TAIYANGNEWS

ALL ABOUT SOLAR POWER

TOP SOLAR MODULES H1-2025



Overview & Analysis of Highest Efficiency Commercial Solar Panels

Authors: Shravan K. Chunduri, Michael Schmela

LONGi

BEYOND BC CHAMPIONSHIP

Hi-MO 9
Utility

Power Up to **670W**

Hi-MO X10
Distributed Generation

Efficiency Up to **24.8%**

- No gridline on the front
  0BB on the back
- Avoiding hot spots
  Anti-shading
- 30 years of lower degradation
- Bifacial 75%-80%+
  On-Demand



Executive Summary

This 6th edition of the TOP SOLAR MODULES Analysis builds on TaiyangNews' monthly TOP SOLAR MODULES feature and marks the 42nd consecutive update. The feature highlights the highest efficiency commercial solar modules across all mainstream technologies from leading integrated manufacturers with their own cell production (see Chapter 2).

As with previous editions, this report examines efficiency data over the past months; 30 in this case – from January 2023 till June 2025. Efficiency remains the central metric, evaluated through product rankings, performance by technology, developments across efficiency bands, and company-specific trends.

The number of listed products grew from 34 in early 2023 to 51 by mid-2025, with participating suppliers increasing from 23 to 33. However, the product count has recently declined as manufacturers discontinue low-efficiency modules, particularly those based on PERC technology (see Chapter 3.1). The best commercial module efficiencies saw a notable rise – from 22.8% in early 2023 to 24.4% in June 2025 – an absolute improvement of 1.4%. AIKO maintained its lead throughout, repeatedly setting new records with its BC modules. By June 2025, the top 3 efficiency rankings were fully dominated by BC products from AIKO, Maxeon, and LONGi, with Huasun's HJT module at 23.5% occupying 4th place (see Chapter 3.2). As of mid-2025, BC modules lead the pack with 24.4% efficiency. HJT follows at 23.5%, TOPCon has reached 23.2%, and PERC remains at 21.7%. The period saw TOPCon become the 3rd technology to surpass the 23% mark, confirming its expanding role in high-efficiency commercial modules (see Chapter 3.3).

To better illustrate the efficiency evolution, modules are grouped into 4 bands: above 22.5%, 22% to 22.5%, 21.7% to 22%, and 21.5% to 21.7%. Chapter 4 tracks how companies moved within these bands and how their relative shares changed over time. This includes graphical summaries of individual company progress and broader band-level dynamics.

Chapter 5 explores technology-specific efficiency developments. BC remains the top performer and showed the highest improvement over the period with a 1.6% absolute gain, led by AIKO, LONGi, and Maxeon. HJT, driven largely by Huasun, improved its peak efficiency by nearly 1% absolute. TOPCon, meanwhile, showed more frequent, incremental gains, with several companies pushing beyond 22.5%, with JA Solar emerging as the current leader at 23.2%, followed by steady improvements from Trinasolar, Astronergy, and DMEGC Solar. In contrast, PERC technology showed no improvement in peak efficiency and saw several modules delisted, reflecting its gradual phaseout.

In addition to efficiency, the report evaluates module power ratings, grouped into 3 classes: below 500 W, 500–600 W, and above 600 W. High-power modules dominated the listing and surpassed the 50% mark by mid-2025 (see Chapter 6.1). The highest rated module power increased from 700 W in January 2023 to 730 W in June 2025, led by Huasun's HJT module. It was followed by Tongwei Solar and Trinasolar at 715 W, with Grand Sunergy and Jetion Solar offering 710 W modules. PERC reached 675 W, represented by Canadian Solar, while AIKO's BC module achieved 660 W by mid-2025 (see Chapter 6.2).

Chapter 7 compiles a company-wise summary of all listed modules, presenting their respective efficiency and power standings at a glance.

Finally, the Badge of Excellence feature, introduced in 2023, returns to recognize companies that appeared in the Top 10 for at least 6 months in a calendar year – highlighting those that consistently demonstrate leadership in solar innovation (see page 8 for details).

Enjoy reading our report on TOP SOLAR MODULES H1-2025.



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AIKO

ABC Upgraded INFINITE

Redefine PV Efficiency Again
Leading 25% Era

- **Ultimate Efficiency**

+30W More Power Than TOPCon With Same Size

1762×1134x30mm Series
(Mono-glass & Dual-glass):
INFINITE Black: Up to
490W

30 years Product Warranty
30 years Performance* Warranty

1762×1134x30mm Series
(Mono-glass & Dual-glass):
INFINITE White: Up to
500W

1954×1134×30 mm Series
(Mono-glass & Dual-glass):
INFINITE Black: Up to
540W Coming Soon...



- **Pure Aesthetics**
  - Front-side grid-free
  - Elegant full-black design
- **Unrivaled Durability**
  - High temperature restriction
  - Micro-crack resistance
  - Hail resistance
  - IEC Fire Class A
- **Intelligent Technology**
  - Partial shading optimization
  - InvisiRibbon
  - ZeroGap
  - Better temperature coefficient

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TAIYANGNEWS
ALL ABOUT SOLAR POWER

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HUASUN

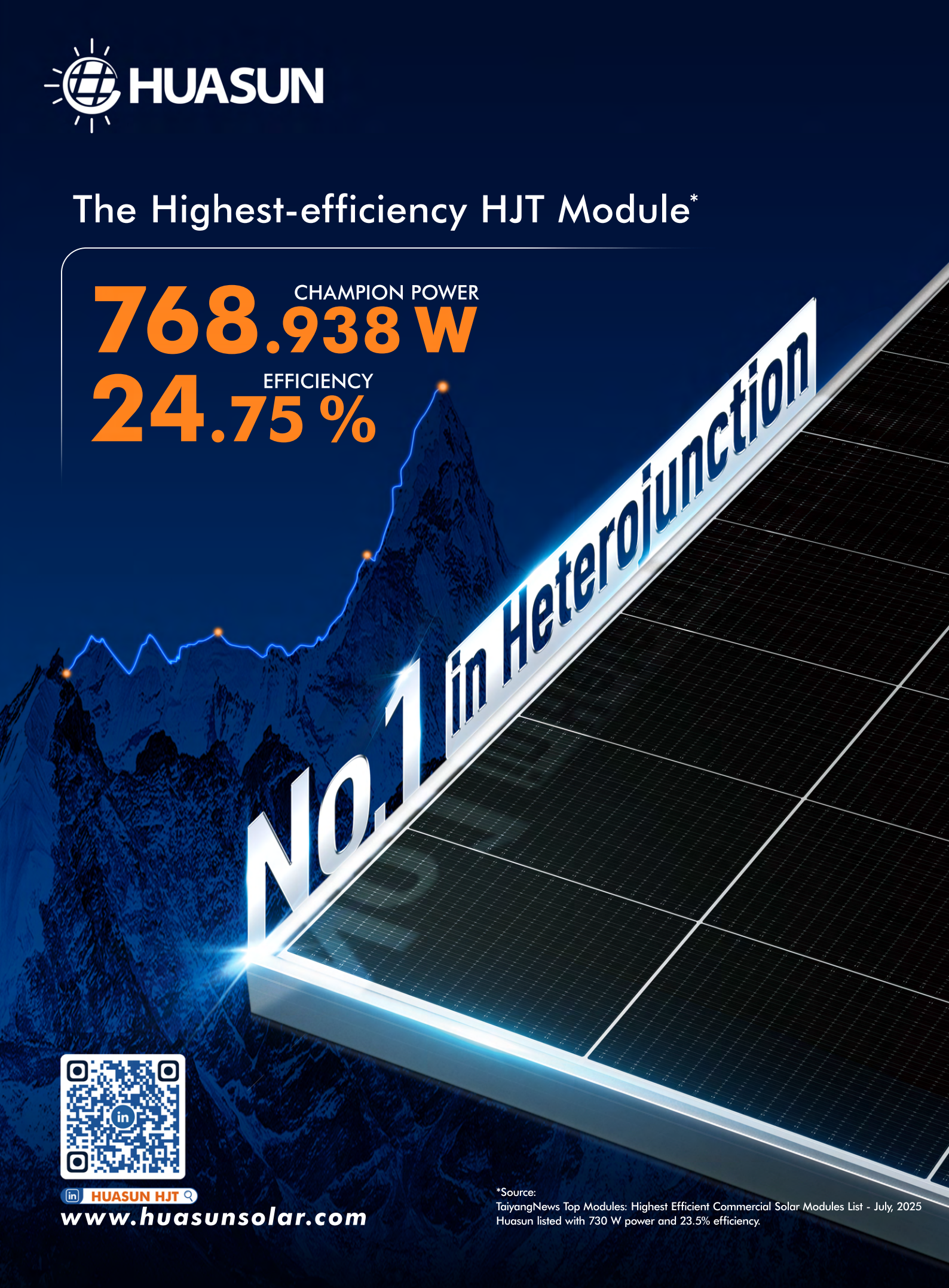
The Highest-efficiency HJT Module*

CHAMPION POWER

768.938 W

EFFICIENCY

24.75 %



HUASUN HJT

www.huasunsolar.com

*Source:
TaiyangNews Top Modules: Highest Efficient Commercial Solar Modules List - July, 2025
Huasun listed with 730 W power and 23.5% efficiency.

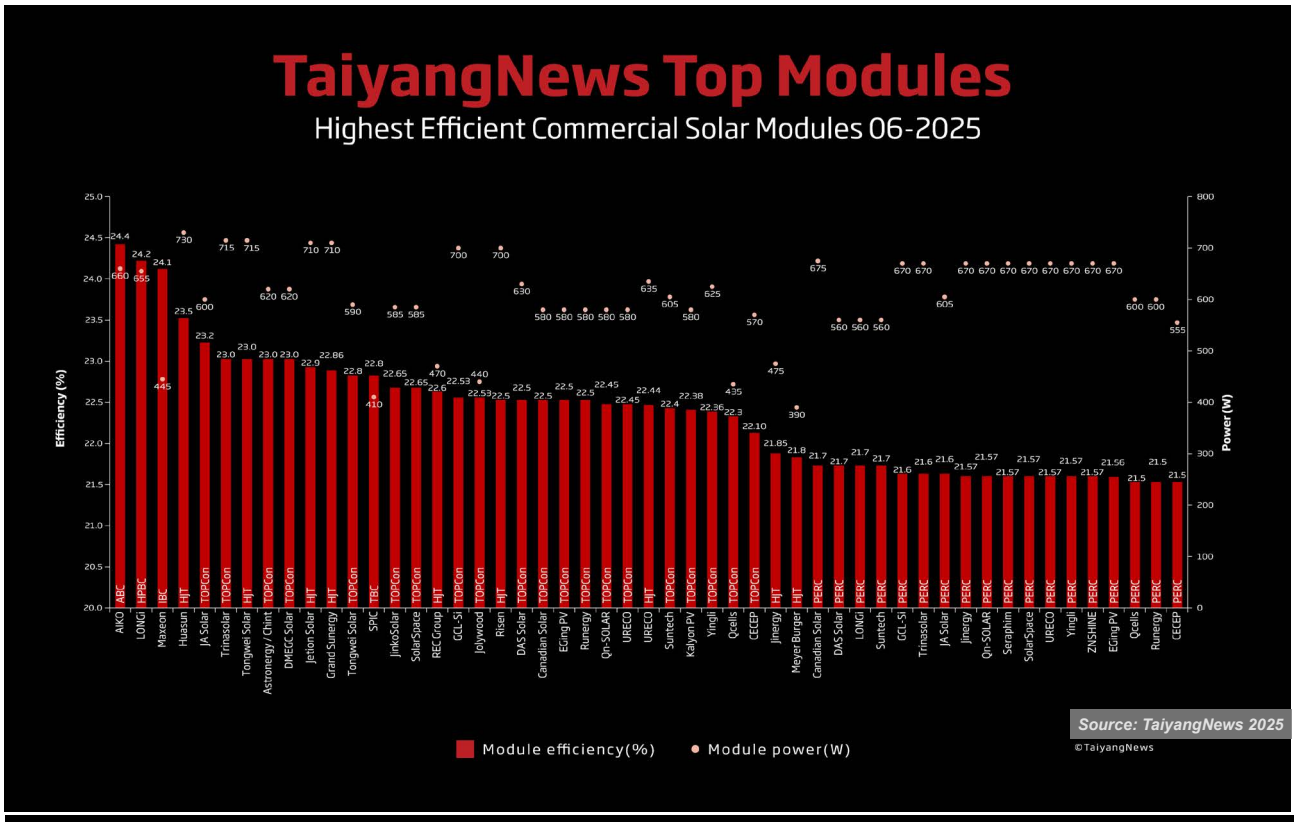
1. Introduction

Solar module efficiency has always been a critical area in the race for better performance. It's the number that sells the product, sets industry benchmarks, and captures headlines. And despite the solar industry grappling with oversupply and downward pricing pressure, efficiency remains one of the few levers manufacturers can still pull to stand out. With every incremental gain, module makers not only increase the power output per square meter but also help reduce system costs and the overall LCOE.

However, the world of solar announcements can be deceptively optimistic. A growing number of claimed efficiencies – often revealed at trade fairs or in promotional slides – may belong more to prototype labs or future roadmaps than to commercial product lines. These figures reflect what might be possible rather than what is already in production. And for developers, EPCs, and buyers making decisions today, it's the commercial reality that matters – not the lab record.

That's why distinguishing between announced potential and actual market availability is increasingly important. To address this gap, TaiyangNews launched the TOP SOLAR MODULES feature in early 2022. Updated monthly, the listing tracks commercially available high-efficiency modules, helping the industry benchmark real-world advancements.

The feature builds on TaiyangNews' long-standing coverage of solar efficiency trends since 2017 through its annual Advanced Module Technologies reports and online conferences. With technology evolving rapidly, a regular monthly update became essential – and thus, TOP SOLAR MODULES was born. The listing includes a curated table, performance graphs, a summary article, and



New Benchmarks: As of June 2025, 5 commercial modules have crossed the 23% efficiency mark, while 3 BC products from AIKO, LONGi and Maxeon continue to lead with efficiencies above 24%.

Badge of excellence

TaiyangNews started an excellence badge scheme in 2023 for its TOP SOLAR MODULES ranking, which was extended to 2024. Those module manufacturers featured in the top 10 for at least 6 months of a calendar year are qualified to claim this badge of excellence. Here are the winners of the TaiyangNews Excellence Badge for 2024: AIKO, LONGi, Maxeon, Huasun, JA Solar, Tongwei Solar, Astronergy, SPIC, DMEGC Solar and JinkoSolar.

TOP SOLAR MODULES 2024 TOP 10

AIKO · ASTRONERGY · DMEGC SOLAR · HUASUN · JA SOLAR · JinKO Solar · LONGi · Maxeon · SPIC · TW SOLAR

Top Solar Modules 2024 Badge of Excellence Winners



an animation video, published monthly on the TaiyangNews website. The June 2025 edition marks the 42nd consecutive update, reflecting 3.5 years of continuous coverage.

To further support industry benchmarking, TaiyangNews launched a Badge of Excellence program in 2023. This initiative recognizes module manufacturers featured in the Top 10 of the TOP SOLAR MODULES listing for at least 6 months in a given calendar year.

Beyond individual rankings, tracking these monthly listings over time reveals broader market trends. To this end, TaiyangNews began publishing summary reports, starting with an annual review of 2022. Since 2023, the format has evolved into a biannual report series, capturing both mid-year and full-year insights. This 6th and most recent edition summarizes developments across 2023, 2024, and the first half of 2025, providing a detailed overview of key shifts in module efficiency and power ratings.

A key update in this (and the previous) edition is the exclusion of 2022 data from graphs and charts to enhance clarity and focus on recent trends. However, 2022 data remains accessible in earlier editions, available for free download from the TaiyangNews website. The scope of this report covers the 30 most recent monthly features, spanning January 2023 to June 2025.

As in past editions, the core focus is on efficiency trends – still the primary metric of module performance. The analysis includes progress across efficiency bands, developments by cell technology (BC, HJT, TOPCon, PERC), and the performance trajectories of individual companies. In addition, while not as detailed as the efficiency coverage, the report also includes power class analysis and top-rated power insights, providing a holistic view of where commercial module innovation stands today.

JA SOLAR

Unleashing Solar Power Anywhere in Any Environment

Unanimous recognition from global customers with products distributed across 178 countries and regions



Rooftop
Hail Resistant
Typhoon-Proof
Plateau
Offshore
Extreme Cold
Light Weight
Anti-Glare
Desert
Anti-Flare
Heat & Humid

TOP SOLAR MODULES 2024 Monthly TOP 10 Companies

Rank	January	February	March	April	May	June
1	AIKO	AIKO	AIKO	AIKO	AIKO	AIKO
2			LONGi	LONGi	Maxeon	Maxeon
3	HUASUN	HUASUN	HUASUN	HUASUN	LONGi	LONGi
4	TW SOLAR	TW SOLAR	TW SOLAR	TW SOLAR	HUASUN	HUASUN
	Maxeon	Maxeon	Maxeon	Maxeon		
5					TW SOLAR	TW SOLAR
6	SPIC	SPIC	SPIC	SPIC	SPIC	SPIC
		TW SOLAR	TW SOLAR	TW SOLAR	TW SOLAR	TW SOLAR
			ASTRONERGY	ASTRONERGY	ASTRONERGY	ASTRONERGY
7	ASTRONERGY					
	JinkoSolar					
8	ASTRONERGY					
	JinkoSolar					
9	中来股份 JOLYWOOD		JinkoSolar	JinkoSolar	JinkoSolar	JinkoSolar
10	risen	中来股份 JOLYWOOD	中来股份 JOLYWOOD	DMEGC SOLAR	DMEGC SOLAR	DMEGC SOLAR
	Trinasolar					
	DASOLAR					
	JA SOLAR					
	Canadian Solar					
	DMEGC SOLAR					
	RUNERGY					
	TW SOLAR					
	Canadian Solar					

Continued From Page 10

July	August	September	October	November	December
AIKO	AIKO	AIKO	AIKO	AIKO	AIKO
Maxeon	Maxeon	Maxeon	Maxeon	Maxeon	Maxeon
LONGi	LONGi	LONGi	LONGi	LONGi	LONGi
HUASUN	HUASUN	HUASUN	HUASUN	HUASUN	HUASUN
TW SOLAR	TW SOLAR	TW SOLAR	TW SOLAR	TW SOLAR	TW SOLAR
				JA SOLAR	JA SOLAR
SPIC	SPIC	SPIC			
TW SOLAR	TW SOLAR	TW SOLAR	Grand Sunergy		
ASTRONERGY	ASTRONERGY	ASTRONERGY			
DMEGC SOLAR	DMEGC SOLAR	DMEGC SOLAR			
JA SOLAR	JA SOLAR	JA SOLAR			
			ASTRONERGY	ASTRONERGY	ASTRONERGY
			JA SOLAR		
			TW SOLAR		
			DMEGC SOLAR		
			SPIC		
				Grand Sunergy	Grand Sunergy
				DMEGC SOLAR	DMEGC SOLAR
				SPIC	SPIC
				TW SOLAR	TW SOLAR

TOP SOLAR MODULES H1-2025 Monthly TOP 10 Companies

Rank	January	February	March	April	May	June
1	AIKO	AIKO	AIKO	AIKO	AIKO	AIKO
2	Maxeon	Maxeon	LONGi Maxeon	LONGi Maxeon	LONGi Maxeon	LONGi
3	LONGi	LONGi				Maxeon
4	HUASUN	HUASUN	HUASUN	HUASUN	HUASUN	HUASUN
5	TW SOLAR JA SOLAR	TW SOLAR JA SOLAR	TW SOLAR ASTRONERGY DMEGC SOLAR	TW SOLAR ASTRONERGY DMEGC SOLAR JA SOLAR	TW SOLAR ASTRONERGY DMEGC SOLAR JA SOLAR Trinasolar	JA SOLAR
6						Trinasolar TW SOLAR ASTRONERGY DMEGC SOLAR
7	ASTRONERGY	ASTRONERGY				
8	Grand Sunergy	Grand Sunergy				
9	DMEGC SOLAR TW SOLAR SPIC	DMEGC SOLAR TW SOLAR SPIC	Grand Sunergy SPIC	Grand Sunergy		
10			TW SOLAR SPIC	TW SOLAR SPIC	Grand Sunergy	Jetion Solar

TIGER Neo III

JinKO Solar

670W | 24.8%

Tiger Neo 3.0 Era is Coming



www.jinkosolar.com

2. Methodology

Before delving into the specifics, the following provides background information on the methodology and selection criteria: module efficiencies have been improving considerably in recent years. In order to make the list rewarding for technically advanced products, we set the minimum efficiency of 21.5% as the criterion to feature among the TOP SOLAR MODULES.

We have listed only commercially available top modules from each cell technology stream of a module maker. For example, suppose a company is offering 2 different products based on PERC technology with efficiencies of more than 21.5%. In that case, only the one with the higher efficiency is considered for this list. But if it has 2 different products based on PERC and TOPCon with efficiencies of 21.5% or above, then both products are listed. Efficiency is the only criterion for ranking in the list (whenever available in the specs, we have used 2 digits after the decimal point for efficiencies, otherwise one). However, as we see products with the same efficiency more often, power determines the order in this case. And when both efficiency and power are the same, we list the manufacturers alphabetically.

The list does not distinguish between different module formats. All typical module sizes used in rooftop and ground-mounted solar system applications are included and treated equally, as companies increasingly use larger modules even for rooftop applications.

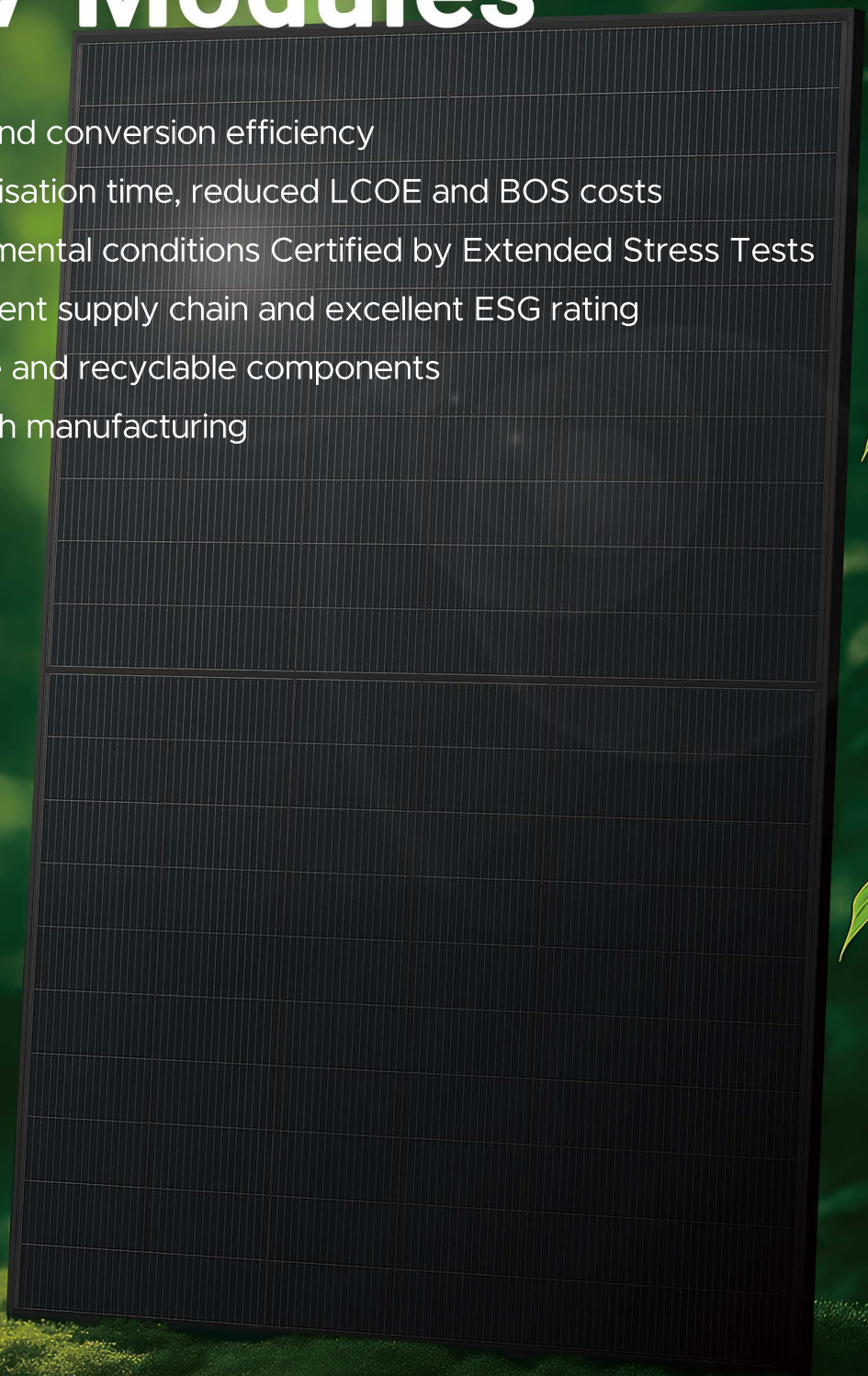
We only list modules that are based on the manufacturer's cells produced in-house, which means modules using externally sourced cells are not featured in the TOP SOLAR MODULES list. Having the complete data sheet listed on its manufacturer's website is the first step for a module to be considered a commercially available product. As such, the efficiency and power data listed here are taken from the datasheets available on the respective company's website. This also means that any new product announcements without final technical data published are not included in the list, as their module specs often differ considerably from the products that are finally available for purchase, and some products presented at trade fairs do not even see commercial light at all.

However, just the existence of an online datasheet generally does not suffice, especially for top efficiencies in the respective technology stream. If module specs listed on the websites seem to have 'conspicuously' high efficiencies or new record-efficiency products are announced, we ask for additional proof of commercialization before we include a product in the list.

DMEGC SOLAR

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- Industry-leading module power and conversion efficiency
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- Protection against harsh environmental conditions Certified by Extended Stress Tests
- 100% green production, transparent supply chain and excellent ESG rating
- Low carbon footprint, PFAS-free and recyclable components
- 40+ years experience in high-tech manufacturing

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TOP PERFORMER 2025 kiwa PV MODULE RELIABILITY SCORECARD

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3. TOP SOLAR MODULE LEADERS

An important feature of TaiyangNews' TOP SOLAR MODULES is that we have been ranking the companies according to their efficiency levels, and companies have always been striving to reach the top positions. It is interesting to see how the top 3 efficiencies have progressed in the last 2 years, as well as the companies that led these innovations. Efficiency is one thing, but cell technology also plays a role here. Thus, we have also analyzed the toppers of 4 cell technologies – BC, TOPCon, HJT and PERC. This chapter provides an analysis of the top 3 efficiencies over time and the top efficiencies in each cell technology, and the respective companies that attained this level.

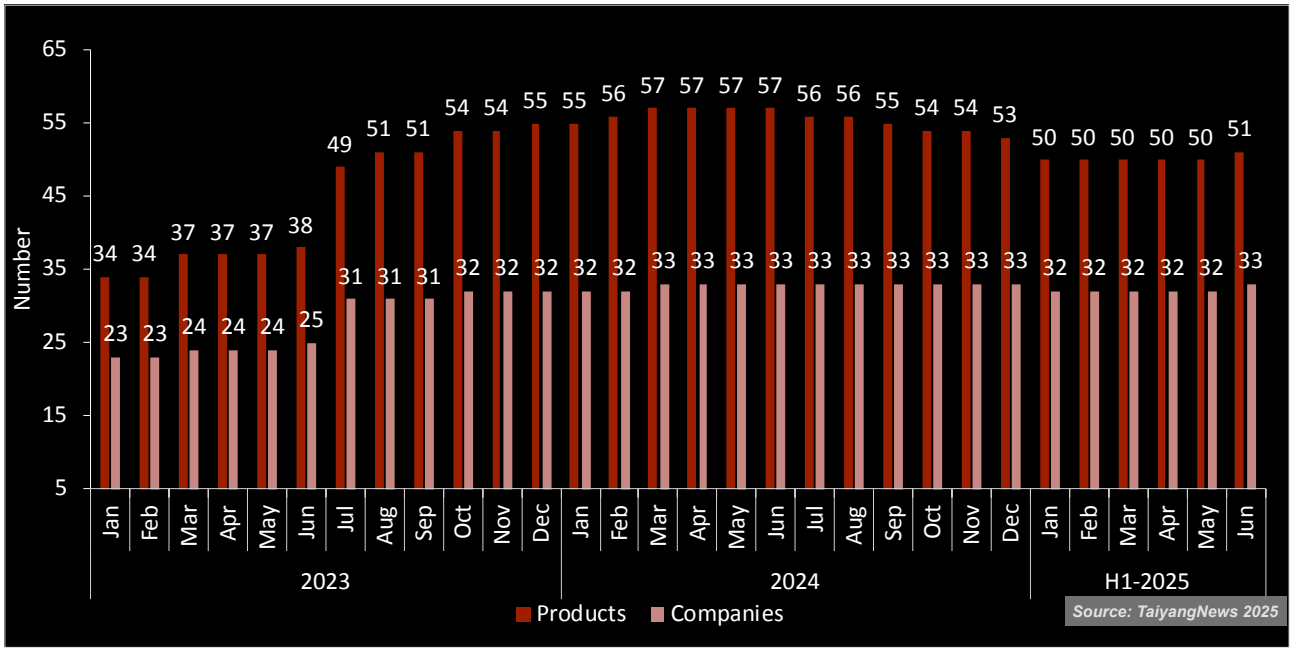
3.1 Count of Companies & Products

Before going into the core analysis, here is a quick peek into the statistics of the TOP SOLAR MODULES over the last 2.5 years. In terms of count, the most notable development in H1 2025 is also the latest, occurring in June, when the number of products increased – albeit by just one – after several months of stability. The June edition also marked the entry of a new company, Jetion Solar, into the TOP SOLAR MODULES list. This is the first new company to join the list since Grand Sunergy's entry in October 2024, which followed Kalyon PV's addition in March 2024.

From January through May 2025, the number of listed products remained the same at 50, after a considerable drop in January due to the delisting of 3 products. The June update took the total to 51.

In H2 2024, the number of listed products started decreasing, dropping to 56 in July from a peak of 57, and ultimately to 53 by December 2024. This was mainly due to a few companies ceasing their commercial activities in the PERC technology stream. A total of 5 products were delisted in H2 2024. In contrast, it was only an upward trend until then. It was in March 2024 that the peak of 57 was achieved, and continued until the end of H1 2024, increasing from the January level of 55 at the beginning of 2024.

TOP SOLAR MODULES Products & Companies Count – 2023 / H1-2025



Persistent Pursuit of Efficiency: The PV industry's consistent drive for higher efficiency first expanded the number of listed products in TOP SOLAR MODULES, while the same focus is now leading to a dip in product count as companies phase out less efficient technologies, such as PERC.

Looking back, starting from 34 in January 2023, the number of listed products grew to 55 by December 2023. This growth was part of a steady rise observed since the start of our TOP SOLAR MODULES feature in January 2022 until H1 2024.

The growth story is slightly different when it comes to the number of companies. As mentioned earlier, the most notable change in H1 2025 occurred in June with the addition of Jetion Solar, which brought the total number of companies back to 33. The count had dropped to 32 in January 2025 due to the delisting of Akcome.

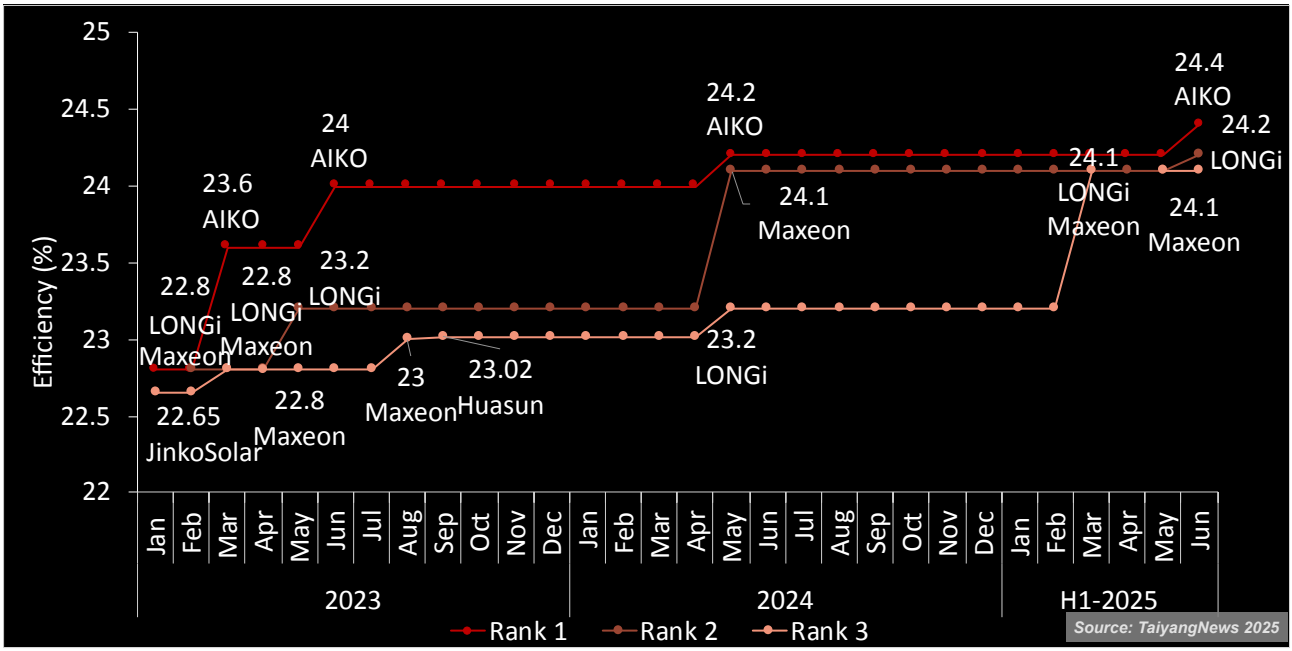
In 2024, the total number of companies increased by just one over the entire year – from 32 in January to 33 in December. Kalyon PV was added in March, and Grand Sunergy entered the list in October. However, this second addition was offset by the delisting of Talesun in the same month, so the overall company count remained unchanged at that time.

The clear disconnect between the changes in the number of products and suppliers indicates that more manufacturers were expanding their portfolios across multiple technologies to achieve module efficiencies above 21.5%. For instance, during H1 2025, 17 companies offered module products based on 2 different technologies, while one company was represented in 3 technologies. Of late, the number has been declining though. Regarding companies represented in 2 technology streams, the count remained steady at 19 throughout 2024. The dip during H1 2025 was due to the omission of Akcome from the TOP SOLAR MODULES list and the delisting of PERC products from Risen. Consequently, the number of companies offering modules based on 2 different technologies dropped from 19 in December 2024 to 17 during H1 2025. The number of companies featuring products across 3 different cell technologies decreased to 1 from 3 already during 2024. Tongwei Solar, previously part of this category, exited the PERC segment in August 2024, while Canadian Solar exited the HJT category in March 2024, leaving URECO as the only company with listings across 3 technologies for the remainder of 2024 as well as for H1 2025. In 2023, 11 companies offered modules using 2 technologies, typically combining PERC with either TOPCon or HJT. No company had products across 3 technologies that year.

3.2 Top 3 Efficiencies

Diving deeper, we now present the progress of the

Top 3 Commercial Module Efficiencies – 2023 / H1-2025



Undisputed Leader: The top 3 efficiency ranks have been held by BC modules for about a year, with AIKO pushing the benchmark to 24.4%, followed by LONGi and Maxeon both exceeding 24%.

top 3 efficiencies, irrespective of cell technologies. Unsurprisingly, the back-contact architecture leads in this area. During H1 2025, the most significant development within the top 3 rankings also occurred in June, with AIKO once again taking the spotlight. The company established a new benchmark by increasing the efficiency of its commercial BC module to 24.4%, surpassing its previous record of 24.2% achieved in May 2024. AIKO has raised the efficiency bar once again, maintaining its No. 1 ranking – a position it has held for all but 2 months within the scope of this report since its debut in March 2023. LONGi and Maxeon shared the top rank for the initial 2 months of 2023.

Leveraging its back contact technology, known as HPBC, LONGi now exclusively holds the 2nd rank. The company improved the top efficiency of its commercially available HPBC modules twice in H1 2025. The latest improvement, to an efficiency of 24.2%, occurred in June 2025, up from the 24.1% it achieved in March 2025 when it shared the 2nd rank with Maxeon. Until then, Maxeon had solely occupied the 2nd rank since April 2024. The predecessor to this 24.1% Maxeon module had an efficiency 1.1% lower in absolute terms and was not even among the top 3. Before Maxeon provided proof of commercialization to secure the 2nd place, LONGi held the rank exclusively since May 2023 with its 23.2% efficiency module. For the preceding 2 months, March and April 2023, the 2nd position was again jointly held by Maxeon and LONGi with 22.8% efficiency. These same 2 modules had shared the top spot for the first 2 months within the scope of this report, January and February 2023.

As of June 2025, Maxeon is ranked 3rd, a position that was vacant for the 2 preceding months as both Maxeon and LONGi jointly held the 2nd position. However, from May 2024 to February 2025, LONGi held the 3rd rank with its 23.2% efficiency product. From September 2023 to April 2024, LONGi's product was ranked 2nd, and Huasun's HJT module was 3rd. This period also saw modules based on non-BC cell architecture featured among the top 3 of the TOP SOLAR MODULES listing. Further back in time, the 3rd rank was held by Maxeon with a 23% product in August 2023 and a 22.8% product from March to July 2023, while Jinkosolar's 22.65% module occupied this position for the first 2 months of that year.

It is important to note that as of the end of H1 2025, the TOP SOLAR MODULES list features 3 commercial modules with efficiencies of 24% or higher, all based on BC technology – underscoring BC's dominance in high-efficiency products.

From January 2023 to June 2025, the top commercial module efficiency improved by 1.4% in absolute terms. Even during the most recent 18 months, from January 2024 to June 2025, the top efficiency improved by 0.4%.

In the year 2024, there was a 0.2% absolute improvement in top efficiency, marking the beginning of a broader upward trend. At the start of the year, BC held the top 2 ranks, while HJT was 3rd. In May, the top 3 efficiency spots became exclusively dominated by BC technology. Each of the top 3 positions saw a revision during the year. AIKO, which had maintained the top rank since the beginning of the year with a 24% efficiency module, surpassed its own record by commercializing a 24.2% efficiency product in May. LONGi's HPBC module, which had held the 2nd position with 23.2% efficiency, remained unchanged until it was overtaken by Maxeon. The latter introduced a 24.1% BC module, pushing LONGi to 3rd and displacing Huasun's HJT product from the top 3. By the end of 2024, 2 commercial modules had crossed the 24% efficiency threshold.

3.3 Top Efficiency of Each Cell Technology

It is evident that module efficiency is mainly driven by cell technology, and companies often rely on advanced cell architectures such as BC, TOPCon, and HJT. The graph on Page 19 summarizes the top-efficiency product in all commercial cell structures.

Sorting the efficiencies based on cell technology also provides some interesting insights, especially when looking at the top efficiencies and – when they are mapped side by side.

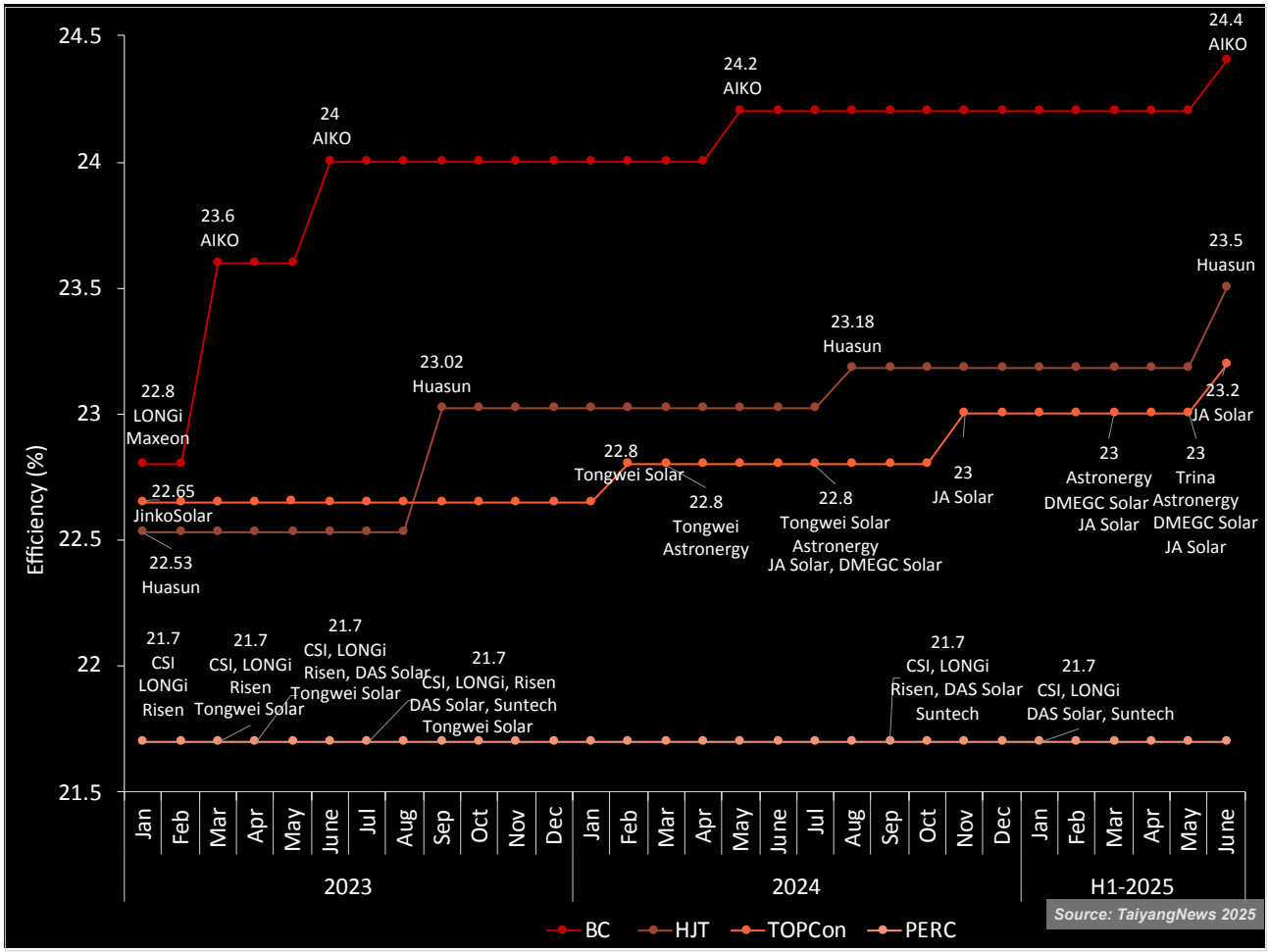
Historically, BC has always been considered the efficiency leader among the commercially offered modules, which is also reflected in our list since we began compiling it. Thus, the explanation of top efficiency progress in the above section is also applicable to BC efficiency progress. This leadership continued into 2025. In H1 2025, AIKO pushed the benchmark further by improving its module efficiency to 24.4% in June, breaking its previous record. At

the beginning of 2024, AIKO held the top position with a 24% module, which it improved to 24.2% in May 2024. At the start of 2023, the top BC efficiency position was held by both LONGi and Maxeon, with both their modules featuring 22.8% efficiency. In March 2023, AIKO directly took the lead with its debut with module achieving 23.6% efficiency, and further strengthened its position with a 24% product in June 2023, staying on top through 2023.

The top commercial module efficiency among TOPCon products continued to improve in H1 2025. JA Solar raised the bar by commercializing a TOPCon module with an efficiency of 23.2%, achieving a new high for the technology in June. This surpassed the previous top efficiency of 23%, which had also been held by JA Solar since November 2024. However, in March 2025, Astronergy and DMEGC Solar joined JA Solar by commercializing modules with 23% efficiency, bringing the total number of companies at this benchmark to 3.

Over the full course of this report's timeline, the best TOPCon efficiency has improved by 0.65% in absolute terms. Most of this progress occurred during 2024. The year began with JinkoSolar leading the category with a 22.65%-efficient module, which was at the top of TOPCon throughout the year 2023. In February, Tongwei Solar surpassed this with a module reaching 22.8%, followed by Astronergy in March. In July, both JA Solar and DMEGC Solar also reached 22.8%, creating a 4-way tie at the time. A major breakthrough came in November 2024, when JA Solar pushed the benchmark to 23% – a

Top Efficiencies For Cell Technologies – BC, HJT, TOPCon & PERC – 2023 / H1-2025



The Tech Toppers: Assessing the highest efficiencies across cell technologies, AIKO continues to lead the BC category, Huasun is spearheading HJT development, and JA Solar now tops the TOPCon segment as of June 2025.

milestone that remained unchallenged until June 2025.

In the HJT category, the top efficiency continues to be represented by Huasun. In June 2025, the company significantly raised its benchmark by improving its commercial HJT module efficiency from 23.18% to 23.5% – the highest recorded value for this technology to date. At the beginning of 2024, Huasun's top module was listed at 23.02%. This was later improved in August 2024, when the company raised the efficiency to 23.18%. Huasun was also the segment leader throughout 2023, improving its top efficiency from 22.53% at the start of the year to 23.02% in September, which briefly placed it among the top 3 across all technologies.

For PERC, the top efficiency remained unchanged at 21.7% through to the end of June 2025.

However, the number of companies representing this efficiency level continued to decline. At the start of 2025, Risen's PERC module was delisted in January, reducing the count from 5 to 4. The remaining companies offering 21.7%-efficient PERC modules are Canadian Solar, LONGi, DAS Solar, and Suntech. Earlier, in 2024, the year began with 6 companies at this level, including Tongwei Solar until its delisting in September, which dropped the number to 5. The same efficiency value was recorded throughout 2023, although only 3 companies – Canadian Solar, LONGi, and Risen – were listed at the beginning of that year. Tongwei Solar joined in March 2023, followed by DAS Solar in April and Suntech in July, bringing the total to 6 by mid-2023.

Trinasolar

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4. Module Efficiency Developments

As mentioned above, efficiency has been the key parameter of this analysis. With the TOP SOLAR MODULES list having grown to 50+ products over the past 2.5 years, it is both difficult to present and consume all the data. So, to make the analysis a little easier on both these fronts, we split them into 4 efficiency bands: >22.5%, >22% to 22.5%, >21.7% to 22%, and 21.5% to 21.7%.

4.1 Share of Different Efficiency Bands

Starting off with numerical data, the graph below provides a 2.5-year overview of the efficiency development of the different products listed in TOP SOLAR MODULES, categorized into the 4 efficiency bands described above.

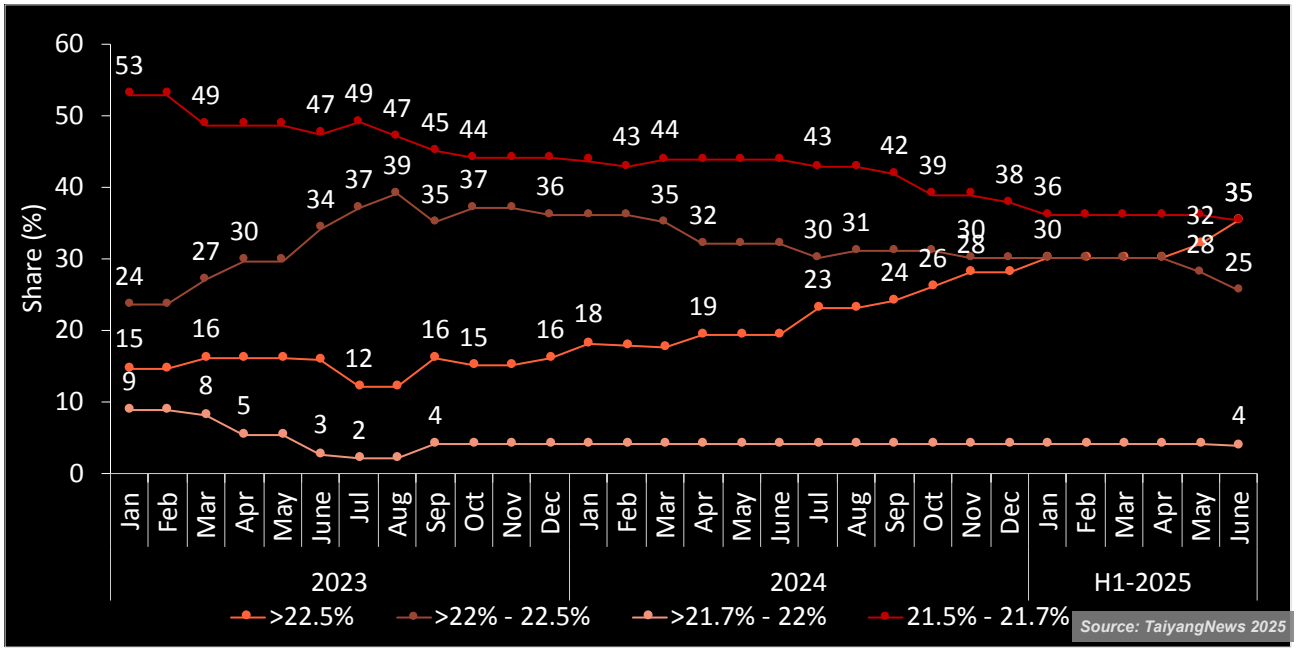
The >22.5% efficiency band continued to expand in H1 2025, with its share increasing from 30%in January to 35% by June. In January, although the number of products in this band remained at 15, the overall decline in total listed modules resulted in a higher share. The count stayed stable till May, when one more company entered this high-efficiency category. In June, there were 2 additions; with 18 products out of a total of 51, June marked the first time the highest efficiency band achieved its largest representation yet – 35% – alongside the lowest efficiency range of 21.5% to 21.7%.

This upward movement follows a year of gradual growth in 2024, where the band started at 18% in January – an increase of 2% over the previous month – then to 26% by October, and reached 28% by December. The gains were supported by more manufacturers commercializing modules above the 22.5% threshold, mainly based on BC and TOPCon cell architectures.

The momentum for this band, however, was not as prominent in 2023. The year began with a 15% share in January and saw a dip to 12% in July and August, before starting an upward trend and reaching 16% by the end of the year. This category transitioned from a premium niche into a major segment of high-performance offerings.

This band has more than tripled in absolute number since January 2023, growing from 5 products with a

Product Shares of Different Efficiency Bands – 2023 / H1-2025



Efficiency Shift In Motion: Over the last 2.5 years, the share of modules with efficiencies above 22.5% more than doubled – from 15% to 35% – while the lowest efficiency band (21.5–21.7%) shrank from 53% to 35%, reflecting the market's steady shift toward higher-efficiency modules.

15% share to 18 products accounting for 35% of the listings by June 2025. The rise reflects a clear trend of manufacturers adopting BC and TOPCon-based architectures to push module efficiencies beyond 22.5%.

Interestingly, the development progress in the next band – >22% to 22.5% – has been inversely proportional to the one above it. For H1 2025, the share of this band was consistent at 30% for the first 4 months. As discussed above, Trinasolar improved the efficiency of its product from 22.5% to 23%, as a result of which, Trinasolar jumped to the higher band, causing a reduction in the share of this band to 28%. Then, it was GCL, which upped the efficiency of its TOPCon module from 22.3% to 22.53%, which led to a decrease in share to 25%.

The band also followed a declining path throughout 2024 – from 36% to 30%. In contrast, in 2023, especially at the beginning, it was on the rise. Starting at a 24% share in January, this band hit a peak of 39% in mid-2023 – August to be precise – and then began a slow decline to 36% by the end of 2023.

This is the band where products from many companies started out with high-efficiency technologies such as HJT and TOPCon. But as they gained expertise eventually, companies improved the efficiency levels of these products and started commercializing modules with much higher efficiencies – a few even beyond 22.5%. This phenomenon explains the fall in the '>22% to 22.5%' efficiency band and the rise in the band above, especially toward the end of 2023 and throughout 2024.

The >21.7% to 22% band has had the lowest in representation. In H1 2025, the share of modules in this efficiency band remained constant at 4% from January through June. The number of products in this category stayed at 2, with no additions or removals during this period.

The situation was similar in 2024, where the band consistently held a 4% share throughout the year. There was no change in product count or relative position in the listing. This category continued to represent a small group of modules that were either early versions of higher-efficiency designs or products not further developed.

In 2023, the share was a little dynamic. It began at 9% in January, fell to 2% by July and August, and then improved slightly to 4% by December. The early drop was due to modules being removed or upgraded, while the later increase reflected a few entries into the range. However, the band's overall representation remained relatively low.

The 21.5% to 21.7% efficiency band is almost exclusively represented by PERC products, especially since 2024. In H1 2025, the share of modules in the band declined slightly from 36% in January to 35% in June, with no new product entries during this period. That being the case, it still remained one of the most populated bands, reflecting the residual presence of PERC modules still active in the market.

Throughout 2024, this band showed a clear downward trend. It started the year with a 44% share in January, plateaued at that level during the first half, and then declined to 38% by December. The decline in the latter part of the year was due to the delisting of 5 products, as the respective companies ceased the production of PERC and were taken off the market. With no new companies entering this band, its share could not be replenished, accelerating the fall.

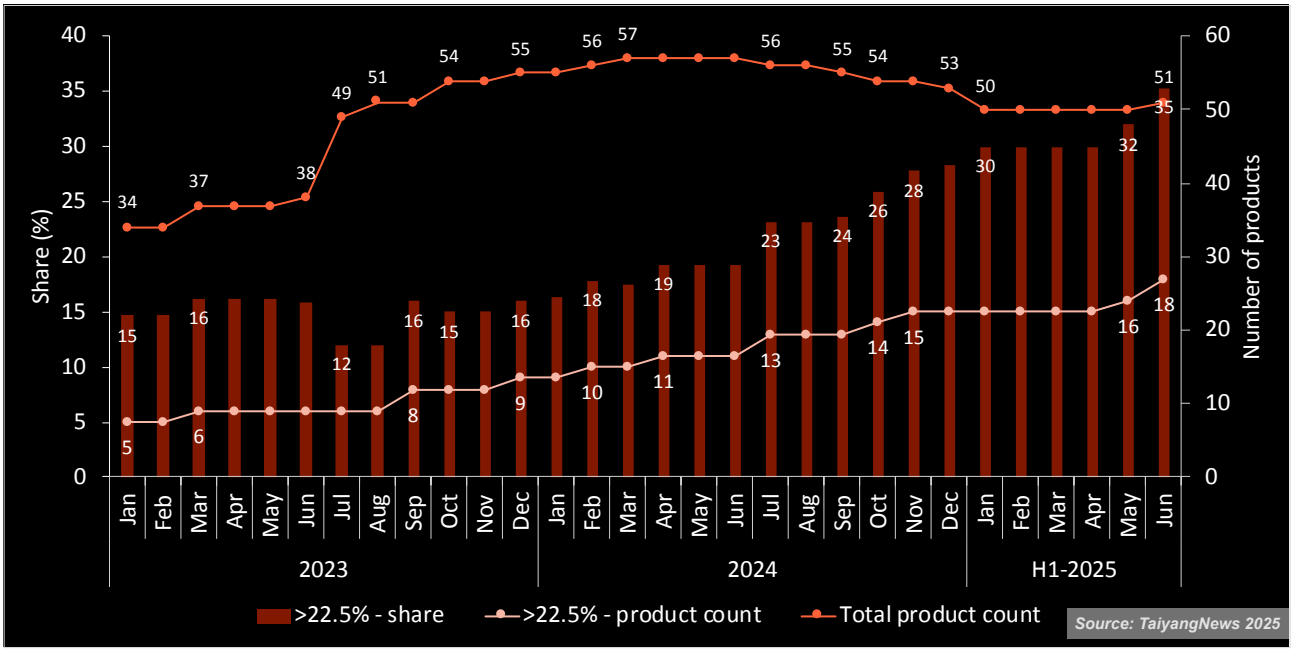
The year 2023 marked the beginning of this contraction. The band opened with the highest share of all categories – 53% in January – but declined steadily to 44% by December. The drop was mainly due to an increasing number of companies adopting advanced cell architectures and commercializing products with higher efficiencies, moving out of this band as a result. Accounting for the bulk of the listing during this period, the entry-level band of 21.5% to 21.7% was mostly represented by PERC, while one HJT module also remained part of it until August 2023.

While this provides a summary, the following subchapter provides a more granular analysis of each efficiency band.

4.2 Efficiencies >22.5%

Continuing with the same chronology, the highest efficiency band of >22.5% comes first. In H1 2025,

Module Count & Share In >22.5% Efficiency Band – 2023 / H1-2025



Holding A Growth Trend: The pursuit of higher efficiencies by module makers is reflected in the rising number of products in this report's top efficiency band – above 22.5% – which grew from 15% to 33% over the past 2.5 years.

this category saw moderate but consistent growth. It started the year with 15 products, accounting for a 30% share in January. Although no new modules were added to this band that month, the overall number of listed products dropped due to the delisting of 3 modules from lower efficiency categories. As a result, the relative share of the >22.5% band increased from 28% in the previous month to 30%. It remained at this level until April 2025.

However, there were some changes within this band that were not reflected in product count. In March, 3 improvements took place, with LONGi making the most significant development. The company increased the efficiency of its best commercial BC module by 0.9% in one stretch. It also provided proof of commercialization for modules based on its HPBC 2.0 technology with an efficiency of 24.1%, replacing the earlier 23.2% product. The other 2 improvements came from Astronergy and DMEGC Solar, which both joined the 23% club. Astronergy increased the efficiency of its TOPCon module from 22.9%, while DMEGC Solar made a slightly higher leap from 22.8%. In May, Trinasolar's module moved into this band, improving the share to 32%. Trinasolar achieved a considerable single-step improvement of 0.5% by raising the top efficiency of its commercial TOPCon module from 22.5% to 23%, adding one more member to the 23% group.

June brought a wave of activity to the TOP SOLAR MODULES listing. A new entrant, Jetion Solar, made its debut with a module in this efficiency band, while GCL also joined the ranks – bringing the total count to 18 and raising the segment's share to 35%. But beyond the numbers, several notable improvements were introduced in the June edition. With the world's largest PV trade show scheduled for June, many companies appeared to have reserved their innovations for this moment – reflected in the 6 changes featured in this update.

Once again, AIKO stole the spotlight by breaking its own record and proving the commercialization of its 24.4%-efficient module. LONGi followed suit, bumping the efficiency of its HPBC module from 24.1% to 24.2%. Huasun also earned a mention by launching its most powerful commercial HJT module to date, rated at 730 W with 23.5% efficiency – up from its earlier 23.18%. Another highlight in the HJT segment came from Jetion, which for the first time provided proof of commercialization for its HJT modules. Its top offering boasts an efficiency



GCL CARBON DATA PLATFORM Inside

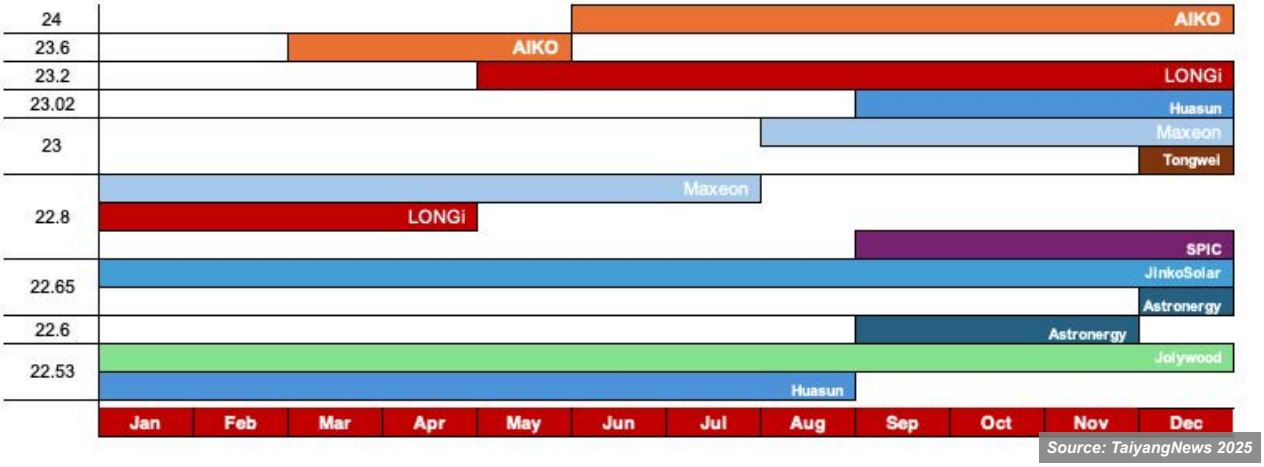
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InfoLink TOP 8 Module Shipment 2024

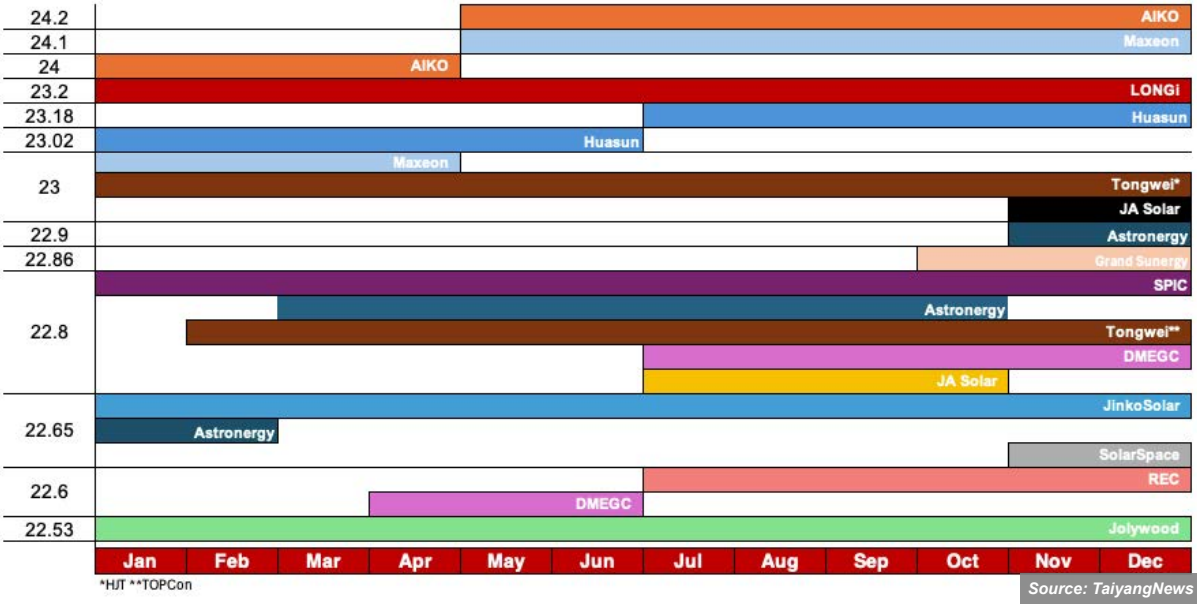
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Module Products With >22.5 Efficiency – 2023



Source: TaiyangNews 2025

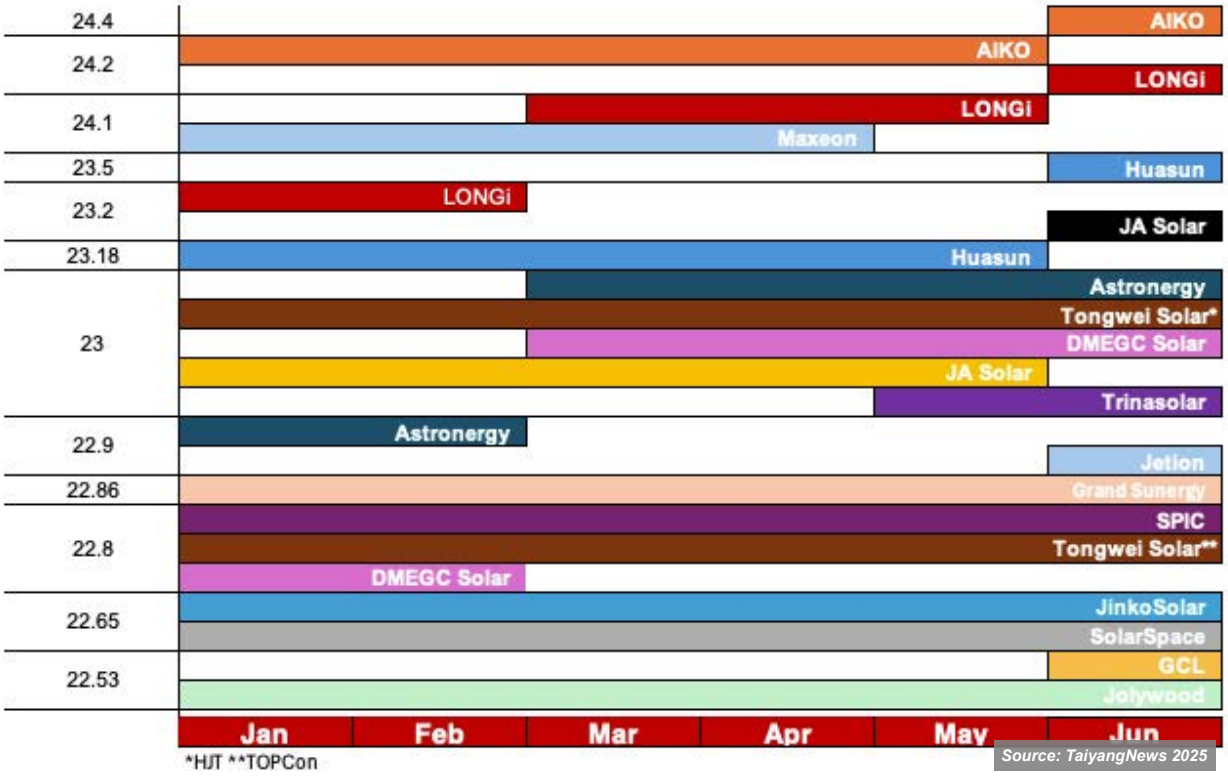
Module Products With >22.5 Efficiency – 2024



*HJT **TOPCon

Source: TaiyangNews 2025

Module Products With >22.5 Efficiency – H1-2025



June Surge: June brought a wave of efficiency gains, with all leaders holding their top spots. AIKO advanced to 24.4%, LONGi hit 24.2%, JA Solar reached 23.2% for TOPCon, and Huasun raised HJT efficiency to 23.5%.

of 22.9% and a power rating of 710 W, marking the first new HJT entrant in the list since October. TOPCon also saw a new benchmark in June. JA Solar raised the efficiency of its top commercial module to 23.2% – a new high for the technology in our listing. Meanwhile, GCL's entry was backed by an improvement in its own TOPCon module, which moved from 22.3% to 22.53% efficiency.

During 2024, the >22.5% efficiency band saw its product count increase from 9 in January to 15 in December, while its share rose from 16% to 28%. The first change took place in February, when Tongwei Solar increased the efficiency of its TOPCon product from 22.5% to 22.8%. This marked Tongwei Solar's first appearance in this band, sharing space with SPIC's BC module, which had been listed at this level since September 2023. The very next month, in March, Astronergy – already part of this club – improved the efficiency of its modules to 22.8%, increasing the number of companies listed at this level to 3, along with Tongwei Solar and SPIC. In April, DMEGC Solar entered this efficiency band with a TOPCon module achieving 22.6% efficiency. With this, the number of products in the band increased to 11. May 2024 saw the most significant advancements. Not only did AIKO introduce a module with an even higher efficiency of 24.2%, but another BC leader, Maxeon, also commercialized a 24.1% module. This marked the first time that 2 commercially available modules surpassed 24% efficiency.

The pace picked up in the second half. In July 2024, JA Solar and REC each added a module to this band, raising the total to 13 and lifting the share to 23%. JA Solar increased its module's efficiency from 22.5% to 22.8%, while REC improved the efficiency of its HJT module from 22.3% to 22.6%. DMEGC Solar, already in this band, also raised its module efficiency to 22.8% in the same month, bringing the number of companies at this level to 5. In August, another intra-band upgrade took place: Huasun improved its module's efficiency from 23.02% to 23.18%. In October, Grand Sunergy made its debut in the list with a 22.86% HJT module, followed by

SolarSpace in November, pushing the product count to 15 and the share to 28%. SolarSpace entered the list with a 22.65% module – a level that had long been occupied by JinkoSolar. A few more changes occurred within the band in November. JA Solar increased its product efficiency to 23%, while Astronergy improved its TOPCon module to 22.9%.

In 2023, the band began with 5 products and a 15% share in January. AIKO made a remarkable entry in March 2023, directly taking the top spot with its 23.6%-efficient ABC module series. This improved both the share (to 16%) and the count (to 6). While LONGi increased the efficiency of its HPBC module from 22.8% to 23.2% in May, and AIKO raised the bar again with a 24% product in June, these improvements had no impact on the total number of products or overall share. In July and August, the share declined to 12% due to a sharp increase in total product count, although the number of products in this band remained at 6. However, one intra-band change took place in August, when Maxeon improved its BC module efficiency from 22.8% to 23%.

Several developments occurred in September. First, Huasun improved its module efficiency from 22.53% to 23.02%. While this had no impact on the number of products, 2 companies entered the band – raising the count to 8 and the share to 16%. SPIC's TOPCon-based BC module came with an efficiency of 22.8%, replacing its previous 22.3% version, and Astronergy's TOPCon product was improved from 22.3% to 22.6%. In October, the product count held at 8, but the share dipped slightly to 15%. By December, the count rose to 9 with the inclusion of Tongwei Solar, and the share returned to 16%. While TOPCon and HJT modules from Tongwei Solar were already included, December 2023 marked the debut of Tongwei Solar's HJT module with 23% efficiency – a level already occupied by Maxeon since August. Another intra-band improvement also took place in the same month, when Astronergy raised the efficiency of its TOPCon module from 22.6% to 22.65%.

4.3 Efficiencies >22 to 22.5%

One could call this the gateway efficiency band – especially for TOPCon and HJT technologies. It was also the band that saw the highest growth in 2023, when more and more companies began commercial activities with TOPCon. However, as companies quickly gained experience and improved their technologies, they eventually moved up to the higher band. As a result, both the number and share of this band started falling from H2 2024 onwards.

This downward trend carried into the first half of 2025. The number of products in this efficiency band slipped from 16 in December 2024 to 15 in January, and dropped further to 14 by June. Correspondingly, the band's share shrank from 30% to 27% over the 6-month period. The first shift came in January, when Akcome's HJT module was delisted. The next and the only other change occurred in May, when Trinasolar improved the efficiency of its TOPCon module from 22.5% to 23%, pushing it into the next higher band. These 2 developments were the only updates impacting this category during H1 2025.

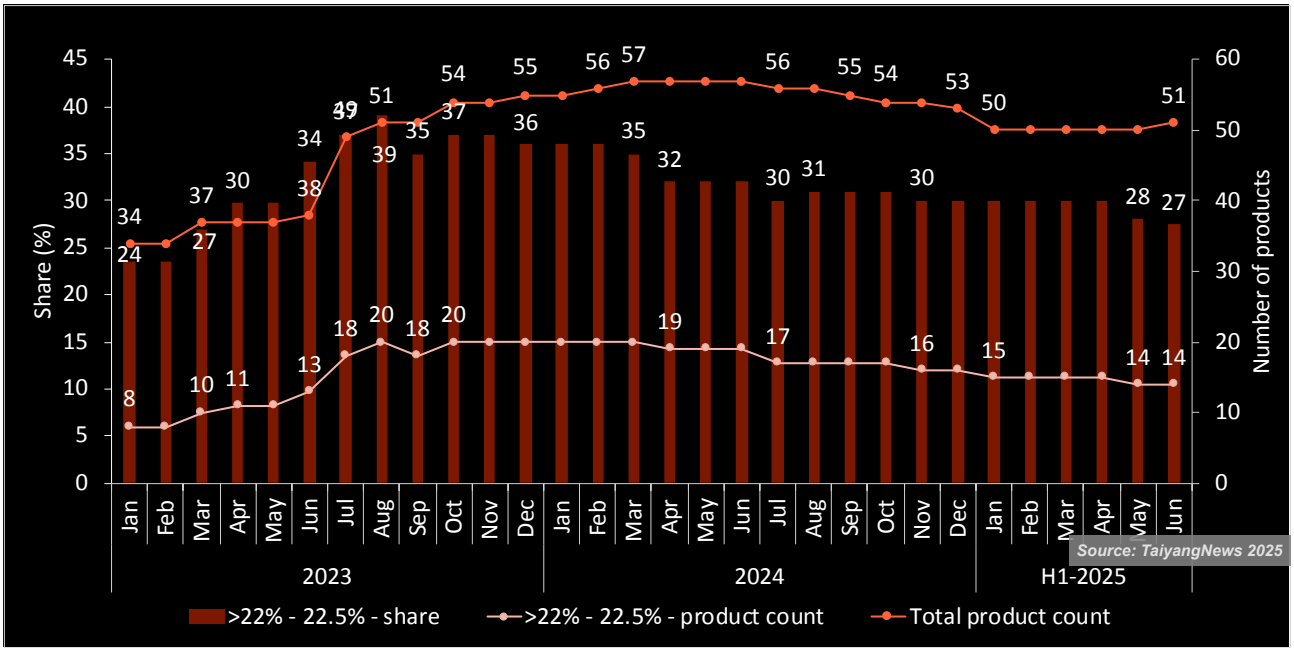
Starting with a share of 36% at the beginning of 2024, this efficiency band saw a consistent decrease to 30% by the end of the year. The number of products declined from 20 to 16 – dropping by one in April, 2 in July, and one more in November. In January 2024, DMEGC Solar's latest TOPCon product reached the top efficiency of this band, improving from 22.45% to 22.5%, before moving into the higher band in April. In February, Tongwei Solar increased the efficiency of its TOPCon module, exiting this band entirely. That same month, Qcells joined our listing with a module rated at 22.3%, which remained unchanged until year-end. In March, Türkiye's Kalyon was listed for the first time with a TOPCon module at 22.38% efficiency. However, this addition was offset by the delisting of Canadian Solar's HJT module that same month. In April, DMEGC Solar once again improved the efficiency of its TOPCon product beyond 22.5%, leaving this group. In May, EGing PV improved its TOPCon module from 22.45% to 22.5%, where it stayed through the end of the year. In July, JA Solar and REC increased their TOPCon and HJT module efficiencies beyond 22.5%, exiting this band. Another upgrade came in November, when SolarSpace improved its TOPCon module efficiency to 22.65%.

In contrast, the year 2023 saw considerable growth in both product count and share for this band. The share rose from 24% in January to 36% in December, while the number of products increased from 8 to 20. There were no changes in the first 2 months of

2023, but several followed. In March, Tongwei Solar began offering TOPCon modules commercially at 22.4% efficiency, the same level as JA Solar's product. Astronergy also increased its efficiency from 22.1% to 22.4% in the same month. Then, in April, both JA Solar and Tongwei Solar reached 22.5%, followed by Astronergy in May. However, Astronergy moved out of this band in September. Canadian Solar, in addition to its already-listed 22.5% HJT module, introduced a TOPCon module with 22.3% efficiency in March. It later improved this to 22.5% in May, matching its HJT offering. Among its peers at the 22.3% level at that time, REC remained unchanged throughout the year, while SPIC exited the band in September with a higher-efficiency product. DAS Solar improved its TOPCon efficiency in March from 22.1% to 22.3%, and later to 22.5%, where it remained for the rest of the year. Trinasolar introduced a 22.3%-efficient TOPCon module in April – its previous 21.9% product was not part of this band. In June, Trinasolar improved the efficiency to 22.5%, which was its final update for the year. Also in June, Risen commercialized an HJT module with 22.5% efficiency, which remained unchanged through year-end. In June 2023, DMEGC Solar entered our listing with a 22.4% efficiency module, which was upgraded to 22.45% in July and remained stable thereafter.

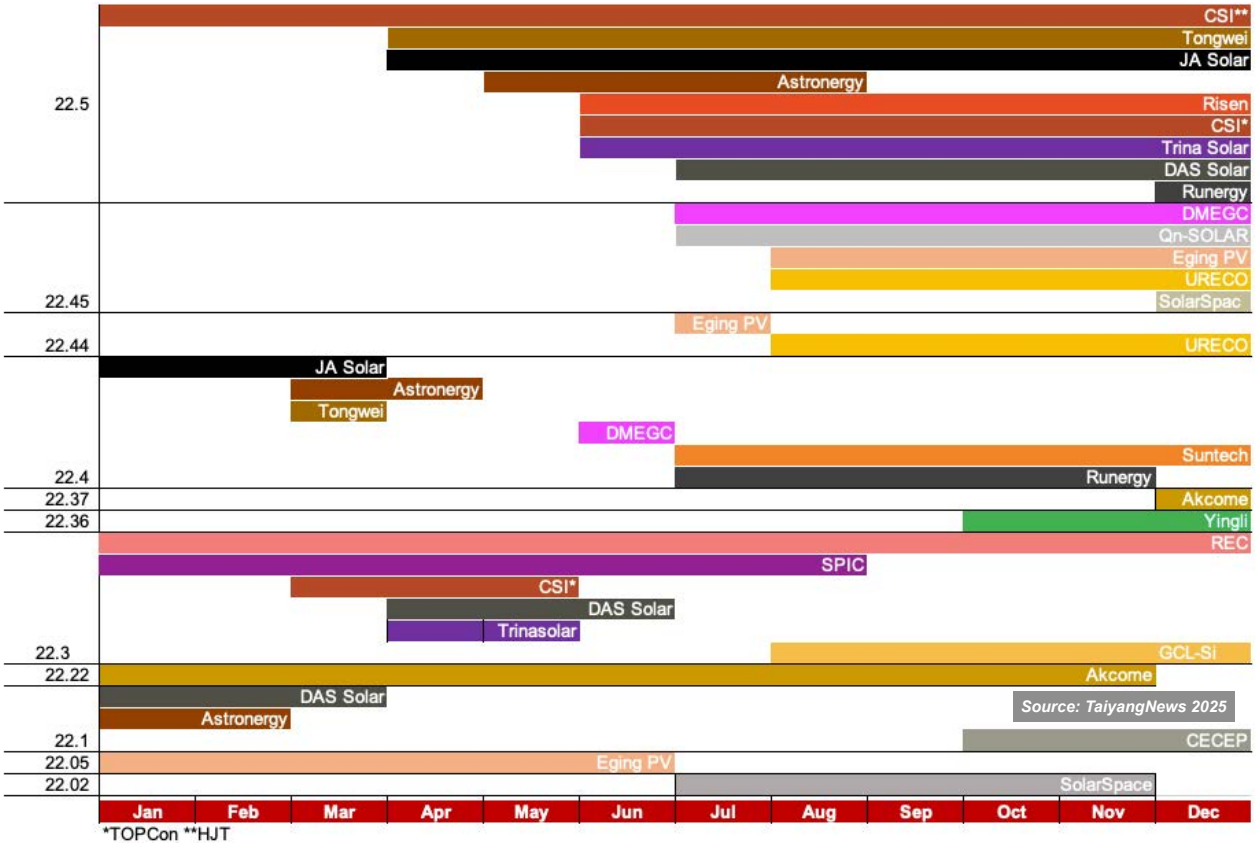
A major development in July 2023 was the entry of 6 new companies into the TOP SOLAR MODULES list, 4 of which had products in this band: Qn-SOLAR with a 22.45% module, Runergy and Suntech at 22.4%, and SolarSpace at 22.02%. While Suntech and Qn-SOLAR maintained their initial levels, SolarSpace and Runergy improved their TOPCon efficiencies in December – to 22.45% and 22.5%, respectively. By December, as many as 8 products were listed at the 22.5% efficiency mark. Also in July, EGing PV, which had been at 22.05% since August 2022, commercialized a 22.44% module, improving it to 22.45% in August, and maintaining this level through the end of 2023. In August, 2 more companies – URECO and GCL SI – joined the list, with 2 products from the former and 1 from the latter. URECO's TOPCon module was rated at 22.45%, and its HJT module at 22.44%; both remained unchanged through the year. GCL SI's TOPCon module entered with 22.3% efficiency and stayed at that level until December. In October, Yingli and CECEP joined the group with TOPCon modules at 22.36% and 22.1%, respectively; neither saw efficiency changes before year-end. In December 2023, Akcome improved the efficiency of its HJT module from 22.22% to 22.37%.

Module Count & Share In >22-22.5% Efficiency Band – 2023 / H1-2025

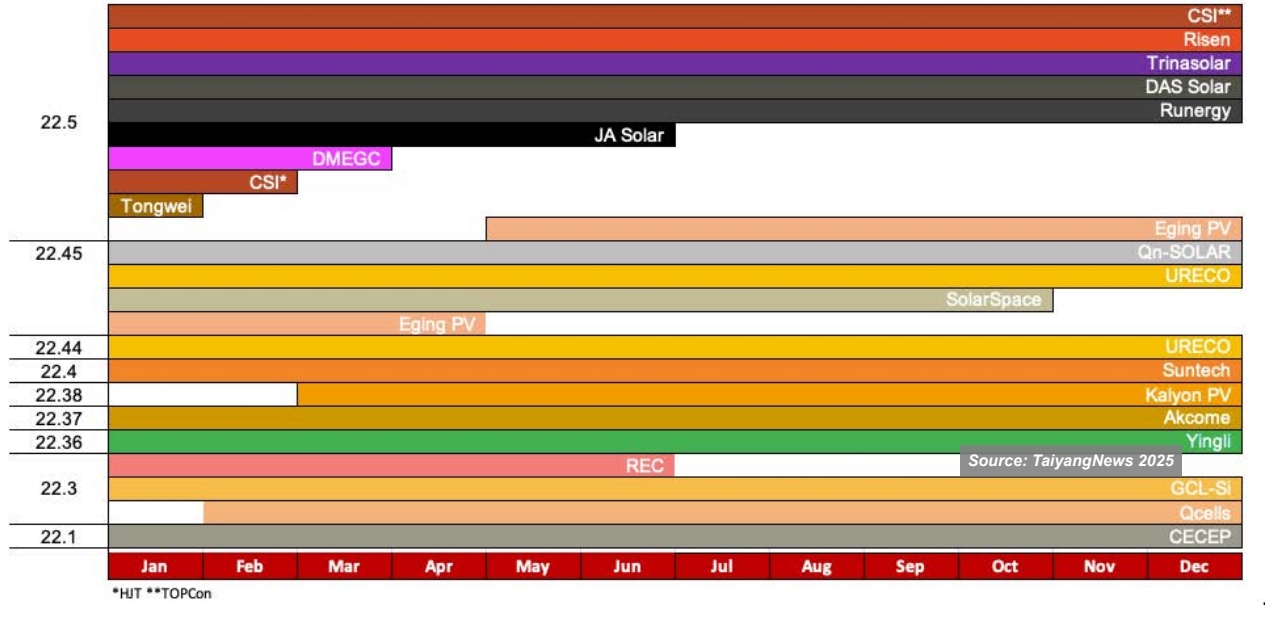


A Rise And Eventual Fall: The share of modules in the >22 – 22.5% efficiency band fell from a peak of 39% in mid-2023 to 27% by June 2025, with the product count declining from 20 to 14 – reflecting the industry's shift toward higher-efficiency modules.

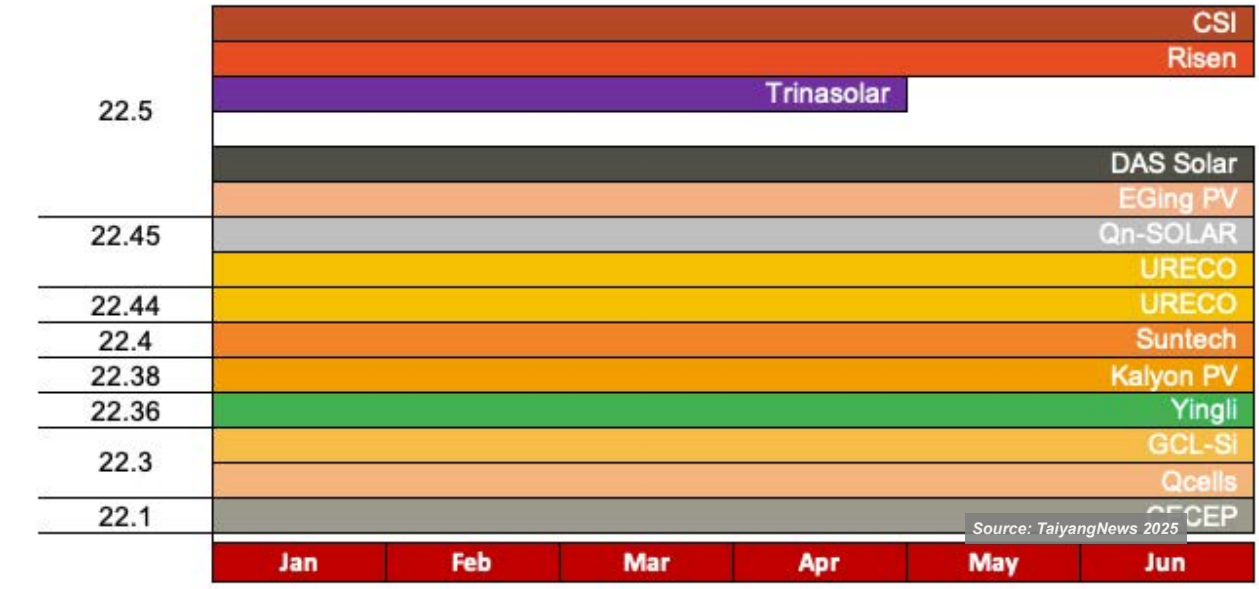
Products With Module Efficiencies >22% – 22.5% – 2023



Products With >22% – 22.5% Efficiency – 2024



Products With >22% – 22.5% Efficiency – H1-2025



A Quick Stop: The >22–22.5% efficiency band, once among the fastest-growing as HJT and TOPCon technologies emerged, now serves as a brief transition point. As these technologies mature, higher-efficiency products are being rapidly rolled out, pushing modules beyond this range.

4.4 Efficiencies >21.7 to 22%

This efficiency band continues to be the least represented in the TOP SOLAR MODULES list. In H1 2025, the number of products remained unchanged at 2, maintaining a constant 4% share from January through June. These 2 HJT products – one from Jinergy at 21.85% and the other from Meyer Burger at 21.8% – were the same modules that had represented the band throughout 2024 and the latter part of 2023. In 2024, the band remained largely static. From January to December, it consistently held a product count of 2 and a 4% share. This stability followed the pattern set in late 2023, after Jinergy entered the listing in September by improving the efficiency of its HJT module from 21.68% to 21.85%, joining Meyer Burger as the second product in this range.

In contrast, 2023 saw more movement in this band. The year began with 3 products, corresponding to a 9% share. One product dropped off the list in April, reducing the count to 2 and the share to 5%. Another exited in June, leaving only one product and bringing the share down to 3%, and further to 2% by August. The entry of Jinergy in September restored the count to 2 and raised the share to 4%, which then held steady through the end of the year.

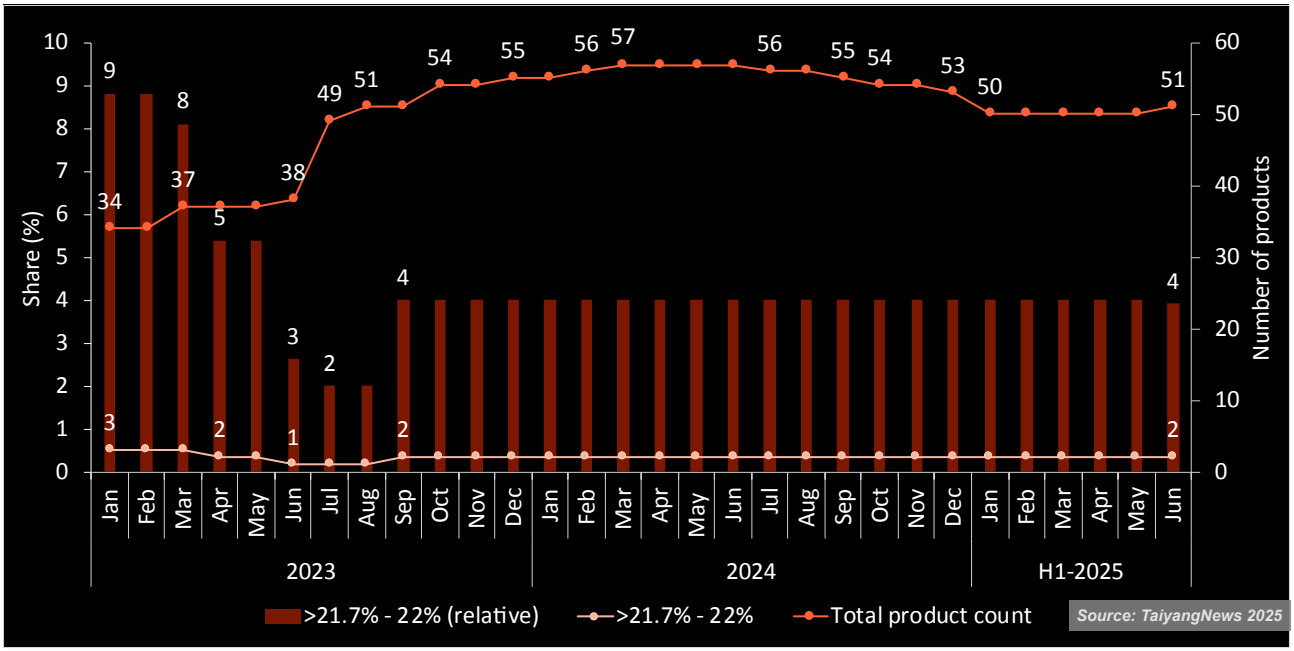
At the beginning of 2023, the 3 products in this band came from Trinasolar, Qcells, and Meyer Burger. Trinasolar, listed since September 2022, exited in early 2023 after improving its module efficiency from 21.9% to 22.5%. Qcells followed in May by increasing its efficiency from 22% to 22.3%, leaving Meyer Burger as the sole occupant of the band until Jinergy joined later that year.

The low representation in this band is mainly because entry-level efficiencies for PERC are already above this range, while those for advanced technologies tend to move quickly beyond it. As a result, this band serves more as a transitional space, with most advanced products progressing to higher efficiency levels once commercialized.

4.5 Efficiencies 21.5% to 21.7%

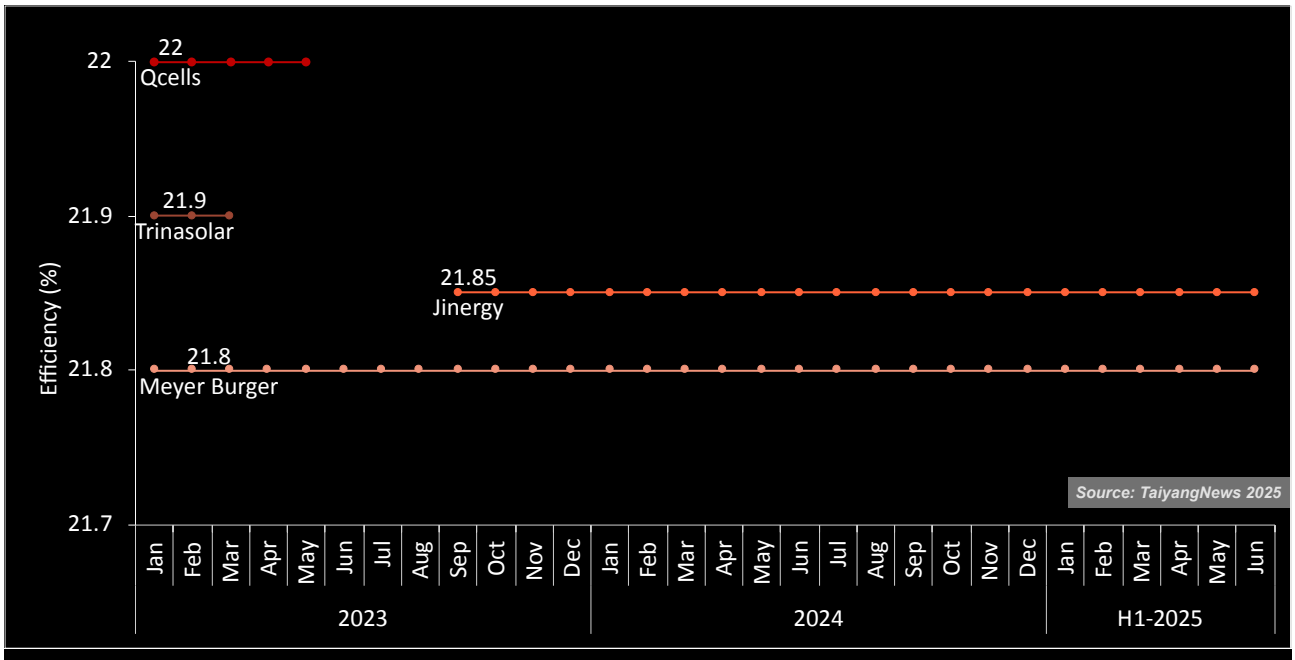
The efficiency range of 21.5% to 21.7% – the lowest band in our rankings – continues to have the highest product representation and remains dominated by PERC technology. However, over the last 2.5 years, its share has been steadily declining, falling from 44% to 35%. The product count dropped from a peak of 24 in July 2023 to 18 in June 2025. Interestingly, the number of products remained exactly at 18 during the first halves of both 2023 and 2025.

Module Count & Share In >21.7 – 22% Efficiency Band – 2023 / H1-2025



Stagnant Segment: The 21.7% – 22% efficiency band has seen no changes since September 2023 – and even before that, the product count fluctuated by just one, reflecting minimal activity in this range.

Module Products With >21.7% – 22% Efficiency – 2023 / H1-2025



A Familiar Duo: For a significant period within this report's scope, Jinergy and Meyer Burger have been the only companies within the efficiency band of >21.7 – 22%.

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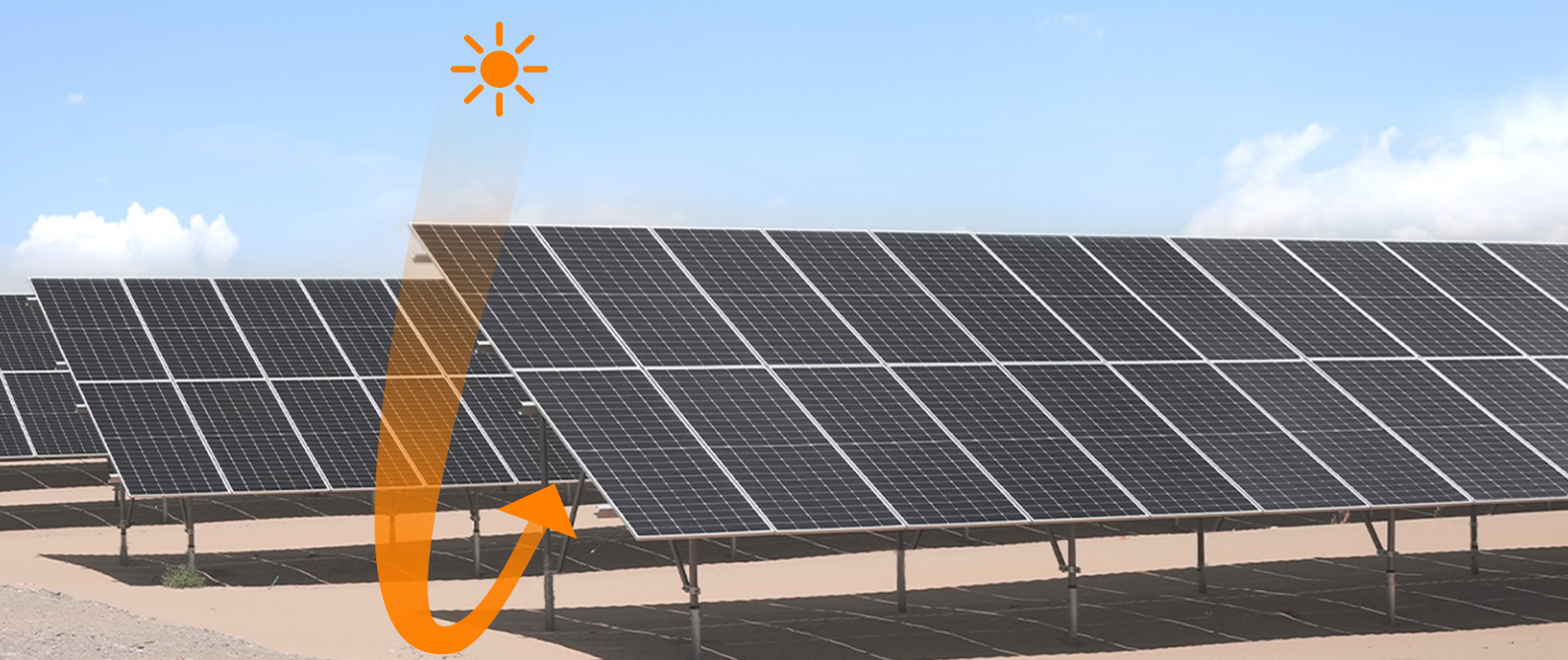
88+% Bifaciality

(Certified by TÜV Rheinland & CGC, in R&D)

+5-10pct
Higher Bifaciality

+0.67%
Higher Energy Yield

+48.01 Million kWh
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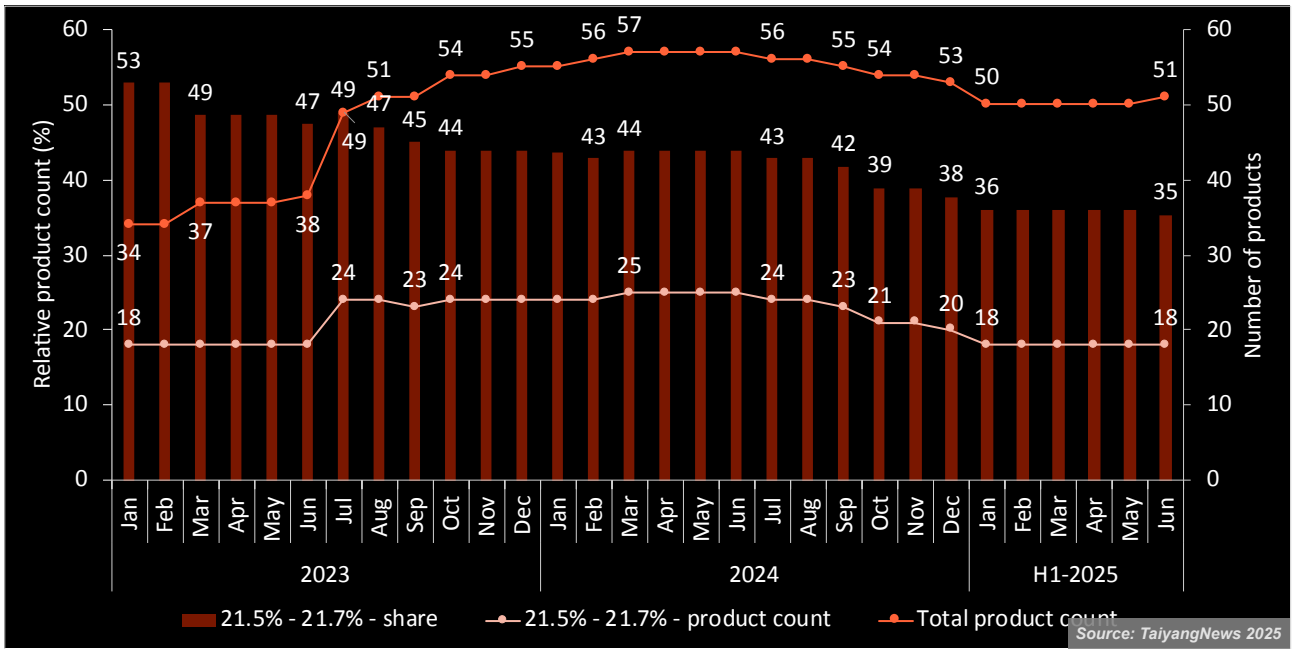
*vs. Standard TOPCon, data from a 100MW utility-scale power plant in Madrid, Spain using TNC 2.0 640W modules

In H1 2025, the number of products declined from 20 to 18 in January and remained unchanged through June. Correspondingly, the share dropped from 38% to 36%, and further to 35% by the end of the first half. These reductions were primarily due to the delisting of PERC modules as companies phased out legacy products from their portfolios. To be specific, in January, both Risen Energy's PERC module with 21.7% efficiency and Akcome's PERC module rated at 21.68% were removed from the listing. The dip in the last month of this period is due to the addition of a product in another band.

In 2024, the product count started at 24 and increased to 25 in March, maintaining this number through June. The only product addition during the year was Kalyon PV's PERC module, rated at 21.61% efficiency, in March. This module was later delisted in July. The second half of the year marked a clear decline. Other deletions included Tongwei Solar in September, Astronergy and Talesun in October, and JinkoSolar in December. This brought down the module count to 20 and share to 38%. All exits were due to the discontinuation of their PERC product lines.

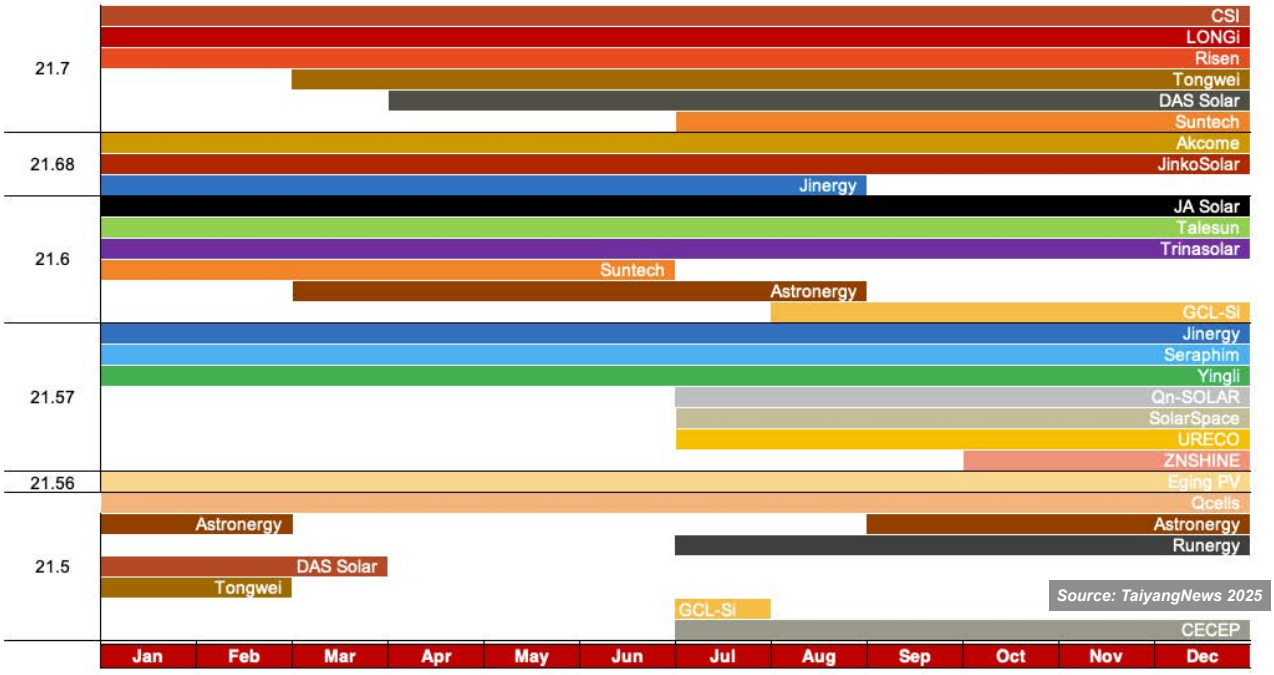
In 2023, the product count remained flat at 18 during the first half, then saw a sharp increase to 24 in July, which continued through December. The share, however, dropped from 53% in January to 44% by year-end, due to a larger increase in total product listings that do not fall into this band. Top-tier products during the year included those from LONGi, Risen, and Canadian Solar at 21.7%, along with stable offerings from JinkoSolar and Akcome at 21.68%, and Trinasolar, JA Solar, and Talesun at 21.6%. In March, Tongwei Solar's module efficiency rose from 21.5% to 21.7%, as did Astronergy's – from 21.5% to 21.6%, which it maintained until reverting in September. DAS Solar reached the 21.7% level in April. In July, 6 companies recorded new efficiency levels: Qn-SOLAR, SolarSpace, and URECO reached 21.57%, while CECEP, GCL SI, and Runergy debuted at 21.5%. GCL SI later improved its module to 21.6% in August, while Jinergy's 21.6% HJT module moved out of the band. In October, ZNSHINE entered with a 21.5% module. All these efficiency levels remained unchanged through the end of the year.

Module Count & Share in 21.5 – 21.7% Efficiency – 2023 / H1-2025

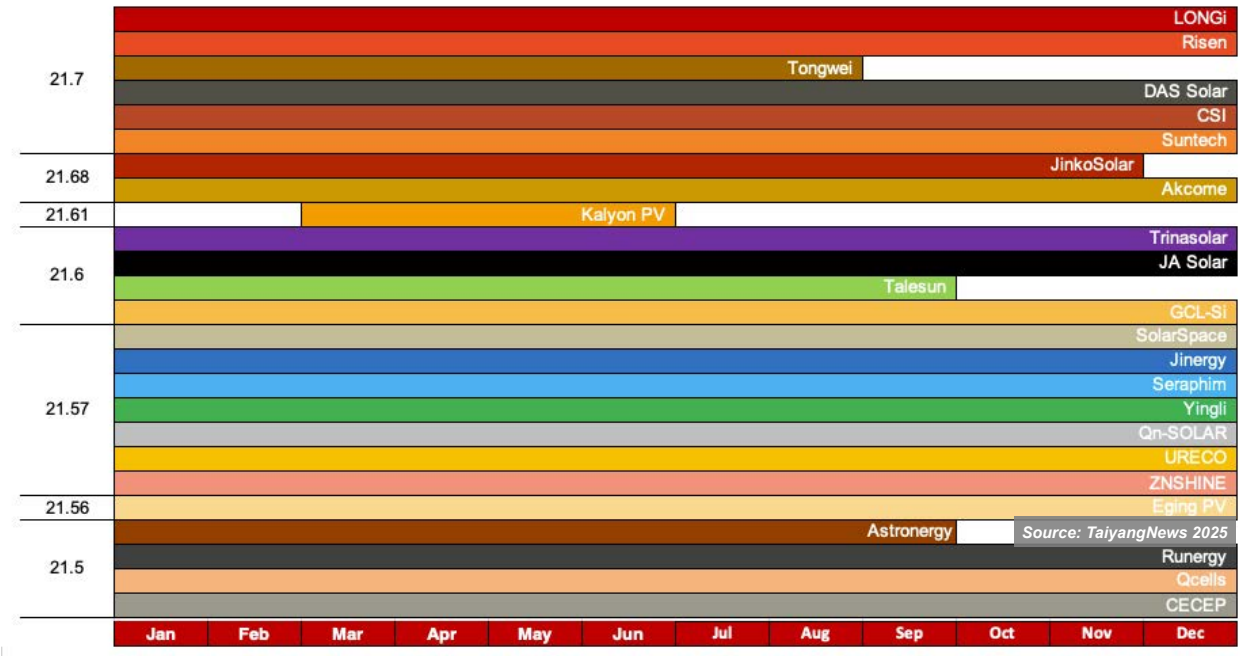


Declining Legacy: Once the dominant category, the 21.5–21.7% efficiency band – primarily populated by PERC modules – has been losing ground on 2 fronts: companies are phasing out their PERC portfolios while shifting focus toward higher-efficiency technologies.

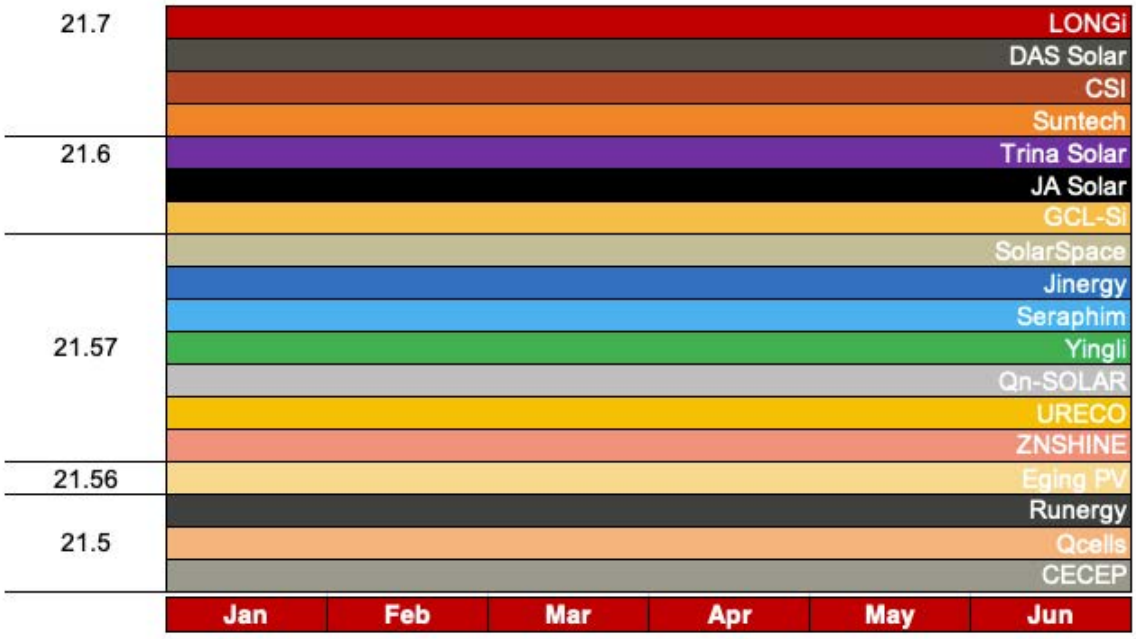
Module Products With >21.5% – 21.7% Efficiencies – 2023



Module Products With 21.5% – 21.7% Efficiency – 2024



Module Products With 21.5% – 21.7% Efficiency – H1-2025



A Phaseout In Sight: Between the beginning of 2024 and the end of H1 2025, a total of 7 products – mainly PERC-based – were delisted from this efficiency band. Kalyon PV was the last to join and the first to exit, while the most recent dropouts were Akcome and Risen in January 2025.

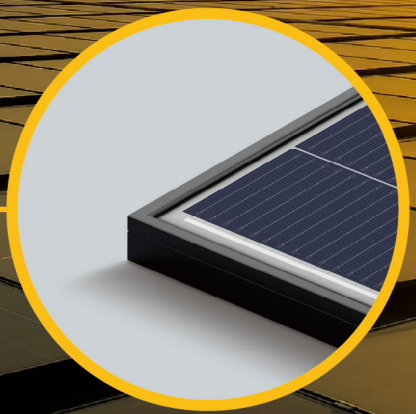
Jeniüs N-HJT

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Visionary Green Energy

740w+

HJT Fiberglass Frame Module

- High bifaciality
- Low carbon footprint
- Extreme temperature coefficient
- Excellent weak light performance



Zhejiang, China **9.688** MW
C&I Rooftop PV Project
Jetion Full EPC, All Fiberglass Frame HJT Modules

TOP PERFORMER 2025 kiwa PV MODULE RELIABILITY SCORECARD
Joint Forces for Solar TOP PV SUPPLIER ROMANIA MODULES 2024
Joint Forces for Solar TOP PV SUPPLIER BULGARIA MODULES 2024
Ariel Green
PV CYCLE

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5. Module Efficiency Developments for Different Cell Technologies

Analyzing efficiency progress by cell technology adds another layer of insight. While efficiency band trends provide a broader picture – since each cell technology generally falls within a specific range – there are always exceptions, and the finer details can be quite revealing. This chapter presents a more in-depth look at the progress of each cell technology.

5.1 Share of Technologies

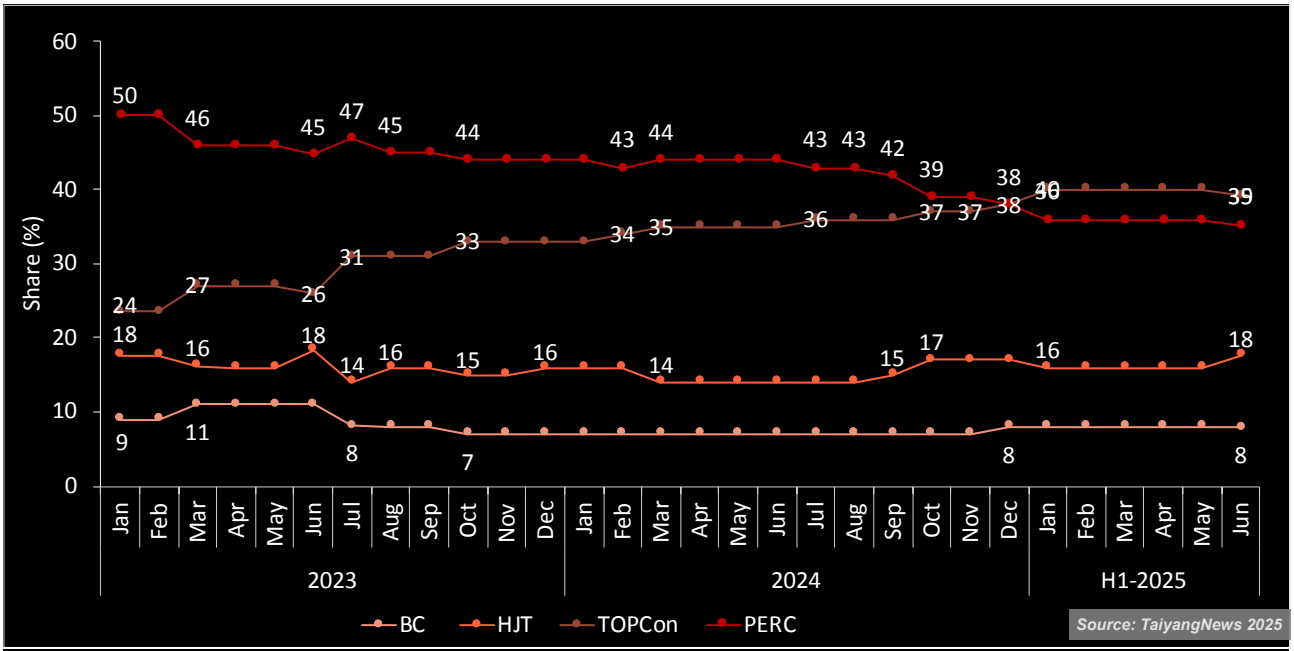
Starting with the most recent data, the first half of 2025 was more or less stagnant. At the beginning of the year, TOPCon marginally overtook PERC in terms of share, climbing to 40% from 38% in the previous month. It maintained this lead, though dipping slightly to 39% by June 2025. In fact, TOPCon benefited from PERC's decline – PERC dropped by the same 2% in January compared to December 2024. The PERC share held steady at 36% for the first 5 months and slipped to 35% in June.

The only technology stream that moved upward was HJT, which gained a new member – Jetion – in June 2025. This pushed HJT's share from 16% in January to 18% by mid-year. BC, despite being the most efficient architecture, remained the least represented, with its share unchanged at 8% throughout H1 2025.

In 2024, TOPCon was the only technology to show steady growth. It started the year at 33% and closed December at 38%, reflecting rising commercial adoption. HJT's share hovered between 14% and 17% over the year, ending at the upper end. BC saw no significant change, consistently contributing 7 products for most of the year, apart from a brief increase to 8 in December. Meanwhile, PERC continued its multi-year decline, with its share dropping from 44% in January to 38% by year-end.

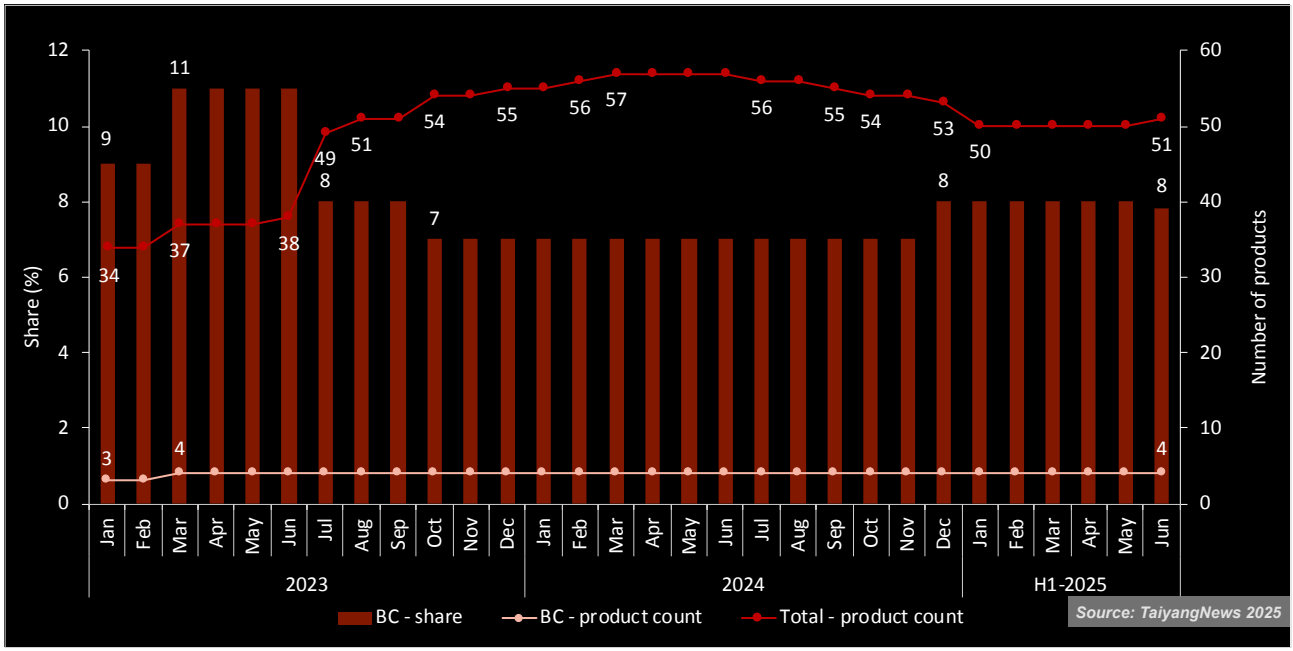
Looking further back to 2023, overall product counts increased for all technologies except PERC. TOPCon had the strongest momentum, with its share rising from 24% in January to 33% by December, driven by an increase in listed products from 24 to 33. HJT showed minor fluctuations, starting and ending the year at 18%, with a few dips mid-year. BC briefly peaked at 11 products in April before settling back to 7 by December. PERC, on the other hand, saw a clear downward trend, falling from 50% in January to

Product Shares Of Different Technologies – 2023 / H1-2025



TOPCon On The Rise: Except for a few specific months, TOPCon's share has generally been increasing, while PERC continues to decline. Meanwhile, HJT and BC have more or less maintained their share in the overall product count.

Product Share Of BC Technology – 2023 / H1-2025



An Exclusive Game: BC has remained a proprietary technology, mastered by only a handful of companies. Since March 2023, it has been represented by just 4 firms – unchanged to date.

44% by year-end, as older modules were phased out and and new entires dwindling.

Overall, the trends continue to underscore TOPCon's rise, the steady position of HJT and BC, and the gradual phaseout of PERC as the industry shifts toward higher-efficiency architectures. With all technologies combined, the graph may appear complex. To improve clarity and insight, the following sub-chapters break down the data by individual cell technology.

5.1.1 BC

Starting with BC, the efficiency frontrunner held onto its top position but remained the least represented among solar technologies. Its limited presence underscores both the technology's exclusivity and the small number of companies capable of bringing it to market.

In the first half of 2025, BC technology maintained a stable presence, with 4 products listed each month and a consistent 8% share. These same 4 BC products – from AIKO, Maxeon, LONGi, and SPIC – continued to represent the technology throughout the period.

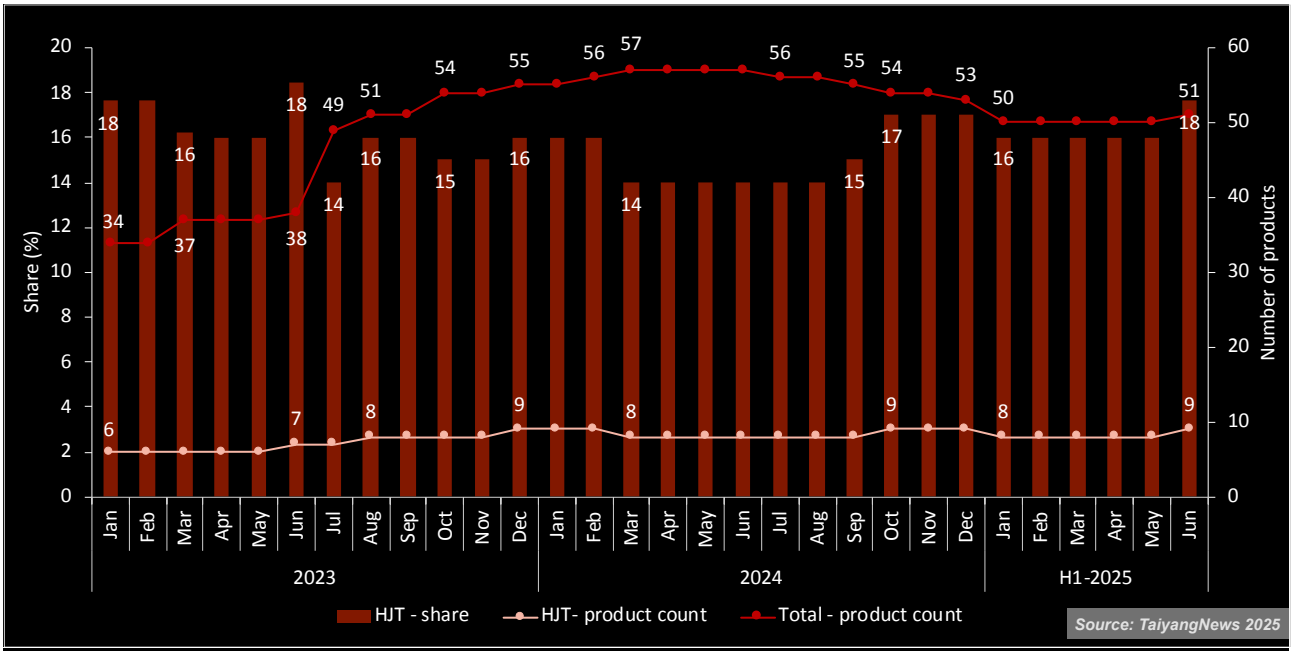
In 2024, the situation remained unchanged. The same 4 BC products were listed throughout the year, with the segment holding a steady 7% share from January to November. This rose slightly to 8% in December, primarily due to a decline in the total number of listed products. The BC segment was represented by the same 4 entries for most of 2023 as well, with no new additions following AIKO's entry in March of that year. BC's share did fluctuate somewhat in 2023. It started at 9% in the first 2 months, peaked at 11% around mid-year, and then gradually declined to 7% by December.

5.1.2 HJT

In the first half of 2025, HJT maintained a stable product count of 8 from January till May, corresponding to a steady 16% share. In June, the count rose to 9 with the entry of Jetion Solar, whose HJT module debut pushed the segment's share to 18%. Earlier, in January, HJT's share had declined from 17% to 16% following the delisting of Akcome's HJT module. Although the total number of listed modules dropped from 53 to 50 that month, the magnitude of Akcome's exit was higher in terms of HJT's share percentage, with the count reducing from 9 to 8.

In 2024, HJT began the year with 9 products and a 16% share in both January and February. In March,

Product Share Of HJT Technology – 2023 / H1-2025



Overshadowed By Others: With just 2 exclusions and 5 additions to the products listed under the HJT category, the share of this technology has fluctuated between 14% and 18% over the past 2.5 years due to the changes in other segments.

Canadian Solar's HJT module was delisted, reducing the count to 8 and the share to 14%. This level held steady until September. In October, Grand Sunergy joined the listing with its HJT module, raising the count back to 9 and increasing the share from 15% to 17%. This level was maintained through the end of the year.

HJT began 2023 with a stable number of products and participating companies until May, with six players – Huasun, Canadian Solar, REC, Akcome, Meyer Burger, and Jinergy. However, the share gradually declined from 18% in January and February to 16% in March, April and May, but went up to 18% in June. The reason? Risen commercialized its HJT module, increasing the product count to 7. Then, URECO entered in August, raising the count to 8. In December, Tongwei Solar debuted with an HJT product, bringing the total to 9. Despite the growth in product numbers, the segment's share fluctuated between 14% and 18%, ending the year at 16%.

5.1.3 TOPCon

TOPCon technology continued to outperform all other technology streams in terms of growth and product representation. In the first half of 2025, TOPCon maintained a consistent product count of 20 from January through June. The share remained steady at 40% for the first 5 months before dipping slightly to 39% in June due to an increase in the total number of products. Notably, although TOPCon products saw efficiency improvements on 3 separate occasions – in March, May, and June – these developments were reflected only in the efficiency values, not in the number of listed products.

In January 2024, the TOP SOLAR MODULES listing consisted of 18 TOPCon-based products with a 33% share. Qcells re-entered the list in February, increasing the total number of products to 19 and the share to 34%. This was followed by another addition in March, with Türkiye's Kalyon PV entering the listing for the first time, taking the product count to 20 and the share to 35%. While there were no further additions in this technology stream for the remainder of the year, it ended with an even higher share of 38% by year-end, due to a decrease in the total number of listed products starting in July.

In 2023, the count of TOPCon modules started at 8 with a share of 24%. The first change occurred in March when Tongwei Solar and Canadian Solar began offering their TOPCon modules commercially,

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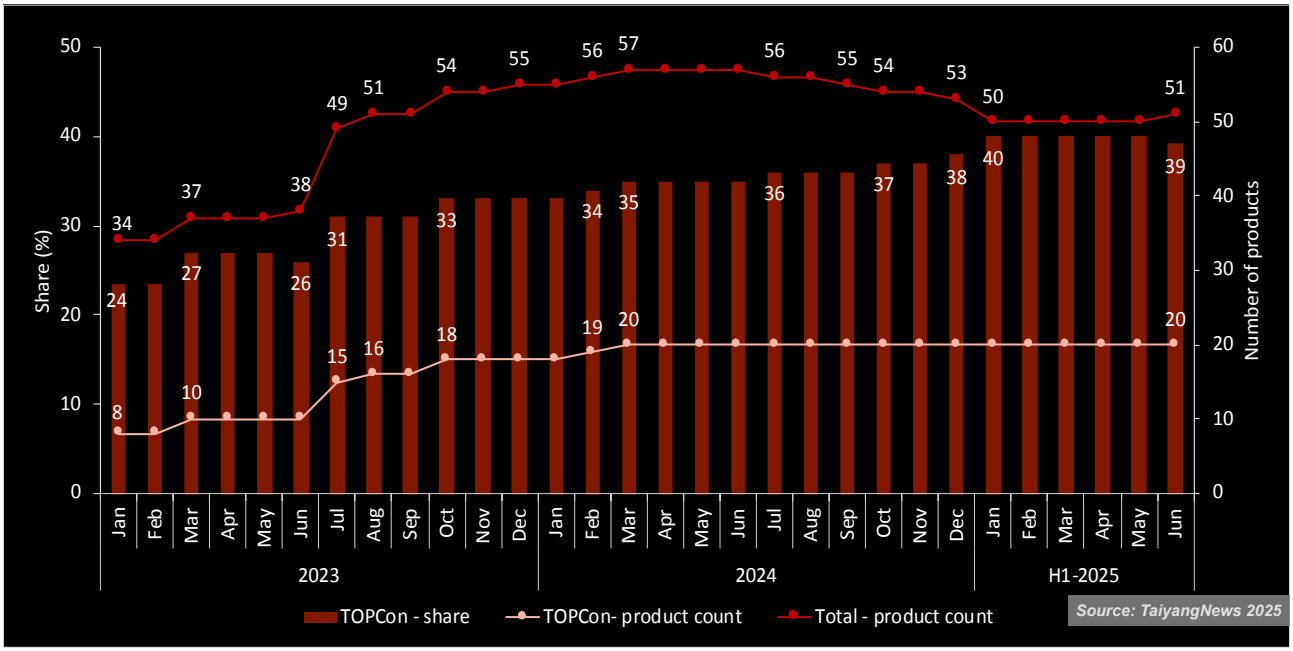
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Product Share Of TOPCon Technology – 2023 / H1-2025



Eventual Leader: Starting from a modest base, TOPCon gradually emerged as the dominant technology in the TOP SOLARMODULES list, reaching a share of nearly 40% in the first half of 2025.

raising the relative share to 27%. In June, Qcells' product was removed from the list due to an unavailable datasheet, but the total product count remained unchanged as DMEGC Solar's product made up for the count in the same month. July saw the addition of five more modules from Qn-SOLAR, Suntech, GCL SI, Runergy, and SolarSpace. This was followed by URECO in August, and Yingli and CECEP in October, bringing the total product count to 18 and the share to 33%. Both the product count and the relative share remained unchanged for the rest of 2023, closing the year with 18 products and a 33% share.

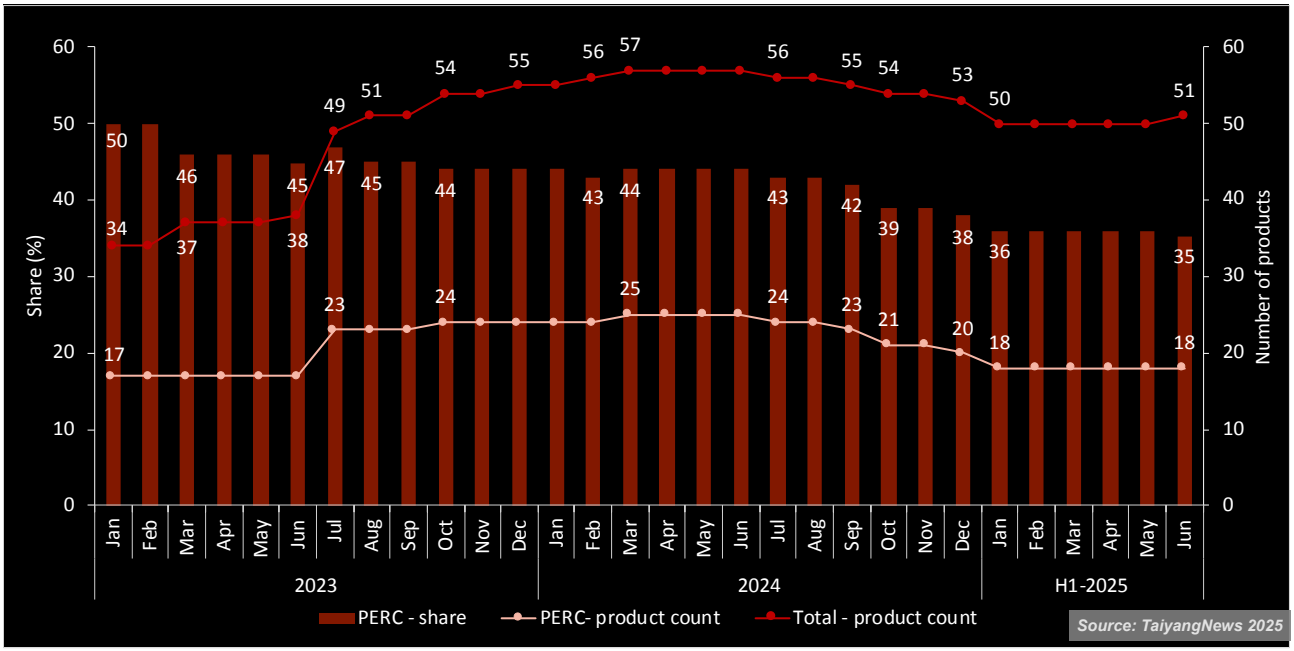
5.1.4 PERC

The share of PERC products has been steadily declining over the past 2.5 years. In the first half of 2025, the number of PERC products dropped from 20 in January to 18 by March, remaining unchanged through June. This reduction led to a drop in share from 38% to 35% over the same period. The decline was driven by the removal of long-standing PERC modules, including those from Risen and Akcome. While PERC still accounts for the highest number of products, its relative influence in the TOP SOLAR MODULES listing continues to wane.

The year 2024 began with 24 PERC products, corresponding to a 44% share – unchanged from the previous month. However, this dropped by 1% in February due to an increase in the total number of listed products. In March, Kalyon's module was added to the list, temporarily pushing the share back up to 44%. The second half of 2024, however, witnessed a steady decline in PERC product numbers, falling from 25 to 20. This began with the delisting of Kalyon's PERC module – just 4 months after its inclusion. Subsequent removals followed: Tongwei Solar in September, Astronergy and Talesun in October, and JinkoSolar in December – all due to these companies phasing out their PERC product lines. As a result, PERC's share dropped significantly to 38% by December 2024.

The situation looked quite different at the start of 2023, when 17 listed PERC products accounted for 50% of the total. This product count remained unchanged through H1 2023, though the share fell to 45% by June. In July, 6 new products were added from Qn-SOLAR, SolarSpace, URECO, CECEP, GCL SI, and Runergy – all commercially available PERC modules with efficiencies at or above 21.5%. These additions briefly pushed PERC's share back near 50%, but this gain eroded in the following months as products based on other technologies entered the list. Although ZNSHINE's PERC module

Product Share Of PERC Technology – 2023 / H1-2025



PERC In Decline: Once dominant with a 50%+ share, PERC has steadily dropped to 35% by mid-2025 as newer technologies take over.

was added in October, the share dropped to 44%, where it remained through the end of the year.

5.2 Module Efficiency Developments for Different Technologies

In this chapter, we delve into the efficiency progress across each technology-specific range, followed by an overview of product-level developments.

5.2.1 BC

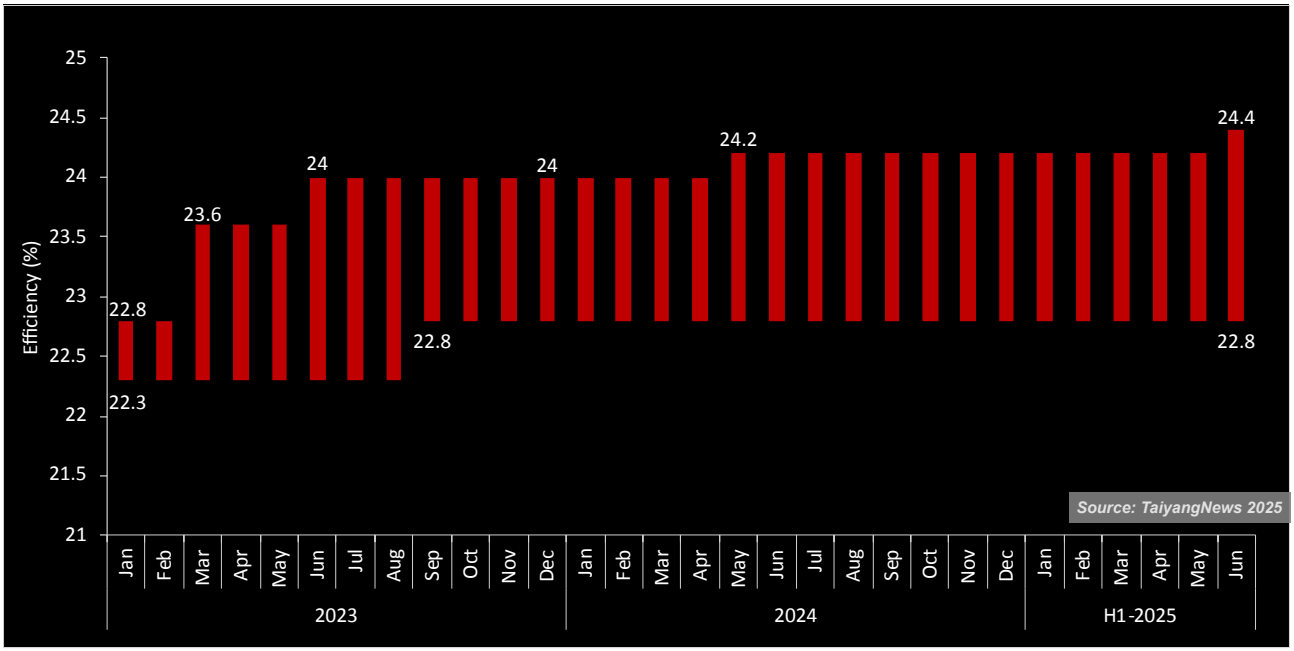
BC has achieved the highest absolute efficiency improvement over the past 2.5 years, with a gain of 1.6 percentage points between January 2023 and June 2025. The same 1.6% delta also applies when comparing the lowest and highest points within June 2025. In H1 2025, the lower limit of the BC efficiency band remained unchanged at 22.8%, while the upper limit was extended further by AIKO, which increased the top efficiency of its commercial BC module to 24.4% in June 2025. This 0.2% absolute gain over its previous 24.2% record from May 2024 strengthens BC's leadership in high-efficiency performance – making it the first and only cell technology to reach this mark with commercially available modules.

In 2024, the efficiency band for BC remained consistent from January to April, with a lower limit of 22.8% and an upper limit of 24%. In May, AIKO raised the upper limit to 24.2%, setting a new benchmark for BC efficiency. This record efficiency remained unchanged for the rest of the year, solidifying BC's position as a leader in module efficiency.

In 2023, BC's efficiency range saw some significant developments. In March, the upper limit increased to 23.6% and further improved to 24% by June. From September onwards, the lower limit also improved from 22.3% to 22.8%, narrowing the efficiency range. This 22.8% to 24% range remained steady through the end of the year and into early 2024.

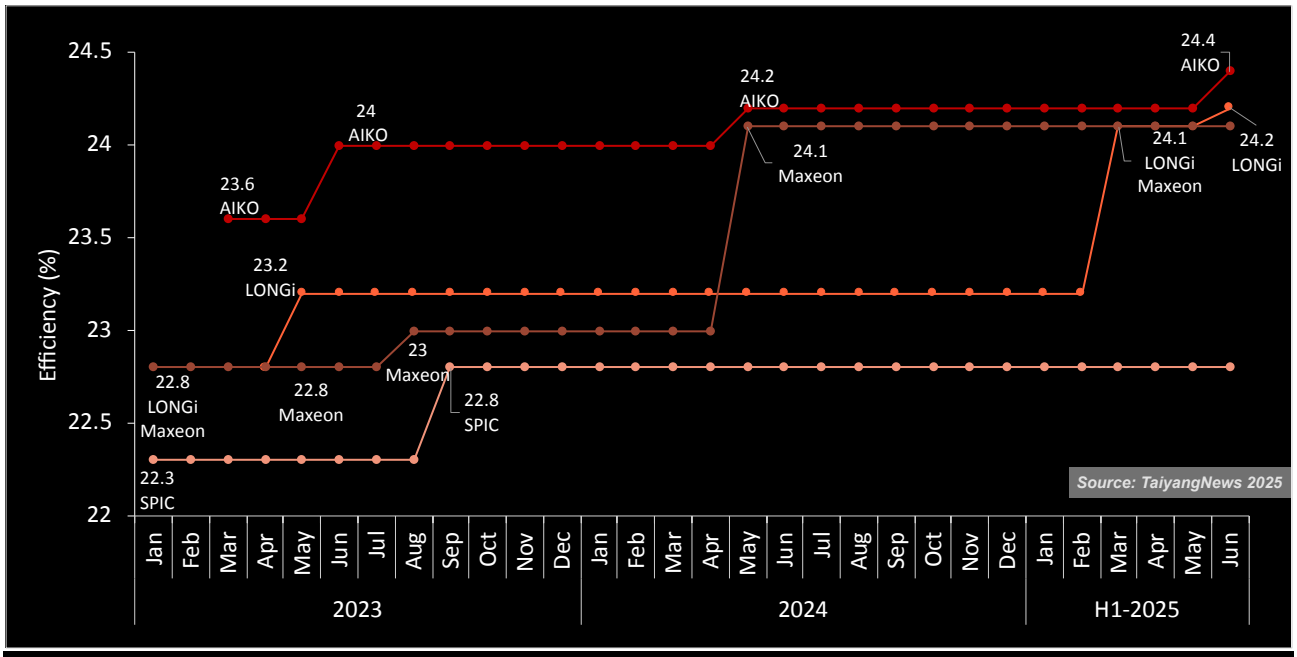
Moving on to the companies and their respective efficiencies, the most notable advancement in H1 2025 came in June when AIKO increased the top efficiency of its commercial BC module from 24.2% to a new benchmark of 24.4%, further extending its lead in the efficiency race. In the same month, LONGi raised the efficiency of its HPBC module to 24.2%, improving from 24.1% in March 2025, and reclaiming exclusive hold over the 2nd rank in the TOP SOLAR MODULES list. Before this, in March, LONGi had already raised its product efficiency from 23.2% to 24.1%, matching Maxeon's level. Throughout this period, SPIC continued to list its

BC Module Efficiency Range – 2023 / H1-2025



4 Peaks In 2.5 Years: Over the past 2.5 years, the upper limit of BC module efficiency has been raised 4 times – the latest in June 2025 to 24.4% – while the lower bound has held steady at 22.8% since mid-2023.

Module Efficiency Progress For BC Technology – 2023 / H1-2025



Leading Since Debut: AIKO has held the top position in TOP SOLAR MODULES since its introduction in March 2023.

BC product at 22.8%, unchanged since September 2023.

In 2024, 2 major developments reshaped the BC landscape in May. AIKO continued its legacy with the commercialization of its Comet 2U series, achieving a record-breaking 24.2% efficiency, reaffirming its lead among BC products. AIKO improved the efficiency from an already high base of 24%. Simultaneously, Maxeon Solar, a pioneer in back-contact technology, commercialized a 24.1% efficiency module, taking the 2nd position in the TOP SOLAR MODULES listing. These advancements remained untouched for the rest of the year, as did the remaining BC product portfolio with LONGi at 23.2% and SPIC at 22.8%.

The most prominent development in BC in 2023 was AIKO's debut in our TOP SOLAR MODULES listing. The company made headlines in March with a module series surpassing 23% efficiency, actually reaching 23.6% efficiency. The very next month, in April, LONGi improved the efficiency of its HPBC commercial modules to 23.2% from the 22.8% level it shared with Maxeon. This propelled LONGi to the 2nd-highest position in both the BC and the entire TOP SOLAR MODULES list. AIKO once again shocked the industry when it broke its own record in June by introducing a 24% efficiency commercial module based on the BC architecture in June 2023. In August, Maxeon improved its efficiency from 22.8% to 23%. Then, SPIC upgraded its BC technology in September to base it on TOPCon, realizing an absolute efficiency gain of 0.5% by attaining 22.8% efficiency, improving from the 22.3% level. The status quo was maintained through the year-end.

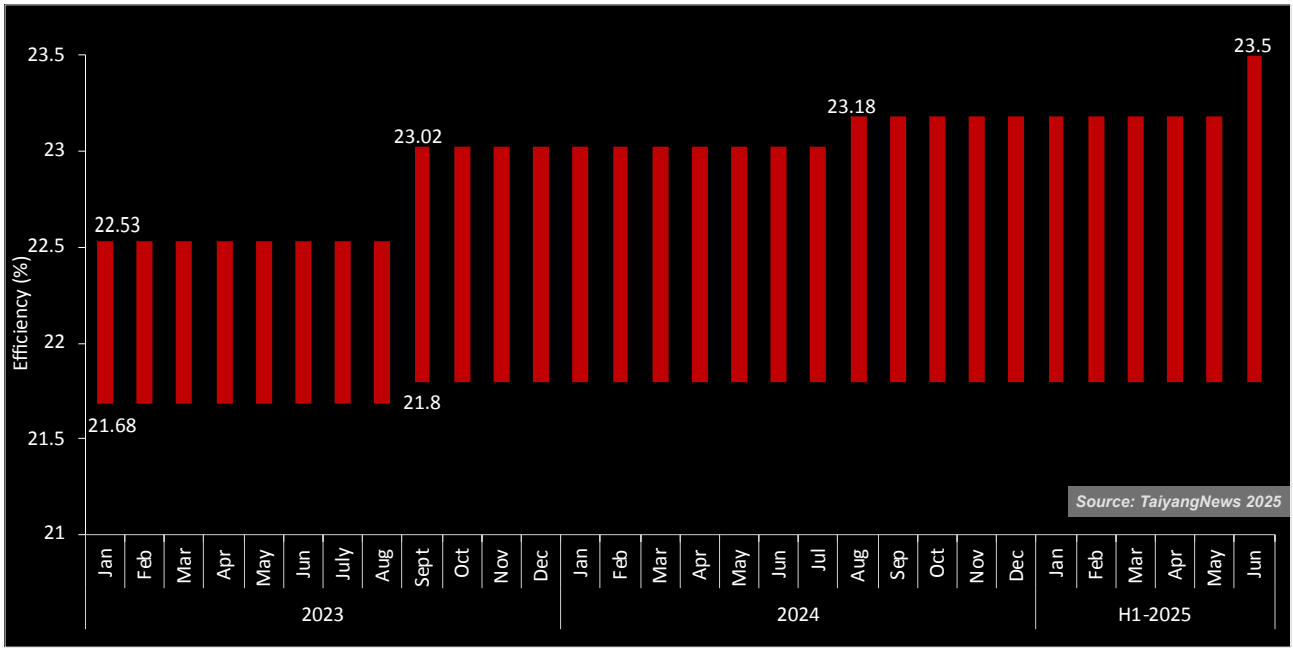
5.2.2 HJT

The efficiency range for HJT has been steadily progressing over the past 2.5 years, with 3 notable increases in its upper limit and 1 revision to its lower limit during this period.

In H1 2025, HJT modules recorded their most recent and largest gain in top efficiency. In June 2025, the highest HJT efficiency rose from 23.18% to a new peak of 23.5%, marking a 0.32% absolute improvement. The lower limit of the technology band, however, remained unchanged at 21.8%, a level maintained since September 2023.

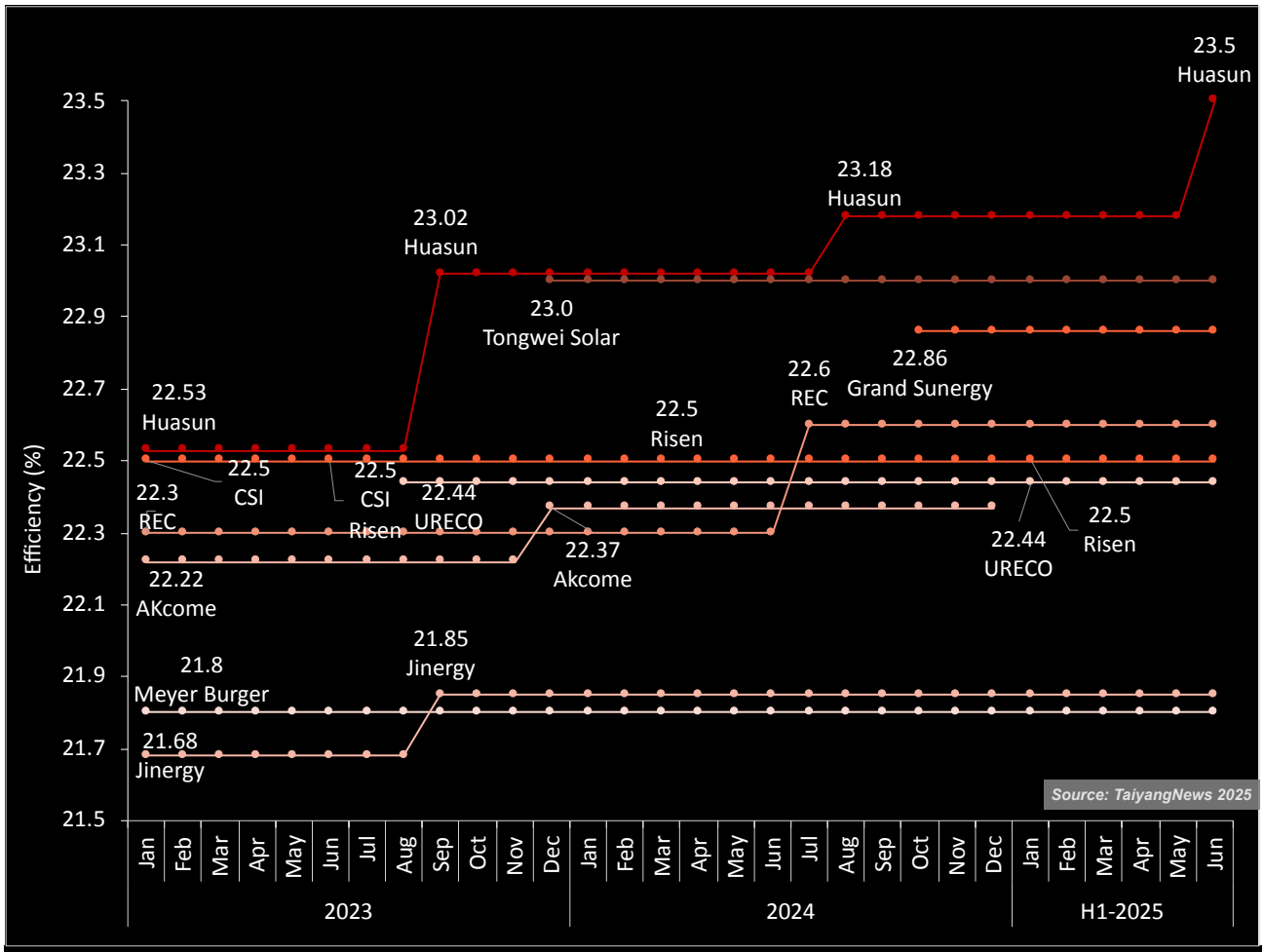
In 2024, the top efficiency increased from 23.02% at the beginning of the year to 23.18% in August,

HJT Module Efficiency Range – 2023 / H1-2025



HJT Progress: The top efficiency of HJT has improved by nearly 1% over the last 2.5 years, with 3 upward revisions, culminating at 23.5% in June 2025, while the lower limit remained steady at 21.8% since mid-2023.

Module Efficiency Progress For HJT Technology – 2023 / H1-2025



Consistent HJT Leader: Huasun has consistently held the top efficiency position for HJT products over the past 2.5 years, maintaining its leadership as the pioneer of this technology.

which remained the highest for HJT for the rest of the year. In 2023, both the upper and lower limits improved simultaneously in September. While the top efficiency took a jump of close to 0.5% absolute from the year's starting level of 22.53% to 23.02%, the lower limit was upped from 21.68% to 21.8%.

As for the companies, Huasun retained its leadership as the top HJT product supplier, holding the highest efficiency position for the past 2.5 years. The latest advancement came in June 2025, when Huasun raised the benchmark by increasing its HJT module efficiency from 23.18% to 23.5% – the highest recorded for HJT in commercial listings to date. Another notable update in H1 2025 was the entry of Jetion Solar, which joined the TOP SOLAR MODULES listing in June with a 22.9%-efficient HJT module, expanding the technology's representation.

In contrast, a significant delisting occurred in January 2025, when Akcome's HJT module was removed from the list, reducing the product count from 9 to 8.

At the beginning of 2024, a 23.02% efficient module represented the company. Then in August, Huasun improved the efficiency of its top HJT commercial offering to 23.18%. Tongwei Solar took the 2nd position with a marginally lower 23% efficiency product throughout the year. The first change in 2024 was delisting a 22.5% efficiency module from Canadian Solar (CSI), leaving the efficiency level solely to Risen. Then in July, REC commercialized its latest Alpha Pure-RX with an improved efficiency of 22.6%, replacing the previous 22.3% product. The last change to this technology stream was in October when China-based Grand Sunergy debuted on the list by providing proof of commercialization for

its 22.86% HJT module. The products that remained unaltered during the course of 2024 were URECO's 22.44% module, the 22.37% product from Akcome, Jinergy's 21.85% module, and the 21.8% efficiency HJT module from Meyer Burger that represented the lower limit for this stream.

The year 2023 also saw its share of HJT product developments. In April, Risen's HJT module appeared in the TOP SOLAR MODULES listing for the first time, boasting an efficiency of 22.5% and matching CSI's performance. URECO joined in August with a 22.44% efficiency module, and all 3 products remained unchanged through the year. Jinergy upgraded its module efficiency from 21.68% to 21.85% in September, pushing Meyer Burger's product to represent the lower limit in this segment. That same month, Huasun set a new benchmark by commercializing its 23.02% efficiency module, surpassing the 23% threshold for the first time, which also earned it a place among the top 3 ranks in our list. Since then, Huasun's HJT module continued to be among the top 3 TOP SOLAR MODULES till April 2024. With this product, Huasun realized a 0.49% jump in absolute efficiency at a stretch.

The last month of 2023 also featured 2 changes related to HJT. In December, Tongwei Solar entered the list with a 23% efficiency module, marginally lower than Huasun's product. In the same month, Akcome also improved the efficiency of its HJT product from 22.22% to 22.37%. These advancements remained unaltered for the rest of the year. The 22.5% HJT module from CSI, REC's 22.3% module, and the 21.8% module from Meyer Burger were 3 products that didn't undergo any change in 2023.

5.2.3 TOPCon

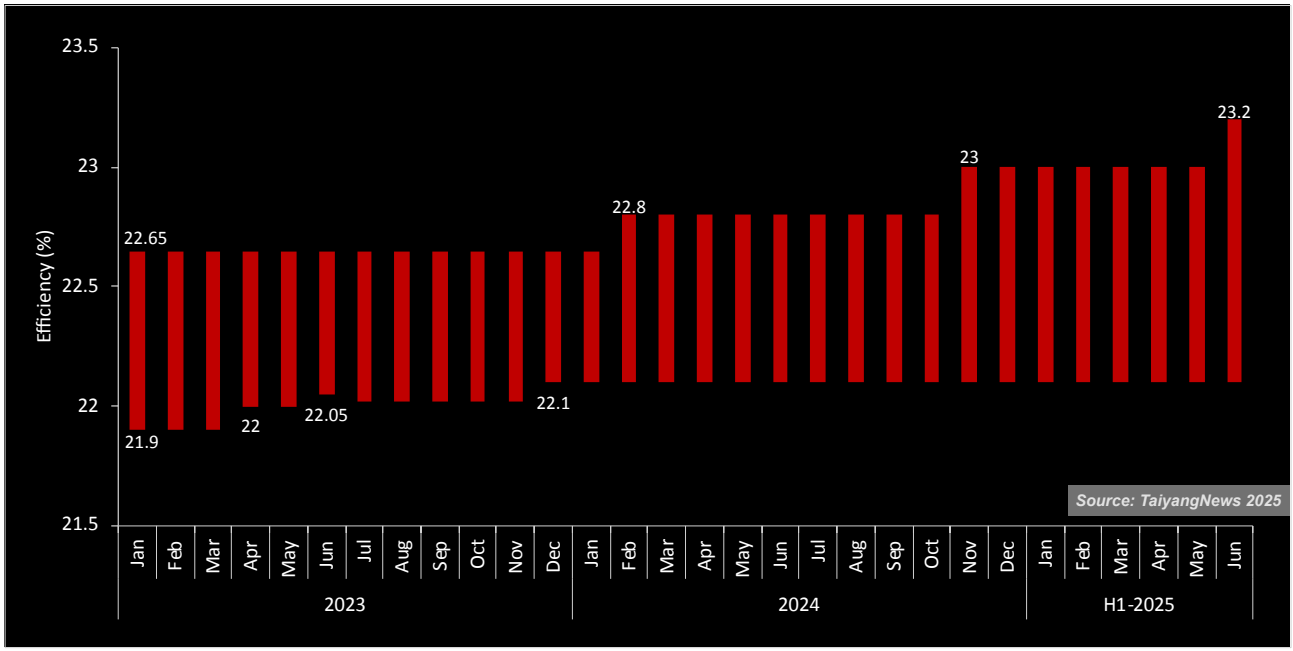
The efficiency range for TOPCon products has continued to improve steadily over the past 2.5 years. In H1 2025, the upper limit of the TOPCon band was raised twice – first to 23.1% in March, and then to 23.2% in June – marking a 0.2% absolute gain within just half a year. However, the lower limit remained unchanged at 22.1% throughout the period, and in fact, all through 2024.

The efficiency range for the TOPCon stream changed twice in 2024, and that too at the upper limit. The best TOPCon efficiency was 22.65% in January, improved to 22.8% in February, and then improved to 23% in November. The lower limit, however, remained the same at 22.1% throughout the year. On the other hand, the highest level in 2023 remained at 22.65% all along the year, while the bottom limit changed 4 times. The first change was in April, from 21.9% to 22%, then improving marginally to 22.05% in June. The level dropped slightly to 22.02% the next month and remained so till November, before rising to 22.1%.

Going into product-level details, TOPCon was the most active technology in terms of efficiency upgrades. The most prominent change in the first half of 2025 was JA Solar's commercialization of a TOPCon module with 23.2% efficiency – a new benchmark for the technology in the commercial space, achieved in June 2025. Among earlier developments, Trinasolar improved the top efficiency of its commercial TOPCon modules by 0.5% absolute, from 22.5% to 23% in May. In March, 2 other companies also made notable gains – DMEGC Solar increased its product efficiency from 22.8% to 23%, while Astronergy raised the top efficiency of its commercial TOPCon module from 22.9% to 23%.

In January 2024, the TOPCon section was led by JinkoSolar's 21.65% module, a position it had held since September 2022. Astronergy's TOPCon module also shared this spot with the same efficiency. As to the major changes in January, DMEGC Solar joined in at the 22.5% level, where a bulk of 6 TOPCon products were already listed in December 2023. With the addition of DMEGC Solar, the count increased to 7. DMEGC Solar's addition came about with it increasing its best TOPCon module's efficiency by 0.05% absolute from the December level of 22.45%. In February, Tongwei Solar raised the bar to 22.8%, breaking through the 22.65% barrier set by JinkoSolar for over a year. In March, Astronergy's best TOPCon module also reached the same level, jumping from its previous highest level of 22.65%. DMEGC Solar also improved its module's best efficiency to 22.6% from 22.5%. In May, there were 2 changes in the TOPCon section for TOP SOLAR MODULES: EGing PV improved the efficiency from 22.45% to 22.5%, and Kalyon's TOPCon module entered our list with an efficiency of 22.38%. While there was no change in June, July saw a further increase in TOPCon efficiency level to 22.8%, attained by JA Solar's

TOPCon Module Efficiency Range – 2023 / H1-2025



One At A Time: In 2023, only the lower limit of TOPCon efficiency shifted 3 times, while in the following 1.5 years, only the upper limit improved – rising to 22.8%, then 23%, and finally 23.2% – as the lower bound remained steady at 22.1%.

product. The next 3 months saw no activity from the TOPCon section, but 3 changes took place in November. First, the top efficiency increased once again, this time by JA Solar, to the 23% milestone. This was followed by Astronergy, tuning up its best commercial TOPCon module efficiency by 0.1% absolute to 22.9%. The third change was from SolarSpace, increasing its best TOPCon product efficiency from 22.45% to 22.65%. These figures continued into December unchanged.

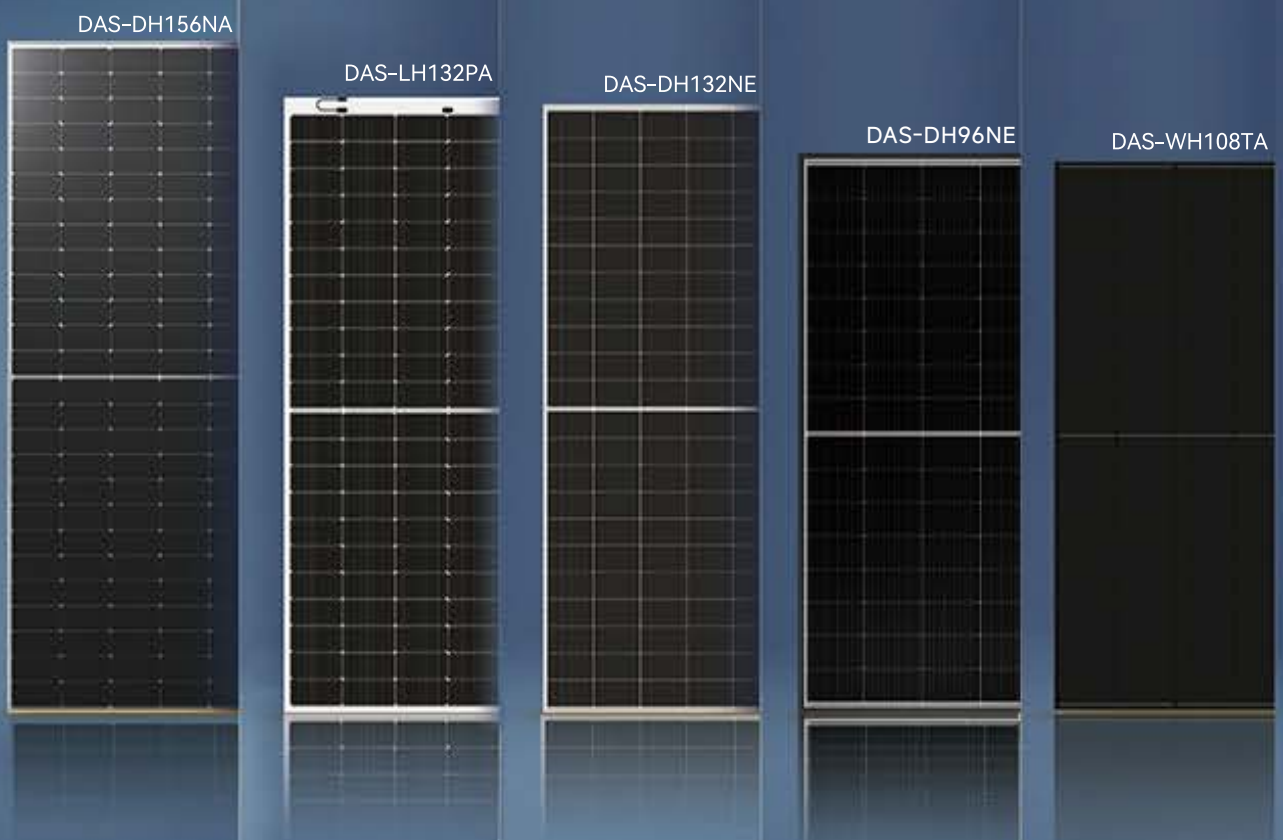
In 2023, JinkoSolar's claim to the TOPCon throne with 22.65% efficiency was unopposed for the entire year. The next highest efficiency level of 22.53% belonged to Jolywood; while there were changes elsewhere, Jolywood continued at this level not only through 2023 but also in 2024. The other products from this technology stream to feature in January 2023 were: JA Solar's 22.4% efficiency module, 22.1% products from DAS Solar and Astronergy, a 22.05% efficiency module from EGing, Qcells at 22%, and Trinasolar with its 21.9% efficiency module.

The next change was in March with Canadian Solar entering the list with a 22.3% model, which was improved only once in June to 22.5%. Tongwei Solar also entered in March with its 22.4% efficiency TOPCon module, which it improved the very next month to 22.5% and remained at this level for the rest of the year. A third change to occur in March was Astronergy improving its TOPCon product efficiency from 22.1% to 22.4%. The company improved the efficiency of its best TOPCon offering 3 more times over the rest of the year – 22.5% in May, 22.6% in September, and 22.65% in December to share the top spot in this category with JinkoSolar.

While there were no new entries in April, a few companies improved the top efficiencies of their TOPCon products. One of them was JA Solar, improving the efficiency of its DeepBlue 4.0 Pro series from 22.4% to 22.5%, which stayed at this level for the rest of the year. Trinasolar also improved the efficiency of its product first to 22.3% from 21.9%, and again in June to 22.5%, to remain there for the rest of the year. DAS Solar followed the same path, improving the efficiency to 22.3% in April, but from a higher level of 22.1%, and staying at 22.3% for a little while before jumping to 22.5% in July. DMEGC Solar was the new company to enter the TOPCon segment in June with 22.45%, which was improved to 22.45% the very next month – the last change for the year.

DASOLAR

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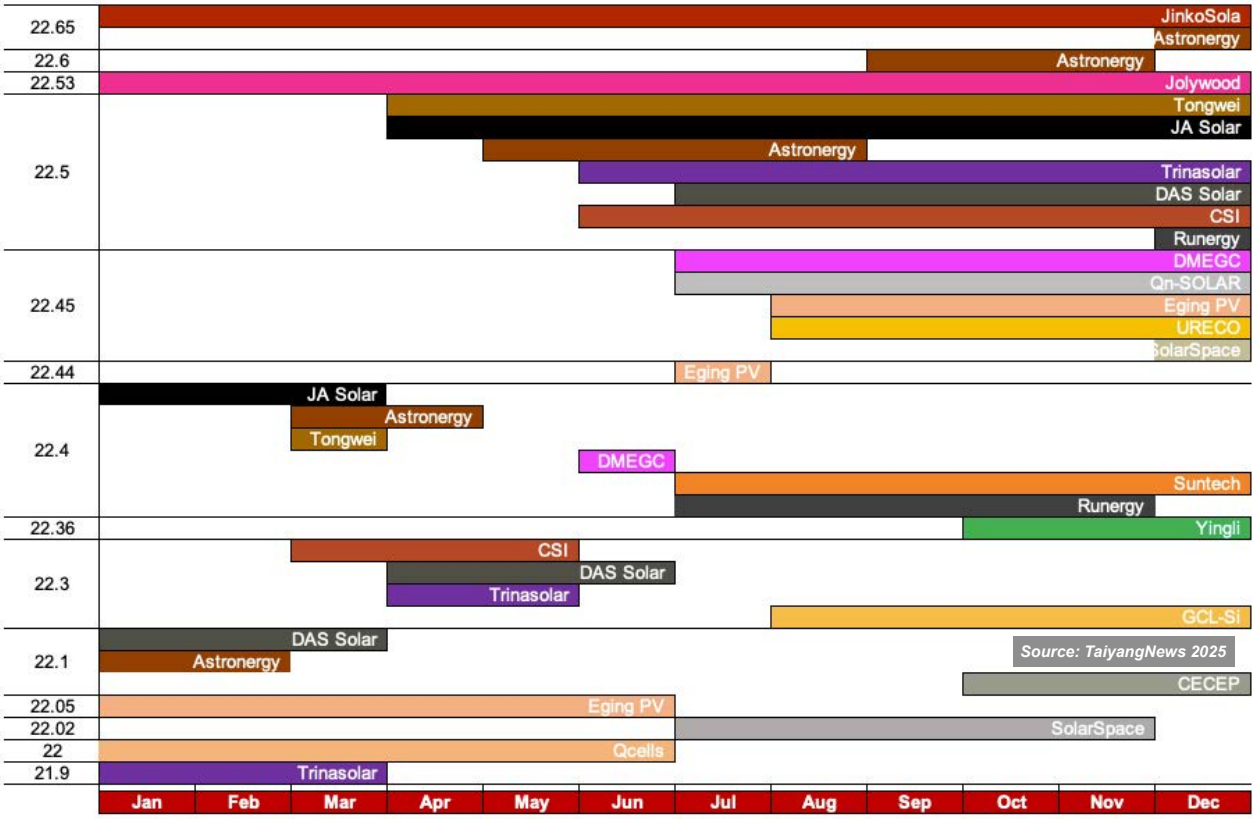
Top 3
N-type Module Shipment

27%
TOPCon 5.0 Average Mass
Production Efficiency

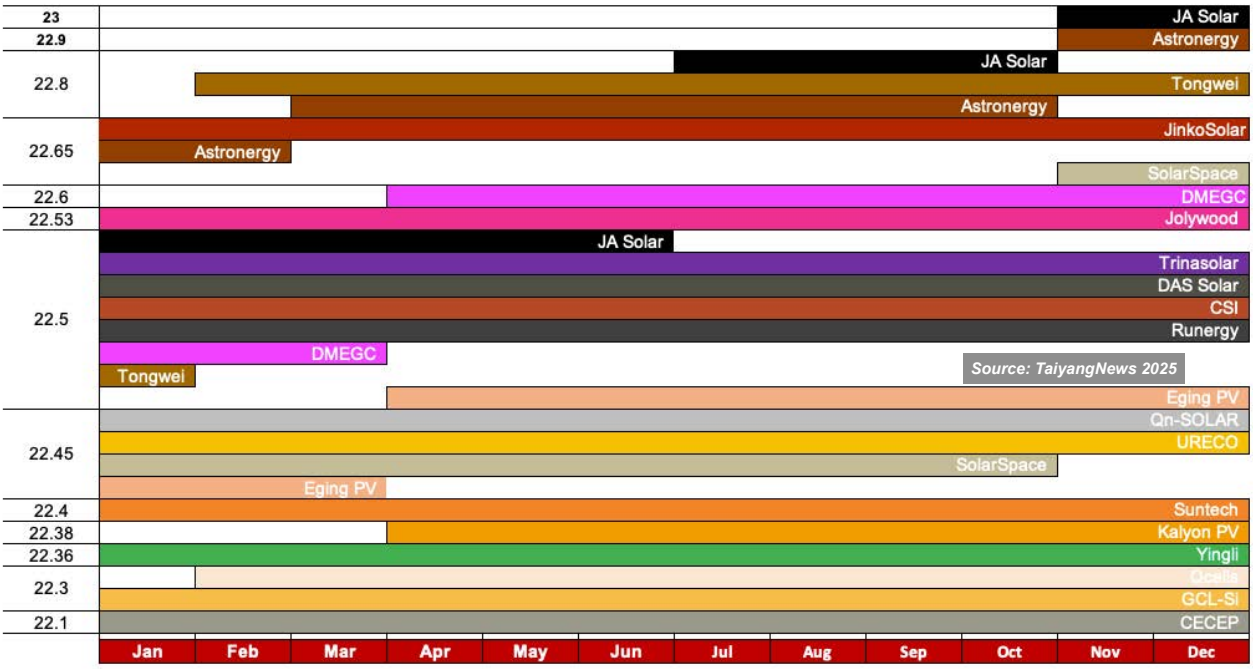
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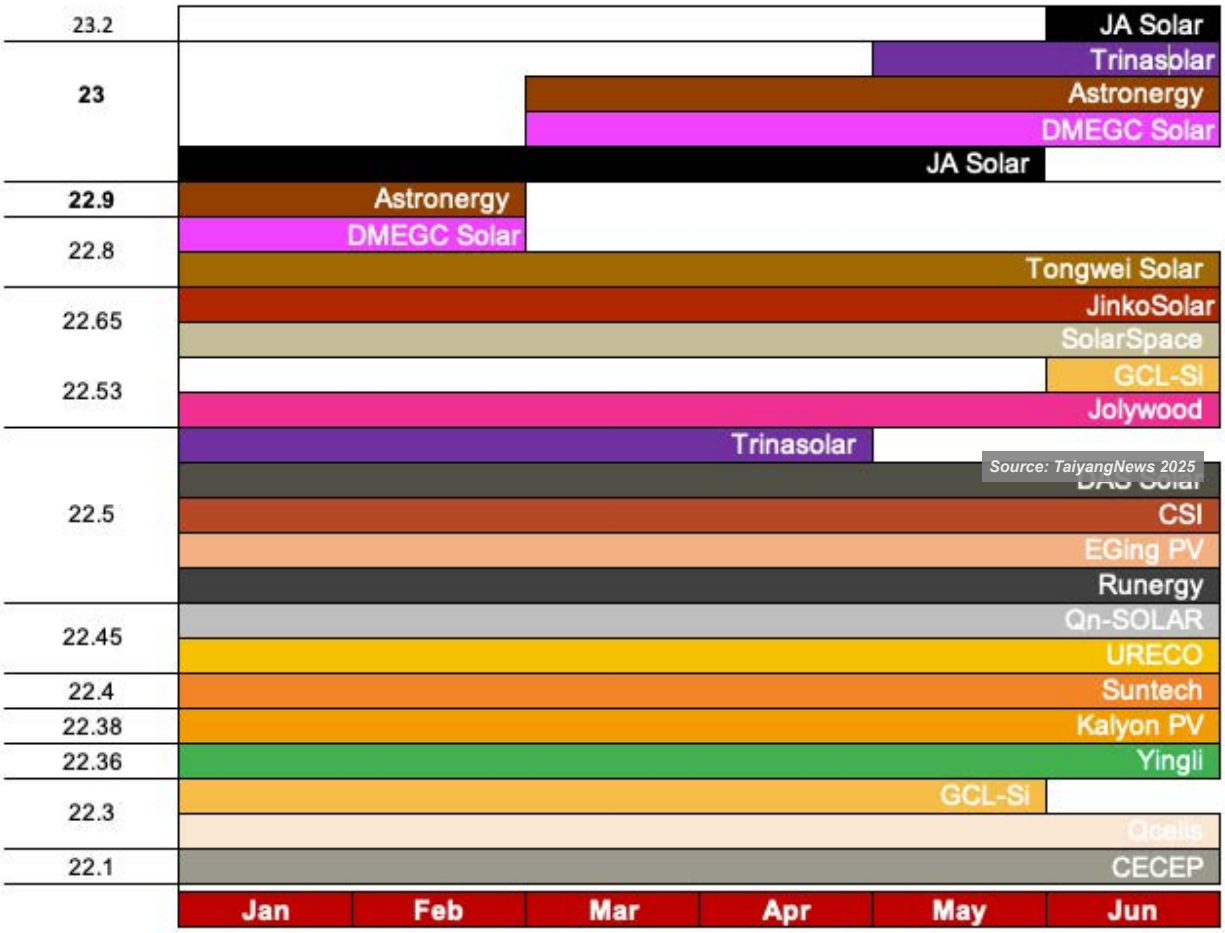
Module Efficiency Progress For TOPCon Technology – 2023



Module Efficiency Progress For TOPCon Technology – 2024



Module Efficiency Progress For TOPCon Technology – H1-2025



Several Changes: The TOPCOn product listing has been most dynamic with new companies entering in the early days and eventually companies improving their efficiency levels frequently.

In July, 5 companies were added with their TOPCon products, all featuring above 22% efficiency. Qn-SOLAR, Suntech, and GCL SI maintained their efficiencies of 22.45%, 22.4%, and 22.3%, respectively, without changes until December. Runergy, entering with 22.4%, improved to 22.5% in December, while SolarSpace, initially at 22.02%, upgraded to 22.45% in the same timeline. In addition to these new companies added to the list, EGing also improved the efficiency of its product from 22.05% first to 22.44% in June and then again marginally to 22.45% in July without any changes till December. URECO joined in August with 22.45% efficiency, which remained the same until the end of the year. In October, Yingli and CECEP joined with 22.36% and 22.1%, respectively, and their efficiencies remained unchanged for the next 2 months.

5.2.4 PERC

If there is anything that has been stagnant in our TOP SOLAR MODULES list, it's the efficiency range of PERC products. While the lower limit would not change as it is also the benchmark efficiency to enter our TOP SOLAR MODULES list, the higher limit has increased only once over the last 3.5 years, in February 2022. That means, within the timeline scope of this report, i.e., 2023–2024, the efficiency range of PERC has not changed at all. While a few companies did announce PERC modules above 21.7%, we did not find proof of commercialization for these modules, and thus excluding them from the TOP SOLAR MODULES list.

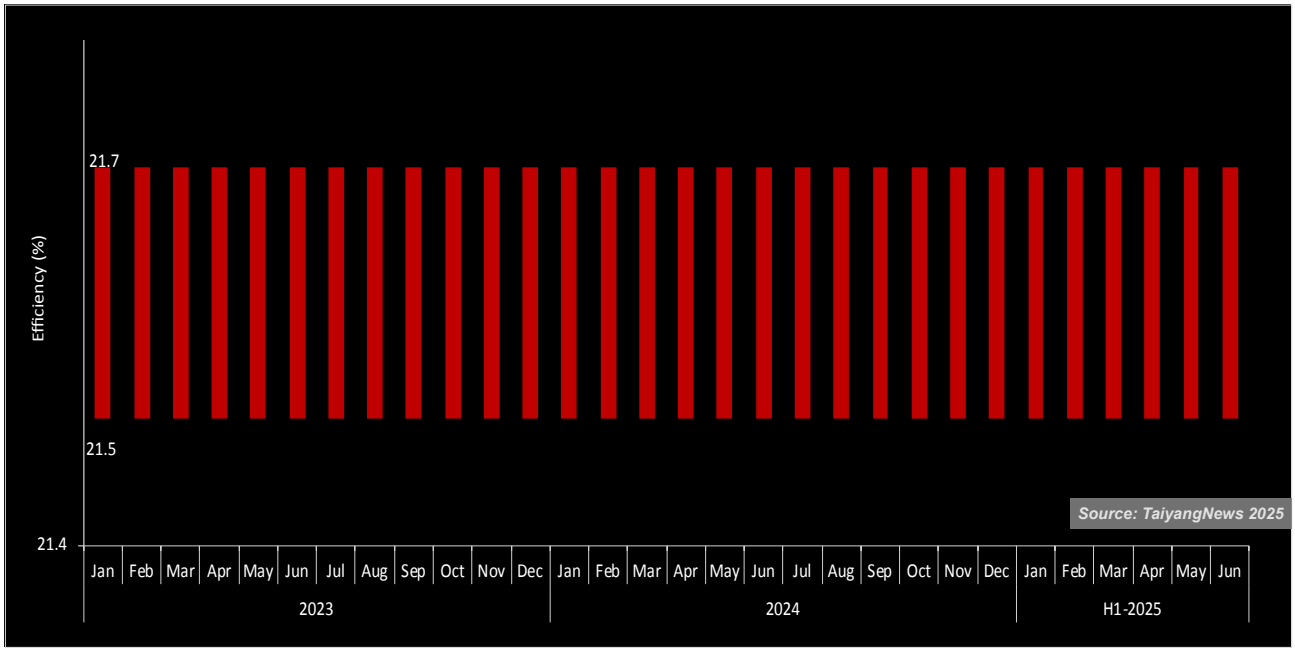
The downward trend for PERC products continued in H1 2025, with 2 long-standing modules delisted in January – one from Risen and the other from Akcome. Risen's PERC product had entered the list in November 2022 with a 21.7% efficiency, while Akcome's was listed with 21.68%. These removals reduced the PERC product count from 20 in December 2024 to 18, further diminishing the technology's share in the TOP SOLAR MODULES listing

In contrast, 2024 saw slightly more activity, though mostly on the negative side. Only one new PERC module was added during the year – Kalyon's 21.61% efficiency module, which debuted in March. However, this was also the first to be delisted, exiting the list in July as the company discontinued its PERC offerings. This was followed by further exits from Tongwei Solar in September, Astronergy and Talesun in October, and JinkoSolar in November, all of whom ceased commercial activity for PERC-based products during the year.

The story was slightly different in 2023. Products from LONGi, Risen, and Canadian Solar were at the top level of 21.7% throughout the year. Other products to remain unaltered during the course of 2023 were: JinkoSolar and Akcome modules at 21.68%; 3 companies at 21.6% – Trinasolar, JA Solar, and Talesun; Jinergy, Seraphim, and Yingli at 21.57%; EGing PV at 21.56%; and Qcells listed at 21.5%.

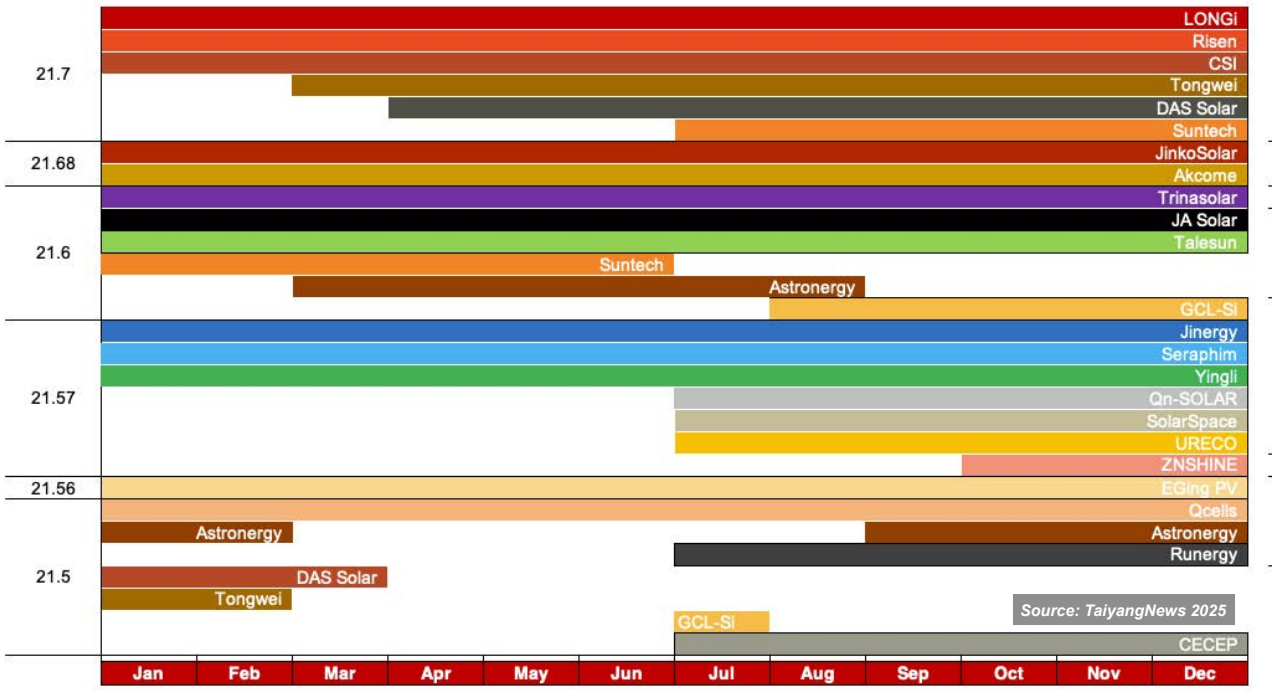
In terms of the changes, Tongwei Solar joined the PERC topper club of 21.7% in March, up from 21.5% previously, and stayed there through 2023. Astronergy also improved the efficiency of its top PERC offering in March, but from 21.5% to 21.6%, and remained at this updated level till August, but then circled back to the 21.5% level in September to stay there till year-end. DAS Solar also joined the top PERC efficiency group in April and didn't see any further changes. From July, Suntech also joined the top spot, improving its module efficiency by 0.1 percentage point to 21.6%. In the same month, Qn-SOLAR, SolarSpace, and URECO joined the 21.57% efficiency point, while CECEP, GCL SI, and Runergy entered with 21.5% efficiency. In August, GCL SI improved the top efficiency of its PERC product to 21.6%. In October, ZNSHINE joined in with an efficiency of 21.5%, and these products maintained their efficiency levels until the end of December 2023.

PERC Module Efficiency Range – 2023 / H1-2025

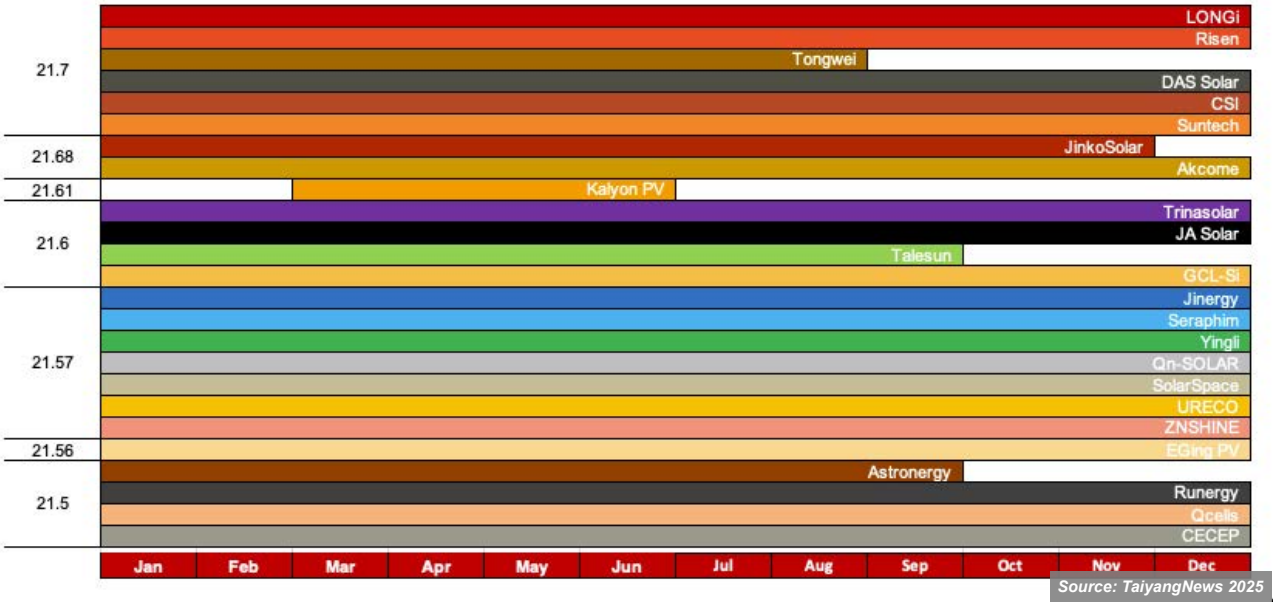


Rock Steady: The efficiency range of PERC products remained consistent at 21.5% to 21.7% across all editions of the TOP SOLAR MODULES – except the very first.

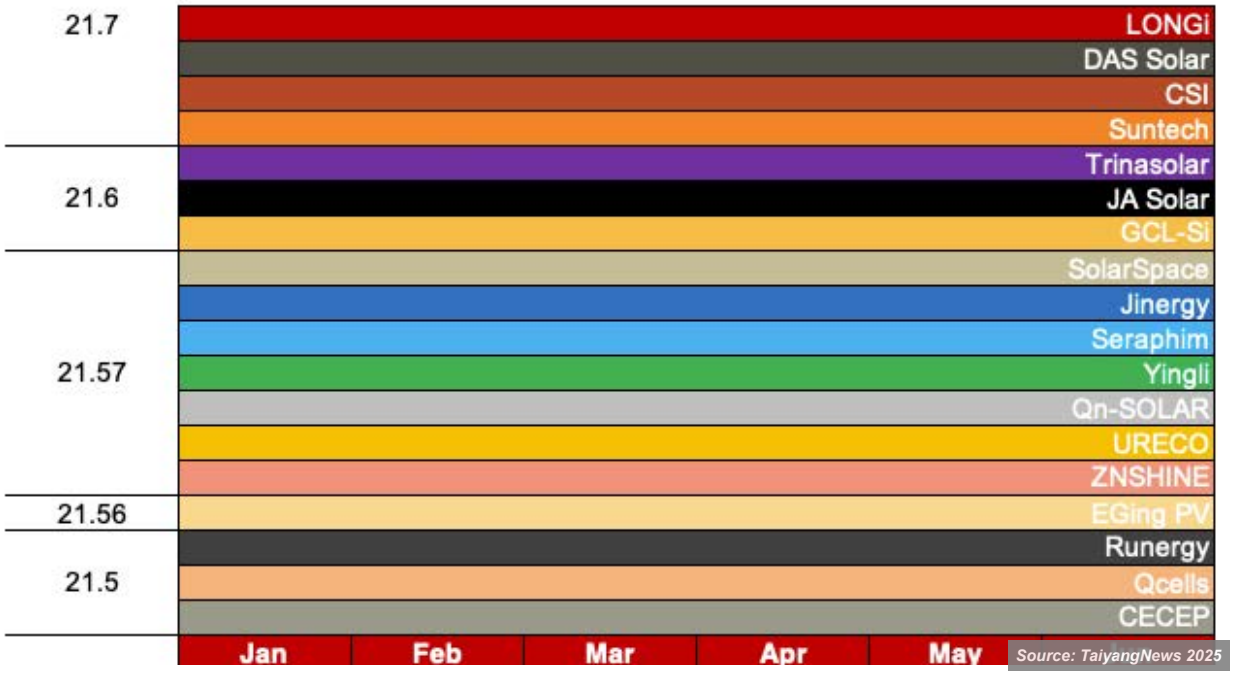
Module Efficiency Progress For PERC Cell Technology – 2023



Module Efficiency Progress For PERC Cell Technology – 2024



Module Efficiency Progress For PERC Cell Technology – H1-2025



Efficiency Plateau: In stark contrast to the influx of new PERC products included in 2023, and a stagnant first half of 2024, the latter half of 2024 saw a steady decline in PERC product listings that also extended into H1 2025.



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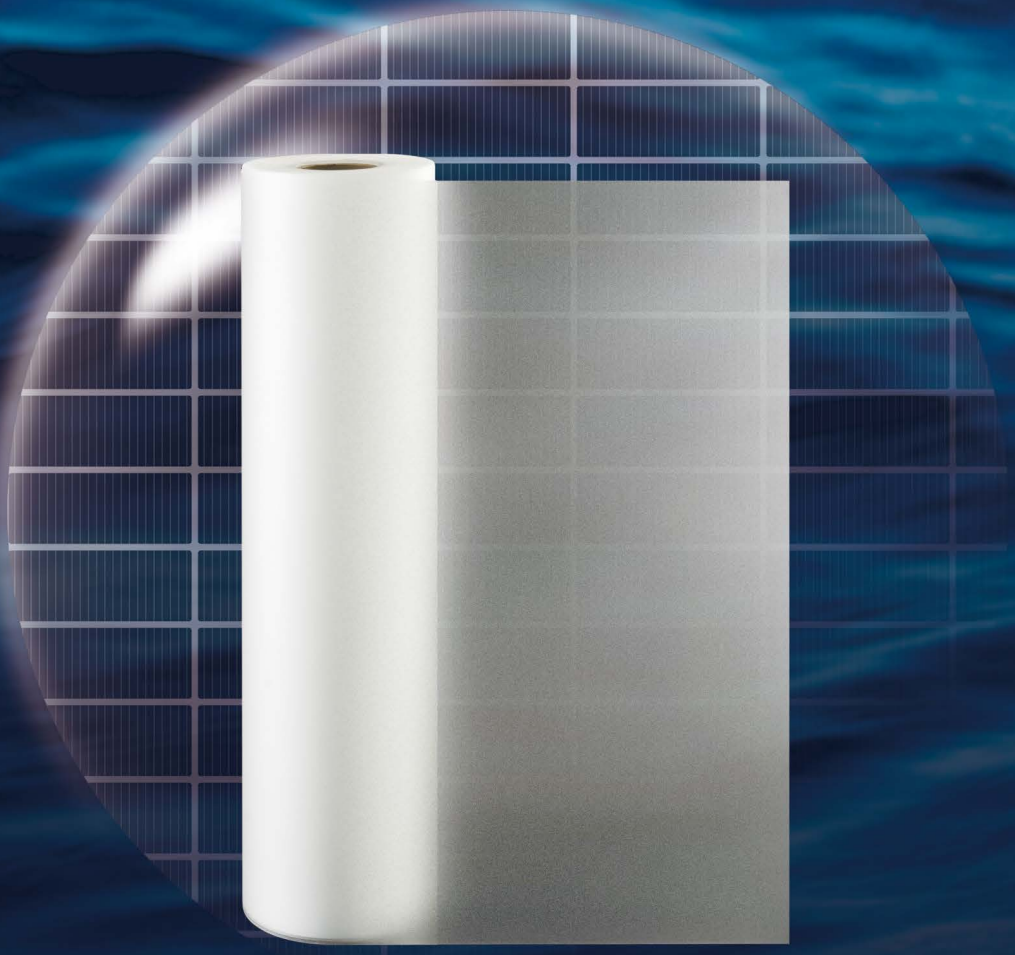
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6. Power

After efficiency, a solar module's wattage is its most telling feature – both in terms of performance and marketability. Rated power is not just a technical specification; it's a key sales metric that often defines a product's commercial success. That's why, alongside our efficiency analysis, this report includes a high-level review of module power ratings.

We assess power development in 2 ways: by tracking changes in the top 3 highest power ratings overall, and by identifying the highest power rating within each cell technology.

As with efficiency, we've grouped power ratings into distinct classes. While not a strict rule, this categorization aligns with common industry practices. Typically, modules below 500 W are used in residential settings, those between 500 and 600 W suit commercial and industrial (C&I) installations, and modules above 600 W are preferred for utility-scale projects. We've applied this same framework in our analysis.

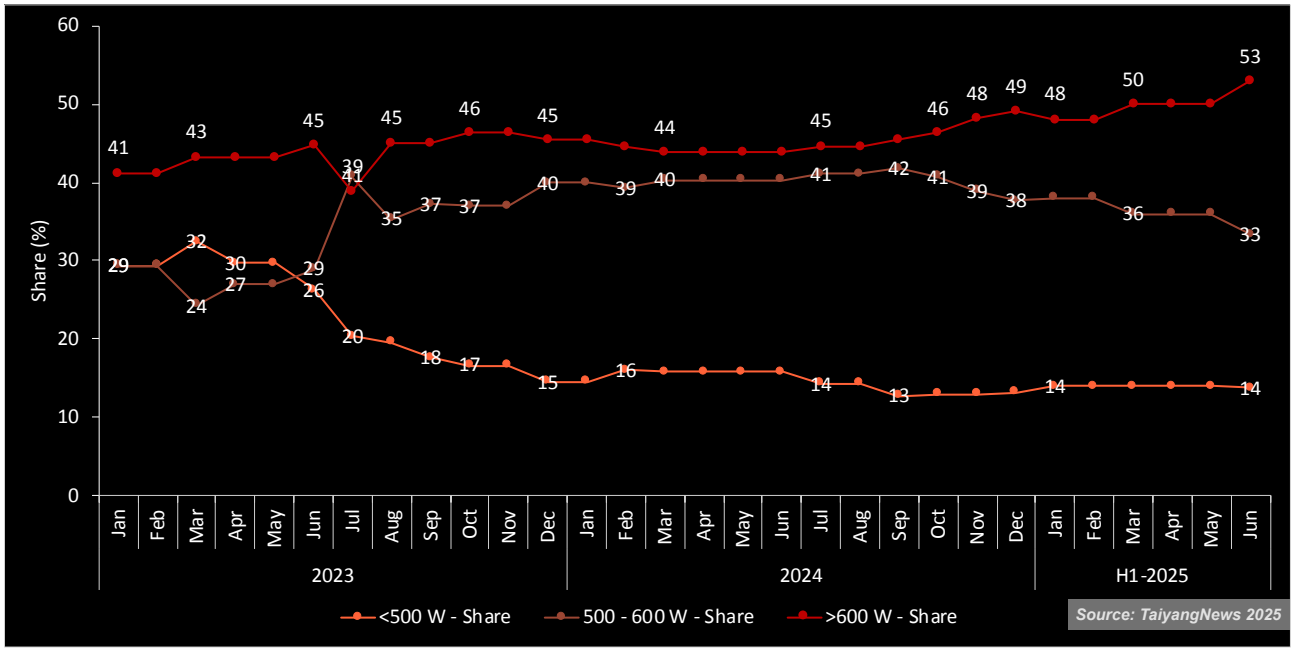
When viewed through this lens, the TOP SOLAR MODULES listing is clearly dominated by high-power modules rated above 600 W.

>600 W Class: This category continues to dominate the TOP SOLAR MODULES listing. In H1 2025, its share rose from 48% in January 2025 to 53% in June 2025, while the number of products increased from 24 to 27. This reflects the increasing dominance of high-power modules.

In 2024, the >600 W class maintained its strong position, starting with a 45% share in January and ending at 49% in December, with product count increasing by just one, from 25 to 26. Despite the relatively small change in count, the class consistently held the highest share throughout the year.

In 2023, this power band experienced the most consistent growth. It started the year at 41% share with 14 products and climbed steadily to 45% with 25 products by December – an increase of 11 products over the year. This marks the largest single-year expansion across all power categories in the TOP

Shares Of Different Top Module Power Ratings – 2023 / H1-2025



The Power Landscape: Our analys indicates that high-power modules dominate the segment, followed by mid-power modules, while lower-power modules have the least representation among high-efficiency products.

SOLAR MODULES listing.

500–600 W Class: In the 500–600 W category, the first half of 2025 saw a slight decline. Product count fell from 20 in December 2024 to 18 in June 2025, resulting in its share dropping from 39% to 35%. Despite this decrease, the segment remains important for the C&I sector.

During 2024, the share for this category hovered around 38% throughout most of the year. Starting with 22 products and a 40% share in January, it ended slightly lower at 20 products and 38% share by December. This reflected a moderate decline as some products were phased out or replaced by higher-power modules.

In 2023, this band underwent significant fluctuation. Beginning the year with 10 products and a 29% share, the count more than doubled to 22 by December. The segment closed the year with a strong 40% share, suggesting increasing popularity during that period, though some of this momentum reversed in 2024.

<500 W Class: The <500 W category continued its downward trend in 2025. The number of products remained static at 7 from January through June. However, due to fluctuations in the overall product count, its share held steady at 14%. This class now represents the least adopted module size in the TOP SOLAR MODULES listing.

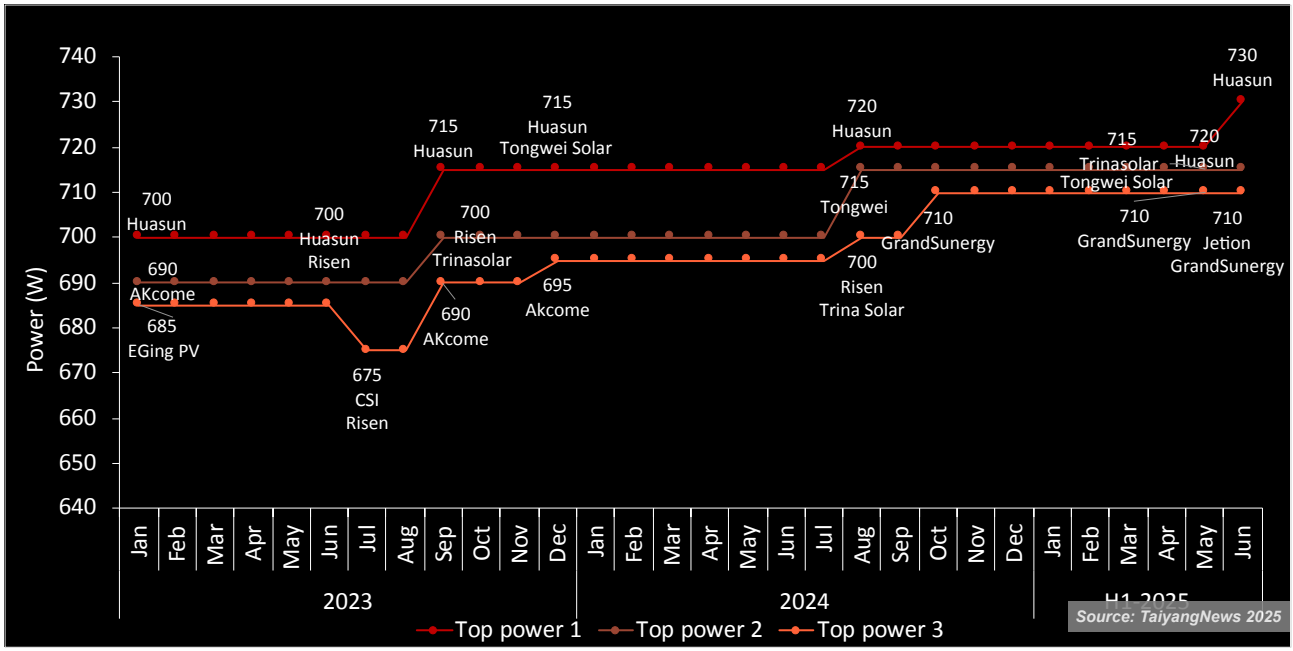
In 2024, this band saw a marginal decline, with its share dropping from 15% in January to 13%. In December and the product count decreased from 8 to 7. The continued market shift toward larger, high-efficiency modules explains the slow erosion of this category.

In 2023, the <500 W power class witnessed the most significant drop in share. Starting with 10 products and a 29% share in January, it briefly peaked at 32% in March with 12 products, before falling sharply to 15% with just 8 products by December.

6.1 Top 3 power ratings

Similar to efficiency, we also examine the products in the top 3 power levels. The highest rated power in the TOP SOLAR MODULES listing improved from 700 W in January 2023 to 730 W in June 2025, a 30 W absolute increase over 2.5 years. In the first half of 2025, this top rating improved from 720 W in January to 730 W in June, representing the largest

Top 3 Power Ratings – 2023 / H1-2025



HJT Dominance: Of the 5 products representing the top 3 power ratings in the TOP MODULES list at the end of H1 2025, 4 are based on HJT – highlighting the technology's strong dominance in the power section.

half-year gain since 2023. The 2nd highest power level remained unchanged at 715 W throughout the period. The third tier, which had reached 710 W in late 2024, also held steady during H1 2025. However, it saw a shift in representation, with Jetion Solar joining Grand Sunergy in offering 710 W modules. Overall, the first half of 2025 showed continued upward momentum at the top end of power ratings, driven entirely by HJT and TOPCon technologies.

In 2024, the top power level increased modestly from 715 W to 720 W in August and stayed at that level through the end of the year. The 2nd rank also saw the gain the same month, moving from 700 W to 715 W. The third tier started at 695 W, increased to 700 W also in August, and was further raised to 710 W in October, maintaining that figure for the rest of the year.

In 2023, the highest power level held steady at 700 W until September, when it increased to 715 W. The 2nd rank began at 690 W and improved to 700 W by year-end. The 3rd rank opened the year at 685 W, dipped to 675 W mid-year due to product reshuffling, and recovered to close at 695 W in December. Going into product-wise development details, the top power slot saw a major upgrade nearing the tail end of H1 2025. In June, Huasun raised the benchmark for the highest power output in the TOP SOLAR MODULES list by commercializing a 730 W HJT module, up from its previous 720 W product launched in August 2024. This marks the highest rated power seen so far in the listing. The 2nd rank remained unchanged during this period, jointly held by Trinasolar and Tongwei Solar, both offering 715 W modules based on TOPCon and HJT technologies, respectively. As for the 3rd rank, while the power rating of 710 W remained the same as in late 2024, there was a notable change in representation. Jetion Solar entered the listing in June 2025 with its first HJT module rated at 710 W, joining Grand Sunergy in this power tier.

In 2024, Huasun and Tongwei Solar shared the top power spot at 715 W at the beginning of the year. This changed in August when Huasun introduced its 720 W HJT module, becoming the sole leader. Tongwei Solar's module, unchanged in specification, was moved to the 2nd rank. Risen and Trinasolar, each with 700 W modules, had occupied the second tier earlier in the year. With the shift at the top, Risen's 700 W HJT module and Trinasolar's 700 W TOPCon product were jointly pushed to 3rd place. In October, Grand Sunergy entered the listing with a 710 W HJT module, becoming the sole occupant of the 3rd rank and maintaining that position through the end of 2024.

The year 2023 saw more frequent changes. Huasun began the year as the top power holder with a 700 W HJT module. Risen joined in June with an identical 700 W module, sharing the top position until September, when Huasun upgraded to a 715 W HJT module. In December, Tongwei Solar matched this with a new HJT product, resulting in a shared top rank. The second slot initially featured Akcome's 690 W HJT module. This was later replaced by Risen and Trinasolar's 700 W modules following Huasun's upgrade. Akcome then moved to the third tier. Grand Sunergy had not yet entered the list. The 3rd rank fluctuated mid-year, beginning at 685 W, dropping briefly, and then being represented by Akcome's 695 W module in December.

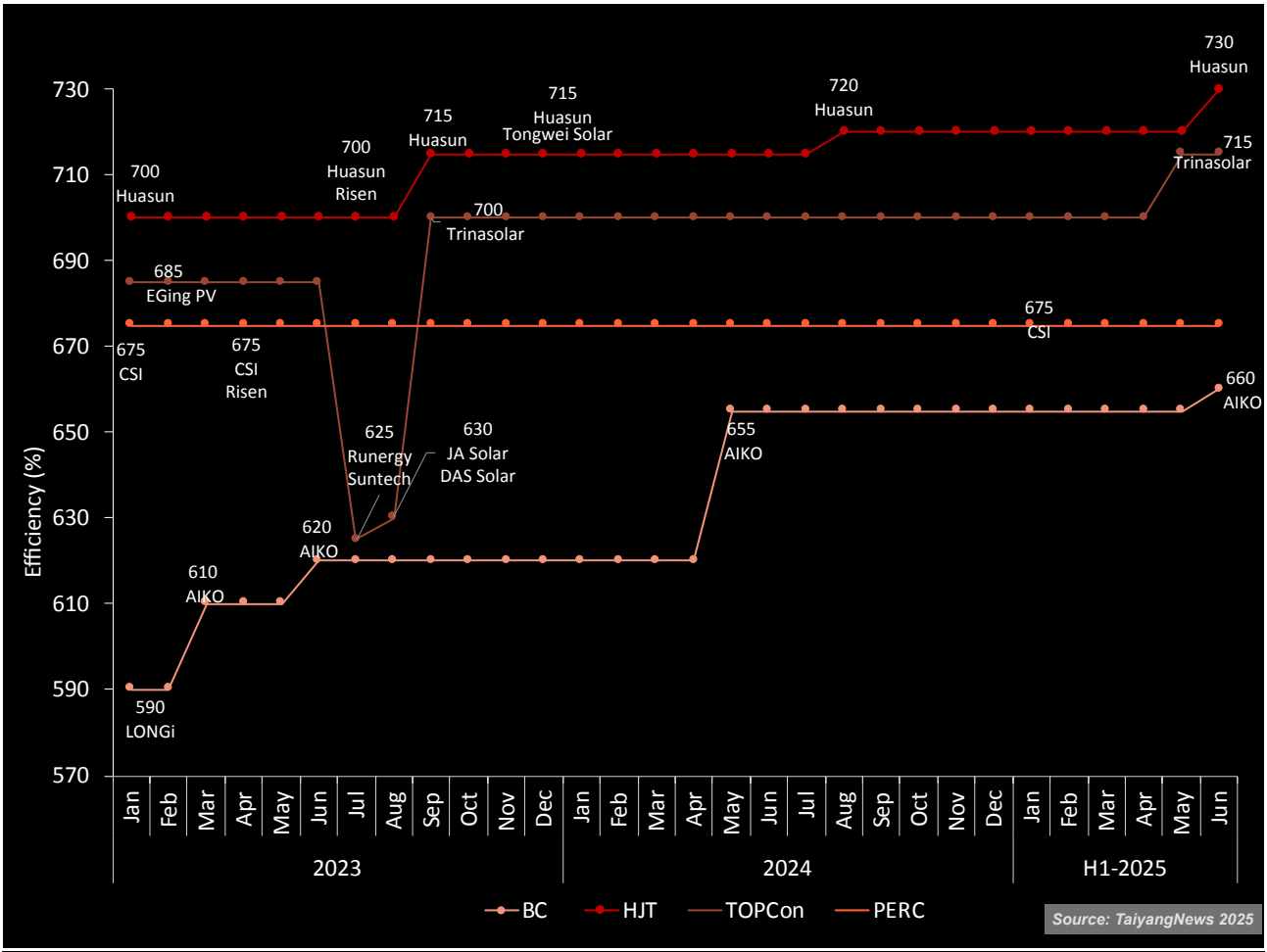
6.2 Top Power of Each Cell Technology

Unlike efficiency, power has no direct relevance to the performance of the cell technology. But it definitely provides insights into technology and product positioning, especially on the application front.

Being the power leader also qualifies HJT for first mention. In H1 2025, Huasun set a new record in June with a 730 W HJT module, surpassing its own 720 W mark and becoming the first company to reach this level in the TOP SOLAR MODULES listing. At the beginning of 2024, Huasun and Tongwei Solar's 715 W products shared the top position for power in the HJT stream. In August, Huasun raised the bar by introducing a 720 W module, securing the top position exclusively through the end of 2024. In 2023, Huasun's 700 W module led both the HJT stream and the overall listing in January. Risen matched this in February, and both shared the lead until September, when Huasun launched a 715 W product. Tongwei Solar caught up in December, leading to a tie at the top again.

TOPCon technology represents the second-highest in power rating. In the first half of 2025, Trinasolar made a notable upgrade by increasing the power

Top Power Of Each Cell Technology – 2023 / H1-2025



The Power Order: Power rankings differ noticeably from efficiency trends. HJT leads in power, followed by TOPCon and then PERC – while the most efficient technology, BC, ranks last in terms of power ratings.

of its TOPCon module to 715 W in May, improving from the 700 W level that had been maintained since 2023. This change pushed the top-rated power for the TOPCon stream up by 15 W, marking its highest level to date. However, there was no change with respect to top power in this technology stream in 2024. Trinasolar's 700 W TOPCon module was the leader throughout the year. The 2023 story was a bit different, with several ups and downs. EGing PV started on top at 685 W and held that position until June. In July, after reducing its product's power to 580 W, the lead shifted to 625 W modules from Runergy and Suntech. DAS Solar and JA Solar briefly took over in August with 630 W modules. In September, Trinasolar set a new record for the category with its 700 W module, which remained unbeaten through 2024.

While PERC comes 3rd in power, there was no change to the top-rated power for the PERC category in H1 2025. However, due to the delisting of PERC module from Risen, this level again represented by Canadian Solar alone during H1-2025. A 675 W module from Canadian Solar has been leading the PERC stream in the power segment since the beginning of 2023. In the month of April, Risen also commercialized a PERC product with the same power rating, thus listing alongside Canadian Solar for the rest of 2023 and throughout 2024.

IBC, albeit an efficiency leader, stood last in power comparison. In H1 2025, AIKO increased the power rating of its leading IBC module from 655 W to 660 W in June, marking a modest but symbolic increase in the IBC stream. The company continues to lead the IBC power ranking without competition. The top

power of this technology changed only once during 2024, but by the same company. AIKO has also been the leader of the IBC power league with a 620 W product. Its record efficiency module, included in May 2024, also brought an improvement in power, rated at 655 W. It was placed directly at the top among IBC modules and retained its lead till the end of the year. However, back in early 2023, LONGi led with a 590 W module. In March, AIKO's ABC series took the lead at 610 W and improved it to 620 W by June, retaining it through the rest of the year.

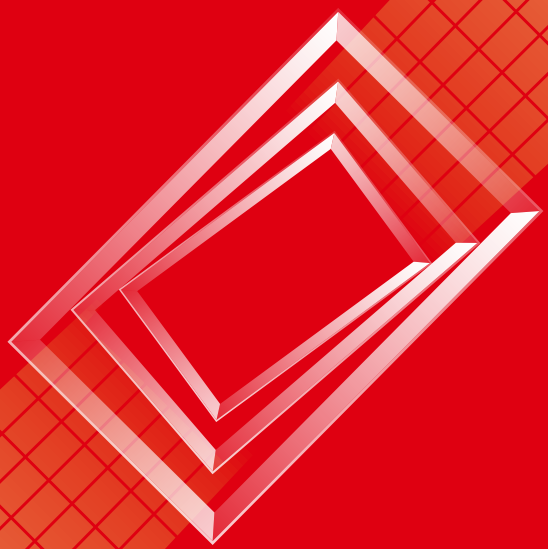
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7. Company-wise Progress

While we have discussed the progress of efficiency and power in the prior chapters, here are the summary tables for each company in our list with respect to efficiency and power. These 2 tables for H1 2025 and 2024 show how the 2 characteristics have progressed for each company in every cell technology segment.

7.1 Efficiency Progress 2023 / H1-2025

TOP SOLAR MODULES: Manufacturer Efficiency Progress For Different Cell Technologies In 2023

Company	Techno-logy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Progress
AIKO	ABC	-	-	23.6	23.6	23.6	24	24	24	24	24	24	24	
Akcome	HJT	22.22	22.22	22.22	22.22	22.22	22.22	22.22	22.22	22.22	22.22	22.22	22.37	
Akcome	PERC	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	
Astronergy	PERC	21.5	21.5	21.6	21.6	21.6	-	21.6	21.6	21.5	21.5	21.5	21.5	
Astronergy	Topcon	22.1	22.1	22.4	22.4	22.5	22.5	22.5	22.5	22.6	22.6	22.6	22.65	
CSI	HJT	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
CSI	TOPCon	-	-	22.3	22.3	22.3	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
CSI	PERC	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	
CECEP	TOPCon	-	-	-	-	-	-	-	-	-	22.1	22.1	22.1	
CECEP	PERC	-	-	-	-	-	-	21.5	21.5	21.5	21.5	21.5	21.5	
DAS Solar	PERC	21.5	21.5	21.5	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	
DAS Solar	TOPCon	22.1	22.1	22.1	22.3	22.3	22.3	22.5	22.5	22.5	22.5	22.5	22.5	
DMEGC Solar	TOPCon	-	-	-	-	-	22.45	22.45	22.45	22.45	22.45	22.45	22.45	
EGing	PERC	21.56	21.56	21.56	21.56	21.56	21.56	21.56	21.56	21.56	21.56	21.56	21.56	
EGing	TOPCon	22.05	22.05	22.05	22.05	22.05	22.05	22.44	22.45	22.45	22.45	22.45	22.45	
Qcells	PERC	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	
Qcells	TOPCon	22	22	22	22	22	-	-	-	-	-	-	-	
Qn-SOLAR	PERC	-	-	-	-	-	-	21.57	21.57	21.57	21.57	21.57	21.57	
Qn-SOLAR	TOPCon	-	-	-	-	-	-	22.45	22.45	22.45	22.45	22.45	22.45	
Runergy	PERC	-	-	-	-	-	-	21.5	21.5	21.5	21.5	21.5	21.5	
Runergy	TOPCon	-	-	-	-	-	-	22.4	22.4	22.4	22.4	22.4	22.5	
GCL SI	PERC	-	-	-	-	-	-	21.5	21.6	21.6	21.6	21.6	21.6	
GCL SI	TOPCon	-	-	-	-	-	-	22.3	22.3	22.3	22.3	22.3	22.3	
Huasun	HJT	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	23.02	23.02	23.02	23.02	
JA Solar	PERC	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	
JA Solar	TOPCon	22.4	22.4	22.4	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
Jinergy	HJT	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.85	21.85	21.85	21.85	
Jinergy	PERC	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	
JinkoSolar	PERC	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	
JinkoSolar	TOPCon	22.65	22.65	22.65	22.65	22.65	22.65	22.65	22.65	22.65	22.65	22.65	22.65	
Jolywood	TOPCon	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	
LONGi	HPBC	22.8	22.8	22.8	22.8	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2	
LONGi	PERC	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	
Maxeon	IBC	22.8	22.8	22.8	22.8	22.8	22.8	22.8	23	23	23	23	23	
Meyer Burger	HJT	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	

Source: TaiyangNews 2025

TOP SOLAR MODULES: Manufacturer Efficiency Progress For Different Cell Technologies In 2023

Company	Techno-logy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Progress
REC	HJT	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	
Risen	HJT	-	-	-	-	-	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
Risen	PERC	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	
Seraphim	PERC	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	
SolarSpace	PERC	-	-	-	-	-	-	21.57	21.57	21.57	21.57	21.57	21.57	
SolarSpace	TOPCon	-	-	-	-	-	-	22.02	22.02	22.02	22.02	22.02	22.45	
SPIC	TBC	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.8	22.8	22.8	22.8	
Suntech	PERC	21.6	21.6	21.6	21.6	21.6	21.6	21.7	21.7	21.7	21.7	21.7	21.7	
Suntech	TOPCon	-	-	-	-	-	-	22.4	22.4	22.4	22.4	22.4	22.4	
Talesun	PERC	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	
Trinasolar	PERC	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	
Trinasolar	TOPCon	21.9	21.9	21.9	22.3	22.3	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
Tongwei Solar	HJT	-	-	-	-	-	-	-	-	-	-	-	23	
Tongwei Solar	PERC	21.5	21.5	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	
Tongwei Solar	TOPCon	-	-	22.4	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
URECO	HJT	-	-	-	-	-	-	-	22.44	22.44	22.44	22.44	22.44	
URECO	PERC	-	-	-	-	-	-	21.57	21.57	21.57	21.57	21.57	21.57	
URECO	TOPCon	-	-	-	-	-	-	-	22.45	22.45	22.45	22.45	22.45	
Yingli	PERC	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	
Yingli	TOPCon	-	-	-	-	-	-	-	-	22.36	22.36	22.36	22.36	
Yingli	PERC	-	-	-	-	-	-	-	-	21.57	21.57	21.57	21.57	
ZNSHINE	PERC	-	-	-	-	-	-	-	-	21.57	21.57	21.57	21.57	

Source: TaiyangNews 2025

TOP SOLAR MODULES: Manufacturer Efficiency Progress For Different Cell Technologies In 2024

Company	Techno-logy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Progress
AIKO	ABC	24	24	24	24	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	
Akcome	HJT	22.37	22.37	22.37	22.37	22.37	22.37	22.37	22.37	22.37	22.37	22.37	22.37	
Akcome	PERC	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	
Astronergy	PERC	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	-	-	-	
Astronergy	Topcon	22.65	22.65	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.9	22.9	
CSI	HJT	22.5	22.5	-	-	-	-	-	-	-	-	-	-	
CSI	TOPCon	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
CSI	PERC	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	
CECEP	PERC	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	
CECEP	TOPCon	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	
DAS Solar	PERC	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	
DAS Solar	TOPCon	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
DMEGC Solar	TOPCon	22.5	22.5	22.5	22.6	22.6	22.6	22.8	22.8	22.8	22.8	22.8	22.8	
EGing PV	PERC	21.56	21.56	21.56	21.56	21.56	21.56	21.56	21.56	21.56	21.56	21.56	21.56	
EGing PV	TOPCon	22.45	22.45	22.45	22.45	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
GCL SI	PERC	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	
GCL SI	TOPCon	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	
Grand Sunergy	HJT	-	-	-	-	-	-	-	-	22.86	22.86	22.86	22.86	
Huasun	HJT	23.02	23.02	23.02	23.02	23.02	23.02	23.02	23.18	23.18	23.18	23.18	23.18	
JA Solar	PERC	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	
JA Solar	TOPCon	22.5	22.5	22.5	22.5	22.5	22.5	22.8	22.8	22.8	22.8	23	23	
Jinergy	HJT	21.85	21.85	21.85	21.85	21.85	21.85	21.85	21.85	21.85	21.85	21.85	21.85	
Jinergy	PERC	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	
JinkoSolar	PERC	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	21.68	-	
JinkoSolar	TOPCon	22.65	22.65	22.65	22.65	22.65	22.65	22.65	22.65	22.65	22.65	22.65	22.65	
Jolywood	TOPCon	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	22.53	
Kalyon PV	PERC	21.61	21.61	21.61	21.61	21.61	21.61	-	-	-	-	-	-	
Kalyon PV	TOPCon	22.38	22.38	22.38	22.38	22.38	22.38	22.38	22.38	22.38	22.38	22.38	22.38	
LONGi	HPBC	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2	
LONGi	PERC	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	
Maxeon	IBC	23	23	23	23	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1	
Meyer Burger	HJT	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	
Qcells	PERC	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	
Qcells	TOPCon	-	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	
Qn-SOLAR	PERC	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	
Qn-SOLAR	TOPCon	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	
REC	HJT	22.3	22.3	22.3	22.3	22.3	22.3	22.6	22.6	22.6	22.6	22.6	22.6	
Risen	HJT	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
Risen	PERC	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	

Source: TaiyangNews 2025

TOP SOLAR MODULES: Manufacturer Efficiency Progress For Different Cell Technologies In 2024

Company	Techno-logy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Progress
Runergy	PERC	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	
Runergy	TOPCon	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
Seraphim	PERC	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	
SolarSpace	PERC	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	
SolarSpace	TOPCon	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.65	22.65	
SPIC	TBC	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	
Suntech	PERC	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	
Suntech	TOPCon	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	
Talesun	PERC	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	-	-	-	
Trinasolar	PERC	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	
Trinasolar	TOPCon	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
Tongwei Solar	HJT	23	23	23	23	23	23	23	23	23	23	23	23	
Tongwei Solar	PERC	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	-	-	-	-	
Tongwei Solar	TOPCon	22.5	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	
URECO	HJT	22.44	22.44	22.44	22.44	22.44	22.44	22.44	22.44	22.44	22.44	22.44	22.44	
URECO	PERC	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	
URECO	TOPCon	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	22.45	
Yingli	PERC	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	
Yingli	TOPCon	22.36	22.36	22.36	22.36	22.36	22.36	22.36	22.36	22.36	22.36	22.36	22.36	
ZNSHINE	PERC	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	21.57	

Source: TaiyangNews 2025

TOP SOLAR MODULES: Manufacturer Efficiency Progress For Different Cell Technologies In 2025

Company	Technology	Jan	Feb	Mar	Apr	May	Jun	Progress
AIKO	ABC	24.2	24.2	24.2	24.2	24.2	24.4	
Grand Sunergy	HJT	22.86	22.86	22.86	22.86	22.86	22.86	
Qcells	TOPCon	22.3	22.3	22.3	22.3	22.3	22.3	
Qcells	PERC	21.5	21.5	21.5	21.5	21.5	21.5	
Astronergy	TOPCon	22.9	22.9	23.0	23.0	23.0	23.0	
Canadian Solar	TOPCon	22.5	22.5	22.5	22.5	22.5	22.5	
Canadian Solar	PERC	21.7	21.7	21.7	21.7	21.7	21.7	
CECEP	TOPCon	22.1	22.10	22.10	22.10	22.10	22.10	
CECEP	PERC	21.5	21.5	21.5	21.5	21.5	21.5	
DAS Solar	TOPCon	22.5	22.5	22.5	22.5	22.5	22.5	
DAS Solar	PERC	21.7	21.7	21.7	21.7	21.7	21.7	
DMEGC Solar	TOPCon	22.8	22.8	23.0	23.0	23.0	23.0	
Eging PV	TOPCon	22.5	22.5	22.5	22.5	22.5	22.5	
Eging PV	PERC	21.56	21.56	21.56	21.56	21.56	21.56	
GCL-Si	TOPCon	22.3	22.3	22.3	22.3	22.3	22.53	
GCL-Si	PERC	21.6	21.6	21.6	21.6	21.6	21.6	
Huasun	HJT	23.18	23.18	23.18	23.18	23.18	23.5	
JA Solar	TOPCon	23	23.0	23.0	23.0	23.0	23.2	
JA Solar	PERC	21.6	21.6	21.6	21.6	21.6	21.6	
Jetion Solar	HJT	-	-	-	-	-	22.9	
Jinergy	HJT	21.85	21.85	21.85	21.85	21.85	21.85	
Jinergy	PERC	21.57	21.57	21.57	21.57	21.57	21.57	
JinkoSolar	TOPCon	22.65	22.65	22.65	22.65	22.65	22.65	
Jolywood	TOPCon	22.53	22.53	22.53	22.53	22.53	22.53	
Kalyon PV	TOPCon	22.38	22.38	22.38	22.38	22.38	22.38	
LONGi	HPBC	23.2	23.2	24.1	24.1	24.1	24.2	
LONGi	PERC	21.7	21.7	21.7	21.7	21.7	21.7	
Maxeon	IBC	24.1	24.1	24.1	24.1	24.1	24.1	
Meyer Burger	HJT	21.8	21.8	21.8	21.8	21.8	21.8	
Qn-SOLAR	TOPCon	22.45	22.45	22.45	22.45	22.45	22.45	
Qn-SOLAR	PERC	21.57	21.57	21.57	21.57	21.57	21.57	
REC Group	HJT	22.6	22.6	22.6	22.6	22.6	22.6	
Risen	HJT	22.5	22.5	22.5	22.5	22.5	22.5	
Runergy	TOPCon	22.5	22.5	22.5	22.5	22.5	22.5	
Runergy	PERC	21.5	21.5	21.5	21.5	21.5	21.5	

Source: TaiyangNews 2025

TOP SOLAR MODULES: Manufacturer Efficiency Progress For Different Cell Technologies In 2025

Company	Technology	Jan	Feb	Mar	Apr	May	Jun	Progress
Seraphim	PERC	21.57	21.57	21.57	21.57	21.57	21.57	
SolarSpace	TOPCon	22.65	22.65	22.65	22.65	22.65	22.65	
SolarSpace	PERC	21.57	21.57	21.57	21.57	21.57	21.57	
SPIC	TBC	22.8	22.8	22.8	22.8	22.8	22.8	
Suntech	TOPCon	22.4	22.4	22.4	22.4	22.4	22.4	
Suntech	PERC	21.7	21.7	21.7	21.7	21.7	21.7	
Tongwei Solar	HJT	23	23.0	23.0	23.0	23.0	23.0	
Tongwei Solar	TOPCon	22.8	22.8	22.8	22.8	22.8	22.8	
Trinasolar	TOPCon	22.5	22.5	22.5	22.5	23.0	23.0	
Trinasolar	PERC	21.6	21.6	21.6	21.6	21.6	21.6	
URECO	TOPCon	22.45	22.45	22.45	22.45	22.45	22.45	
URECO	HJT	22.44	22.44	22.44	22.44	22.44	22.44	
URECO	PERC	21.57	21.57	21.57	21.57	21.57	21.57	
Yingli	TOPCon	22.36	22.36	22.36	22.36	22.36	22.36	
Yingli	PERC	21.57	21.57	21.57	21.57	21.57	21.57	
ZNSHINE	PERC	21.57	21.57	21.57	21.57	21.57	21.57	

Source: TaiyangNews 2025

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Source: JinkoSolar

7.2 Power Progress 2023 / H1-2025

TOP SOLAR MODULES: Manufacturer Power Ratings Progress For Different Cell Technologies In 2023

Company	Techno-logy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Progress
AIKO	ABC	-	-	610	610	610	620	620	620	620	620	620	620	
Akcome	HJT	690	690	690	690	690	690	690	690	690	690	690	695	
Akcome	PERC	560	560	560	560	560	560	560	560	560	560	560	560	
Astronergy	PERC	550	550	670	670	670	670	670	670	555	555	555	555	
Astronergy	TOPCon	570	570	625	625	580	580	580	580	585	585	585	585	
CSI	TOPCon	-	-	575	575	575	580	580	580	580	580	580	580	
CSI	HJT	440	440	440	440	440	440	440	440	440	440	440	440	
CSI	PERC	675	675	675	675	675	675	675	675	675	675	675	675	
DAS Solar	PERC	555	555	555	560	560	560	560	560	560	560	560	560	
DAS Solar	TOPCon	570	570	570	435	435	435	580	630	630	630	630	630	
DMEGC Solar	TOPCon	-	-	-	-	-	580	580	580	580	580	580	580	
EGing	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
EGing	TOPCon	685	685	685	685	685	685	580	580	580	580	580	580	
Qcells	PERC	590	590	590	590	590	590	590	590	590	590	590	590	
Qcells	TOPCon	395	395	395	395	395	395	-	-	-	-	-	-	
Qn-SOLAR	PERC	-	-	-	-	-	-	670	670	670	670	670	670	
Qn-SOLAR	TOPCon	-	-	-	-	-	-	580	580	580	580	580	580	
Runergy	PERC	-	-	-	-	-	-	555	600	600	600	600	600	
Runergy	TOPCon	-	-	-	-	-	-	625	625	625	625	625	580	
GCL SI	PERC	-	-	-	-	-	-	555	670	670	670	670	670	
GCL SI	TOPCon	-	-	-	-	-	-	580	575	575	575	575	575	
Huasun	HJT	700	700	700	700	700	700	700	700	715	715	715	715	
JA Solar	PERC	605	605	605	605	605	605	605	605	605	605	605	605	
JA Solar	TOPCon	625	625	625	580	580	580	580	630	630	630	630	630	
Jinergy	HJT	395	395	395	395	395	395	395	395	475	475	475	475	
Jinergy	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
JinkoSolar	PERC	560	560	560	560	560	560	560	560	560	560	560	560	
JinkoSolar	TOPCon	585	585	585	585	585	585	585	585	585	585	585	585	
Jolywood	TOPCon	440	440	440	440	440	440	440	440	440	440	440	440	
LONGi	HPBC	590	590	590	590	600	600	600	600	600	600	600	600	
LONGi	PERC	560	560	560	560	560	560	560	560	560	560	560	560	
Maxeon	IBC	440	440	440	440	440	440	440	445	445	445	445	445	
Meyer Burger	HJT	390	390	390	390	390	390	390	390	390	390	390	390	

Source: TaiyangNews 2025

TOP SOLAR MODULES: Manufacturer Power Ratings Progress For Different Cell Technologies In 2023

Company	Techno-logy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Progress
REC	HJT	430	430	430	430	430	430	430	430	430	430	430	430	
Risen	PERC	450	450	450	675	675	675	675	675	675	675	675	675	
Risen	HJT	-	-	-	-	-	700	700	700	700	700	700	700	
Seraphim	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
SolarSpace	PERC	-	-	-	-	-	-	670	670	670	670	670	670	
SolarSpace	TOPCon	-	-	-	-	-	-	430	430	430	430	430	580	
SPIC	TBC	440	440	440	440	440	440	440	440	410	410	410	410	
Suntech	PERC	670	670	670	670	670	670	560	560	560	560	560	560	
Suntech	TOPCon	-	-	-	-	-	-	625	625	625	625	625	625	
Talesun	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
Trinasolar	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
Trinasolar	TOPCon	425	425	425	445	445	450	450	450	700	700	700	700	
Tongwei Solar	HJT	-	-	-	-	-	-	-	-	-	-	-	715	
Tongwei Solar	PERC	660	660	430	430	430	430	430	430	430	430	430	430	
Tongwei Solar	TOPCon	-	-	430	580	580	580	580	580	580	580	580	580	
URECO	HJT	-	-	-	-	-	-	-	635	635	635	635	635	
URECO	TOPCon	-	-	-	-	-	-	-	580	580	580	580	580	
URECO	PERC	-	-	-	-	-	-	670	670	670	670	670	670	
Yingli	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
Yingli	TOPCon	-	-	-	-	-	-	-	-	-	625	625	625	
Yingli	PERC	-	-	-	-	-	-	-	-	-	670	670	670	
ZNSHINE	PERC	-	-	-	-	-	-	-	-	-	670	670	670	

Source: TaiyangNews 2025

TOP SOLAR MODULES: Manufacturer Power Ratings Progress For Different Cell Technologies In 2024

Source: TaiyangNews 2025

Company	Techno-logy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Progress
AIKO	ABC	620	620	620	620	655	655	655	655	655	655	655	655	
Akcome	HJT	695	695	695	695	695	695	695	695	695	695	695	695	
Akcome	PERC	560	560	560	560	560	560	560	560	560	560	560	560	
Astronergy	PERC	555	555	555	555	555	555	555	555	555	-	-	-	
Astronergy	TOPCon	585	585	590	590	590	590	590	590	590	590	640	640	
CSI	HJT	440	440	-	-	-	-	-	-	-	-	-	-	
CSI	TOPCon	580	580	580	580	580	580	580	580	580	580	580	580	
CSI	PERC	675	675	675	675	675	675	675	675	675	675	675	675	
CECEP	PERC	555	555	555	555	555	555	555	555	555	555	555	555	
CECEP	TOPCon	570	570	570	570	570	570	570	570	570	570	570	570	
DAS Solar	PERC	560	560	560	560	560	560	560	560	560	560	560	560	
DAS Solar	TOPCon	630	630	630	630	630	630	630	630	630	630	630	630	
DMEGC Solar	TOPCon	580	580	580	580	580	580	615	615	615	615	615	615	
EGing PV	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
EGing PV	TOPCon	580	580	580	580	580	580	580	580	580	580	580	580	
GCL SI	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
GCL SI	TOPCon	575	575	575	575	575	575	575	575	575	575	575	575	
Huasun	HJT	715	715	715	715	715	715	715	720	720	720	720	720	
JA Solar	PERC	605	605	605	605	605	605	605	605	605	605	605	605	
JA Solar	TOPCon	630	630	630	630	630	630	590	590	590	590	595	595	
Jinergy	HJT	475	475	475	475	475	475	475	475	475	475	475	475	
Jinergy	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
JinkoSolar	PERC	560	560	560	560	560	560	560	560	560	560	560		
JinkoSolar	TOPCon	585	585	585	585	585	585	585	585	585	585	585	585	
Jolywood	TOPCon	440	440	440	440	440	440	440	440	440	440	440	440	
Kalyon PV	PERC	380	380	380	380	380	380	-	-	-	-	-	-	
Kalyon PV	TOPCon	580	580	580	580	580	580	580	580	580	580	580	580	
LONGi	HPBC	600	600	600	600	600	600	600	600	600	600	600	600	
LONGi	PERC	560	560	560	560	560	560	560	560	560	560	560	560	
Maxeon	IBC	445	445	445	445	445	445	445	445	445	445	445	445	
Meyer Burger	HJT	390	390	390	390	390	390	390	390	390	390	390	390	
Qcells	PERC	590	590	590	590	590	590	590	590	590	590	590	590	
Qcells	TOPCon	-	400	435	435	435	435	435	435	435	435	435	435	

Source: TaiyangNews 2025

TOP SOLAR MODULES: Manufacturer Power Ratings Progress For Different Cell Technologies In 2024

Company	Techno-logy	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Progress
Qn-SOLAR	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
Qn-SOLAR	TOPCon	-	580	580	580	580	580	580	580	580	580	580	580	
REC	HJT	430	430	430	430	430	430	470	470	470	470	470	470	
Risen	HJT	700	700	700	700	700	700	700	700	700	700	700	700	
Risen	PERC	675	675	675	675	675	675	675	675	675	675	675	675	
Runergy	PERC	600	600	600	600	600	600	600	600	600	600	600	600	
Runergy	TOPCon	580	580	580	580	580	580	580	580	580	580	580	580	
Seraphim	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
SolarSpace	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
SolarSpace	TOPCon	580	580	580	580	580	580	580	580	580	580	585	585	
SPIC	TBC	410	410	410	410	410	410	410	410	410	410	410	410	
Suntech	PERC	560	560	560	560	560	560	560	560	560	560	560	560	
Suntech	TOPCon	605	605	605	605	605	605	605	605	605	605	605	605	
Talesun	PERC	670	670	670	670	670	670	670	670	670	-	-	-	
Trinasolar	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
Trinasolar	TOPCon	700	700	700	700	700	700	700	700	700	700	700	700	
Tongwei Solar	HJT	715	715	715	715	715	715	715	715	715	715	715	715	
Tongwei Solar	PERC	430	430	430	430	430	430	430	430	-	-	-	-	
Tongwei Solar	TOPCon	580	590	590	590	590	590	590	590	590	590	590	590	
URECO	HJT	635	635	635	635	635	635	635	635	635	635	635	635	
URECO	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
URECO	TOPCon	580	580	580	580	580	580	580	580	580	580	580	580	
Yingli	PERC	670	670	670	670	670	670	670	670	670	670	670	670	
Yingli	TOPCon	625	625	625	625	625	625	625	625	625	625	625	625	
ZNSHINE	PERC	670	670	670	670	670	670	670	670	670	670	670	670	

Source: TaiyangNews 2025

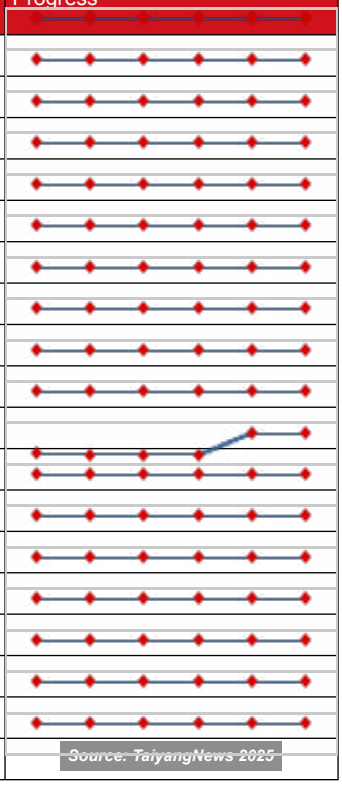
TOP SOLAR MODULES Producer's Power Ratings Progress For Different Cell Technologies In 2025

Company	Technology	Jan	Feb	Mar	Apr	May	Jun	Progress
AIKO	ABC	655	655	655	655	655	660	
Grand Sunergy	HJT	710	710	710	710	710	710	
Qcells	TOPCon	435	435	435	435	435	435	
Qcells	PERC	590	590	590	590	590	600	
Astronergy	TOPCon	640	640	620	620	620	620	
Canadian Solar	TOPCon	580	580	580	580	580	580	
Canadian Solar	PERC	675	675	675	675	675	675	
CECEP	TOPCon	570	570	570	570	570	570	
CECEP	PERC	555	555	555	555	555	555	
DAS Solar	TOPCon	630	630	630	630	630	630	
DAS Solar	PERC	560	560	560	560	560	560	
DMEGC Solar	TOPCon	615	615	620	620	620	620	
Eging PV	TOPCon	580	580	580	580	580	580	
Eging PV	PERC	670	670	670	670	670	670	
GCL-Si	TOPCon	575	575	575	575	575	700	
GCL-Si	PERC	670	670	670	670	670	670	
Huasun	HJT	720	720	720	720	720	730	
JA Solar	TOPCon	595	595	595	595	595	600	
JA Solar	PERC	605	605	605	605	605	605	
Jetion Solar	HJT	-	-	-	-	-	710	
Jinergy	HJT	475	475	475	475	475	475	
Jinergy	PERC	670	670	670	670	670	670	
JinkoSolar	TOPCon	585	585	585	585	585	585	
Jolywood	TOPCon	440	440	440	440	440	440	
Kalyon PV	TOPCon	580	580	580	580	580	580	
LONGi	HPBC	600	600	650	650	650	655	
LONGi	PERC	560	560	560	560	560	560	
Maxeon	IBC	445	445	445	445	445	445	
Meyer Burger	HJT	390	390	390	390	390	390	
Qn-SOLAR	TOPCon	580	580	580	580	580	580	
Qn-SOLAR	PERC	670	670	670	670	670	670	
REC Group	HJT	470	470	470	470	470	470	
Risen	HJT	700	700	700	700	700	700	

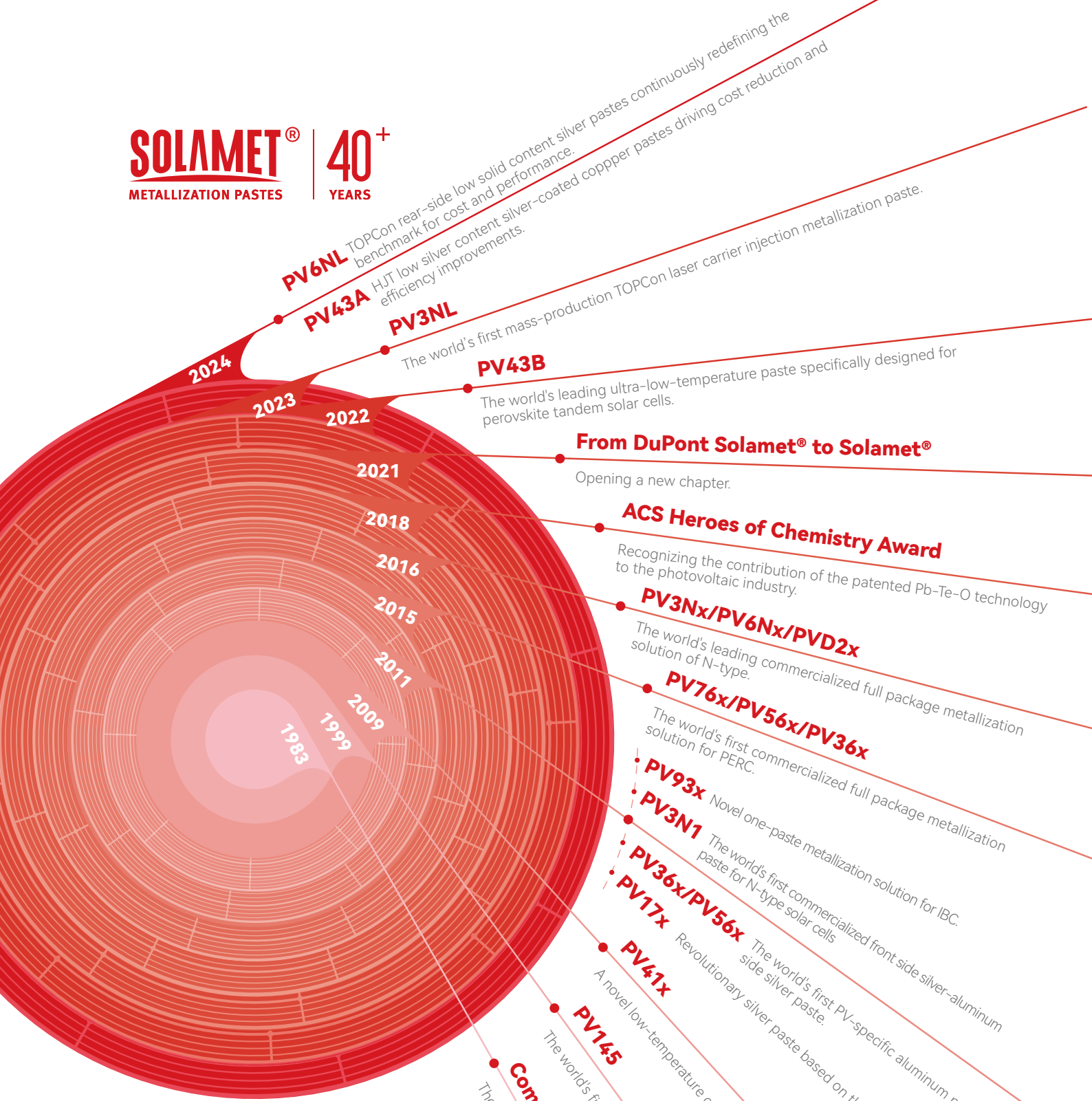
Source: TaiyangNews 2025

TOP SOLAR MODULES: Manufacturer Power Ratings Progress For Different Cell Technologies In 2025

Company	Technology	Jan	Feb	Mar	Apr	May	Jun	Progress
Runergy	TOPCon	580	580	580	580	580	580	
Runergy	PERC	600	600	600	600	600	600	
Seraphim	PERC	670	670	670	670	670	670	
SolarSpace	TOPCon	585	585	585	585	585	585	
SolarSpace	PERC	670	670	670	670	670	670	
SPIC	TBC	410	410	410	410	410	410	
Suntech	TOPCon	605	605	605	605	605	605	
Suntech	PERC	560	560	560	560	560	560	
Tongwei Solar	HJT	715	715	715	715	715	715	
Tongwei Solar	TOPCon	590	590	590	590	590	590	
Trinasolar	TOPCon	700	700	700	700	715	715	
Trinasolar	PERC	670	670	670	670	670	670	
URECO	TOPCon	580	580	580	580	580	580	
URECO	HJT	635	635	635	635	635	635	
URECO	PERC	670	670	670	670	670	670	
Yingli	TOPCon	625	625	625	625	625	625	
Yingli	PERC	670	670	670	670	670	670	
ZNSHINE	PERC	670	670	670	670	670	670	



SOLAMET® | 40+
METALLIZATION PASTES | YEARS



PV6NL TOPCon rear-side low solid content silver pastes continuously redefining the benchmark for cost and performance.

PV43A HJT low silver content silver-coated coppper pastes driving cost reduction and efficiency improvements.

PV3NL The world's first mass-production TOPCon laser carrier injection metallization paste.

PV43B The world's leading ultra-low-temperature paste specifically designed for perovskite tandem solar cells.

From DuPont Solamet® to Solamet®
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The world's first photovoltaic conductive paste is introduced.

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From n-type to perovskite tandem solar cells, we are making possibilities into realities.

Annex: Monthly TOP SOLAR MODULES H1-2025 Rankings from January to June

TAIYANGNEWS ALL ABOUT SOLAR POWER

TaiyangNews Top Modules: Highest Efficient Commercial Solar Modules 01-2025

Rank	Company	Series	Model	Wafer type	Cell Size	Cells No.	Cell Tech	Module Technology	Power (W)	Efficiency (%)
1	AIKO	Comet 2U	AIKO-G655-MCH72Mw	n-type	182	144	ABC	Half-cell, Back Contact	655	24.2
2	Maxeon	Maxeon 7	SPR-MAX7-445-PT	n-type	125	112	IBC	Back Contact, Full-cell	445	24.1
3	LONGi	Hi-MO X6	LR5-72HTH-590-600M	p-type	182	144	HPBC	Half-cell, Back Contact	600	23.2
4	HUASUN	Himalaya	HS-210-B132DS720W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	720	23.18
5	TW SOLAR	-	TWMHF-66HD700-715W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	715	23.0
5	JA SOLAR	DeepBlue 4.0 Pro	JAM72D40 595/MB	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	595	23.0
7	ASTRONERGY	Astro N5	CHSM78N(DG)/F-BH625-640W	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	640	22.9
8	Grand Sunergy	-	GSM-MH3/132-BHDG710	n-type	210	132	HJT	Bifacial, Half-cell, MBB	710	22.86
9	DMEGC	Infinity RT	DM615G12RT-B66HSW	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	615	22.8
9	TW SOLAR	-	TWMND-72HS585-590W	n-type	182	144	TOPCon	Half-cell, MBB	590	22.8
9	SPIC	ANDROMEDA 3.0	SPICN6(LDF)-60/BIH410W	n-type	166	120	TBC	Bifacial, Back Contact, Half-cell, MBB	410	22.8
12	JinkoSolar	Tiger Neo	JKM585N-72HL4-BDV	n-type	-	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
12	SolarSpace	Lumina II	SS8-72HD-585N	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
14	REC Group	AlphA®Pure-RX	REC470AA Pure-RX	n-type	210	88	HJT	Bifacial, half-cell, MBB	470	22.6
15	JOLYWOOD	Niwa Pro	JW-HD108N415-440W	n-type	182	108	TOPCon	Bifacial, Half-cell, MBB	440	22.53
16	risen	Hyper-ion	RSM132-8-700BHDG	n-type	210	132	HJT	Bifacial,Half-cell, MBB	700	22.5
16	Trinasolar	Vertex N	TSM-NEG21C.20	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	700	22.5
16	DAS SOLAR	-	DAS-DH156NA-620-630W	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	630	22.5
16	Canadian Solar	TOPHiKu6	CS6W-570-580T	n-type	182	144	TOPCon	Half-cell, MBB	580	22.5
16	Eging PV	STAR Pro	EG-580NT72-HL/BF-DG	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
16	RUNERGY	-	HY-DH144N8	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
22	Qn-SOLAR	-	QNN182-HG-72	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
22	URECO	GLORY	FBF580B8D	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
24	URECO	HELLO	FCG635B7Y	n-type	210	120	HJT	Bifacial, Half-cell, MBB	635	22.44
25	Suntech	Ultra V Pro	STP605S-H66-Nsh+	n-type	182	132	TOPCon	Bifacial, Half-cell, MBB	605	22.4
26	Kalyon PV	-	-	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.38
27	Yingli	PANDA 3.0 PRO 1	YL625CF78 e/2	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	625	22.36
28	GCL-Si	GCL LOTUS	GCL-NT10/72GDF	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	575	22.3
28	Qcells	Q.TRON	Q.TRON M-G2+	n-type	-	108	TOPCon	Half-cell, MBB	435	22.3
30	CECEP	-	CEC6-72-570TDHV	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	570	22.10
31	Jinergy	-	JNHM144-475	n-type	166	144	HJT	Bifacial, Half-cell, MBB	475	21.85
32	Meyer Burger	Meyer Burger Glass	MB_TG120ByB_390W	n-type	-	120	HJT	Bifacial, Half-cell, SWCT	390	21.8
33	Canadian Solar	HiKu7	CS7N-645-675MS	p-type	210	132	PERC	Half-cell, MBB	675	21.7
33	DAS SOLAR	-	DAS-DH144PA-540-560W	p-type	182	144	PERC	Bifacial, Half-cell, MBB	560	21.7
33	LONGi	Hi-MO 5m	LR5-72HPH 545 - 560M	p-type	182	144	PERC	Half-cell, MBB	560	21.7
33	Suntech	Ultra V	STP560S-C72/Vmh	p-type	182	144	PERC	Half-cell, MBB	560	21.7
37	GCL-Si	GCL GEMINI	GCL-M12/66GDF	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.6
37	Trinasolar	Vertex	TSM-DE21	p-type	210	132	PERC	Half-cell, MBB	670	21.6
37	JA SOLAR	DeepBlue 3.0	JAM78D30 580-605/MB	p-type	182	156	PERC	Bifacial, Half-cell, MBB	605	21.6
40	Jinergy	PERC Series	JNBM132-650-670	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	Qn-SOLAR	-	QNM210-HG-66	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	Seraphim	Seco Series	SRP-670-BMC-BG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	SolarSpace	Lumina I	SS9-66HD 645-670M	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	URECO	PEACH	FCK670MED	p-type	210	132	PERC	Half-cell, MBB	670	21.57
40	Yingli	YLM 3.0 Plus 1	YL670DF66 f/2	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	ZNSHINE	-	ZXM8-TPLDD	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
47	Eging PV	Aurora	EG-670M66-HU/BF-DG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.56
48	RUNERGY	-	HY-DH156P8	p-type	182	156	PERC	Bifacial, Half-cell, MBB	600	21.5
48	Qcells	Q PEAK	DUO XL-G11	p-type	-	156	PERC	Half-cell, MBB	590	21.5
48	CECEP	-	CEC6-72-555MDHV	p-type	182	144	PERC	Bifacial, Half-cell, MBB	555	21.5

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Top Solar Modules 2024 Badge of Excellence



TaiyangNews Top Modules: Highest Efficient Commercial Solar Modules 02-2025

Rank	Company	Series	Model	Wafer type	Cell Size	Cells No.	Cell Tech	Module Technology	Power (W)	Efficiency (%)
1	AIKO	Comet 2U	AIKO-G655-MCH72Mw	n-type	182	144	ABC	Half-cell, Back Contact	655	24.2
2	Maxeon	Maxeon 7	SPR-MAX7-445-PT	n-type	125	112	IBC	Back Contact, Full-cell	445	24.1
3	LONGi	Hi-MO X6	LR5-72HTH-590-600M	p-type	182	144	HPBC	Half-cell, Back Contact	600	23.2
4	HUASUN	Himalaya	HS-210-B132DS720W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	720	23.18
5	TW SOLAR	-	TWMHF-66HD700-715W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	715	23.0
5	JA SOLAR	DeepBlue 4.0 Pro	JAM72D40 595/MB	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	595	23.0
7	ASTRONERGY	Astro N5	CHSM78N(DG)/F-BH625-640W	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	640	22.9
8	Grand Sunergy	-	GSM-MH3/132-BHDG710	n-type	210	132	HJT	Bifacial, Half-cell, MBB	710	22.86
9	DMEGC SOLAR	Infinity RT	DM615G12RT-B66HSW	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	615	22.8
9	TW SOLAR	-	TWMND-72HS585-590W	n-type	182	144	TOPCon	Half-cell, MBB	590	22.8
9	SPIC	ANDROMEDA 3.0	SPICN6(LDF)-60/BIH410W	n-type	166	120	TBC	Bifacial, Back Contact, Half-cell, MBB	410	22.8
12	JinKO Solar	Tiger Neo	JKM585N-72HL4-BDV	n-type	-	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
12	SolarSpace	Lumina II	SS8-72HD-585N	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
14	REC Group	AlphA®Pure-RX	REC470AA Pure-RX	n-type	210	88	HJT	Bifacial, half-cell, MBB	470	22.6
15	中来股份 JOLYWOOD	Niwa Pro	JW-HD108N415-440W	n-type	182	108	TOPCon	Bifacial, Half-cell, MBB	440	22.53
16	risen	Hyper-ion	RSM132-8-700BHDG	n-type	210	132	HJT	Bifacial,Half-cell, MBB	700	22.5
16	Trinasolar	Vertex N	TSM-NEG21C.20	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	700	22.5
16	DASOLAR	-	DAS-DH156NA-620-630W	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	630	22.5
16	Canadian Solar	TOPHiKu6	CS6W-570-580T	n-type	182	144	TOPCon	Half-cell, MBB	580	22.5
16	Eging PV	STAR Pro	EG-580NT72-HL/BF-DG	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
16	RUNERGY	-	HY-DH144N8	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
22	Qn-SOLAR	-	QNN182-HG-72	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
22	URECO	GLORY	FBF580B8D	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
24	URECO	HELLO	FCG635B7Y	n-type	210	120	HJT	Bifacial, Half-cell, MBB	635	22.44
25	Suntech	Ultra V Pro	STP605S-H66-Nsh+	n-type	182	132	TOPCon	Bifacial, Half-cell, MBB	605	22.4
26	Kalyon PV	-	-	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.38
27	Yingli	PANDA 3.0 PRO 1	YL625CF78 e/2	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	625	22.36
28	GCL-Si	GCL LOTUS	GCL-NT10/72GDF	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	575	22.3
28	Qcells	Q.TRON	Q.TRON M-G2+	n-type	-	108	TOPCon	Half-cell, MBB	435	22.3
30	CECEP	-	CEC6-72-570TDHV	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	570	22.10
31	Jinergy	-	JNHM144-475	n-type	166	144	HJT	Bifacial, Half-cell, MBB	475	21.85
32	Meyer Burger	Meyer Burger Glass	MB_TG120ByB_390W	n-type	-	120	HJT	Bifacial, Half-cell, SWCT	390	21.8
33	Canadian Solar	HiKu7	CS7N-645-675MS	p-type	210	132	PERC	Half-cell, MBB	675	21.7
33	DASOLAR	-	DAS-DH144PA-540-560W	p-type	182	144	PERC	Bifacial, Half-cell, MBB	560	21.7
33	LONGi	Hi-MO 5m	LR5-72HPH 545 - 560M	p-type	182	144	PERC	Half-cell, MBB	560	21.7
33	Suntech	Ultra V	STP560S-C72/Vmh	p-type	182	144	PERC	Half-cell, MBB	560	21.7
37	GCL-Si	GCL GEMINI	GCL-M12/66GDF	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.6
37	Trinasolar	Vertex	TSM-DE21	p-type	210	132	PERC	Half-cell, MBB	670	21.6
37	JA SOLAR	DeepBlue 3.0	JAM78D30 580-605/MB	p-type	182	156	PERC	Bifacial, Half-cell, MBB	605	21.6
40	Jinergy	PERC Series	JNBM132-650-670	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	Qn-SOLAR	-	QNM210-HG-66	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	Seraphim	Seco Series	SRP-670-BMC-BG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	SolarSpace	Lumina I	SS9-66HD 645-670M	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	URECO	PEACH	FCK670MED	p-type	210	132	PERC	Half-cell, MBB	670	21.57
40	Yingli	YLM 3.0 Plus 1	YL670DF66 f/2	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	ZNSHINE	-	ZXM8-TPLDD	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
47	Eging PV	Aurora	EG-670M66-HU/BF-DG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.56
48	RUNERGY	-	HY-DH156P8	p-type	182	156	PERC	Bifacial, Half-cell, MBB	600	21.5
48	Qcells	Q PEAK	DUO XL-G11	p-type	-	156	PERC	Half-cell, MBB	590	21.5
48	CECEP	-	CEC6-72-555MDHV	p-type	182	144	PERC	Bifacial, Half-cell, MBB	555	21.5

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Rank	Company	Series	Model	Wafer type	Cell Size	Cells No.	Cell Tech	Module Technology	Power (W)	Efficiency (%)
1	AIKO	Comet 2U	AIKO-G655-MCH72Mw	n-type	182	144	ABC	Half-cell, Back Contact	655	24.2
2	LONGi	Hi-MO 9	LR7-72HYD 625-650M	n-type	182	144	HPBC	Bifacial, Half-cell, Back Contact	650	24.1
2	Maxeon	Maxeon 7	SPR-MAX7-445-PT	n-type	125	112	IBC	Back Contact, Full-cell	445	24.1
4	HUASUN	Himalaya	HS-210-B132DS720W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	720	23.18
5	TW SOLAR	-	TWMHF-66HD700-715W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	715	23.0
5	ASTRONERGY	Astro N7	CHSM66RN(DG)/F-BH	n-type	182	132	TOPCon	Bifacial, Half-cell, MBB	620	23.0
5	DMEGC SOLAR	Infinity RT	DM620G12RT-B66HSW	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	620	23.0
5	JA SOLAR	DeepBlue 4.0 Pro	JAM72D40 595/MB	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	595	23.0
9	Grand Sunergy	-	GSM-MH3/132-BHDG710	n-type	210	132	HJT	Bifacial, Half-cell, MBB	710	22.86
10	TW SOLAR	-	TWMND-72HS585-590W	n-type	182	144	TOPCon	Half-cell, MBB	590	22.8
10	SPIC	ANDROMEDA 3.0	SPICN6(LDF)-60/BIH410W	n-type	166	120	TBC	Bifacial, Back Contact, Half-cell, MBB	410	22.8
12	JinkoSolar	Tiger Neo	JKM585N-72HL4-BDV	n-type	-	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
12	SolarSpace	Lumina II	SS8-72HD-585N	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
14	REC Group	AlphA®Pure-RX	REC470AA Pure-RX	n-type	210	88	HJT	Bifacial, half-cell, MBB	470	22.6
15	JOLYWOOD	Niwa Pro	JW-HD108N415-440W	n-type	182	108	TOPCon	Bifacial, Half-cell, MBB	440	22.53
16	risen	Hyper-ion	RSM132-8-700BHDG	n-type	210	132	HJT	Bifacial,Half-cell, MBB	700	22.5
16	Trinasolar	Vertex N	TSM-NEG21C.20	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	700	22.5
16	DASOLAR	-	DAS-DH156NA-620-630W	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	630	22.5
16	Canadian Solar	TOPHiKu6	CS6W-570-580T	n-type	182	144	TOPCon	Half-cell, MBB	580	22.5
16	Eging PV	STAR Pro	EG-580NT72-HL/BF-DG	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
16	RUNERGY	-	HY-DH144N8	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
22	Qn-SOLAR	-	QNN182-HG-72	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
22	URECO	GLORY	FBF580B8D	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
24	URECO	HELLO	FCG635B7Y	n-type	210	120	HJT	Bifacial, Half-cell, MBB	635	22.44
25	Suntech	Ultra V Pro	STP605S-H66-Nsh+	n-type	182	132	TOPCon	Bifacial, Half-cell, MBB	605	22.4
26	Kalyon PV	-	-	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.38
27	Yingli	PANDA 3.0 PRO 1	YL625CF78 e/2	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	625	22.36
28	GCL-Si	GCL LOTUS	GCL-NT10/72GDF	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	575	22.3
28	Qcells	Q.TRON	Q.TRON M-G2+	n-type	-	108	TOPCon	Half-cell, MBB	435	22.3
30	CECEP	-	CEC6-72-570TDHV	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	570	22.10
31	Jinergy	-	JNHM144-475	n-type	166	144	HJT	Bifacial, Half-cell, MBB	475	21.85
32	Meyer Burger	Meyer Burger Glass	MB_TG120ByB_390W	n-type	-	120	HJT	Bifacial, Half-cell, SWCT	390	21.8
33	Canadian Solar	HiKu7	CS7N-645-675MS	p-type	210	132	PERC	Half-cell, MBB	675	21.7
33	DASOLAR	-	DAS-DH144PA-540-560W	p-type	182	144	PERC	Bifacial, Half-cell, MBB	560	21.7
33	LONGi	Hi-MO 5m	LR5-72HPH 545 - 560M	p-type	182	144	PERC	Half-cell, MBB	560	21.7
33	Suntech	Ultra V	STP560S-C72/Vmh	p-type	182	144	PERC	Half-cell, MBB	560	21.7
37	GCL-Si	GCL GEMINI	GCL-M12/66GDF	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.6
37	Trinasolar	Vertex	TSM-DE21	p-type	210	132	PERC	Half-cell, MBB	670	21.6
37	JA SOLAR	DeepBlue 3.0	JAM78D30 580-605/MB	p-type	182	156	PERC	Bifacial, Half-cell, MBB	605	21.6
40	Jinergy	PERC Series	JNBM132-650-670	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	Qn-SOLAR	-	QNM210-HG-66	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	Seraphim	Seco Series	SRP-670-BMC-BG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	SolarSpace	Lumina I	SS9-66HD 645-670M	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	URECO	PEACH	FCK670MED	p-type	210	132	PERC	Half-cell, MBB	670	21.57
40	Yingli	YLM 3.0 Plus 1	YL670DF66 f/2	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	ZNSHINE	-	ZXM8-TPLDD	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
47	Eging PV	Aurora	EG-670M66-HU/BF-DG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.56
48	RUNERGY	-	HY-DH156P8	p-type	182	156	PERC	Bifacial, Half-cell, MBB	600	21.5
48	Qcells	Q PEAK	DUO XL-G11	p-type	-	156	PERC	Half-cell, MBB	590	21.5
48	CECEP	-	CEC6-72-555MDHV	p-type	182	144	PERC	Bifacial, Half-cell, MBB	555	21.5

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Rank	Company	Series	Model	Wafer type	Cell Size	Cells No.	Cell Tech	Module Technology	Power (W)	Efficiency (%)
1	AIKO	Comet 2U	AIKO-G655-MCH72Mw	n-type	182	144	ABC	Half-cell, Back Contact	655	24.2
2	LONGi	Hi-MO 9	LR7-72HYD 625-650M	n-type	182	144	HPBC	Bifacial, Half-cell, Back Contact	650	24.1
2	Maxeon	Maxeon 7	SPR-MAX7-445-PT	n-type	125	112	IBC	Back Contact, Full-cell	445	24.1
4	HUASUN	Himalaya	HS-210-B132DS720W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	720	23.18
5	TW SOLAR	-	TWMHF-66HD700-715W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	715	23.0
5	ASTRONERGY	Astro N7	CHSM66RN(DG)/F-BH	n-type	182	132	TOPCon	Bifacial, Half-cell, MBB	620	23.0
5	DMEGC SOLAR	Infinity RT	DM620G12RT-B66HSW	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	620	23.0
5	JA SOLAR	DeepBlue 4.0 Pro	JAM72D40 595/MB	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	595	23.0
9	Grand Sunergy	-	GSM-MH3/132-BHDG710	n-type	210	132	HJT	Bifacial, Half-cell, MBB	710	22.86
10	TW SOLAR	-	TWMND-72HS585-590W	n-type	182	144	TOPCon	Half-cell, MBB	590	22.8
10	SPIC	ANDROMEDA 3.0	SPICN6(LDF)-60/BIH410W	n-type	166	120	TBC	Bifacial, Back Contact, Half-cell, MBB	410	22.8
12	JinkoSolar	Tiger Neo	JKM585N-72HL4-BDV	n-type	-	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
12	SolarSpace	Lumina II	SS8-72HD-585N	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
14	REC Group	AlphA®Pure-RX	REC470AA Pure-RX	n-type	210	88	HJT	Bifacial, half-cell, MBB	470	22.6
15	JOLYWOOD	Niwa Pro	JW-HD108N415-440W	n-type	182	108	TOPCon	Bifacial, Half-cell, MBB	440	22.53
16	risen	Hyper-ion	RSM132-8-700BHDG	n-type	210	132	HJT	Bifacial,Half-cell, MBB	700	22.5
16	Trinasolar	Vertex N	TSM-NEG21C.20	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	700	22.5
16	DASOLAR	-	DAS-DH156NA-620-630W	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	630	22.5
16	Canadian Solar	TOPHiKu6	CS6W-570-580T	n-type	182	144	TOPCon	Half-cell, MBB	580	22.5
16	Eging PV	STAR Pro	EG-580NT72-HL/BF-DG	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
16	RUNERGY	-	HY-DH144N8	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
22	Qn-SOLAR	-	QNN182-HG-72	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
22	URECO	GLORY	FBF580B8D	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
24	URECO	HELLO	FCG635B7Y	n-type	210	120	HJT	Bifacial, Half-cell, MBB	635	22.44
25	Suntech	Ultra V Pro	STP605S-H66-Nsh+	n-type	182	132	TOPCon	Bifacial, Half-cell, MBB	605	22.4
26	Kalyon PV	-	-	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.38
27	Yingli	PANDA 3.0 PRO 1	YL625CF78 e/2	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	625	22.36
28	GCL-Si	GCL LOTUS	GCL-NT10/72GDF	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	575	22.3
28	Qcells	Q.TRON	Q.TRON M-G2+	n-type	-	108	TOPCon	Half-cell, MBB	435	22.3
30	CECEP	-	CEC6-72-570TDHV	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	570	22.10
31	Jinergy	-	JNHM144-475	n-type	166	144	HJT	Bifacial, Half-cell, MBB	475	21.85
32	Meyer Burger	Meyer Burger Glass	MB_TG120ByB_390W	n-type	-	120	HJT	Bifacial, Half-cell, SWCT	390	21.8
33	Canadian Solar	HiKu7	CS7N-645-675MS	p-type	210	132	PERC	Half-cell, MBB	675	21.7
33	DASOLAR	-	DAS-DH144PA-540-560W	p-type	182	144	PERC	Bifacial, Half-cell, MBB	560	21.7
33	LONGi	Hi-MO 5m	LR5-72HPH 545 - 560M	p-type	182	144	PERC	Half-cell, MBB	560	21.7
33	Suntech	Ultra V	STP560S-C72/Vmh	p-type	182	144	PERC	Half-cell, MBB	560	21.7
37	GCL-Si	GCL GEMINI	GCL-M12/66GDF	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.6
37	Trinasolar	Vertex	TSM-DE21	p-type	210	132	PERC	Half-cell, MBB	670	21.6
37	JA SOLAR	DeepBlue 3.0	JAM78D30 580-605/MB	p-type	182	156	PERC	Bifacial, Half-cell, MBB	605	21.6
40	Jinergy	PERC Series	JNBM132-650-670	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	Qn-SOLAR	-	QNM210-HG-66	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	Seraphim	Seco Series	SRP-670-BMC-BG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	SolarSpace	Lumina I	SS9-66HD 645-670M	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	URECO	PEACH	FCK670MED	p-type	210	132	PERC	Half-cell, MBB	670	21.57
40	Yingli	YLM 3.0 Plus 1	YL670DF66 f/2	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	ZNSHINE	-	ZXM8-TPLDD	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
47	Eging PV	Aurora	EG-670M66-HU/BF-DG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.56
48	RUNERGY	-	HY-DH156P8	p-type	182	156	PERC	Bifacial, Half-cell, MBB	600	21.5
48	Qcells	Q PEAK	DUO XL-G11	p-type	-	156	PERC	Half-cell, MBB	590	21.5
48	CECEP	-	CEC6-72-555MDHV	p-type	182	144	PERC	Bifacial, Half-cell, MBB	555	21.5

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2	Maxeon	Maxeon 7	SPR-MAX7-445-PT	n-type	125	112	IBC	Back Contact, Full-cell	445	24.1
4	HUASUN	Himalaya	HS-210-B132DS720W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	720	23.18
5	TW SOLAR	-	TWMHF-66HD700-715W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	715	23.0
5	Trinasolar	Vertex N	TSM-NEG21C.20	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	715	23.0
5	ASTRONERGY	Astro N7	CHSM66RN(DG)/F-BH	n-type	182	132	TOPCon	Bifacial, Half-cell, MBB	620	23.0
5	DMEGC SOLAR	Infinity RT	DM620G12RT-B66HSW	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	620	23.0
5	JA SOLAR	DeepBlue 4.0 Pro	JAM72D40 595/MB	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	595	23.0
10	Grand Sunergy	-	GSM-MH3/132-BHDG710	n-type	210	132	HJT	Bifacial, Half-cell, MBB	710	22.86
11	TW SOLAR	-	TWMND-72HS585-590W	n-type	182	144	TOPCon	Half-cell, MBB	590	22.8
11	SPIC	ANDROMEDA 3.0	SPICN6(LDF)-60/BIH410W	n-type	166	120	TBC	Bifacial, Back Contact, Half-cell, MBB	410	22.8
13	JinKO Solar	Tiger Neo	JKM585N-72HL4-BDV	n-type	-	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
13	SolarSpace	Lumina II	SS8-72HD-585N	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
15	REC Group	AlphA®Pure-RX	REC470AA Pure-RX	n-type	210	88	HJT	Bifacial, half-cell, MBB	470	22.6
16	中来股份 JOLYWOOD	Niwa Pro	JW-HD108N415-440W	n-type	182	108	TOPCon	Bifacial, Half-cell, MBB	440	22.53
17	risen	Hyper-ion	RSM132-8-700BHDG	n-type	210	132	HJT	Bifacial,Half-cell, MBB	700	22.5
17	DASOLAR	-	DAS-DH156NA-620-630W	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	630	22.5
17	Canadian Solar	TOPHiKu6	CS6W-570-580T	n-type	182	144	TOPCon	Half-cell, MBB	580	22.5
17	Eging PV	STAR Pro	EG-580NT72-HL/BF-DG	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
17	RUNERGY	-	HY-DH144N8	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
22	Qn-SOLAR	-	QNN182-HG-72	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
22	URECO	GLORY	FBF580B8D	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
24	URECO	HELLO	FCG635B7Y	n-type	210	120	HJT	Bifacial, Half-cell, MBB	635	22.44
25	Suntech	Ultra V Pro	STP605S-H66-Nsh+	n-type	182	132	TOPCon	Bifacial, Half-cell, MBB	605	22.4
26	Kalyon PV	-	-	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.38
27	Yingli	PANDA 3.0 PRO 1	YL625CF78 e/2	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	625	22.36
28	GCL-Si	GCL LOTUS	GCL-NT10/72GDF	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	575	22.3
28	Qcells	Q.TRON	Q.TRON M-G2+	n-type	-	108	TOPCon	Half-cell, MBB	435	22.3
30	CECEP	-	CEC6-72-570TDHV	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	570	22.10
31	Jinergy	-	JNHM144-475	n-type	166	144	HJT	Bifacial, Half-cell, MBB	475	21.85
32	Meyer Burger	Meyer Burger Glass	MB_TG120ByB_390W	n-type	-	120	HJT	Bifacial, Half-cell, SWCT	390	21.8
33	Canadian Solar	HiKu7	CS7N-645-675MS	p-type	210	132	PERC	Half-cell, MBB	675	21.7
33	DASOLAR	-	DAS-DH144PA-540-560W	p-type	182	144	PERC	Bifacial, Half-cell, MBB	560	21.7
33	LONGi	Hi-MO 5m	LR5-72HPH 545 - 560M	p-type	182	144	PERC	Half-cell, MBB	560	21.7
33	Suntech	Ultra V	STP560S-C72/Vmh	p-type	182	144	PERC	Half-cell, MBB	560	21.7
37	GCL-Si	GCL GEMINI	GCL-M12/66GDF	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.6
37	Trinasolar	Vertex	TSM-DE21	p-type	210	132	PERC	Half-cell, MBB	670	21.6
37	JA SOLAR	DeepBlue 3.0	JAM78D30 580-605/MB	p-type	182	156	PERC	Bifacial, Half-cell, MBB	605	21.6
40	Jinergy	PERC Series	JNBM132-650-670	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	Qn-SOLAR	-	QNM210-HG-66	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	Seraphim	Seco Series	SRP-670-BMC-BG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	SolarSpace	Lumina I	SS9-66HD 645-670M	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	URECO	PEACH	FCK670MED	p-type	210	132	PERC	Half-cell, MBB	670	21.57
40	Yingli	YLM 3.0 Plus 1	YL670DF66 f/2	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
40	ZNSHINE	-	ZXM8-TPLDD	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
47	Eging PV	Aurora	EG-670M66-HU/BF-DG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.56
48	Qcells	Q PEAK	DUO XL-G11S.3/BFG	p-type	-	156	PERC	Bifacial, Half-cell, MBB	600	21.5
48	RUNERGY	-	HY-DH156P8	p-type	182	156	PERC	Bifacial, Half-cell, MBB	600	21.5
48	CECEP	-	CEC6-72-555MDHV	p-type	182	144	PERC	Bifacial, Half-cell, MBB	555	21.5

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Top Solar Modules 2024 Badge of Excellence



TaiyangNews Top Modules: Highest Efficient Commercial Solar Modules 06-2025

Rank	Company	Series	Model	Wafer type	Cell Size	Cells No.	Cell Tech	Module Technology	Power (W)	Efficiency (%)
1	AIKO	Comet 2U	AIKO-G660-MCH72Mw	n-type	182	144	ABC	Half-cell, Back Contact	660	24.4
2	LONGi	Hi-MO 9	LR8-66HYD 635-655M	n-type	182	132	HPBC	Bifacial, Half-cell, Back Contact	655	24.2
3	Maxeon	Maxeon 7	SPR-MAX7-445-PT	n-type	125	112	IBC	Back Contact, Full-cell	445	24.1
4	HUASUN	Himalaya	HS-210-B132DS730W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	730	23.5
5	JA SOLAR	DeepBlue 4.0 Pro	JAM72D40600/MB	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	600	23.2
6	Trinasolar	Vertex N	TSM-NEG21C.20	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	715	23.0
6	TW SOLAR	-	TWMHF-66HD700-715W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	715	23.0
6	ASTRONERGY	Astro N7	CHSM66RN(DG)/F-BH	n-type	182	132	TOPCon	Bifacial, Half-cell, MBB	620	23.0
6	DMEGC SOLAR	Infinity RT	DM620G12RT-B66HSW	n-type	210	132	TOPCon	Bifacial, Half-cell, MBB	620	23.0
10	Jetion Solar	Jeniüs	JT SLk(B) 690-710W	n-type	210	132	HJT	Bifacial, Half-cell, MBB	710	22.9
11	Grand Sunergy	-	GSM-MH3/132-BHDG710	n-type	210	132	HJT	Bifacial, Half-cell, MBB	710	22.86
12	TW SOLAR	-	TWMND-72HS585-590W	n-type	182	144	TOPCon	Half-cell, MBB	590	22.8
12	SPIC	ANDROMEDA 3.0	SPICN6(LDF)-60/BIH410W	n-type	166	120	TBC	Bifacial, Back Contact, Half-cell, MBB	410	22.8
14	JinkoSolar	Tiger Neo	JKM585N-72HL4-BDV	n-type	-	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
14	SolarSpace	Lumina II	SS8-72HD-585N	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	585	22.65
16	REC Group	AlphA®Pure-RX	REC470AA Pure-RX	n-type	210	88	HJT	Bifacial, half-cell, MBB	470	22.6
17	GCL	-	GCL-NT12/66GDF	n-type	210	132	TOPCon	Bifacial, half-cell, MBB	700	22.53
17	中来股份 JOLYWOOD	Niwa Pro	JW-HD108N415-440W	n-type	182	108	TOPCon	Bifacial, Half-cell, MBB	440	22.53
19	risen	Hyper-ion	RSM132-8-700BHDG	n-type	210	132	HJT	Bifacial,Half-cell, MBB	700	22.5
19	DASOLAR	-	DAS-DH156NA-620-630W	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	630	22.5
19	Canadian Solar	TOPHiKu6	CS6W-570-580T	n-type	182	144	TOPCon	Half-cell, MBB	580	22.5
19	Eging PV	STAR Pro	EG-580NT72-HL/BF-DG	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
19	RUNERGY	-	HY-DH144N8	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.5
24	Qn-SOLAR	-	QNN182-HG-72	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
24	URECO	GLORY	FBF580B8D	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.45
26	URECO	HELLO	FCG635B7Y	n-type	210	120	HJT	Bifacial, Half-cell, MBB	635	22.44
27	Suntech	Ultra V Pro	STP605S-H66-Nsh+	n-type	182	132	TOPCon	Bifacial, Half-cell, MBB	605	22.4
28	Kalyon PV	-	-	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	580	22.38
29	Yingli	PANDA 3.0 PRO 1	YL625CF78 e/2	n-type	182	156	TOPCon	Bifacial, Half-cell, MBB	625	22.36
30	Qcells	Q.TRON	Q.TRON M-G2+	n-type	-	108	TOPCon	Half-cell, MBB	435	22.3
31	CECEP	-	CEC6-72-570TDHV	n-type	182	144	TOPCon	Bifacial, Half-cell, MBB	570	22.10
32	Jinergy	-	JNHM144-475	n-type	166	144	HJT	Bifacial, Half-cell, MBB	475	21.85
33	Meyer Burger	Meyer Burger Glass	MB_TG120ByB_390W	n-type	-	120	HJT	Bifacial, Half-cell, SWCT	390	21.8
34	Canadian Solar	HiKu7	CS7N-645-675MS	p-type	210	132	PERC	Half-cell, MBB	675	21.7
34	DASOLAR	-	DAS-DH144PA-540-560W	p-type	182	144	PERC	Bifacial, Half-cell, MBB	560	21.7
34	LONGi	Hi-MO 5m	LR5-72HPH 545 - 560M	p-type	182	144	PERC	Half-cell, MBB	560	21.7
34	Suntech	Ultra V	STP560S-C72/Vmh	p-type	182	144	PERC	Half-cell, MBB	560	21.7
38	GCL	GCL GEMINI	GCL-M12/66GDF	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.6
38	Trinasolar	Vertex	TSM-DE21	p-type	210	132	PERC	Half-cell, MBB	670	21.6
38	JA SOLAR	DeepBlue 3.0	JAM78D30 580-605/MB	p-type	182	156	PERC	Bifacial, Half-cell, MBB	605	21.6
41	Jinergy	PERC Series	JNBM132-650-670	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
41	Qn-SOLAR	-	QNM210-HG-66	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
41	Seraphim	Seco Series	SRP-670-BMC-BG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
41	SolarSpace	Lumina I	SS9-66HD 645-670M	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
41	URECO	PEACH	FCK670MED	p-type	210	132	PERC	Half-cell, MBB	670	21.57
41	Yingli	YLM 3.0 Plus 1	YL670DF66 f/2	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
41	ZNSHINE	-	ZXM8-TPLDD	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.57
48	Eging PV	Aurora	EG-670M66-HU/BF-DG	p-type	210	132	PERC	Bifacial, Half-cell, MBB	670	21.56
49	Qcells	Q PEAK	DUO XL-G11S.3/BFG	p-type	-	156	PERC	Bifacial, Half-cell, MBB	600	21.5
49	RUNERGY	-	HY-DH156P8	p-type	182	156	PERC	Bifacial, Half-cell, MBB	600	21.5
49	CECEP	-	CEC6-72-555MDHV	p-type	182	144	PERC	Bifacial, Half-cell, MBB	555	21.5

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RayBo film produced by Cybrid under license of Choushu Industry.

Patent No:JP2012211071

Cybrid Technologies' Innovative UV Light Conversion Raybo® Film

Enhancing Efficiency and Extending Lifespan for HJT/TOPCon Modules

High-Efficiency Protection with Superior Conversion Rates

Converts UV light into blue light to protect solar cells, achieving quantum conversion efficiency of over **95%**.

Long-Lasting Durability and Reliability

Encapsulation with the light conversion film ensures less than **1%** power attenuation under **180 kWh** of UV exposure over long-term outdoor use, meeting the **30-year** lifespan requirement.

Exceptional Performance, Boosting Power Output

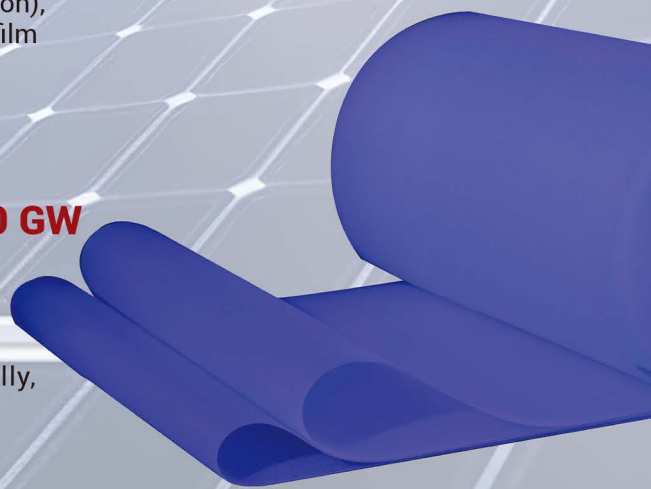
Power output of modules encapsulated with the light conversion film increases by 1% to 1.5% (compared to standard encapsulation), enhancing solar plant investment efficiency by 10%–17%. The film combines excellent adhesion and superior light transmittance.

International Certification and Market Recognition

Certified by TUV and UL, with a cumulative global shipment of **10 GW** to date.

Patented Technology

RayBo® Film has exclusive intellectual property rights globally, authorized by Supershield Industries.



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UV Conversion Film

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