PV Industry Trends

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24th October 2024, ISES Webinar

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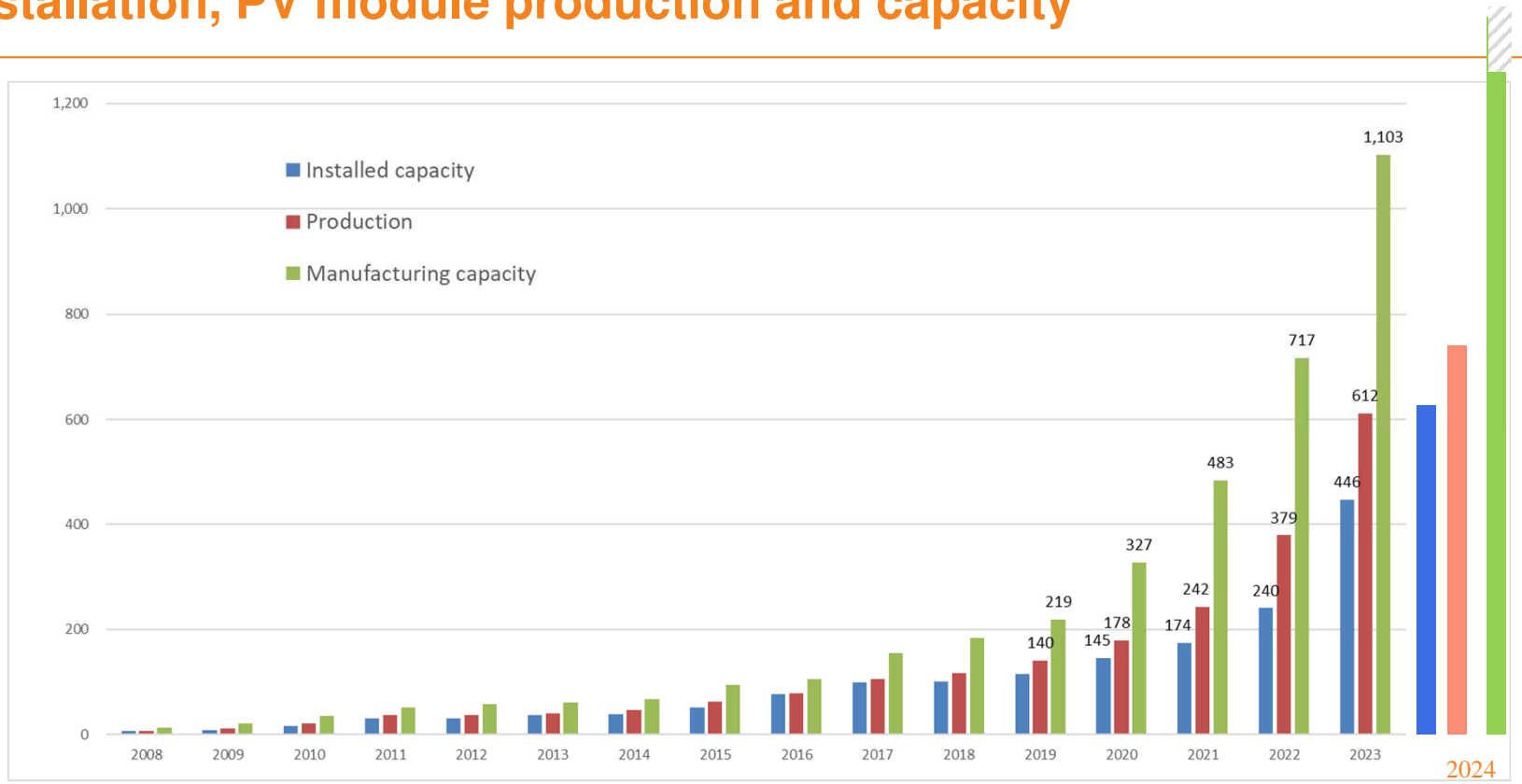
- Status of global PV industry
  - Share by country, factors affecting local production
- 1H2024 status and industry trends
  - Production and price trends
- Cost reduction opportunities
- Summary

Installation, PV module production and capacity



- 2023 : 612GW of production with >1 TW/year production capacity
- Capacity enhancement is slowing down in China (>60GW for Cell >20GW for module cancelled)
- Demand supply gap will continue

Source : IEA PVPS, Trends Report 2024

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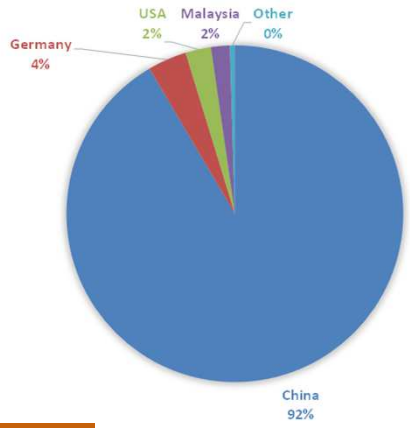
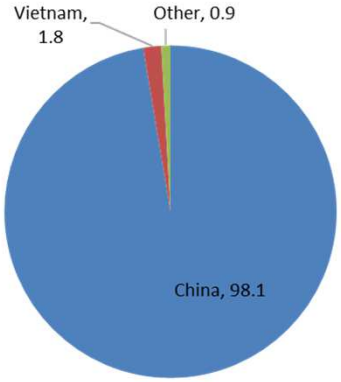
PV Supply Chain and share by country (2023)

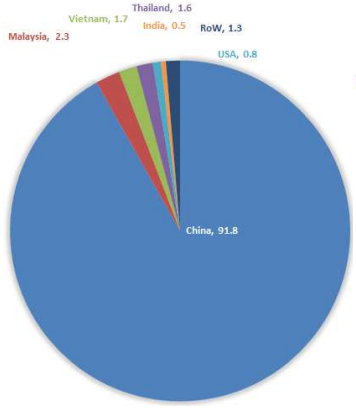
Wafer

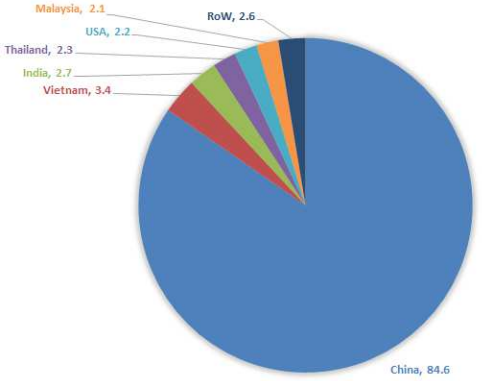
Cell

PV Module









Share of China

2022: 86%
2023 : 92%

2022 : 97.5%
2023: 98.1%

2022 : 84%
2023: 92%

2022 77.8%
2023: 84.6%

- China increased the share of production along the value chain
- Inverters, materials such as glass, encapsulants, equipment also China dominates
- Trade barriers and measures for local manufacturing contribute diversification of production sites

Source：IEA PVPS, Trends Report 2024

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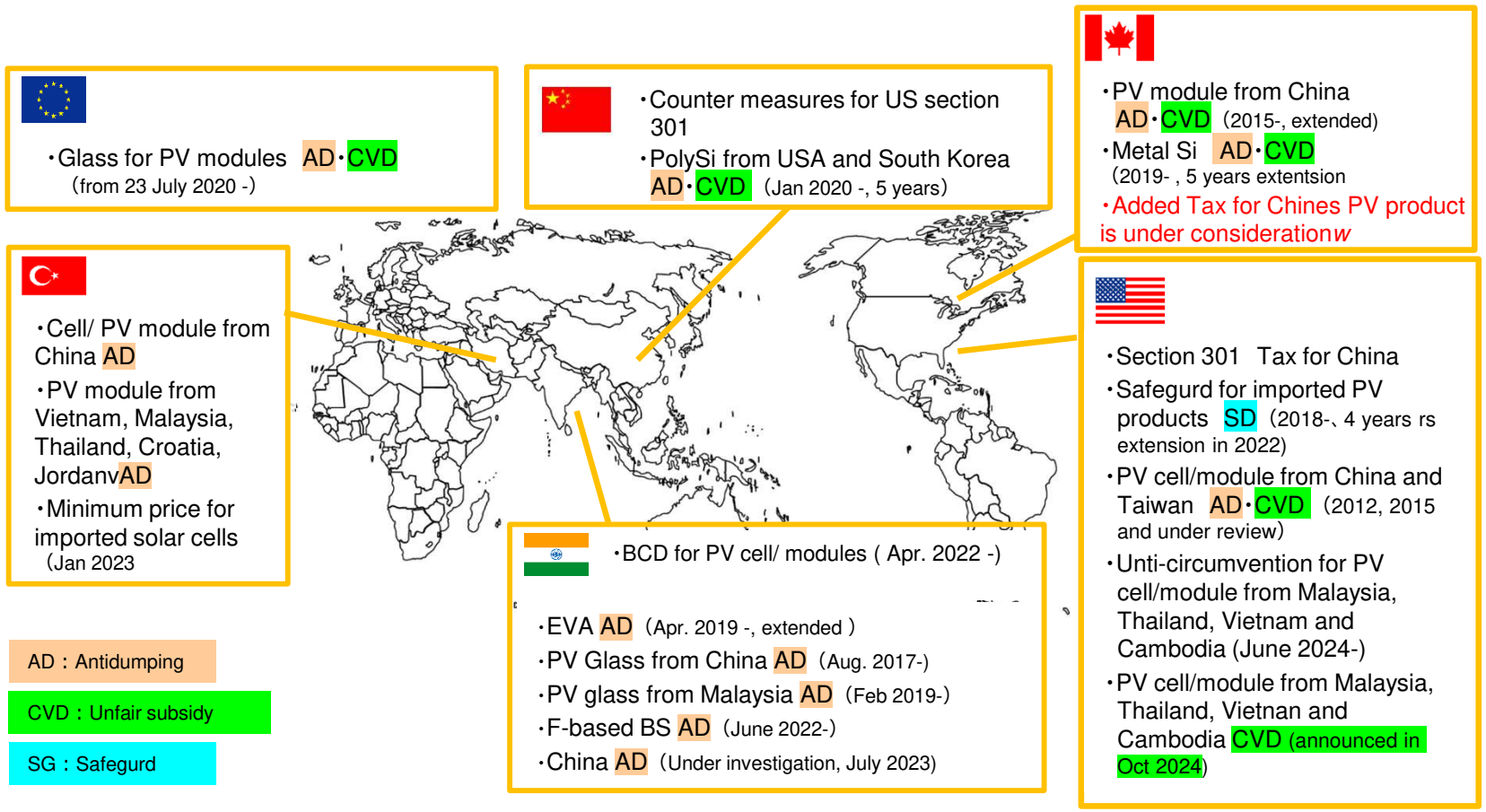
Trade issues affecting production bases



Source：RTS Corporation as of August 2024

Support measures for domestic PV supply chain

	Manufacturing	Domestic products	Barriers for import
USA 	- Tax credit for production under IRA (incentive for produced amount and incentive for CAPEX), Augst 2022	- Bonus tax credit for domestic content for projects	- AD and CVD (2012, 2014) - Safeguard Duty(2019) - Sec.301 Punitive tariffs on Chinese imports (2018) - Uyghur Forced Labor Prevention Act (UFLPA) (2020) - Anti Circumvention (2022) - **CVD for MY, TH, VT and KH (Oct 2024)**
	- PLI program (incentive for produced amount), Selection in 2021 and 2022	- **ALMM (qualification) (2021 -), mandate for solar cell from April 2026** - Domestic content for SECI auctions - Auctions for production and projects	- Basic Custom Duty (BCD)(Apr. 2022) - AD and CVD for materials for PV modules (EVA:2019, BS:202、Glass:2019, 2017)
	- EU Innovation Fund (CAPEX) - Incentive by member countries (DE, NL, ES, FR, HU, PR….)	- Resilience Auction based on Net Zero Industry Act -	- Ban on distribution of products produced using forced labor guideline being developed)

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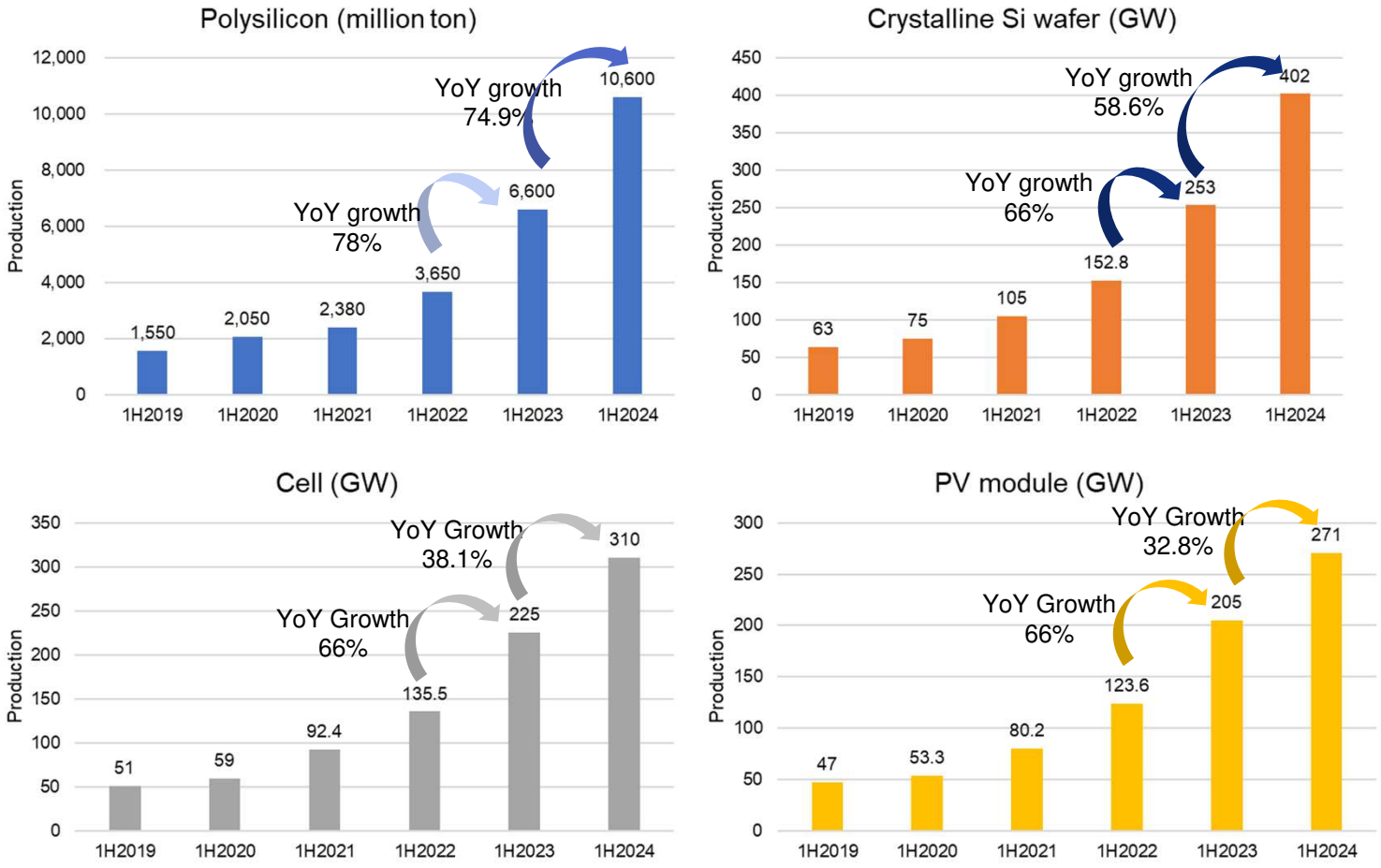
1H2024 Production amount along the value chain in China

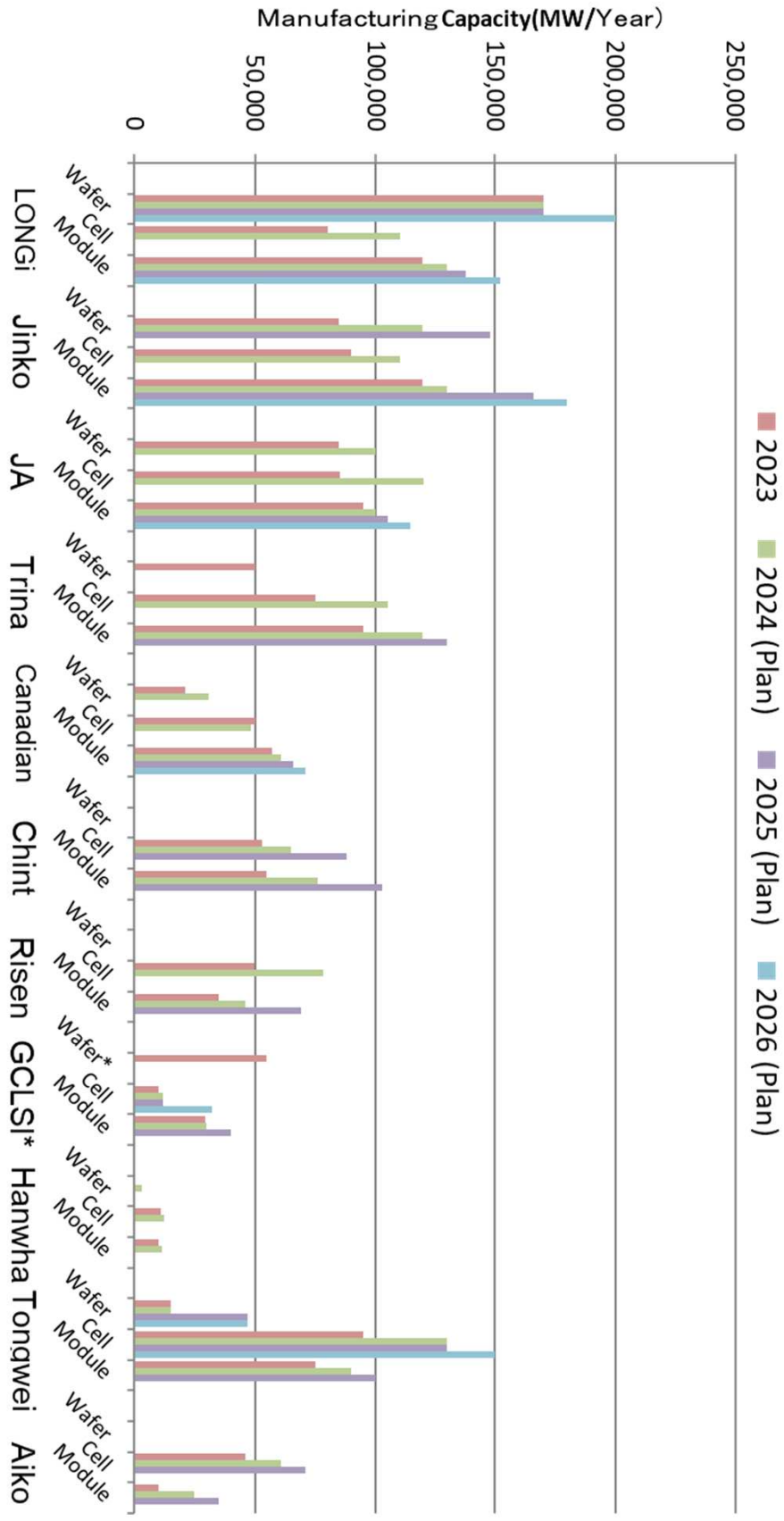


Source：Ministry of Industry and Information Technology （MIIT), China Photovoltaic Industry Association (CPIA), compiled by RTS Corporation

1H 2024 rankings of PV module shipment by supplier

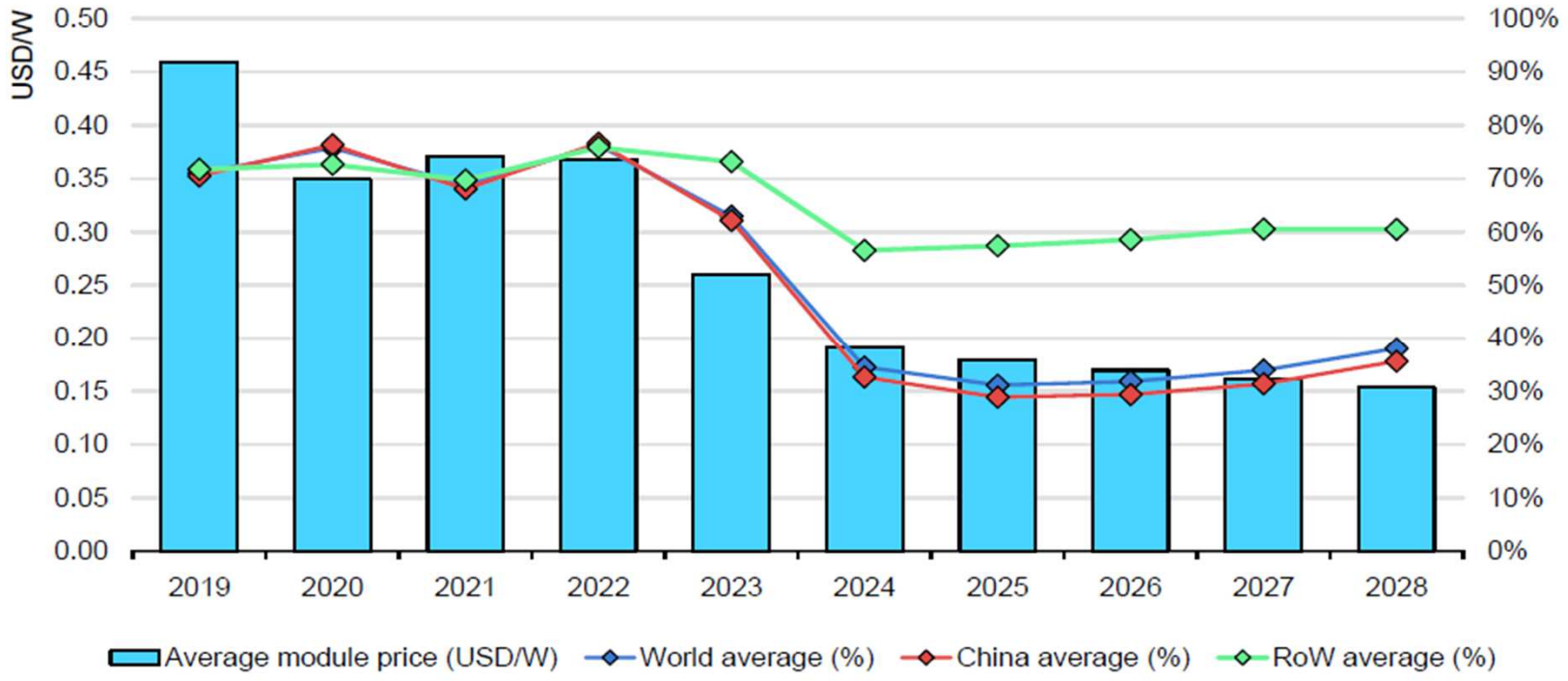
Ranking	1H2024（GW）		2023（GW）		2022（GW）	
1	JinkoSolar	43.8	JinkoSolar	78.5	LONGi Green Energy Technology	46.76
2	JA Solar Technology	38	LONGi Green Energy Technology	67.5	JinkoSolar	44.5
3	Trina Solar	34	Trina Solar	65.2	Trina Solar	43.09
4	LONGi Green Energy Technology	31.34	JA Solar Technology	55.3	JA Solar Technology	39.75
5	Tongwei	18.67	Tongwei	31.11	Canadian Solar	21.1
6	Zhejiang Chint Electrics	18	Canadian Solar	30.7	Risen Energy	13.5
7	Canadian Solar	14.5	Zhejiang Chint Electrics	28.0	Zhejiang Chint Electrics	13.5
8	GCLSI	10 – 11	Risen Energy	18.99	First Solar	*9.3*
	DAS Solar	10 - 11	DAS Solar	17.7	Hanwha Solutions	9
10	Hengdian Group DMEGC Magnetics	8.1	GCLSI	16.4	DAS Solar	8.5

Source：RTS Corporation, including estimated number


Manufacturing Capacity(MW/Year)
0
50,000
100,000
150,000
200,000
250,000
2023
2024 (Plan)
2025 (Plan)
2026 (Plan)
LONGi
Jinko
JA
Trina
Canadian
Chint
Risen
GCLSI*
Hanwha
Tongwei
Aiko
Wafer
Cell
Module
Wafer*

Outlook for PV module price by IEA

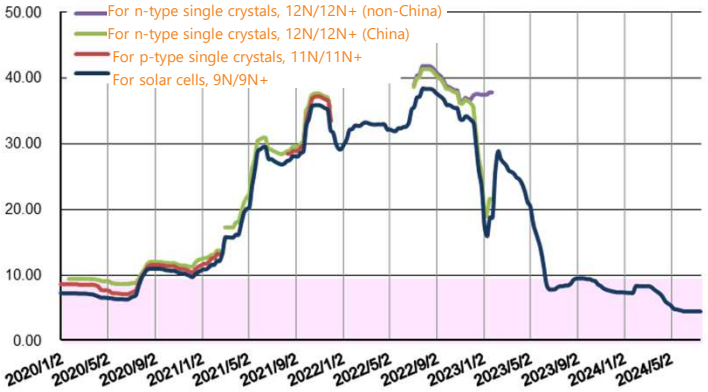
As oversupply continues, the price of PV module is predicted to remain low. Also, the operating rate of the facilities in the entire world continues to be low.



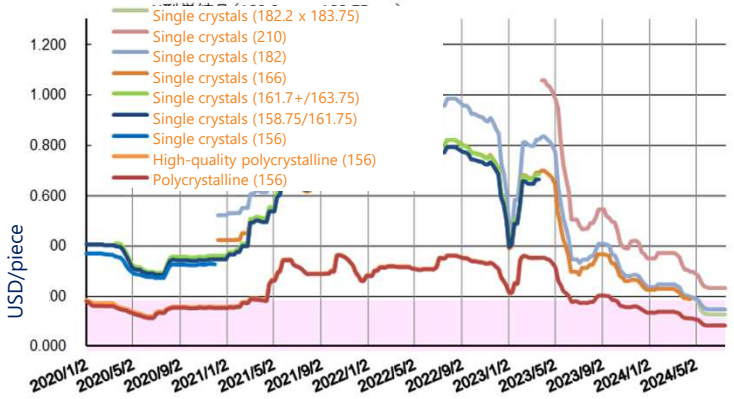
Source: International Energy Agency (IEA), "Renewables 2023" (January 2024)

Price trends along the value chain : Prices goes far below forecast

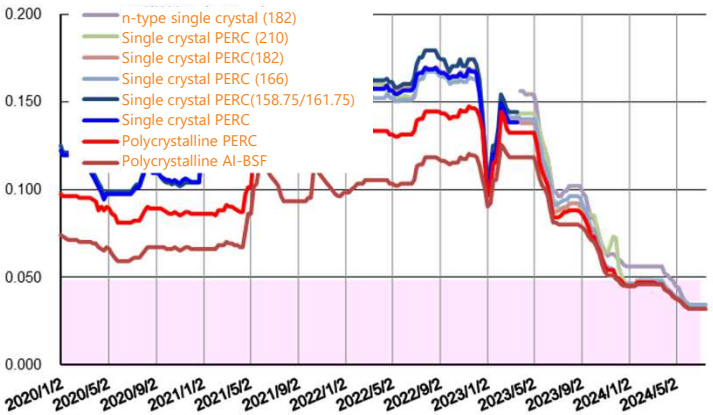
Polysilicon (USD/kg)



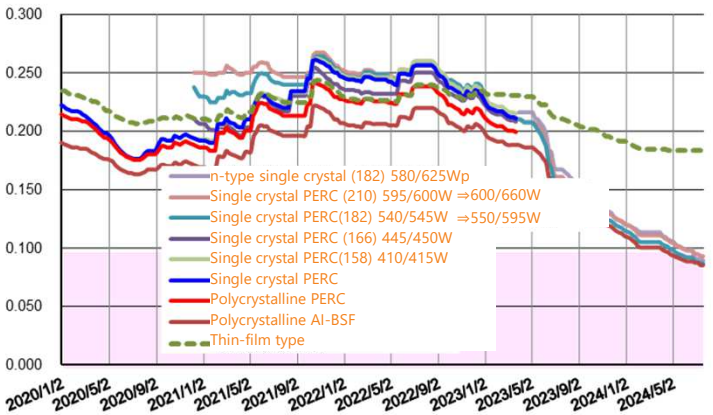
Silicon wafers (USD/Piece)



Solar cells (USD/W)

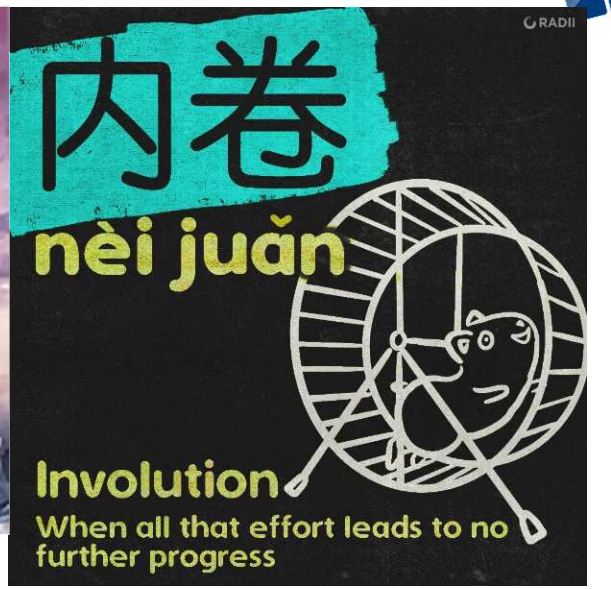


PV modules (USD/W)



Sources: PVinsights (Published from January 2, 2020 – July 2024, 28), compiled by RTS Corporation

Buzzword at SNEC (June 2024) :Involution



https://x.com/RADII_Media/status/1407910575196278786

- Comment of Founder of GCL Group: at Opening of SNEC 2024
- "Chinese PV industry is facing the most serious "Involution or 内卷（excessive competition)". The industry is entering an ice age due to a severe imbalance in supply and demand".

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Industry trends in China

- Shipping price is under manufacturing cost

PoliSilicon Manufacture	Average manufacturing cost	Average Shipping price
Daqo New Energy	6.19 USD/kg	5.12 USD /kg
Xinite Enegy	48,000 RMB/t	42,300 RMB/t

- Major manufactures reported loss in their financial statement (Ex. JA Solar Technology, LONGi Green Energy Technology, Risen Energy)
- More focus on storage batteries (Trina, Canadian Solar, etc.)
- Bankrupty : Lingda Group, Akcome, etc.
- Consolidation is ongoing
- Chinese government : addressing excess manufacturing capacity by revising norm for the PV industry

“Norm” for PV Manufacturing Industry

- The Ministry of Industry and Information Technology (MIIT) of China announced draft of “Norm for PV Manufacturing Industry‘’
- The draft specifies performance standards for polysilicon, solar cell modules, and inverters
- Draft requirement of PV module manufacturing

		Existing factory		Capacity Addition/ New Capacity	
		2021 version	2024 draft	2021 version	2024 draft
P-type mono	**Minimum Efficiency**	**19.6%**	**21.2%**	**20%**	**21.8%**
	Degradation ratio after 1 year	≦ 2.5%	≦ 2%	≦ 2.5%	≦ 2%
	After 2 years	≦ 0.6%	≦ 0.55%	≦ 0.6%	≦ 0.55%
	After 25 years	≦ 17%	≦ 15%	≦ 17%	≦ 15%
	Total electricity consumption	≦ 40MWh/Mwp	≦ 25MWh/Mwp	≦ 40MWh/Mwp	≦ 25MWh/Mwp
N-type mono	**Minimum Efficiency**	**-**	**22.3%**	**-**	**23.1%**
	Degradation ratio after 1 year	-	≦ 1%	-	≦1%
	After 2 years	-	≦ 0.4%	-	≦0.4%
	After 25 years	-	≦ 11%	-	≦11%
	Total electricity consumption	-	≦ 25MWh/Mwp	-	≦25MWh/Mwp

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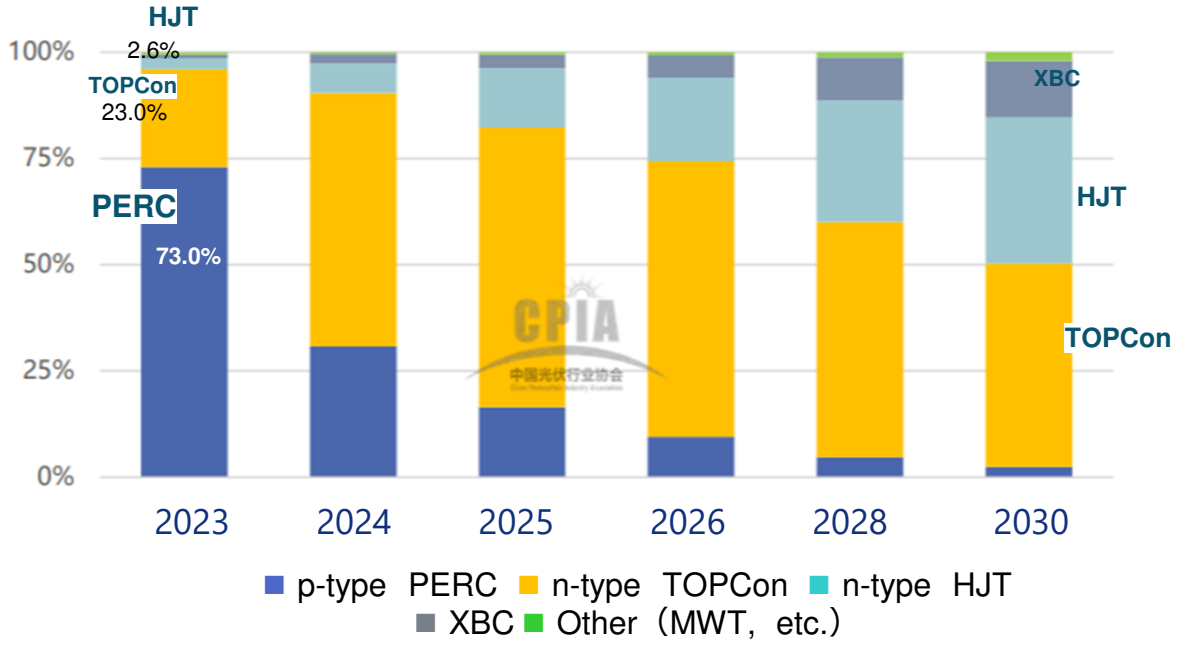
Capacity enhancement by major PV manufacturers

- While expansion plans are declining, major manufacturers continue to invest
- The number of companies withdrawing or going bankrupt is increasing, but total production capacity does not drop because major companies are acquiring manufacturing facilities.
- Most new plans are for heterojunction solar cells and n-type crystalline silicon (TOPCon or HJT)

Company	N-type manufacturing capacity as of the end of 2023	Plan for n-type capacity from 2024	Planned manufacturing capacity (total)
Tongwei	25	41	66
Aiko	25		25
Trina	40		40
LONGi	30		30
JA Solar	36	21	57
JinkoSolar	67.5		67.5
Hainan Drinda	44		44
Risen		29	29
TCL Zhonghuan	0.5	25	25.5
GCLSI	10	10	20
Canadian	30	15	45
Total	283	166	449

Share of PV cell technology and outlook by CPIA

- PERC : 2022: 88% → 2023: 73%
- N-type TOPCon : 2022: 8.3% → 2023: 23%
- N-type: HJT: 2022: 0.6% → 2023: 2.6%

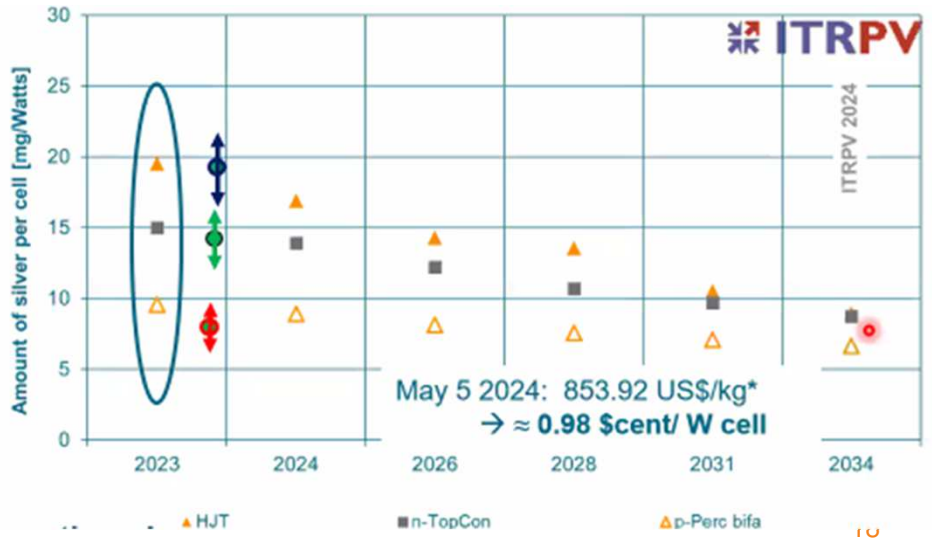


Source：CPIA, China PV Industry Development Roadmap 2022-2023 (February 2024)

Challenges for n-type technologies:Ag consumption

- In 2023, solar cells represent the 16% of world consumption of Silver (used for contact)
- N-type cell technology consumes more silver
  - ⇒ Silver consumption levels by top manufacturers (Tier 1) :
    PERC: 7-8 mg/W, TOPCon: 12-16 mg/W, HJT: 17-20 mg/W
- Cu replacement is one of the solutions: Ag-coated Cu

https://tradingeconomics.com/commodity/silver



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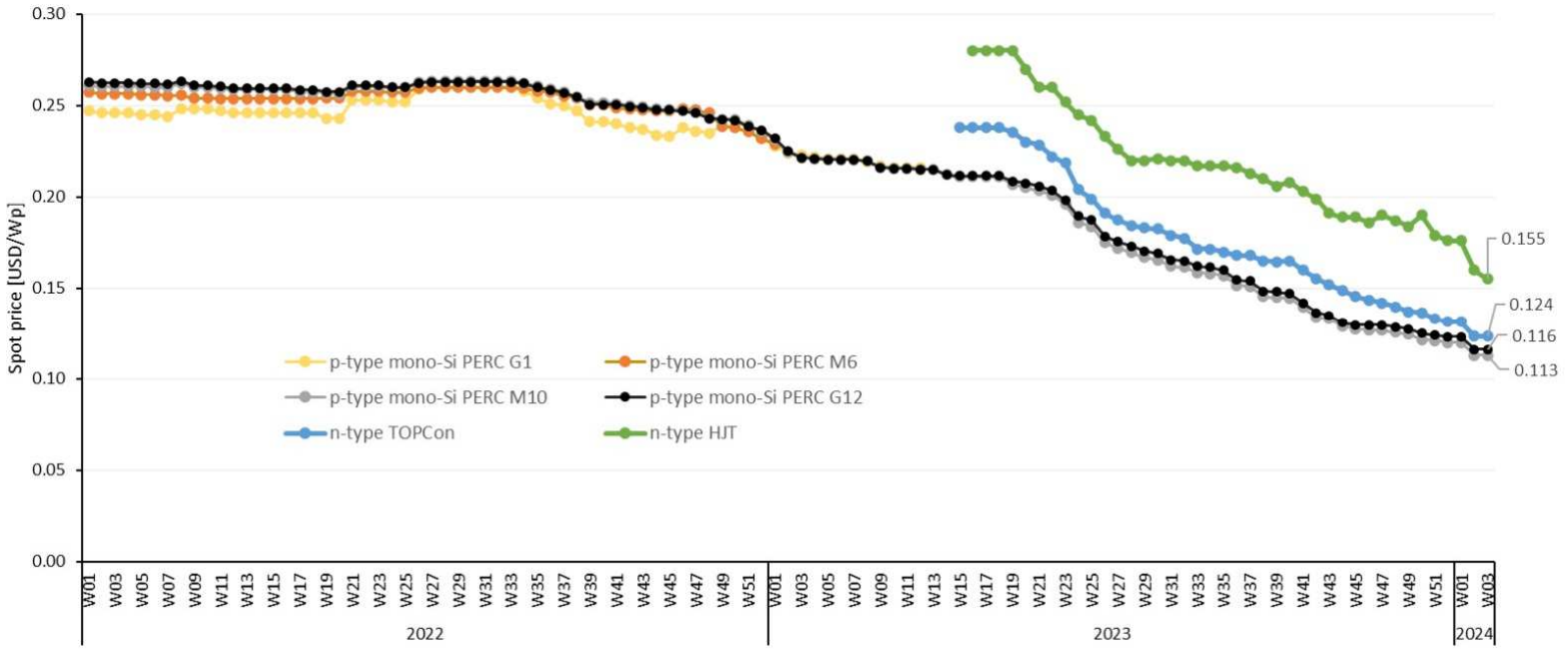
Further cost reduction?

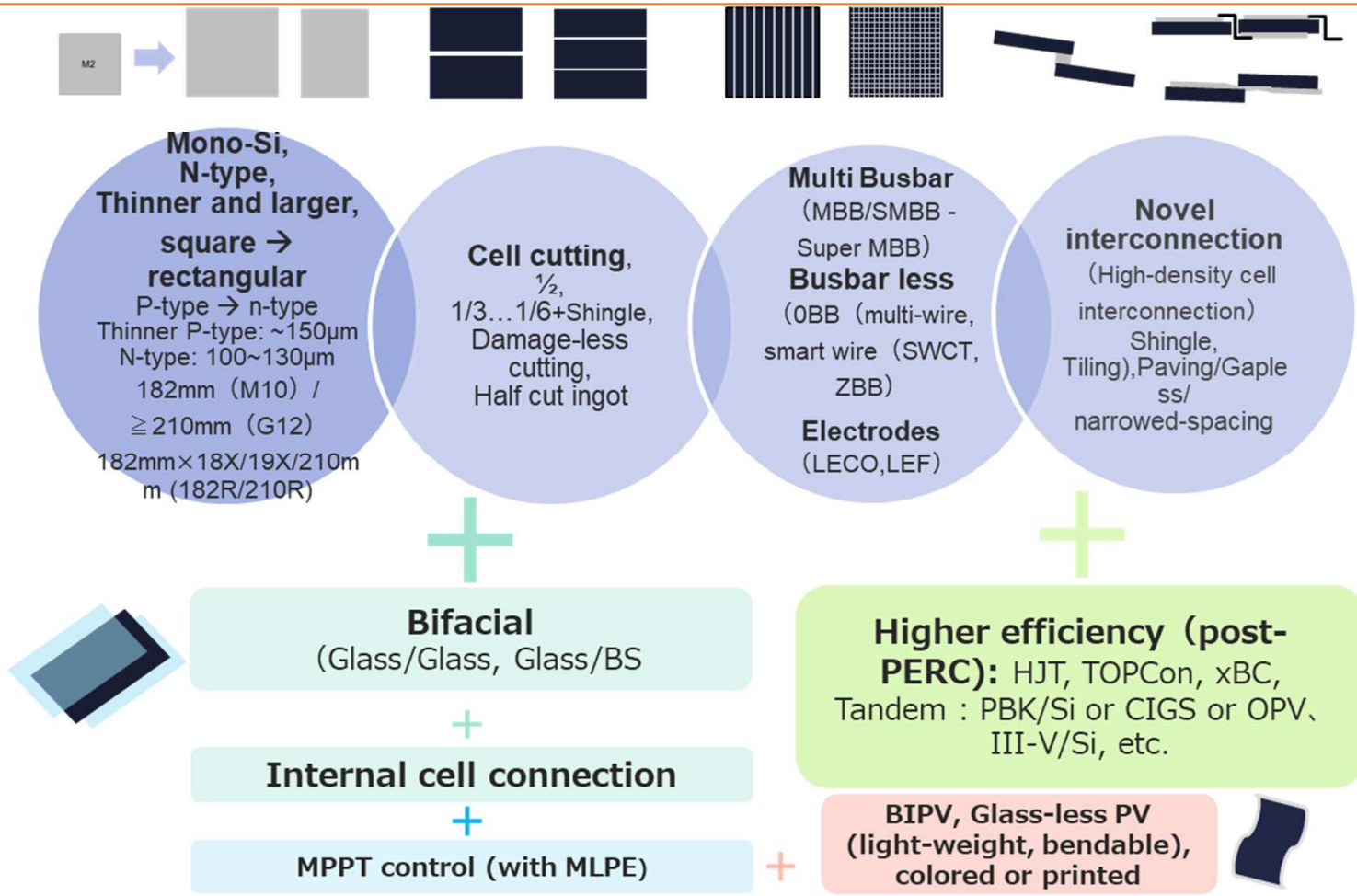


PV costs have reduced dramatically thanks to:

1. Technical improvements (efficiency gains, larger and thinner wafers, etc.)
2. Learning by doing : economies of scales (excess capacity) and standard
3. Policies that stimulated market growth through CN target

Source : IEA PVPS, Trends Report 2024

Technology drives further cost reduction



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Cost reduction opportunity: Silver consumption

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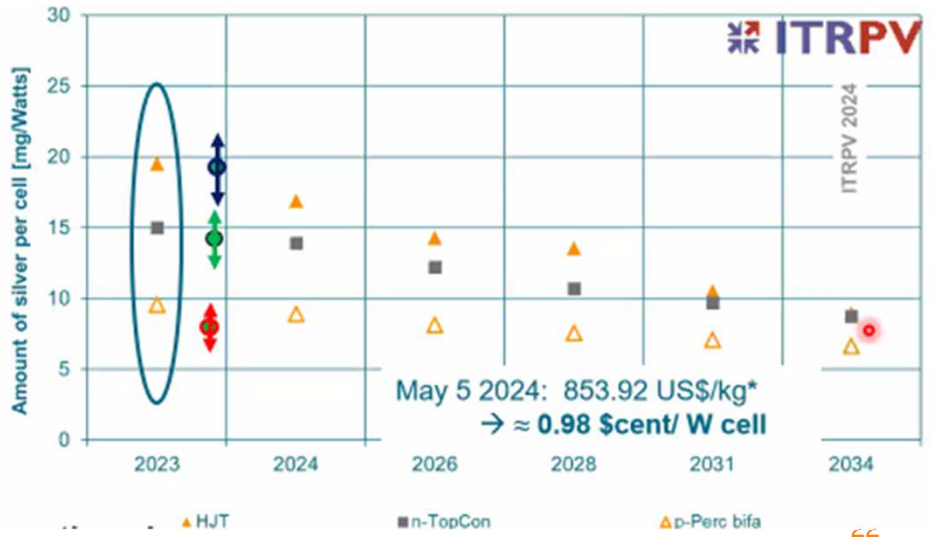

Rectangular wafers adopted by major manufacturers

- Major manufacturers are adopting rectangular waferse, mainly for utility scale PV.
- As of Dec. 2023, 5 manufacturers use 182 x 210mm 210R wafers (66 full-size equivalent)
- Rectangular wafers are also used in small 54-cell and 48-cell modules for roofs
- The width of the short side is unified at 1,134 mm

Source：Astronergy(Chint Group)

Cost reduction opportunities: standard size

- 6 major companies* reach agreement in December 2023 on standard size for large 700W modules with 210mm cells
- It is proposed to comply with the existing industry consensus dimensions (module size: 1,303mm x 2,384mm, vertical hole spacing on the long side of the module: 400mm/1400mm), and that a hole spacing of 790mm
- *6 companies = Trina Solar, Astronergy, Canadian Solar, Risen Energy, TCL Zhonghuan, TW Solar (Tongwei)
- 700W+ Photovoltaic Open Innovation Ecological Alliance established on December 15, 2023 after launching joint initiative on standardization and application of 700W+ photovoltaic module design

Summary:

- ✓PV manufacturing capacity reached 1TW/year in 2023
- ✓China dominates supply chain (polysilicon, wafer, cell, modules and other materials + manufacturing equipment and inverters) but diversification of production sites is expected by measuers to support local production
- ✓Global PV industry has over capacity and PV module manufactures are suffering from lowering profit → Industry consolidation is ongoing
- ✓There are space for cost reduction with standardization, materials, new technologies, while sustainable investment is key and new technologies are need to ensure reliability

PVSEC-35

35th International Photovoltaic Science and Engineering Conference

10-15 Nov. 2024

"Fuji" Conference

12th Nov.: PVPS Workshop
Session 1: T1 & T12
Session 2: Task 13
Session 3: Agrovoltaics

Thank you for your kind attention !

感谢您的关注

끝까지 경청해 주셔서 감사합니다

ご清聴ありがとうございました

Acknowledgement for the support of PVPS activities

NEDO New Energy and Industrial Technology Development Organization

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