

Solar - China (H)

Solar Glow #5: Selective in the race to the bottom

Government Regulations

More divergence in the race to the bottom

Solar module oversupply in 2024 looks worse than our last update in summer 2023, resulting in more diverging performance to the integrated solar manufacturers. Amid this race to the bottom, we think higher TOPCon & US shipments are the two keys to secure sales and earnings. Please also check report China Matters series #2 which discuss China's solar sector from up to downstream.

Module oversupply ratio worsening from summer 2023

Five months after our Solar Glow #1 report, we see the oversupply ratio worsening further to 131% in 2024 (was 98%) as announced capacity continues to outpace demand growth despite a challenging profit outlook. We still see decent solar demand growth at c.14% in 2024-25E as demand from emerging markets and potential lower interest rate in 2H24 could alleviate headwinds in construction, grid, inventory, distributed segment. Hence, we see the industry will stay on a downtrend in most of 2024 with integrated manufacturer margin down to 5-10% range.

Not all capacity is created equal – TOPCon & US shipment

As the race to the bottom intensifies in 2024, we see more alpha opportunities arising among the manufacturers, focusing on 1) more N-type shipment to ride on the technology shift and 2) earning a high premium from the US shipment. We think TOPCon shipment will be favored supporting utilization and hence lower costs. The next phase of downcycle will see a flight to quality balance sheet. But given the slow capacity exit and more ample financial resources, we think earnings is still the focus for now.

A bottom in the sector may not come so soon

While we are bearish on the sector, we acknowledge cash cost for integrated manufacturers is near RMB80c/W now, which is not far from some of the *lowest* quotes in recent tenders. But limited downside in prices does not suggest a bottom as low price could last for longer. We assume some recovery in TOPCon gross margin to RMB10c/W (half of 2023's level) from RMB5c/W in 2024E, but this depends on more meaningful capacity exit in 2024 which remains highly uncertain.

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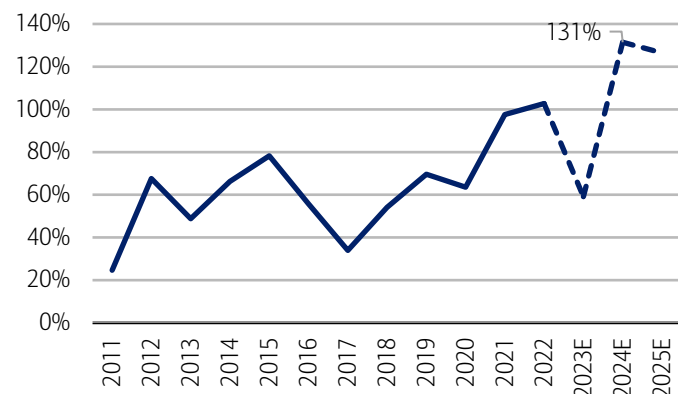
Race to the bottom keeps us cautious

Oversupply keeps rising to the worst in over a decade

Despite strong solar demand, we expect oversupply in module segment with >1200GW global module capacity by year end 2023 and more in 2024, comparing to our estimated 482/521GW module demand in '23/24. Hence, industry oversupply ratio will rise to 131% in '24, much higher than 68% in the '12 downturn, and the highest level in more than a decade.

Exhibit 1: Global module oversupply ratio vs effective capacity

We expect module oversupply ratio to be the highest in this decade



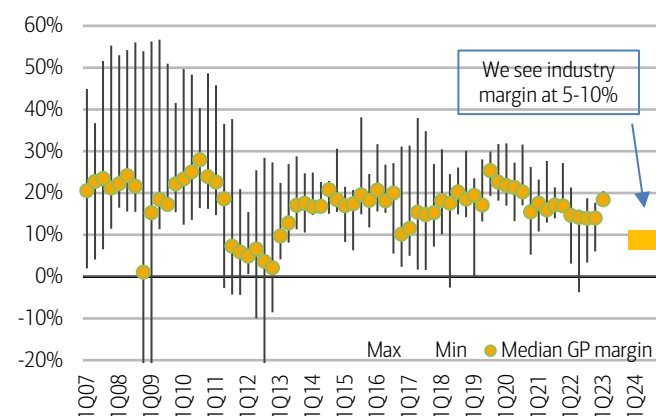
Source: BofA Global Research estimates

Note: Oversupply ratio = Module effective capacity / Module demand - 1

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Exhibit 2: Historical median industry gross margin

We see GPM of main players across solar supply chain at 5-10% in this downturn, bear case at 0% as in 2012



Source: BofA Global Research estimates, company report. Note companies include LONGi, JA Solar, Trina Solar, Jinko Solar, Canadian Solar, Yingli, Suntech, First Solar

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Integrated manufacturers earnings assumptions

Current PERC module ASP is <Rmb0.9/W, which we estimate will keep at this level in 2024E on price war and N-type taking up market share.

Average price premium of TOPCon module vs PERC is at Rmb5-6 cent/W in FY23, which will be enlarge to Rmb8 cent/W in FY24 when PERC to be gradually retired from the market.

Exhibit 3: Module price and margin assumption in 2023-24E for TOPCon and PERC module

We expect the TOPCon and PERC price will at same level in 2025E

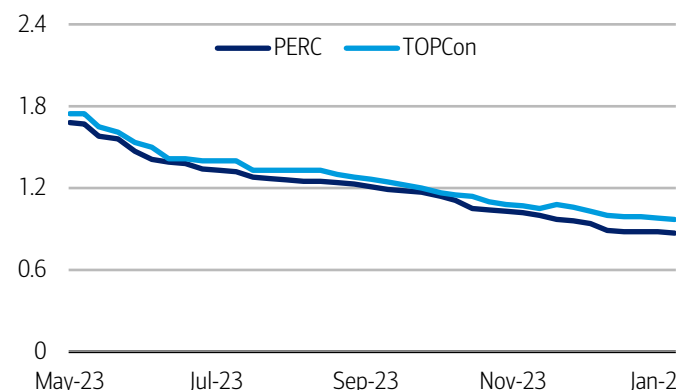
RMB/W	2023	2024	2025
TOPCon module			
Price inc. VAT	1.49	0.95	1.00
COGS	1.12	0.80	0.78
Gross profits	0.20	0.05	0.10
PERC module			
Price inc. VAT	1.43	0.87	
COGS	1.09	0.77	
Gross profits	0.18	0.00	

Source: BofA Global Research estimates

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Exhibit 4: Weekly module price (Rmb/W) for PERC and TOPCon

TOPCon has Rmb5-10c/W premium over PERC

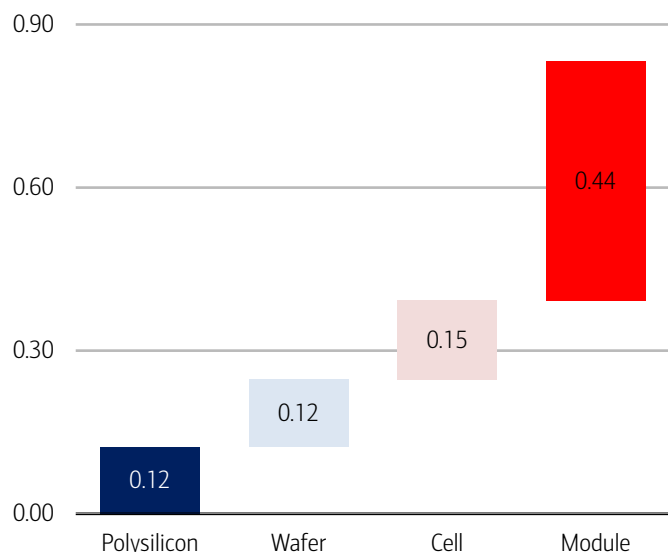


Source: BofA Global Research, Solarzoom, PV Infolink

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Exhibit 5: Unit cost (Rmb/W) for integrated manufacturers

Total cost at Rmb0.83/W ex VAT

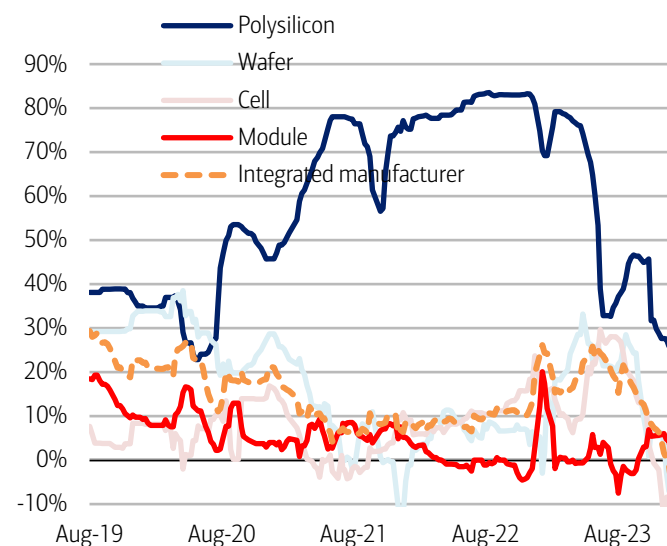


Source: BofA Global Research estimates

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Exhibit 6: Gross profit margin for solar value chain

Profit still concentrated at upstream of the value chain.



Source: BofA Global Research estimates, Solarzoom

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Worsening demand/supply outlook

Decent module demand at 520GW in 2024

On demand side, our base case sees global solar module demand will reach 482/521/622GW dc, about 14% p.a. growth in 24-25E. Geographically, among the global cumulative PV capacity at 1,713GW dc by '23, China took 41% with 701GW dc, followed by EU with 15% at 264GW dc and US with 10% at 175GW dc. In terms of new module demand, China (260GW dc) will likely account for over half of the global module demand at 482GW dc in 2023.

Exhibit 7: PV production new additions by regions, '22-25 (in GW dc)

Global annual solar PV installation is estimated to reach 482/521/622GW dc in '23/24/25E

In GW dc	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023E	2024E	2025E
Annual solar PV installations														
Global	32	42	46	56	75	101	107	119	146	182	252	482	521	622
China	3	14	13	19	30	53	44	33	52	69	107	260	240	264
US	3	6	8	7	14	11	10	12	18	24	24	33	40	45
EU	18	8	4	4	4	5	9	17	20	27	38	56	56	60
India	1	1	1	2	5	10	11	12	4	12	18	17	17	24
Other	6	13	20	24	22	22	32	45	51	50	65	116	168	229
YoY %														
Global	8%	31%	11%	21%	34%	34%	6%	11%	23%	25%	38%	91%	8%	19%
China	32%	310%	-3%	44%	58%	76%	-16%	-25%	57%	31%	55%	144%	-8%	10%
US	114%	74%	29%	-4%	89%	-23%	-6%	13%	59%	32%	-3%	40%	21%	13%
EU	-11%	-54%	-54%	2%	-3%	28%	79%	92%	21%	35%	39%	47%	0%	7%
India	202%	14%	0%	90%	155%	94%	8%	4%	-63%	192%	48%	-7%	0%	41%
Other	33%	114%	61%	17%	-7%	0%	46%	41%	12%	-2%	32%	77%	45%	36%

Source: BNEF, CPIA, BofA Global Research estimates

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China: In 2023, China added 217GW ac PV new installations, +c150% YoY. Looking forward, we believe new installation growth will moderate given high base and potential wastage. We think utility projects will lead 5-10% growth in '24-25.

US: The US targets to make solar power take 30% of its total power generation by '30 vs. 5% now. US installed 33GW dc in '23 and Wood Mackenzie/SEIA project 36GW dc in '24, with 20GW upside or downside in '23-24, depending on the ability to optimize the Inflation Reduction Act's bonus credits. We estimate US cumulative solar capacity will reach 440GW dc by '28 and further to 635GW dc by '30 vs. 175GW dc in '23. However, there is also concern that grid capacity and trade policies could constrain near-term growth, especially in residential solar PV.

EU: Solar power demand in EU is spurred by distributed PV growth and rising energy prices. The Green Deal Industrial Plan is likely to drive renewable energy growth in the long term. And REPowerEU Plan launched by the European Commission in '22 targets to make all members to have 45% of electricity generated by renewable energy by '30. On solar power, the Plan targets to reach cumulative 320GW ac installations by '25 and 600GW ac by '30, vs. 200GW ac in '22. We forecast EU will reach cumulative 379GW dc installations by '25.

Rest of the world: India is a key country of solar power driven by its 450GW renewable plan by '30 and the associated Production-Linked Incentives (PLI) scheme. Our India Utilities team, led by Amish Shah, expects 17-24GW dc annual installations in '23-25E.

Exhibit 8: PV new addition installations estimate BofA view vs. other agencies

Our forecasts are on the more positive side among external forecasts

PV new addition installations	2023E		2024E		2025E	
	Global	China	Global	China	Global	China
BofA (GW ac)	380	217	410	200	490	220
AECEA (GW ac)	340-380	160-170	400	170-180	460	NA
CPIA (GW ac)	345-390	160-180	300-360	95-120	324-386	100-125
IEA (GW ac)	382	NA	390	NA	NA	NA
Solar power Europe (GW ac)	341	NA	401	NA	462	NA
Wood Mackenzie (GW ac)	358	NA	353	NA	371	NA
LONGi (GW ac)	>350	>150	NA	NA	NA	NA
BNEF (GW dc)	413	240	508	233	530	252
PV infolink (GW dc)	412-455	170	474-546	170	NA	180

Source: AECEA, CPIA, NEA, IEA, BNEF, PV Infolink, Company data, BofA Global Research

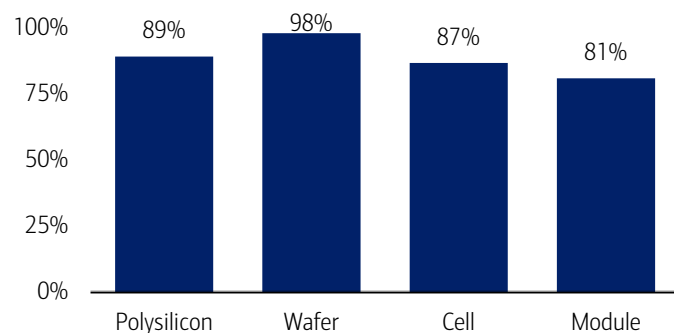
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But supply rising even faster as competition intensifies

Our latest assessment of solar supply across the key sub-segments suggest supply remains very high compared to demand. Compared to summer 2023, we saw mixed adjustments with cell and module. Module capacity in 2024E is estimated to be about 100GW higher now (>1,400GW) while supply for upstream wafer (-300GW) and polysilicon (-1000GW) have started to see some adjustments.

Exhibit 9: FY22 China PV capacity in 4 segments as a % of global capacity

China dominates the global PV supply-chain with over 80% penetration

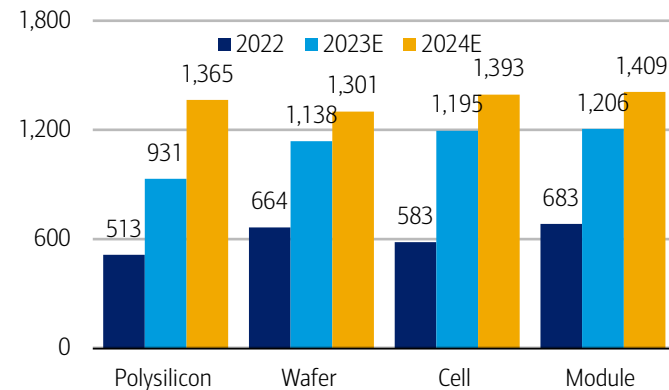


Source: Solarzoom; BofA Global Research

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Exhibit 10: Y/E capacity in the 4 segments in FY22-24E (GW)

We see overcapacity across the 4 main segments



Source: Solarzoom; BofA Global Research.

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Exhibit 11: BofA global solar module supply & demand forecasts

A big mismatch in global solar module demand and supply in 2024E

	2019	2020	2021	2022	2023E	2024E
CPIA Global module YE production capacity (GW/year)	219	320	465	683	1,206	1,409
YoY change %	20.9%	46.3%	45.4%	46.8%	76.6%	16.8%
Capacity addition (GW/year)	38	101	145	218	523	203
LONGi	5	36	10	25	25	
Jinko Solar	5	15	14	25	40	
Trina Solar	1	14	28	15	30	
JA solar	2	12	17	10	45	
Canadian Solar	4	3	8	8	18	
Others	20	22	68	134	365	
Global module annual production (GW/year)	138	164	221	347	522	759
YoY	19.3%	18.5%	34.9%	57.3%	50.2%	45.6%
Global PV power installation forecast (GW)	119	145	175	240	380	410
YoY	21.4%	21.8%	20.7%	37.1%	58.2%	8.0%
Global module demand (GW)	119	146	182	252	482	521
YoY	11.2%	23.1%	24.8%	38.3%	91.3%	8.0%
Module production volume vs. terminal demand (%)	16.5%	12.1%	21.2%	37.8%	8.2%	45.8%

Source: Solarzoom, BofA Global Research

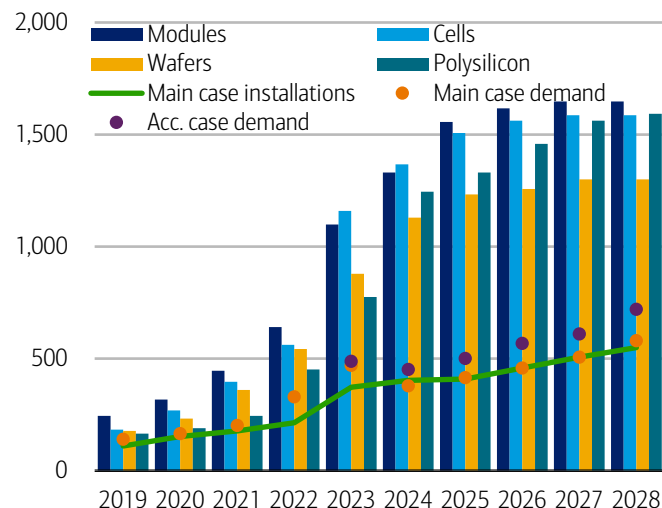
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Long term over 1,600GW module capacity per IEA

In the longer term, International Energy Agency (IEA) sees global module capacity will reach about 1,600GW in 2025-28E, which will be more than doubled the global solar module demand per their forecasts. This is nameplate capacity so not all will come online in our view, but the extent of oversupply remains concerning and required meaningful capacity response to restore the demand/supply balance.

Exhibit 12: IEA global nameplate solar capacity, annual installation and module demand

IEA sees current global solar module capacity can reach >1,600GW by 2028, more than doubled demand

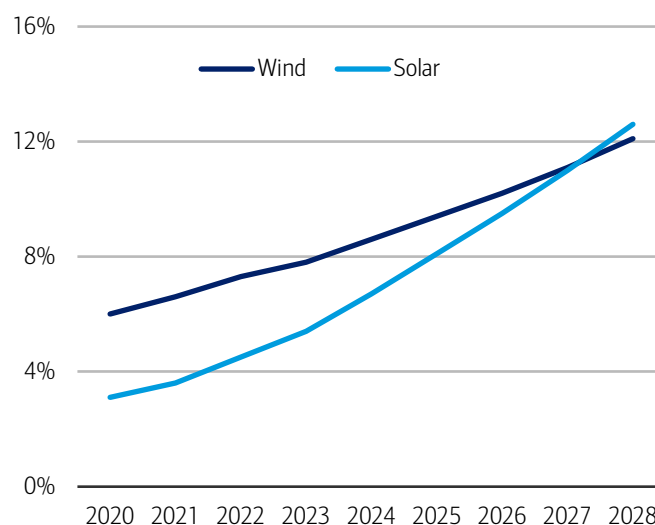


Source: IEA

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Exhibit 13: IEA global solar and wind power output as % of total

IEA sees variable renewables (wind+solar) will account for 25% of global power output by 2028



Source: IEA

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But not all capacity is the same

We think 2024 will start to see more divergence in solar module manufacturers' performance. In an oversupply downturn where companies are slashing prices to gain market share, we believe capacity structure toward more N-type capacity which will see better demand is key to maintain higher utilization (hence lower cost) and cash inflow.

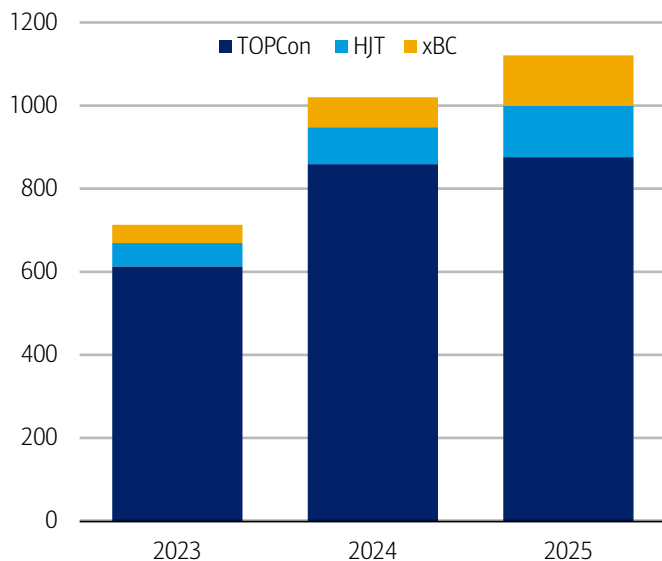
In addition, while US solar price premium is narrowing, any shipment to the US will likely earn an extremely high margin compared to other markets and domestic China. We estimate gross profits from the US could account for 45-59% of 2024E total gross profits for the 4 major manufacturers.

N-type technology will see better demand

In an industry downturn, we think shipment volume is the key to protect earnings and cash flow. The N-type TOPCon is going to see a rising share of shipment in 2024. For instance recent Chinese solar module tenders show the TOPCon share reached 70% of the total volume already. We estimate TOPCon capacity has reached >500GW in YE23 and likely going to >850GW in 2024E while total planned TOPCon capacity is far above at >1,500GW but we will monitor the pace of rolling out to the market.

Exhibit 14: High-efficiency capacity (GW) by technology, 2023-25E

TOPCon will dominate the market in 2023-25E

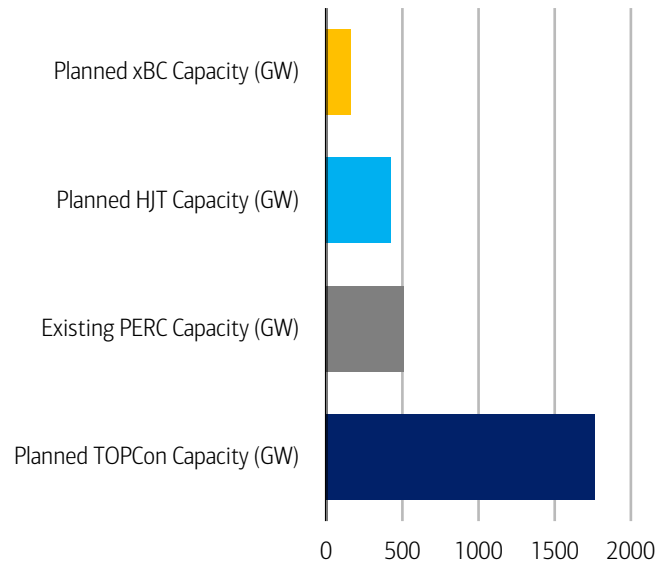


Source: BofA Global Research estimates, PV Infolink, Solarzoom

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Exhibit 15: Existing PERC and planned N-type capacity (GW)

Rapid development of n-type technology



Source: BofA Global Research estimates, Solarzoom, Infolink, company report

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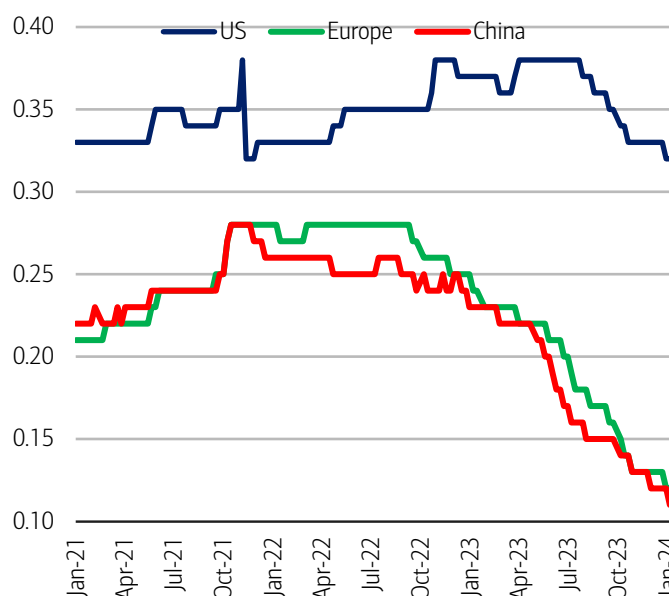
Among the major solar module manufacturers, Jinko has the highest about 86% of its shipment under N-type (TOPCon), followed by JA, Trina and LONGi within our coverage. LONGi which has ~20% of 2024E shipment coming from TOPCon will have more BC-type shipment (HPBC) which is seeing more uncertain growth as the distributed segment in Europe, the main market of its HPBC product, is highly uncertain in 1H24 given inventory issues. Our recent channel check calls suggest European solar module inventory is still very high at 60-80GW by end 2023, which are mainly distributed solar modules under P-type.

A race to ship to the US premium market

The US market is the only major market still having high module prices given its domestic trade policies to ringfence the imports of Chinese oversupply. According to Infolink, US module price on average is still above USD30c/W although according to our US Utilities analyst Julie Dumoulin-Smith certain quote in the distributed segment is as low as USD15-20c/W already. According to our checks, for prices at USD30-40c/W, the Chinese manufacturers, by shipping from the Southeast Asian factories, can earn a gross profit of almost RMB90c/W, compared to probably RMB5-10c/W in China and other overseas markets.

Exhibit 16: Average solar module prices by region (USD/W)

US module prices holding up better than other regions



Source: BofA Global Research, Bloomberg

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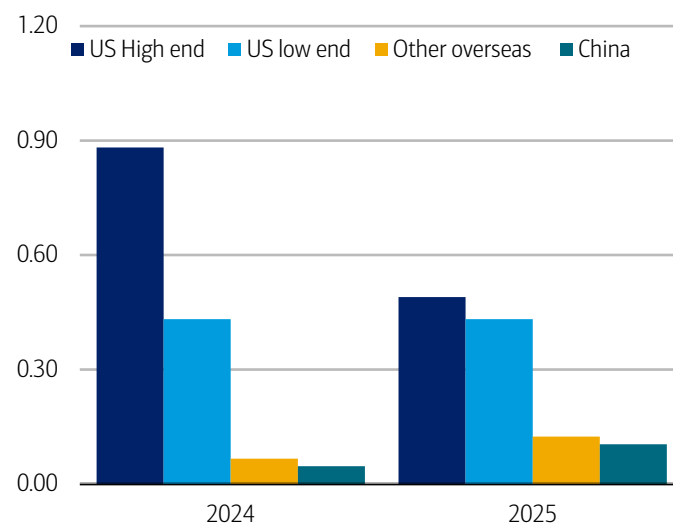
While the Chinese manufacturers will try to ship every watt of solar module into the US, trade measures by the US mean the Chinese manufacturers will still rely on their Southeast Asian facilities to ship the goods. Our checks suggest Jinko and LONGi could each ship 9-10GW to the US, Trina at 5-7GW and JA at 4-5 GW in 2024. Some of them already secured at a high price of USD30-40c/W, while some volume will be signed at spot prices. We assume those signed at spot price will still be able to earn a gross margin of about RMB40c/W.

The question is whether these targets can be met in the US given demand headwinds especially in the distributed segment and the availability of non-Chinese polysilicon. Made-in-Xinjiang polysilicon used to account for 50% of total production capacity in China in 2020. However, the penetration ratio has now dropped to 1/3 by YE23 as new capacities have been avoiding Xinjiang since 2021 given the UFLPA policy. New capacities from Inner Mongolia, Sichuan and Qinghai gradually picked up. In overseas market, Wacker, Hemlock, Tokuyama and Elkem continue to be the major overseas polysilicon providers, which have total production capacity of 171k ton/year.

We estimate global polysilicon capacity is around 3.6mn tons/year by YE2024, which can support 1,430GW solar cell and module demand in 2024. Silicon capacities in China can support 1,362GW of demand. The rest overseas capacities can satisfy 68GW demand vs US demand of 40GW.

Exhibit 17: Unit gross profit (Rmb/W) comparison for shipment to the US, China, and other overseas markets in 2024-25E

US is forecast enjoy a big premium in 2024-25E

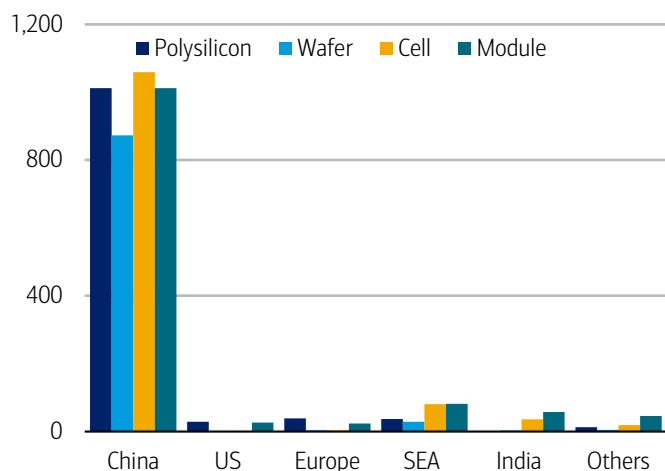


Source: BofA Global Research estimates

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Exhibit 18: Manufacturing capacity (GW) across solar supply chain in 2023E

China dominates all the 4 the sectors

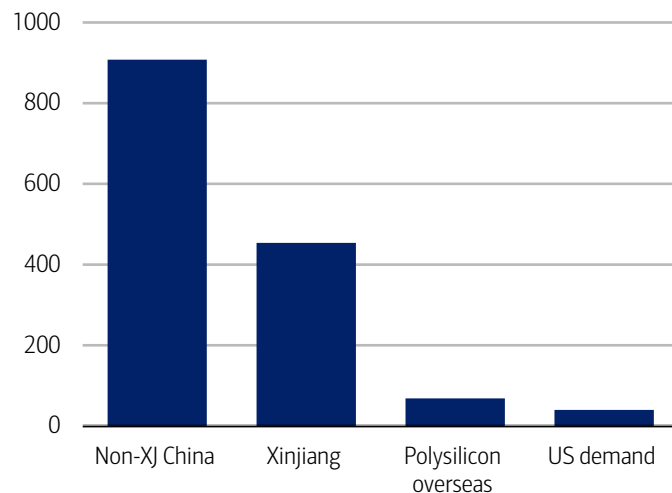


Source: Wood Mackenzie

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Exhibit 19: Polysilicon capacity by regions vs US demand (GW) 2024E

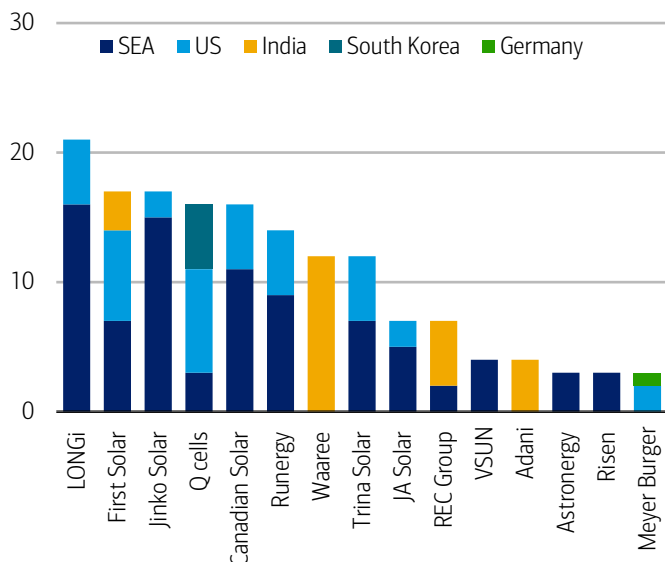
Chinese polysilicon capacity could support 1,362GW demand in 2024E



Source: BofA Global Research; Solarzoom
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Exhibit 20: Module capacity expansion outside China by manufacturers (GW)

Chinese module producers aggressively expand capacity in overseas

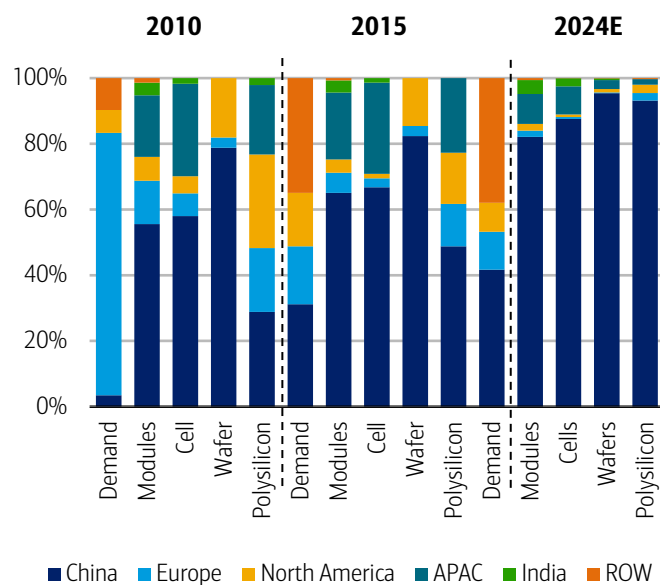


Source: BofA Global Research estimates, Solarzoom, Infolink, company report

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Exhibit 21: Solar PV manufacturing capacity by country and region 2010, 2015 and 2024E

China remains dominant in global solar PV supply chain



Source: CPIA, IEA, BofA Global Research estimates

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Key events to watch in 2024

New expansion pause or capacity exit

Module ASP < Rmb1/W could be very challenging for most 2nd or 3rd tier module producers. The continued price war will force those medium and smaller players to going out of business. Also, manufactures may delay or even cancel their future capacity expansion plan under margin pressure, which will mitigate current oversupply situation. For instance, Gokin Solar withdrew their IPO listing application. Zhejiang Sunflower canceled Rmb800mn cell equipment purchase contract with SC New Energy. Tighter financing in A share market will also limit solar companies expansion.

Exhibit 22: Suspended solar capacity announced in 2023-24

Most were announced in 2H23

Time	Company	Suspended solar project	Initial / planned investment (Rmb mn)	Status
May-23	Jinko Solar	14GW silicon rod	n.a.	Sell 100% of subsidiary Xinjiang Jinko
Jun-23	Allwin Telecommunication	5GW HJT cell & module	210	Terminate
Aug-23	QianjingLandscape	1GW HJT cell & 2GW HJT module	469	Terminate
Aug-23	Letong Chemical	4.8GW HJT cell & 4.8GW intelligence cell production line	4,700	Investment decrease to Rmb12.5mn, equity share dropped from 40% to 5%.
Oct-23	Guangxi Royal Dairy	20GW TOPCon cell	10,000	Sell
Oct-23	Shenzhen Procto Supply Chain Management	Distributed solar farm	308	Terminate
Oct-23	Daqo Energy	100k ton Polysilicon	n.a.	Put into production time delayed from YE23 to 2Q24
Nov-23	Golden Solar	4.8GW HJT cell & 1.2GW module	1,400	Terminate
Dec-23	Jinko Solar	14GW module	n.a.	Close down
Dec-23	Jingyuntong	22GW silicon rod and slicing	n.a.	Put into production time delayed from Dec 2023 to Dec 2024
Dec-23	J.S. Machine	Core equipment R&D project for HJT and perovskite cell	n.a.	Put into production time delayed to June 30, 2024
Dec-23	Ojing Tech	Recycling industrial silicon project	n.a.	Put into production time delayed from YE23 to Dec 2024
Dec-23	NENGHUI TECH	Distributed solar farm	n.a.	Put into production time delayed from YE23 to Dec 2024
Jan-24	Shanxi Coal International Energy	3GW HJT cell	1,000	Terminate
Jan-24	EGING PV	10GW TOPCon cell	n.a.	Suspended equipment manufacturer's delivery

Source: BofA Global Research

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Government-led supply adjustments

In November 2023, the Ministry of Industry and Information Technology arranged a meeting with over 20 solar companies calling for rational expansion and high-quality development. No concrete follow-up after the meetings but any government-directed measures could accelerate the industry consolidation.

Trade policies on Chinese solar & US presidential election

The market expects that the US-China relationship may improve following the Biden-Xi meeting in November 2023. A few key events to watch in 2024:

- **ITC report in February:** Module panels imported into U.S. are currently tariffed at 14.5% through Feb 2024 and drop by 0.25% each year through Feb 2026. ITC will check if the tariff is able to prevent cheap panel dumping into the U.S. market and make suggestion to the U.S. president whether to extend or revise the tariff.
- **AD/CVD expiry in June:** Tariffs as high as 254% will be extended to these SE Asian exports of solar modules in Jun, unless 1) using a non-Chinese wafer to make the cells, 2) using no more than 2 of the following materials from China, i.e. silver paste, aluminum frames, glass, backsheets, EVA sheets and junction boxes, or 3) be found to not be circumventing.
- **US Presidential election:** One of the most important events for not just solar but overall market is the US president election. Whether the new president is more care about clean energy development or local manufacture protection will impact China's solar product export.

Currently, two major limitations on U.S. exportation are :

1. “Uyghur Forced Labor Prevention Act” (UFLPA), which required Chinese solar product manufacture to proof no ingredients from Xinjiang.
2. Various tariff including Antidumping & Anti countervailing (ADCVD) duty and 201& 301 tariff. For producers circumvent ADCVD duty through South East Asia countries, a 254% tariff will extend to those produces after mid-2024.

Although we don’t expect U.S. to completely remove constrains on China’s solar product, we may see some extent of mitigation including:

- Less detention of Chinese solar products in U.S. port;
- Module contains polysilicon sourced from China (except Xinjiang) is allowed to enter U.S.

Exhibit 23: China and foreign countries PV trade dispute summary

China faces export headwinds over the long run

Country	Event	Details
US	2011 First antidumping and anti-countervailing investigation	Anti-countervailing duty: 14.78%-15.97% Anti-dumping duty: 18.32%-249.96%
	2014 Second antidumping and anti-countervailing investigation	Anti-countervailing duty: 27.64%-49.21% Anti-dumping duty: 26.71%-165.04%
	2017 Section "201"	Initial tariff rate set at 30%, decreasing by 5% every year in next 3 years.
	2018 Section "301"	25% tariff applied to made in China solar module and inverters, etc.
	2021 "Uyghur Forced Labor Prevention Act" (UFLPA)	All products containing Xinjiang ingredients are prohibited from entering the United States.
	2022 Section "201" extension	14.75% initial duty, decreasing 0.25% each year in next 3 years To earn the extra 10% tax credit under ITC or PTC will require 40% of the cost of manufactured product to be made in U.S. This ratio will increase by 5% each year till 55% in 2026.
	2023 Inflation Reduction Act (IRA)	254% tariffs extended to 5 Chinese cell and module producers operating in SE Asia.
India	Mar-21 Basic custom duty raise	Announced to raise solar module tariff from 0% to 40%; solar cell tariff from 0% to 25%; effective from Apr 2022
	May-21 Third antidumping investigation	Investigation ended with no further actions in Nov 2022
	Apr-22 Approved List of Models and Manufacturers (ALMM) list	Require solar farm operator to only use modules on the ALMM list. As of now, ALMM has not been undertaken.
	Sep-22 National Programme on High Efficiency Solar PV Modules	Aims to build an ecosystem for manufacturing of high efficiency solar PV modules in India, and thus reduce import dependence in the area of renewable energy.
EU	Antidumping and anti-countervailing investigation on 2013 Chinese producers	Chinese manufacturers have been allowed to sell solar products in Europe free of duties if they do so at or above a progressively declining minimum price. If sold for less than that price, they are subject to duties of up to 64.9%.
	Antidumping and countervailing duties on imports from China, Malaysia and Chinese Taipei for solar glass, initiated 2020 in 2013 and extended to 2025.	For solar glass: antidumping duty ranges from 17.5% to 75.4%; Anti-countervailing duty ranges from 3.5-17.1%.
	Mar-23 Net-Zero Industry Act	The proposal sets a benchmark for the manufacturing capacity of strategic net-zero technologies to meet at least 40% of the EU's annual deployment needs by 2030
France	Carbon footprint certification	PV products entering the France PV market must meet the certification of the French Energy Regulatory Commission (CRE) in terms of carbon emissions, environmental relevance, uncleared land and urban planning authorization from raw materials, production, transportation, and life cycle.
Italy & Sweden	Environmental Product Declaration (EPD)	More restrict than France CRE certification
South Korea	Low carbon certification	On July '23, PV module suppliers should submit low-carbon certification qualification, which was implemented immediately. By February 2023, none of PV module enterprises in China had obtained certification qualification, and many Korean enterprises had obtained carbon footprint certification for more than 500 modules.
Türkiye	Import tax on all imports and antidumping duty on solar modules from China starting in 2017; no stated end date	Import tax set at US\$25/kg and antidumping duty at US\$20-25/sqm
Brazil	Import tax on PV equipment with some exemptions	Up to 12% for modules and 14% for inverters

Source: BofA Global Research

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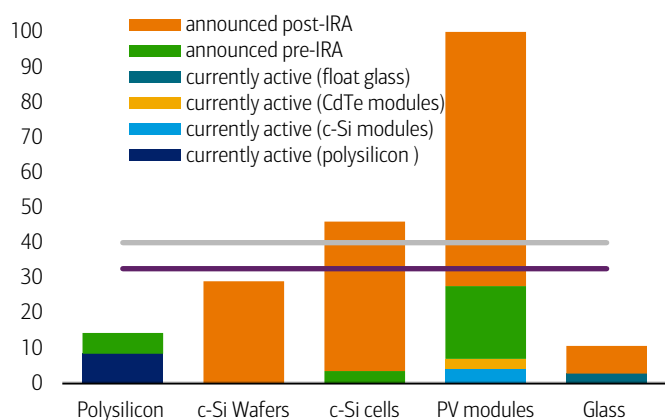


Besides the above limitations on Chinese solar products, the U.S. also launched IRA to support its local solar production capacity expansion.

According to NREL, >185GW PV manufacturing capacity expansion plans have been announced in the US so far, including 93GW module, 46GW cell and 29GW wafer. However, our US Utilities team believe it is unrealistic to expect all these capacities to be launched as not all will have capital backing and knowhow, and some sole Chinese investment could be complicated to be approved. Only 30GW out of the c.100GW module expansion has capital backing. And out of that 30GW, half are Chinese firms which have questionably ability to invest directly. The team believes it is suspicious given no incumbent players announcing expansion plans in the upstream polysilicon and wafer.

Exhibit 24: U.S. solar supply chain manufacturing capacity (GWdc) announcements

Over 185GW has been announced



Source: BofA Global Research, NREL

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Exhibit 25: Possible silicon solar supply chains for US module makers

US is actively planning module capacity domestically

Wafer	Cells	Modules	Company examples
US	US	US	Hanwha Q Cells
China	US	US	Maxeon, Enel 3 Sun
China / Europe	US	US	Meyer Burger
Southeast Asia	Southeast Asia	US	Longi, JA Solar, Jinko Solar
China	China / India	US	Waaree, Vikram Solar
	South Korea /		
China / Europe	Southeast Asia	US	Hanwha Q Cells

Source: BNEF, BofA Global Research

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Relief in demand headwinds

We expect global solar demand to increase by 8% YoY in 2024. After a robust growth in 2023, market is concerned about further demand growth in 2024. We expect PV demand headwind can be relieved if:

- **China** to have more thermal power units turn into peak shifting units, enabling more solar power installation and output.
- **EU/US:** Inventory level in EU piled up in 2023 and some modules were even shipped back to China. As destocking is close to a bottom, coupled with lower interest rate environment sometime in 2024, this could help demand to rebound .
- **Other countries:** Countries in Middle East and Africa record strong demand growth in 2024.

Higher freight costs from Red Sea disruptions

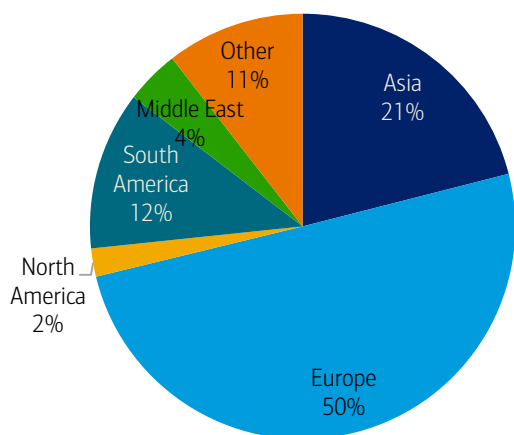
The freight cost increase from Red Sea disruptions could jeopardize earnings to the overseas markets, but on the other hand longer shipment days from 30-35 days to 45 days for now could partially help digest the high inventory in Europe if demand picks up.

According to Drewry, WCI Shanghai to Rotterdam container freight rate for a 40-foot box is about US\$5,000, compared to around US\$1,500 in December 2023. A container can ship 620 solar modules assuming each a capacity of 550W. This translates to about USD1c/W.

That said, solar module companies tend to secure long-term contract with shipping companies for secured overseas orders in advance, while spot cargo could pass on the freight cost to customers.

Exhibit 26: Chinese solar module exports by region, 2023

Half of Chinese exports went to Europe



Source: BofA Global Research; China Customs

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Exhibit 27: Drewry Shanghai-Rotterdam container cost per 40ft box

Surging to almost USD5,000/40ft box recently



Source: Bloomberg

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Major progress in more advanced technology

During the transition from P-type cell to N-type, existing top players like Jinko and JA Solar focus mainly on TOPCon due to similarities between PERC and TOPCon. However, new players tend to choose heterojunction (HJT) and there is 409GW new HJT capacity expansion plan announced in 2022-2023. If there is major breakthrough causing HJT or BC cell cost decline below TOPCon or even PERC level, we may see TOPCon capacity to be retired earlier than expected.

Exhibit 28: 2022-2023 HJT cell capacity expansion plan

A total of 409GW HJT expansion plans were announced in 2022-23

Companies	Country	GW	Companies	Country	GW
2022			2023		
Huasun Solar	China	22.3	Jiangxi Haiyuan Composite	China	15
Golden Solar	China	20	Huasun Solar	China	13.5
Akcome	China	15.8	Xinrui electronics	China	12
Risen Energy	China	15	Anhui Guangshineng	China	10.8
CR Power	China	12	Jp-Solar Power	China	10
Huayao Photoelectric Technology	China	10	Xiamen 35.com Technology	China	8
Hunan Tongze Solar	China	10	Xinhongxing Group	China	8
Guangdong Zhengye Tech	China	8	Hongjun New Energy	China	7.2
Haitai Solar	China	5	HDHM	China	6.5
Talesun	China	5	Ouhao Group	China	6
Mingyang	China	5	Gongqingcheng Junshan Investment	China	6
Shuifa Energy	China	5	Mingyang	China	5
Guosheng Energy	China	5	CNBM	China	5

Exhibit 28: 2022-2023 HJT cell capacity expansion plan

A total of 409GW HJT expansion plans were announced in 2022-23

Companies	Country	GW	Companies	Country	GW
2022			2023		
Taoistic Solar	China	5	Znshine Solar	China	5
Huaneng (cooperate with Huasun)	China	5	Lingda Group	China	5
Zhongli Group	China	5	State Power Investment	China	5
Runergy New Energy	China	5	Newsunmi New Energy	China	5
Gansu Golden Glass	China	4.8	Allwin Telecommunication	China	5
Reliance (REC)	India	4.8	Shanghai Electric	China	4.8
Jiangsu Boamax	China	4	MingR	China	4
Guorun Energy	China	3	Quanwei Technology	China	3
Yaoling Times (Guangdong) New Energy	China	2	Huayuan Electric	China	1.5
LONGi	China	1.2	GS Solar	China	5
Saiwei Energy	China	0.6	Linuo Group	China	8
			Shanghai Tianchen	China	20
			Letong Chemical	China	4.8
			Hengdian Group DMEGC Magnetics	China	12
			Leascend PV Technology	China	8
			Jiangsu Sunport Power	China	3
			Wuxi Chuangu Technology	China	1.2
			Gree Group	China	7.2
			Honghui New Energy	China	10
2022 subtotal		179	2023 subtotal		230.5
2022 & 23 grand total		409			

Source: BofA Global Research

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Exhibit 29: TOPCon capacity additions (GW) in 2022-23

TOPCon capacity expect to reach c500GW by YE23

Companies	2022	2023	Accumulative TOPCon
Jinko Solar	35	40	70
Drinda New Energy	8	36	44
Trina Solar	8	32	40
JA Solar	6.3	50.7	57
Astronergy	4	28	32
CSI Solar	0	30	30
Das Solar	20	10	30
Yingfa Deyao	10	30	40
LONGi	0	30	30
Tongwei	9	16	25
Others	1	114	114
Total	100	417	512

Source: BofA Global Research

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Exhibit 30: Glossary table
Full forms of abbreviation used

Abbreviation	Ful form
mn	million
bn	billion
PV	Photovoltaic
dc	Direct current
TOPCon	Tunnel oxide passivated contact
HJT	Heterojunction
PERC	Passivation emitter rear contact
BC	Back contact
W	Watt
kW	Kilowatt
MW	Megawatt
GW	Gigawatt
kWh	Kilowatt hour
FCF	Free cash flow
UHV	Ultra-high voltage
ASP	Average selling price
GPM	Gross profit margin
SEA	Southeast Asia
APAC	Asia–Pacific
ROW	Rest of the world
EPC	Engineering, procurement, and construction
RHS	Right hand side
IRA	Inflation Reduction Act
UFLPA	Uyghur Forced Labor Prevention Act
SF	Solar farm
AR	Account receivables
AP	Account payables
VAT	Value added tax
CPIA	China Photovoltaic Industry Association
IEA	International Energy Agency
BNEF	Bloomberg New Energy Finance
AECEA	Asia Europe Clean Energy (Solar) Advisory
ITC	International Trade Commission
AD/CVD	Antidumping and Countervailing Duties
NREL	National Renewable Energy Laboratory
Avg.	Average

Source: BofA Global Research estimates

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