TAIYANGNEWS

ALL ABOUT SOLAR POWER

Special Edition 2023

LONGi Module Products Overview

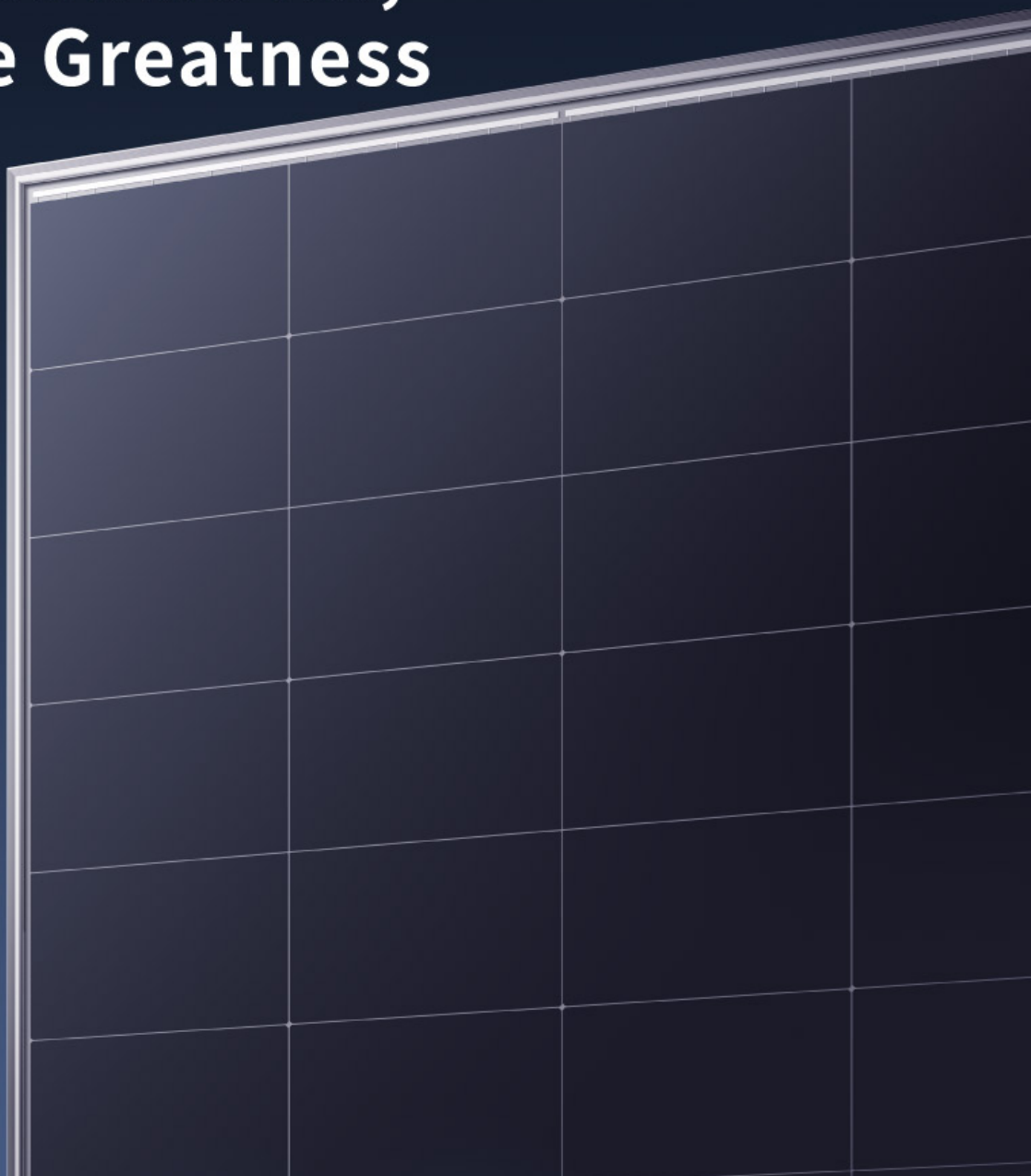
LONGi's HPBC

LONGi

Hi-MO X6 Max

Break Boundaries, Embrace Greatness

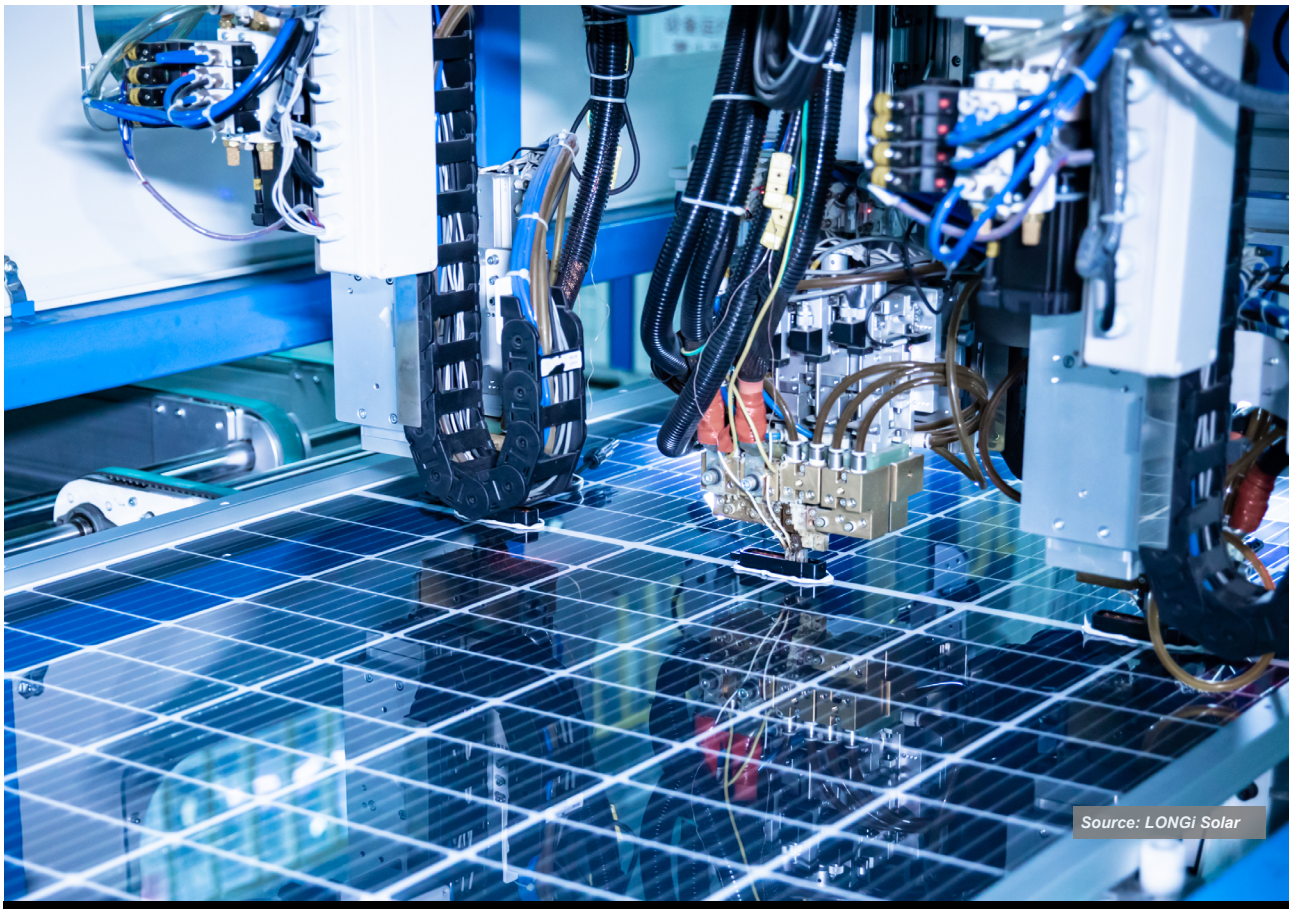
TaiRay Inside · M11 · HPBC



Blending Aesthetics with High Performance

LONGi, one of the world's largest integrated PV manufacturers and a leader in back contact technology, is committed to building a diverse portfolio that includes silicon wafers, solar modules, photovoltaic solutions, and hydrogen energy equipment. By the end of 2023, LONGi had achieved substantial production capacities: 170 GW for silicon wafers, 80GW for cells, and 120 GW for modules. Beyond mainstream PV, LONGi has actively expanded into the Building Integrated Photovoltaics (BIPV) sector, offering products that range from BIPV modules to integrated photovoltaic storage solutions for parking. Additionally, LONGi's subsidiary, LONGi Hydrogen, has become one of the world's leading suppliers of green hydrogen equipment.

As a pioneer in the technological revolution of monocrystalline silicon wafers, LONGi continues to achieve breakthroughs in wafer technology. In March 2024, it launched the TaiRay series of silicon wafers, known for their high resistance uniformity and effective impurity capture. LONGi is a consistent innovator in advanced solar module technology. Its Hi-MO X6 module series, based on its proprietary HPBC technology, is the world's first mass-produced back contact module using p-type cells. LONGi has also been working on HJT technology and created history by breaking a 5-year-old efficiency world record for crystalline silicon with 26.81% efficiency and recently attained 27.3% for HBC cell under lab conditions. The company has also attained 33.9% efficiency for its crystalline-perovskite tandem cells, which is also claimed to be record level performance.



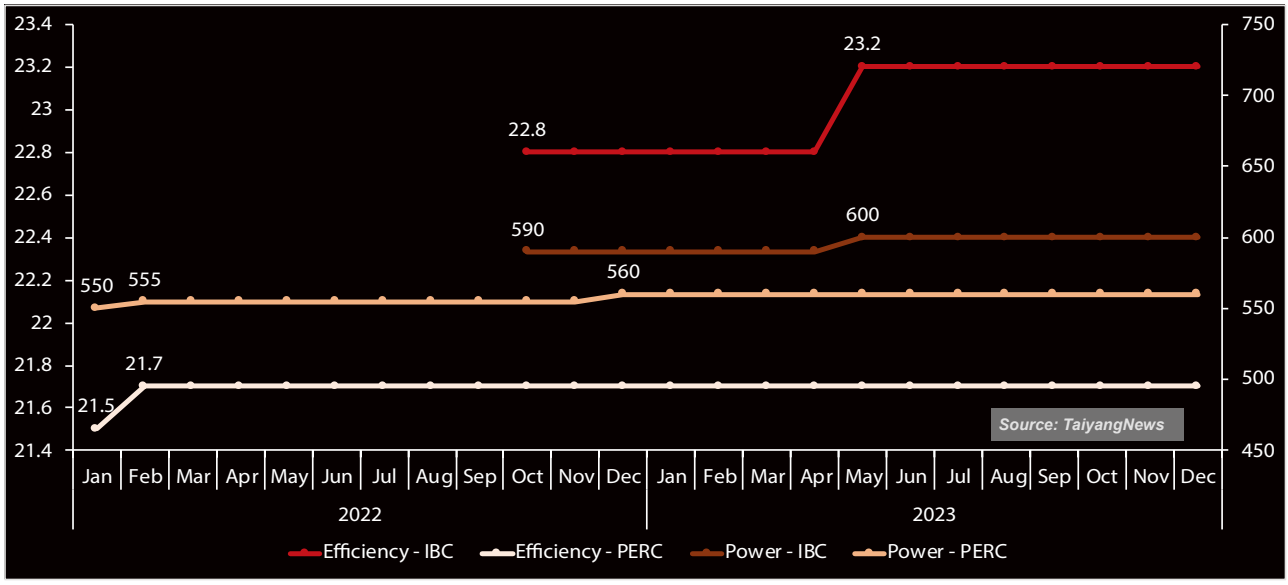
Innovations also at the module level: In addition to several advancements at the cell level, LONGi's HPBC structure also supports line interconnections at the module level rather than Z-shaped connections, reducing stress along the cell rim.

Efficiency and power progress

LONGi is among the first Chinese companies to commercialize the back contact cell architecture. The company's HPBC module series, debuted in our 'TOP SOLAR MODULES' listing for the first time in October 2022, with an efficiency of 22.8% and a power rating of 590 W. With such a high efficiency at that time, the product directly took the top spot in our efficiency ranking and remained at the top until the March 2023 edition. LONGi's HPBC module series was ranked 2nd in the listing from April till the end of 2023. The product is based on the M10 wafer format and built with 144 half-cells. The module also underwent a few changes during this period; in May 2023, its efficiency increased to 23.2% and power increased to 600 W, both of which remained the same till year-end. The company's PERC products underwent changes once each for efficiency and power. Initially listed in January 2022 with an efficiency of 21.5% and power of 550 W, the Hi-MO 5 series products were built with 144 half-cell pieces of the M10 format. However, the very next month, in February 2022, Hi-MO 5m became the company's top PERC product at 21.7% efficiency and a power of 555 W, with no changes in the module configuration. Although the efficiency remained the same till the end of 2023, the power of the product series was slightly increased to 560 W in December 2022 without any apparent changes.

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. JA Solar, with its TOPCon product DeepBlue 4.0, was one of the top 10 companies in the 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, Trina Solar (status: Feb. 2024)

LONGi Solar Efficiency & Power Progress - 2022 / 2023



Hitting the top spots: LONGi's HPBC module series has been at one of the top 2 ranks since its debut in October 2022.

Achieving Ultimate Efficiency Across All Cell Technologies

Not only is LONGi the world's largest integrated manufacturer, but has also spearheaded several industry technology trends. The company has led the industry's transition from multicrystalline to monocrystalline and then to PERC technology. Additionally, LONGi was an early adopter of bifacial and half-cell technologies. It was the first to introduce the M6 wafer format and has significantly contributed to establishing the M10 standard wafer size in the industry. LONGi has set multiple performance records across a variety of wafer and cell types. About a year ago, the company launched its back contact (BC) structure under the Hi-MO 6 brand name, which was later upgraded to Hi-MO X6. Despite introducing the Hi-MO 7 TOPCon product range in 2023, the BC structure remains a top promotional item for the company.

LONGi has provided answers to several questions related to BC technology. Regarding why BC technology is used, it has shown the highest theoretical limit and performance among forerunner technologies, with a limit exceeding 29%. LONGi's analysis of the historical progress of crystalline silicon solar cells suggests that BC is the ultimate option for achieving the highest efficiency levels with any cell technologies, be they high-temperature-based or low-temperature (HJT route), such as HPBC, TBC, and HBC.

Benefits of BC

Further analysis reveals why BC dominates cell efficiency rankings: the absence of metal contacts, which eliminates metal shading losses. This design also allows the relocation of heavily doped layers, such as emitters, from the front to the back, significantly reducing parasitic absorption. Additionally, the design contributes to a pattern-free, superior aesthetic with a stunning black appearance. The absence of front metal contacts also enhances optimal passivation, achieving 100% coverage and significantly improving the Voc and FF. The

Source: LONGi Solar

Updated: LONGi updated its back contact structure from Hi-MO 6 to Hi-MO X6 by adopting a mix of passivation strategies.

Stunning aesthetics: Due to the stunning all-black superior appearance, the HPBC module series is preferred for rooftops, while the other performance parameters such as a low-temperature coefficient and better low-light response make it suitable for utility applications.

BC structure is versatile, supporting both p-type and n-type materials, allowing for a broad range of integrated structures to meet diverse market demands.

On the rear side, a polished surface provides the optimal platform for passivation, enhancing carrier collection and reducing contact resistivity. This leads to higher Voc and FF, particularly beneficial in transport design. Another compelling feature of the BC structure is the ability to adopt various passivation and selective contact strategies, such as the aluminum back surface field, PERC series, TOPCon, HJT, and other emerging technologies.

Crux of HPBC

Regarding LONGi's proprietary technology, HPBC, originally an acronym for high-performance back-contact cell, it now stands for hybrid passivated back-contact, indicating a mix of different passivation strategies. HPBC technology combines the cost-effectiveness and process simplification of conventional crystalline silicon solar cells with the advantages of IBC, such as no shading losses and superior aesthetics.

LONGi started developing its HPBC technology in 2017, achieving significant simplifications in manufacturing processes and a mass production efficiency of over 25.8% by September 2023. The company aims to exceed 26.5% efficiency soon. Various modifications have been implemented to improve optical and electrical properties, such as introducing sub-micron texturing technology that significantly reduces reflectance and modifying ARC coatings for a darker cell appearance. These enhancements, along with optimized cleaning methods and passivation strategies, have improved the implied Voc from 739 mV to over 747 mV. Further adjustments have been made to the rear side of the cells to optimize performance.

The BC structure also supports line interconnections rather than Z-shaped connections, reducing stress along the cell rim from 50 MPa to 26 MPa, thereby enhancing structural integrity.

LONGi offers 2 types of solar modules: a pure black module and a white backsheet-based module. The HPBC Hi-MO X6 module features a low temperature coefficient of 0.29% and excels in weak light

LONGi Solar's Module Series (As of 2023)

Product Series	Hi-MO X6 Scientist	Hi-MO X6 Guardian	Hi-MO X6 Scientist
Model name	LR5-72HTH-600M	LR5-72HTHF-590M	LR5-54HTH-450M
Wafer type	p-type	p-type	p-type
Cell technology	HPBC	HPBC	HPBC
Cell size	182 mm	182 mm	182 mm
No. of cells	144	144	108
Module technology	Half-cell, Back Contact	Half-cell, Back Contact	Half-cell, Back Contact
No. of busbars	-	-	-
Maximum power (Pmax)	600 W	590 W	445 W / 450
Module efficiency STC	23.2%	22.8%	22.8% / 23%
Bifaciality	-	-	-
Dimensions	2,278 x 1,134 x 35 mm	2,281 x 1,134 x 30 mm	1,722 x 1,134 x 30 mm
Weight	27.5 kg	27.2 kg	20.8 kg
Warranty	30 years	30 years	30 years
Applications	Utility	C&I	Residential

Source: TaiyangNews

conditions, offering a power generation premium of up to 2% in low light at 200 W/m². All this data has been certified by TÜV SÜD. As for the reliability of the Hi-MO X6, it has been thoroughly tested in various harsh conditions, such as thermal cycles, salt spray, and hail impact. The tests show that the Hi-MO X6's degradation is well below 2%, far surpassing the IEC standard of 5%. Due to all these benefits, in addition to the premium rooftop market, LONGi is also promoting its products for utility-scale applications. Currently, LONGi has achieved a production capacity of 30 GW, with further expansions anticipated.

Disclaimer & Imprint

This Special Edition was independently written by the TaiyangNews Team based on recent conference presentations of the company featured. Those companies among the top 10 of TOP SOLAR MODULES List granted a Badge of Excellence are each featured in an individual Special Edition

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