TAIYANGNEWS
ALL ABOUT SOLAR POWER

Special Edition 2023

Huasun Module Products Overview

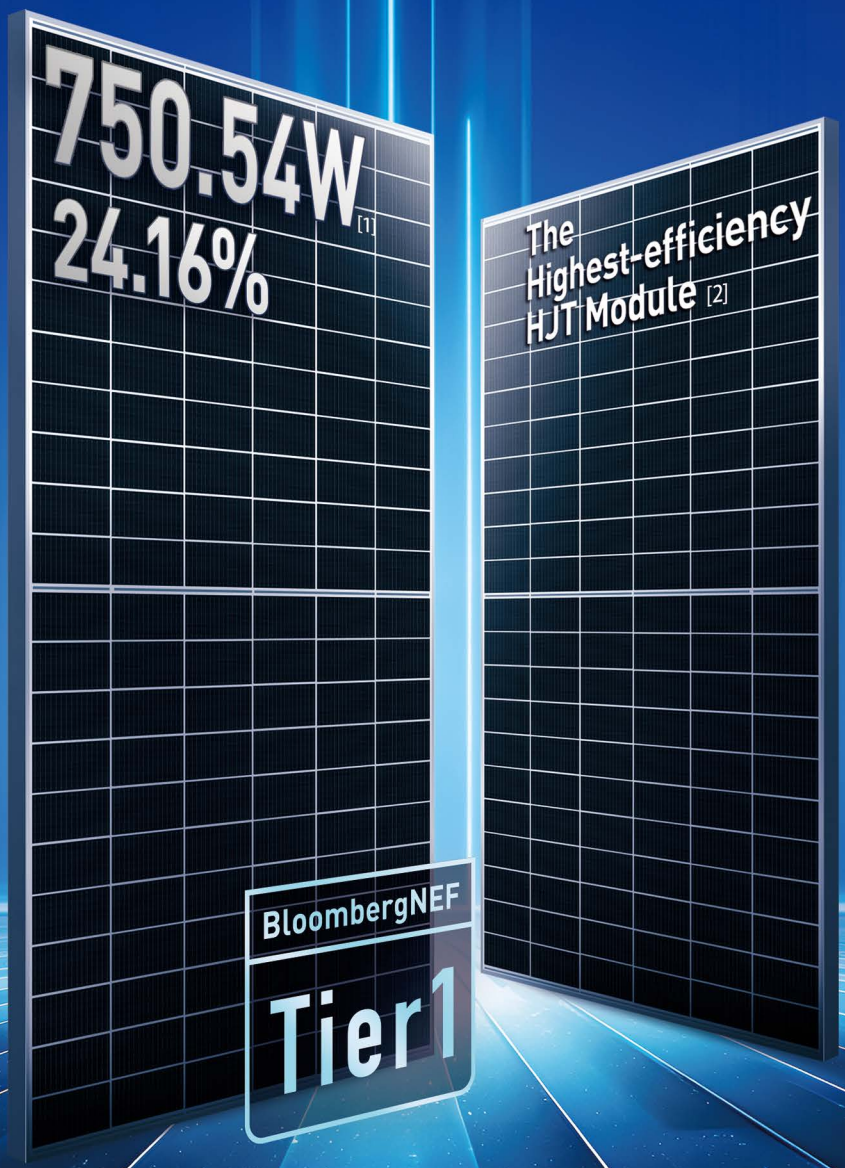
Pioneer of HJT Technology Offering Products For All PV Applications

HUASUN

No.1 in Heterojunction

Capacity
20GW+

Shipment
5GW+



[1] Certified by TÜV SÜD

[2] Source: TaiyangNews Top Modules

www.huasunsolar.com sales@huasunsolar.com Follow us on

Huasun’s HJT At Par With Costs

Huasun is a technology pioneer for HJT. Apart from playing a key role in commercializing several important technical breakthroughs in HJT cell and module technology, the sole focus for this Chinese company is HJT. Having initially built integrated cell and module fabs, Huasun also established in-house wafer production in order to deepen its understanding of the upstream process from an HJT point of view. As of Q1 2024, Huasun has a wafer production capacity of 6 GW, and 20 GW each for cells and modules, making it the largest HJT manufacturer.

Huasun launched several “first-in-industry products,” the most recent being HJT modules based on G12 R rectangular cells and 0BB module technology. The company is currently promoting Everest G12R Series and Himalaya G12 Series modules, both of which can be adapted to 0BB technology. The G12 product with power output of > 700 W is mainly promoted for utility-scale solar applications. The G12R based product are mainly promoted for residential, C&I and utility full scenario apllications.

Huasun continues to focus on innovative approaches that improve performance and/or reduce costs. At the same time, the company is also actively developing next-generation advanced solar technologies and plans to commence testing of perovskite-HJT tandem modules in 2024, aiming for mass production and market introduction by 2025 or 2026.

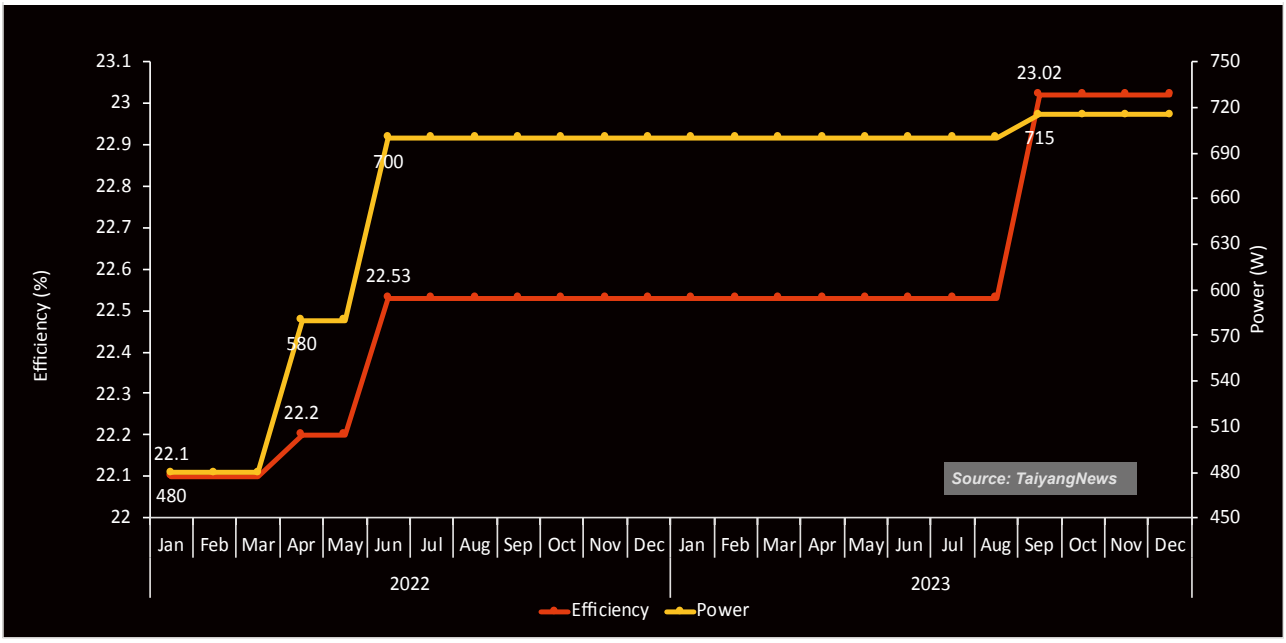
Products for all applications: Huasun, focusing exclusively on HJT technology, offers module products for all mainstream applications.

Efficiency and power progress

A young company established in 2020, Huasun focuses extensively on research and technology development and has quickly become the largest HJT manufacturer in the world. Since the beginning, the company's HJT products have featured in the TaiyangNews TOP SOLAR MODULES listing. The January 2022 edition included the Himalaya series with an efficiency of 22.1% and a power output of 480 W. The first half of the year saw modest gains in efficiency, slightly rising to 22.2% by April, while power output increased significantly to 580 W. Such a big jump in power rating is the result of adopting larger G12 wafer formats, shifting from M6. The next notable leap was observed in June when efficiency and power improved together-efficiency reached 22.53% and power shot up to 700 W, marking a major advancement. While the efficiency increase is the result of several developments, which also improved the rated power, the key contributor to the boost in power rating is increasing the number of half cells to 132 from 110. The company maintained the status quo for its top HJT product till August. Efficiency climbed to a peak of 23.02% by September, while power also saw a further increase to 715 W. These enhancements were maintained through the end of the year.

As module efficiency is the parameter that truly reflects the ability of the solar device to convert sunlight into power per area, TaiyangNews tracks the progress of the best commercially available high-efficiency panels to publish them in our TOP SOLAR MODULES listing on our website. In addition to this monthly update, we are publishing bi-annual reports analyzing the developments of these TOP SOLAR MODULES. As a further extension of that project, TaiyangNews started an excellence badge scheme in Dec. 2023. Manufacturers who are featured in the TOP 10 for at least 6 months within a calendar year are eligible to apply for the Badge of Excellence. Huasun was in the top 10 of TOP SOLAR MODULES List from January to December 2023. For 2023, the Badge of Excellence has been granted to Aiko Solar, **Huasun**, JA Solar, JinkoSolar, LONGi Solar, Risen Energy, Tongwei Solar, and Trina Solar (status: Feb. 2024).

Huasun Efficiency & Power Progress - 2022 / 2023



Different development avenues: Huasun has carried the HJT baton through multiple development phases including adopting larger wafer sizes and optimization of device structure, which are also reflected in its power and efficiency progress.

Offsetting high cost

HJT has been a desirable technology since 2018, but it has been a niche product owing to its costs. With continuous innovation and process improvements in HJT cell technology, efficiency has continued to progress while costs are lowered. However, even though the gap to TOPCon has reduced, it does remain costlier.

Huasun still finds HJT competitive at the systems level. While module costs made up more than 50% or sometimes even 75% of the total system cost in 2008, they've now reduced dramatically to less than 1/3rd, thanks to a significant drop in module prices. At the same time, in today's context, improvements in module performance attributes have a greater impact on reducing LCOE and cost reduction.

Key characteristics

Huasun claims that HJT modules currently available have higher efficiencies of over 23% and higher power ratings vis-à-vis TOPCon counterparts. Along with efficiency and power, temperature coefficient and bifaciality are the major metrics that affect module performance in the field, thus also impacting LCOE. Indeed, HJT has a temperature coefficient of -0.24%/^{o}C and a minimum bifaciality of 85%, both of which are better than TOPCon.

Huasun has achieved a 0.5% annual absolute efficiency gain at the cell level in the last 3 years. By the end of 2023, the company had realized 25.5% efficiency on a 210R size HJT cell. This consistent improvement was the result of adopting innovative technologies like replacing doped amorphous silicon layers with microcrystalline silicon layer in mass production and metallization optimization. The company also added a few innovations at module level such as light conversion film, super multi-busbar (SMBB) interconnection.

The inclusion of a light conversion film based encapsulant in the module converts UV light into

Different sizes: Huasun launched several first-in-industry products based on HJT, with the rectangular wafers being the latest .

Also for utility: Huasun is strongly promoting its HJT module also for utility, underscoring the LCOE advantage over the mainstream TOPCon-based products.

a longer wavelength visible light, enhancing the module's current output. When it comes to light conversion, it is more inevitable than an option, as HJT cells are so UV-sensitive that they would need a UV-cutoff film if not for a light conversion film. Thus, the light conversion film, in addition to enhancing the light absorption that increases efficiency, also protects the cells from UV-induced degradation, safeguarding efficiency.

The adoption of a SMBB cell metallization pattern lets additional sunlight fall over the cell surface and reduces costly silver consumption. The deposition of a microcrystalline silicon layer over the intrinsic layer of amorphous silicon (a-Si) of the HJT cell structure improves the passivation properties and increases cell efficiency.

While these are already implemented in mass production, Huasun also has a long list of technologies to be implemented in the near future. Technology routes like transitioning from an SMBB busbar layout to a busbar-free (0BB), adopting ultra-thin wafers of 90 mm thickness to improve the ingot's utilization, and the inclusion of copper plating metallization, in addition to increasing the performance, also come with the potential to reduce costs. Additionally, the company is also working on indium-free TCO. These potential technology improvement routes are at different levels of R&D at Huasun.

As for reliability, Huasun says its modules perform equal to, if not better than, TOPCon in any reliability metric. The company has showcased substantiative long-term test results at several online events. Huasun also highlights that HJT is not a new technology and that it was already commercially established in 2005 after Japan's Sanyo introduced it commercially in 1997. That means the technology has a 20+ year track record, which gives it a cutting edge over the nascent TOPCon. Another point that adds to reliability is that HJT cells, with no laser scribing, are fundamentally more flexible and have more mechanical load stability than TOPCon cells. In addition, Huasun uses PIB as an edge sealant to restrict moisture ingression from the edges.

It is clear that HJT has progressed and still has room for efficiency, and has better performance attributes. These 2 strong fortes of HJT can already offset its current high costs. The price of HJT modules from main players like Huasun is well within the range that can offset high costs with these two aspects, according to Huasun. All these are paving the path

Huasun's Module Series (As of 2023)

Product Series	Himalaya	Himalaya	Himalaya
Model name	HS-210-B132	HS-182-B144	HS-182-B108
Wafer type	n-type	n-type	n-type
Cell technology	HJT	HJT	HJT
Cell size	210*105 mm	182*91 mm	182*91 mm
No. of cells	132	144	108
Module technology	Bifacial, half-cell, MBB	Bifacial, half-cell, SMBB	Bifacial, half-cell, SMBB
No. of busbars	15 BB	18 BB	18 BB
Maximum power (Pmax)	715 W	585 W	440 W
Module efficiency STC	23.02%	22.65% *Source: TaiyangNews*	22.53%
Bifaciality	85±5%	85±5%	85±5%
Dimensions	2,384 x 1,303 x 35 mm	2,278 x 1,134 x 30 mm	1,722 x 1,134 x 30 mm
Weight	38.7 kg	27.6 kg	24.2 kg/21.2 kg
Warranty	30 years	30 years	30 years
Applications	Utility	Utility and C&I	Residential

for the rapid introduction of HJT in utility-scale applications. In addition, with the implementation of technologies that also have the potential for cost reduction, the costs of HJT technology would be so similar that by 2025 HJT will not just become mainstream, but a leading technology and not just made by Huasun, but by many more, emphasizes the company.

As to the current offerings, Hausun is promoting a wide range of products under Himalaya series. The highest efficiency among the commercial offering as also featured in our TOP MODULES is a 132 half cell module with an efficiency of 23.02%. it has a power rating of 715 W. Huasun launched Everest G12R Series with efficiency up to 23.7% in November 2023.

Looking into future technology developments, Huasun is actively working on perovskites-based tandem structures. Due to the unique structure of TCO, HJT serves as the ideal bottom cell for such tandem structures. The company is planning to come out with module samples in 2024 and expects to bring the technology into mass production around 2025.

Publisher: TaiyangNews UG (haftungsbeschraenkt) An der Golzheimer Heide 23, 40468 Duesseldorf, Germany,
Michael Schmela, michael.schmela@taiyangnews.info,
www.taiyangnews.info

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