2023 SEMI-ANNAL Report

VOL.2023- 반기
-1(2023.02.08.)

Photovoltaic Industry Trends in the Second Half of 2022

Write

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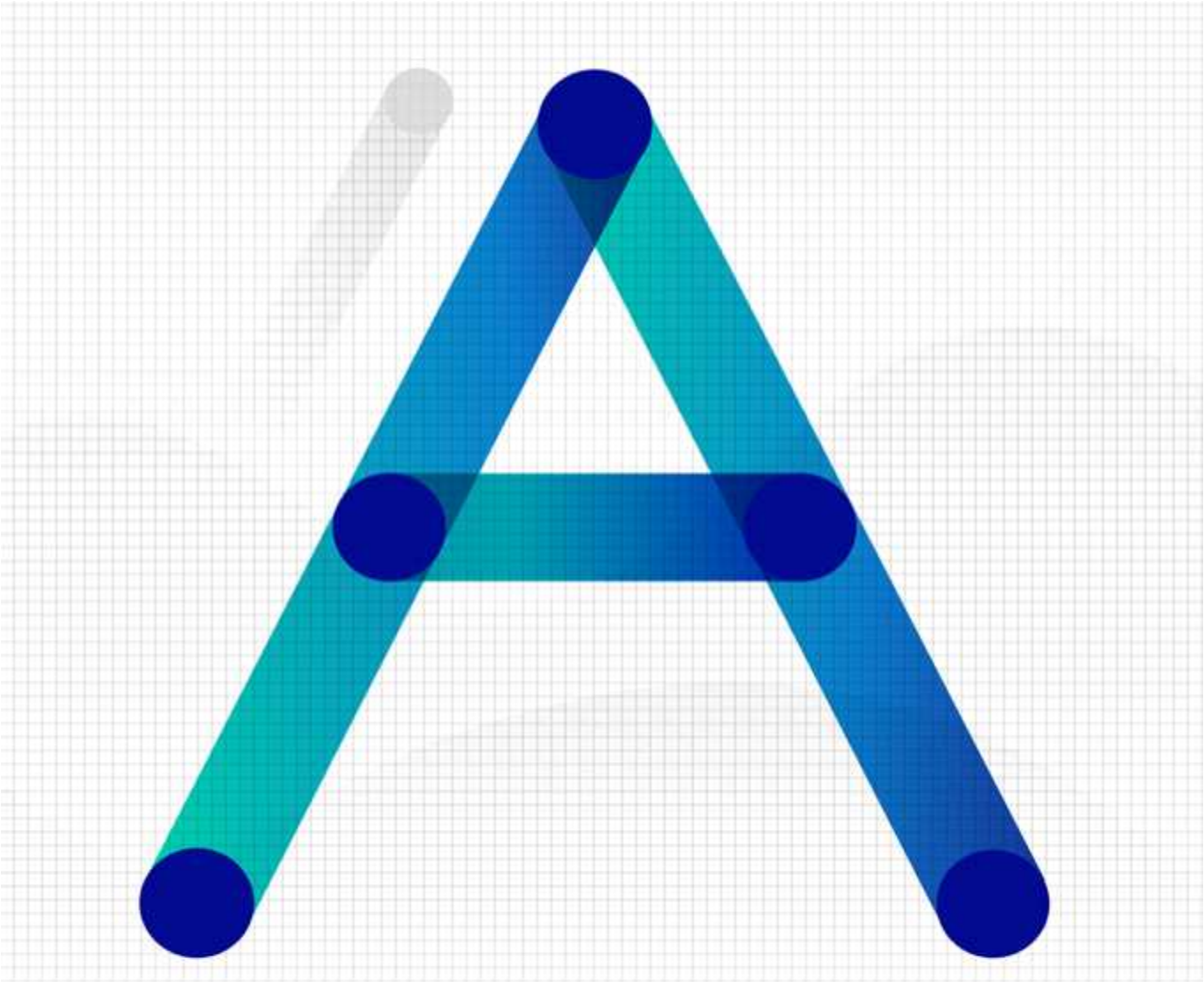


한국수출입은행 | 해외경제연구소

< about >

In 2022, global solar installations are estimated to be 260~280GW, an increase of more than 40% year-on-year, and the installed volume in 2023 is expected to be 320GW.

Ÿ Demand in China and the United States is robust, and the demand for solar power generation has increased significantly, especially in Europe, due to the rise in global energy prices following the Russia-Ukraine crisis in 2022.

Ÿ The era of 300GW of global solar installations is expected to be achieved as early as 2024 to 2023, and the global photovoltaic market is expected to record continuous growth until 500GW by 2030.

As of January 2023, the price of polysilicon is $22/kg, down 43.6% from its August 2022 high ($39/kg).

Ÿ In 2022, the global polysilicon production capacity was 900,000 tons, but with the large-scale capacity expansion, the production capacity is expected to increase to about 1.3 million tons in 2023, resulting in a 20% excess of supply compared to demand.

- Polysilicon prices are expected to decline rapidly due to the oversupply of polysilicon, and polysilicon prices are expected to stabilize downward below $15/kg from the first half of this year.

Ÿ As of January 2023, the price of monocrystalline solar cells is $0.11/W and the price of monocrystalline modules is $0.23/W, down 35% and 18% respectively from the year-on-year highs.

The main keyword of the global photovoltaic supply chain in 2022 is the acceleration of China's monopolization

Ÿ In 2022, the global polysilicon production capacity is 980,000 tons, with the polysilicon production capacity by country being 794,000 tons in China, 60,000 tons each in the United States and Germany, 35,000 tons in Malaysia, 11,000 tons in Japan, 8,000 tons in Qatar, 7,000 tons in Norway, and 6.5 thousand tons in South Korea.

Ÿ As of 2022, the global module production capacity is 649GW, and China's module production capacity increased from 400GW in 2021 to 536GW in 2022, a year-on-year increase of 136GW, accounting for 76% of the global module expansion in 2022

- 2022 년 중국 이외의 국가별 모듈 생산용량은 베트남 26.3GW, 인도 14.9GW, 말레이시아 14.5GW, 한국 10GW, 터키 7.6GW, 태국 6.9GW, 미국 4.5GW, 대만 4.2GW, 독일 2.8GW

The REC price, which had been on a downward trend, has rebounded from a low of 29,542 won in July 2021 and has maintained the 60,000 won level since August 2022.

Ÿ The SMP price soared to 268 won per kW in December 2022 due to the continued high flight in coal and gas prices due to global energy supply disruptions due to the Russia-Ukraine crisis, and the profit margin of solar projects also increased significantly as REC prices also strengthened.

In 2022, the export value of solar cells and modules increased by 43.7% year-on-year to $1.55 billion.

Ÿ Looking at the export value by country, the United States accounted for 92.2% of the total solar cell and module exports at $1.43 billion, followed by the Netherlands at $0.35 billion, China at $0.21 billion, Angola at $0.17 billion, and Australia at $0.11 billion.

Ÿ In 2022, wafer imports increased by 17.0% year-on-year to $570 million, while imports by weight decreased by 19.4%, but wafer imports by value increased by 17.0% due to the increase in wafer prices.

In 2022, the cumulative business performance of major domestic photovoltaic companies in the third quarter improved year-on-year, but the gap with Chinese companies widened

Ÿ Until the third quarter of 2022, the cumulative performance of major global photovoltaic companies is sharply different between Chinese companies VS non-Chinese companies, and between material companies such as polysilicon and product companies such as modules.

- China 's top companies such as Longi, JA Solar, and Jinko Solar saw a significant year-on-year increase in sales in 2021 due to the massive expansion of facilities and the increase in global solar demand in 2022, but the U.S. company First Solar posted an operating deficit.

Ÿ OCI posted KRW 1.23 trillion in sales and KRW 389 billion in operating profit, up 33.6% and 25.9% year-on-year, while Hanwha Solutions posted KRW 3.49 trillion in sales and KRW 118.2 billion in operating profit, up 35.2% year-on-year, and operating profit turned into a surplus.

Ÿ Corporate earnings in 2023 are expected to deteriorate year-on-year as the prices of raw materials such as polysilicon are expected to stabilize downward.

Checks on China's monopoly are expanding, and Korean companies are expected to benefit from the process of building a global solar supply chain centered on the U.S.

Ÿ Chinese companies account for more than 80% of the supply of photovoltaic products, monopolizing the global photovoltaic industry.

Ÿ With the implementation of the Inflation Reduction Act in the United States, we are trying to reduce our dependence on China by building solar power production facilities in our country, and Korean companies operating in the United States are expected to benefit from this process.

Ÿ Timely investment funding for the construction of production facilities to target the U.S. market is expected to increase the competitiveness of Korea's photovoltaic industry.

I. Global Photovoltaic Industry Trends

1. Global Solar Installation Trend

In 2022, the global solar installation volume is estimated to be 260~280GW, an increase of more than 40% year-on-year, despite the strong product prices due to global inflation.

Ÿ Polysilicon prices, which were only $8/kg in June 2020, continued to be strong throughout 2022, including $28/kg in July 2021, $33/kg in January 2022, $39/kg in August 2022, and $31/kg in December 2022.

Ÿ The rise in the price of raw materials such as polysilicon could lead to an increase in the prices of products such as solar cells and modules, which could lead to a contraction in the demand for solar photovoltaics, but strong global demand for solar power led to a significant year-on-year growth

Ÿ The high growth of the global photovoltaic market in 2022 is mainly due to the improvement in the relative economic feasibility of Taeyang power generation due to the rising cost of energy such as coal and gas, the increase in demand for clean energy due to climate change issues, and the increase in demand for energy security due to the Russia-Ukraine crisis.

- In the first half of 2021, the average unit price ($/MWh) of each global power generation source was 67 for coal, 74 for gas, and 39 for stationary solar power, but in the first half of 2022, the average unit price ($/MWh) for each global power generation source was 74 for coal, 81 for gas, and 45 for solar power, with coal and gas power generation prices up 10.4% and 9.5%, respectively.

- In the second half of 2022, the average unit cost of power generation by global power generation source (unit: $/MWh) was 80 for coal, 100 for gas, and 45 for stationary solar power, with the unit price of coal and gas power generation up 9.1% and 23.1%, respectively.

- In the second half of 2022, the unit price of coal and gas power generation recorded a significant increase due to the increase in fuel prices, but the unit price of solar power generation remained at a similar level, widening the difference between the unit price of coal and gas power generation

- Solar power generation has secured a high level of price competitiveness compared to coal and gas power generation, which is in line with the trend of expanding the use of eco-friendly energy to reduce carbon dioxide, driving the increase in global solar power demand in 2022.

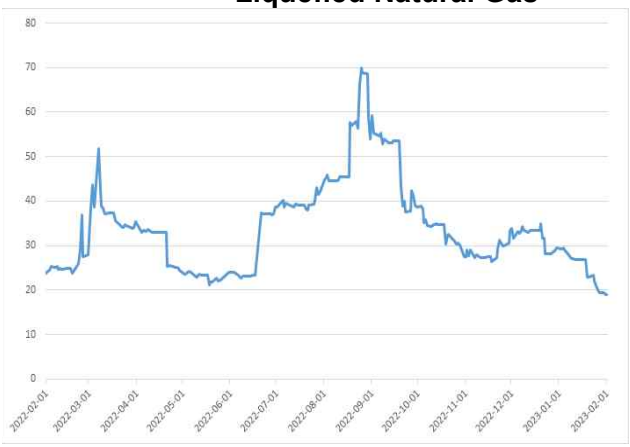
Ÿ As the Russia-Ukraine crisis raises concerns about gas supply in Europe, energy security issues are emerging

- Europe receives 45% of its annual natural gas supply from Russia, which poses a major threat to Europe's economy and security in the medium term.
- As the need for energy supply security increases, solar power is emerging as a key alternative for energy self-sufficiency

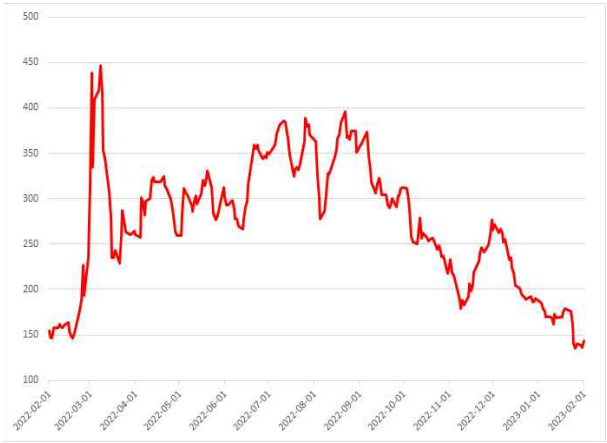
< Fuel Price Trend for Power Generation >

(Unit : USD/MM BTU, USD/TON)

Liquefied Natural Gas



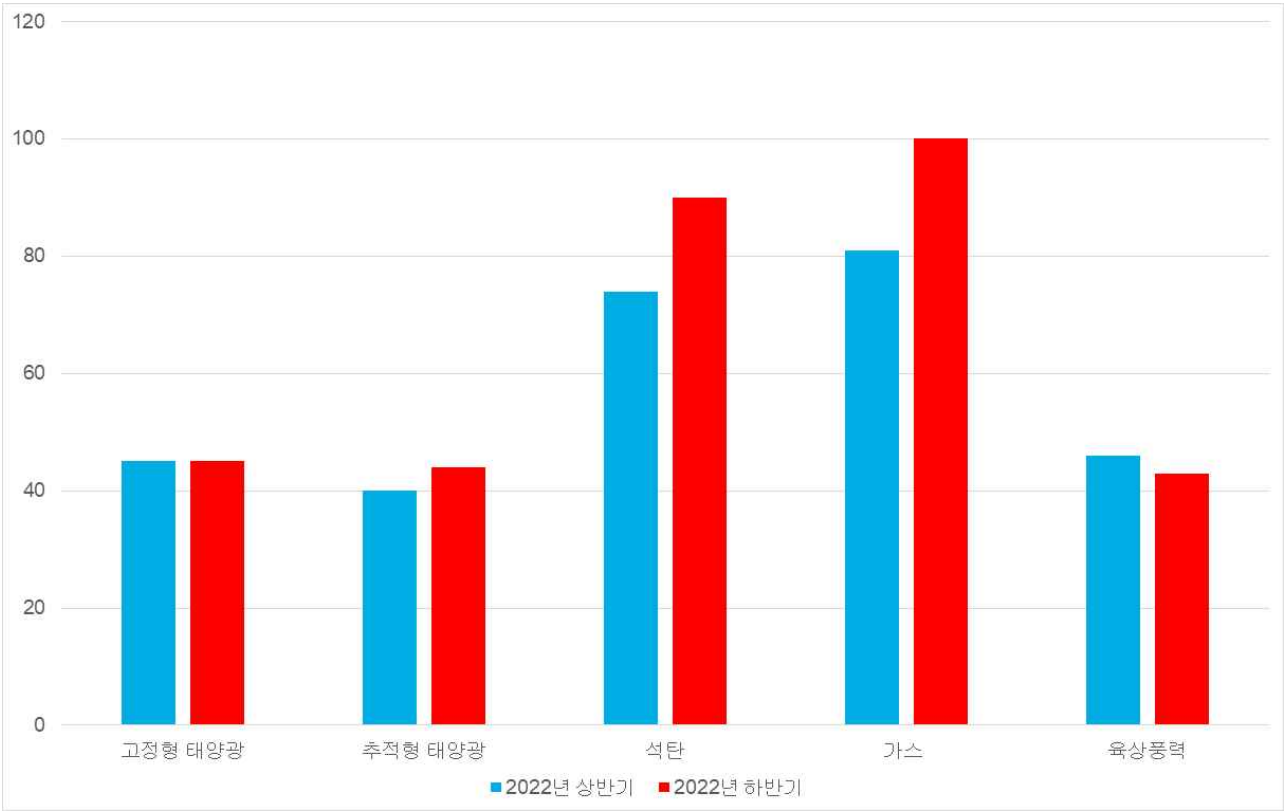
Coal for Power



Source: Korea PDS, CME Exchange, CIF ARA price

< First half of 2022 VS Second half of 2022 > of power generation by global power generation source

(Unit : $/MWh)



Material: BNEF

Global solar installations are expected to reach 320GW in 2023, up more than 20% year-on-year

Ÿ 2023 is the first year to usher in the era of 300GW of global solar installations, and demand is expected to increase rapidly not only in major solar power consumers such as China and the United States, but also in developing countries such as South America, the Middle East, and Africa.

- Following 2022, which recorded a larger-than-expected growth, this year is expected to continue its significant growth from the previous year.

Ÿ The demand for solar power in the Big2 (China and US) market, which accounts for more than 50% of global solar installations, is expected to exceed 150GW in 2023 (130GW in China and 30GW in the US), continuing to grow well from the previous year.

Ÿ The demand for solar power in Europe for energy security and climate change prevention is also expected to increase by 20% year-on-year to 50GW.

- European solar installations in 2022 are estimated at 40 GW, and installations are expected to reach 50 GW in 2023

Global solar installations are expected to exceed 350 GW in 2024, 400 GW in 2027, and 500 GW in 2030.

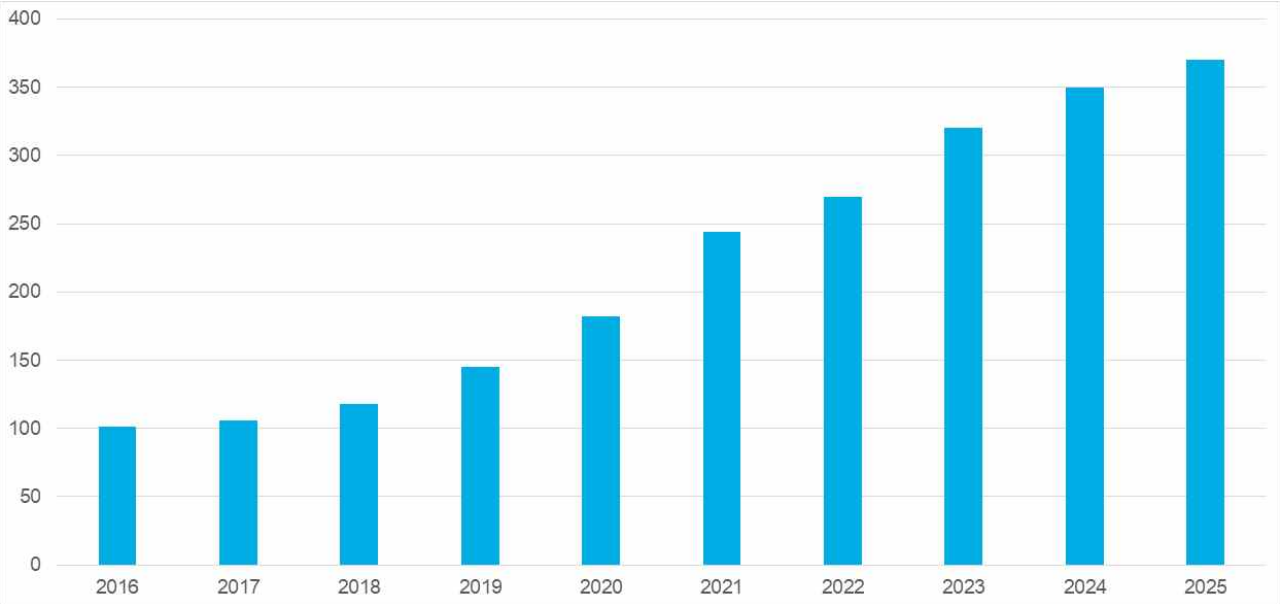
Ÿ The global photovoltaic market has been growing rapidly since exceeding 100GW in 2017, and will enter the second growth period to exceed 300GW in 2024.

- The global photovoltaic market passed through the initial market formation stage from 2000~2010 and entered the first growth period from 2010 to 2017 when economies of scale were established mainly by Chinese companies, resulting in an increase in demand due to the decline in product prices.
- From 2018 to 2025, global solar installations are expected to reach 300GW due to economies of scale due to large-scale investments as well as the increase in high-efficiency products due to technological advancements.

Ÿ China, which led the global solar power demand, is expected to slow down to a peak of 140GW in 2025, but the demand from developing countries such as MENA and Asia, led by India, is expected to grow rapidly, driving the growth of the global solar power market.

< Global Solar Installation Status and Forecast >

(Unit : GW)



Material: BNEF

< Solar Installations in Major Countries and Prospects >

(Unit : GW)

country	2017	2018	2019	2020	2021	2022	2023
People's Republic of China	53.0	44.3	33.1	52.1	69.0	125	130
United States	10.9	10.2	11.5	18.7	24.0	25	30
India	10.3	11.1	11.6	4.2	12.4	17	15
Brazil	1.4	1.5	2.8	3.9	6.7	11	10
Germany	1.7	3.6	3.8	4.9	5.3	7.0	9.0
Japan	7.4	6.7	6.7	8.7	6.5	5.5	5.0
Spain	0.1	0.3	5.0	2.9	4.6	7.0	8.0
Australia	1.3	4.0	3.5	3.6	4.7	4.5	5.0
South Korea	1.3	2.3	3.7	4.1	4.2	3.0	3.0
France	0.08	0.2	0.8	0.3	2.6	2.5	3.5
Global	106	118	145	182	244	270	320

Source: BNEF, Export-Import Bank forecast

2. Photovoltaic Main Product Price Trend

As of January 2023, the price of polysilicon is $22/kg, down 43.6% from its August 2022 high of $39/kg.

Ÿ In 2022, polysilicon prices soared due to the tight polysilicon supply situation due to the increase in global solar demand, but the supply and demand situation is expected to improve in 2023 due to the expansion of polysilicon in China.

Ÿ In 2022, the global polysilicon production capacity was 980,000 tons, but the production capacity is expected to increase to about 1.3 million tons in 2023 due to large-scale facility expansion.

- 1.3 million tons of polysilicon has the capacity to make about 500 GW of solar cells, and assuming a global polysilicon plant utilization rate of 80%, the production capacity is estimated to be 400 GW this year, and the oversupply is expected to reach 20%.

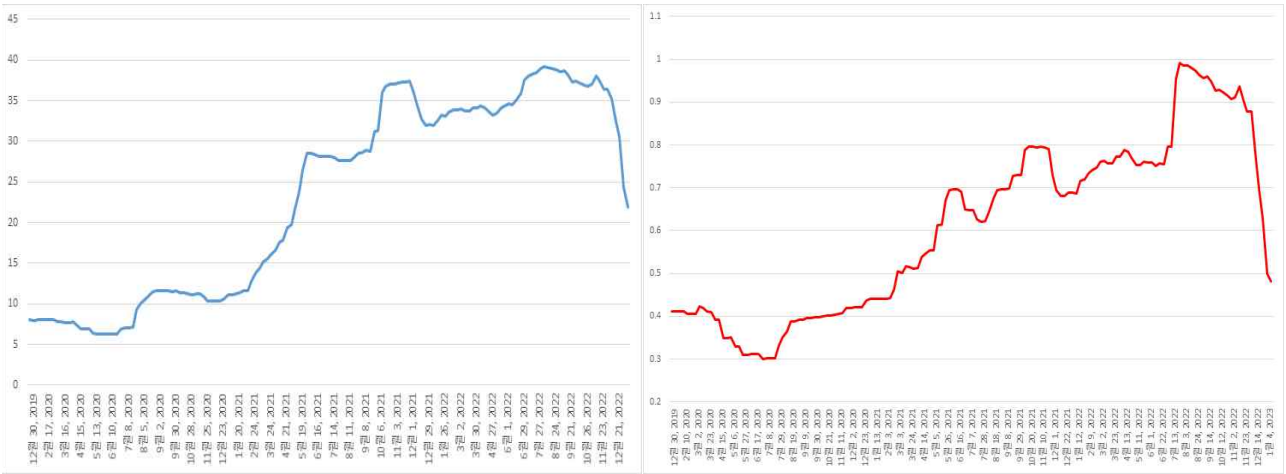
Ÿ Polysilicon prices are expected to decline rapidly due to the oversupply of polysilicon, and polysilicon prices are expected to stabilize downward below $15/kg in the first half of this year.

- In January 2023, polysilicon prices plunged 30% month-on-month to $22/kg, and further declines in polysilicon prices are inevitable considering the polysilicon supply situation.

- Polysilicon prices continued to be strong in the $30/kg range in 2022, but are expected to stabilize at the 2020 level of $10~15/kg this year.

< Polysilicon and Monocrystalline Wafer Price Trends > (단위 : $/kg, $/piece)

Polysilicon **Single Crystal Wafer**



Material: BNEF

As of January 2023, the monocrystalline silicon wafer price was $0.48/piece, down 51.5% from the July 2022 high of $0.99/piece.

Ÿ Wafer prices, which have been weak since 2019, continued to strengthen throughout the first half of 2022, but reversed downward from November 2022

Ÿ Wafer prices in 2023 are likely to decline further as polysilicon prices turn bearish

- In 2022, the prices of raw materials such as polysiliton and wafers recorded a larger increase than the prices of solar cells and modules, so the price normalization is expected to be faster when it falls.

As of January 2023, the price of monocrystalline solar cells was $0.11/W and the price of monocrystalline modules was $0.23/W, down 35% and 18% respectively from the previous year's highs.

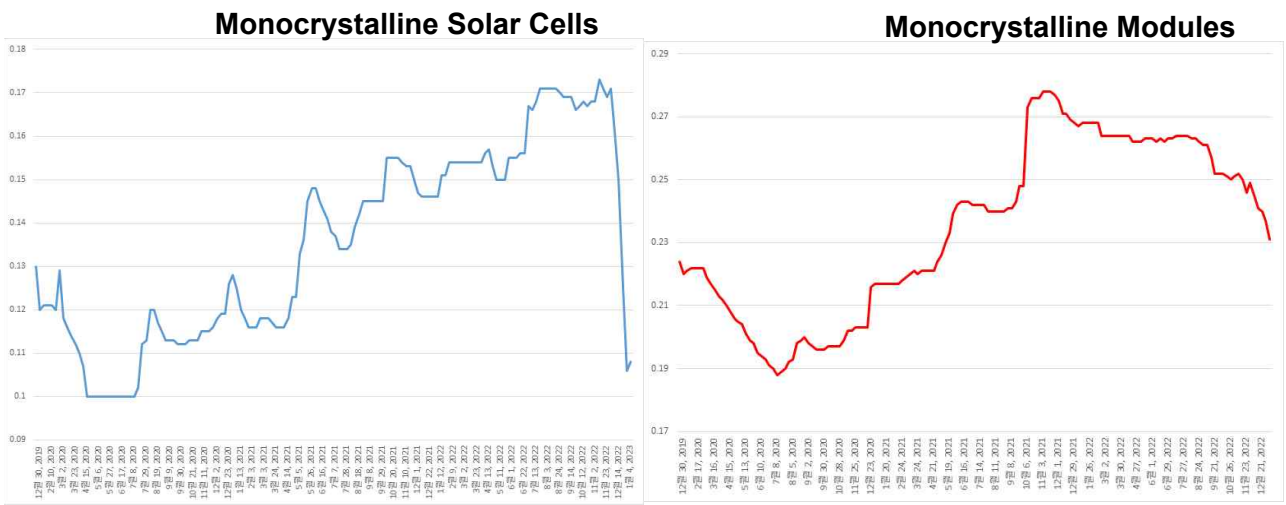
Ÿ In January 2023, the prices of solar cells and modules also fell significantly, but the decline in polysilicon and wafer prices was relatively small

- Since the price of the product has a time lag in the rate of reflection of the rise and fall of the price of raw materials, the product price has the characteristic of falling relatively gently even when it falls.

Ÿ Despite the increase in global solar demand in 2023, the prices of solar cells and modules are expected to stabilize downward due to weak prices of raw materials such as polysilicon and wafers.

- The production capacity of solar cells and modules by Chinese companies has increased significantly, greatly exceeding supply compared to demand, and the prices of solar cells and modules are expected to return to 2019 levels this year due to the decline in manufacturing costs due to the decline in raw material prices.

< Monocrystalline Solar Cells & Modules Price Trend > (Unit : $/W)



Material: BNEF

3. 2022 Solar Supply Trends

As of 2022, the global polysilicon production capacity was about 980,000 tons, an increase of 18.4% compared to 2021.

Ÿ The polysilicon production capacity by country is 794,000 tons in China, 60,000 tons each in the United States and Germany, 35,000 tons in Malaysia, 11,000 tons in Japan, 8,000 tons in Qatar, 7,000 tons in Norway, and 6.5 thousand tons in South Korea.

- The polysilicon production capacity added in 2022 is about 150,000 tons, all of which will be added to China

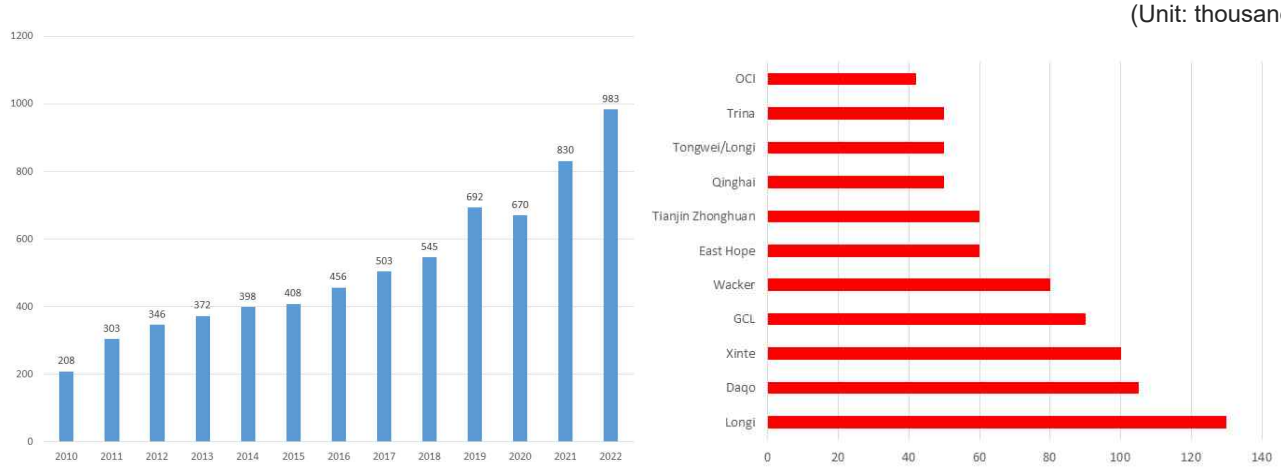
- China accounts for 81% of polysilicon production capacity, making the polysilicon sector virtually exclusive to China.

Ÿ 업체별 생산용량을 살펴보면 Longi 사 13 만 톤 , Daqo New Energy 10.5 만 톤 , Xinte Energy 10 만 톤 , GCL 9 만톤 , Wacker 8 만 톤 순

Ÿ In 2020, China's share in polysilicon production was only about 60%, but with the large-scale expansion, the proportion of Chinese products in the global polysilicon supply has exceeded 80%, securing China's monopoly position in the polysilicon field.

< > the current status of polysilicon production capacity by global and company as of 2022

(Unit: thousand tons)



Material: BNEF

As of 2022, the global wafer production capacity was 492GW, up 13.4% year-on-year.

Ÿ Looking at the production capacity by country in 2022, China accounted for 478GW, followed by Vietnam with 4GW, Taiwan with 3.7GW, and Norway with 1GW.

- In 2022, China's wafer production capacity increased by 56GW year-on-year, leading the expansion of global wafer production capacity

- China's share of global wafer production capacity is 97% in 2022, making it impossible to produce solar cells

without China's wafer supplyŸ As China's monopoly in the photovoltaic manufacturing sector intensifies, countries around the world are making efforts to break away from it, and the U.S. is planning to build a solar power supply network by passing the Inflation Reduction Act (IRA)1)

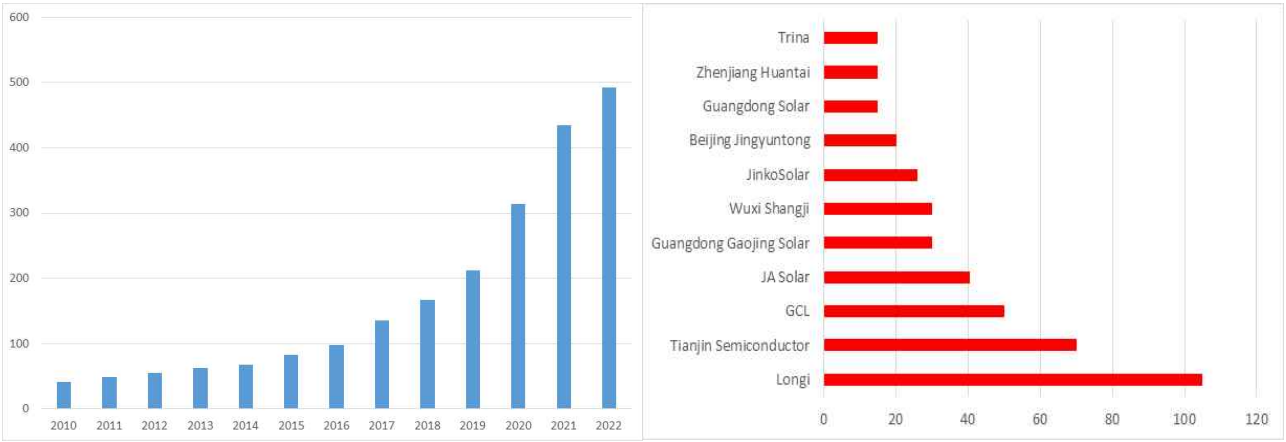
- Efforts are underway to reduce dependence on China as Chinese monopolization of the solar manufacturing sector intensifies, and tax credits are planned to ensure price competitiveness.

- Hanwha Solutions plans to invest KRW 3.2 trillion in the U.S. to build a supply chain that spans the entire value chain, including ingots, wafers, solar cells, and modules.

- If the U.S. subsidy policy to foster the industry is successful, it could spread to Europe, where the demand for solar power is growing significantly.

< Wafer production capacity status by global and company as of 2022 >

Unit: GW



Source: BNEF

As of 2022, the global solar cell production capacity was 528GW, a year-on-year increase of 21.6%.

Ÿ In 2021, the global solar cell production capacity was 435GW, and in 2022, the global solar cell production capacity reached 528GW, with 93GW newly added

Ÿ China's solar cell production capacity increased by 77GW from 374GW in 2021 to 451GW in 2022, accounting for 83% of the world's total solar cell expansion.

Ÿ As of 2022, the production capacity of solar cells in major countries other than China is 18.0GW in Vietnam, 16.3GW in Thailand, 16.2GW in Malaysia, 7.9GW in South Korea, 6.7GW in Taiwan, 3.6GW in India, and 1.7GW in Turkey.

- 2021 년 주요국 태양전지 생산용량은 말레이시아 13.0GW, 베트남 12.0GW, 태국 9.6GW, 한국 7.9GW, 대만 6.7GW, 인도 3.6GW, 터키 1.7GW

1) Inflation Reduction Act: The U.S. will provide $433 billion to secure a green energy supply chain in the country, focusing on increasing the deployment of renewable energy and electric vehicles to combat climate change and inflation.

- In 2022, the solar cell production capacity of Vietnam, Thailand and Malaysia increased by 6GW, 6.7GW, and 3.2GW, respectively, compared to 2021, accounting for 99.4% of the 16GW capacity expansion in countries other than China.

Ÿ In the first half of 2022, excluding China, the production capacity of solar cells by country was 16.9GW in Malaysia, 14GW in Vietnam, 9.6GW in Thailand, 8.0GW in South Korea, 7.0GW in Taiwan, and 3.6GW in India.

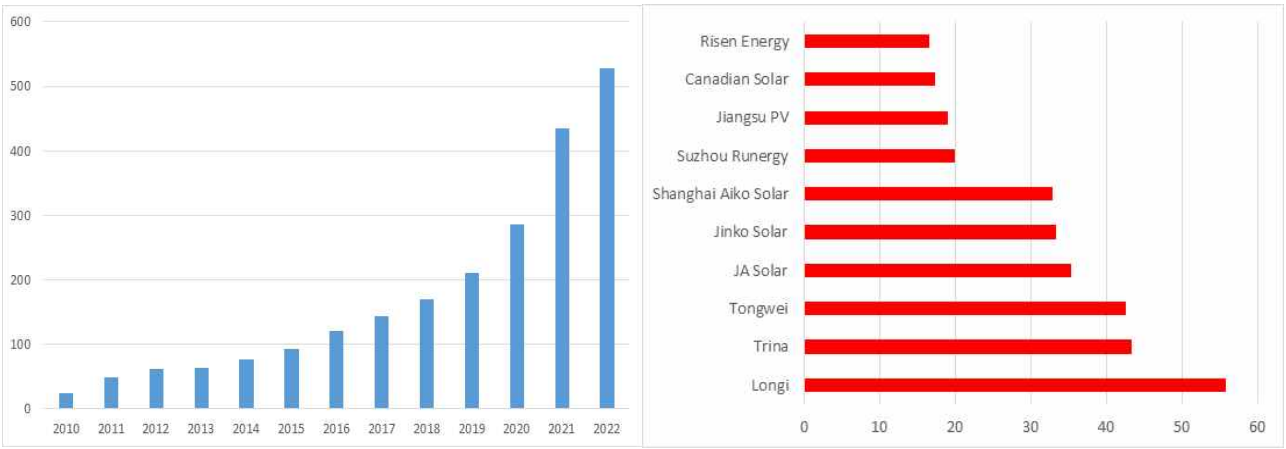
Ÿ In 2022, there are 4 companies that have secured more than 30GW of solar cell production capacity, and competition among top companies to expand their facilities is fierce

- Longi increased 22.5 GW from 33.3 GW in 2021 to 55.8 GW in 2022, Trina Solar increased 8 GW from 35.4 GW in 2021 to 43.4 GW in 2022, and Tongwei increased 7.5 GW from 35.0 GW in 2021 to 42.5 GW in 2022

Ÿ The expansion of Chinese companies in the global solar cell market is rapidly increasing, and the monopoly position of Chinese companies is further strengthened

< 2022 Global and Company Solar Cell Production Capacity Change Status >

Unit: GW



Source: BNEF

As of 2022, the global module production capacity was 649GW, up 29.8% year-on-year.

Ÿ In 2021, the global module production capacity was 500GW, and about 150GW will be newly added in 2022.

Ÿ China's module production capacity increased by 136GW year-on-year from 400GW in 2021 to 536GW in 2022, accounting for 76% of global module expansion in 2022

Ÿ 2022 년 중국 이외의 국가별 모듈 생산용량은 베트남 26.3GW, 인도 14.9GW, 말레이시아 14.5GW, 한국 10GW, 터키 7.6GW, 태국 6.9GW, 미국 4.5GW, 대만 4.2GW, 독일 2.8GW 순

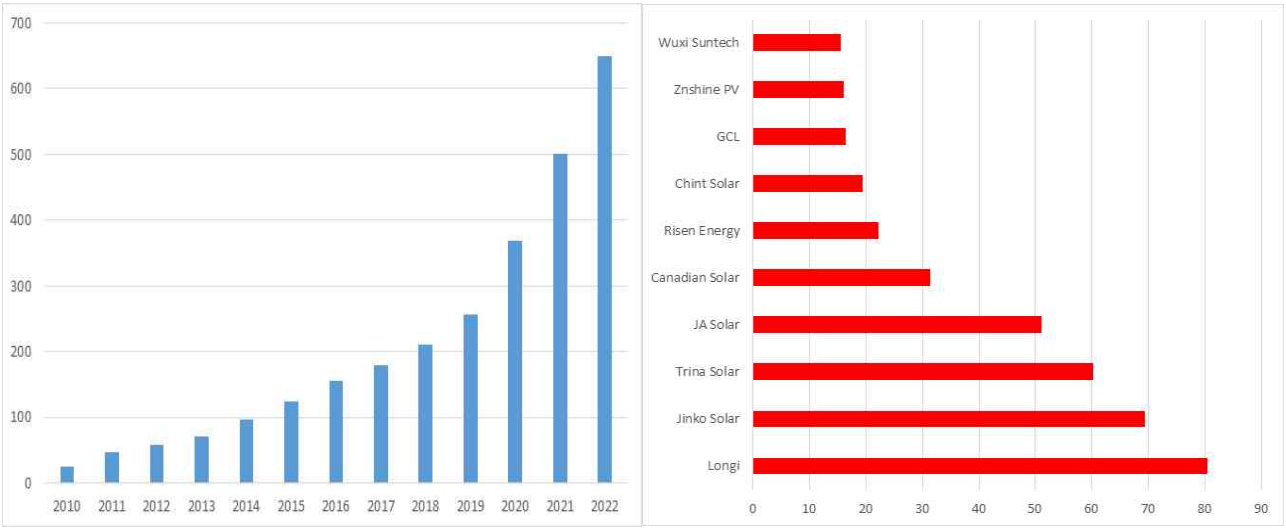
Ÿ 2022 년 기업별 모듈 생산용량을 살펴보면 Longi 80.4GW, Jinko Solar 69.3GW, Trina Solar 60.3GW, JA Solar 51.0GW, Canadian Solar 31.4GW 였으며 , 우리나라 한화큐셀은 12.4GW 로 13 위 를 기록

- 2021 년 및 2022 년 상위 5 개사 모듈 생산용량 변동분을 살펴보면 Longi 60.0GW → 80.4GW, Jinko Solar 45.2GW → 69.3GW, Trina Solar 50.3GW → 60.3GW, JA Solar 40.2GW → 51.0GW, Canadian Solar 23.9GW → 31.4GW

- Compared to 2021, the capacity of the top 5 companies in 2022 reached 71.8GW, accounting for 47.9% of the increase in global production capacity.

Ÿ In 2023, the oversupply of modules compared to the global solar demand (320GW) has exceeded 300GW, which may lead to price competition to secure module demand, which will hurt some companies that are less competitive.

< 2022 Global and Company-Specific Module Production Capacity Status > Unit: GW



Source: BNEF

4. Export and Import Trends of Major Countries

(China) In 2022, the export value of solar cells and modules was $42.3 billion, up 48% year-on-year

Ÿ Due to the increase in global solar demand, China's exports of photovoltaic products have increased significantly year-on-year

- China has a monopoly position in the global photovoltaic industry, and in 2022, the price of photovoltaic products will also be strong, resulting in a significant increase in exports.

Ÿ Exports to the Netherlands $11.3 billion, Brazil $4.8 billion, Spain $2.9 billion, India $2.7 billion, Japan $1.8 billion, Germany $1.7 billion, Australia $1.3 billion, Poland $1.2 billion, Greece $1 billion, and Portugal $970 million

- In Europe, module imports from China surged in the first half of the year as demand for solar power increased significantly due to the rise in electricity prices due to the surge in gas prices.

- Korea's imports of solar cells and modules from China reached $270 million Ÿ Exports to the United States in

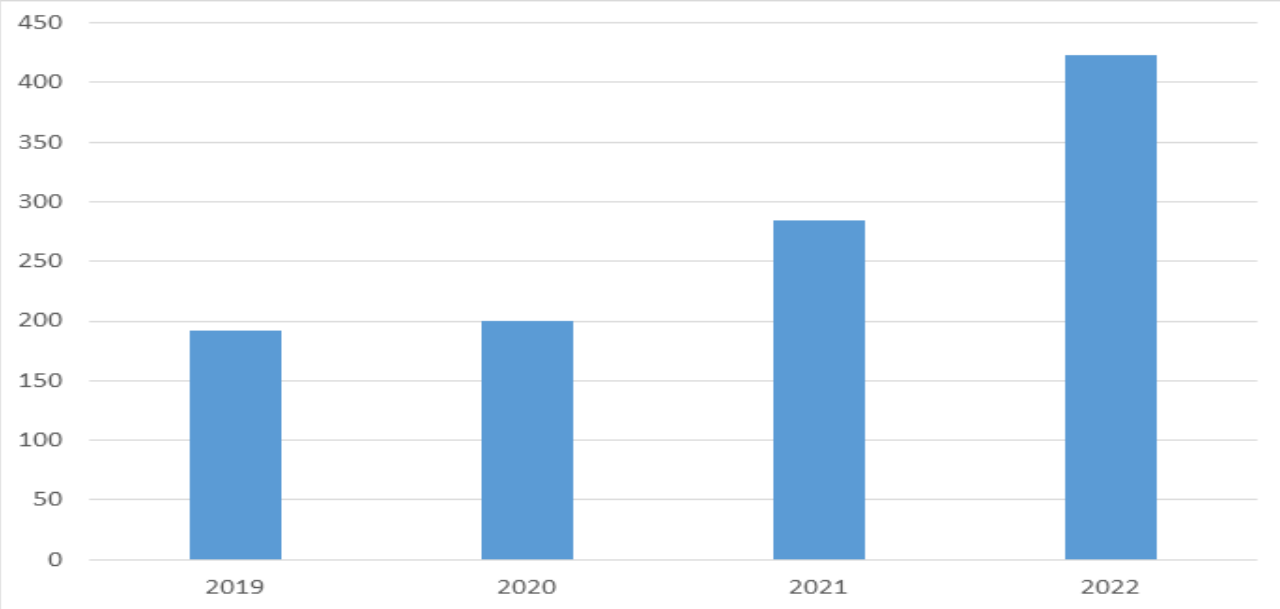
2022 were only $97 million due to the escalating trade dispute between the United States and China.

- In 2022, the U.S. installed solar power capacity was 25GW, the world's second-largest market, but due to the US-China trade dispute, imports of solar products from China amounted to $66 million and only $97 million in 2022.

Ÿ In 2022, China's polysilicon imports were valued at 2.75 billion USD, up 29.2% year-on-year.

- The average import price of polysilicon soared from $12/kg in 2021 to $32/kg in 2022, resulting in a significant increase in import value despite the decrease in import volume.

< > of China's Solar Cell and Module Exports (Unit: Billion USD)



Source: International Trade Association

(US) Imports of solar cells and modules through November 2022 were $8.58 billion, up 32% year-on-year

Ÿ The import value of solar cells in the United States has been increasing every year from $270 million in 2018 → $430 million in 2019 → $480 million in 2020 → to $540 million in 2021, and by November 2022, the import value of solar cells was $630 million, a year-on-year increase of 34%.

Ÿ U.S. module imports were $2.85 billion → in 2018, $5.71 billion in 2019 → $7.74 billion in 2020 → $6.29 billion in 2021, with imports reaching $7.95 billion by November 2022, a year-on-year increase of 33.1% year-on-year.

- Due to the increase in solar demand and the increase in module import prices, the US module import value in 2022 reached a record high

Ÿ By November 2022, the import value of solar cells by major importing countries was USD 380 million from Malaysia, USD 140 million from Vietnam, and USD 0.3 billion from South Korea

- As of November 2021, the import value of solar cells by region was $230 million from South Korea, $110 million from Malaysia, and $0.8 billion from Vietnam, accounting for 48.1% of solar cells from Korea in 2021, but only 5% in

2022 Ÿ By November 2022, the import value of modules by region was $2.73 billion from Vietnam, $1.39 billion from Thailand, $1.13 billion from Malaysia, and $1.05 billion from South Korea

- As of November 2021, Malaysia imported modules by region was USD 1.97 billion, followed by Vietnam USD 1.86 billion, Thailand USD 1.06 billion, and South Korea USD 450 million.

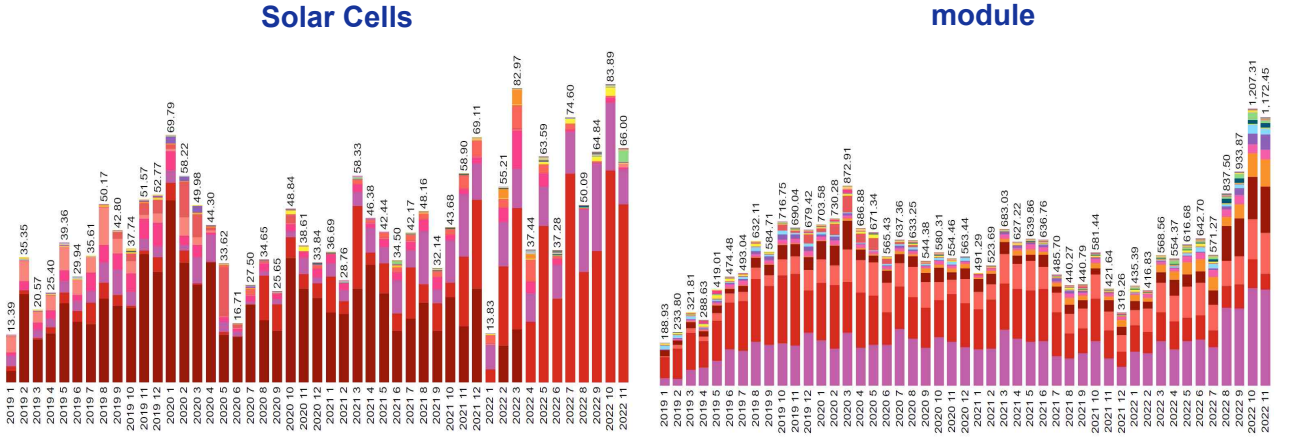
- Korea has a factory in the U.S., and until 2021, solar cells were imported from Korea to manufacture modules, but in 2022, direct exports of modules have increased.

- This is due to the fact that the cost of local module production is higher than expected due to the importation of solar cells, so it is estimated that it is more economical to import Korean modules directly.

Ÿ As the demand for solar power in the United States increases, the import value of solar cells and modules has increased significantly, and Chinese companies are increasing exports using production bases in Southeast Asia, such as Malaysia, Thailand, and Vietnam, to avoid customs barriers

< US Solar Cell & Module Import Status >

(Unit: Million Dollars)



자료 : Sinoimex, USITC, BNEF

II. Trends in the Domestic Photovoltaic Industry

1. REC Price Trend

The REC price, which had been on a downward trend, has rebounded from its low of 29,542 won in July 2021 and has remained at the 60,000 won level since August 2022.

Ÿ The profit structure of the photovoltaic power generation business consists of SMP2) + REC3), and the higher the SMP and REC prices, the higher the profit of the solar power business.

Ÿ Due to the disruption of global energy supply due to the Russia-Ukraine crisis, the price of coal and gas continued to soar, and in December 2022, the SMP price soared to 268 won per kW, and the profit margin of solar projects also increased significantly as the REC price also strengthened.

- The unit price of fuel for LNG power generation increased from KRW 82,800/GCAL in December 2021 to KRW 151,718/GCAL in December 2022, and the price of coal also increased from KRW 32,853/GCAL in December 2021 to KRW 61,854/GCAL in December 2022.

- Due to the increase in fuel costs, the SMP price increased from 142 KRW/kWh in December 2021 to 268 KRW/kWh in December 2022

- As of August 2022, the compensation price for solar power generation is 247 won per kW, which is 192 won for SMP + 55 won for REC, and the unit price of solar power generation in Korea is estimated to be 150 won per kW.

- Unlike in 2021, when the SMP price was low and it was necessary to secure additional revenue through REC sales, in 2022, there is no need to secure additional revenue through REC trading due to the high SMP price, and the REC price continues to be strong as the supply of REC decreases.

Ÿ The government implemented the SMP cap in December 2022 to ease the burden on KEPCO by placing a certain limit on the price of electricity purchased by KEPCO from solar power generation companies with more than 100kW.

- If the SMP average for the previous 3 months is more than 10% of the average of the last 10 years, the SMP cap will be applied, and the SMP cap price will be 158.96 won/kWh on land and 226.56 won/kWh in Jeju.

Ÿ There is controversy over the profitability of solar power generation, but Korea is also about to reach grid parity with solar power generation, so the need for it is increasing as a means to reduce energy dependence on external sources.

- Barriers to green trade, which require the production of products using electricity produced from clean energy sources such as solar power, are also being strengthened, emphasizing the need for an appropriate combination of solar power generation and other energy sources.

2) SMP (System Marginal Price): The price at which KEPCO purchases power from power generation companies through the Korea Power Exchange
3) REC (Renewable Energy Certificate): REC is a certificate for the production of 1MWh of electricity obtained from renewable energy power generation facilities, and large power generation companies purchase RECs to meet the mandatory quota for renewable energy.

< Domestic REC Price Trend >

(단위 : 원 , $/W)

Source: Korea Power Exchange

2. Export Trends

Polysilicon exports in 2022 were valued at US$61.7 million, down 35.2% year-on-year.

Ÿ Despite the increase in global solar demand and the rise in polysilicon prices, polysilicon exports have continued to decline since 2018

- Since 2019, polysilicon companies in Korea have stopped operating their production facilities due to the sharp decline in polysilicon prices and the larger the deficit the more they produce.

- OCI has stopped domestic production and moved its factory to Malaysia to produce polysilicon, and exports have decreased significantly compared to the past

Ÿ There is an expectation for the resumption of domestic polysilicon factories due to the strong polysilicon prices, but the resumption of production is still unclear

- The current price range of polysilicon is at a level that can be profitable even if the domestic plant is operated, but it is not easy to make a decision to restart the plant due to various uncertainties such as future fluctuations in polysilicon prices and the entry of new volumes due to the expansion of factories in China.

In 2022, the export value of solar cells and modules increased by 43.7% year-on-year to USD 1.55 billion.

Ÿ Looking at the export value by export destination, the United States accounted for 92.2% of the total solar cell and module exports with $1.43 billion, followed by the Netherlands with $0.35 billion, China with $0.21 billion, Angola with $0.17 billion, and Australia with $0.11 billion.

- The reason why exports to the United States account for a large proportion is that the United States is preventing Chinese products from entering the market due to the trade dispute between the United States and China, and the products produced in the United States are given tax benefits, so they are entering the US market through the production of local modules through the export of solar cells

Ÿ In the case of Europe, where there are no tariff barriers for Chinese products, the export competitiveness of Chinese products is deteriorating every year, and the export value is decreasing.

- The price of products is more than 20% higher than that of Chinese products, making it difficult to export to the European market due to price competitiveness.

Ÿ Despite the increase in global demand for photovoltaics, exports are decreasing every year due to the weakening of export competitiveness in regions other than the United States, and it is necessary to prepare alternatives to strengthen export competitiveness.

< > of the export trend of the domestic photovoltaic industry

(Unit: Million Dollars)

	Year 2018	In 2019	Year 2020	Year 2021	Year 2022
Polysilicon	746.4 (-27.8%)	476.2 (-36.2%)	118.7 (-75.1%)	95.2 (-19.8%)	61.7 (-35.2%)
Ingot	6.7 (-41.7%)	6.4 (-4.2%)	0.7 (-89.6%)	1.1 (65.1%)	2.0 (77.9%)
wafer	94 (-7.8%)	20.3 (-78.4%)	12.1 (-40.7%)	9.0 (-25.5%)	7.7 (-13.8%)
Solar Cells & Modules	1,605.2 (-)	1,592.3 (-0.8%)	1,382.1 (-13.2%)	1,089.3 (-21.2%)	1,547.8 (43.7)

Source: Trade Associations, Solar Cells (8541409021) and Modules (8541409022) HS Code Consolidated into 8541430000 2022

3. Import Trends

(Wafer) imports in 2022 increased by 17.0% year-on-year to $570 million.

Ÿ Imports by weight decreased by 19.4%, but wafer imports by value increased by 17.0% due to the increase in wafer prices.

Ÿ Imports from China accounted for $530 million, accounting for 93% of the total, with imports of $0.39 billion from Taiwan.

(Solar cells and modules) imports in 2022 were $270 million, down 58.3% year-on-year

Ÿ In 2021, the import of modules from China increased due to the increase in domestic solar demand, such as the domestic solar installation volume exceeded 4GW, but this year, the import volume also decreased significantly as the domestic solar installation volume decreased.

Ÿ Of the $270 million imports of solar cells and modules, the imports to China accounted for $260 million, accounting for 96.3% of the total imports from China.

Ÿ The implementation of the carbon certification system is defending Chinese solar cell and module products, and the import value of solar cells is also decreasing as it becomes difficult to export Chinese solar cells to the United States.

- The U.S. tightening protectionism on Chinese products is also affecting the landscape of the domestic solar industry, and the full-scale implementation of the Inflation Prevention Act (IRA) will bring about even greater changes.

< > Import Trend of Domestic Photovoltaic Industry (Unit : Million USD)

	Year 2018	In 2019	Year 2020	Year 2021	Year 2022
Polysilicon	31.6 (-53.5%)	26.9 (-14.9%)	18.0 (-33.0%)	32.3 (79.4%)	6.4 (-80.3%)
Ingot	3.5 (-74.6%)	6.8 (94.3%)	5.3 (-21.3%)	19.5 (265.2)	24.5 (25.7%)
wafer	569.0 (5.2%)	398.0 (-30%)	343.2 (-13.7%)	485.1 (41.4%)	567.7 (17.0%)
Solar Cells & Modules	359.0 (10%)	760.0 (192%)	624.5 (-32.5%)	647.7 (18.0%)	269.9 (-58.3%)

Source: Trade Associations, Solar Cells (8541409021) and Modules (8541409022) HS codes incorporated into the 8541430000 in 2022

III. Earnings Trends of Solar Companies

1. Earnings Trends of Major Overseas Companies

Until the third quarter of 2022, the cumulative performance of major global photovoltaic companies is starkly different between Chinese companies VS non-Chinese companies, and between material companies such as polysilicon and product companies such as modules.

Ÿ Longi, JA Solar, Jinko Solar, and other top Chinese companies saw a significant year-on-year increase in sales due to the significant expansion of facilities in 2021 and the increase in demand for global solar power in 2022.

- China's Longi's cumulative revenue through Q3 was $13.17 billion, up 51.5% year-on-year, while Jinko Solar was up 113%

- Chinese solar companies have not only increased their sales but also recorded significant growth in operating profit

- On the other hand, in the case of First Solar, a U.S. solar power company, despite the booming global solar market, sales decreased year-on-year due to weakening competitiveness, and operating profit turned into a deficit.

- While the dominance of China's top companies in the global photovoltaic industry is increasing, the business situation of non-Chinese companies that have not secured economies of scale is not improving.

Ÿ Tongwei, Daqo and other polysilicon companies' earnings in the third quarter of 2022 hit a record high due to strong polysilicon prices.

- In the third quarter of 2022, Tongwei's revenue increased 114% year-on-year to $15.45 billion, and operating profit increased 293% to $4.87 billion.

Ÿ The earnings of the top leading companies in 2022 are expected to reach a record high due to the booming global solar market

< Earnings Trends of Major Solar Companies > (Unit: billion dollars)

Company Name	2019		2020		2021		Q1 ~ Q3 2021		Q1 ~ Q3 2022	
	Sales	Operating Profit	Sales	Operating Profit	Sales	Operating Profit	Sales	Operating Profit	Sales	Operating Profit
Longi	47.6	9.4	79.2	14.4	125.5	14.8	86.9	13.1	131.7	12.3
AND solar	30.6	3.5	37.5	3.6	64.0	5.7	40.0	3.0	74.7	5.7
Jinko Solar	43.1	2.7	51.0	3.4	62.9	8.4	37.5	2.3	79.9	3.2
Canadian Solar	32.0	2.6	34.8	2.2	52.8	2.3	37.5	1.2	54.8	2.2
Trina Solar	33.8	1.6	42.7	2.7	69.0	3.7	48.3	2.5	88.0	4.7
Tongwei	54.5	5.2	64.1	5.9	98.4	17.9	72.2	12.4	154.5	48.7
Daqo	3.5	0.5	6.8	1.9	16.8	10.7	12.8	8.3	37.3	26.9
First Solar	30.6	2.6	27.1	4	29.2	4.8	20.2	2.9	16.2	-1.3

Source: Bloomberg

2. Earnings Trends of Major Domestic Companies

In 2022, the cumulative business performance of major domestic photovoltaic companies improved year-on-year until the third quarter, but the gap with Chinese companies widened.

Ÿ Due to the rise in polysilicon prices, OCI reported KRW 1.23 trillion in sales and KRW 389 billion in operating profit until the third quarter, up 33.6% in sales and 25.9% in operating profit compared to the same period last year.

- Polysilicon prices continue to be strong, hitting their highest level since 2011, and the second half of 2022 is expected to continue to be strong.

- Polysilicon prices have been falling sharply since December 2022, and this year's business performance is expected to be lower than the previous year as prices are expected to weaken sharply due to the oversupply of polysilicon.

Ÿ By the third quarter of 2022, Hanwha Solution's operating performance was KRW 3.49 trillion in sales and KRW 118.2 billion in operating profit, with sales of 35.2% and operating profit turning black compared to the same period last year.

- In terms of economies of scale, the gap with China's leading companies is widening, but the company is securing competitiveness by expanding investment in strategic regions, such as investing KRW 3.2 trillion in the U.S. to build a supply chain

- 2023 business performance is expected to improve year-on-year due to lower manufacturing costs due to lower prices of raw materials such as polysilicon and wafers, as well as good demand for solar power in the United States.

< > the earnings trends of major domestic photovoltaic companies (Unit : Billion KRW)

Company Name	2019		2020		2021		2021 1~3Q		2022 1~3Q	
	Sales	Operating Profit	Sales	Operating Profit	Sales	Operating Profit	Sales	Operating Profit	Sales	Operating Profit
OIC (Basic Chemical)	12,120	-2,290	8,520	-77	13,330	4,870	9,220	3,090	12,320	3,890
Hanwha Solutions Solar Power Business	35,552	2,235	37,023	1,904	35,685	-3,285	25,785	-1,752	34,865	1,182
Shinsung ENG RE Division	-	-	1,183	-84	1,041	-130	732	-106	989	54
S Energy	2,169	10	2,548	-59	2,520	-183	1,710	10	1,412	-16

Data : Business performance data of each company

IV. Implications

In 2022, global solar demand grew by more than 40% due to rising energy prices and energy security issues following the Russia-Ukraine crisis, and the era of global solar installations of 300GW is expected to open in 2023.

Ÿ Due to the rise in fuel prices such as coal and gas due to the Russia-Ukraine crisis, the global power generation unit price in 2022 will rise significantly compared to the previous year.

- As the unit cost of coal and gas power generation rises, solar power generation, which is free from fuel costs, is emerging as a low-cost energy source

- In Europe, the demand for solar power generation has soared due to the surge in electricity prices due to the rise in gas prices and the issue of change.

Ÿ In the case of fossil energies such as coal and gas, there is a high dependence on certain regions, so the importance of solar power generation is expected to be further highlighted in terms of energy supply diversification and security issues.

- As energy security issues aggravate due to the Russia-Ukraine crisis, such as emergency gas supply in Europe, self-sufficient solar power generation is expected to grow in strategic importance as a means of energy independence.

Ÿ The global photovoltaic industry is entering the second growth phase due to many positive factors such as grid parity, climate change issues, and energy security issues.

- Solar power generation is expected to emerge as the most economical energy source in 2022, increasing demand in major countries such as China, Europe, and the United States, as well as accelerating its spread to developing countries in 2023.

- This year, due to the abnormal weather around the world, the need to use eco-friendly energy such as renewable energy to prevent climate change is being emphasized, and the need for energy self-sufficiency is being emphasized

- As a result, the global photovoltaic industry is expected to continue to grow to 500GW per year by 2030.

Checks on China's monopoly in the photovoltaic industry are expanding, and Korean companies are expected to benefit from the process of building a global photovoltaic supply chain centered on the United States.

Ÿ Chinese companies account for more than 80% of the supply of photovoltaic products, monopolizing the global photovoltaic industry.

- In order to overcome the impossibility of normal competition under the current situation, the United States plans to create and implement legislation to protect domestic companies.

Ÿ With the implementation of the Inflation Reduction Act in the United States, the United States is trying to reduce its dependence on China by building solar power production facilities in Korea, and in the process, Korean companies operating in the United States

are expected to benefit- Through tax reductions, we plan to increase the price competitiveness of products produced in the United States to a level that can compete with Chinese products, thereby expanding the use of U.S. products, and Korean companies with production facilities in the U.S. are expected to benefit accordingly.

Ÿ If the U.S. measures succeed, there is a possibility that it will spread to countries that oppose China's monopoly, such as Europe.

In order to compete with Chinese companies that dominate the global photovoltaic market, it is essential to have a localization strategy through increased investment, such as the establishment of production facilities in the United States, which is a strategic region.

Ÿ As the share of domestic companies in the global photovoltaic market continues to decline, the US market is currently the only market that can be strategically targeted, and it is inevitable to increase investment to secure the US market share.

- As of July 2022, the share of exports of solar cells and modules to the United States has exceeded 80%, effectively losing its competitiveness in the competition with Chinese companies in markets other than the United States.

- For the survival of domestic solar companies, expanding market share in the U.S. is the best alternative, and it is necessary to increase investment for localization.

Ÿ Financial support is needed to expand our entry into the U.S. market, which is the core export market of Korean companies.

- Hanwha Solutions has decided to invest KRW 3.2 trillion to invest in the supply chain in the U.S., and the demand for finance for overseas investment is growing.

- Timely investment funding for the construction of production facilities to target the U.S. market is expected to increase the competitiveness of Korea's photovoltaic industry.