The Value Proposition of HJT in Today's Solar Technology Landscape

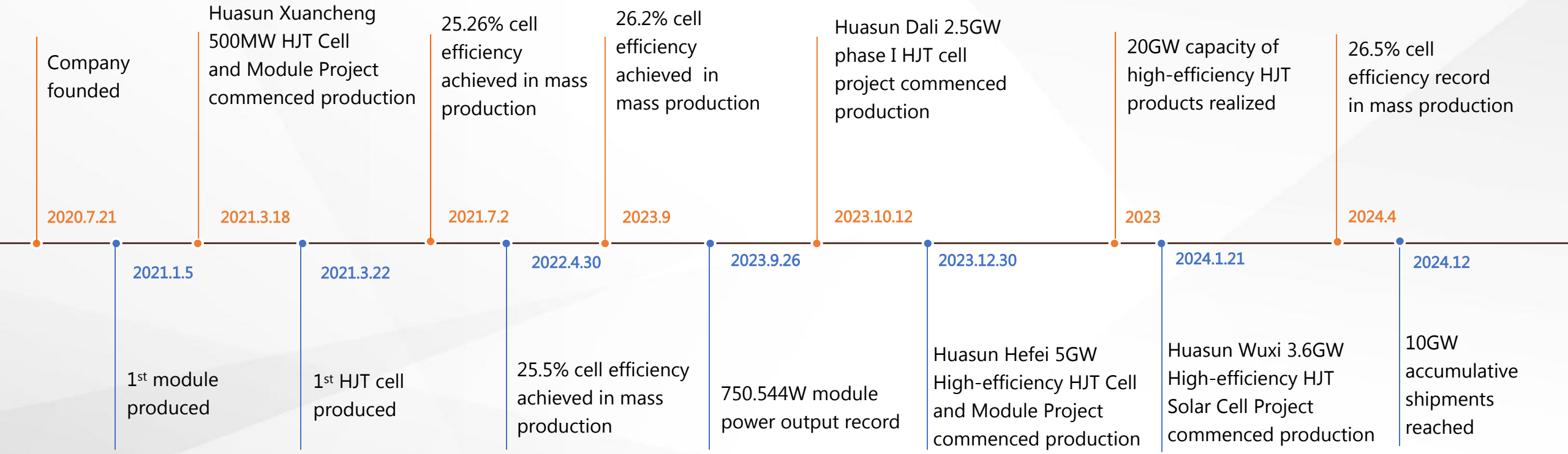
Presented by: Abhishek Kaushal, Director –South Asia, Huasun Energy

CONTENT

PART 1

Company Profile

About Huasun



About Huasun

No.1

HJT
Ingot/Wafer/Cell/Module
Manufacturer

5,000+

Employees
Worldwide

11 GW+

Shipments

60+

Countries & Regions

Huasun is a technological innovation enterprise specializing in the development and application of ultra-high efficient n-type silicon based heterojunction (HJT) solar technology as well as the product large-scale manufacturing of ingots, wafers, cells and modules.

About Huasun

20GW
Annual Capacity of HJT Products

Sales Center
Nanjing·Jiangsu

Headquarters
Xuancheng·Anhui

Manufacturing Facilities
Xuancheng·Anhui
Hefei·Anhui
Wuxi·Jiangsu
Dali·Yunnan
Yinchuan·Ningxia

Headquarters Sales Center Manufacturing Facilities

R&D Capability

Approx. **548** million (CNY)

Cumulative R&D investment in HJT as of the end of 2024

Approx. **5%**

R&D investment as a share of revenue

15Y+

Team members' average experience in top solar companies

470+

Talents in HJT field

200+

PhDs and MSs

8

4 industrial scientists
4 national-level leading talents

Industry Recognition

Tier 1 PV Module Manufacturer

Youngest company in the BNEF Tier1 PV Module Maker List.
First on the list specializing in HJT solar technology and mass production.

"Global Unicorn"

Listed in the 2023 Hurun Research Institute and Forbes Global Unicorn Rankings.

PVEL "Top Performer"

Huasun Himalaya G12 Series HJT Module passed PV Evolution Labs' Product Qualification Program and was recognized as "Top Performer".

Badge of Excellence Top Solar Modules

Huasun consistently secured a place in Top 10 in TaiyangNews's Top Solar Modules List throughout 2023, solidifying its position as the leading player in HJT since September 2023.

pv magazine Award

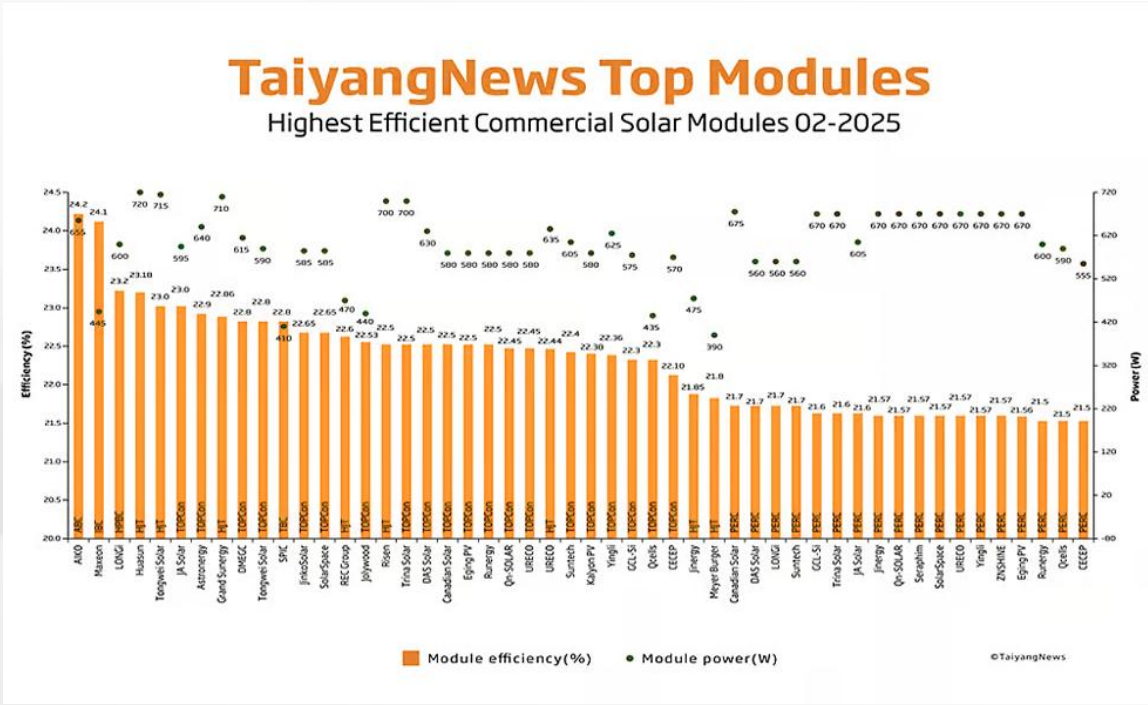
Huasun Himalaya Series G12-132 Module awarded top solar module of the year by pv magazine.

Industry Recognition

Huasun Himalaya G12-132 715W HJT module has consistently ranked as the top HJT product in TaiyangNews Top Modules since September 2023 with a conversion efficiency of 23.02%. It stands out as the leading performer in both power and efficiency among all conventional non-BC bifacial modules.

With a stellar performance throughout the year, Huasun was awarded the 2023 Badge of Excellence for its outstanding achievements.

The record was updated in August 2024, with the power and efficiency now reaching 720W and 23.18%, maintaining its leadership.

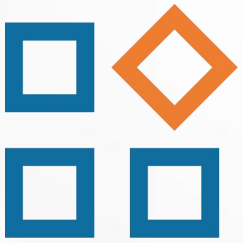


TAIYANGNEWS ALL ABOUT SOLAR POWER — **TaiyangNews Top Modules: Highest Efficient Commercial Solar Modules 02-2025**

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	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	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

TaiyangNews Top Modules- February 2025

Certifications



System Management

ISO9001/ ISO14001/ ISO45001

ISO50001/ ISO14067

IEC TS 62941

IEC TS 62994

SA8000

……

Products

IEC61215 / IEC61730

IEC62892 / IEC63209-1

IEC62938

Salt Mist Corrosion, Ammonia Corrosion, Anti-PID, Dust and Sand

……

Laboratory Qualifications

CNAS ISO

IEC17025

TÜV SÜD TMP

……

Certifications

National/Regional Access

CE Certification / EU

EPD / NORWAY

BIS / INDIA

JP-AC / JAPAN

CEC / AUSTRALIA

MCS / UK

QAD / ABU DHABI

INMETRO / BRAZIL

DEWA / DUBAI

ECS CRE4 / FRANCE

Adhering rigorously to quality standards for safety, performance, and environmental impact, Huasun's HJT products have earned authoritative certifications in numerous countries and regions worldwide.

HUASUN

RECORD-BREAKING!

Himalaya G12-132

768.938W Power

24.75% Efficiency

Everest G12R-132

669.1W Power

24.77% Efficiency

www.huasunsolar.com

PART 2

HJT Technology

WHY CHOOSE HJT?

HJT technology offers significant advantages in efficiency, performance and low carbon footprint, outperforming other technologies such as PERC and TOPCon.

Huasun is confident that HJT technology will become the mainstream standard in the new era of photovoltaics, driving the future of the solar industry.

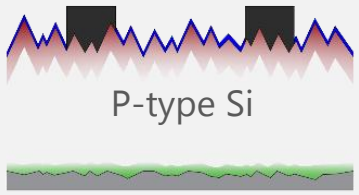
Why Choose HJT?

← P type

N type →

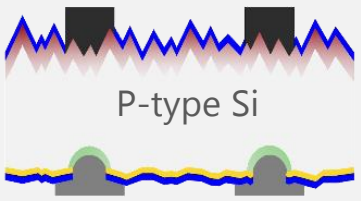
BSF Cell

~21%



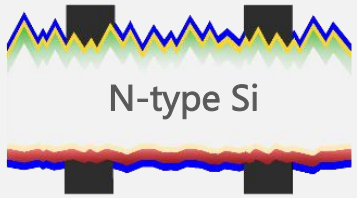
PERC Cell

~23%



TOPCon Cell

>24.5~25.5%

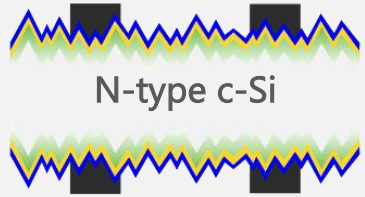


1. 10+ manufacturing steps
2. 800℃ + manufacture temp.
3. High carbon footprint

740W+

HJT Cell

>25.5~26.5%



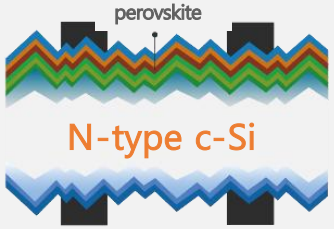
1. 4 manufacturing steps
2. 200℃ manufacture temp.
3. Lower carbon footprint

800W+

Tandem Cell

HJT + Perovskite

>28%



← Poly era

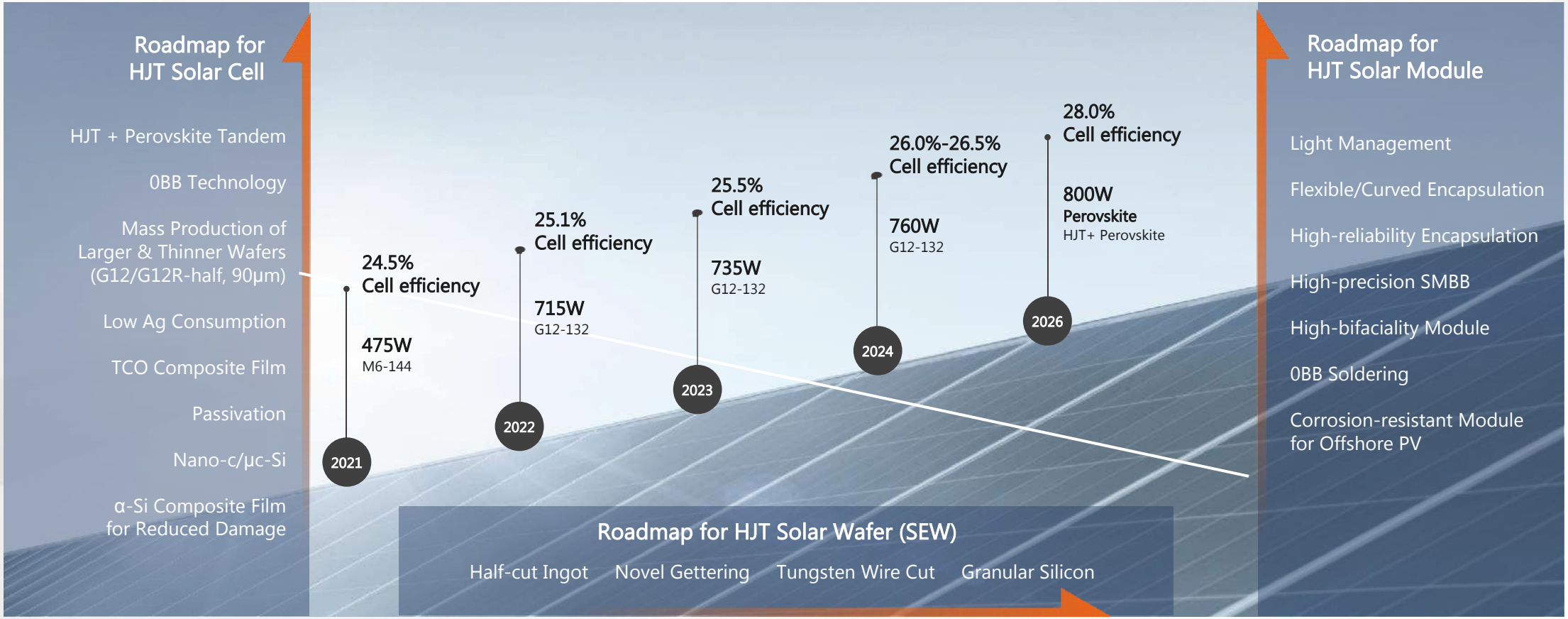
Mono era →

Why Choose HJT?

Huasun continuously innovates by integrating HJT with other advanced technologies, enabling us to enhance efficiency and reduce costs across our product lines.

800W+

HJT + Perovskite + 210mm Wafer



HUASUN HJT

Higher Efficiency

Top-tier modules with unparalleled efficiency and power output maximize energy yield for solar projects.

Ultra-high Reliability

Use of advanced materials ensures unmatched reliability within the industry.

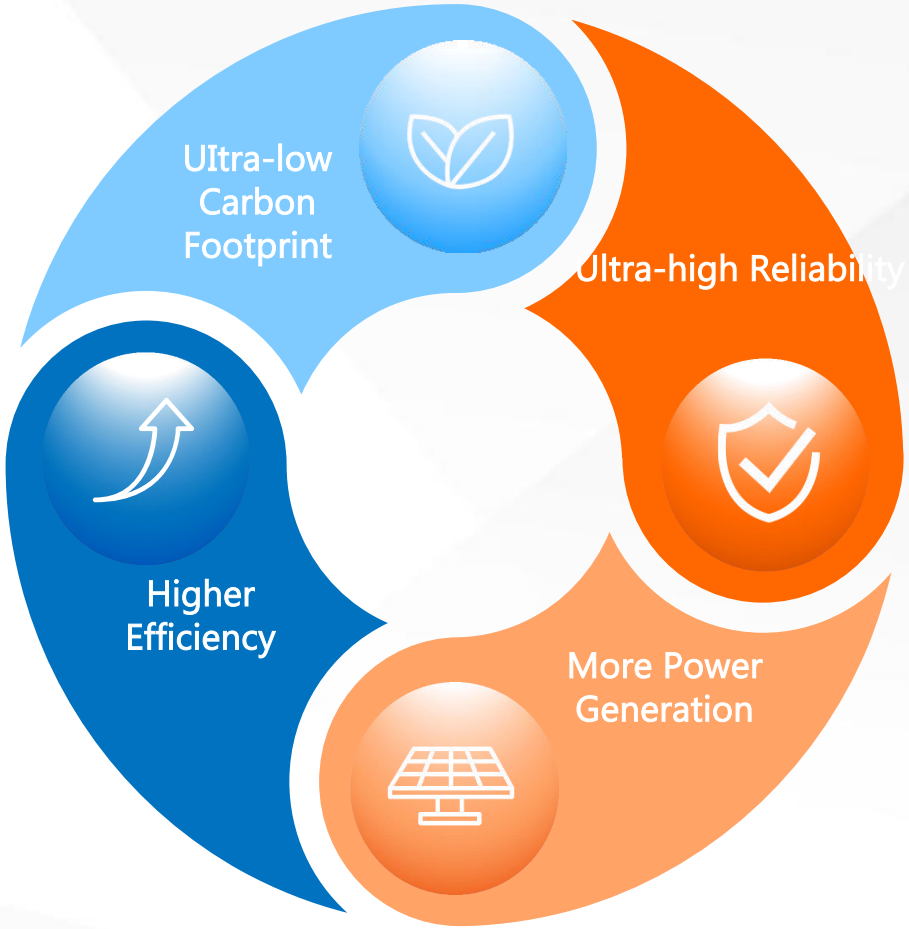
More Power Generation

Superior temperature coefficient, higher bifacial energy yield, and reduced lifetime degradation lead to higher power generation.

Ultra-low Carbon Footprint

As low as

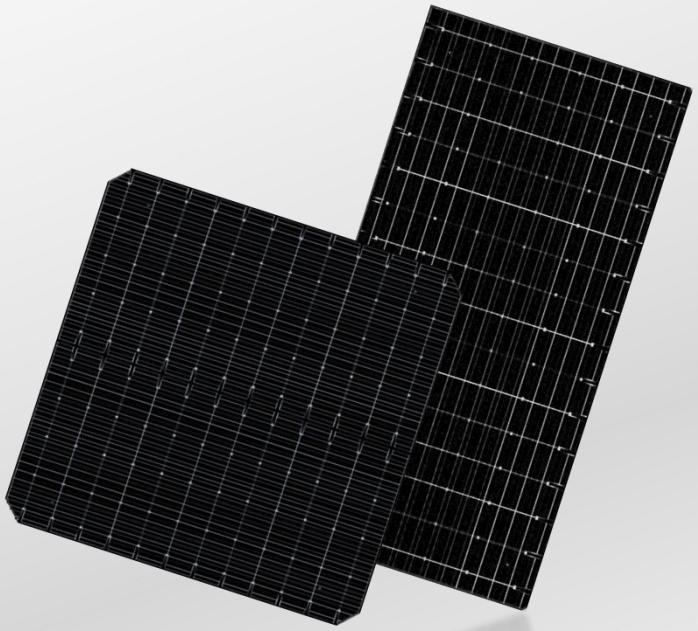
366.12kg CO_2 eq/kW.



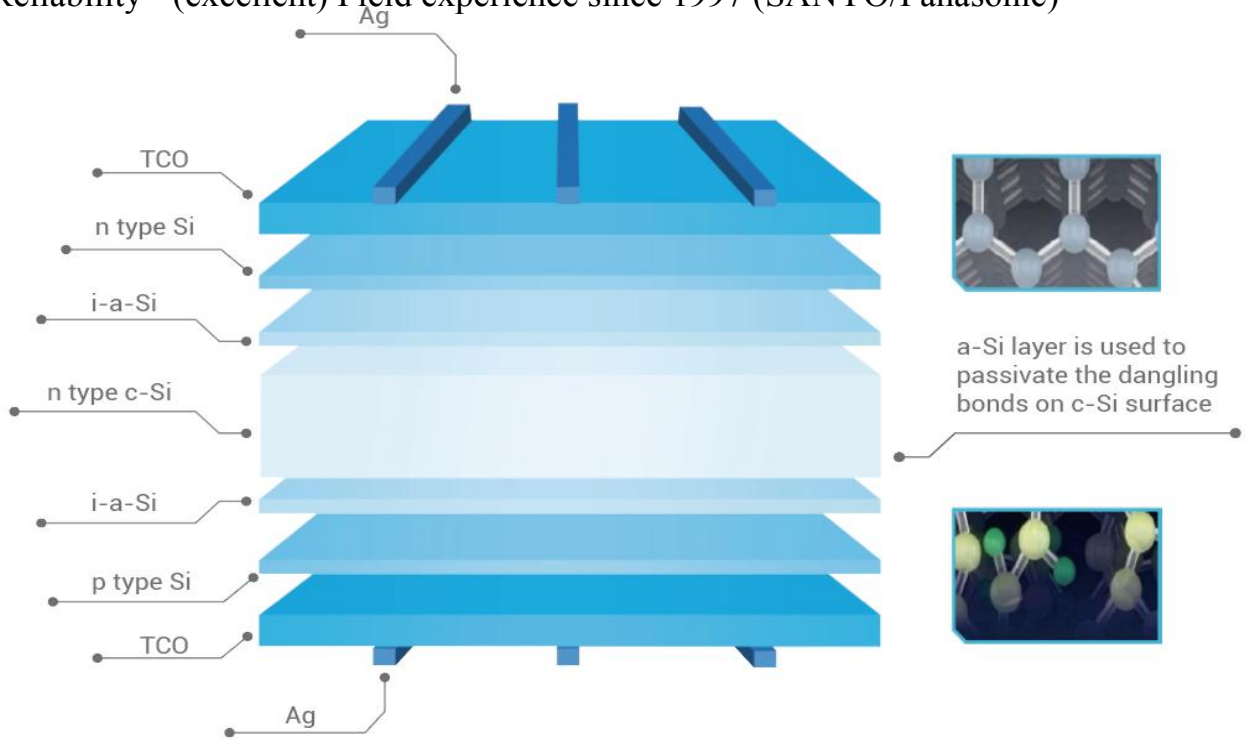
Heterojunction

Latest Generation Tech

HJT



- HJT cells combine the advantages of crystalline silicon and thin film technologies, offering superior light absorption and passivation. HJT cells enhance conversion efficiency and power output. They represent the future direction of solar cell technology platforms.
- N-type silicon
- Passivation with a-Si, u-Si and n-Si
- Cell bifaciality up to 97%
- Simple cell manufacturing process
- Proven Reliability - (excellent) Field experience since 1997 (SANYO/Panasonic)



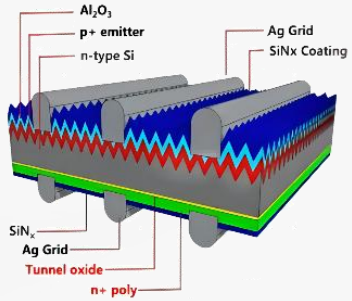
Higher Efficiency

TOPCon

TOPCon, an upgrade based on PERC cell structure, offers cell eff. between 24.5% and 25.2%, but has limited room for future enhancement.

Cell eff.

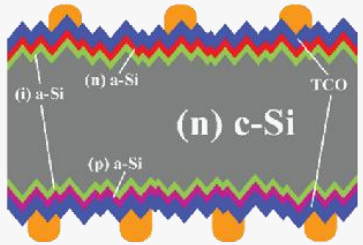
24.5~25.5%



Unclear path for cell eff. improvement in future.

Champion efficiency in mass production

26.5%



Clear path to improve cell efficiency, offering significant potential for further upgrades.

HJT

HJT achieves higher cell eff. than TOPCon, with Huasun's mass production line averaging 26.15%.

* Huasun G12 Series HJT solar cells achieve an average mass production of 26.15%, with champion production efficiency reaching 26.5%.

More Power Generation

-0.24%/°C

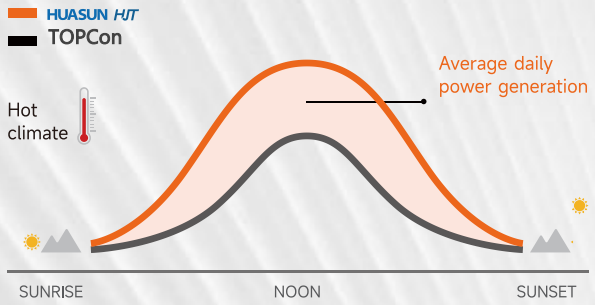
Industry Leading Temp. Coefficient

+2~5%

Higher Bifacial Energy Yield

≤9.7%

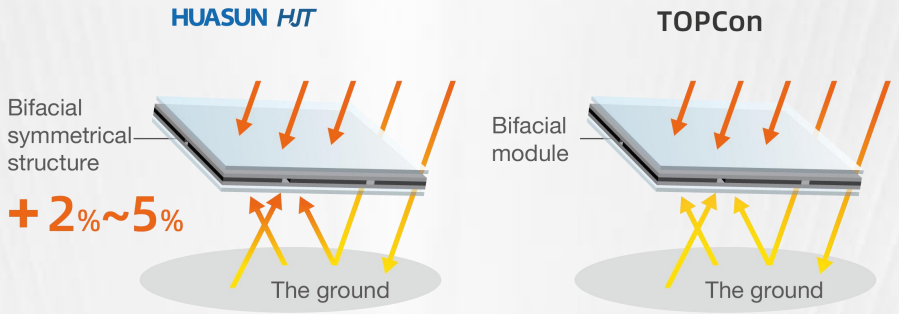
Lower Lifetime Degradation Rate



Temp. Coefficient

HJT -0.24%/°C

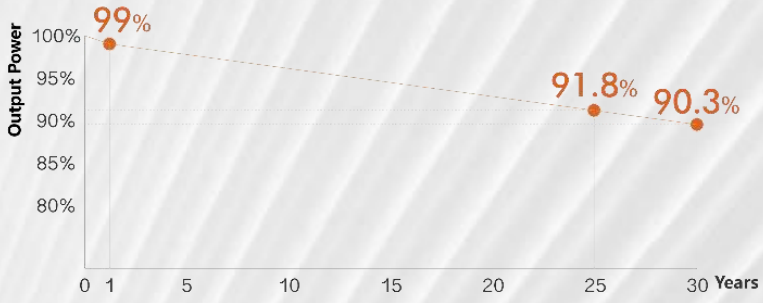
TOPCon -0.29%/°C



Bifaciality

HJT up to 95%

TOPCon 80%



≤1% degradation in the first year

≥90.3% of rated power maintained after 30 yrs

Ultra-high Reliability

First-class Materials Ensure Ultra-high Reliability

Half Cut Ingot

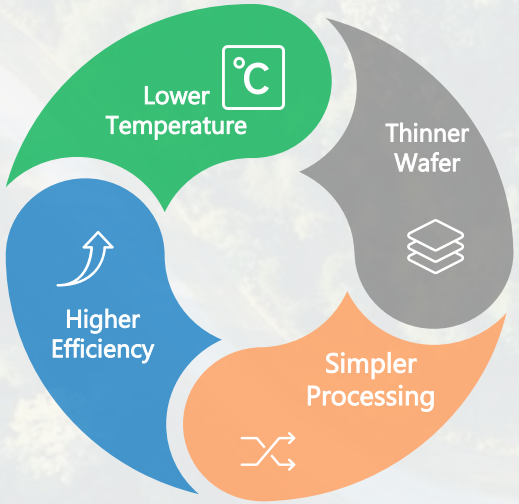
Light Conversion Film

Sealing with PIB Based Sealant

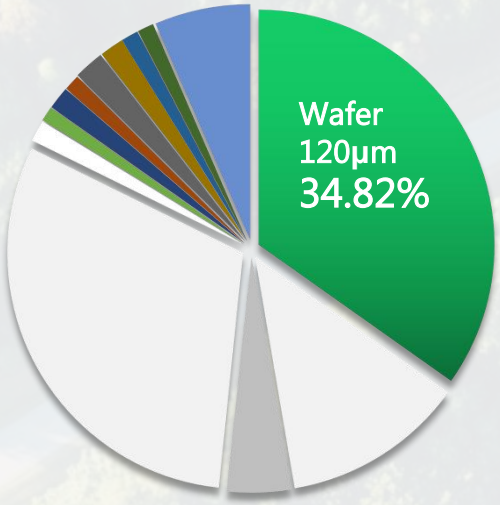
Double Glass Design with Frame

Huasun partners with top-tier material suppliers worldwide
and delivers products that exceed industry quality standards.

Carbon Footprint

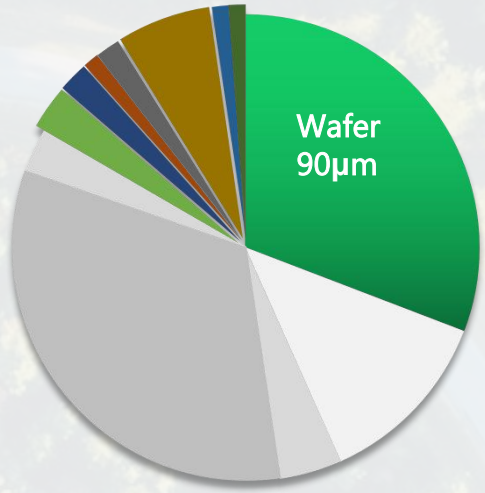


Industry Leading Carbon Footprint



366g CO_2 eq/W

- Certified by TÜV Rheinland
- Issued Date: **July 14th, 2023**
- Module: **HUASUN HJT Module**
- Wafer Thickness: **120μm**



Future <300g CO_2 eq/W

Carbon Footprint

Advantages of a Thinner Wafer

HJT	90-110μm
TOPCon	130μm
PERC	150μm

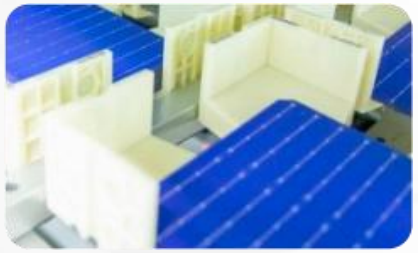
- As the technology matures, HJT solar cells are now being manufactured using silicon wafers with a thickness of **90μm.**
- Combining with **0-busbar solar cells** enables the HJT modules to achieve even **higher efficiencies.**

Process Advantages

01 Cleaning & Texturing

02 Bifacial CVD

03 Bifacial PVD



04 Screen Printing

4

Steps

HJT

200℃

VS

10+

Steps

OTHER

800℃

Unlike other solar cell technologies, Huasun's HJT cells are produced using just 4 low-temperature process steps, resulting in significantly higher productivity lower carbon footprint.

Cost Down in Heterojunction

Factory CAPEX

Wafer

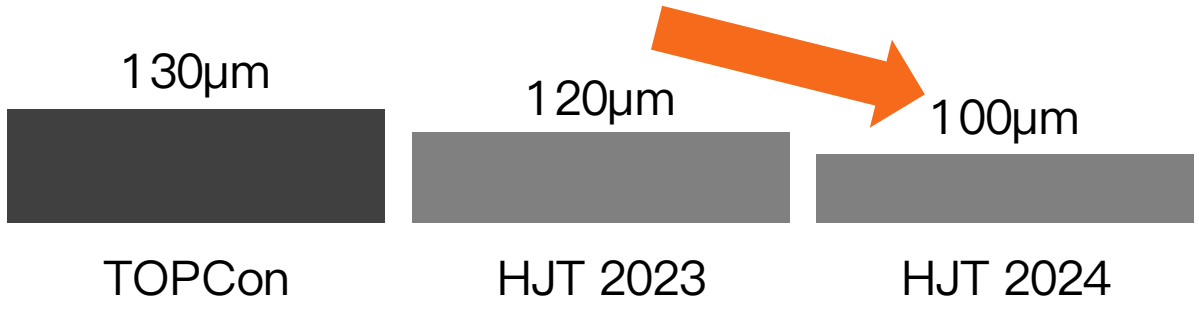
Silver/Indium

Other

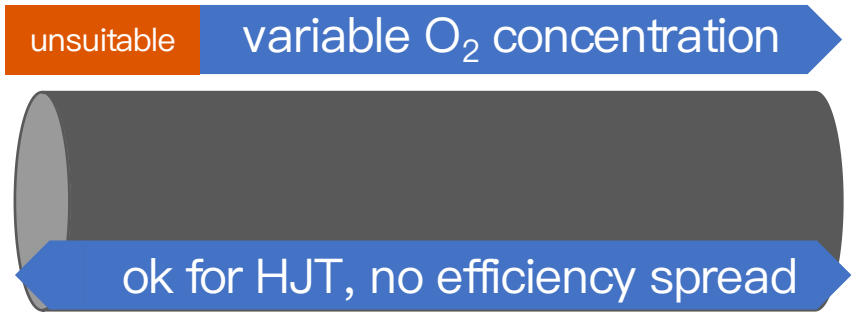
Cost Down in Heterojunction

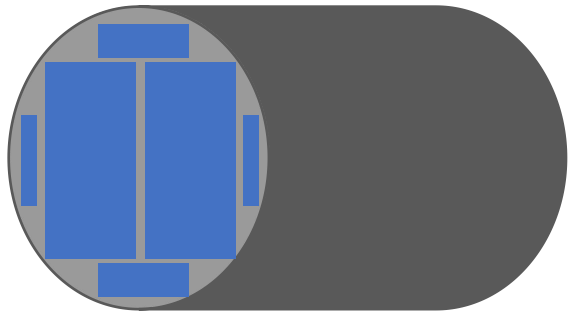
- Factory CAPEX
- Wafer
- Silver/Indium
- Other

Wafer thickness



TOPCon requires stable and low O_2 concentration





With half-cut wafers, we can make 1/2 size slabs from the rest of the original ingot to utilize more and waste less

Cost Down in Heterojunction

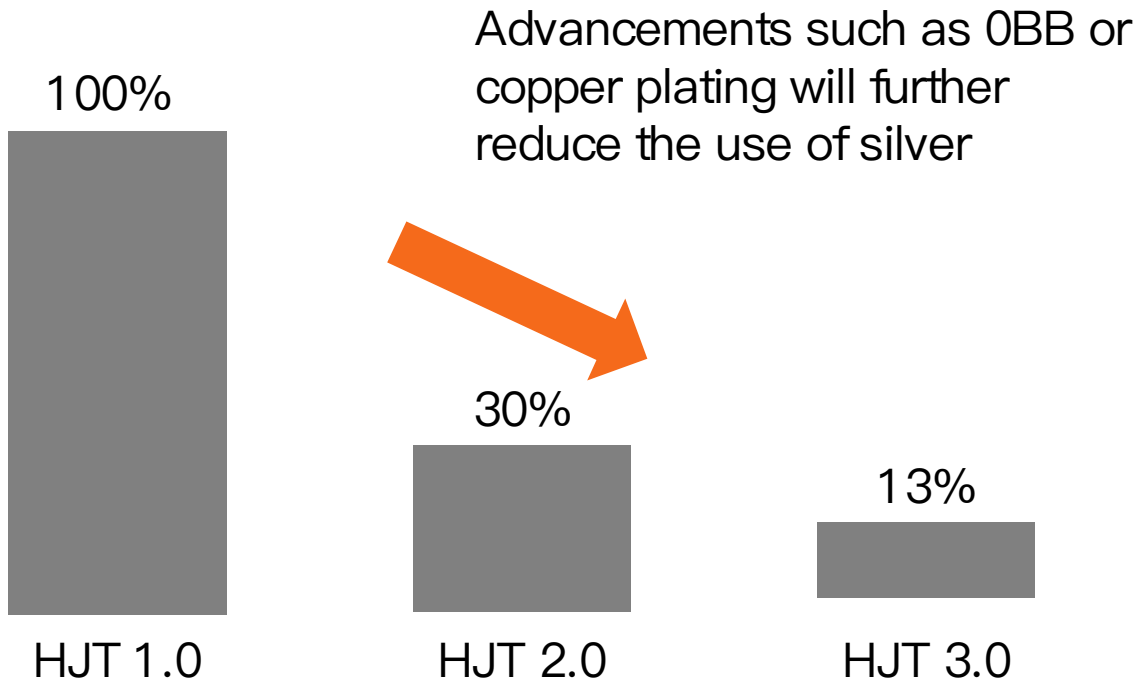
Factory CAPEX

Wafer

Silver/Indium

Other

Silver consumption per Wp



- Indium-free TCO alternatives are under evaluation
- Low-indium-use alternatives are under implementation

Reliability and durability / handling the main degradation sources

✓ LID

NO BORON

✓ LeTID

n-type silicon

MICROCRACKS

✓ Contact Ageing

TC2000

✓ PID

TCO surface

UV irradiance

Humidity ingress
(corrosion/isolation failure)

✓ HOTSPOTS

max 72 SMBB cell in series

✓ Other (at cell or module level)

HJT track record >20 years, IEC x 3 test sequences

Microcracks

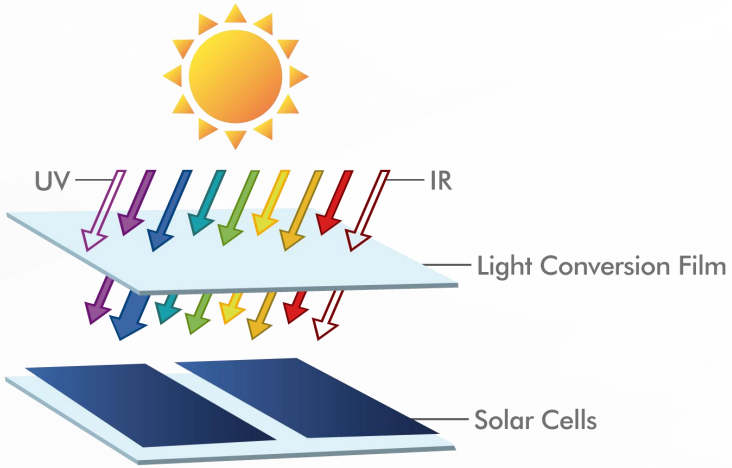
- Wafer of 120 μm (2023), <100μm (2024)
- No laser damage
- Flexible without breaking
- Symmetrical structure
- Glass/glass module

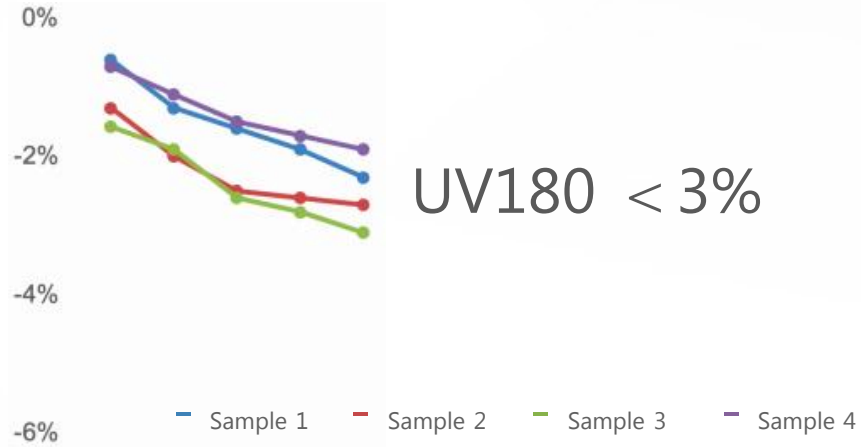
- **For Huasun HJT, cells are not prone to crack through mechanical stress**

Ultra-high Reliability

Light Conversion Film

The Huasun HJT module is encapsulated with light conversion film that converts UV light (<380nm) to blue light (~400-550nm). This feature significantly enhances the module's UV resistance.

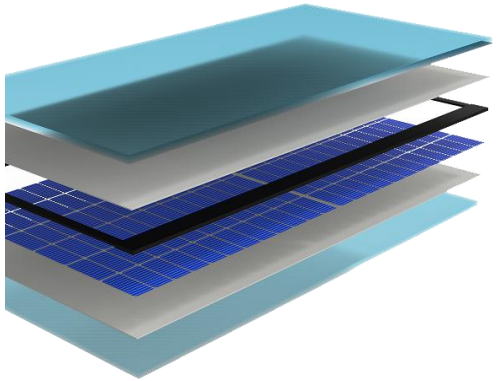


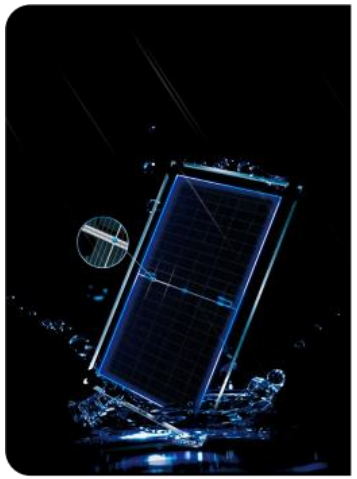


UV180 < 3%

Degradation and module failure caused by water vapor ingress

- For n-type cell technologies (TOPCon /Heterojunction), there exists the risk of degradation caused by the **ingress of humidity** until reaching the cell (metallization/TCO corrosion)
- Huasun uses **sealing of the module edges and glass openings**, using a material (PIB) 100x better than the best current option (POE/EPE), in terms of resistance to water penetration
- We have run the tests (DH6000) that emulate a very hostile environment for the complete module lifetime, and they show **very low and stabilized degradation**
- We exclusively use **glass-glass**, eliminating additional backsheet risks (quality, ageing, scratches, etc)





100 times

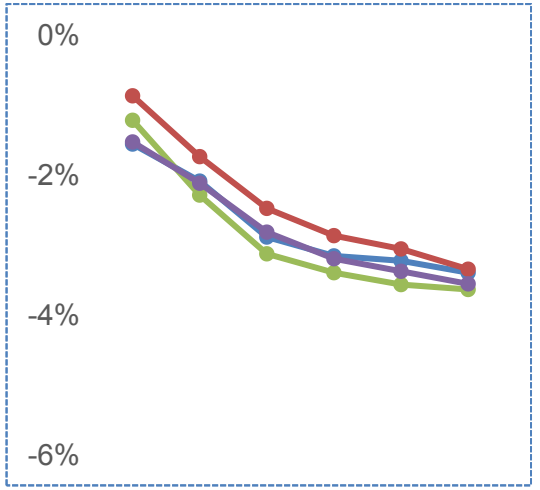
Water penetration resistance

Silicon penetration rate

30~50 g/m²•d

Butyl rubber penetration rate

< 0.3 g/m²•d



DH6000 power degradation < 4%

Reliability and durability / handling the main degradation sources

✓ LID

NO BORON

✓ LeTID

n-type silicon

MICROCRACKS

✓ Electrical Ageing

TC2000

✓ PID

TCO surface

UV irradiance

Humidity ingress
(corrosion/isolation failure)

✓ HOTSPOTS

max 72 cell in series

✓ Other (at cell or module level)

HJT track record >20 years, IEC x 3 test sequences

PART 3

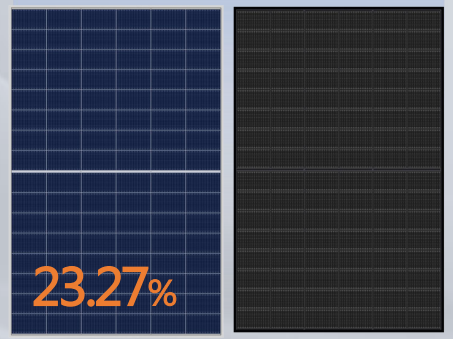
HJT
PV MODULES

Product Portfolio

465W

G12R-96

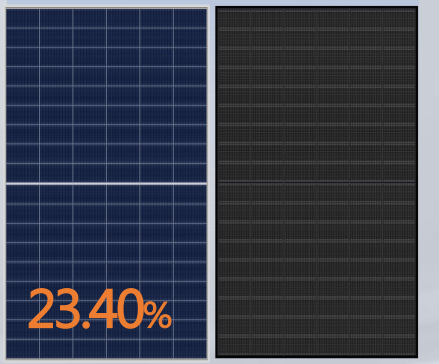
1762 x 1134mm



520W

G12R-108

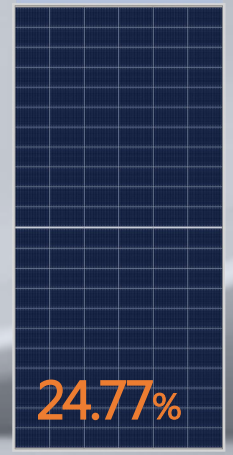
1960 x 1134mm



669W

G12R-132

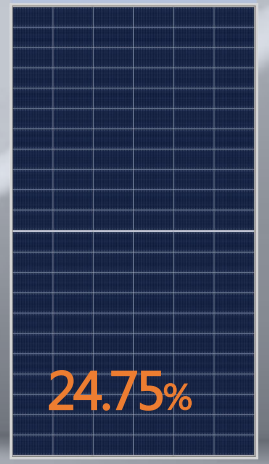
2382 x 1134mm



768W

G12-132

2384 x 1303mm



Residential

Commercial & Industrial

Utility-scale

Available in DSB and DSN versions: G12R-96, G12R-108

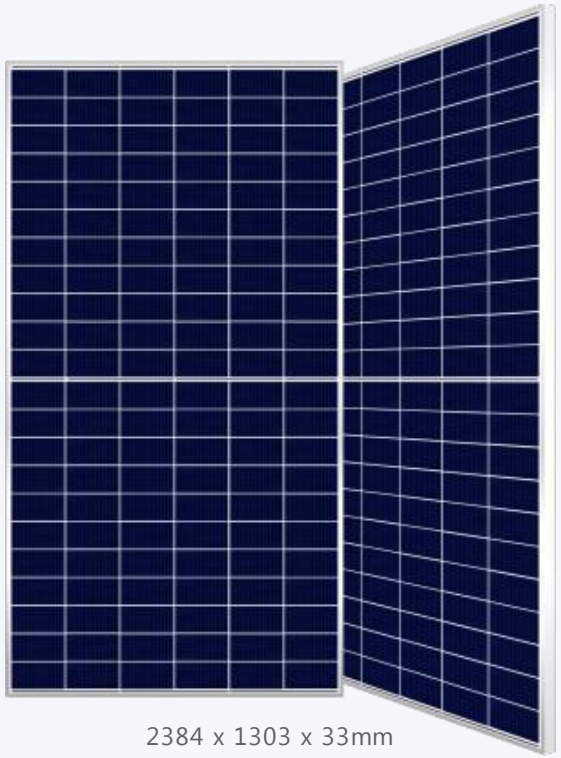
Himalaya G12 Series

Bifacial double-glass HJT module

768W
Module Power

24.75%
Module Efficiency

- µc-Si technology
- N-type 210mm solar cells
- Half-cut ingot
- SMBB/0BB technology
- Up to 95% bifaciality
- Ideal for large-scale utility projects



2384 x 1303 x 33mm

Competitor Specs

- N-type TOPCon
- 700W
- 22.7%
- 2384 x 1303 x 33mm

15 Years PRODUCT WARRANTY

30 Years PERFORMANCE WARRANTY

132 Cells

Himalaya G12 Series

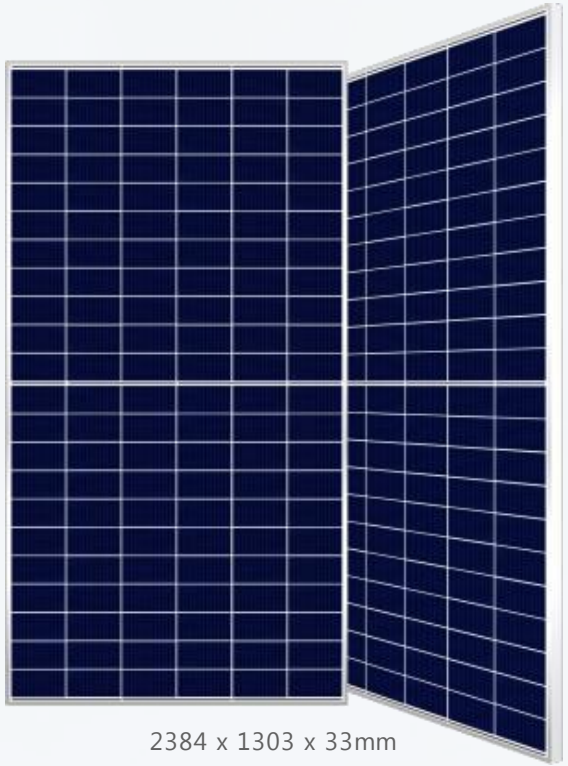
Himalaya V-ocean

High-efficiency HJT module

768W
Module Power

24.75%
Module Efficiency

- µc-Si technology
- N-type 210mm HJT solar cell
- Light conversion film
- Complete PIB sealing and IP68 junction box
- Integrated coating frames
- Double-layer coated glass
- Enhanced wind load resistance
- Improved vibration resistance
- Exceptional watertightness
- Superior salt mist resistance



2384 x 1303 x 33mm

Competitor Specs

- N-type TOPCon
- 635W
- 22.8%
- 2465 x 1134 x 35mm

15 Years PRODUCT WARRANTY
30 Years PERFORMANCE WARRANTY
Ariel Re
BUREAU VERITAS

Himalaya G12 Series

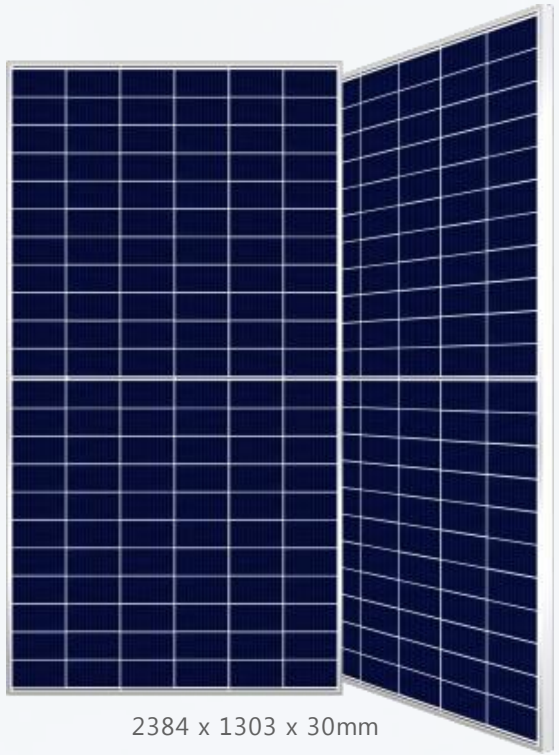
Ultra-bifaciality double-glass HJT module for vertical installations

768W
Module Power

24.75%
Module Efficiency

- N-type 210mm solar cells
- Double-sided microcrystalline technology
- Special frame design increases bifaciality to an average of 95%+
- SMBB technology
- Minimal land footprint and ultra-low operating & maintenance costs
- 15-year product warranty
- 30-year linear performance warranty

Ideal for farm, rangeland and utility projects



2384 x 1303 x 30mm

- Farm
- Rangeland
- Highway

15 Years PRODUCT WARRANTY

30 Years PERFORMANCE WARRANTY

Ariel Re

132 Cells

Everest G12R Series

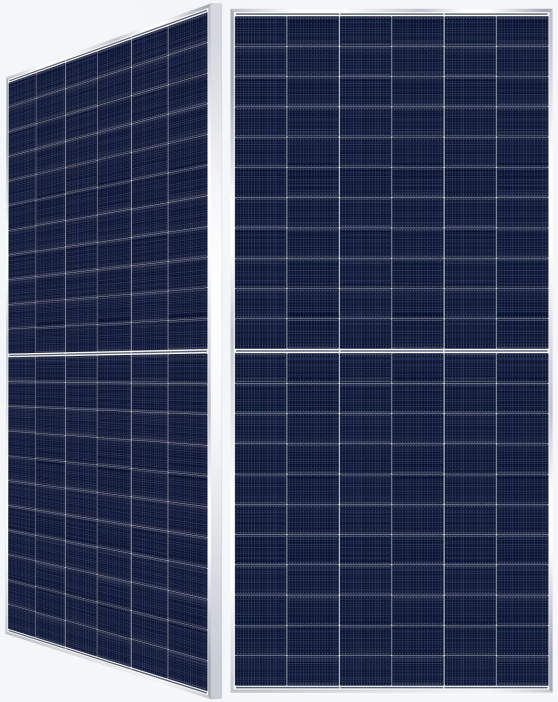
Bifacial double-glass HJT module

669W
Module Power

24.77%
Module Efficiency

- N-type 210R solar cells
- Double-sided microcrystal cells
- Half-cut ingot
- SMBB/0BB technology
- Up to 95% bifaciality

Ideal for residential, commercial & industrial rooftops, and utility projects



2382 x 1134 x 30mm

Competitor Specs

- N-type TOPCon
- 635W
- 22.8%
- 2465 x 1134 x 35mm

15 Years PRODUCT WARRANTY

30 Years PERFORMANCE WARRANTY

Ariel Re

132 Cells

Everest G12R Series

BLACK & LIGHT

Bifacial double-glass HJT module

- Sleek all-black design
- Lightweight for fast installation
- Ideal choice for residential rooftops

HJT solar cell

Black mesh glass/ Black film

Black matte frame

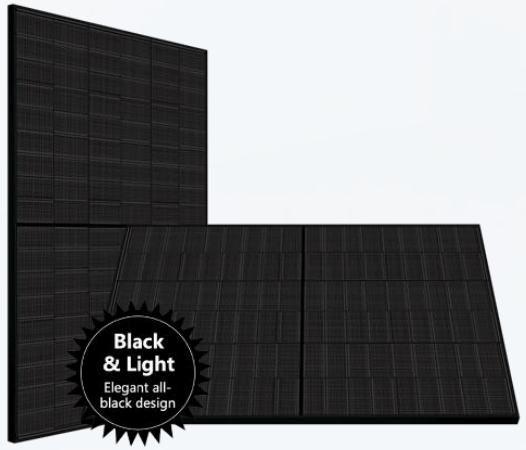
Sleek design

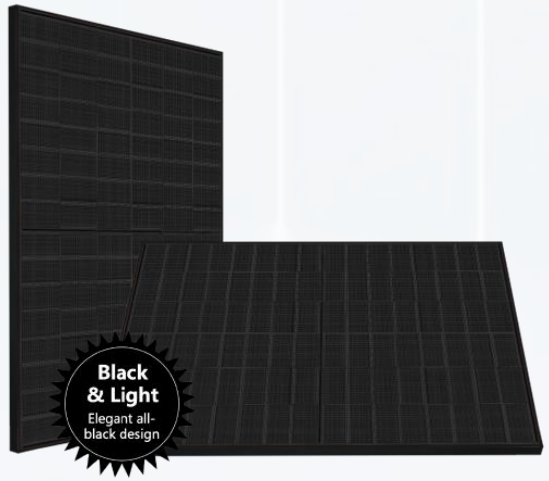
520W Module Power

23.40% Module Efficiency

465W Module Power

23.27% Module Efficiency





15 Years PRODUCT WARRANTY

30 Years PERFORMANCE WARRANTY

Ariel Re

Available in DSB and DSN versions: G12R-108, G12R-96

Warranty & Reinsurance

Product Warranty

15 Years PRODUCT WARRANTY

30 Years PERFORMANCE WARRANTY

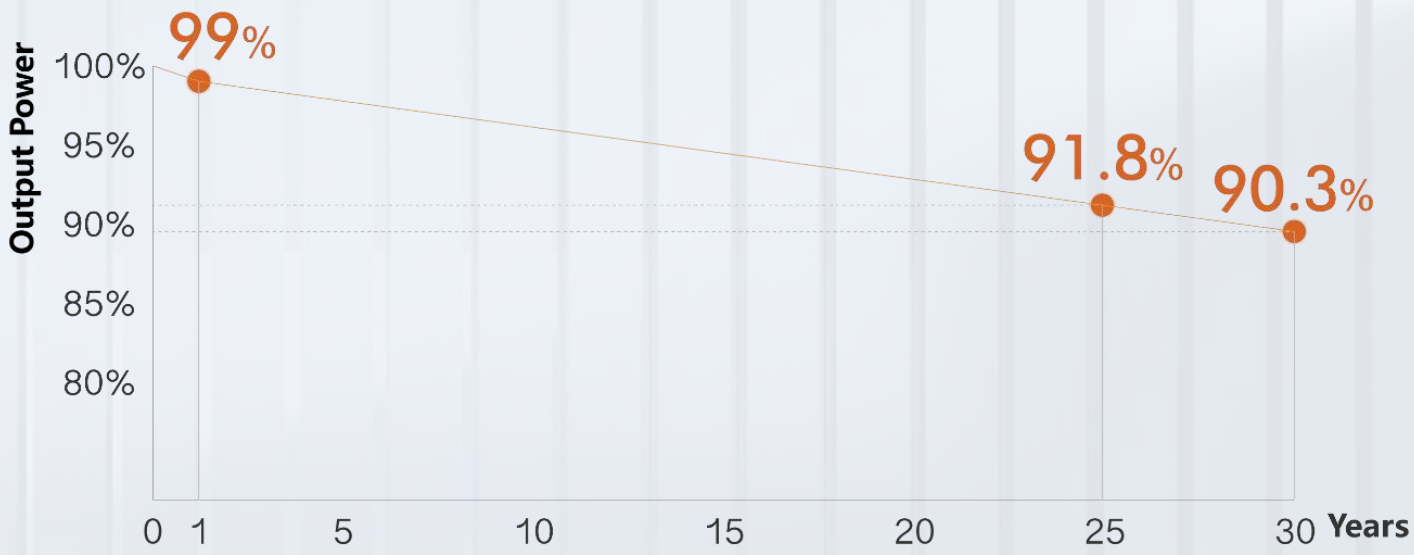
*A 30-year residential rooftop product warranty is available in select markets, including Europe, Australia, Japan, and Korea.

Third Party Reinsurance

The FIRST insurance-backed HJT module manufacturer

*Ariel Re: Ariel Re Lloyd's of London, is one of the most experienced insurance and reinsurance institutions in the world with its 30 years of underwriting history and experience.

Linear Power Degradation



*Refer to HUASUN standard warranty for details

* ≤1% degradation in the 1st year
≤0.3% annual degradation during the 2nd to 30th years
≥90.3% of rated power maintained after 30 years

PART 4

Powering the World

Project References

Bulgaria
650MW Utility Project

Currently the world's LARGEST single-site

HJT utility tracking solar project.

- Location: **Pazardzhik, Bulgaria**
- Capacity: **650MW**
- Annual Power Generation: **1.06 billion kW·h**
- Annual Coal Saving: **320,000 tons**
- Annual CO_2 Emission Reduction: **870,000 tons**

Project References

Ruoqiang, China
1.8GW Utility Project

Currently the world's LARGEST single-site

HJT utility solar project.

- Location: **Ruoqiang, China**
- Capacity: **1.8GW**
- Annual Power Generation: **2.7 billion kW·h**
- Annual Coal Saving: **814,000 tons**
- Annual CO2 Emission Reduction: **2,217,000 tons**

Project References

Dali, Yunnan
1.7GW Utility Project

- Location: **Dali, China**
- Capacity: **1.7GW**
- Annual Power Generation: **2.66 billion kW·h**
- Annual Coal Savings: **802,000 tons**
- Annual CO_2 Emission Reduction: **2,184,000 tons**

Weifang, Shandong
50MW Agrivoltaic Project

Currently the LARGEST HJT agrivoltaic project in China.

- Location: **Shandong, China**
- Capacity: **50MW**
- Annual Power Generation: **63,180,000 kW·h**
- Annual Coal Savings: **19,000 tons**
- Annual CO_2 Emission Reduction: **52,000 tons**

Project References

Germany
5.2MW Agri Solar Park

- Location: **Merzig-Welligen, Germany**
- Capacity: **5.2MW**
- Annual Power Generation: **6,020,000 kW·h**
- Annual Coal Savings: **2,000 tons**
- Annual CO_2 Emission Reduction: **5,000 tons**

Project References

Xuancheng, Anhui, China
23MW Fishery Photovoltaic Project

Shouguang, Shangdong, China
10MW Floating Solar Project

Ningguo, Anhui, China
15MW C&I Rooftop

Hamamatsu, Shizuoka, Japan
6MW Utility Project

Bắc Giang, Vietnam
20MW C&I Rooftop

Thun, Switzerland
43kW Residential Rooftop

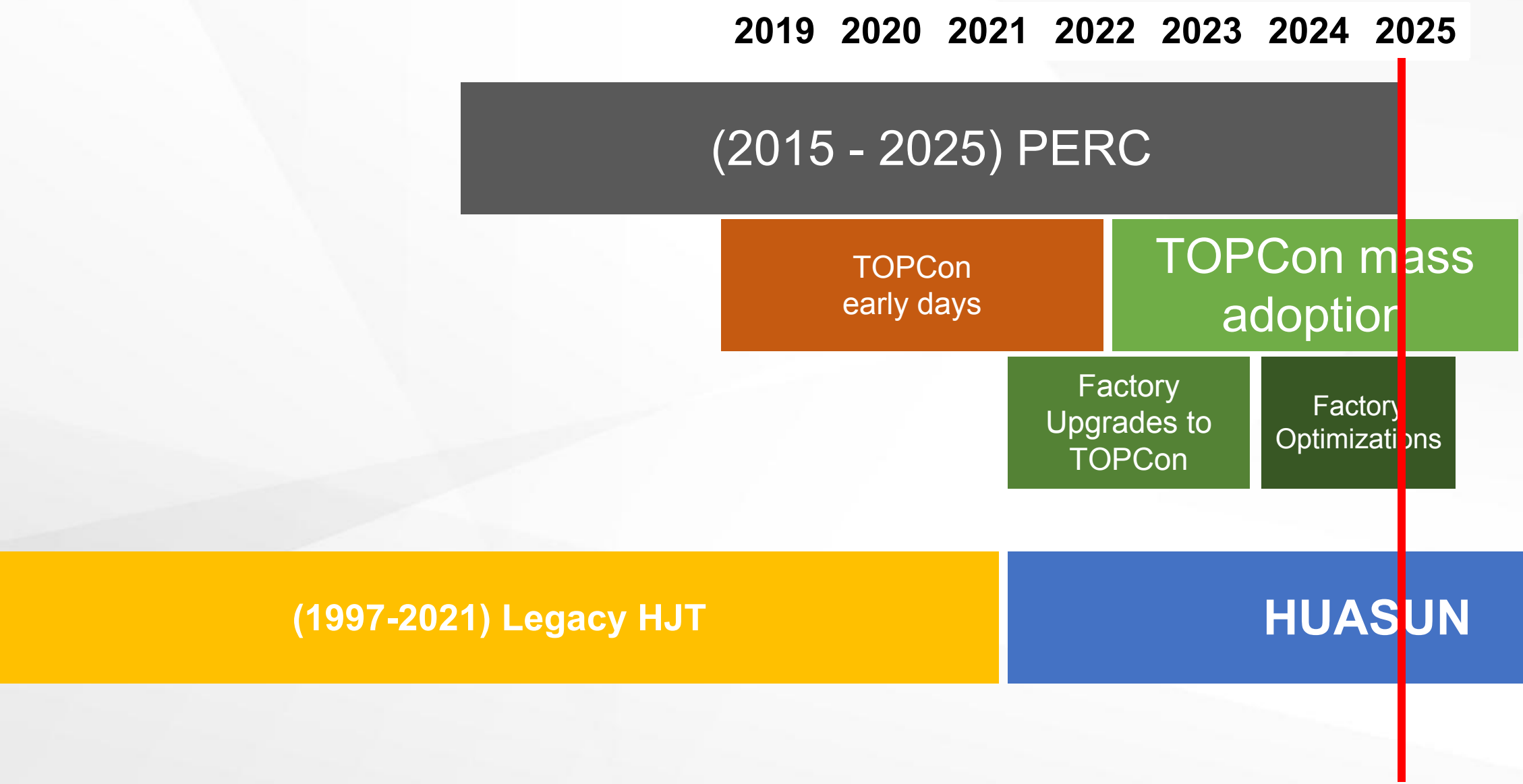
Global Network

Huasun Himalaya and Everest high-efficiency HJT products have been delivered to more than 60 countries and regions worldwide.

before we go...

SOME ADDITIONAL **INFORMATION**

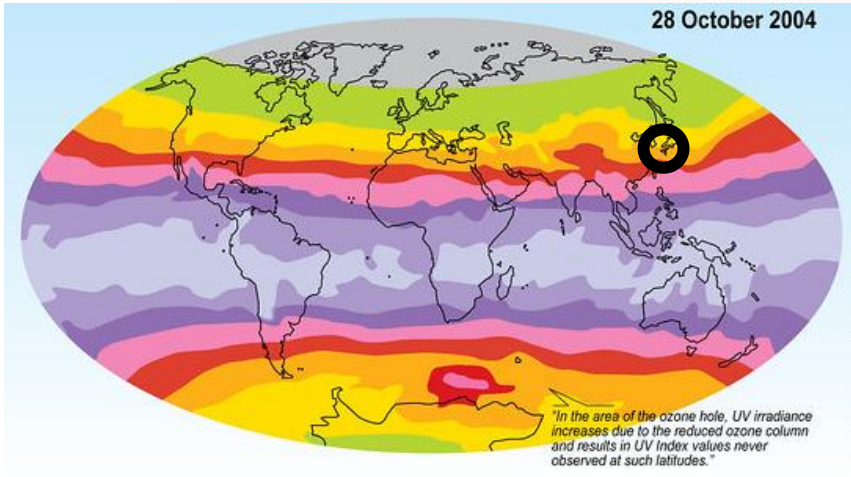
How proven is the reliability?



Ultra-high Reliability

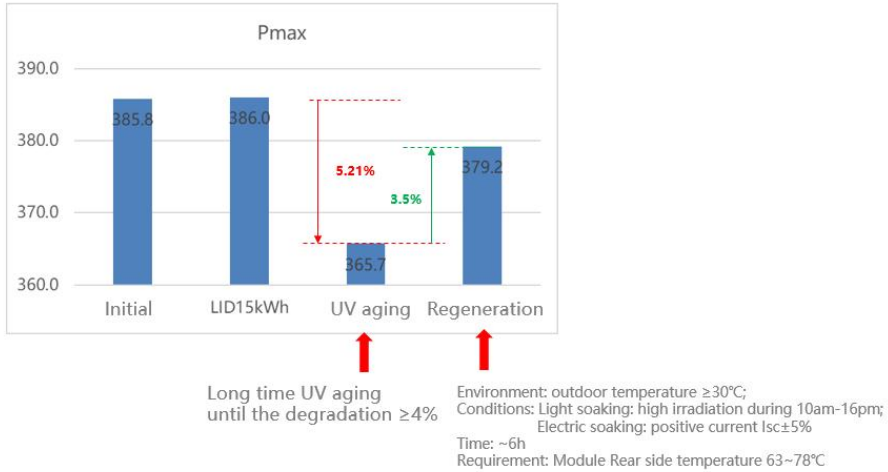
In 2014, customers in Osaka, Japan adopted Panasonic HJT optical conversion technology modules, with a **cumulative degradation of only 1.6% after more than 8 years of operation**.

Residential modules in Osaka, Japan (installed in 2014)



Source: GRID-Arendal, Emmanuelle Bournay

HJT has a UV regeneration mechanism, which is activated in the same weather conditions in which UV is relevant (i.e. high irradiance and high temperature)



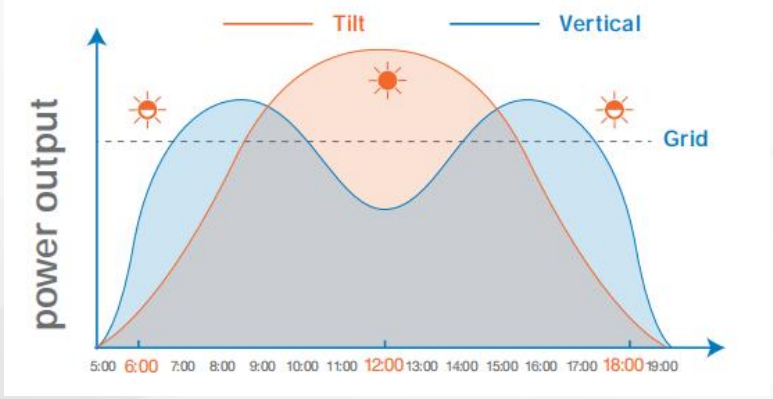
We test what we sell (BOM). Huasun 3 x IEC (2023)

Component	Type	Critical	% of mass production	Retesting if alternative used
Glass	Wujiang CSG Ultrawhite toughened glass 2mm	no	60%	SML, DML
Encapsulation	Cybrid WT11 0.55mm (front)	yes	60%	DH3000, PID
Frame	Conch 6005-T6	no	55%	SML, DML
Sealing	Kommerling GmbH PVS101	yes	100%	DH3000
Ribbon	Yan Cheng 0.26mm Sn43Pb43Bi14	yes	80%	TC600, DH3000
Flux agent	Suzhou COSTAR FD-309	no	70%	TC300
Cell Interconnection	Huasun SMBB (G12)	yes	70%	TC600, DH3000
...	...			

Representative BOM choice (selected randomly by 3rd party)

Application Scenario-Vertical Installation

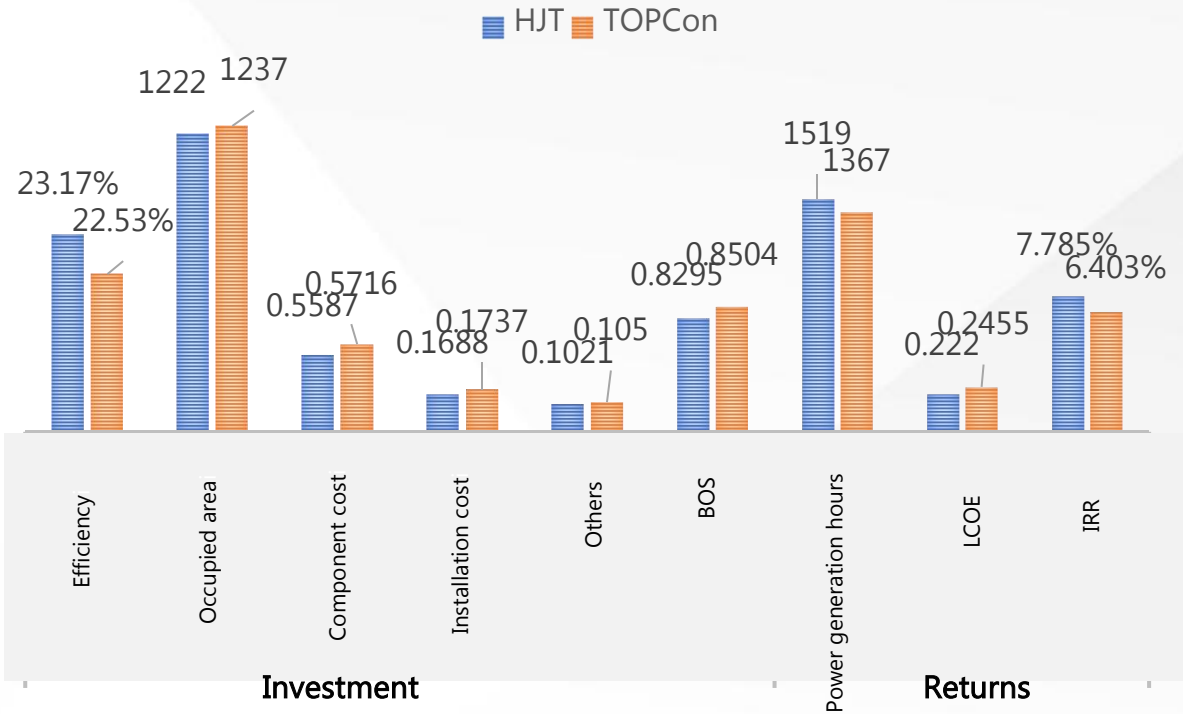
No.	Power output -front	Power output -back	Bifaciality	Average bifaciality
1	715. 79	683.09	95.4%	95.3%
2	717. 21	682.51	95.2%	
3	717.68	685.01	95.4%	
4	716.81	682.51	95.2%	
5	715. 94	682.54	95.3%	
6	718.51	683.87	95.2%	



- Vertical installation of PV modules enables **dual-peak** electricity generation, making it a perfect fit for market-based peak-valley electricity price trading models.
- In vertical installation scenarios, HJT modules deliver superior power generation performance: surpassing TOPCon modules by **10%-12%** and PERC modules by **16%-20%**.

HJT Vertical Installation Solution for Agri-PV （Jinta, Gansu, China）

Type	TOPCon 700W	HJT 720W	Comparison
Module power (Wp)	700	720	20W higher
Module dimension (mm)	2384*1303*33	2384*1303*33	/
1st-year power degredation	1%	1%	/
Annual linear degredation	0.4%	0.3%	0.1% lower per year
Bifaciality	80%	95%	15% higher
Array	2P	2P	/
Installation tilt (°)	90	90	/
Front facing	west	west	/
Number of modules per string (pcs)	26	26	/
Pnom Ratio	1.51	1.51	/
Number of strings	4100	3986	114 strings less
Number of modules	106600	103636	2964 pcs modules less
AC system capacity (MW)	49.5	49.5	/
Land area (ha)	82.4667	81.4667	1ha less



When compared to TOPCon 700W with fixed trackers, HJT 720W module offers several advantages:

- 0.64% efficiency gain
- Saves 1 ha land use and cuts BOS costs by 2.45%
- 11.12% more electricity generation hours in first year
- 9.57% lower LCOE and 1.38% higher IRR

HEADQUARTERS

No. 99 Qingliu Road, Xuancheng Economic Development Zone, Xuancheng, Anhui, China

SALES CENTER

14F, Jingfeng Center, 1698 Shuanglong Ave. Jiangning District, Nanjing, Jiangsu, China

E-mail: sales@huasunsolar.com
Tel: +86-25-86216170