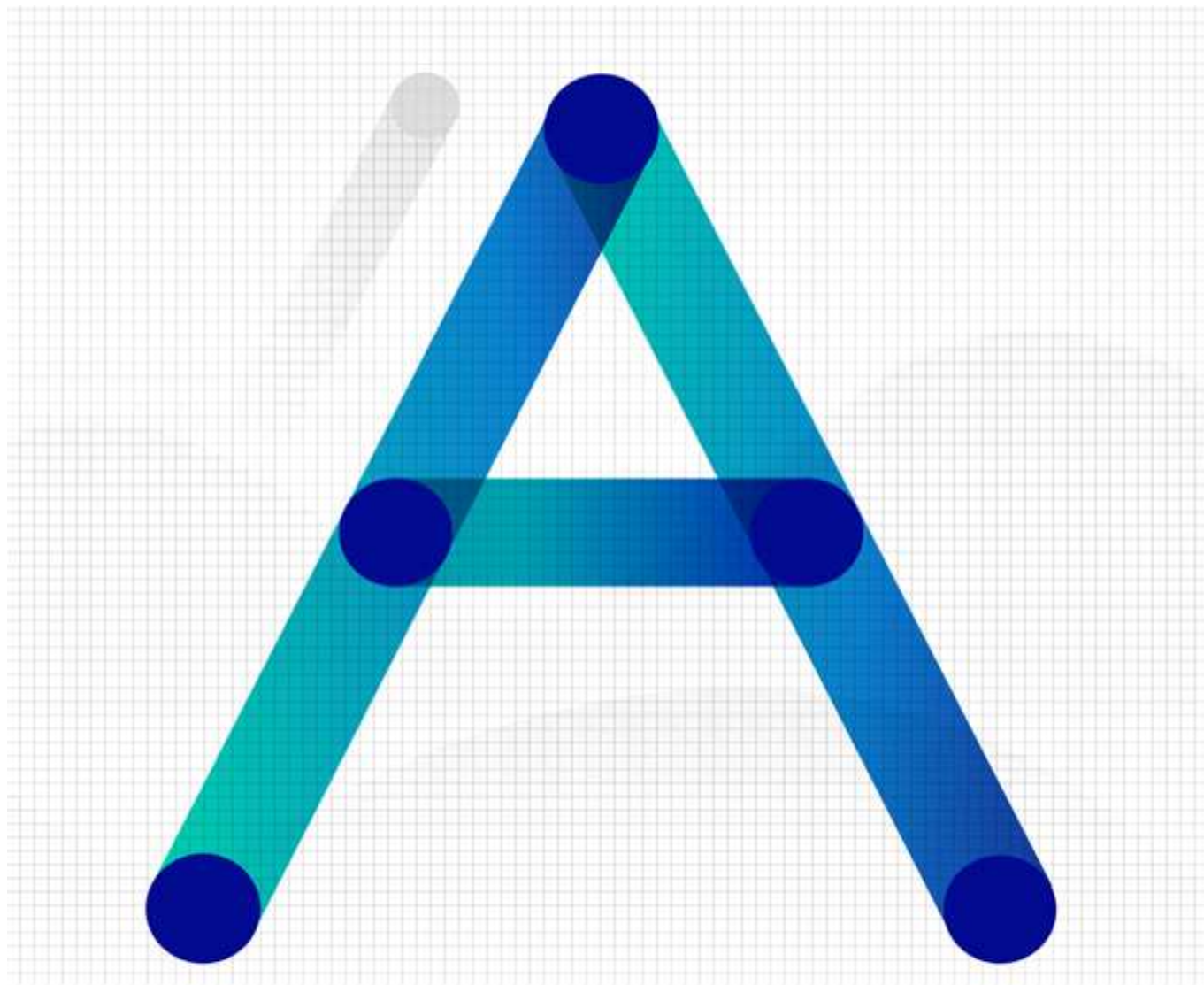


Photovoltaic Industry Trends in the First Half of 2023

I. Global Photovoltaic Industry
Trends II. Major Issues and
Corporate Performance in the
Photovoltaic Industry III..
Trends in the Domestic
Photovoltaic Industry IV.
Implications

Write

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< about >

It is estimated that the global solar installation volume in the first half of 2023 significantly exceeded the previous year's level due to the significant increase in demand in the Big2 (China and the United States) markets.

☞ The growth in global solar demand in 2023 is driven by the decline in product prices, especially in China, which is the largest demand destination.

- With the decline in product prices, the installation cost has been significantly reduced compared to 2022, and the demand for installing solar power at a low price is rapidly increasing, and the installed volume of solar power in China increased by 190% year-on-year to 48GW from January ~ April 2023.

☞ Global solar installations in 2023 will be revised upward to 340~360GW, an increase of 20GW from the 320~340GW forecast at the beginning of the year.

As of July 2023, the polysilicon price is \$7.85/kg, down 79.9% from its August 2022 high (\$39/kg).

☞ As we enter 2023, large-scale expansion volumes are being supplied to the market, and polysilicon prices are falling sharply due to the decline in raw material prices due to global interest rate hikes.

☞ In 2022, the global polysilicon production capacity was 980,000 tons, but the production capacity available by the end of 2023 is expected to increase to about 1.6 million tons due to large-scale capacity expansion.

- In 2023, the production capacity of polysilicon has been raised from 1.3 million tons to 1.6 million tons, and 1.6 million tons of polysilicon has the capacity to make about 600 GW of solar cells, which is more than 240 GW of oversupply compared to the 360 GW global solar demand.

The main keywords of the global photovoltaic supply chain in 2023 are the possibility of diversification of the supply chain due to the monopolization of China and the implementation of the IRA in the United States

☞ The polysilicon production capacity by country is 940,000 tons in China, 61,000 tons in the United States, 60,000 tons in Germany, 35,000 tons in Malaysia, 11,000 tons in Japan, 8,000 tons in Qatar, 7,000 tons in Norway, and 65,000 tons in South Korea.

☞ In 2023, the module production capacity by country is 540GW in China, followed by 26GW in Vietnam, 15GW in Malaysia, 14GW in India, 10GW in Thailand, and 10GW in South Korea.

- When the current expansion is completed, the global module production capacity is expected to reach 740GW, of which Korea accounts for about 84%

¥ The core competitiveness of China's photovoltaic industry is competitive low investment cost through the development of its own production technology and cost competitiveness through securing a stable economy.

- Annual production capacity of 1GW and investment costs in the value chain of major regions of the photovoltaic industry as of 2022 are as follows:

- Polysilicon investment is \$34 million in China, \$44 million in Southeast Asia, and \$124 million in the U.S. and Europe, which is only 27% of the U.S. and Europe.

¥ With the implementation of the IRA, the price of U.S. solar modules is expected to compete with the price of modules manufactured in Southeast Asia.

- It is estimated that the manufacturing cost of wafer-solar cell-module produced in Southeast Asia is about 24 cent/W, and the production cost of wafer-to-module production through IRA subsidies in the United States

is 23 cent/W, which is estimated to be competitive compared to products produced in Southeast Asia.

In 2023, the domestic photovoltaic market is expected to reach 2.7GW, down 15% year-on-year, and demand is expected to be around 2.5~3.0GW per year by 2030.

¥ Domestic solar power installations are expected to stagnate due to changes in government policies, such as lowering the proportion of renewable energy to 21.6% in 2030, abolishing the RPS system and

introducing

an auction system, and fixing the ceiling on the wholesale electricity price (SMP).

¥ Domestic photovoltaic power generation is still recognized as an expensive source of power generation, but due to the continuous decline in module prices, Korea is also about to reach grid parity in solar power generation, and the need for it is increasing as a means to reduce energy dependence on external sources.

After 2025, the construction of a new U.S. solar supply chain is expected to change the China-centric solar supply system, which is expected to exacerbate the oversupply in China.

¥ When the supply chain in the U.S. is established, the oversupply of Chinese companies is expected to increase further, and if the oversupply in the Chinese domestic market is not digested, there is a possibility that the prices of major solar products such as modules will plummet.

In order to develop Korea's photovoltaic industry, it is necessary to develop a market not only in the manufacturing field but also in the field of developing solar photovoltaic projects, which are growing rapidly.

¥ Project development and operation can create more added value than the manufacturing field, and it is possible to enter various markets through program development linked to entering the market of developing countries using EDCF.

I. Global Photovoltaic Industry Trends

1. Global Solar Installation Trend

It is estimated that the global solar installation volume in the first half of 2023 significantly exceeded the previous year's level due to the significant increase in demand in the Big2 (China and the United States) markets.

Ÿ As the price of polysilicon falls, the cost of manufacturing modules is falling, and the decline in module manufacturing costs is leading to a decrease in the unit cost of solar installations.

Ÿ Falling cost of photovoltaic installations leads to improved profitability of photovoltaic projects, and as installation costs fall, the demand for photovoltaic increases proportionately.

Ÿ The increase in global solar demand in 2023 is driven by the decline in product prices, especially in China, which is the largest demand destination, due to a surge in demand for solar power

- As product prices have decreased, installation costs have been significantly reduced compared to 2022, resulting in a surge in demand in China to install solar power at a low price, and China's solar installation volume increased by 190% year-on-year to 48GW from January ~ April 2023.
- Considering that the first quarter is the off-season for solar power, the demand growth is significant, and the installation volume in the second half of the year is expected to be larger than the growth in the first quarter.

Global solar installations in 2023 will be revised upward to 340~360GW, an increase of 20GW from the 320~340GW forecast at the beginning of the year.

Ÿ The U.S. installation forecast for 2023 has also been revised upward from 24GW to more than 30GW, and Germany, Europe's leading solar market, has also been revised upward from 7GW to 10GW.

- 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 photovoltaic power in the Big2 (China and US) market, which accounts for more than 50% of global solar installations, is expected to exceed 165GW in 2023 (135GW in China and 30GW in the United States), continuing the good growth trend from the previous year.

Ÿ The demand for solar installations in Europe for energy security and climate change prevention is also expected to reach 60GW from 50GW

The global solar installation forecast has been revised upward from 350 GW in 2024, 420 GW in 2027 and 530 GW in 2030 to 400 GW in 2024, 530 GW in 2027 and 680 GW in 2030.

☞ China is expected to peak at 140 GW in 2025 and slow down, but demand is expected to grow faster than expected, reaching 180 GW in 2025, 200 GW in 2027, and 260 GW in 2030.

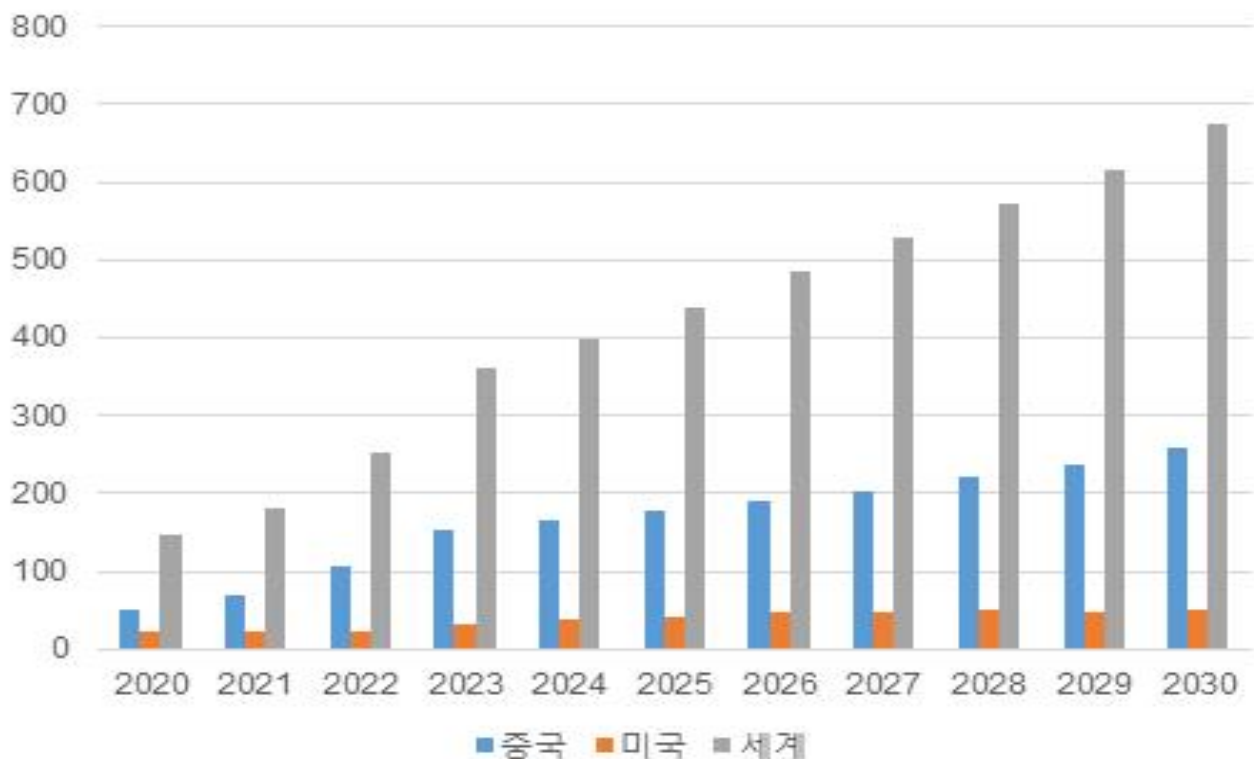
☞ The U.S., which ranks second in global solar installations, is expected to continue its steady growth with 45 GW in 2025, 50 GW in 2028, and 55 GW in 2030.

☞ As demand from developing countries such as Asia, the Middle East and Africa increases, the share of the Big2 (China and US) market, which exceeded 50%, is expected to fall below 50% after 2025.

- Rapidly growing demand for solar power in developing countries is expected to replace a significant portion of the demand in the Big2 market after 2025

< 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 Forecast at the beginning of the year	2023 Revised Forecast
People's Republic of China	53.0	44.3	33.1	52.1	69.0	125	130	155
United States	10.9	10.2	11.5	18.7	24.0	25	30	35
India	10.3	11.1	11.6	4.2	12.4	17	15	15
Brazil	1.4	1.5	2.8	3.9	6.7	11	10	15
Germany	1.7	3.6	3.8	4.9	5.3	7.0	9.0	10
Japan	7.4	6.7	6.7	8.7	6.5	5.5	5.0	5.0
Spain	0.1	0.3	5.0	2.9	4.6	7.0	8.0	8.0
Australia	1.3	4.0	3.5	3.6	4.7	4.5	5.0	5.0
South Korea	1.3	2.3	3.7	4.1	4.2	3.0	3.0	2.5
France	0.08	0.2	0.8	0.3	2.6	2.5	3.5	3.5
Global	106	118	145	182	244	270	320	340

Source: BNEF, Export-Import Bank forecast

2. Photovoltaic Main Product Price Trend

As of July 2023, the polysilicon price was \$7.85/kg, down 79.9% from its August 2022 high of \$39/kg.

☞ In 2022, the tight polysilicon supply situation due to the increase in global solar demand and the surge in raw material prices due to global inflation led to a high of \$39/kg in polysilicon prices

☞ As we enter 2023, large-scale expansion volumes are being supplied to the market, and polysilicon prices are falling sharply due to the easing of inflation due to global interest rate hikes.

- Polysilicon prices rebounded from \$24/kg in January 2023 to \$29.9/kg in March, but fell below \$10/kg in May

☞ From January to April 2023, the output of Chinese polysilicon enterprises was about 420,000 tons, a year-on-year increase of 90%

- From the second half of 2022, newly expanded polysilicon volumes are entering the market, and the supply is higher than expected, resulting in a sharp price situation.

✚ In 2022, the global polysilicon production capacity was 980,000 tons, but the production capacity is expected to increase to about 1.6 million tons in 2023 due to large-scale facility expansion.

- 1.6 million tons of polysilicon has the capacity to make about 600 GW of solar cells, which is more than 240 GW of oversupply compared to the global demand of 360 GW

✚ Due to the oversupply of polysilicon, polysilicon prices were expected to clean up below \$15/kg in the first half of this year, but the decline is steeper due to the higher than expected supply.

- The U.S. trade sanctions on polysilicon produced in Xinjiang and Uyghur (which accounts for about 40% of China's polysilicon production) and the need for polysilicon produced in Xinjiang and Uyghur to be digested in China's domestic market are also contributing to the sharp decline in prices.

- Polysilicon produced in Europe and Southeast Asia has a premium of \$5~10/kg compared to Xinjiang and Uyghur acid, so the price is relatively defensible

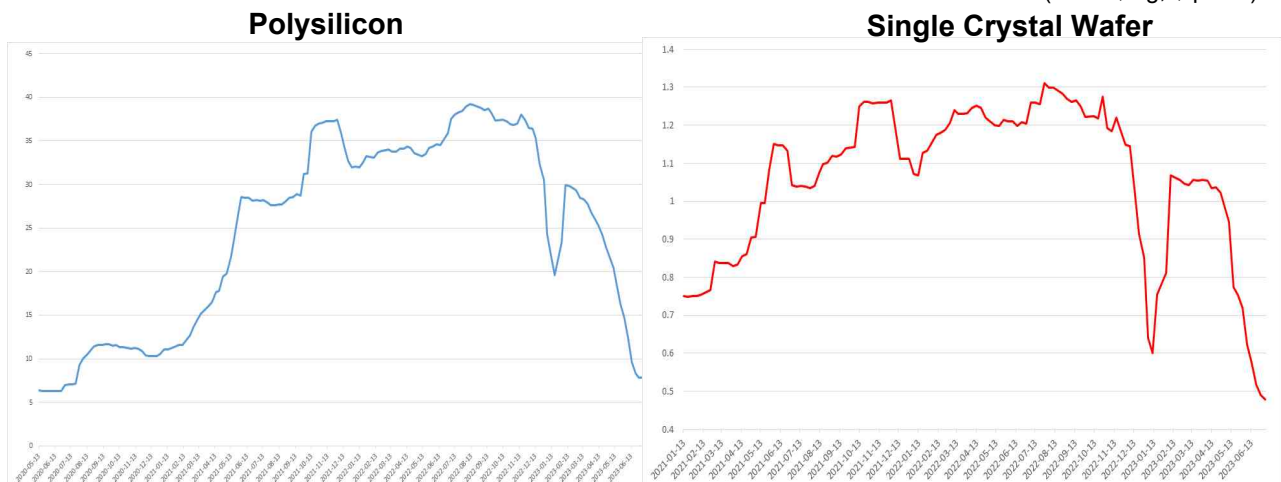
(Wafer) As of July 2023, the price of 210mm monocrystalline silicon wafer is \$0.48/piece, down 63.1% from the July 2022 high (\$1.31/piece).

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

✚ In 2023, wafer prices are declining in a pattern similar to the decline in polysilicon prices, and further declines are likely

- In the case of wafers made of polysilicon produced in Xinjiang and Uyghur regions, exports are limited and must be digested in China's export market, but this is not the case, so the oversupply is more serious than expected.

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



Material: BNEF, 210mm monocrystalline wafer price standard

As of July 2023, the price of 210mm monocrystalline solar cells was \$0.09/W and the price of 210mm monocrystalline modules was \$0.18/W, down 45.0% and 33.3% respectively from the year-on-year highs.

☞ In July 2023, solar cell and module prices also fell significantly compared to the previous year's highs, but the decline compared to polysilicon and wafer prices was relatively small

- Product prices have a time lag in the rate of reflection of rising and falling raw material prices, so even when they fall, product prices fall relatively modestly.

☞ Product price decline in 2023 is expected to act as a positive factor for the growth of solar demand in the second half of the year

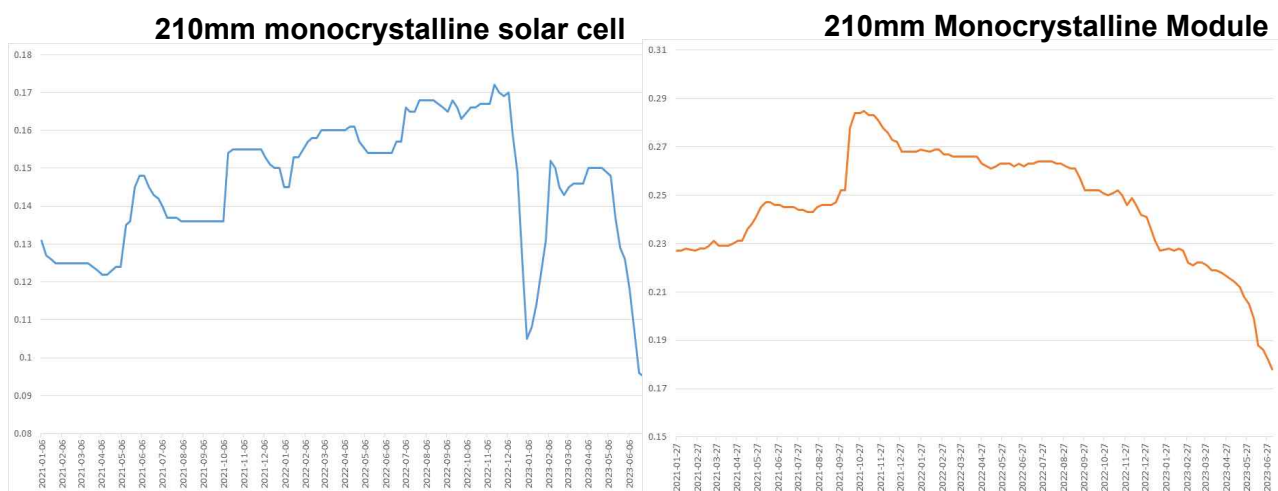
- The module cost accounts for 20~40% of the solar project cost, so the decrease in module price leads to a decrease in project cost and solar power generation unit price.

- Since cost reduction is directly related to the improvement of the economic feasibility of solar projects, the return rate of solar projects, which was low in 2022, is expected to improve from the second half of 2023 onwards, which is expected to increase the development of solar projects.

☞ Despite the increase in global solar demand in 2023, the price of solar cells and modules is expected to continue its downward trend in the second half of the year due to weak prices of raw materials such as polysilicon and wafers and oversupply.

- The production capacity of solar cells and modules by Chinese companies has significantly exceeded 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. Solar Supply Trends

As of completion in 2023, the global polysilicon production capacity is 1.13 million tons.

☞ The polysilicon production capacity by country is 940,000 tons in China, 61,000 tons in the United States, 60,000 tons in Germany, 35,000 tons in Malaysia, 11,000 tons in Japan, 8,000 tons in Qatar, 7,000 tons in Norway, and 65,000 tons in South Korea.

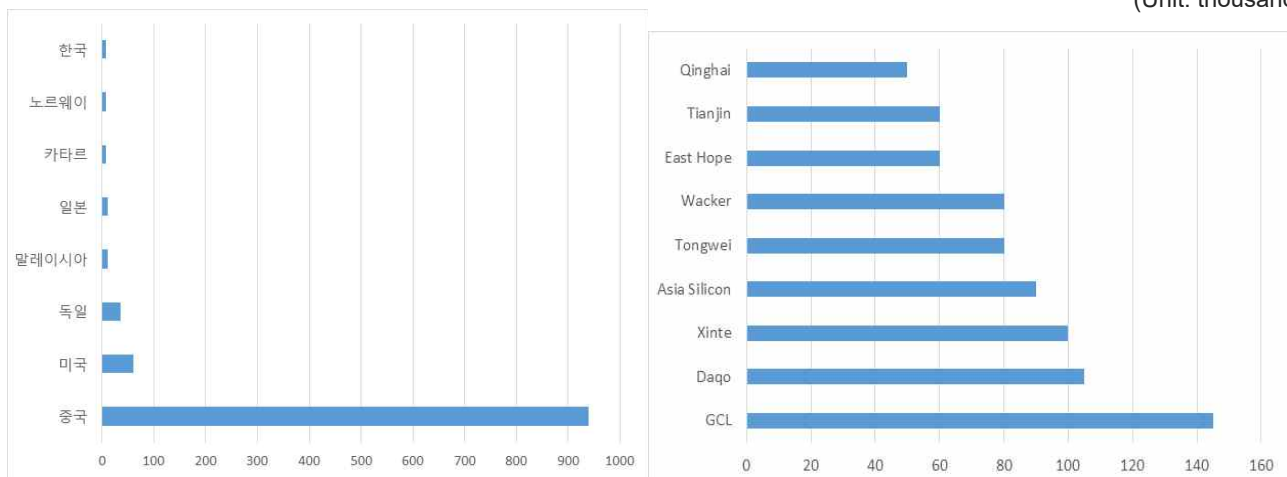
- As of 2023, China's share of production capacity by country is 83%, followed by the United States (5.4%), Germany (5.3%), and Malaysia (3.1%).

☞ Looking at the production capacity of each company, GCL 145,000 tons, Daqo New Energy 105,000 tons, Xinte Energy 100,000 tons, Asia Silicon 90,000 tons, and Wacker 80,000 tons

☞ 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 global and corporate polysilicon production capacity as of 2023

(Unit: thousand tons)



Material: BNEF

(Wafers) As of completion in 2023, the global wafer production capacity is 492GW

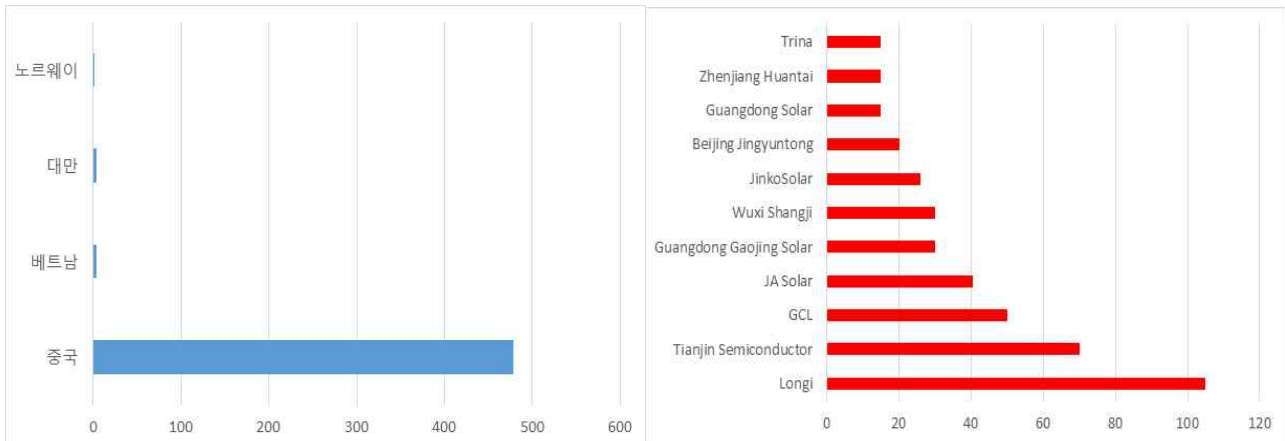
☞ Looking at the production capacity by country in 2023, China 478GW, Vietnam 4GW, Taiwan 3.7GW, and Norway 1GW

☞ As of 2023, the wafer production capacity under construction is 116GW, with 101GW in China and 15GW in Vietnam under construction

- Wafer production capacity is expected to exceed 600GW by 2024, and China's wafer production capacity is expected to reach 580GW

< Wafer production capacity status by world and company as of 2023 >

Unit: GW



Source: BNEF

As of completion in 2023, the world's solar cell production capacity is 538W

☞ In 2023, the production capacity by country was 460GW in China, followed by 18GW in Vietnam, 16GW in Thailand, 16GW in Malaysia, and 7.8GW in South Korea.

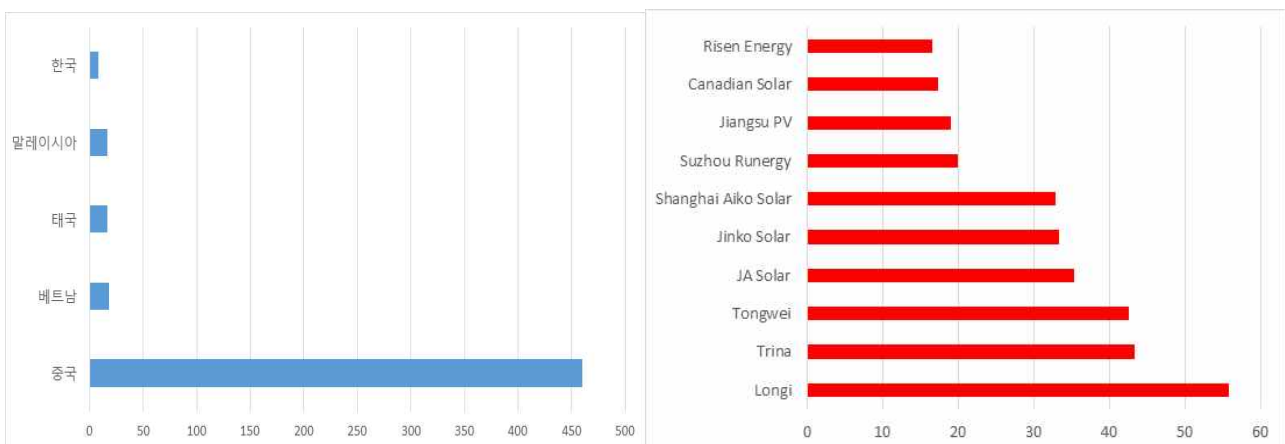
- As of 2023, the share by country is 86% in China, 3.3% in Vietnam, 3.0% in Thailand, 3.0% in Malaysia, and 1.4% in South Korea.

☞ Currently, the solar cell capacity under expansion is about 110GW, and the global solar cell production capacity is expected to reach 650GW when the expansion is completed.

- The volume of new solar cells expanded to 106GW in China and 5.4GW in Thailand

< 2023 Solar Cell Production Capacity Status by World and Company >

Unit: GW



Source: BNEF

As of 2023, the global module production capacity is 657GW

☞ In 2023, the module production capacity by country is 540GW in China, followed by 26GW in Vietnam, 15GW in Malaysia, 14GW in India, 10GW in Thailand, and 10GW in South Korea.

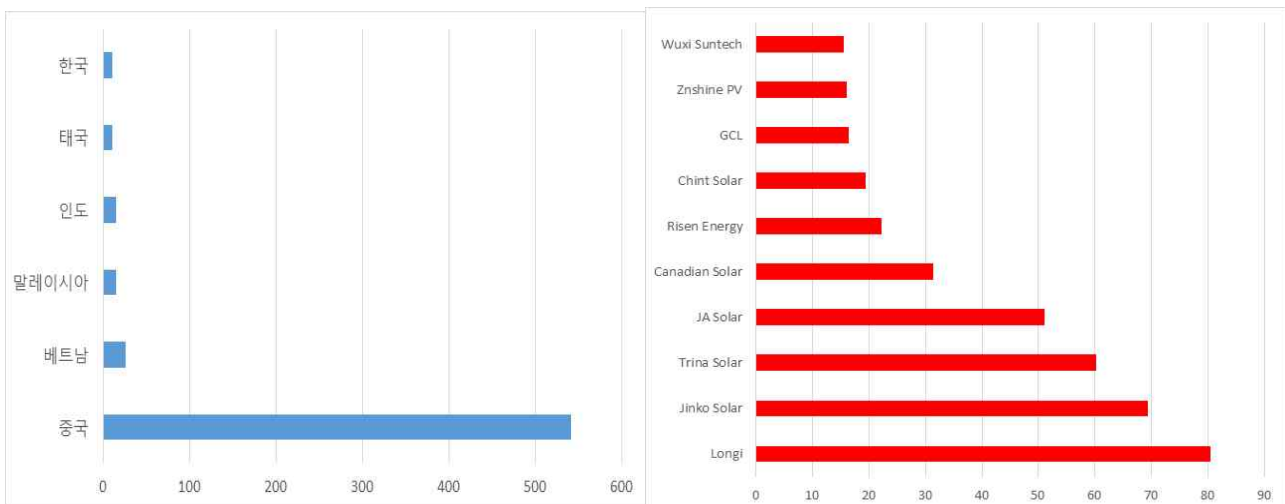
☞ As of 2023, the production capacity under construction for expansion is 81GW, followed by 72GW in China, 4.5GW in India, 1GW in Austria, and 1GW in Turkey

- When the current expansion is completed, the global module production capacity is expected to reach 740GW, of which China accounts for about 84%

☞ Looking at the module production capacity by company in 2022, Longi 80.4GW, Jinko Solar 69.3GW, Trina Solar 60.3GW, JA Solar 51.0GW, Canadian Solar 31.4GW, and Korea's Hanwha Q CELLS ranked 13th with 12.4GW.

☞ In 2023, the module supply capacity compared to the global solar demand (320GW) will reach 657GW, and the oversupply will exceed 300GW, and module prices are expected to weaken for the time being.

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



Source: BNEF

II. Major Issues in the Photovoltaic Industry and Corporate Performance

1. Analysis of the Competitiveness of China's Photovoltaic Industry

The core competitiveness of China's photovoltaic industry is competitive low investment cost through the development of its own production technology and cost competitiveness through securing economies of scale.

✓ Chinese photovoltaic companies have dominated the global photovoltaic industry by securing economies of scale through large-scale investments, and through continuous investment, there are now no competitors.

- China has a virtual monopoly on photovoltaic manufacturing, securing more than 80% of the entire value chain of the photovoltaic industry, including polysilicon, wafers, solar cells, and modules.

✓ Based on the annual production capacity of 1GW in 2022, the investment cost for each value chain in the major regions of the photovoltaic industry is as follows.

- Polysilicon investment is \$34 million in China, \$44 million in Southeast Asia, and \$124 million in the U.S. and Europe, which is only 27% of the U.S. and Europe.

- The investment cost of solar cells is 46 million US dollars in China, 68 million US dollars in Southeast Asia, and 196 million US dollars in Europe and China, which is only 23% of the US and Europe, so it takes more than 4 times more investment than China to build solar cell factories in the US and Europe.

- The investment cost of solar modules is 19 million USD in China, 25 million USD in Southeast Asia, and 84 million USD in the United States and Europe, which is 23% of the investment cost in the United States and Europe.

✓ The key to the cost competitiveness of China's photovoltaic industry is due to low capital investment costs through self-sufficiency of manufacturing facilities.

- In the early days, China's photovoltaic industry technology entered the market through the introduction of equipment developed in Europe and the United States, but now a large part of the production equipment has been internalized to produce solar products.

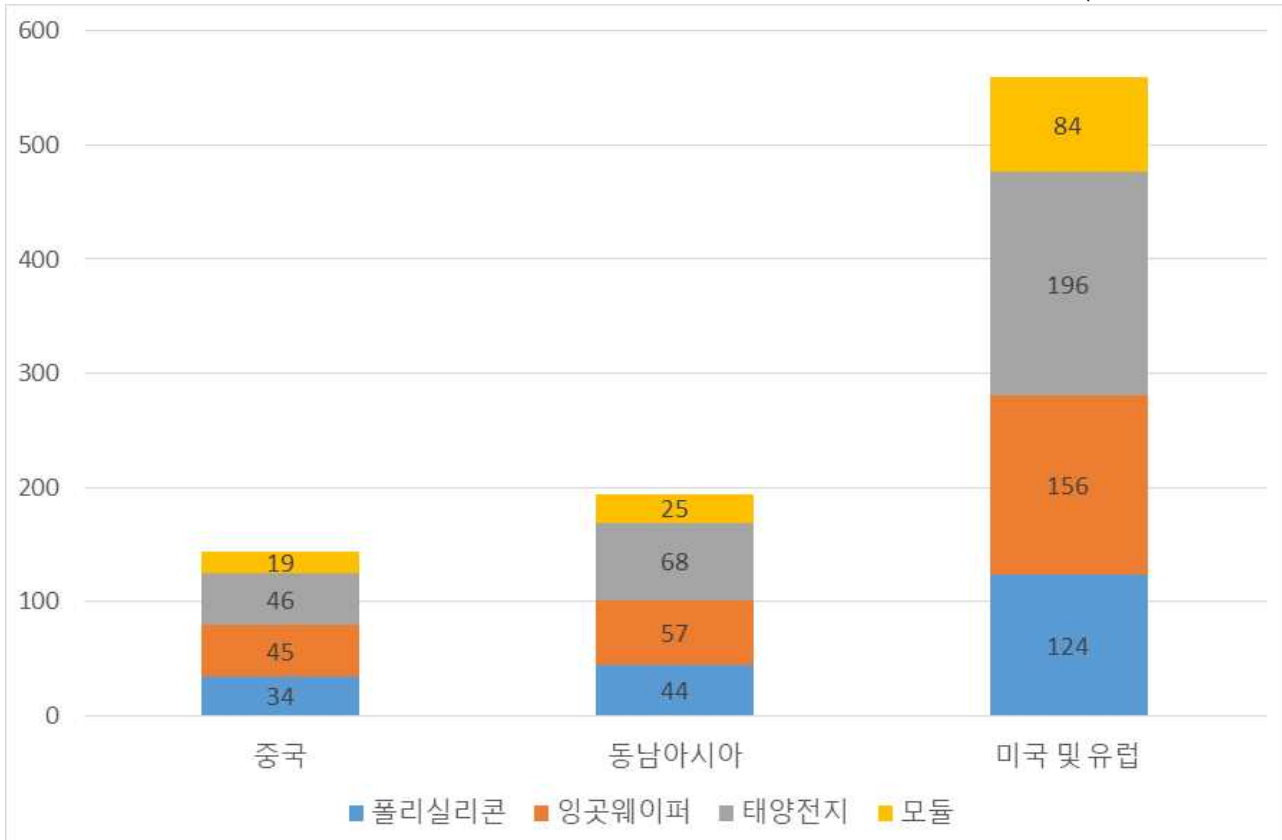
- In particular, we have secured the world's best technology in the field of ingots and wafers, such as single crystal growth and diamond cutting technology, and there are no competitors

✓ China's industrial competitiveness in next-generation photovoltaic technology is also at a high level, and Chinese companies' leadership in the global photovoltaic industry is expected to be maintained for a considerable period of time.

- In order to increase the efficiency and price competitiveness of next-generation solar cells, large-scale wafers are becoming a major trend, and for this, the supply of large-sized wafers is essential.

- China accounts for 97% of wafer supply, making it impossible to produce next-generation solar cells without China's wafer supply, leading the way in next-generation solar cell technology standards.

< As of 2022, the current status of investment expenditures by solar value chain by region > (Unit: Million Dollars)



Material: BNEF

Chinese photovoltaic companies have secured cost competitiveness through economies of scale, and achieved vertical integration of the value chain to maximize cost competitiveness.

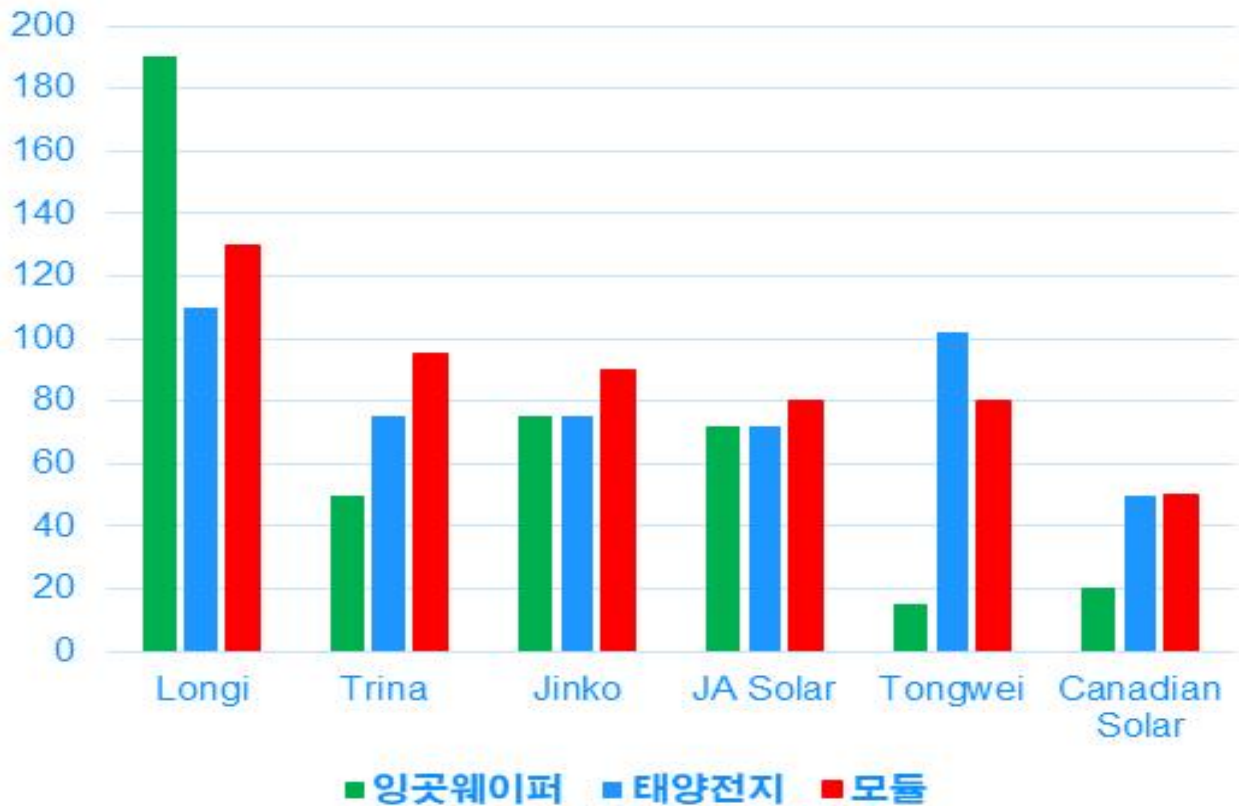
☞ In the past, Hanwha Solutions and others have made efforts to secure competitiveness through vertical integration, but as the competitive power of each value chain has not secured the highest level in the industry, it acts as a factor that weakens the competitiveness of the company.

☞ Recently, Chinese companies have been maximizing profits through direct integration by securing the highest level of competitiveness in each value chain through large-scale investments.

☞ As of 2023, Longi, a leading global solar power company, has secured the world's highest economies of scale across all stages of the value chain, including 190 GW of ingots and wafers, 110 GW of solar cells, and 130 GW of modules, and is realizing the world's highest operating profit

☞ China's major photovoltaic companies are expected to further strengthen vertical integration to maximize profits, and appropriate investments will continue to be made to maintain the competitiveness of each value chain.

< > the current status of vertical integration of major companies as of 2023 (Unit : GW)



Material: BNEF

2. IRA Enforcement Implications

The IRA is the most realistic way to lower the cost of solar equipment investment through the Advanced Manufacturing Production Tax Credit (AMPC) and Investment Tax Credit, making U.S. products competitive with Chinese products.

☞ The AMPC policy allows for tax credits ranging from a minimum of \$8.1 million to a maximum of \$70 million per 1 GW of polysilicon to modules, with a 10-year credit period from 2023 to 2032.

☞ Localization of the entire value chain, from polysilicon to modules, provides IRA tax incentives of up to \$0.17 per watt

- The deductions for each value chain are \$0.01/W for polysilicon, \$0.05/W for wafers, \$0.04/W for solar cells, and \$0.07/W for modules

☞ The deduction for wafer production is \$0.05/W, which provides a higher level of subsidy to promote active investment in view of the high cost of wafer production in the United States.

< IRA Highlights >

type	article	content	period
Installation-related tax credits	Investment Tax Credit (48 Revision)	I Deduct a percentage of capital expenditure (up to 30%)	Phase-out after 2032 (extended if carbon emissions are not reduced by more than 75% in 32 compared to 22 years)
	Production Tax Credit (48C Amendment)	I Deduction per power unit production	
Manufacturing Credit	Investment Tax Credit (48C deduction)	I Deduct a certain percentage of the investment amount of production facilities (up to 30%) I 10 billion in total	Construction must be completed within 2 years after obtaining a deduction permit from the authorities.
	Manufacturing Tax Credit (45X new)	I Tax credit per unit of production - Polysilicon : \$3/kg - Wafer: \$12/m2 - Cell: \$0.04/W, Module: \$0.07/W	Reduction of deductions after 30 years - 30.1.1~ : 75% compared to 29 years - 31.1.1~ : 50% compared to 29 years - 32.1.1~ : 25% compared to 29 years - 33.1.1~ : 0% compared to 29 years

Source: International Trade Association

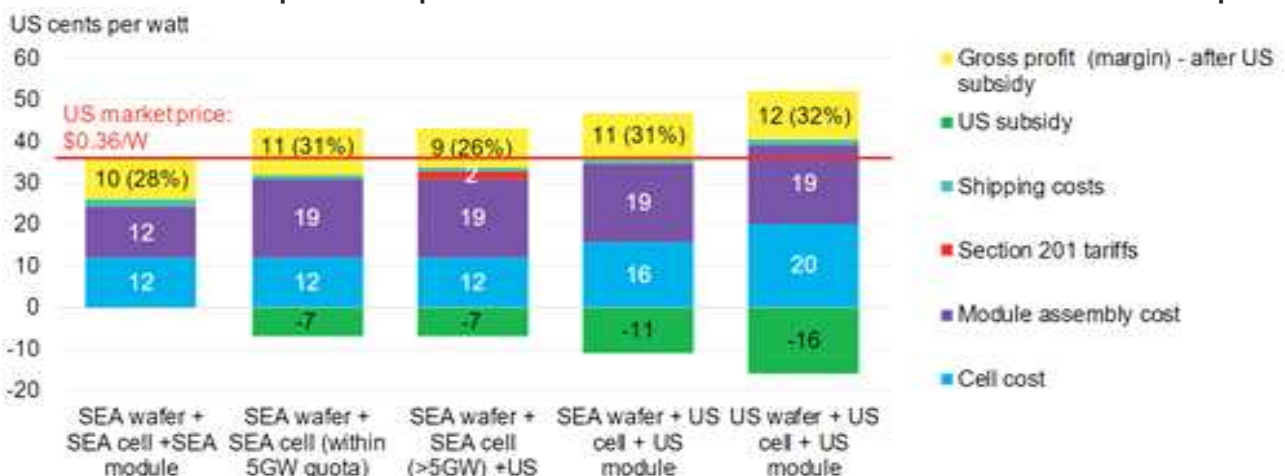
With the implementation of the IRA, the price of solar modules made in the United States is expected to be competitive compared to the price of modules manufactured in Southeast Asia.

ÿ The manufacturing cost of wafer-solar cell-module produced in Southeast Asia is about 24 cent/W, and if wafer-to-module production is produced in the U.S. through IRA subsidy, the production cost is estimated to be 23 cent/W, which is expected to secure price competitiveness compared to products produced in Southeast Asia

ÿ If the suspended tariffs on Chinese products circumventing through Southeast Asia are normalized by December 2024, the price competitiveness of U.S. products is expected to increase.

ÿ The implementation of the IRA for the establishment of solar manufacturing facilities in the U.S. is likely to have a policy effect

< Comparison of production costs in the US VS Southeast Asia when IRA is implemented >



Material: BNEF

The implementation of the IRA is expected to benefit our solar companies, and the IRA tax deduction effect will be reflected in the financial statements starting this year.

☞ Hanwha Solutions plans to invest KRW 3.2 trillion to build a solar hub in Georgia, U.S., to prepare for the implementation of the IRA.

- Newly built plant to produce ingots, wafers, solar cells, and modules with an annual capacity of 3.3GW each, and expand the number of modules with an annual production capacity of 1.7GW to 8.4GW through additional production lines.

☞ When ingot, wafer, and solar cell factories start mass production from 2025, the tax deduction is expected to increase from 159 billion won this year to 690 billion won in 2025.

☞ The best strategy to target the U.S. solar market is to supply products through the construction of local factories

- As the supply of products through Southeast Asia is also expected to become less competitive due to the imposition of tariffs in the future, the best way to target the US solar market is through a localization strategy.

< > estimate of Hanwha Solutions' tax deduction amount due to IRA implementation

	2023년		2024년		2025년		2026년	
	생산용량	생산량	생산용량	생산량	생산용량	생산량	생산용량	생산량
모듈	3.1GW	1.9GW	8.4GW	2.7GW	8.4GW	5.8GW	8.4GW	8.4GW
잉곳/ 웨이퍼	-	-	3.3GW	-	3.3GW	2.0GW	3.3GW	3.3GW
태양전지	-	-	3.3GW	-	3.3GW	2.0GW	3.3GW	3.3GW
세제지원 금액	1,590억 원		2,310억 원		6,900억 원		1조590억 원	

Source: Hanwha Solution, NH Securities

3. Key Company Performance

Until the first quarter of 2023, the performance of major global photovoltaic companies has not been affected by the price decline of products such as polysilicon, and the performance of major companies improved year-on-year.

☞ Longi, JA Solar, Jinko Solar, and other top Chinese companies have continued to see an upward trend in sales due to major capacity expansion since 2021.

- China's Longi reported revenue of \$4.14 billion in the first quarter of 2023, up 41.2% year-on-year, while the revenue of major solar companies such as JA Solar and Jinko Solar in the first quarter of 2023 increased by more than 20% year-on-year.

Y Until the first quarter of 2023, the operating performance of photovoltaic companies is expected to be good, but the performance of photovoltaic companies is expected to deteriorate QoQ after the second quarter, when the price decline is reflected in earnest.

- Revenue is expected to increase due to increased demand for photovoltaics, but product margins are expected to decline as solar product prices weaken
- The profitability of materials companies such as polysilicon, which has recorded high operating profits, is expected to decline significantly, but in the case of module companies, the decline in raw material prices is expected to be greater than the decline in module prices, so profitability is expected to be relatively good.

Y The performance of photovoltaic companies in the second half of 2023 is expected to be better than that of material companies such as polysilicon.

- In particular, the IRA deduction effect will be reflected from the second half of the year, which is expected to further improve the performance of companies receiving IRA benefits.

< Overseas Companies' Performance Trends > (Unit: billion dollars)

Company Name	2020		2021		2022		Q1 2022		Q1 2023	
	Sales		Sales		Sales		Sales		Sales	
	Operating Profit		Operating Profit		Operating Profit		Operating Profit		Operating Profit	
Long	79.2	14.4	125.5	14.8	191.8	13.1	29.3	4.1	41.4	3.8
JA SOLAR	37.5	3.6	64.0	5.7	108.5	10.1	19.4	1.6	29.9	4.4
Jinco Solar	51.0	3.4	62.9	8.4	122.9	5.3	23.1	0.9	33.8	3.1
Canadian	34.8	2.2	52.8	2.3	74.7	4.2	12.5	0.2	17	1.5
Solar										
Trina Solar	42.7	2.7	69.0	3.7	126.5	7.2	24.1	1.2	31.1	2.2
Tongwei	64.1	5.9	98.4	17.9	211.8	63.1	38.9	11.3	48.6	18.6
Daqo	6.8	1.9	16.8	10.7	46.1	30.4	12.8	8	7.1	4.6
First Solar	27.1	4	29.2	4.8	26.2	-1.4	3.7	-0.5	5.5	0.4

Data: IR data

III. Trends in the Domestic Photovoltaic Industry

1. Domestic Photovoltaic Market Trend

In 2023, the domestic photovoltaic market is expected to have 2.7GW installed, a decrease of 15% compared to the previous year, and the annual demand is expected to be around 2.5~3.0GW by 2030.

☞ Domestic photovoltaic installations are decreasing after peaking at 5.5GW in 2020, and demand is expected to stagnate within 2.5~3.0GW in the future.

- Domestic solar power installations are expected to stagnate due to changes in government policies, such as lowering the proportion of renewable energy to 21.6% in 2030, abolishing the RPS system, introducing an auction system, and fixing the wholesale electricity price (SMP) cap.

☞ With the rise of the RE100 issue in the global supply chain, the demand for solar power from domestic manufacturers is expected to increase significantly.

- Global companies such as Apple are demanding domestic companies to produce products using renewable energy, and the demand for producing products using renewable energy is expected to intensify in the future.

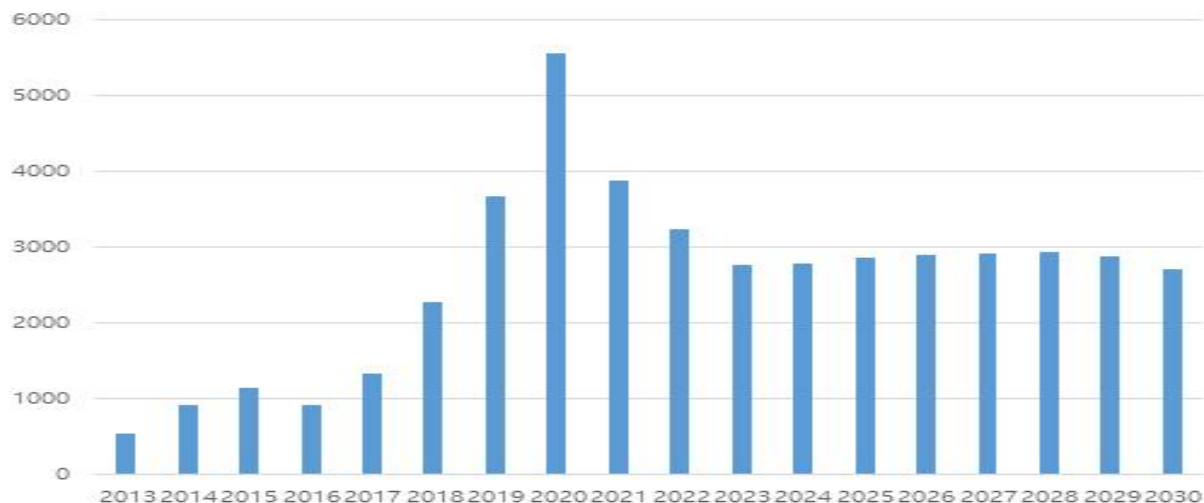
- Demand for solar power generation by domestic companies is expected to play a major role in the demand for solar installations in Korea

☞ Domestic photovoltaic power generation is still recognized as an expensive source of power generation, but due to the continuous decline in module prices, Korea is also about to reach grid parity in solar power generation, and 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.

< Domestic Solar Installation Status and Prospects >

(Unit : MW)



Source: Korea Energy Agency, Export-Import Bank

2. Export Trends

Polysilicon exports in the first half of 2023 fell 11.7% year-on-year to \$29.1 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, and exports have decreased significantly compared to the past

☞ Polysilicon exports in 2023 are expected to be only around \$50 million due to a significant drop in polysilicon prices.

- Exports continue to decline, and exports in the second half of the year are expected to decline more than in the first half of the year as polysilicon prices turn bearish.

In the first half of 2023, solar cells and modules exports increased by 50.2% year-on-year to \$680 million.

☞ Looking at the export value by export destination, the United States accounted for 670 million US dollars, accounting for 98.5% of the total solar cell and module exports, almost all of which are exported to 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.

☞ Except for the U.S. market, which is restricting Chinese products, the competitiveness of domestic photovoltaic products continues to be inferior to that of Chinese products.

- Regional diversification of solar exports is needed, but the current situation is expected to persist until it has a clear technological and price advantage over China.

3. Import Trends

Imports in the first half of 2023 fell 20.6% year-on-year to \$210 million.

☞ In the first half of 2023, wafer imports have fallen sharply due to the sharp decline in wafer prices, and the import value in the second half of the year is also expected to decline significantly.

☞ Imports from China accounted for \$207 million, accounting for 99% of the total, with imports of \$3 million from Taiwan.

- The company is fully dependent on wafers from China and has a very weak industrial structure in terms of supply chain diversification

Imports in the first half of 2023 increased by 21.7% year-on-year to \$155 million.

☞ In the first half of 2023, the import value of solar cells and modules increased by 21.7% year-on-year, and the main importer was China, which accounted for \$150 million of the total import value of \$155 million.

☞ Module cost accounts for about half of the cost of a solar project, so the unit cost of the module is the most important factor in the construction of the project, as the profitability of the project is improved if the inexpensive module is installed.

☞ As the financing cost for project construction rises, it is expected that the preference for cheaper Chinese-made modules will increase further in order to lower the cost of the project

<Domestic Photovoltaic Industry Export and Import Trends > (Unit: Million Dollars)

	2019, 2020, 2021, 2022								June 2023	
	export	import	export	import	export	import	export	import	export	import
Polysilicon	476.2 (-36.2%)	26.9 (-14.9%)	118.7 (-75.1%)	18.0 (-33.0%)	95.2 (-19.8%)	32.3 (79.4%)	61.7 (-35.2%)	6.4 (-80.3%)	29.1 (-11.7%)	1.8 (-47.2%)
Ingot	6.4 (-4.2%)	6.8 (94.3%)	0.7 (-89.6%)	5.3 (-21.3%)	1.1 (65.1%)	19.5 (265.2)	2.0 (77.9%)	24.5 (25.7%)	0.6 (-9.3%)	2.8 (-80.3%)
wafer	20.3 (-78.4%)	398.0 (-30%)	12.1 (-40.7%)	343.2 (-13.7%)	9.0 (-25.5%)	485.1 (41.4%)	7.7 (-13.8%)	567.7 (17.0%)	2.2 (-46.5%)	210.7 (-20.6%)
Solar Cells & Modules	1,592.3 (-0.8%)	760.0 (192%)	1,382.1 (-13.2%)	624.5 (-32.5%)	1,089.3 (-21.2%)	647.7 (18.0%)	1,547.8 (43.7)	269.9 (-58.3%)	683.2 (50.2%)	154.6 (21.7%)

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

4. Domestic Corporate Performance Trend

Led by module companies, the business performance of major domestic photovoltaic companies in the first quarter of 2023 improved year-on-year

☞ OCI Polysilicon sales increased by 11.9% year-on-year to KRW 218 billion, while operating profit decreased by 20.2% to KRW 8.9 billion

- In 2022, sales and operating profit improved significantly due to strong polysilicon prices, but operating profit decreased slightly year-on-year in 2023 due to the bearish reversal of polysilicon prices.

- However, due to the tightening of U.S. regulations on Chinese polysilicon, Q2 earnings are expected to be better than expected amid a slump in polysilicon prices due to a premium for polysilicon produced outside of China.

☞ In the first quarter of 2023, Hanwha Solutions' photovoltaic division posted KRW 1.37 trillion in sales and KRW 245 billion in operating profit, up 48.4% year-on-year with sales and operating profit turning into a surplus.

- Although the gap with China's leading companies in terms of economies of scale is widening, the company is securing competitiveness in the U.S. market by investing KRW 3.2 trillion in the U.S. to build a supply chain and become the No. 1 market share in the U.S. market

- Business performance in 2023 is expected to improve significantly 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 performance status of domestic solar companies (Unit : Billion KRW)

기업명	2020		2021		2022		2022 1분기		2023 1분기	
	매출액	영업 이익	매출액	영업 이익	매출액	영업 이익	매출액	영업 이익	매출액	영업 이익
OCI (베이직케미칼)	8,520	-77	13,330	4,870	8,651	895	1,948	109	2,180	87
한화솔루션 태양광사업	37,023	1,904	35,685	-3,285	55,685	3,501	9,206	-1,142	13,661	2,450
현대에너지 솔루션	3,944	88	5,932	95	9,848	902	1,761	77	1,408	80
신성 이엔지 RE사업부	1,183	-84	1,041	-130	1,196	47	291	6	200	15

Materials: IR materials of each company

IV. Implications

In 2023, the global solar installation volume is expected to be more than 20GW more than the forecast at the beginning of the year (320~340GW) due to good demand in the Big2 (China and USA) region and the rapid growth of the developing market

Ÿ The decline in module prices has led to an improvement in economic feasibility due to the reduction of investment costs in solar projects, which is driving new demand.

Ÿ The main factor behind the surge in China's photovoltaic demand in Q1 is the improvement in the economic feasibility of photovoltaic projects due to module prices.

Ÿ As module prices are expected to decline further in the second half of the year, solar installations in major regions are expected to increase significantly more than expected.

Ÿ Demand in Europe and the Middle East is also growing rapidly, and global solar installations in 2023 are expected to exceed previous estimates

Global solar demand is expected to accelerate even further after 2023, with annual solar demand expected to reach 500 GW before 2027.

Ÿ As the global solar power installation of 500GW is expected to be achieved by 2027, the need to reduce the use of fossil energy such as coal and gas and expand the use of renewable energy such as solar power is becoming more prominent as the damage caused by global climate change such as droughts and typhoons is rapidly increasing.

- As the climate catastrophe caused by global warming is in full swing, efforts to reduce greenhouse gas emissions are expected to accelerate, and cleanliness of the power generation sector, which accounts for 40% of greenhouse gas emissions, is inevitable.

Ÿ The most realistic way to clean up the power generation sector is to expand the use of renewable energy that is economically feasible, which is expected to lead to an increase in demand for solar power.

Ÿ With the overlap of many positive factors such as the arrival of grid parity and energy security issues, as well as climate change issues, the era of 500GW of global solar installations, which was expected to take place in 2027, is expected to be realized a little earlier.

- 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.

- With the Russia-Ukraine war highlighting the need for energy self-sufficiency, global solar installations are expected to grow faster than previously expected.

After 2025, the construction of a new U.S. solar supply chain is expected to transform the China-centered solar power supply system, which is expected to further exacerbate the oversupply in China.

☞ 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.

☞ With the implementation of the Inflation Reduction Act in the United States, the country is trying to reduce its dependence on China by building solar power production facilities in the country, and after 2025, domestic facilities will be able to produce products that can meet domestic demand.

☞ If the import of modules from Southeast Asia is banned at the end of 2024, it is likely that the volume of exports that Chinese companies have exported to the United States through their Southeast Asian production facilities will be blocked, and although demand from developing countries is increasing, there is too much oversupply for products produced in China for domestic demand.

☞ If the oversupply in China worsens, there is a possibility that the prices of major products such as modules will drop significantly, and in this case, the profitability of Chinese solar companies may deteriorate significantly.

☞ The oversupply situation leads to a decrease in product prices, but the decrease in product prices is expected to have a positive effect on solar power consumers who can purchase products at a lower price, leading to an increase in solar demand.

For the development of Korea's photovoltaic industry, it is necessary to develop a market not only in the manufacturing field but also in the field of developing solar power projects, which are growing rapidly.

☞ The reality of the manufacturing sector of the domestic photovoltaic industry is that there is currently no market that can take competitiveness except for the U.S. market, which is blocking Chinese products due to protectionism.

- Looking at the export value of solar cells and modules in the first half of 2023, exports to the United States accounted for 98.5%, with almost no exports to the United States

- If the IRA is implemented, more products will be produced in the U.S., which will likely further reduce solar exports

- The way to strengthen the competitiveness of the domestic photovoltaic manufacturing sector is to localize in areas where there is demand, and it is currently limited to the United States

☞ Project development and operation can create more added value than the manufacturing field, and it is possible to enter various markets through program development linked to entering the market of developing countries using EDCF.

- It is necessary to expand into the field of solar power project development, which forms a larger market than the manufacturing sector, and active financial support is needed for this