



Capacity, Applications, and Outlook for Large-Sized Wafers, Cells, and Modules for 2022

2022Q2

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Wafers: Capacity for Large-Sized Wafers to Exceed 80% in 2022; Development in Wafer Thinning has Surpassed Expectation

- In terms of capacity, the tendency of large-sized wafers is now distinctive, where the combined capacity for 182mm & 210mm (including 210R) is now sitting at roughly 83.1% in 2022, of which 210mm wafers (including 210R) account for 164GW at a ratio of 32.25%. The demand for 166mm and below wafers is dropping, and partial production lines of 166mm have accelerated on the process of decommissioning or upgrade to 182mm having considered the cost and the technical improvement cap in equipment. Production lines with weak compatibility and higher cost are gradually exiting from the market, which is why capacity for 166mm and below wafers will drop to approximately 16.89%.
- The progress of wafer thinning has exceeded the initial expectation, which yielded a sizable reduction of wafer consumption. Businesses, under the current obstinately high prices of raw materials, are constantly lowering their consumption of wafers by rapidly switching from 165 μ m to 160/155 μ m in mainstream thickness, and are going to continue to march towards 150 μ m. Wafer consumption is thus expected to lower from 2.7-2.8g/W in 2021 to approximately 2.6g/W.

Cells: Deployment in Large-Sized Products Steadily Falls in Line with 210mm (Including 210R) Gradually Occupying Nearly 50% of Capacity

- The deployment for large-sized 182mm & 210mm (including 210R) cells continues to advance amidst businesses' capacity upgrades and iterations, as well as their shift of demand. The combined capacity for 182mm & 210mm (including 210R) cells is sitting at roughly 82.5% in 2022, of which 210mm (including 210R) accounts for 247.6GW under a ratio of 47.83%.
- Capacity deployment in large-sized cells is progressively falling in place, where approximately 80% (56) of businesses are now capable of producing 210mm and below cells.

Modules: Accelerated Tendency in Large-Sized Products to Fulfill Requirements in Various Application Scenarios

- The capacity for 182mm & 210mm (including 210R) modules is expected to arrive at 442.2GW at the end of 2022 under a ratio of 82.86%, of which 210mm (including 210R) accounts for 253.9GW under a ratio of 47.57%.
- The tendency of large-sized products is becoming apparent under different application scenarios. Large-sized and high-power modules are receiving increasing attention among ground power station projects, where roughly 23 module makers have marched towards the 600W+ level. The incessant robustness in the distributed PV market, together with the vigorous support from national policies such as the provincial-level implementation, are likely to generate a rapid development in large-sized distributed PV products.
- The ratio of tenders for 182mm & 210mm (including 210R) modules has elevated significantly. High-power \geq 530 182mm and 210mm (including 210R) modules are the mainstream products adopted by central and state-owned enterprises this year at a tender ratio of 87.97%. The demand for bifacial modules has surged drastically, and prompted a tender ratio of 62%. Bifacial and double-glass modules are gradually recognized by the market.

N-Type + Large-Sized Products; Modules to March towards the 700W+ Era with Product Quantity Expected to Grow Exponentially

- Pertaining to new technology, deployment in N-type and large-sized products has now become the mainstream trend. TOPCon will first attain mass production, while most businesses are currently at the medium pilot run phase for HJT, and XBC is also under continuous advancement. In terms of product deployment, most businesses are carrying on with their R&D in HJT and TOPCon products, and will likely bump up the quantity of products in a swift manner.

*210mm products mentioned in this report include 210R, and 182mm products comprise the 182*18X rectangular variation.

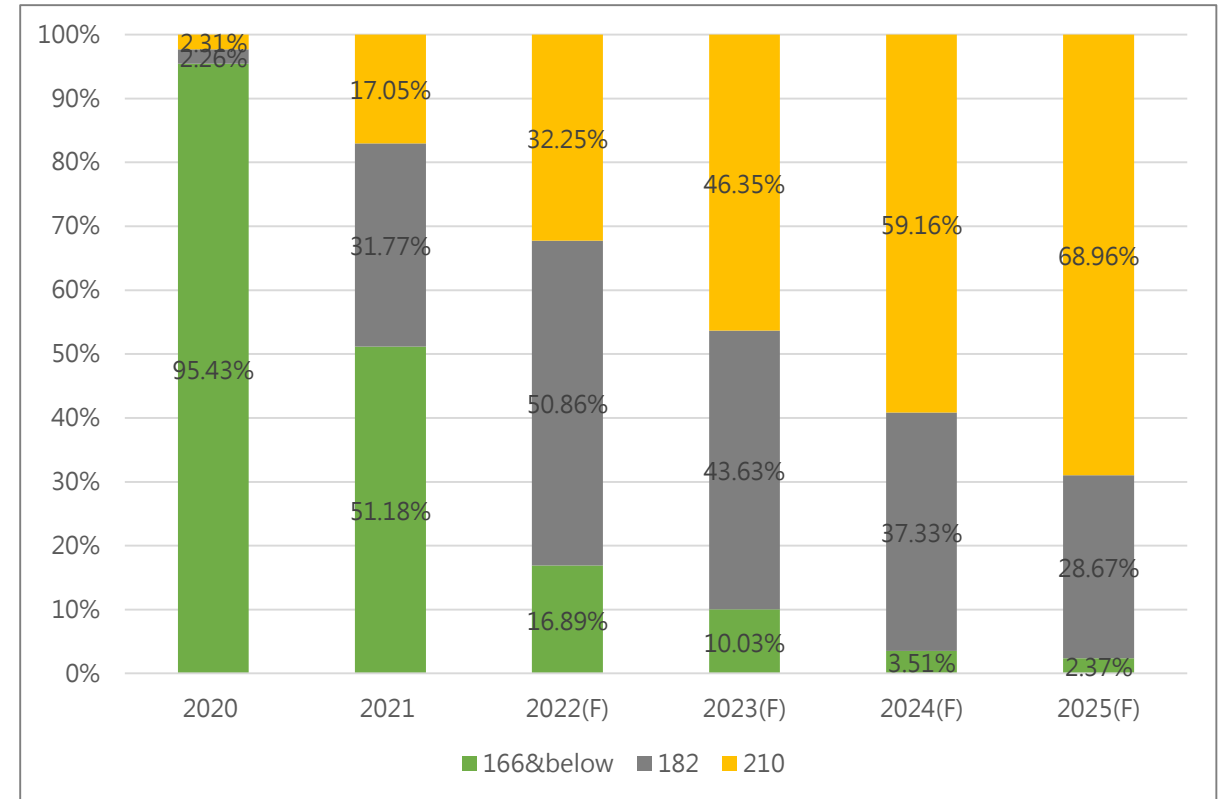
A background image showing a business meeting. In the foreground, a person's hand is writing on a document with a pen. The document features a bar chart with blue and orange bars and a pie chart. To the left, a pair of glasses and a spiral notebook are visible. In the background, another person is holding a tablet and a pen, and there are stacks of books and a cup on a table. The overall scene is brightly lit, suggesting a professional office environment.

Development Status of Wafer Technology

Large-Sized Wafers to Arrive at 83.1% in Capacity amidst Established Tendency in 2022

- The tendency of large-sized products has been established for 2022, and the corresponding ratio will surpass 80%. The single GW investment cost for large-sized products is constantly dropping at the current stage, where the apparent advantages of cost-performance ratio in production lines, as well as the compatibility with 182-210mm wafers from most new capacity, are prompting an estimated capacity of 422.6GW for large-sized wafers (182mm & 210mm) in 2022 under a ratio of 83.1%, **of which 210mm would account for 164GW at 32.25%**. Large-sized wafers (182mm & 210mm) will successively complete in capacity layout by 2023, and arrive at a market share of 89.97% then, **where 210mm would attain a capacity of 274.6GW**.
- Reserve capacity is either technically transformed or accelerated in exit as wafers below 166mm deplete in market share.** Taking into account cost and the upper restrictions in the technical transformation of equipment, partial production lines of 166mm wafers have accelerated in the speed of phasing out or upgrade to 182mm, and production lines with a weak compatibility and higher cost will gradually exit from the market, which results in an apparent reduction in market share, where total capacity for 166mm and below wafers will drop to about 16.89%.
- The progress of wafer thinning has exceeded expectation, followed by a sizable reduction in silicon consumption.** Businesses are constantly lowering silicon consumption in order to cut down their cost amidst the obstinately high prices of raw materials at the current stage. The mainstream thickness has swiftly switched from 165 μ m to 160/155 μ m, and continues to march towards 150 μ m. Silicon consumption is likely to drop from 2.7-2.8g/W during 2021 to roughly 2.6g/W.

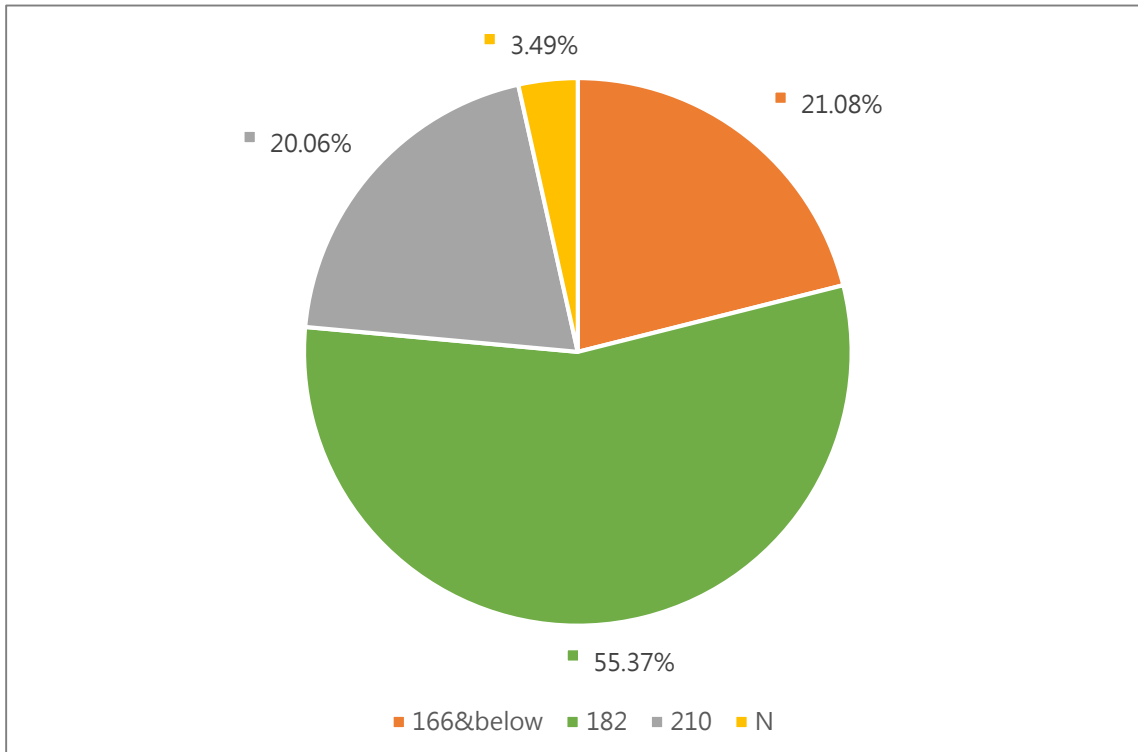
Capacity Ratio for Various Sized Wafers between 2020 and 2025 (Unit: %)



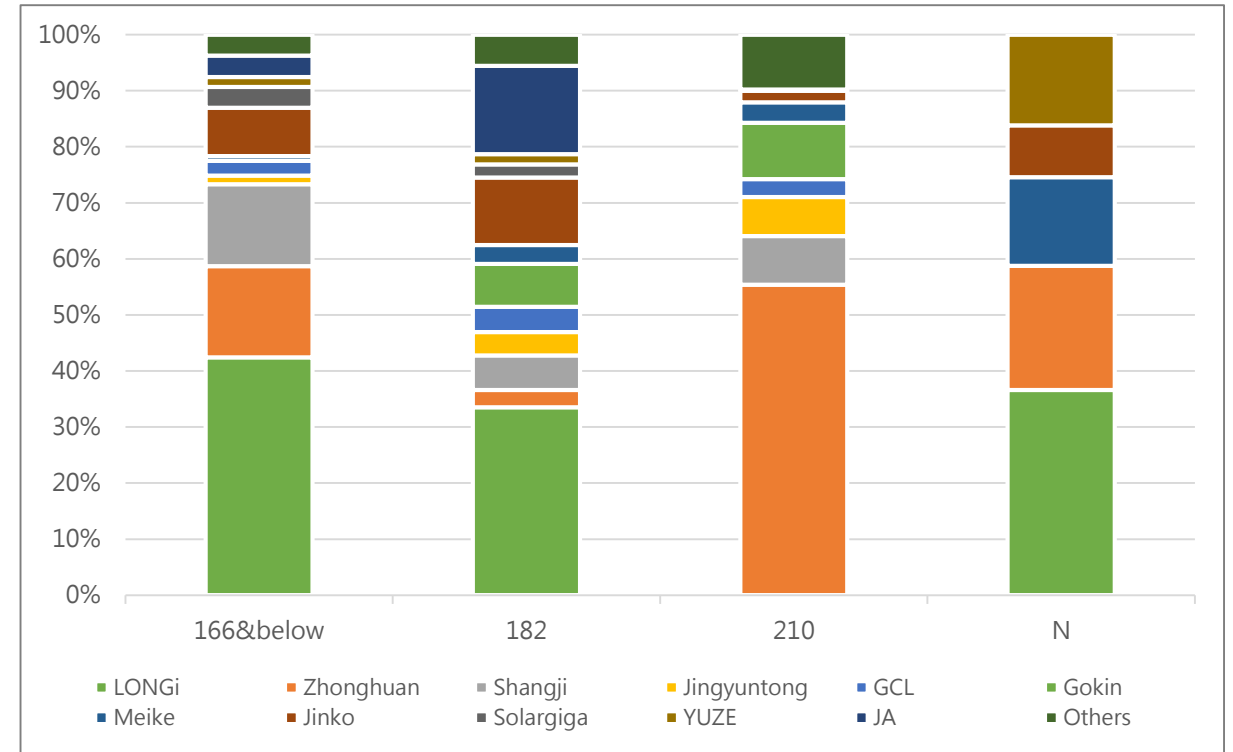
Wafer Production: N-Type Demand Steadily Increases as Large-Sized Wafer Market Persists in Robustness

- The production of large-sized wafers occupied a leading ratio of 75.42% in demand between January and May 2022, of which 210mm had accounted for 20.06%. The diminishing demand for 166mm and below wafers had yielded a production ratio of 21.08% for the same period.
- More than 50% of businesses are currently producing 210mm wafers. In order to conform to the large-sized tendency, a number of wafer businesses are expanding their capacity to being compatible with 210mm and below sizes. More than 50% of wafer businesses are currently producing 210mm wafers, and they are Zhonghuan, Shangji, JYT, GCL, Gokin, Huantai Meike, Jinko, Yuze, Canadian Solar, and Tonghe.
- The demand for large-sized N-type wafers is likely to gradually ascend with downstream N-type modules getting verified by projects. According to statistics, most module products have adopted 182mm and 210mm (including 210R) wafers, expect individual businesses who remain on 166mm wafers for their N-type modules. Demand for large-sized N-type wafers is expected to surge alongside the steadily increasing acceptance from the N-type module market.

Production Ratio of Various Sized Wafers between January and May 2022 (Unit: %)



Production Ratio among Various Businesses between January and May 2022 (Unit: %)



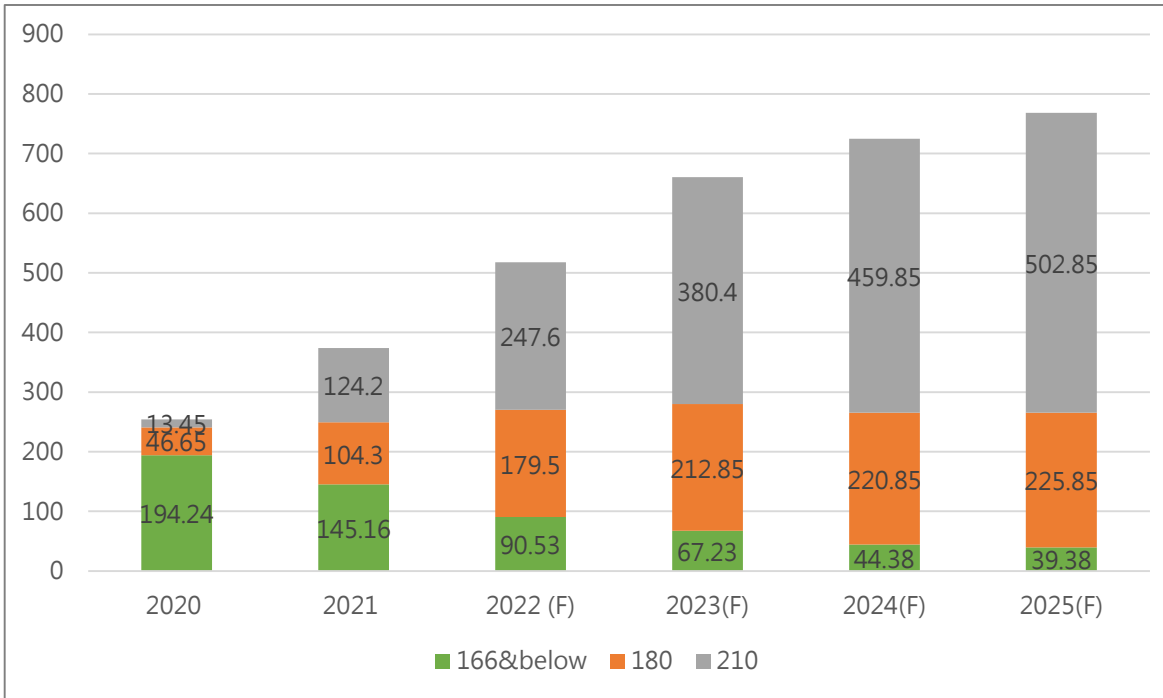


Development Status of Cell Technology

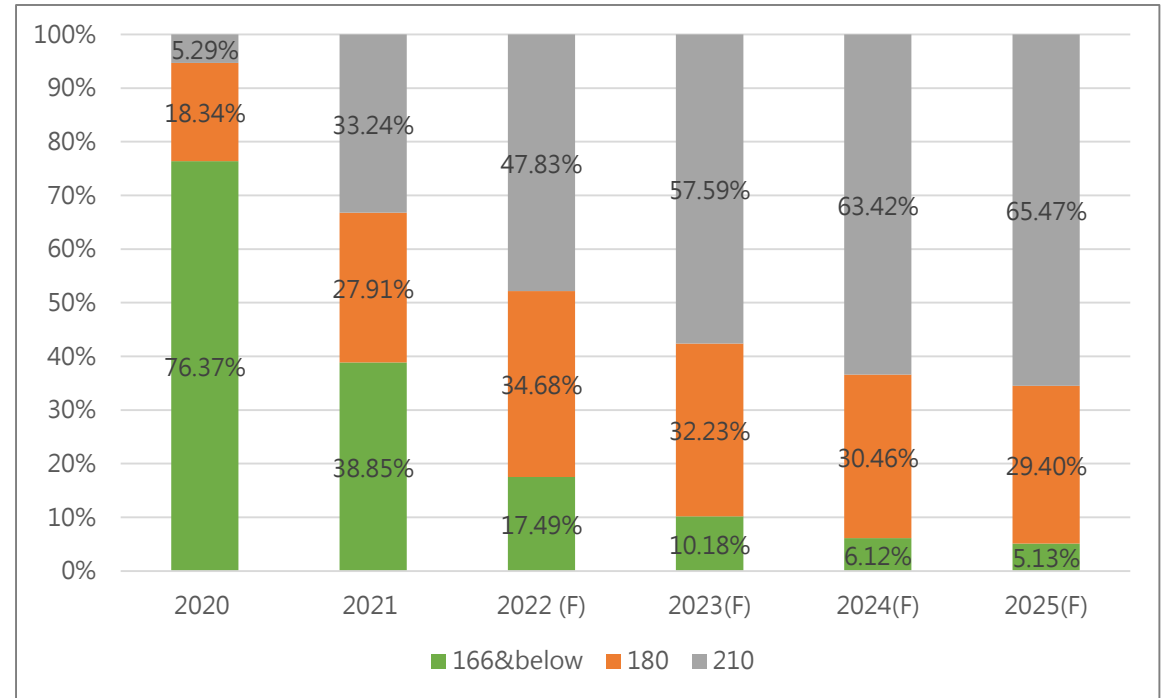
Capacity Ratio for 210mm Cells to Arrive at 47.83% in 2022

- **The demand for 166mm and below batteries is gradually diminishing, with capacity of large-sized cells occupying a ratio of 82.5% in 2022.** The cell segment continues to propel in large-size (182 & 210mm) deployment, with large-sized products fully occupying the currently expanding capacity. The capacity for large-sized cells is expected to arrive at 427.1GW in 2022, **of which 210mm would sit at a capacity of 247.6GW under a market share of 47.83%.** As market transfers in demand, partial 166mm capacity has accelerated to large sizes, and overall capacity for 166mm and below batteries is estimated to be 17.49% in 2022.
- As businesses successively initiate new capacity and further transfer in demand, **the capacity for large-sized cells (182mm & 210mm) is expected to arrive at 593.25GW in 2023,** of which 210mm cells would ascend to 380.4GW in overall capacity, and further increase in market share to 57.59% then.
- **Capacity deployment in large-sized cells is steadily falling in place.** As indicated by statistics, most existing businesses have completed their capacity layout in large-sized products, and are now capable of producing cells of 210mm and below sizes, where specific output will be implemented according to market demand.

Capacity of Various Sized Cells (Unit: GW)



Capacity Ratio of Large-Sized Cells (Unit: GW)



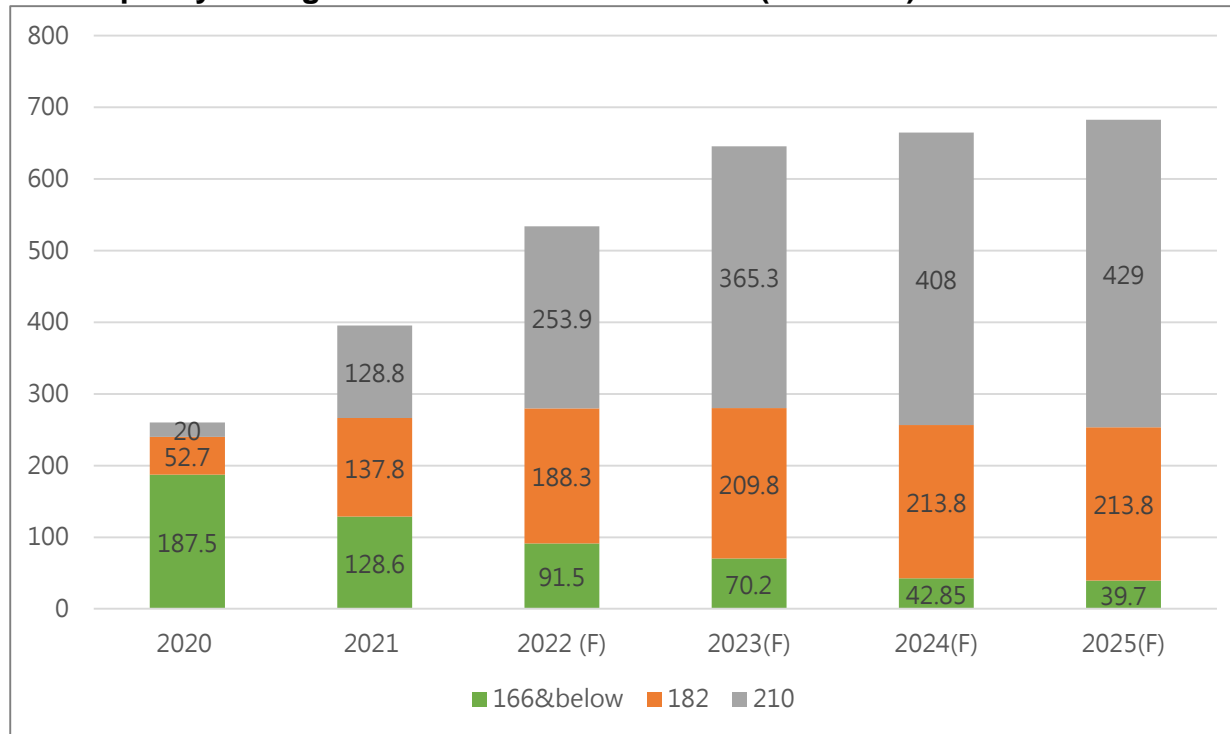


Development Status of Module Technology

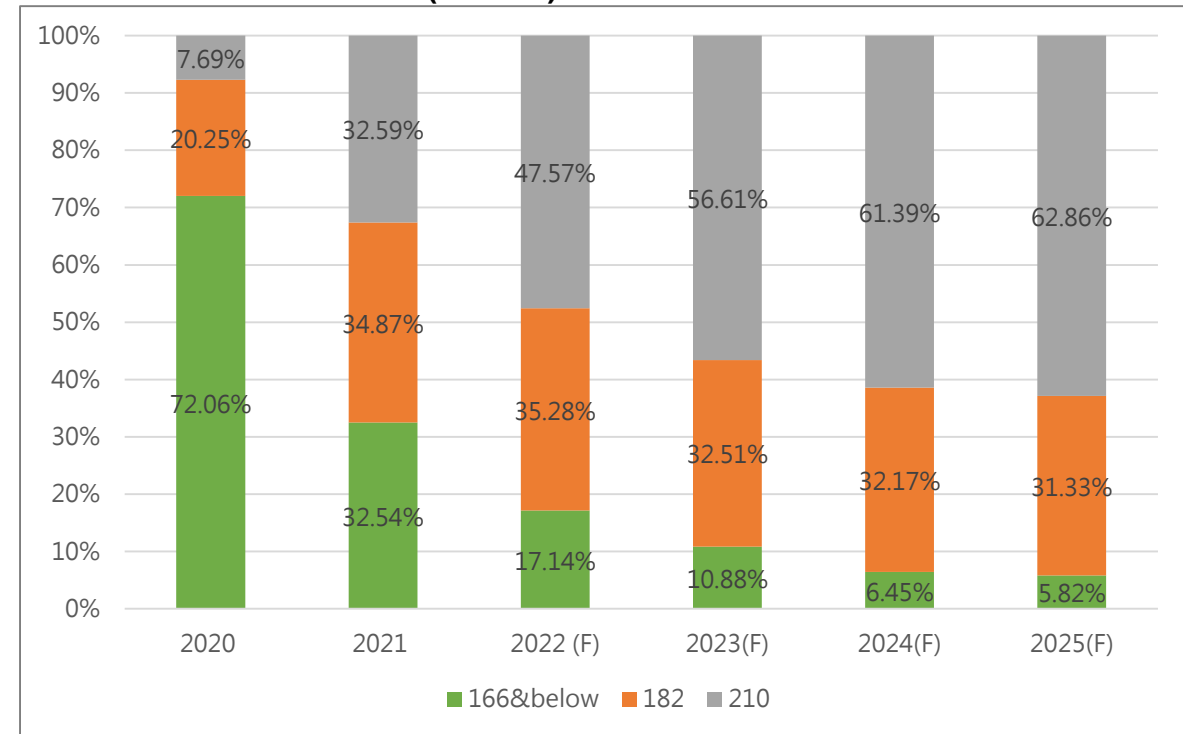
210mm Modules to Arrive at 253.9GW in Capacity amidst Diversified Application Scenarios

- Large-sized modules will continue to expand in capacity during 2022. New established capacity is essentially compatible with 210mm and below sizes. **Large-sized modules are expected to arrive at 442.2GW in capacity at the end of 2022 under a market share of 82.86%, of which 210mm modules would account for 253.9GW in capacity under a market share of 47.57%.** 166mm and below modules will gradually diminish in capacity, and will occupy merely 17.14% of market share amid demand migration as well as businesses' elimination or upgrades of old capacity.
- **Homogeneous product competition has become increasingly intense under diversification in application scenarios of large-sized modules.** 166 modules have accelerated in the exit from the market, while the competition between 182mm and 210mm has become exceedingly ferocious. The current demand from ground power stations sits primarily at large-sized products (182 & 210mm). For the distributed PV area, businesses are expediting on the release of products compatible with large-sized modules, which are more in line with the market demand, and are more apparent in advantages pertaining to conversion efficiency and power amidst a continuous reduction in the cost per single wattage.

Capacity Changes in Various Sized Modules (Unit: GW)



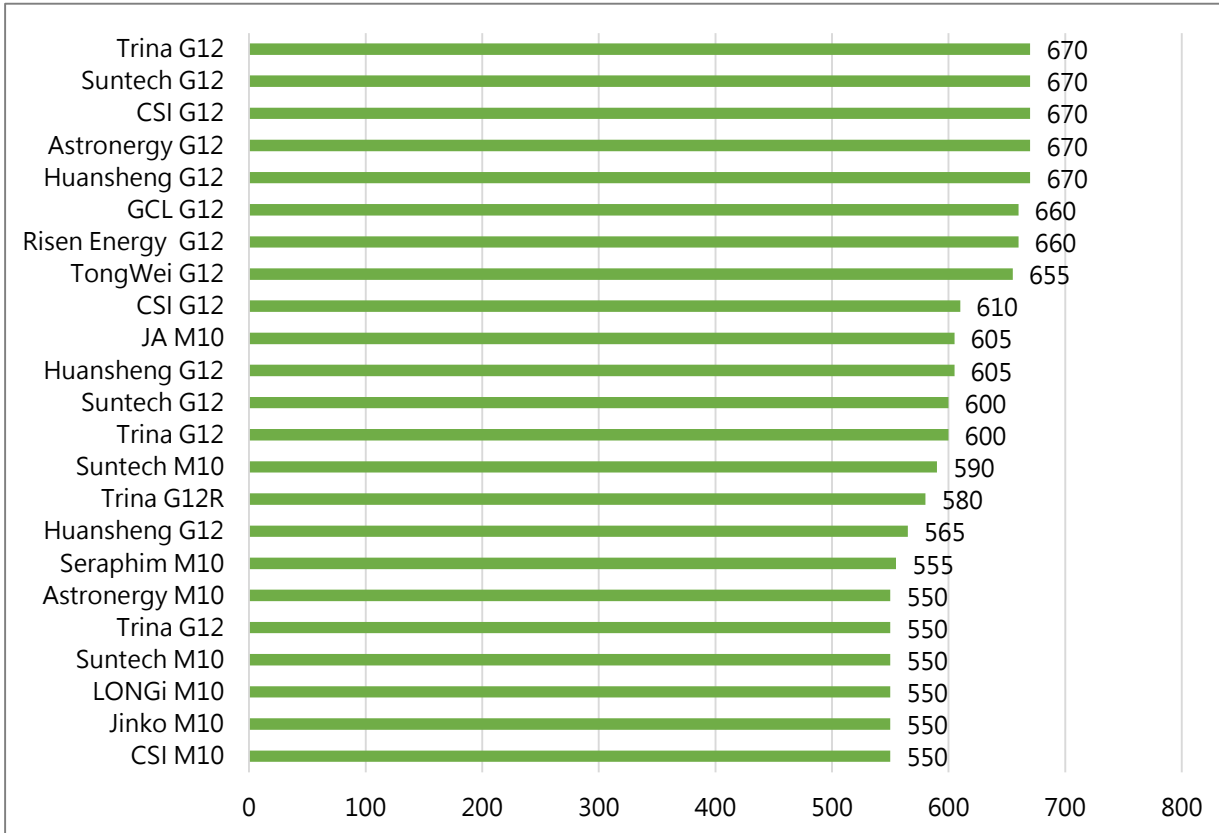
Market Share of Modules (Unit: %)



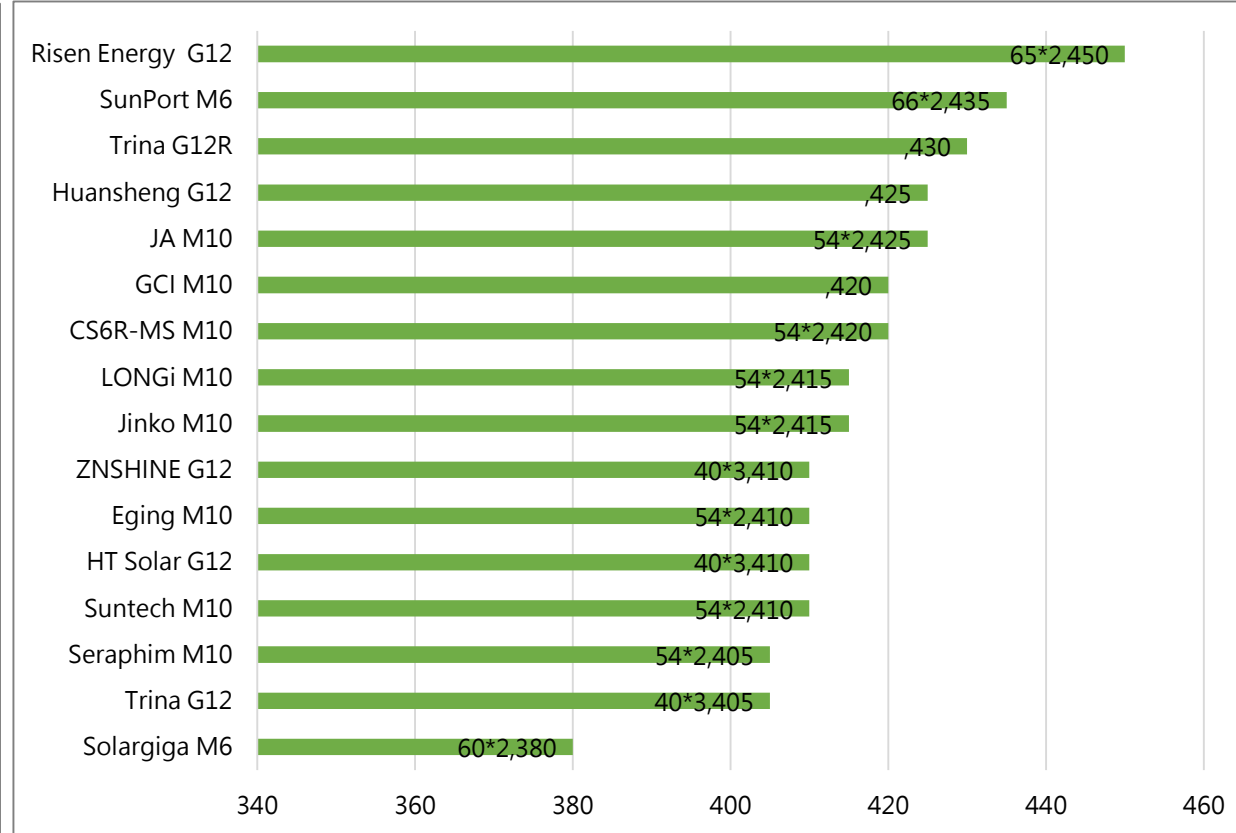
Product: Mainstream PV Businesses Have Fully Marched into 600W+

- The high-power tendency is now apparent among products applied on ground power stations, which prompted a fast transition to the 600W+ phase. In terms of power ranges, 600W and below is primarily seen among M10 products, with G12 products at more than 600W now serving as market mainstream. Combining with advantages of large-sized products, Trina Solar has released the G12R product that is applicable on ground power stations and distributed scenarios, and the product is adopted with 210mm * 182mm wafers, as well as 210mm rectangular wafers (G12R) for cell and module designs, which not only elevates power, but also conserves transportation cost. The particular roadmap is also compatible with various solar cell technology, and exerts apparent economic benefits.
- The quantity of residential and industrial & commercial products is expected to see a rapid increase under the thriving intensity of the distributed market. Residential and industrial & commercial products are currently sitting at a power range of 400-450W, with approximately 68.75% of products at 410-430W. The continuous intensity of the distributed market, as well as the major support from national policies such as provincial-level implementation, are expected to expedite the development of distributed products. Longi, Jinko Solar, and Trina Solar have been releasing new products since 2022 in order to better adapt to the distributed scenario that will introduce larger values for their clients.

Power of PERC Modules among Ground Power Stations (Unit: Watt)



Power of PRC Modules among Residential and Industrial & Commercial Scenarios (Unit: Watt)

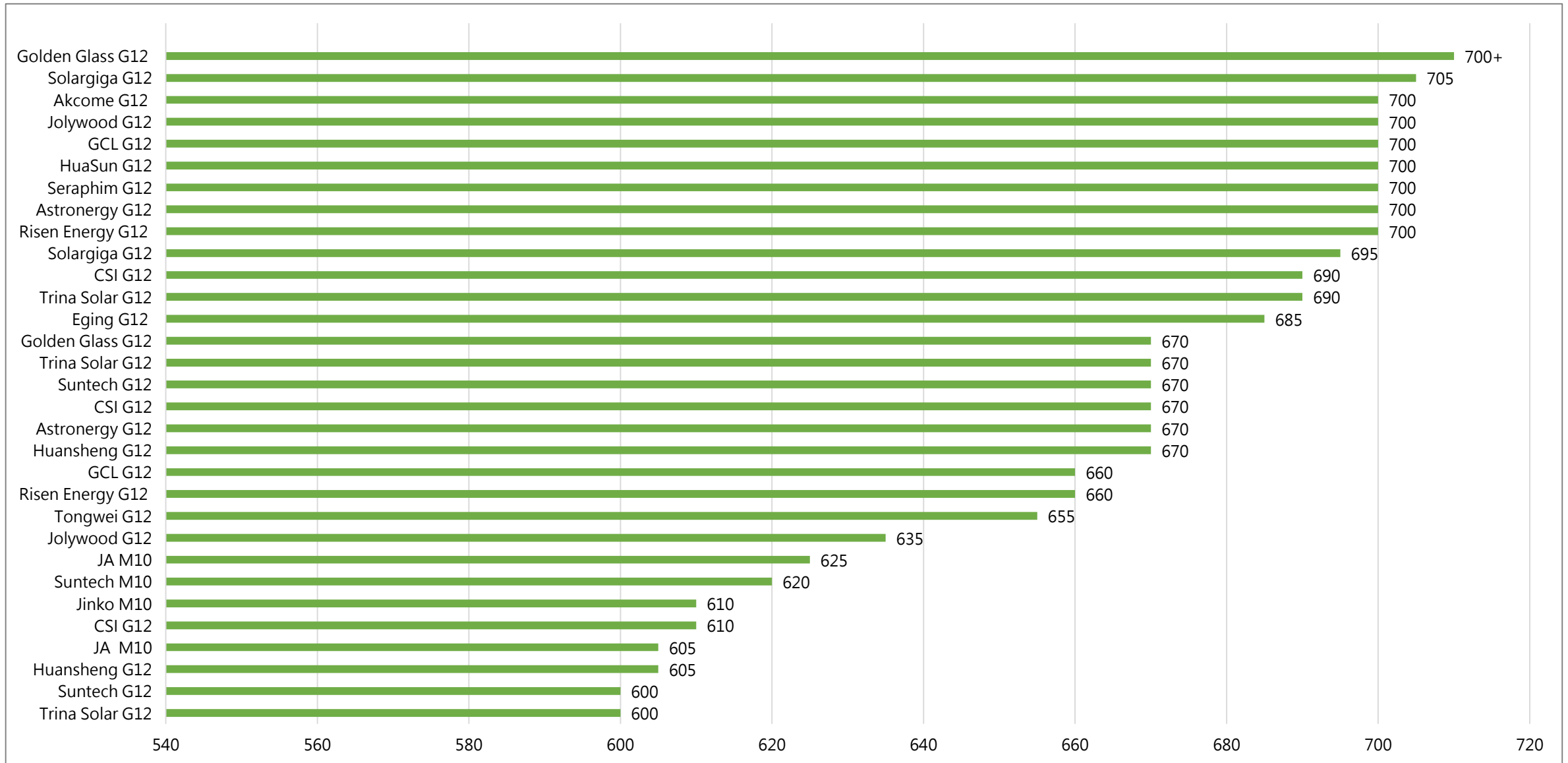


N-Type Modules Accelerate in Deployment and March Towards 700W

- PERC cells have been exerting relatively low cost in recent years, though their space for efficiency elevation is now approaching the cap. As cost of materials, transportation, and land increases, a further improvement in conversion efficiency, reduction in system cost, and acceleration in iteration and upgrades for N-type technology, are becoming essential factors for PV businesses in occupying competitive advantages within the industry chain. 210mm cells are products of the times, and are currently transitioning from PERC to N-type, which is also the direction in technology and products for the PV industry in the future. 700W+ modules adopted with 210mm cells and N-type technology have achieved technical breakthroughs.

Module Maker	Product Model	Wafer Size (mm)	Cell Quantity	Maximum Module Power (W)	Maximum Module Efficiency (%)	Encapsulation	Scenario	Cell Technology	Remark
Golden Glass		210		700+			Ground power station	HJT	
Solargiga		210		705	23.02%	Single glass	Ground power station	HJT	Half-cut cell technology
Risen Energy	Hyper-ion	210		700	22.53%		Ground power station	HJT	210mm HJT half-cut, 120mm, microcrystalline, 24 busbars, low silver paste content, alloy steel frame
CHINT	Astro N6	210		700	22		Ground power station	TOPCon	MBB + half-cut + high density encapsulation + non-destructive cutting
Seraphim	S5 Series N Type	210		700	22.53		Ground power station	HJT	
HuaSun	Himalaya G12 series	210		700	22.5	Bifacial and double glass	Ground power station	HJT	SMBB design and half-cut wafer with advance cutting and zero wear and tear
GCL-Poly	GCL-M12/66GDF-N	210		700	24.5	Bifacial and double glass	Ground power station	TOPCon	
Jolywood	Niwa	210		700		Bifacial and double glass	Ground power station	TOPCon	
Akcome	AK iPower 7.0	210		700	22.53		Ground power station	HJT	1/3-cut, low-temperature welding
Solargiga		210	132	695		Single glass	Ground power station	TOPCon	Half-cut cell technology
Trina Solar	Vertex N	210	132	690	22.2	Bifacial and double glass	Ground power station	TOPCon	
Canadian Solar	TOPBiHiKu7	210		690	22.2	Bifacial	Ground power station	TOPCon	SMBB + non-destructive cutting
Eging	Aurora Pro	210		685			Ground power station	TOPCon	MBB, non-destructive cutting, high density lamination
Golden Glass		210		670			Ground power station	HJT	
Jolywood	Niwa Max	210	120	635	22.4	Bifacial and double glass	Ground power station	TOPCon	
JA Solar	DeepBlue 4.0 X	182	156	625	22.4		Ground power station	TOPCon	Round welding strip and distinctive buffering design, zero pitch, no hidden cracks
Suntech	Ultra V pro PLUS	182	156	620	22.4	Mono-Si and bifacial	Ground power station	TOPCon	
Jinko Solar	Tiger Neo	182	156	610	21.82	Mono-si bifacial and double glass	Ground power station	TOPCon	
Longi Leye	Hi-MO N	182	144	570	22.3	Double glass	Ground power station	TOPCon	
Suntech	Ultra V pro	182	144	570	22.1	Bifacial and transparent backplane	Ground power station	TOPCon	
CHINT	Astro N5	182		570	22		Ground power station	TOPCon	MBB + half-cut + high density encapsulation + non-destructive cutting
Sumec	Draco series			565			Ground power station	TOPCon	
HuaSun	All-black bifacial double glass HJT module	166	144	480		Bifacial and double glass	Ground power station	HJT	
Canadian Solar	HiHero	182	108	440	22.5		Distributed	HJT	
Suntech	Ultra V pro mini	182	108	430	22	Mono-Si and single-sided	Ground power station	TOPCon	
Jolywood	Niwa Super	182	108	430	21.94		Distributed	TOPCon	
Jolywood	Niwa Black	182	108	430	21.43	Bifacial	Distributed	TOPCon	
REC	Alpha Pure-R	210		430	22.3	Bifacial and double glass	Distributed	HJT	HJT half-cut cell, lead-free, gapless technology
Trina Solar	Vertex S+	210		420	21.7	Bifacial and double glass	Distributed	TOPCon	
CHINT	Astro N5s	/		420	22		Distributed	TOPCon	MBB + half-cut + high density encapsulation + non-destructive cutting
HuaSun	All-black bifacial double glass HJT module	166	120	390		Bifacial and double glass	Distributed	HJT	

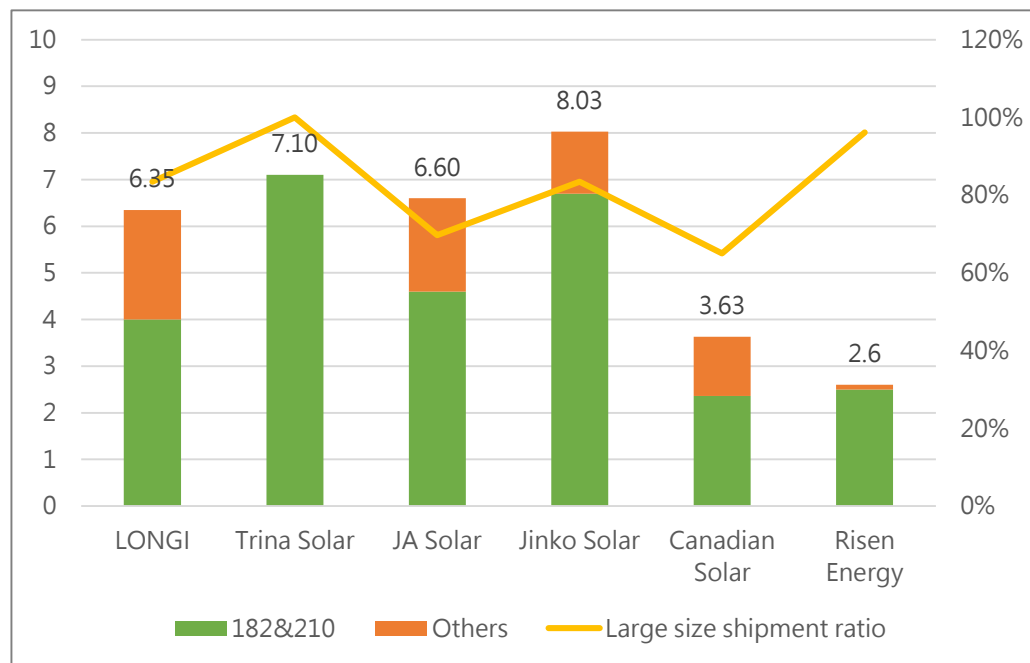
N+210 has obvious advantages in 600W+ high power module products



Shipment: Large-Sized Shipment at 27.26GW in 2022Q1 at 79%

- Major module makers had shipped a total of 34.31GW during 2022Q1, where large-sized modules (182mm & 210mm) had accounted for approximately 27.26GW at 79%. Among which, 210mm modules (including 210R) had shipped 11.96GW at 34.86%.
- Major module makers had shipped a total of 132.23GW throughout 2021, where large-sized modules (182mm & 210mm) had accounted for approximately 65.85-66.35GW at 49.8-50.18%. Among which, 210mm modules had shipped 30.75-31.25GW at 23.25-23.63%.
- The subsiding demand for M6 and below modules in 2022Q1 had prompted large-sized modules to accelerate in shipment. Major module makers are expected to ship a total of 203-230GW throughout 2022, and 210mm modules (including 210R) will expedite in shipment at the same time.

Shipment of Mainstream Module Makers during 2022Q1 (Unit: GW)



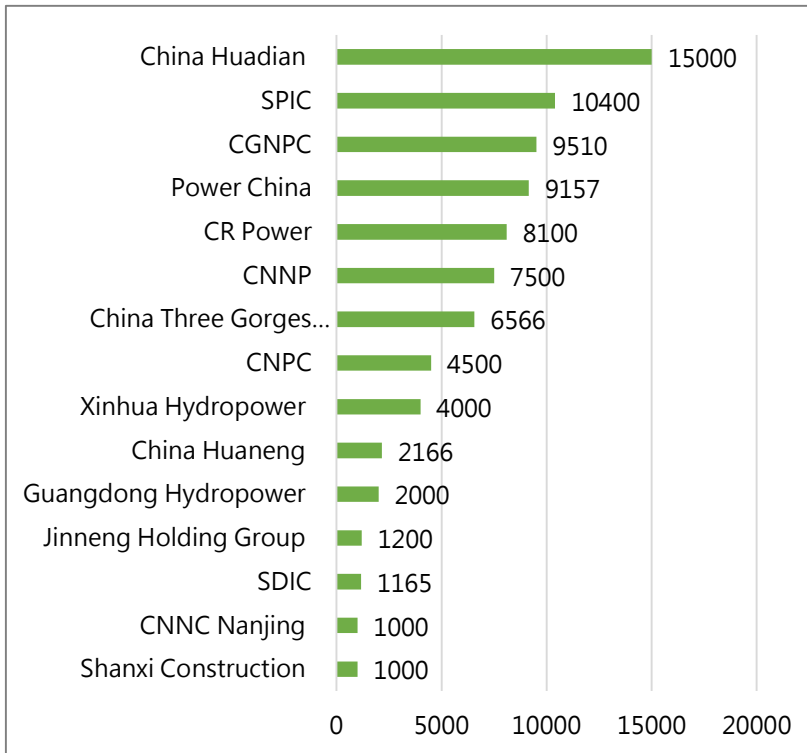
Shipment of Mainstream Module Makers between 2021 and 2022 (Unit: GW)

Business	2021 Module Shipment	2021 Large-Sized Module Shipment	2021 Large-Sized Module Shipment Ratio	2022F Module Shipment	2022F Large-Sized Module Shipment Ratio
Longi	38.52	12.8	33.23%	50-60GW	Expected to surpass 50%.
Trina Solar	24.8	16	64.52%	43	/
JA Solar	24.07	12	49.85%	35-40	/
Jinko Solar	22.23	10.3	46.33%	35-40	/
Canadian Solar	14.5	7.25	50%	20-22	75-80%
Risen Energy	8.11	7.5-8	92.48%-98.64%	20-25	80%
Total	132.23	65.85-66.35	49.8%-50.18%	203-230	/

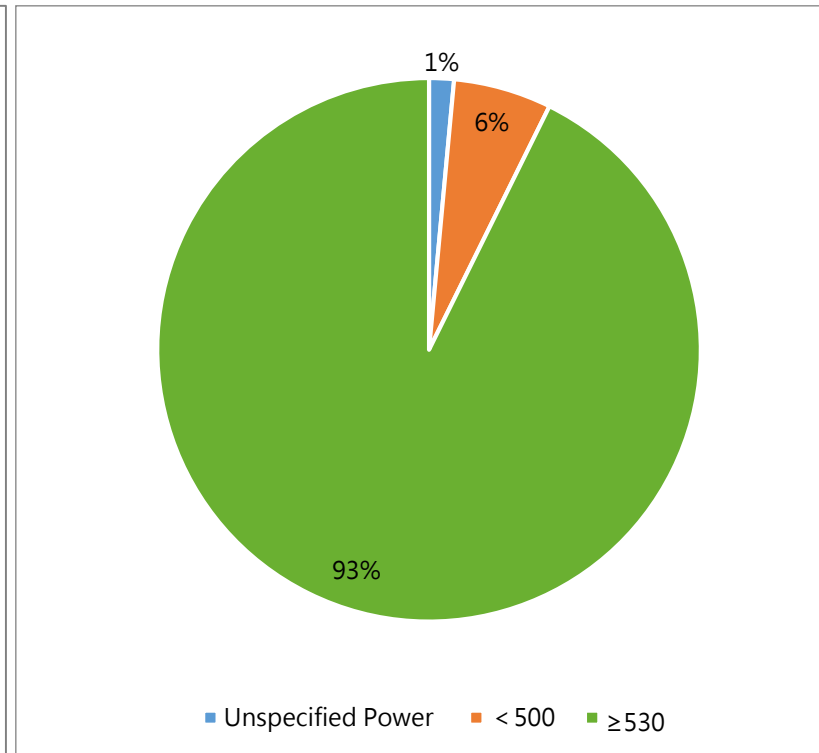
Tender Scale: 530W+ High-Power Modules at 92.69%; Large-Sized Modules (182mm & 210mm) at 96.4%

- Various central and state-owned enterprises have announced 89.4GW of PV module tenders in 2022, and remain as the main driver of procurement judging by tenderers. China Huadian and SPIC have both exceeded 10GW in centralized PV module procurement in 2022, while the top 5 businesses are occupying 61.03% of the total tender scale. It is worth mentioning that new emerging companies, such as Xing Gang Investment, Fushun Mining Group, Chinal Coal Energy, and Tysen-kld, have also started amplifying their intensity in PV module purchases.
- **High-power modules remain thriving in demand among confirmed module tenders.** The confirmed tender capacity for 530W+ modules is at 82.9GW, which occupies 92.69% of the total tender scale. 182/210mm modules are mainstream products favored by central and state-owned enterprises this year. N-type modules have surpassed 2GW in tender scale, and are also favored by central and state-owned enterprises. Modules at 375W-470W are merely seeing a tender scale of 5GW, which is a rapid reduction from the purchase volume in 2021.
- Large-sized modules (182mm & 210mm) have thus accelerated in deployment, with a tender ratio now arriving at 93%. As seen from the announced PV module tenders at 89.4GW, there are approximately 72.2GW of tenders (77%) that have yet to clearly specify size requirements, and are only asking for a power of 530W and above. 17.2GW of tenders have specified on module sizes, of which large-sized modules (182mm & 210mm) have a scale of 13.97GW at 81.2% (ratio for sizes specified by 17.2GW).

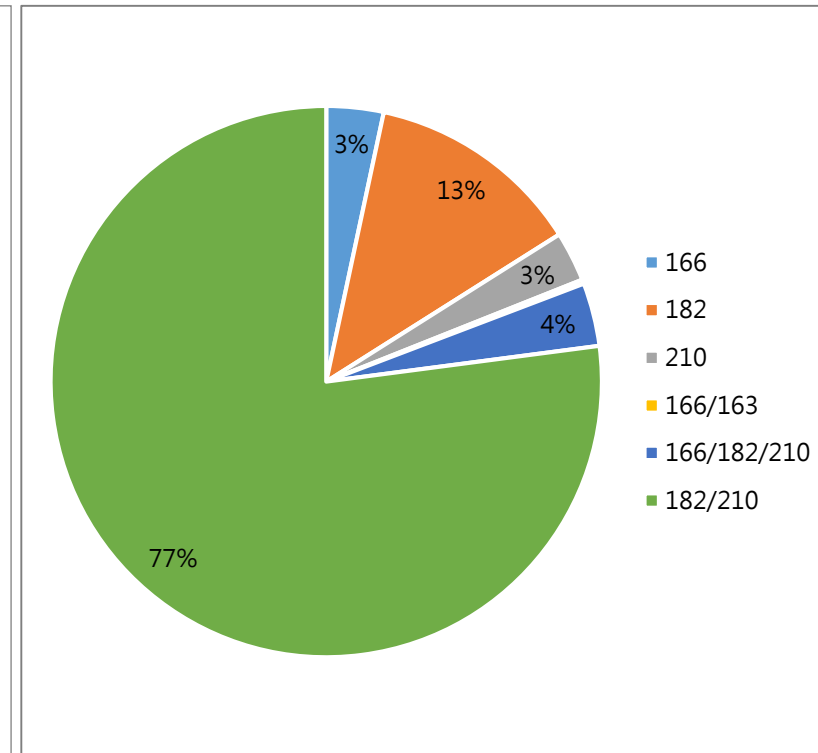
Top 15 Tenderers (Unit: MW)



Tender Scale for Modules of Various Power Ranges (Unit: MW)



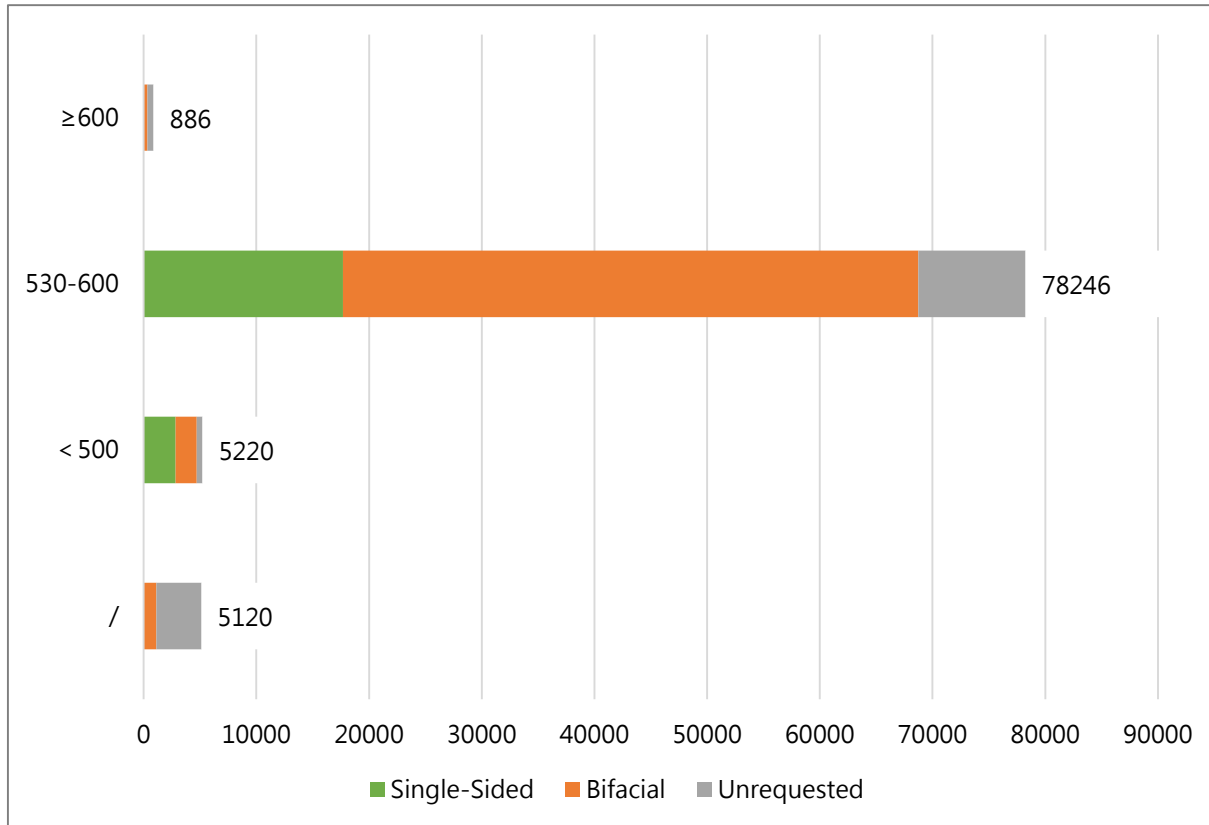
Tender Scale for Various Sized Modules (Unit: MW)



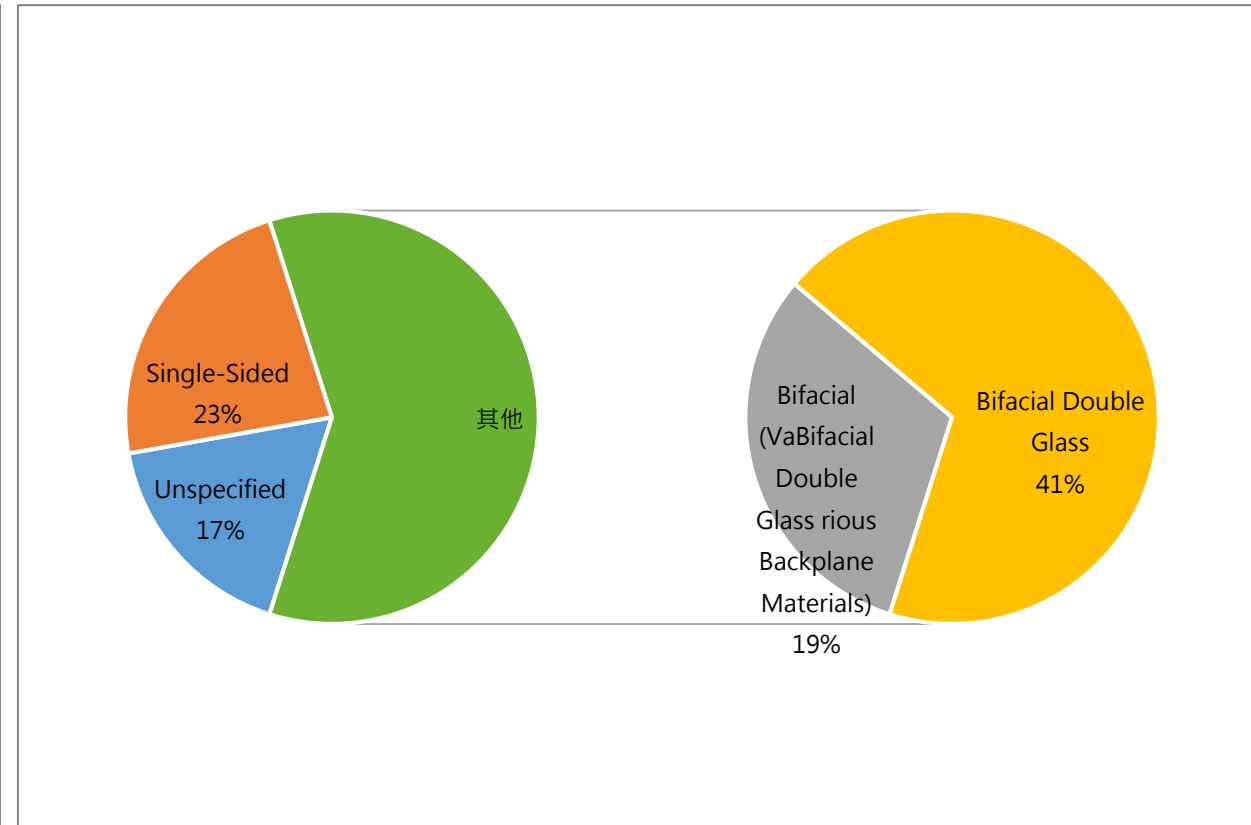
Tender Scale: Bifacial Module Tender Demand at 53.4GW (60%)

- Confirmed single-sided and bifacial PV module tenders have arrived at 73.9GW in the centralized procurement of PV modules for 2022, of which bifacial modules are occupying 53.4GW at 60%, while single-sided modules are accounting for 23% (20.5GW), with bifacial double glass modules seizing 41% (36.7GW).
- Bifacial double glass modules are gradually recognized by the market amidst the elevating demand for bifacial modules in 2022. Bifacial modules are expected to constantly increase in future market share thanks to their annual 0.1% depletion as opposed to that of single-sided modules, and the relatively higher gains for power stations. With that being said, the control on the purchase cost of glasses is tested for various module makers amidst the obstinately high supply chain cost.

Tender Scale for Single-Sided and Bifacial Modules of Various Power Ranges (Unit: MW)



Domestic Tender Ratio for Single-Sided and Bifacial Modules (Unit: MW)



A person in a light blue shirt is holding a tablet and a pen, standing over a desk. The desk is cluttered with business-related items: a laptop, a pair of glasses, a spiral notebook, and several sheets of paper featuring bar charts and pie charts. In the background, there are stacks of books and a white mug. The scene is brightly lit, suggesting a professional office environment.

Technology Deployment for Large-Sized Products Among Businesses

Technology Roadmap: TOPCon First Enters Mass Production with Module Power Now Fully Marching Towards 600W+

- High density encapsulations and non-destructive cutting technology have become the standard configuration for the products of mainstream module makers.** 182 and 210mm modules have currently adopted MBB, non-destructive cutting, high density encapsulation, and slicing. Aside from a continuous adoption of 9BB by Longi, all other businesses have attained a busbar level of 10-12BB for their modules.
- Distributed PV and ground power stations may adopt different module products seeing how the advantageous parameters of new technology are differentiated.** In terms of construction for production lines, most businesses are currently in the medium pilot run phase for HJT, while TOPCon businesses, such as Jinko Solar, JA Solar, and Trina Solar, will initiate GW-grade capacity in 2022, with Longi first initiating expansion in XBC cells and attaining mass production. Most businesses are currently under continuous R&D for HJT and TOPCon products.
- Longi: prioritizes on HPBC for distributed PV.** Longi will initiate HPBC capacity starting from August 2022, and ship 2GW within the same year under a ratio of 3-4% that will be used for the new technology (unknown) of ground power stations. Ordos may initiate production for its 30GW capacity during 2022.
- Jinko Solar, Trina Solar: priority placed on TOPCon,** with the former now holding onto 16GW of capacity and may ship more than 10GW within 2022, and the latter initiating 8GW of TOPCon capacity and 10GW of capacity for 210*182mm products that are used for distributed PV during the second half of the year.
- JA Solar and Canadian Solar are deploying multiple production lines.** Both businesses have chosen TOPCon products for ground power stations, while Canadian Solar has adopted HJT for distributed PV, and JA Solar has adopted TOPCon or IBC for distributed PV. JA Solar and Canadian Solar are going to initiate TOPCon capacity within 2022, where the former's 6.3GW of TOPCon expansion may attain mass production during the second half of the year.
- Risen Energy: focuses on HJT,** and has been the leader in HJT shipment for multiple years, with more than 15GW of capacity expansion expected for 2023.

Cell and Module Technology Development among Mainstream Module Makers

Business	Size (mm)	Cells			Modules		
		TOPCon	HJT	XBC	Module Power (W)	Busbar	High Density Encapsulation (mm)
Canadian Solar	166/182/210	250MW medium pilot production line + 5GW mass production line currently under construction	250MW medium pilot production line constructed in 2021	/	72pcs (530-550W)-182 60pcs (580-610W)-210 66pcs (640-670)-210	10BB(182) 12BB(210)	≤1
Risen Energy	166/210	Medium pilot production line	250MW medium pilot production line + 2.6GW mass production line currently under construction	/	55pcs (530-555W) 60pcs (580-605W) 66pcs(645-670)	12BB(210 PERC) 24BB(210 HJT)	0.5
JA Solar	166/182/210	100MW medium pilot production line + 6.3GW mass production line currently under construction	Medium pilot production line currently under construction	/	72pcs (525-550W) 78pcs (430-450W)	11BB(182)	≤1
Jinko Solar	163/166/182	Announcement for new 182mm TOPCon module; capacity reaching 16GW in 2022	/	/	72pcs (530-550W)-PERC 72pcs (555-575W)-TOPCon 78pcs (595-615W)-TOPCon	10BB(182 PERC) 16BB(182 TOPCon)	-0.5
Longi	166/182	Medium pilot production line	Medium pilot production line	P-IBC	72pcs (535-555W)	9BB(182)	0.6
Trina Solar	166/210/210R	500MW medium pilot production line + 8GW mass production line currently under construction	Medium pilot production line	/	55pcs (530-555W) 60pcs (585-605W) 66pcs (645-670W)	12BB(210)	0.5

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