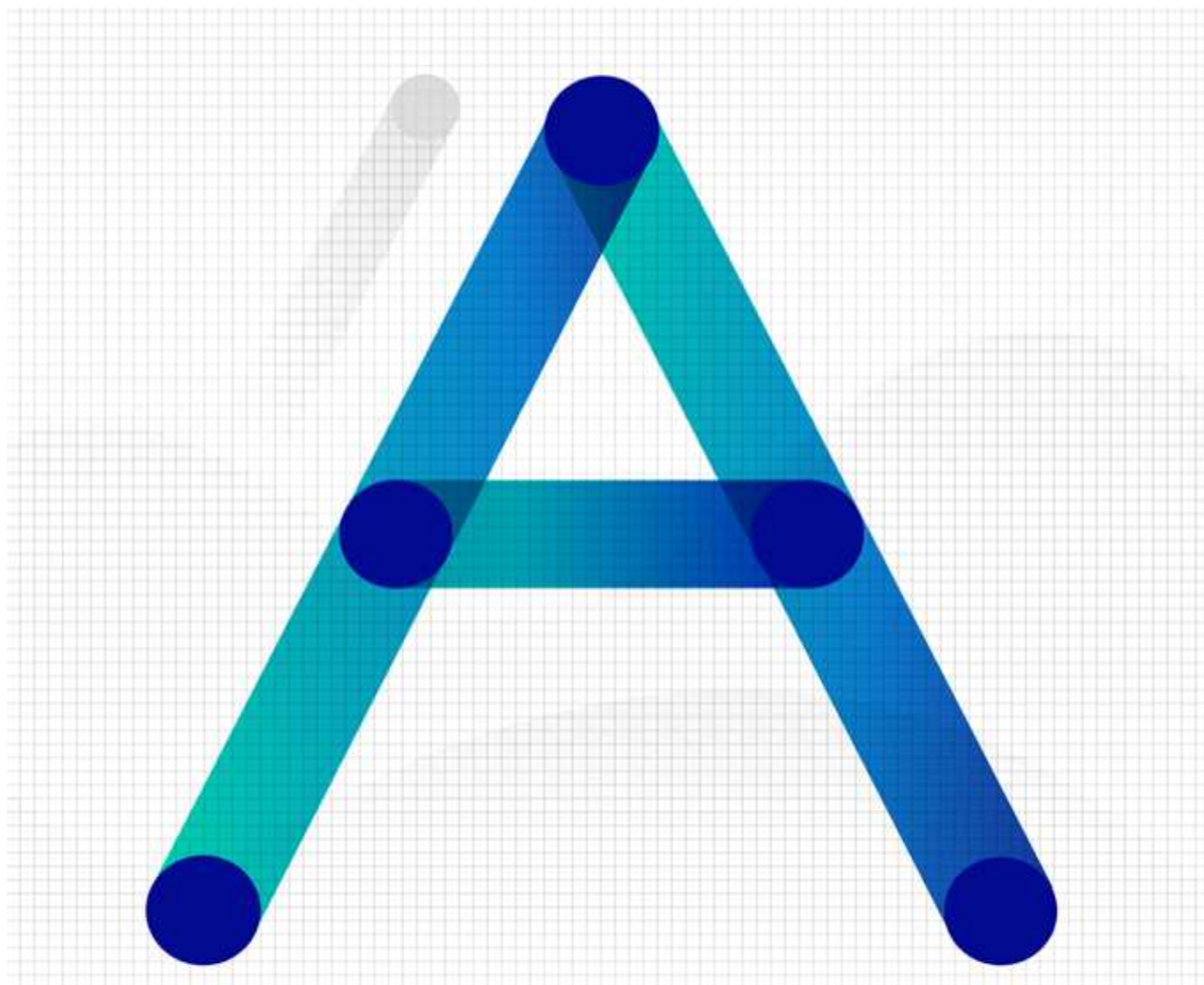


Photovoltaic Industry Trends in the First Half of 2022

I. Global Photovoltaic
Industry Trends II. Trends
in the Domestic
Photovoltaic Industry III..
Trends in the
Performance of
Photovoltaic Companies
IV. Implications

Write

Senior Researcher Kang Jeong-hwa (6252-3612)



< about >

In the first half of 2022, global solar installations are estimated to have increased by more than 20% year-on-year, and the forecast for 2022 has been revised upward from 230 GW to 240 GW.

Ÿ After the Russia-Ukraine crisis in 2022, due to the rise in global energy prices, the number of solar power generation has increased significantly, mainly in Europe.

Ÿ Global solar installations are expected to exceed 270 GW in 2023 and 300 GW in 2024, and will continue to grow beyond 400 GW in 2029.

As of August 2022, the price of polysilicon was \$39.2/kg, the highest since October 2011.

Ÿ In 2022, global polysilicon demand is expected to be at least 570,000 tons and up to 690,000 tons, and the global polysilicon production capacity is estimated to be about 830,000 tons.

- Assuming an 80% global polysilicon plant utilization rate, this year's production capacity is estimated to be 660,000 tons, and the supply surplus is expected to remain at about 5%.

Ÿ As of August 2022, the price of monocrystalline solar cells was \$0.171/W and the price of monocrystalline modules was \$0.264/W, up 27% and 10% year-on-year, respectively.

(Supply Chain Trends) Accelerating China's Monopolization in the Global Solar Supply Chain in 2022

Ÿ All 70,000 tons of polysilicon production capacity added in 2022 was added to China, and the increase in module capacity reached 114GW out of 123GW, accounting for 92.7% of the global module expansion

As of July 2022, the cumulative export value of solar cells and modules was \$616 million, down 10.6% year-on-year, and the cumulative import value was \$143 million, down 62.9% year-on-year.

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

The main issue in the global photovoltaic industry in the first half of 2022 is the strengthening of protectionism for supply chain recovery, and Korean companies are expected to benefit from the process of building the global solar power supply chain.

Ÿ Korean companies entering the U.S. are expected to benefit from the implementation of the U.S. Inflation Reduction Act, and timely investment funding for the construction of production facilities to preempt 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 the first half of 2022, the global photovoltaic market is cruising with good demand growth in Asia and Europe despite strong product prices.

☛ Polysilicon prices, which were \$28/kg in July 2021, continued to be strong throughout the first half of 2022, including \$33/kg in January 2022 and \$39/kg in August 2022

- Polysilicon prices were expected to stabilize at \$30/kg at the start of the year, but continued to be strong in August, hitting \$39/kg
- As the price of raw materials such as polysilicon and wafers rises, the prices of products such as solar cells and modules are also rising.

☛ Rising coal and gas prices due to global inflation and the Russia-Ukraine crisis are stimulating global solar demand by increasing the price competitiveness of photovoltaic power generation.

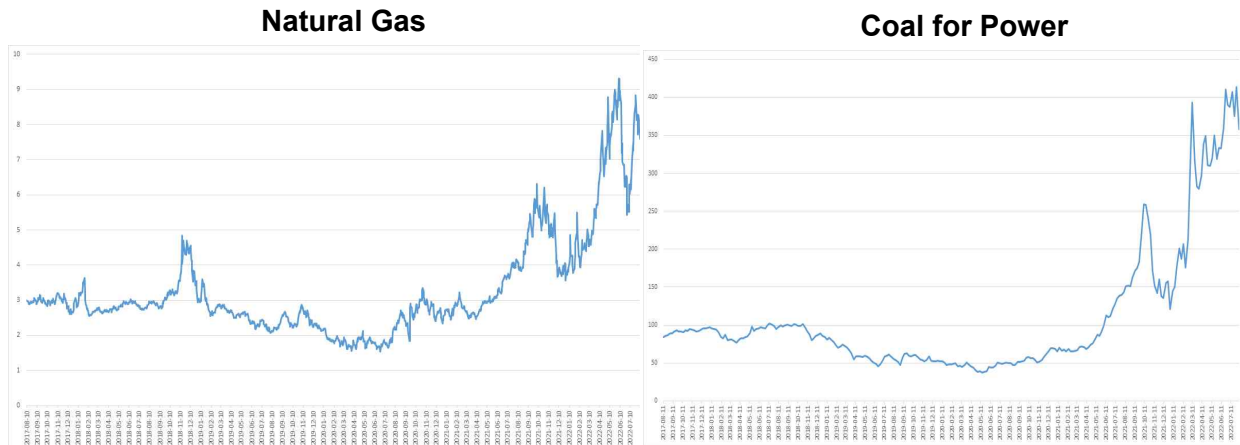
- The price of fuel coal for power (6000 kcal/kg, based on ARA (CIF)) was \$120 per ton in July 2021 and \$413 per ton as of July 2022, up 244% year-on-year
- Natural gas prices (based on CME (NYMEX)) increased 130% year-over-year from \$3.7 per million BTUs in 2021 to \$8.5 per million BTUs in July 2022.
- In the first half of 2021, the average unit cost of power generation (\$/MWh) by 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 cost (\$/MWh) for each global power generation source was 74 for coal, 81 for gas, and 40 for solar power, with coal and gas power generation prices up 10.4% and 9.5%, respectively.
- As the price competitiveness of photovoltaic power generation has strengthened, the global photovoltaic market has seen an increase in demand since the first quarter of 2022 as the construction of photovoltaic projects, which had been delayed since the fourth quarter of 2021, has resumed rapidly, mainly in China and Europe.

☛ 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

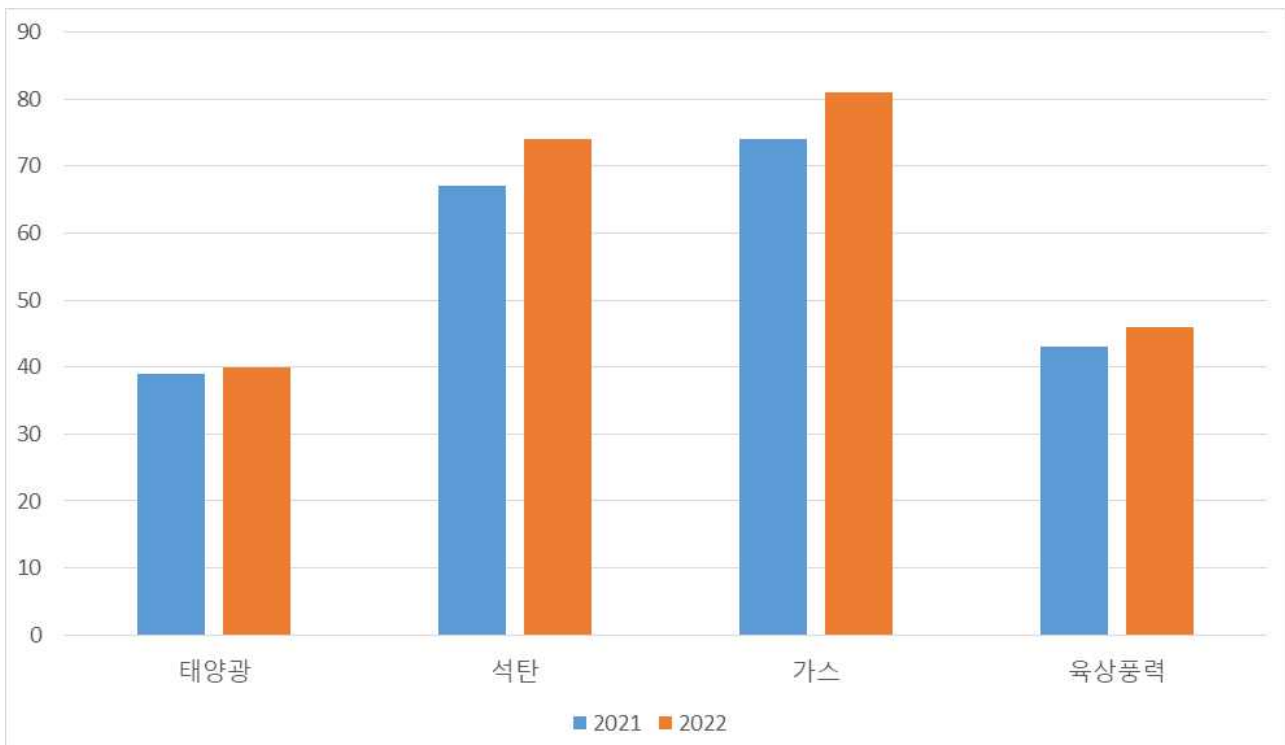
☛ Despite strong product prices, global solar installations in the first half of the year are estimated to have increased by more than 20% year-on-year due to good demand in Asia and Europe, including China.

< Fuel Price Trend for Power Generation > (Unit : USD/MM BTU, USD/TON)



Source: Korea PDS

< First Half of 2021 VS First Half of 2022 > of Unit Cost by Global Power Generation Source (Unit : \$/MWh)



Material: BNEF

Global solar installations in 2022 were revised upward by 4.3% from 230 GW to 240 GW

At the beginning of the year, global solar installations in 2022 were expected to increase by 25% year-on-year to 230GW, but the forecast was revised upward to 240GW due to stronger-than-expected demand growth from Europe after the first quarter.

- After the Russia-Ukraine war, the forecast for solar installations in major regions of Europe has been raised to 5.5 GW → 7.5 GW in Germany, 5.0 GW → 4.8 GW in Spain, 3.8 GW → 2.1 GW in Poland, 3.1 GW → 2.8 GW in France, and 1.0 GW → 1.4 GW in Italy

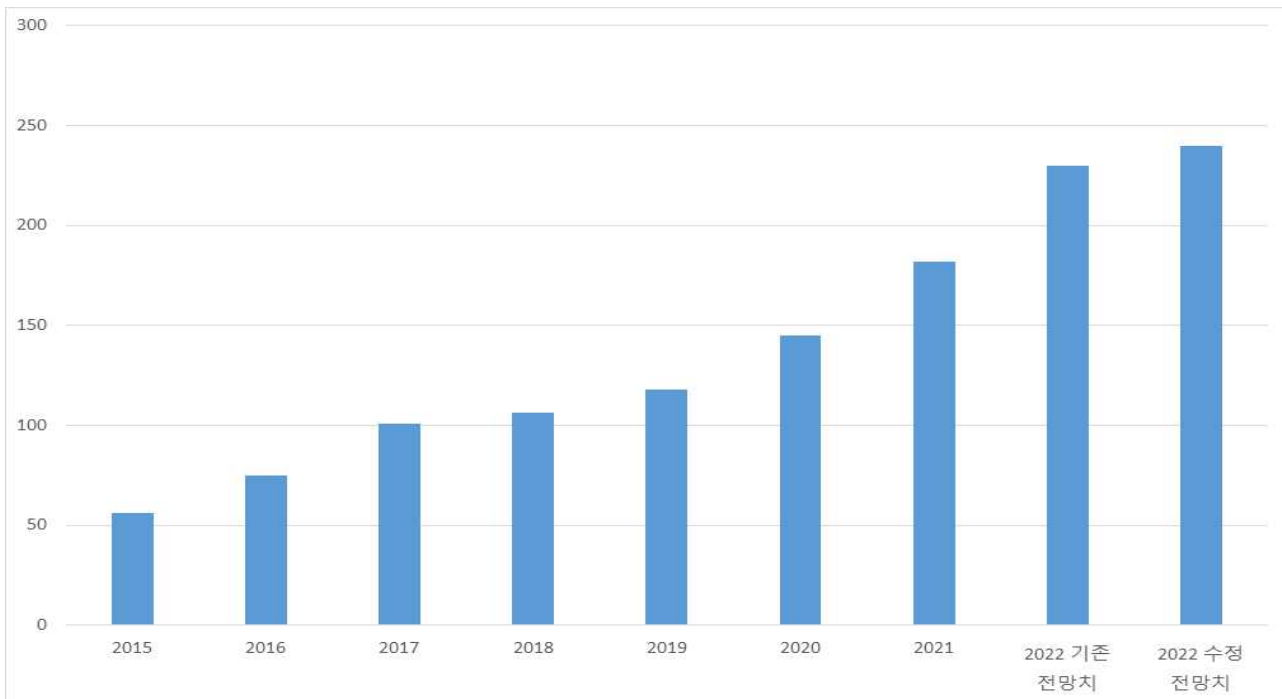
- Installed volume in Europe in 2022 is expected to grow by more than 20% year-on-year due to stronger-than-expected demand growth

The Big2 (China and US) market, which accounts for more than 60% of global solar installations, is expected to have good solar power numbers in 2022

- China's solar installations are expected to exceed 100GW in 2022, up from 69GW in 2021, and 27GW of solar installations in the U.S. are expected to be installed

< 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 | Previous Forecast for 2022 | 2022 Revised Forecast |
|----------------------------|------|-------|-------|-------|-------|----------------------------------|-----------------------------|
| People's Republic of China | 53.0 | 44.3 | 33.1 | 52.1 | 69.0 | 100 | 105 |
| United States | 10.9 | 10.2 | 11.5 | 18.7 | 24.0 | 30 | 27 |
| India | 10.3 | 11.1 | 11.6 | 4.2 | 12.4 | 11.0 | 16 |
| Brazil | 1.4 | 1.5 | 2.8 | 3.9 | 6.7 | 12.0 | 12.0 |
| Germany | 1.7 | 3.6 | 3.8 | 4.9 | 5.3 | 5.5 | 7.5 |
| Japan | 7.4 | 6.7 | 6.7 | 8.7 | 6.5 | 4.4 | 5.0 |
| Spain | 0.1 | 0.3 | 5.0 | 2.9 | 4.6 | 4.8 | 5.0 |
| Australia | 1.3 | 4.0 | 3.5 | 3.6 | 4.7 | 4.9 | 4.9 |
| South Korea | 1.3 | 2.3 | 3.7 | 4.1 | 4.2 | 4.1 | 4.1 |
| Poland | 0.08 | 0.2 | 0.8 | 0.3 | 2.6 | 2.1 | 3.8 |
| France | 0.9 | 0.9 | 1.0 | 1.0 | 2.8 | 2.8 | 3.1 |
| Italy | 0.4 | 0.4 | 0.7 | 0.7 | 0.9 | 1.0 | 1.4 |
| Vietnam | 0.02 | 0.17 | 5.4 | 12.7 | 0.85 | 1.8 | 1.4 |
| United Kingdom | 0.9 | 0.3 | 0.3 | 0.3 | 0.6 | 0.8 | 1.2 |
| Global | 99.0 | 108.0 | 118.0 | 144.0 | 184.0 | 230 | 240 |

Source: BNEF, Export-Import Bank forecast

Global solar installations are expected to exceed 270 GW in 2023 and 300 GW in 2024, and will continue to grow to exceed 400 GW in 2029.

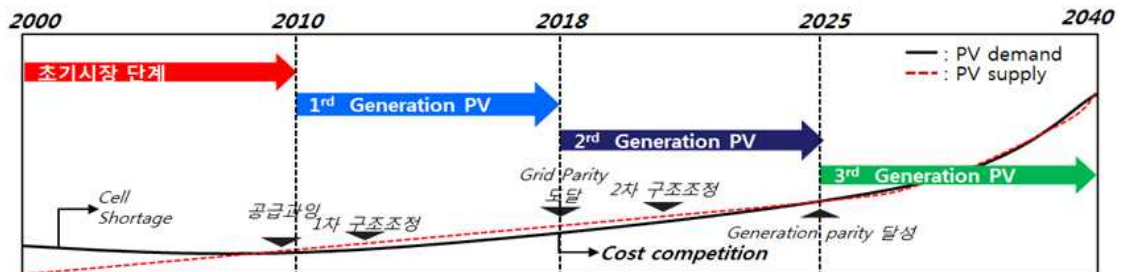
☞ The global photovoltaic market has been growing rapidly since surpassing 100GW in 2017, and is expected to enter the second growth phase with 270GW in 2023 and 300GW in 2024.

- 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.

☞ China, which led the global solar power demand, is expected to slow down to a peak of 110GW in 2025, but the demand in developing countries such as MENA and Asia, led by India, is expected to grow rapidly, driving the growth of the global solar market.

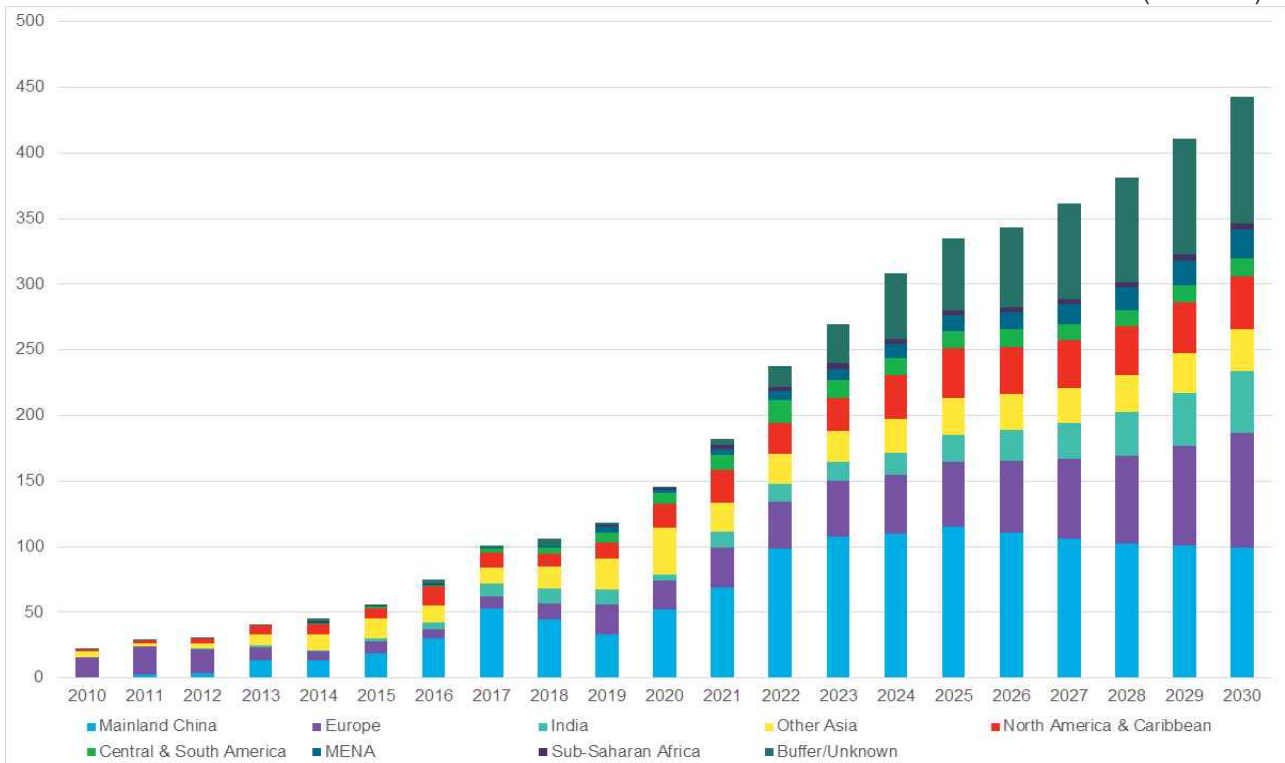
< Global Photovoltaic Industry Growth Cycle >



| | | | | |
|------|--|--|---|---|
| 주요시장 | ✓ 독일 등 유럽시장 | ✓ 중국, 미국, 일본 | ✓ 개도국 확산 | ✓ 전 세계 |
| 산업특성 | <ul style="list-style-type: none"> ✓ 정부 지원 주도의 성장 ✓ Feedstock shortage에 의해 경쟁과 성장이 정체됨 ✓ First Mover는 높은 성장률과 높은 수익률을 향유함 | <ul style="list-style-type: none"> ✓ 기존 업체에 의한 급속한 Capacity 확장과 많은 신규 사업자의 시장진입 ✓ 공급과잉에 따른 1차 구조조정 | <ul style="list-style-type: none"> ✓ 생존업체가 Value chain을 Control하며 진입장벽을 높임 ✓ 태양전지 고효율화 등 성능개선 ✓ ESS 결합 등 분산전원 등장 | <ul style="list-style-type: none"> ✓ 블록체인 및 인공지능 결합 ✓ PV + ESS + 가상발전소 분산전원이 보편화 ✓ 플랫폼 비즈니스 등장 |
| 게임법칙 | 정부 지원 | 비용과 효율 개선 경쟁 | 고효율화 및 Application 확장 | IoT와 결합한 수요개발 |

Source: Export-Import Bank

< Mid- to long-term global solar installation outlook > (Unit : GW)



Material: BNEF

2. Photovoltaic Main Product Price Trend

As of August 2022, the polysilicon price was \$39.2/kg, the highest since October 2011.

✓ In 2022, global polysilicon demand is expected to be at least 570,000 tons and up to 690,000 tons, and the global polysilicon production capacity is estimated to be about 830,000 tons.

- Assuming an 80% utilization rate of global polysilicon plants, the production capacity is estimated to be 660,000 tons this year, and the supply surplus is expected to be about 5%.

- In addition, the increase in electricity costs, which account for 40% of the production cost of polysilicon due to the increase in the price of fuels for power generation such as coal, also contributed to the increase in polysilicon prices. Polysilicon prices rose 40% year-on-year to \$39.2/kg as of August 2022, the highest since 2011.

✓ The increase in global photovoltaic demand in the first half of the year and the accident at the East Hope Xinjigang factory in June have made the supply and demand of polysilicon still tight.

- In the first quarter of 2022, China's photovoltaic installed volume reached 13GW, up 90% year-on-year, showing a hot global solar water supply

- Accident at East Hope plant adversely affects tight polysilicon supply and demand, pushing up polysilicon prices

✓ The tight supply of polysilicon relative to solar demand is expected to continue in the second half of the year, and polysilicon prices are expected to continue to be strong above \$30/kg in the second half of the year.

- The expansion of the polysilicon sector in the photovoltaic value chain is relatively slow, and supply instability factors such as factory disruptions due to the shortage of electricity supply in China are expected to continue in the second half of the year.

✓ Polysilicon prices are expected to gradually stabilize downward after the first half of 2023 when additional capacity expansion volumes enter the market.

(Wafer) As of August 2022, the monocrystalline silicon wafer price was \$0.99/piece, the highest since May 2016.

✓ Wafer prices, which have been weak since 2019, continued to strengthen throughout the first half of 2022, and prices in August 2022 hit a five-year high.

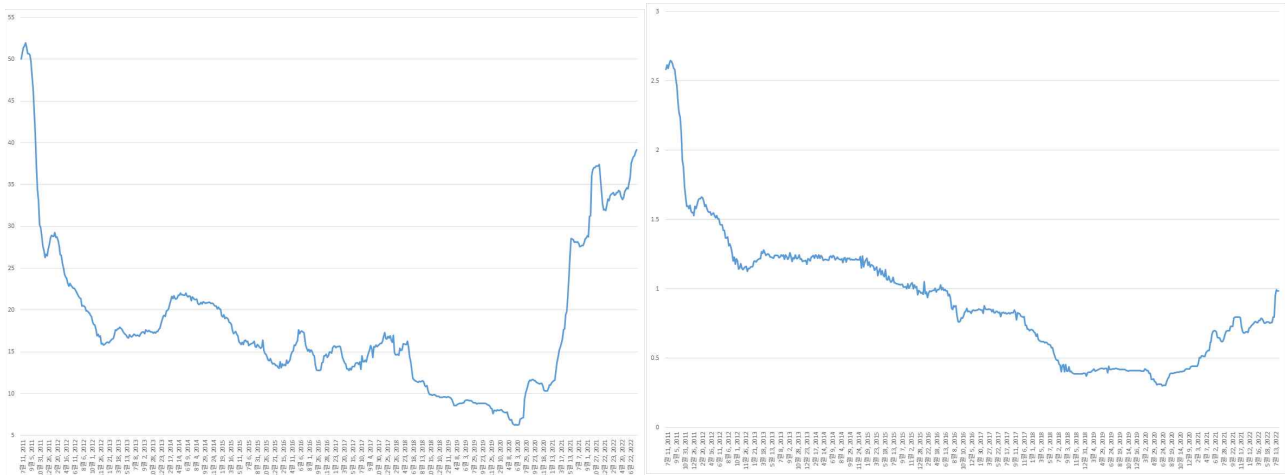
✓ The rise in wafer prices is due to the surge in the price of polysilicon, a raw material, and as the price of polysilicon is expected to continue to be strong in the second half of the year, the price of wafer in the second half of the year is also expected to continue to be strong

- Chinese companies monopolize the wafer market, allowing the increase in the price of raw materials such as polysilicon to be reflected immediately in the wafer price, which is why the price of polysilicon and wafer is moving together.

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

Polysilicon

Single Crystal Wafer



Material: BNEF

As of August 2022, the price of monocrystalline solar cells was \$0.171/W and the price of monocrystalline modules was \$0.264/W, up 27% and 10% year-on-year, respectively.

☞ Due to the rise in the price of raw materials such as polysilicon and wafers, the prices of products such as solar cells and modules have also increased, but the margin of victory is relatively small.

- As of August 2022, the year-on-year price increase of major photovoltaic products was 42.5% for polysilicon, 60% for wafers, 27% for solar cells, and 10% for modules.

☞ Despite the rise in manufacturing costs, it is relatively difficult for photovoltaic manufacturers to reflect the increase in material costs, which worsens their profitability compared to raw material companies.

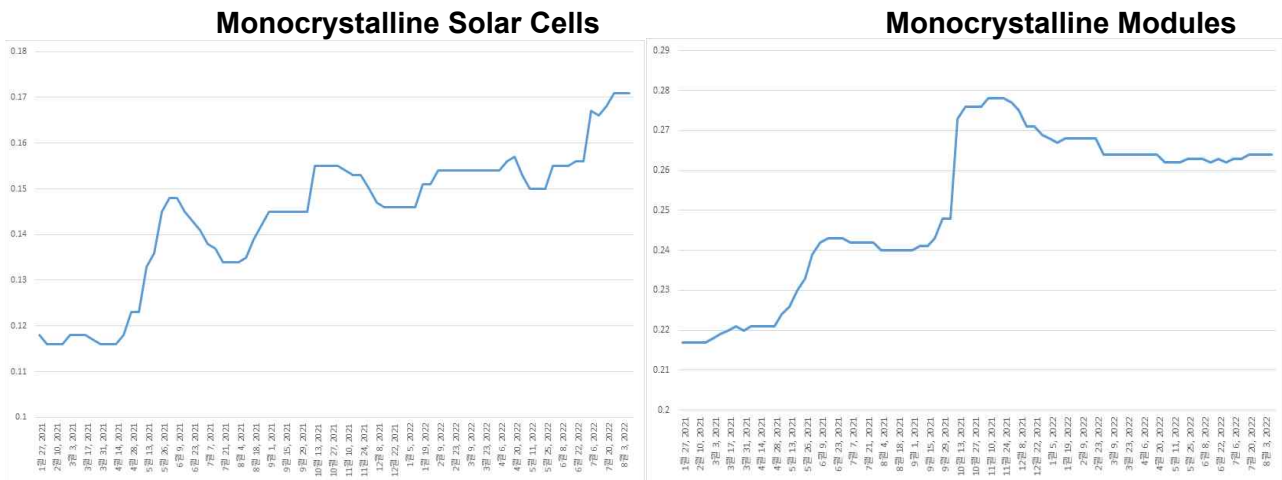
- Raw material prices are rising significantly, but module prices have only risen slightly, making the difference in performance between polysilicon and module companies stark

☞ In the second half of the year, the prices of raw materials such as polysilicon and wafers are expected to continue to be strong and the prices of solar cells and modules are expected to continue to rise due to the increase in global solar demand.

- At the beginning of the year, the price of photovoltaic products in the second half of the year was expected to stabilize downward due to the expansion of supply due to the expansion of facilities, but there were many factors that increased product prices such as stronger-than-expected demand in Europe and production disruptions due to drought in China.

- In the second half of the year, solar cell and module prices are expected to rise by more than 5% compared to current prices.

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



Material: BNEF

3. 2022 Solar Supply Chain Trends

As of the first half of 2022, the global polysilicon production capacity was about 830,000 tons, an increase of 7.8% compared to 2021.

☞ The polysilicon production capacity by country is 647,000 tons in China, 60,000 tons each in the United States and Germany, 27,000 tons in Malaysia, 15,000 tons in Japan, and 6.5 thousand tons in South Korea

- The polysilicon production capacity expanded in 2022 is about 70,000 tons, and all 70,000 tons will be added to China.

- China's share of polysilicon production capacity is 78%, further strengthening its dominance in the photovoltaic materials sector

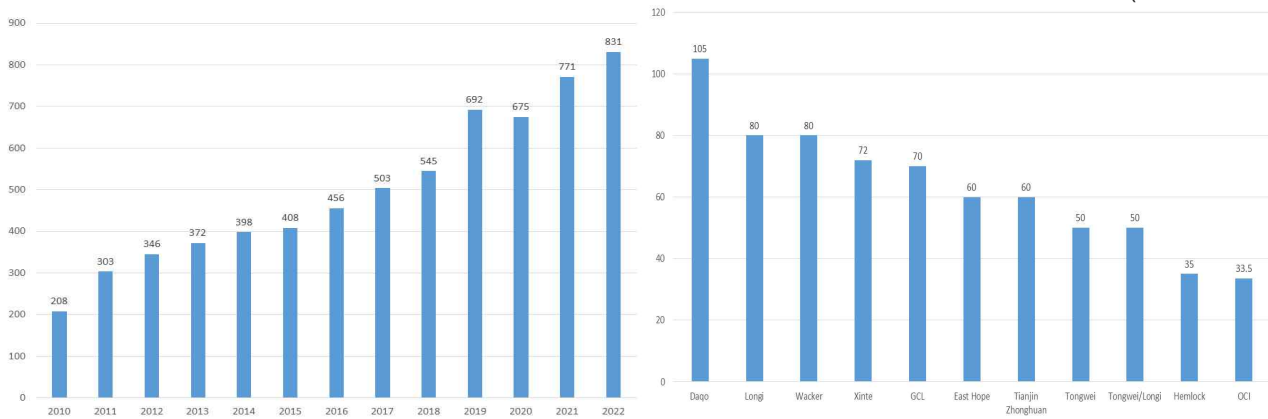
☞ 업체별 생산용량을 살펴보면 Daqo New Energy 10.5 만 톤 , Longi 사 8 만톤 , Wacker 8 만 톤 순

☞ Polysilicon accounted for the lowest share of China's photovoltaic supply chain, but with the large-scale expansion, the share of Chinese products in global polysilicon supply is expected to exceed 80% after 2023.

- It is expected that the polysilicon sector will also secure pricing power based on its overwhelming market share.

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

(Unit: thousand tons)



Material: BNEF

As of the first half of 2022, the global wafer production capacity was 470GW, up 40.3% year-on-year.

Looking at the production capacity by country in the first half of 2022, China 456GW, Taiwan 3.7GW, Vietnam 2GW, and Norway 1GW

- In 2022, China's wafer production capacity increased by 132GW year-on-year, leading the expansion of global wafer production capacity

- China's share in global wafer production capacity is 97% in 2022, making it impossible to produce solar cells without China's wafer supply, as it monopolizes wafers, which are the core materials for solar cells.

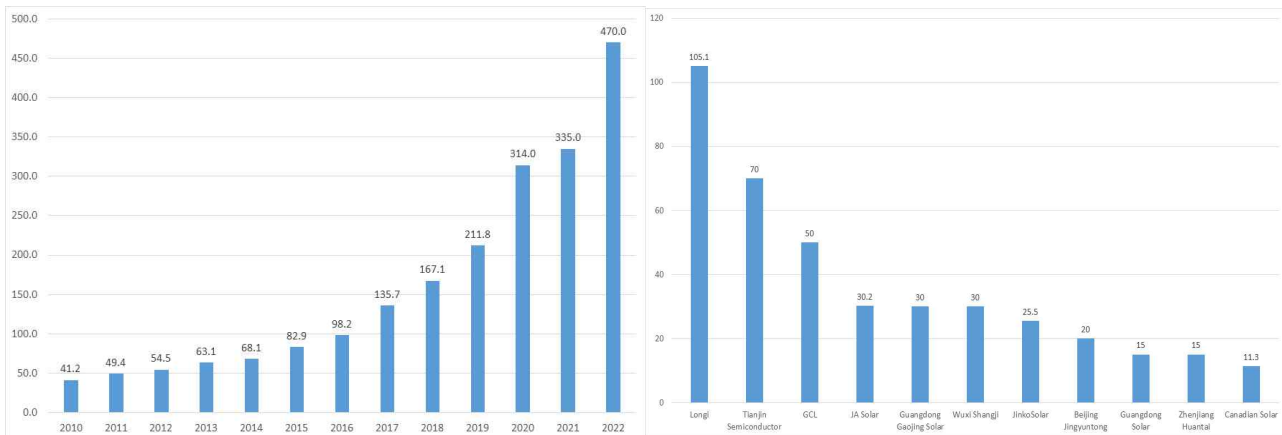
Recently, the U.S. passed the Inflation Reduction Act (IRA)¹⁾ to build a solar power supply chain, but the most difficult challenge is to solve the wafer supply problem.

- It may be possible to supply products through the construction of solar cell and module manufacturing plants in the U.S. through some remaining companies outside of China, but in the case of wafers, it will not be easy to enter the wafer field through large-scale investment as there are no companies that have secured manufacturing know-how.

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.

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

Unit: GW



Source: BNEF

As of the first half of 2022, the global solar cell production capacity was 468GW, a year-on-year increase of 38.5%.

☞ In the first half of 2021, the global solar cell production capacity was 338 GW, and in the first half of 2022, the production capacity was 468 GW.

☞ As of the first half of 2021, China's solar cell production capacity was 283 GW, but in the first half of 2022, it increased by 41.3% to 400 GW.

- Compared to 2021, China's solar cell production capacity increased by 117GW, accounting for 90% of the global solar cell production capacity growth.

- China's share of global solar cell production capacity increased by 1.8% from 83.7% in 2021 to 85.5% in 2022

☞ 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.

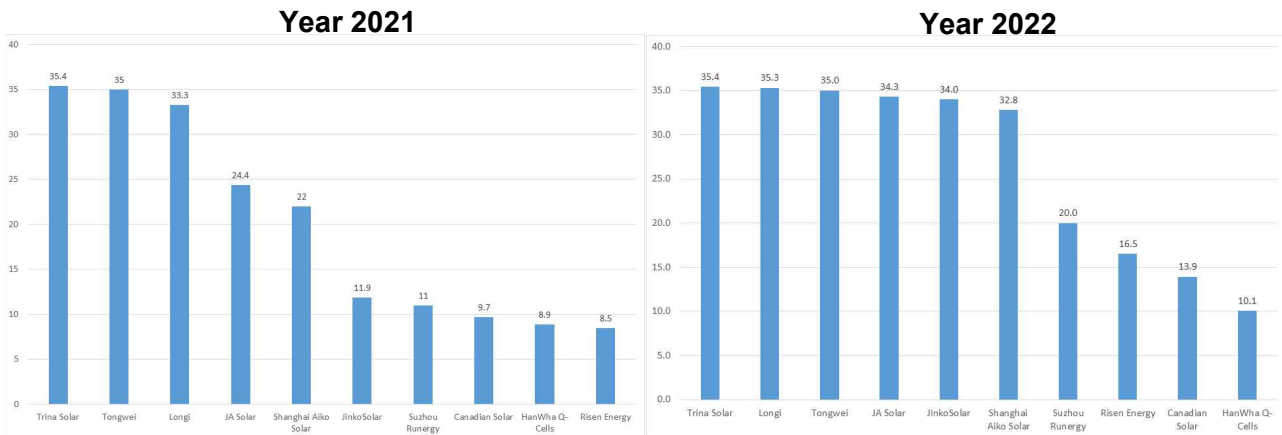
☞ In 2021, there were 3 companies with a production capacity of more than 30GW, but in the first half of 2022, the number increased to 6, and the competition for expansion among top companies is intensifying

- Jinko Solar's production capacity increased by 22.4 GW from 11.9 GW in 2021 to 34.3 GW in 2022, and Shanghai Aiko Solar also increased by 10.8 GW from 22 GW in 2021 to 32.8 GW in 2022

☞ In the global solar cell market, Chinese companies are rapidly expanding their production, and the monopoly position of Chinese companies is further consolidating

< 2021 VS 2022 > of changes in solar cell production capacity by company

Unit: GW



Source: BNEF

As of the first half of 2022, the global module production capacity was 541GW, up 29.4% year-on-year.

☞ As of the first half of 2021, the global module production capacity was 418GW, and the production capacity in the first half of 2022 was 541GW, an increase of 123GW year-on-year.

☞ China's module production capacity was 322GW in the first half of 2021 and 436GW in the first half of 2022, a year-on-year increase of 114GW

- Of the 123GW increase in global module production capacity, 114GW was increased in China, accounting for 92.7% of the global module expansion.

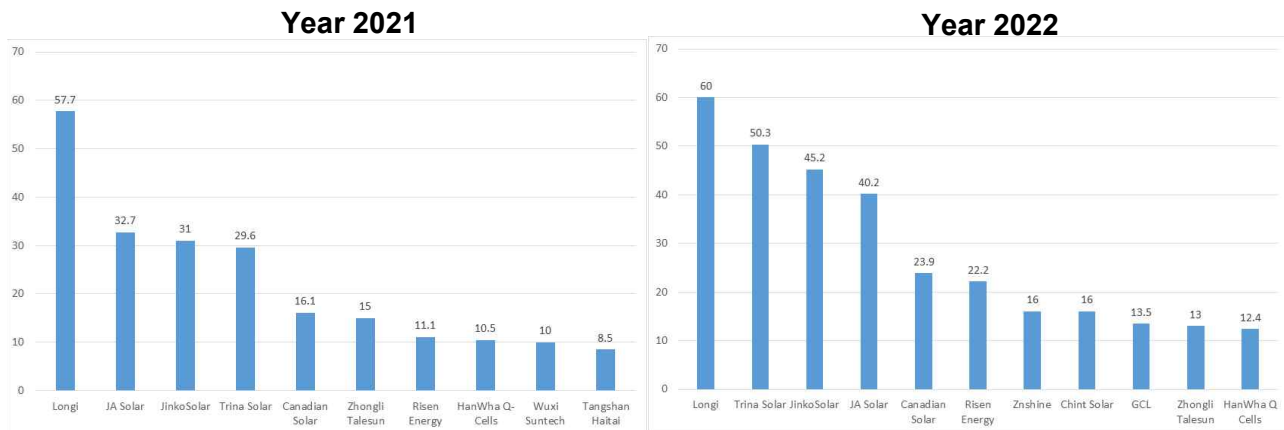
☞ In the first half of 2022, the module production capacity by country outside China was 23GW in Vietnam, 14.5GW in India, 14.3GW in Malaysia, 10GW in South Korea, 7.6GW in Turkey, 6.9GW in Thailand, 4.5GW in the United States, 4.2GW in Taiwan, and 2.8GW in Germany

☞ 2022 년 상반기 기업별 모듈 생산용량을 살펴보면 Longi 60GW, Trina Solar 50.3GW, Jinko Solar 45.2GW, JA Solar 40.2GW, Canadian Solar 23.9GW 였으며 , 우리나라 한화큐셀은 12.4GW 로 11 위 를 기록

- Trina Solar increased from 29.6 GW in 2021 → to 50.3 GW in the first half of 2022, Jinko Solar increased from 31 GW in 2021 → 45.2 GW in the first half of 2022, accounting for 56% of the global production capacity increase in the first half of 2022

☞ The production capacity gap is gradually widening even in the top 10 companies, and it is expected that the top 10 companies will be restructured in the future because they are lagging behind in the competition for economies of scale.

< 2021 VS 2022 Module Production Capacity Status by Company > Unit: GW



Source: BNEF

4. Export and Import Trends of Major Countries

In the first half of 2022, solar cell and module exports reached \$23.8 billion, up 96.7% year-on-year.

Assuming an average export price of \$0.16/W for solar cells and \$0.27/W for modules, it is estimated that the export volume of solar cells is 11GW and the export volume of modules is 82GW.

Exports by major countries were followed by Europe \$11.5 billion (up 150% year-on-year), India \$2.9 billion, Brazil \$2.5 billion, Southeast Asia \$1.2 billion, Japan \$900 million, Pakistan \$500 million, Turkey \$400 million, Chile \$300 million, and South Korea \$300 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.

Exports to the United States in the first half of 2022 fell 24.2% year-on-year to only \$50 million due to the intensification of the US-China trade dispute.

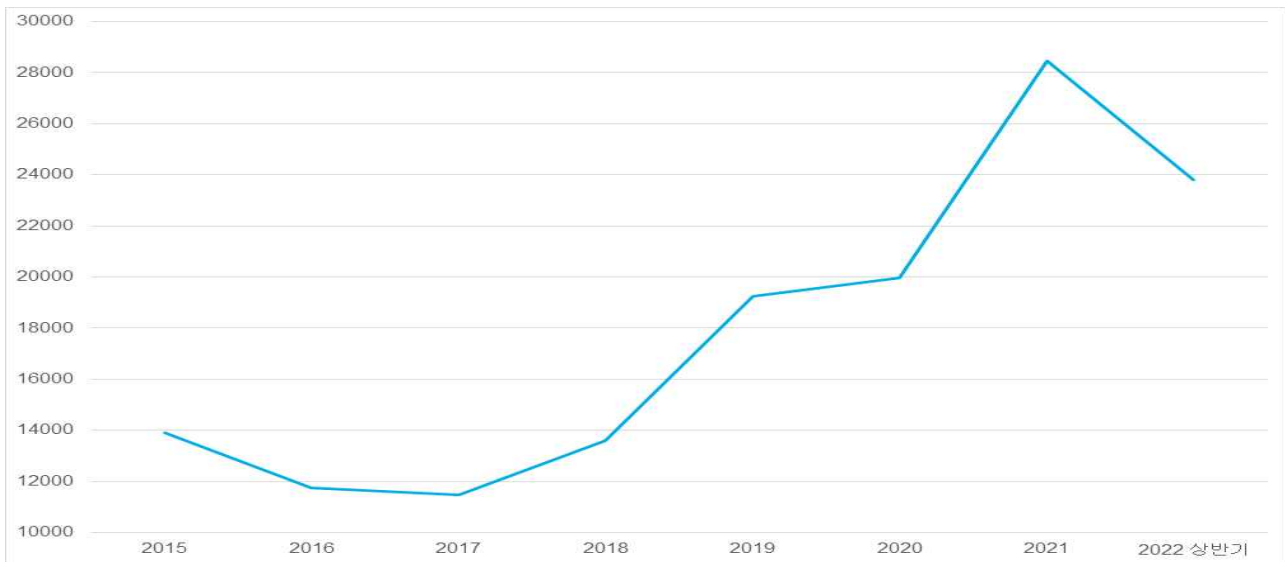
- The U.S. installed solar power in 2021 was 24GW, the world's second-largest market, but due to the US-China trade dispute, China's imports of solar products in 2021 were only \$660 million.

In the first half of 2022, China's polysilicon import volume was 41,600 tons, with an import value of 1.2 billion US dollars, a year-on-year decrease of 31% year-on-year in terms of volume, but the import value increased by 54% year-on-year due to the increase in polysilicon prices.

- The average import price of polysilicon soared from \$12/kg in the first half of 2021 to \$29/kg in the first half of 2022, resulting in a decrease in the volume of imports but a significant increase in the amount of imports.

< > of China's Solar Cell & Module Exports

(Unit: Million Dollars)



Material: BNEF

(US) Imports of solar cells and modules in the first half of 2022 were \$3.52 billion, down 2% year-on-year

☞ The import value of solar cells in the United States has been increasing every year → \$270 million in 2018, \$430 million in 2019, → \$480 million in 2020, → \$540 million in 2021, and the import value of solar cells in the first half of 2022 was \$290 million, a year-on-year increase of 17%.

☞ The import value of modules in the United States was \$2.85 billion in 2018 → \$5.71 billion in 2019, → → \$7.73 billion in 2020 and \$6.27 billion in 2021, with imports in the first half of 2022 to \$3.23 billion, a year-on-year decrease of 10%

☞ In the first half of 2022, the import value of solar cells by region was USD 140 million to Malaysia, USD 0.6 billion to Vietnam, and USD 0.3 billion to South Korea

- In the first half of 2021, South Korea accounted for \$260 million, Malaysia \$130 million, and Vietnam \$100 million, accounting for 48.1% of the total number of Korean Taeyang batteries.

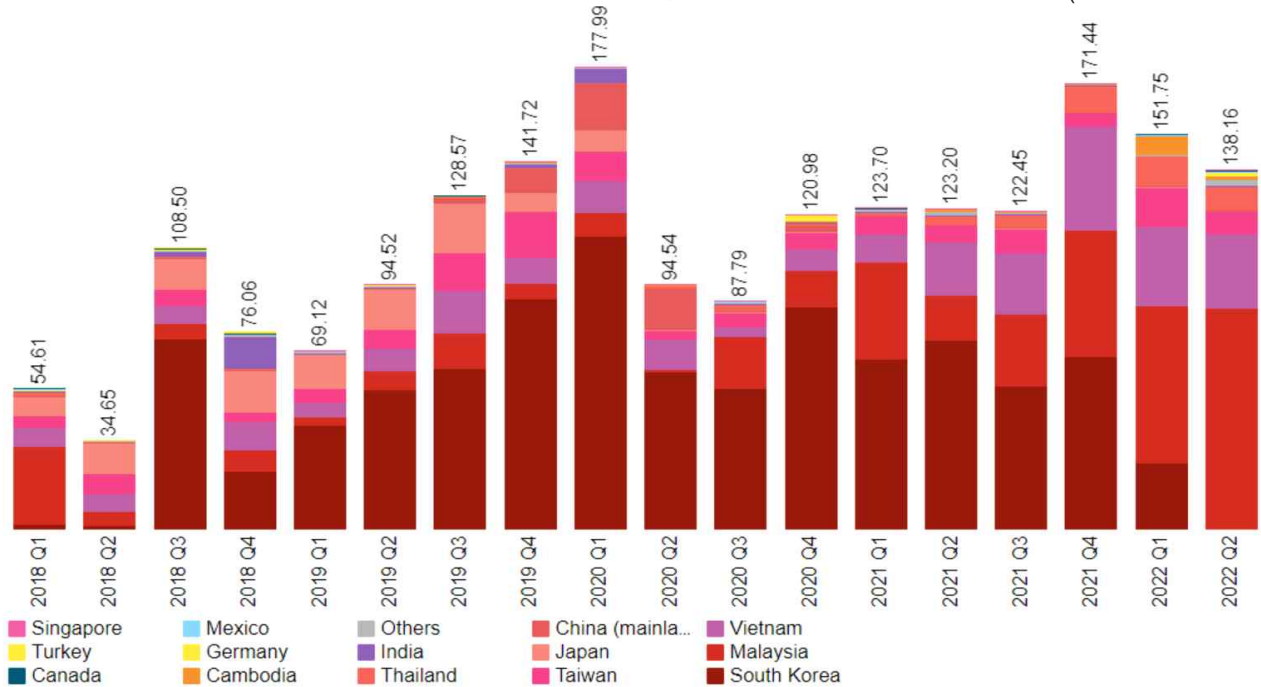
☞ In the first half of 2022, the import value of modules by region was \$660 million from Malaysia, \$1.04 billion from Vietnam, \$690 million from Thailand, and \$280 million from South Korea.

- In the first half of 2021, Malaysia \$2.04 billion, Vietnam \$1.94 billion, Thailand \$1.13 billion, and South Korea \$480 million

☞ As the U.S. supply chain restructuring moves to localize module production facilities, module imports are decreasing, while solar cell imports are increasing.

< US Solar Cell Import Status >

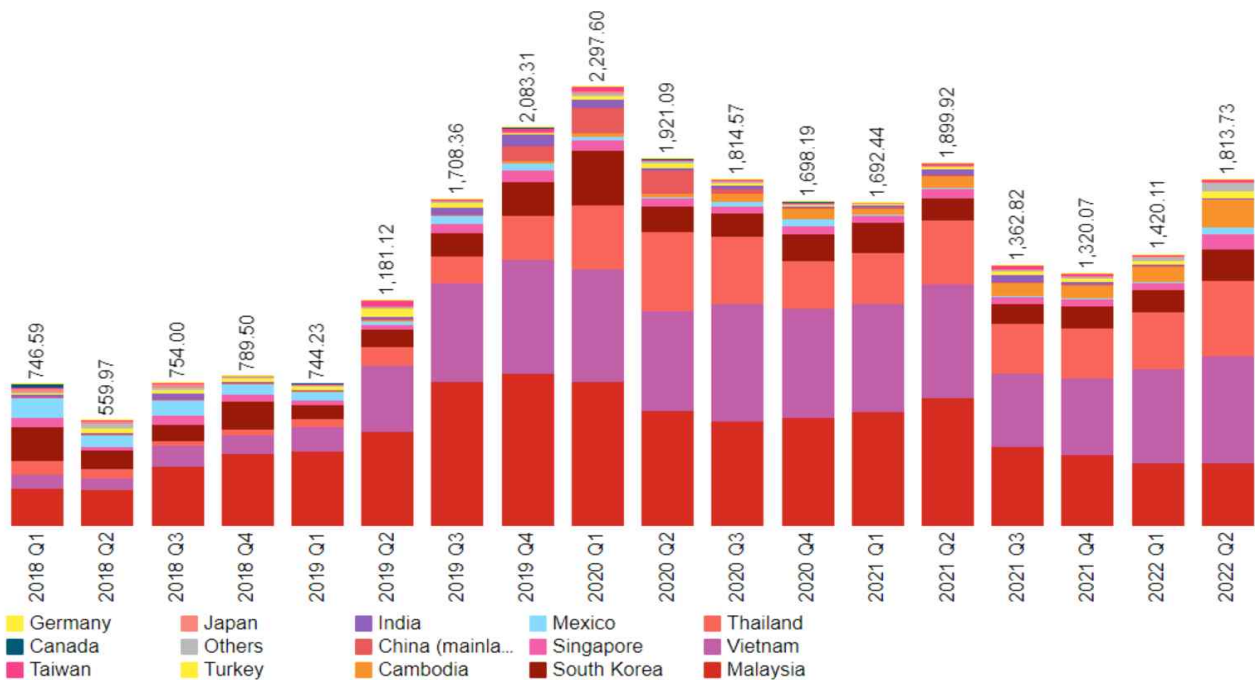
(Unit: Million Dollars)



자료 : Sinoimex, USITC, BNEF

< U.S. 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, rebounded from a low of 29,542 won in July 2021, rose to 56,036 won in February 2022, fell to 47,520 won in March, and rebounded to 55,606 won in July.

☞ The profit structure of the photovoltaic power generation business consists of SMP+REC²⁾, and the higher the REC price, the higher the profit of the photovoltaic business.

☞ With the recent significant increase in coal and natural gas prices, the SMP price soared to 192 won per kW in August, and the profitability of solar projects improved significantly year-on-year as REC prices also strengthened.

- As of August, the compensation price for solar power generation is 247 won per kW, which is 192 won for SMP + 55 won for REC, and the current unit price of solar power generation 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 the current case, there is no need to secure additional revenue through REC trading due to the high SMP price, so REC sellers are reducing the supply for REC trading at a higher price, which leads to an increase in REC prices.

☞ As coal and gas prices continue to soar due to global energy supply disruptions due to the Russia-Ukraine crisis, SMP prices are expected to remain strong in the second half of the year due to the shortage of REC supply

- The increase in the mandatory RPS ratio of power generation companies is also expected to act as a factor to increase the demand for RECs in the future, which will act as a factor for the strengthening of REC prices.

☞ RE100³⁾ market activation is also expected to lead to an increase in demand for RECs, and if there is not enough supply of RECs in the future, the price of RECs may rise significantly, disrupting the REC market order.

- Currently, the main supplier of RECs is solar power generation, and if the construction of solar projects is delayed until this year and next year, it is difficult to rule out the possibility of a sharp price surge due to the imbalance in the supply and demand of RECs

- Expanding the supply of photovoltaic power generation, which is becoming more cost-competitive, is also necessary for stabilizing the REC market and energy security.

2) REC (Renewable Energy Certificate): REC is a certificate for the production of 1MWh of electricity from renewable energy generation facilities, and large power generation companies purchase RECs to meet the renewable energy quota.

3) RE100: An abbreviation for 100% renewable energy, an international campaign with the goal of dedicating 100% of the electricity used by companies to renewable sources such as wind and solar power by 2050.

< Domestic REC Price Trend >

(단위 : 원, \$/W)



Source: Korea Power Exchange, BNEF

2. Export Trends

(Polysilicon) From January ~ July 2022, the cumulative export value of polysilicon decreased by 45.1% year-on-year to USD 35.8 million.

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, so exports are significantly lower than in the past

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.

(Solar Cells & Modules) From January ~ July 2022, the cumulative export value of solar cells and modules decreased by 10.6% year-on-year to USD 616 million.

☞ Looking at the export value by country, the United States was \$515 million, followed by the Netherlands \$0.34 billion, Angola \$0.17 billion, China \$0.16 billion, and Australia \$0.11 billion.

- The proportion of exports of solar cells and modules to the United States reached 83.6%, making the country highly dependent on the United States

- 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

☞ 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.

☞ 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 | January ~ July 2022 |
|-----------------------|-------------------|--------------------|---------------------|---------------------|------------------------|
| Polysilicon | 746.4 (-27.8%) | 476.2 (-36.2%) | 118.7 (-75.1%) | 95.2 (-19.8%) | 35.8 (-45.1%) |
| Ingot | 6.7 (-41.7%) | 6.4 (-4.2%) | 0.7 (-89.6%) | 1.1 (65.1%) | 1.0 (15.2%) |
| wafer | 94 (-7.8%) | 20.3 (-78.4%) | 12.1 (-40.7%) | 9.0 (-25.5%) | 4.3 (-37.6%) |
| Solar Cells & Modules | 1,605.2 (-) | 1,592.3 (-0.8%) | 1,382.1 (-13.2%) | 1,089.3 (-21.2%) | 616.0 (-10.6) |

Source: Trade Associations, Solar Cells (8541409021) and Modules (8541409022) HS codes integrated into 8541430000

3. Import Trends

(Wafers) cumulative imports from January ~ July 2022 increased by 17.5% year-on-year to \$315 million

☞ Imports by weight decreased by 27.5%, but wafer imports increased by 17.5% due to the increase in wafer prices.

☞ Imports from China accounted for 289.8 million US dollars, accounting for 92% of the total, and 24 million US dollars from Taiwan.

(Solar Cells & Modules) From January ~ July 2022, the cumulative import value decreased by 62.9% year-on-year to USD 143 Mn

☞ 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.

☞ Of the \$143 million imports of solar cells and modules, the import value to the public was 138.5 million USD, accounting for 97.2% of the total imports.

☞ In the global photovoltaic market, Korea has a high self-sufficiency rate in solar products, but it is becoming increasingly difficult to defend the domestic market against Chinese products that are selling their products based on price competitiveness

- As domestic interest rates rise rapidly, the adoption of cheaper Chinese products may increase compared to domestic products to preserve the profitability of solar projects, which may reduce sales of domestic products that are less competitive in price.

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

| | Year 2018 | In 2019 | Year 2020 | Year 2021 | January ~ July 2022 |
|-----------------------|------------------|------------------|-------------------|------------------|------------------------|
| Polysilicon | 31.6 (-53.5%) | 26.9 (-14.9%) | 18.0 (-33.0%) | 32.3 (79.4%) | 4.3 (-81.4%) |
| Ingot | 3.5 (-74.6%) | 6.8 (94.3%) | 5.3 (-21.3%) | 19.5 (265.2) | 15.4 (30.6%) |
| wafer | 569.0 (5.2%) | 398.0 (-30%) | 343.2 (-13.7%) | 485.1 (41.4%) | 315 (17.5%) |
| Solar Cells & Modules | 359.0 (10%) | 760.0 (192%) | 624.5 (-32.5%) | 647.7 (18.0%) | 143.0 (-62.9%) |

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

4. Issues in the Domestic Photovoltaic Industry

The U.S. Inflation Reduction Act (IRA) has passed the House and Senate, and the implementation of the bill is expected to positively benefit domestic solar companies.

☞ The main content of the Inflation Reduction Act is to raise \$737 billion in tax revenue from large corporations over 10 years, spend \$437 billion on energy security, climate change, and health care expansion, and reduce fiscal debt by about \$300 billion.

☞ Major tax incentives and subsidies related to renewable energy are as follows:

- \$64.5 billion in energy security and U.S. production support, \$72 billion + α in economic decarbonization, \$10 billion in consumer energy savings + α , \$7 billion in community and environmental justice investments, and \$27.6 billion + α in investments in agricultural/forestry workers and rural communities
- Highlights of energy security and climate change response include onshoring production tax credits for solar panels, wind turbines, and batteries, investment tax credits for technology development and production facilities, tax credits for the purchase of U.S.-made electric and alternative energy vehicles, and energy efficiency improvements for low-income homes.

☞ The implementation of the Inflation Reduction Act is expected to benefit local renewable energy and electric vehicle/battery companies, accelerating the production and distribution of eco-friendly energy.

- The construction of a 1GW module factory in Korea will cost about 140 billion won, and 93 billion won will be subsidized annually when the inflation reduction bill is applied.
- The tax credit for production facilities is expected to significantly reduce the payback period for investment costs, which will greatly increase the incentive for renewable energy companies to invest in production facilities.

☞ **Local** investment is expected to increase for Korean solar companies to enter the U.S. solar market.

- Hanwha Solutions currently has a 1.7GW solar module production facility and plans to expand its installed capacity to 3.1GW in 2023.
- Under the Inflation Reduction Act, tax cuts worth KRW 200 billion per year for 10 years are expected to greatly help the U.S. secure competitiveness.

<Highlights of the U.S. Inflation Reduction Act >

| category | program | Scale (billion dollars) | Scale (trillion won) | Renewable |
|----------|---|-------------------------------|----------------------------|-----------|
| | Financing secondary batteries 7370 960 Reform of prescription drug pricing (e.g., abolishing rebates and capping prescription drug prices) 2690 345 Increasing tax revenues | | | |
| | - A minimum corporate tax rate of 15% applies to companies with annual profits of more than \$1 billion | 4720 | 615 | 2220 |
| | - Internal Revenue Service (IRS) strengthens tax enforcement | 289 | 1240 | 161 |
| | - Share buybacks are subject to a 1% tax | 96 | | 96 |
| 68 | - Limitation of tax credits for U.S. energy security and climate change | 4370 | 569 | 3690 |
| | 4370 569 3690 481 재생에너지 생산자 인센티브 American Energy Security and Domestic Manufacturing | | | |
| | - Solar panel, wind turbine, battery production, and essential mineral refining tax credits | 300 | 39 | Or Or |
| | - Tax credit for the construction of solar panels, wind turbines, batteries, and other eco-friendly technology production facilities | 100 | 13 | Or Or |
| | - Loans/subsidies for the establishment and conversion of eco-friendly vehicle production facilities - Promotion of energy technology research and application of DPA for heat pumps and essential mineral refining Decarbonize the Economy | 220 | 29 | Or |
| | - Tax credits for green power generation and energy storage | 300 | 39 | Or |
| | - Tax credits and subsidies for reducing greenhouse gas emissions from industrial production | 60 | 8 | Or |
| | - Development of eco-friendly energy technology | 270 | 35 | Or |
| | - Federal procurement program for U.S.-made green technologies | 90 | 12 | |
| | - Tax credits and subsidies to reduce carbon emissions in the transportation sector | a | a | Or |
| | - 천연가스 운송 및 생산 과정에서의 메탄 배출 저감 프로그램 Invest in Communities and Environmental Justice | a | a | |
| | - Air Pollution/Climate Change Community Action Grants | 70 | 9 | |
| | - 지역사회 접근성 개선 및 평등 보조금 - 친환경 대형차량 보조금 | 30 | 4 | |
| | Farmers, Forestland Owners and Resilient Rural Communities | 30 | 4 | |
| | 재생에너지 소비자 인센티브 (Lower Consumer Energy Costs) | 10 | 1 | |
| | - Incentives for low-income households to install eco-friendly energy and improve energy efficiency | 276+ α | 36+ α | |
| | - Home Energy Efficiency Improvement Grant Funding | 100+ α | 13+ α | |
| | - Tax benefits for home energy efficiency and green energy use (10 years) | 90 | 12 | Or |
| | Incentives for the purchase of electric vehicles (up to \$4,000 for used cars and \$7,500 for new cars each) Increased health care expenditures (e.g., extension of the Affordable Care Act) Drought Relief in the Western United States | 10 | 1 | Or |
| | Renewable Energy Tax Credits and Investments | α | α | Or |
| | Secondary Battery-Related Tax Credits and Investments | \$116.5 billion+ α | 152 trillion won+ α | |
| | | \$81 billion+ α | 105 trillion won+ α | |

자료 : Senate Democrat, 한화투자증권

III. Earnings Trends of Solar Companies

1. Earnings Trends of Major Overseas Companies

In the first half of 2022, the performance of major global photovoltaic companies is clearly different from Chinese companies VS non-Chinese companies, material companies such as polysilicon and product companies such as modules.

✓ Longi, JA Solar, Jinko Solar and other top Chinese companies saw a significant increase in sales in the first half of 2021 due to the massive expansion of facilities in 2021 and the increase in global solar demand in the first half of 2022.

- 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.

- As the dominance of China's top companies in the global photovoltaic industry grows, the business situation of non-Chinese companies that have not secured economies of scale is becoming more difficult.

✓ The performance of polysilicon companies such as Tongwei and Daqo in the first half of 2022 reached a record high due to the strong polysilicon price

- Tongwei's revenue in the first half of 2022 increased 127% year-on-year to \$9.31 billion, and its operating performance increased 333% to \$2.8 billion.

✓ The performance of the top leading companies in the second half of 2022 is expected to continue its upward trend due to the booming global photovoltaic market.

< Earnings Trends of Major Solar Companies > (Unit: Million Dollars)

| Company Name | 2019 | | 2020 | | 2021 | | First half of 2021 | | First half of 2022 | |
|----------------|-------|------------------|-------|------------------|--------|------------------|--------------------|------------------|--------------------|------------------|
| | Sales | Operating Profit | Sales | Operating Profit | Sales | Operating Profit | Sales | Operating Profit | Sales | Operating Profit |
| Longi | 4,763 | 941 | 7,919 | 1,437 | 12,549 | 1,476 | 5,425 | 913 | 7,780 | 896 |
| AND solar | 3,063 | 349 | 3,750 | 361 | 6,404 | 568 | 2,503 | 165 | 4,393 | 347 |
| Jinko Solar | 4,307 | 270 | 5,096 | 338 | 6,290 | 843 | 2,431 | 167 | 5,156 | 245 |
| Canadian Solar | 3,201 | 259 | 3,476 | 218 | 5,277 | 229 | 2,519 | 309 | 3,564 | 132 |
| Trina Solar | 3,377 | 156 | 4,268 | 266 | 6,897 | 374 | 3,120 | 160 | 5,514 | 326 |
| Tongwei | 5,438 | 517 | 6,413 | 586 | 9,844 | 1,787 | 4,105 | 645 | 9,311 | 2,796 |
| Daqo | 350 | 48 | 675 | 188 | 1,679 | 1,065 | 697 | 401 | 2,524 | 1,721 |
| First Solar | 3,063 | 255 | 2,711 | 400 | 2,923 | 483 | 1,432 | 231 | 988 | -77 |

Resources: Comprehensive Industry Resources

2. Earnings Trends of Major Domestic Companies

In 2022, the business performance of major domestic photovoltaic companies in the first half of the year improved year-on-year, but the gap with Chinese and domestic companies widened.

☞ Due to the rise in polysilicon prices, OCI posted KRW 730 billion in sales and KRW 188 billion in operating profit in the first half of the year, up 30.4% in sales and 18.2% 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.

☞ Hanwha Solutions turned positive in operating profit in the second quarter of 2022, but the first half of the year is still in the red.

- In the past, it ranked 3rd in global module production capacity, but now it has fallen to 11th place, widening the gap with China's leading companies in terms of economies of scale.

- However, in terms of the global supply chain, the strategic value of companies other than Chinese companies that can supply large-scale solar cells and modules is growing

- Plans to expand investment in strategic regions and produce next-generation modules to differentiate and compete with Chinese companies

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

| Company Name | 2019 | | 2020 | | 2021 | | First half of 2021 | | First half of 2022 | |
|---|--------|------------------|--------|------------------|--------|------------------|--------------------|------------------|--------------------|------------------|
| | Sales | Operating Profit | Sales | Operating Profit | Sales | Operating Profit | Sales | Operating Profit | Sales | Operating Profit |
| OCI (Basic Chemical) | 12,120 | -2,290 | 8,520 | -77 | 13,330 | 4,870 | 5,600 | 1,590 | 7,300 | 1,880 |
| Hanwha Solutions Solar Power Business | 35,552 | 2,235 | 37,023 | 1,904 | 35,685 | -3,285 | 17,512 | -795 | 21,549 | -790 |
| Shinsung ENG RE Division | - | - | 1,183 | -84 | 1,041 | -130 | 478 | -82 | 696 | 25 |
| S Energy | 2,169 | 10 | 2,548 | -59 | 2,520 | -183 | 1,015 | 6 | 806 | -43 |

Resources: Comprehensive Industry Resources

IV. Implications

Global solar demand in 2022 is growing faster than expected due to rising energy prices and energy security issues following the Russia-Ukraine crisis, and the era of global solar capacity of 300GW is expected to open in 2024

Ÿ Due to the rise in fuel prices such as coal and gas due to the Russia-Ukraine crisis, the cost of generating fossil fuel power generation sources is rising significantly.

- As the cost of coal and gas power generation rises, solar power generation, which is free from fuel costs, is emerging as a relatively inexpensive energy source
- In Europe, demand for solar power generation has soared due to soaring electricity prices due to rising gas prices.

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 If the current high price of coal and gas power generation continues, there is a possibility that the era of global solar power demand of 300GW will be accelerated from 2024 to 2023.

- 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, the need to use eco-friendly energy such as renewable energy to prevent climate change is being further highlighted due to abnormal weather around the world, which is expected to lead to an increase in global solar power demand.

Although the supply of polysilicon has been newly increased since the second half of 2021, the supply of polysilicon remains tight due to the increase in global solar demand, and the price is expected to continue to be strong in the second half of 2022 to exceed \$30/kg

Ÿ Due to the increase in global solar demand and rising manufacturing costs due to the rise in electricity costs, the high prices of materials such as polysilicon and ingots and wafers are expected to be inevitable for the time being.

Ÿ Due to the rise in material prices, the prices of products such as solar cells and modules are inevitable, and it is expected that it will be difficult for the prices of major products to stabilize downward due to the strong prices of raw materials in the second half of the year.

The main issue in the global photovoltaic industry in the first half of 2022 is the strengthening of protectionism for supply chain recovery, and Korean companies are expected to benefit from the process of building the global solar power supply chain.

☞ Chinese companies have secured the world's highest level of competitiveness through vertical integration of the value chain, and there are currently no companies that can compete with Chinese companies.

- The price gap with Chinese products is more than 10%, and it is difficult to surpass Chinese products in terms of technological competitiveness.
- Normal competition is not possible under the current circumstances, and in order to overcome this, the United States will create and implement legislation to protect its companies.

☞ 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 Korean companies operating in the United States are expected to benefit from this process.

- The tax cuts will increase the price competitiveness of U.S. products to a level that can compete with Chinese products, thereby expanding the use of U.S. products, which will benefit Korean companies with production facilities in the U.S.

☞ 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.

☞ 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 only alternative, and for this, it is necessary to expand the current localization and investment.

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

- The demand for finance for investment in the U.S. is expected to increase, and timely investment funding for the construction of production facilities to preempt the U.S. market is expected to enhance the competitiveness of Korea's photovoltaic industry.