



#KOREA# PRESENTATION

Chinho Park, Korea Institute of Energy Technology (KENTECH)

61st Task 1 Meeting, 23-27 October, 2023 [Adelaide, Australia]

S. Korea – General Information



- Population : 51.8 million
- Total electricity demand : 594.4 TWh (total electricity generation : 611.0 TWh)
- Share of renewables : 7.35% (as of 2021F)
- Share of solar : 4.16% (as of 2021F)
- Solar development targets (capacity and year) : Based on the '10th Electricity Demand & Supply Plan' released on January, 2023
 - New & Renewables: 72.7 GW (36.7%) by 2030, 108.3 GW (45.3%) by 2036
 - Solar PV: 46.5 GW by 2030, 65.7 GW by 2036

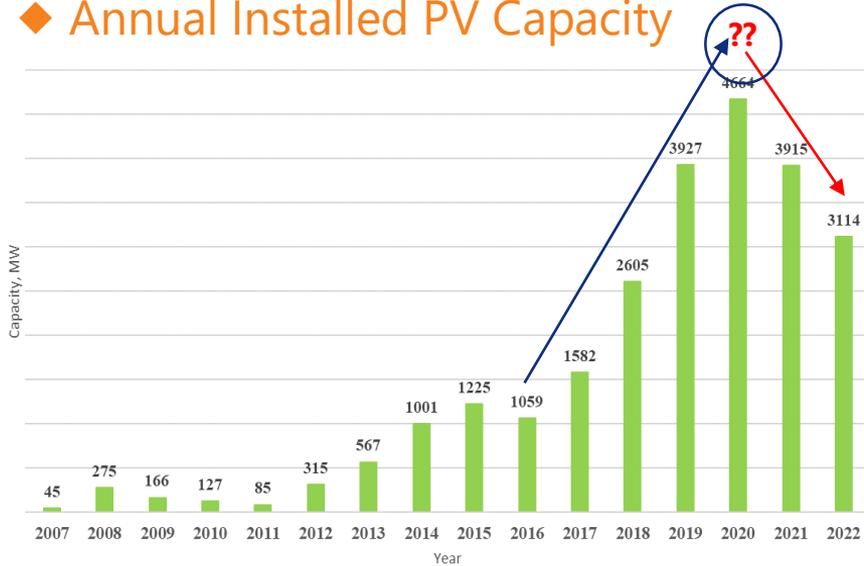
√ But, 11th Electricity Plan is under preparation, and these targets are subject to change!!

PV Market Evolution



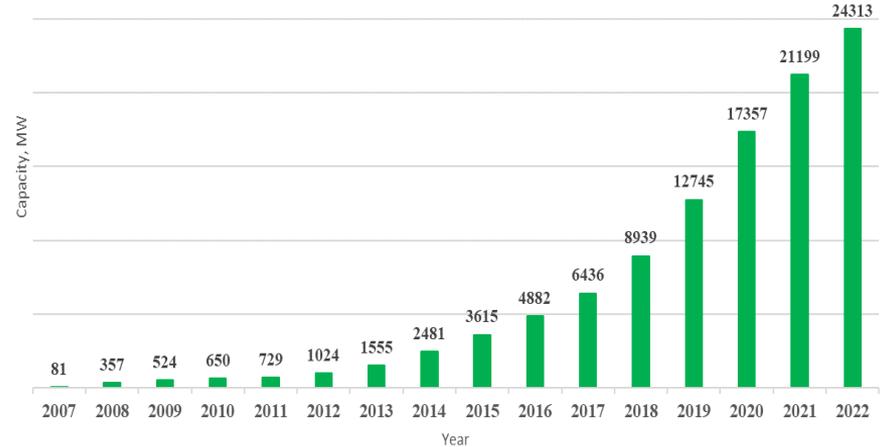
◆ Annual Installed PV Capacity

What happened??



◆ Cumulative Installed PV Capacity

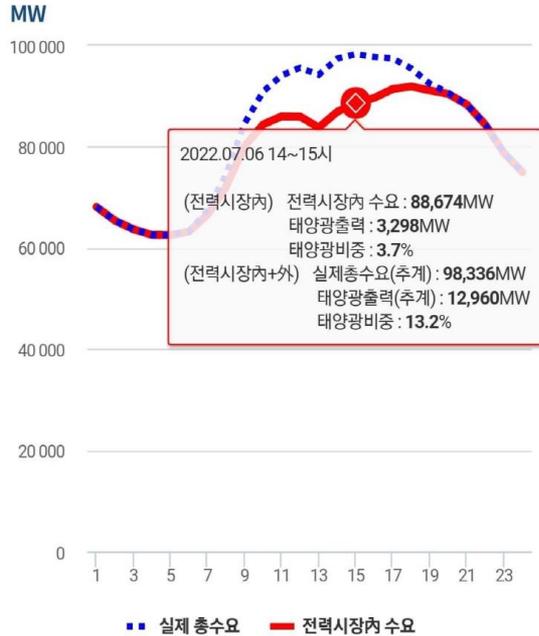
PV electricity: ~4.6% as of 2022F



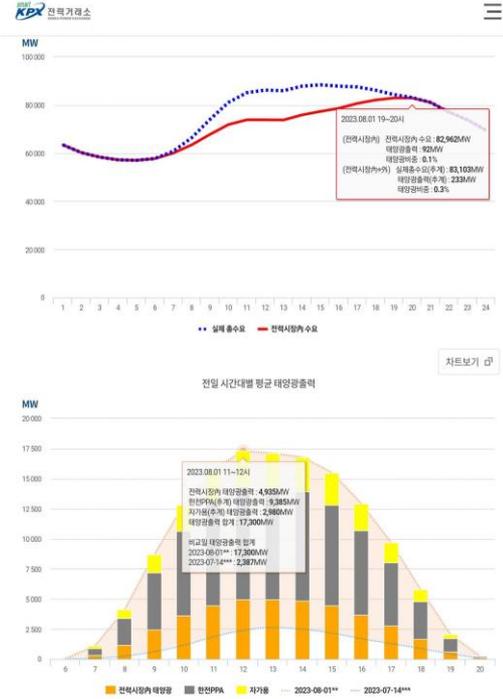
PV Market Evolution



Effect of Reducing Peak Demand



Record-breaking Electricity Peak Demand in Kora on July 07, 2022



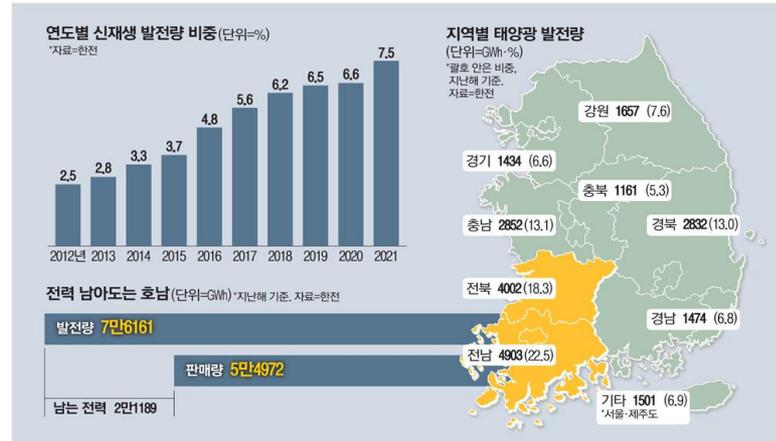
*참조 : 본 자료의 미래형 태양광(한전PPA, 자가용) 발전량은 주계급이며, 태양광 발전량은 당일의 00시 기준 취득정보로 차이가 발생할 수 있음
**비교일(2023-08-01) : 최근 1개월내 발전량 합계 기준 최상위 참조일
***비교일(2023-07-14) : 최근 1개월내 발전량 합계 기준 최하위 참조일

PV Market Evolution

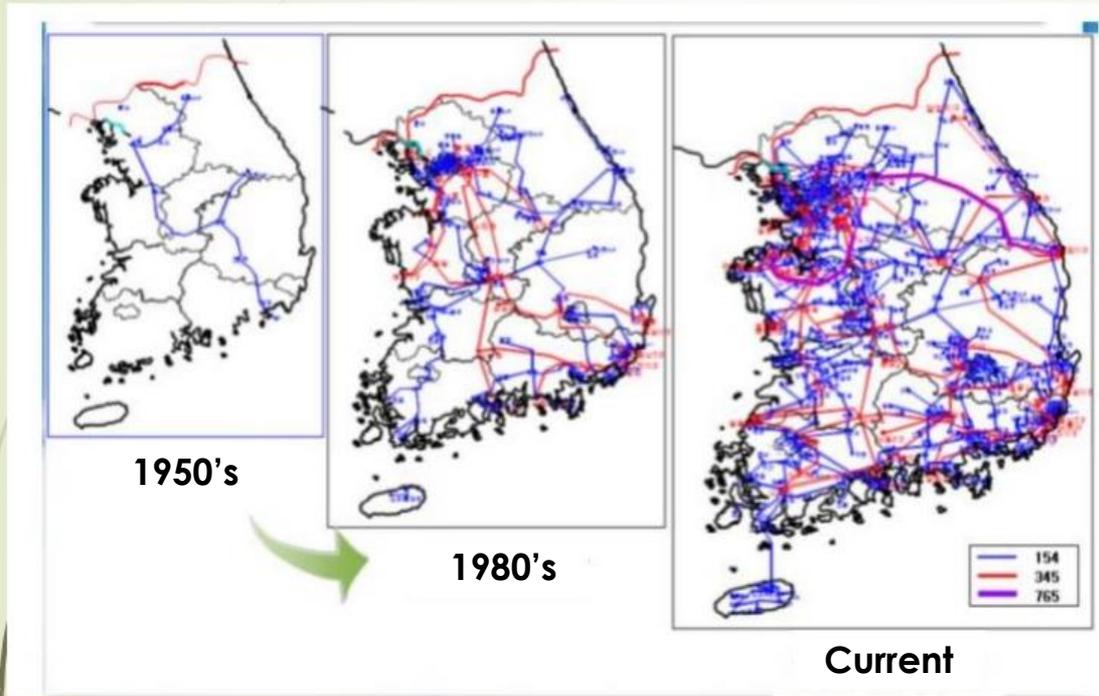


However, regional grid congestion issues were surfaced..

- Minimum electricity demand is falling from 45.6 GW in 2018 to 41.4 GW in 2022 in the last five years due to rapid increase in the PV capacity.
- PV capacity of 26.4 GW (as of March, 2023) exceeds the nuclear capacity of 23.2 GW in Korea.
- Uneven regional distribution in PV capacity as well as grid capacity is making the situation worse.
- ESS installation is very slow due to recent fires in ESS systems.
- About 1.05 GW of PV in southern regions has no LVRT (Low Voltage Ride Through) function, and these are the ones which will be curtailed first if necessary, and were really curtailed in April and May, 2023.



S. Korea's Progress in Electric Grids in the Last 70 Years



S. Korea became one of the poorest powered countries in the world due to N. Korea's sudden and unilateral power cut in May, 1948, but in the last 70 years, S. Korea has become one of the best countries who have most sophisticated and high-quality electricity grids.

PV Market Evolution



Social Acceptance Issues

Environmental & Aesthetic Damage due to PV



PV System Collapsed due to Heavy Rain



Fake Farmland PV System



√These are not everywhere and very rare, but still the impact was significant to the public. Although these were facts, the story was enough to make a mountain out of molehill.

S. Korea's Renewable Energy Policy Change_(Nov., 2022)

- Reasonable but realistic deployment of Renewable Electricity (~5 MW/year installations till 2030)
- Lowering of the RPS obligation percentage and promotion of private sector participation
 - Introduction of auction market, Establishment of RE100 company (25) alliance
- Balanced deployment of solar and wind
 - 87:13 in 2021 → 60:40 in 2030
- More focus on installations in idle spaces rather than installations in mountains & farming areas
 - BIPV, Floating PV, Roof-top PVs in factories, parking lots, irrigation & drain channels, etc.
 - Especially BIPV will be promoted by several policy measures and incentives from the government (subsidy for BIPV installations, mandatory inclusion of BIPV for public buildings, more REC weighting, zero-energy building regulations including BIPV, government-led procurements)
- More emphasis on PV manufacturing industry development than simple expansion of deployment
 - Top-down R&D support for high efficiency solar cell (perovskite tandem cell, etc.) development
- Details to be prepared in the “6th NRE Basic Plan” scheduled in 2023 → **But currently in delay!!**

Changes in Renewable Electricity Mix Plan



Overview of Market Drivers



Special Act on Distributed Energy Activation

☑ Background and Objectives

- Passed congress on May 15, 2023, will be executed after one year.
- Social conflict due to constructions of large scale power plants and long distance power transmission lines
- Overcoming the limitations of centralized power systems
- Developing distributed energy systems for electricity production and consumption near demand points

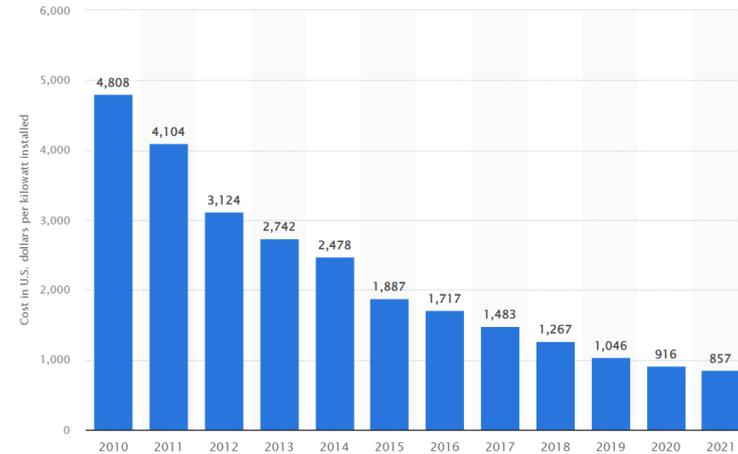
☑ Main Contents

- Introduction of power system impact assessment system
- Introduction of distributed energy specialized region system (Direct PPA possible)
- Introduction of VPP system
- Introduction of distributed energy installation mandate system
- Introduction of the obligation to manage stable distribution network to DSO's
- Establishment of basis for implementation of differentiated electricity fares by region

Turnkey PV System Prices of Different Typical PV Systems in Korea_2022

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 (typically 3 kW for household)	1 600 - 2 000
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	1 500 - 1 900
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.	2 000 - 3 000
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.	1 300 - 1 500
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.	1 500 - 2 000
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.	1 200 - 1 500
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.	1 500 - 2 500
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	1 150 - 1 450
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.	1 050 - 1 600
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.	1 050 - 1 600
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.	1 350 - 1 800
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.	market, not established yet

Average installed cost for solar photovoltaics worldwide from 2010 to 2021



➔ Average installed cost for solar photovoltaics in Korea as of 2022 is 2,025 KRW/W (=1,534 USD/kW)

Showcase System



- 41.5 MW Floating PV Installation in Hapcheon Dam
- 467,000 m² PV Area (1.8% of Dam Water Storage Area)



45 MW Floating PV Installation in Imha Dam (Under Construction)



Large-scale PV Installation Projects by Regional Governments



<1.5 GW PV by Daegu Metropolitan City Government>



<3.0 GW PV by Gyeongbuk Provincial Government>

Gyeonggi Province, “100,000 Power Independent Households Project”, May, 2023

*BIPV promotion is underway:

- 1) Building subsidy percentage for BIPV installation is increased to 15% from 13.4%.
- 2) Building completion requirement length for BIPV is increased to 275 days from formerly 210 days.

PV Industry in S. Korea (Silicon PV)



Poly-silicon

Wafer

Cell

Module

System

Hanwha Energy Solution (4,500 MW)
Hyundai Energy Solution (650 MW)

Shinsung E&G (800 MW)
S-Energy (400 MW)
HanSol Technics (500 MW)
SDN (400 MW)
Hanwha Energy Solution (2,900 MW)
Hyundai Energy Solution (1,400 MW)

LG CNS
S-Energy
Hanwha Solar Power
KT, Topinfra, KD Power

Value Chain	Poly-silicon (ton)	Ingot/Wafer (MW)	Cell (MW)	Module (MW)
Total (Domestic)	0*	0	5,155**	7,475**

*OCI's Malaysia plants : 32,000 ton (original capacity of 20,000 ton by Tokuyama)

**Hanwha's total cell capacity including overseas plants is 10.0 GW: 4.5 GW (Korea), 3.2 GW (China), 2.3 GW (Malaysia), and total module capacity including overseas plants is 10.8 GW: 2.9 GW (Korea), 3.9 GW (China), 2.3 GW (Malaysia) and 1.7 GW (USA).

***Hanwha is investing in EVA production jointly with GS Energy (H&G Chemical), which will increase their production capacity to 920,000 ton to make them the world's No. 1 supplier of EVA (currently 790,000 ton by Exxon Mobil).

PV Industry in S. Korea – Hollowing Out?



CBAM*, European Green Deal, EU-Taxonomy, Just Transition, REPowerEU, TCTF, etc



RE-100 Alliance – More than 420 Enterprises as of Oct. 10, 2023 (34 Korean companies)



IRA (Inflation Reduction Act) & IIJA (Infrastructure Investment & Job Act)



✓ Energy transition is not just a matter of environment, but it is broadening its concept to include the reconstruction the Global Value Chain (GVC) and protection of domestic industries globally.

PVPS

OCI's Mission Solar in Texas, USA is expanding its module capacity to 1 GW, and preparing its cell production, too.



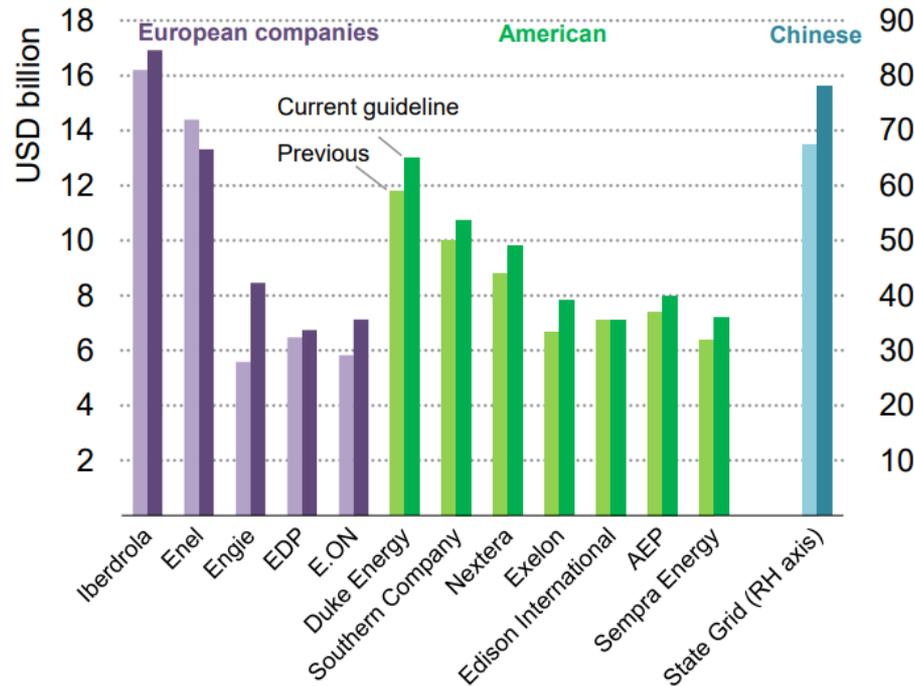
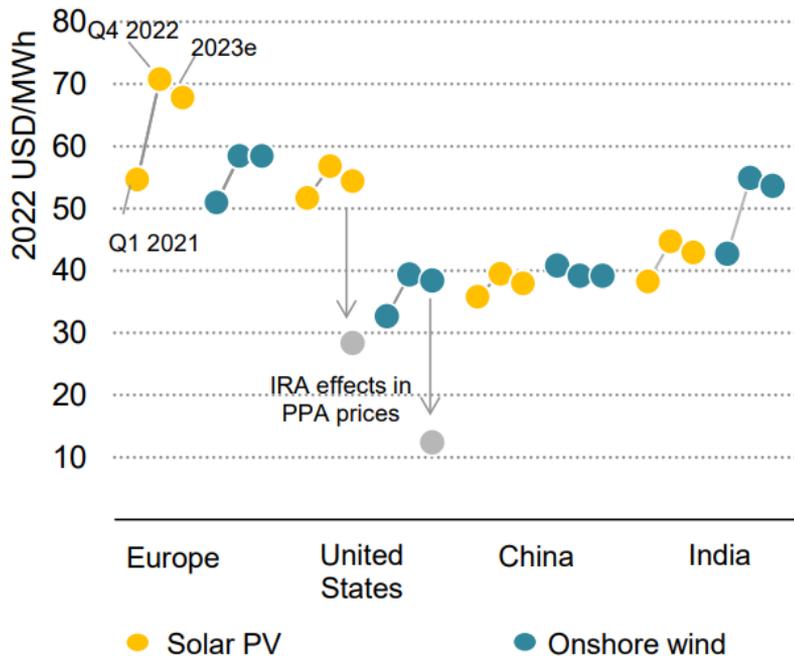
Hanwaha is expanding its module capacity in Dalton and Bartow, Georgia, USA from 1.7 to 3.1 GW, and looking for increased module production capacity of 8.4 GW in USA by 2024 with 2.46 Billion USD investment, and also taking over 16.67% of REC's stocks. Hanwaha tries to build a complete PV value chains in USA.



*Carbon Border Adjustment Mechanisms; **Temporary Crisis & Transition Framework

LCOE Reduction Effect by US-led IRA Policy

LCOE estimates of utility-scale solar PV and wind; and average annual short-term investment guidelines of selected power companies



*Source: World Energy Investment 2023, International Energy Agency, 2023.

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