (i.e. cost for electrician, etc.)	50	50	50
Project margin	134	119	160
Subtotal Soft costs	**434**		
Total (excluding VAT)	**1 474**		
Average VAT	147		
Total (including VAT)	**1 621**		

Table 11: Cost breakdown for a grid-connected, ground-mounted, centralized PV systems of >10 MW.

Cost category	Average [KRW/W]	Low [KRW/W]	High [KRW/W]
Hardware			
Module	370	330	420
Inverter	75	70	80
Mounting material	280	250	320
Other electronics (cables, etc.)	250	230	350
Subtotal Hardware	**975**		
Soft costs			
Planning	30	25	35
Installation work	250	230	350
Shipping and travel expenses to customer	70	50	90
Permits and commissioning (i.e. cost for electrician, etc.)	180	150	200
Project margin	77	70	90
Subtotal Soft costs	**607**		
Total (excluding VAT)	**1582**		
Average VAT	158		
Total (including VAT)	**1 740**		

2.4 Financial Parameters and specific financing programs

Table 12: PV financing information in 2018.

Different market segments	Loan rate [%]
Average rate of loans – residential installations	3,5 - 4,0
Average rate of loans – commercial installations	3,5 - 5,0 (1,75 for Agricultural PV)
Average cost of capital – industrial and ground-mounted installations	4,0 (Project Financing)

2.5 Specific investments programs

Table 13: Summary of existing investment schemes.

Investment Schemes	Introduced in Korea
Third party ownership (no investment)	No
Renting	No
Leasing	Korea Energy Agency (KEA) offers solar lease program for households which use electricity more than 200 kWh/month on the average in the previous year period. The household pays less than 80% of the typical electricity bill for (PV leasing fee + electricity fare), and the leasing company provides O&M services and makes profit from collecting leasing fee from the household and selling renewable energy point (REP) to the RPS obligators.
Financing through utilities	No
Investment in PV plants against free electricity	No
Crowd funding (investment in PV plants)	Private companies attract investors for PV power plants by crowdfunding scheme, and typical earning rate is about 7-8%.
Community solar	Maximum 20% increase in REC multiplier when community residents are involved in the projects.
International organization financing	No
Other (please specify)	No

2.6 Additional Country information

Table 14: Country information.

Retail electricity prices for a household [KRW/kWh]	93,3~280,6 KRW/kWh for low voltage[1] (93,3 for 0-200 kWh; 187,9 for 201-400 kWh; 280,6 for >400 kWh)[2]			
Retail electricity prices for a commercial company [KRW/kWh][3]	53,7~196,6 KRW/kWh			
Retail electricity prices for an industrial company [KRW/kWh]	52,8~196,6 KRW/kWh			
Population at the end of 2018	51,607 million			
Country size [km^2]	100 377,7 km^2 as of 2018			
Average PV yield in [kWh/kW]	1 136,9 kWh/kWp			
Name and market share of major electric utilities		Electricity production [%]	Share of grid Subscribers [%]	Number of retail customers [%]
	KEPCO	100	100	100

[1]Low voltage: 110-380 V; High voltage A: 3 300-66 000 V; High voltage B: 154 000 V; High voltage C: 345 000 V or higher.

[2]For hot summer season (July and August), retail electricity prices are adjusted favourably to the consumers to reduce the total price: 93,3 for 0-300 kWh; 187,9 for 301-450 kWh; 280,6 for >450 kWh.

[3]Retail electricity prices for a commercial company varies depending on the contract power (lower or higher than 300 kW), existence or absence of divided meters, time or season of use (summer, spring & fall, winter, day or night), and supply voltage. Electricity prices for educational facilities and farming use follow different fare structure.

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.

Table 15: Summary of PV support measures.

	On-going measures in 2018 – Residential	Measures introduced in 2018 – Residential	On-going measures in 2018 – Commercial + Industrial	Measures introduced in 2018 – Commercial + Industrial	On-going measures in 2018 – Centralized	Measures introduced in 2018 – Centralized
Feed-in tariffs	-	-	-	Yes Below 30 kW for every one Below 100 kW for farmers and cooperatives	-	-
Feed-in premium	-	-	-	-	-	-
Capital subsidies	yes	-	-	-	-	-
Green certificates	-	-	-	-	-	-
Renewable portfolio standards (RPS)	-	-	yes	-	-	-
Income tax credits	-	-	yes	-	-	-
Self-consumption	-	-	-	-	-	-
Net-metering	yes	-	-	-	-	-
Net-billing	-	-	-	-	-	-
Collective self-consumption and virtual net-metering	-	-	-	-	-	-
Commercial bank activities e.g. green mortgages promoting PV	-	-	-	-	-	-
Activities of electricity utility businesses	-	-	-	-	-	-
Sustainable building requirements	-	-	Public building is obliged to install renewable energy	-	-	Seoul Metropolitan City government introduced zero-energy building

						requirements in the Seoul territory
BIPV incentives	-	-	-	-	-	-

3.1 National targets for PV

In December 2017 Government announced the 'Renewable Energy 3020 Plan,' which aims at supplying 20% of the electricity from renewable sources. Due to this plan, the cumulative installed capacity of renewable electricity will be 63,8 GW by 2030 (15,1 GW in 2017F), among which PV (57%) and wind (28%) will occupy 85%. Newly installed capacities of PV and wind during the planned period will be 30,8 GW and 16,5 GW, respectively.

In June 2019, the Korean government also announced the 'Third Energy Master Plan' which stated that electricity generation by renewable sources will increase to account for 30-35% in the electricity mix by 2040. In terms of cumulative generation capacity, an increase of 103-129 GW will be necessary to achieve this goal. Nuclear and fossil-powered sources will decrease due to Korean government's commitment to the greenhouse gas reduction and cleaner & safer energy. The detailed breakdown for the 2040 generation power mix scenario will be available in 2020.

3.2 Direct support policies for PV installations

Since the beginning of the current government in 2017, Korea has been trying to change the energy infrastructure from using a centralized system with more than 75 percent coal and nuclear into a more distributed system based on renewable energy resources. This new policy is supported by many citizens suffering from coal power plants (fine dust problems) together with the nuclear safety issue (magnified by the recent earthquakes near the nuke-populated areas). Government announced the 'Renewable Energy 3020 Plan' as described above, which aims at supplying 20% of the electricity from renewable sources. In this context, many support measures will be used and are expected to be newly introduced. Korea's current policy structure to promote PV deployment can be categorized into four areas: 1) subsidies for installation, 2) incentives, 3) obligatory measures, and 4) infrastructure building. The 'Third Energy Master Plan' announced in 2019 will provide the legal ground for future energy transition in Korea.

3.2.1 Subsidy Programs for PV Installation

<Subsidy for Residential Installation>

This program was launched in 2004 that merged the existing 100 000 rooftop PV system installation program, and aims at constructing one million green homes utilizing PV as well as solar thermal, geothermal, small-size wind, fuel cell and bio-energy until 2020. In general, single-family houses and multi-family houses including apartments can benefit from this program. The KEA provides maximum 60% of the initial PV system cost for single-family and private multi-family houses, and maximum 100% for public multi-family rent houses. The maximum PV capacity allowed for a household is 3 kW. In 2018, total 77 776 kW PV systems at 113 652 sites were installed under this program.

<Subsidy for Building Installation>

The KEA supports up to 50% of the installation cost for PV systems (below 50 kW) in buildings excluding private homes. In addition, the KEA supports maximum 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. In 2018, total 16 872 kW PV systems at 733 sites were

installed under this program. Various grid-connected PV systems were installed in schools, public facilities, welfare facilities as well as universities.

<Subsidy for Local Government>

The KEA supports up to 50% of installation cost for NRE (including PV) systems owned or operated by local authorities. In 2018, 17 871 kW PV systems at 374 sites were supported from this program.

<Subsidy for Hybrid Installation>

This is a new NRE subsidy program started in 2013. A consortium led either by local authority or public institution with NRE manufacturing companies and individuals can apply for this program. The 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 for this program, thus the optimal integration of 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. Total 25 574 kW PV systems at 6 275 sites were installed in 2018 under this program.

<Solar Lease Program>

In 2013, MOTIE (through KNREC) introduced this new scheme to promote PV deployment and launched a few demo projects for 60 detached houses. The Solar Lease program fully began in 2014, and it is designed in such a way that the private companies take care of installations and maintenance without support from the Government, while consumers pay the leasing fee. Household owners of using more than 200 kWh/month (monthly average in the recent one year period) can apply for this program. Owners pay PV system leasing fee (monthly maximum: 70 000 KRW) which is on the average less than 80% of the typical electricity bill) for minimum 7 years and can use the PV system with no initial investment and O&M cost for the leasing period. PV leasing companies recover the investment by earning PV leasing fee from the households and selling REP (Renewable Energy Point) to RPS obligators with no multiplier. Leasing fee, lease period and REP price are properly set to motivate the participation of PV leasing companies and consumers. The maximum PV capacity allowed for a household is 3 kW for houses of consuming 200~599 kWh electricity monthly average and maximum 9 kW for houses of consuming 600 kWh or higher electricity monthly average. In 2018, 21 115 kW PV systems at 19 077 sites were installed under this program.

<Comparison between PV subsidy program and Solar lease program>

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

<Korean-type Feed in Tariff (FiT)>

To improve the bankability of small-scale distributed PV system installations, a new temporary (5 years for the period of 2018-2022) subsidy measure was introduced in 2018. A fixed contract price (for maximum 20 years) will be provided for systems less than 30 kW with no restriction, and for systems less than 100 kW if they are run by farmers, fishermen or Co-ops.

3.2.2 Incentive Programs for PV Installation

<Capital Subsidy (NRE Loan) Program>

This program is aimed at tackling the up-front cost barrier, either for specific equipment for NRE use or facilities for NRE products. KEA (Korea Energy Agency) through KNREC (Korea New & Renewable Energy Center) evaluates the proposal from the companies and provide the financing fund to participating financial institutions such as banks, and the participating banks lend money (up to 90% of the necessary fund) to the companies with low interest rate (typically 1,75% variable), grace period option (1 to 5 years) and amortization option (2 to 10 years). This subsidy loan can be used for financing facilities (purchase, installation, upgrade, etc.), production funds as well as the working capital. In 2018, total budget of 175 972 million KRW for1 122 cases was allocated for NRE (about 86% was used for PV related businesses).

<Investment Tax Credit Incentive Program>

This program is aimed at promoting the energy savings for individuals and companies, and provides exemption of tax for the investment of energy-saving facilities (including NRE production facilities) and manufacturing facilities for NRE production (e.g. polysilicon production equipment, silicon wafer production equipment, solar cell & module manufacturing equipment, etc.). This program will last until the end of 2018. Small-size enterprises get 6% tax exemption, medium-size enterprises get 3% tax exemption, and Korean national individuals get 1% tax exemption from investment cost.

3.2.3 Obligatory Programs for PV Installation

<RPS Program for Power Businesses>

The RPS is a mandated requirement that the electricity utility business sources a portion of their electricity supplies from renewable energies. In Korea, 21 obligators (electricity utility companies with electricity generation capacity of 500 MW or above) are required to supply 10% of their electricity from NRE sources by 2023, starting from 2% in 2012. The PV set-aside requirement was set to be 1,5 GW by 2015, and the goal was surpassed. In 2018 alone, 1 897,1 MW was installed under this program, while total 497 MW was installed for the entire period under FIT program which was ended in 2011. The RPS is expected to be the major driving force for PV installations in the next few years in Korea with improved details such as boosting small-scale installations (for systems less than 100 kW size) by adjusting the REC and multipliers (1,2), and unifying the PV and non-PV markets. To further enhance the predictability of profit (to attract project financing entities), MOTIE launched a new long-term (max. 20 years) fixed price (SMP+REC) RPS scheme in 2017. This scheme has an advantage of guaranteeing the long-term power purchase with a fixed price which is determined by the market-following system including the competitive bidding. In 2017, the fixed price was 188~189 KRW/kWh. To facilitate the involvement of local communities, MOTIE also launched a new REC multiplier scheme, in which maximum 20% increase in REC multiplier when community residents are involved in the projects. Grid connection of PV systems is guaranteed up to 1 MW by the Government since 2017. Newly adjusted REC multiplier scheme based on five evaluation criteria (economic feasibility, environmental effect, potential, industry promotion effect, and policy priority) is summarized below.

<REC Multipliers in RPS>

Multiplier	Eligible Energy Sources	
	Installation Type	Details
1,2	On land	Less than 100 kW
1,0		100 kW ~ 3 000 kW
0,7		More than 3 000 kW
0,7	On forestland	Regardless of capacities
1,5	On building or existing facilities	Less than or equal to 3 000 kW
1,0		More than 3 000 kW
1,5	Floating on the water surface	

<NRE Mandatory Use for Public Buildings>

The new buildings of public institutions, the floor area of which exceeds 1,000 m^2, are obliged by law to use more than 24% (in 2018) of their total expected energy from newly installed renewable energy resources. Public institutions include state administrative bodies, local autonomous entities, and state-run companies and institutions. In 2018, 71 577 kW was installed under this scheme. The building energy mandate percentage will increase up to 30% by 2020.

3.2.4 BIPV development measures

The BIPV is still not considered as a special system for subsidy and considered same as 'PV in buildings.' Many government-led R&D and demonstration projects are underway to develop BIPV systems for various cases. A government level discussion is on the way to provide support measures for BIPV installations such as adjusting the REC multiplier (greater than 1.0), amending the regulations of local governments, and financial support. New subsidy measures are expected to be introduced from 2019. The 'Third Energy Master Plan' announced in 2019 emphasizes the energy efficiency, thus new policy schemes are expected to be introduced to incentivise the energy efficiency improvement in buildings and near-zero or positive-energy buildings.

Zero Energy Building (ZEB) Demonstration Projects

The Ministry of Land, Infrastructure and Transport (MOLIT) launched five nearly (greater than 90% self-support) ZEB demonstration projects in December, 2014 and is actively continuing total seven projects (5 residential and 2 commercial) in 2015 using both passive and active ingredients. Maximum 30 to 50% of the NRE installation cost is supported by the Government, and the building owners get 15% tax (acquisition and property taxes) exemption for 5 years. The MOLIT has a plan to make the nearly ZEB as a mandatary requirement for all new buildings from 2020, first making the nearly ZEB to be obligatory for the public buildings.

3.3 Self-consumption measures

Self-consumption measures are discussed in Korea but not specifically introduced as new measures.

Table 16: Summary of self-consumption regulations for small private PV systems in 2018.

PV self-consumption	1	Right to self-consume	
	2	Revenues from self-consumed PV	
	3	Charges to finance Transmission, Distribution grids & Renewable Levies	
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	

	5	Maximum timeframe for compensation of fluxes	
	6	Geographical compensation (virtual self-consumption or metering)	
Other characteristics	7	Regulatory scheme duration	
	8	Third party ownership accepted	
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	
	10	Regulations on enablers of self-consumption (storage, DSM…)	
	11	PV system size limitations	
	12	Electricity system limitations	
	13	Additional features	

3.4 Collective self-consumption, community solar and similar measures

Collective self-consumption, community solar and similar measures are discussed in Korea but not specifically introduced as new measures.

In Korea, community solar is increasing due to the recent announcement by the Government. Then new scheme provides maximum 20% increase in REC multiplier when community residents are involved in the projects.

3.5 Tenders, auctions & similar schemes

Tenders, auctions and similar measures are discussed in Korea but not specifically introduced as new measures except the fixed price bidding (Korean-type FiT) for small size systems as described in Section 3.2.1.

Tenders and Auctions

Currently Korea's RPS scheme relies on the auction system with upper and lower bound managed by the Government.

Opening of Negawatt Electricity Market

MOTIE announced the opening of DRR (Demand Response 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 Energy-related New Industry Development Plan for Climate Change Response.' Now new businesses for trading saved electricity are slowly growing since 2016.

3.6 Other utility-scale measures including floating and agricultural PV

Measures favouring the development of large-scale PV, ground-mounted, floating, or agricultural are discussed in Korea but not specifically introduced as new measures except the REC weighting factor of 1,5 for floating PV as described in Section 3.2.3.

Floating PV Installation

Floating PV on the lakes is getting popular in Korea (with potential of ~10 GW). In July 2017, Korea Rural Community Corporation conducted a study about South Korea's potential of on-water PV and estimated 3,26 GW from water reservoir (10% of the total reservoir), 2,633 GW from fresh-water lakes (20% of the total) and 73 MW from irrigation and drain channels (2% of the total). In addition, K-Water can utilize 8% of the dams, which sums up to 3,7 GW. Therefore, the total on-water PV potential in Korea is estimated to be about 9,7 GW. Floating PV gets 1,5

REC multipliers under current RPS scheme and thus is very attractive to the developers. Also, Korean government recently announced 'The 4 GW Saemangeum Project' in the region southwest of the capital city and that includes about 2,8 GW of PV and 1 GW of off-shore wind. The Saemangeum area was originally in the sea, and now it is reclaimed but still many parts are covered by salty water. Thus the technology developed for floating PV will have more opportunities to be used in that area but in a salty water situation.

Agricultural PV Installation

Agricultural PV (in short Agri-PV) is getting higher attention since the new government announced 'RE3020 plan,' and many demonstration projects are undertaken by power producing companies collaborating with local authorities. The 3,3 GW by 2022 and 10 GW by 2030 Agri-PV installation is planned by the Government, and governmental level discussions are on the way to facilitate Agri-PV installations.

3.7 Social Policies

Energy Peace Foundation, a non-profit organization, and Solar Terrace company installed 30 kW mini-PV systems for 100 energy-vulnerable households (300 W/household) in Seoul with the financial aid from Seoul Metropolitan government. This type of mini-PV installations is becoming popular in Korea to reduce the electricity bill burden during the summer.

Korean government also runs the so-called 'Energy Voucher' system to help the handicapped or vulnerable households to pay the energy bills during the summer and winter periods.

3.8 Retrospective measures applied to PV

3.9 Indirect policy issues

3.9.1 Rural electrification measures

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

'Carbon-free Island Jeju by 2030 Project' was jointly planned by Jeju provincial government and central government in 2012 and will be expanded to more islands in Korea. Wind power, PV, geothermal, ESS, and EV will be utilized within the smart grid infrastructure to increase the NRE portion in the energy mix for the islands. Jeju island plans to make the island completely fossil free by 2030.

Eco-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)), which is designed to deploy 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 the whole nation since 2015 by improving the program details from the lessons learned from these demo programs.

<Eco-friendly Energy Town Program contents>

Site	Program Contents
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

3.9.2 Support for electricity storage and demand response measures

ESS demo project was first launched in 2009, and the early ESS was typically used for frequency regulation purposes. Due to the recent support from the Government since 2016, mainly giving incentives in electricity fare for consumers equipped with ESS system for peak-load reduction, the cumulative ESS installation was remarkably increased in the recent few years (30 MWh in 2013, 206 MWh in 2016, 723 MWh in 2017, and 3 632 MWh in 2018). Consumers can get maximum 50% savings in their electricity use under the current scheme.

Support Measures for PV+ESS Installation

Government provides very attractive REC weighting factor for PV power with ESS system. It is a temporary subsidy, though, giving 5,0 REC weighting factors for 2018 and 2019, and it will be decreased to 4,0 in 2020. Also, self-use PV electricity transactions get 1,0 REC weighting factors.

3.9.3 Support for electric vehicles (and VIPV)

The Government recently announced a very aggressive plan to expand the domestic production of eco-friendly vehicles, in which the cumulative EVs will be 430 0000 vehicles by 2022 (56 000 vehicles as of 2018), and the cumulative hydrogen fuel cell vehicles will be 65 000 vehicles by 2022 (923 vehicles as of 2018). To achieve these goals, the obligatory purchase percentage of eco-friendly vehicles by public entities will rise to 100% by 2020 (currently 70% in 2018), and 2 000 hydrogen buses (cumulative) will be deployed by 2022. Ten hydrogen taxis will be operating in Seoul as a demonstration and test since 2019. Charging infrastructures for EVs and hydrogen fuel cell cars will be prepared by local governments with support from the central government. Currently this movement in Korea is not directly related with the VIPV development, but automobile companies (Hyundai/Kia) are developing VIPV as an option for eco-friendly vehicles. The first VIPV electric vehicle will show up in 2019 made by Hyundai/Kia.

3.9.4 Curtailment policies

Curtailment policies are discussed in Korea but not specifically introduced as new measures.

3.10 Financing and cost of support measures

The cost of PV incentives in Korea is mainly covered by the central and regional governments (tax payers' money). Some costs are covered by the 21 RPS obligators indirectly affecting the electricity prices (Government controls the electricity price).

4 INDUSTRY

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

Table 17: Silicon feedstock, ingot and wafer producer's production information for 2018.

Manufacturers	Process & technology	Production Capacities	Product destination	Price
OCI	Siemens Process	52 000 tonnes in Korea*	China, Taiwan, Germany, etc.	
HK Silicon	Siemens Process	15 000 tonnes Ceased production	Shipment has been recorded to be zero	
Hanwha Chemical	Siemens Process	15 000 tonnes	China, Korea, etc.	
Total		**82 000 tonnes** in Korea*		
Woongjin Energy	sc-Si Ingot (mono)	2 000 MW	Germany, USA, Korea (in-house), etc.	
Total	sc-Si Ingot	**2 000 MW**		
Woongjin Energy	sc-Si Wafer (mono)	2 000 MW	USA, Germany, Korea, etc.	
Total		**2 000 MW**		

*OCI's total production capacity is 79 000 tonnes including 27 000 tonnes capacity in Malaysia

The production of poly Si from OCI plants in Korea has been sluggish in recent years because of low profitability. Instead, OCI has been increasing the production capacity in Malaysian plants. The Malaysian plant is advantageous for OCI, because it can operate at much lower electricity cost which plays a crucial role in lowering the total cost of polysilicon production.

HK Silicon went bankrupt in 2017 and has not been operational until now. Hanwha chemical also underwent the hardships in polysilicon business due to low product price and small production volume.

Although Woongjin Energy enhanced productivity, it has been experiencing serious difficulties in management due to accumulated deficits and filed for court receivership in 2019.

4.2 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 below.

Table 18: PV cell and module production and production capacity information for 2018.

Cell/Module Manufacturer		Total Production (MW)	Maximum Production Capacity (MW/yr)

	Technology (sc-Si, mc-Si, a-Si, CdTe)	Cell	Module	Cell	Module
Wafer-based PV manufactures					
1 SolarTech	mc-Si	0	0	0	30
2 Solariver	sc-Si / mc-Si	0	16	0	20
3 SDN	mc-Si	0	80	0	100
4 S-Energy	mc-Si	0	150	0	400
5 BJ Power	mc-Si	5	25	5	25
6 HHI Green	sc-Si	600	600	800	800
7 Hanwha Q-Cells*	sc-Si / mc-Si	3 500	4 000	3 700	3 700
8 Shinsung E&G	c-Si /mc-Si	500	200	600	200
9 Hansol Technics	mc-Si	0	500	0	500
10 Daeyou SE	mc-Si	0	0	0	120
11 JSPV	mc-Si	0	400	0	400
12 SolarParkKorea	mc-Si	0	480	0	600
13 TopSun	mc-Si	0	80	0	150
14 LG Electronics	sc-Si	1 100	1 300	1 800	1 800
15 Luxco	mc-Si	0	150	0	150
16 KPE	mc-Si	0	0	20	0
17 T&Solar	mc-Si	0	40	0	50
18 SK Solar Energy	sc-Si / mc-Si	0	50	0	50
Total	***c-Si***	***5 700***	***8 071***	***6 925***	***9 095***
Thin film manufacturers					
1		x	*x*	y	*y*
2					
Cells for concentration					
1		g		h	
2.					
Total	***c-Si***			***6 925***	***9 095***

*Hanwha Q-cells China plant has the additional capacity of 2 200 MW cells and 2 500 MW modules, and its Malaysian plant has the additional capacity of 1 700 MW cells and 1 700 MW modules.

About 90% of the modules produced in Korea are exported to foreign countries.

LG Electronics is using PERT cells to mass-produce n-type modules including bifacial modules.

Hanwha Q-Cells completed module assembly line in Dalton Georgia, USA in February 2019. Hanwha established this US module production line to escape the duties caused by safeguard. It was reported that Hanwha invested USD 150 million to set up US assembly plant whose production capacity is 1 700 MW.

LG Electronics also invested USD 28 million to initiate its module production in Alabama, USA. LGE would be equipped with 500 MW of module production capacity on the company's 48-acre campus in Huntsville.

Korean players have been pursuing the technological edge of premium solar cells and modules incorporating diverse technical approaches such as n-type mono wafer, PERC (Passivated Emitter and Rear Contact) process, half-cell technology and bifacial modules.

4.3 Manufacturers and suppliers of other components

- PV inverters (for grid-connection and stand-alone systems) and their typical prices

As the volume of Korean PV market increases, many foreign inverter players like Chinese companies and European makers have been breaking into Korean PV market by establishing sales points and service networks in Korea.

On the other hand, it is estimated that Korean government would tighten up the criteria of safety standards related with inverters. It is due to the increasing fire accidents and O&M troubles connected with the inverters.

- Storage batteries

In Korea, PV systems combined with ESS were spotlighted, because the system has been awarded with higher subsidies, multiplied REC (Renewable Energy Certificate) values. However, the systems combining PV and ESS recently suffered from many unspecified fire accidents. It hindered developers from investing in PV systems combined with ESS, because there were not clear clues.

As Korean government announced the probe report of ESS fire in 2019, it is now expected that the dissemination of storage batteries for ESS would increase again.

5 PV IN THE ECONOMY

This chapter aims to provide information on the benefits of PV for the economy.

5.1 Labour places

Table 19: Estimated PV-related full-time labour places in 2018

Market category	Number of full-time labour places
Research and development (not including companies)	
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	7 732
Distributors of PV products	4 917
System and installation companies	6 076
Electricity utility businesses and government	
Other	
Total	**18 725**

5.2 Business value

Table 20: Rough estimation of the value of the PV business in 2018 (VAT is excluded).

Sub-market	Capacity installed in 2018 [MW]	Average price [KRW/W]	Value	Sub-market
Off-grid	0	0	0	*0*
Grid-connected distributed	176	1 474	259 424 000 000	259 424 000 000
Grid-connected centralized	2 191	1 582	3 466 162 000 000	3 466 162 000 000
Value of PV business in 2018*				**3 725 586 000 000**

*Total PV value-chain companies' sales in Korea was 6 459 700 000 000 KRW (domestic sales: 2 111 600 000 000 KRW, export: 3 023 400 000 000 KRW, overseas production/sales: 1 324 800 000 000) according to 2018 New and Renewable Energy Industry Statistics by KEA.

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. 2 in the world, and silicon solar cell capacity is currently No. 1 in the world. The Korean-made products are mostly exported to foreign countries including China, EU, Japan and USA.

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

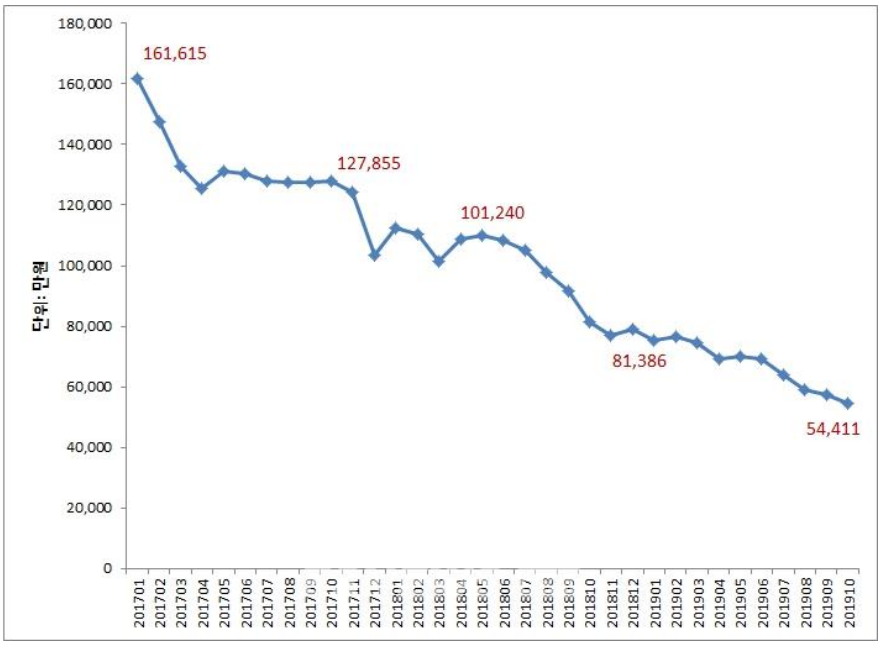
Structure of the electricity system in Korea can be summarized as below:

- Vertically integrated structure
- Retailers and network businesses -integrated (monopoly)
- Public ownership (government owned)
- Regulated by central government

6.2 Interest from electricity utility businesses

Since 2012, the RPS scheme started and replaced the FiT which lasted until 2011. Total 21 companies including electricity generation companies, electricity generation business companies and other corporates which have the electricity generation capacity greater than 500 MW have participated the RPS scheme mandatorily. 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 to drop significantly together with the fast falling PV product prices. The electricity utility businesses preferred to have more PV to replace the non-PV RPS to lower the cost and fulfil their duties. In March 2016, PV REC market and non-PV REC were merged into one. After the market merger, the annual average REC price increased from 92 638 KRW/MWh in 2015 to 144 136 KRW/MWh in 2016. In 2017, 92.9% of the duties was attained, supplying 17 626 GWh (duties: 18 975 GWh). The REC price was also stabilized down to average 131 000 KRW/kW. However, since the new government announced RE3020 plan in 2017 and incentivized PV installations, due to oversupply of PV systems with ever-decreasing PV system cost, the REC price has fallen very rapidly in the last two years as shown in the figure below. In 2018, duties were 21 999 611 MWh (5%).

<REC Pricing Trend in Korea (KRW/REC)>



In the 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 five criteria: 1. Influence on environment, 2. Technology development and industry vitalization, 3. Cost in electricity generation, 4. Potential amount, and 5. Policy priority. In practice, however, there exist some mismatches and conflicts

to hinder the RPS participants from fulfilling their duties. Some regions with large PV potential have either low REC weighting factor or under strict regulation. The first year's RPS practice revealed many of these problems. Thus, Korean government simplified the REC weighting factor scheme in 2014, and minor adjustments were made from time to time to reflect the issues arising from implementation.

Electricity utility businesses in general were originally hesitant to participate aggressively in the PV deployment, asking for more support from the Government. However, since the start of new government in 2017 and due to the recent RE3020 plan, electricity utility businesses are now actively engaged in PV deployment. Large-scale PV deployment projects are being announced competitively by the electricity utility businesses. Especially, recently announced 4 GW Saemangeum project that includes about 2,8 GW of PV and 1 GW of off-shore wind is expected to drive the electricity utility businesses more into participating in the PV installations.

Solar lease program (third party ownership) is introduced in 2014, and grew fast in the following years. A so-called "Negawatt" market was also introduced in 2014 and has been fully operational. This is an electricity trade scheme not on a production or supply basis but on a saving and peak time trading basis.

KEPCO, the largest and only electricity business company in Korea, participated in many PV related activities including "Energy-independent Islands Project" and "Korea Smart-grid Project." Especially after the announcement of "RE3020 Plan," KEPCO started to more actively engage in various PV development and dissemination projects.

6.3 Interest from municipalities and local governments

The Capital city, Seoul has been campaigning "One Less Nuclear Power Plant for Seoul" since 2011 and conducted many programs to reduce the electricity consumption and to increase the NRE dissemination. This plan is to reduce the energy consumption in Seoul as much as 2 million toe (equivalent to the energy supplied by on nuclear power plant). As a result, Seoul's electricity consumption was reduced from 46 903 GWh in 2011 to 45 019 GWh in 2014. Seoul revived a modified type of FIT scheme to facilitate the PV deployment in the energy production area. The second phase of "One Less Nuclear Power Plant for Seoul" began in 2015 targeting total 4 million toe reduction and GHG 10 million ton reduction, and the goals involve the 20% electricity independence rate (currently 13%) of Seoul by 2020. In particular, cumulative 42 332 PV systems (37 405 kW) including 31 951 (8 630 kW) mini-PV (typically 250-300 W) for households was installed in 2017, and citizen crowd-funded PV power plants were also launched in 2015. Seoul metropolitan government announced a new slogan of 'City of Sun 2022' which aims at deploying 157 384 kW (605 185 systems) PV power plants by 2022.

Chungbuk Province's slogan is "A Land of Life and Sun." In this province, more than 50% of Korean-made PV modules (more than 70% of PV cells) are produced, and about 100 PV related companies are in business. The province is holding 'Solar Festival' every year and recently established a plan to construct a PV R&BD hub (called 'Asia Solar Valley'). Chungbuk Technopark is located in Cheongju city and actively engaged in PV module (including BIPV) testing and certification. The province is trying to host the KITECH (Korea Institute of Industrial Technology) Chungbuk Branch and building a 'PV Tech Support Center' for region's SMEs. KIER (Korea Institute of Energy Research), a national laboratory covering all kinds of energy except nuclear energy, is also located in the neighboring 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 which PVMI (PV Market Insight) conference is held regularly as a

parallel event. The “22nd World Energy Congress” in 2013, “7th World Water Forum” and “ISES Solar World Congress” in 2015 were held in Daegu. Solar Cell/Module RIC (Regional Innovation Centre) and MOTIE-sponsored MW PV Testbed are located in Yeungnam University in the neighboring Gyeongbuk 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 Gyeongbuk Province. Gyeongbuk province also launched a project called “Sunlight Energy Farming” in 2015 to secure regular incomes for rural households (relatively disadvantaged from recent FTA with foreign countries) using low interest rate fund from provincial government and REC purchasing agreement with KHNP (Korea Hydro & Nuclear Power).

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 insolation in Korea and thus the largest number of PV power plants in Korea. KEPCO, KPX, Honam PV test-bed at Jeonnam Technopark and KITECH (Korea Institute of Industrial Technology) Jeonnam Branch are both located in Jeonnam province and the neighboring city, Gwangju (meaning ‘Sunshine Village’). GEI (Green Energy Institute) is also located in the neighboring city, Mokpo.

Jeonbuk Province launched with a strong support from central government ‘4 GW Saemangeum RE’ project and have a plan to construct renewable energy industry complex near the Saemangeum area.

Jeju Special Self-governing Province launched the ‘Carbon-free Island Jeju’ project and aims at becoming a 100% carbon-free island by 2030.

Other provinces including Busan metropolitan city (the second largest city in Korea), Gyeonggi province, Ulsan city and Chungnam province also began to be actively engaged in PV deployment and PV related industry development since the start of the new government.

7 HIGHLIGHTS AND PROSPECTS

7.1 Highlights

Since "The Renewable Portfolio Standards" (RPS) replaced the Korean FiT at the end of 2011, the Korean PV market followed an upward trend that stabilized around the GW mark: The country installed 2 367 MW in 2018, after having installed 1 362 MW in 2017.

Utility-scale PV plants accounted for around 2 191 MW of the installed capacity in 2018. Distributed PV systems amounted to around 10% of the total cumulative capacity. The share of off-grid PV systems has continued to decrease and represents less than 1% of the total cumulative installed PV capacity. At the end of 2018, the total installed capacity reached 8,1 GW. PV contributed to 1,8% of the total electricity consumption in 2018.

Various incentives have been used to support PV development. 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 plan includes many new subsidy measures including the development of 'Eco-friendly Energy Towns,' 'Energy-independent Islands,' and 'Solar Lease Programs.'

The RPS scheme launched in 2012 will be active until 2024 and is expected to be the major driving force for PV installations in Korea, with improved details such as boosting the small-scale installations (less than 100 kW size) by adjusting the REC and multipliers, and unifying the PV and non-PV markets.

To improve the bankability of small-scale distributed PV system installations, a new temporary (5 years for the period of 2018-2022) subsidy measure was introduced in 2018. A fixed-price contract (so-called 'Korean-type FiT') for max. 20 years will be provided for systems less than 30 kW with no restriction, and for systems less than 100 kW if they are run by farmers, fishermen or Co-ops.

Korean PV industry, completely established the value chain for crystalline silicon solar cells from raw materials (polysilicon), ingot and wafers, cells, modules, systems and power plants, continued to grow and expand its production capacities. Among these, OCI's polysilicon production capacity is currently No. 2 in the world, and Hanwha Q-Cells' silicon solar cell capacity is currently No. 1 in the world. Korean cell players have been pursuing the technological edge of premium solar cell and module incorporating diverse technical approaches such as n-type mono wafer, PERC (Passivated Emitter and Rear Contact) process, half-cell technology and bifacial modules. The Korean-made products are mostly exported to foreign countries including China, EU, Japan and USA. In the next generation PV technology area, Korea is leading the research on Perovskite solar cell and its tandem cell technology. VIPV is also being developed by research institutes, and Hyundai/Kia motor company demonstrated the production of VIPV cars in 2019.

7.2 Prospects

In 2019, the 'Third Energy Master Plan' was announced which aims at supplying 30~35% of the electricity generation by renewable sources by 2040. Due to the availability of sites and public acceptance, PV is expected to be the major renewable source to fulfil the target set in the Master Plan. The 'Fifth Basic Plan for the Promotion of Technological Development, Use, and Diffusion of New and Renewable Energy" will be announced in early 2020.