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9 November 2023

11:00 am – 12:00 pm | CET, Berlin

2:00 pm – 3:00 pm | Dubai

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Emiliano Bellini

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Heterojunction at the height of its power

Welcome!

Do you have any questions? ? 

Send them in via the Q&A tab.  We aim to answer as many as we can today!

You can also let us know of any tech problems there.

We are recording this webinar today. 

We'll let you know by email where to find it and the slide deck, so you can re-watch it at your convenience.  



HETEROJUNCTION for UTILITY SCALE PV

HJT



Anhui Huasun Energy Co., Ltd

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CHRISTIAN COMES

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Contents - Heterojunction for utility scale PV

01 **Heterojunction**

Cell technology overview

02 **Why HJT in utility scale?**

Cost down

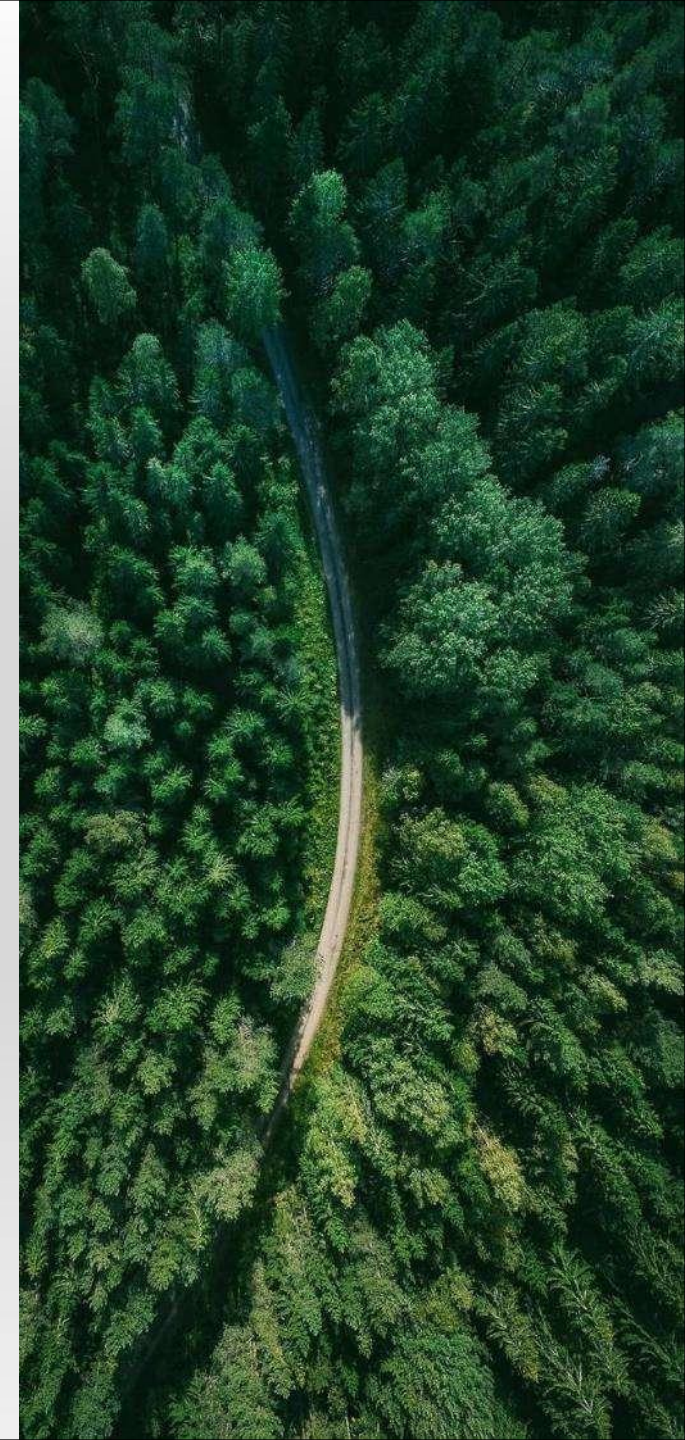
Industrial scale manufacturing

Reliability

Efficiency and Performance

03 **LCOE**

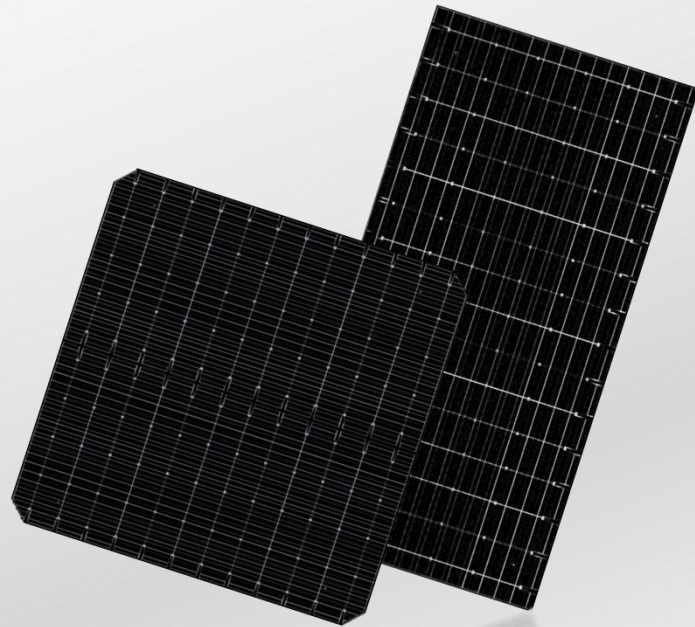
04 **Outlook**



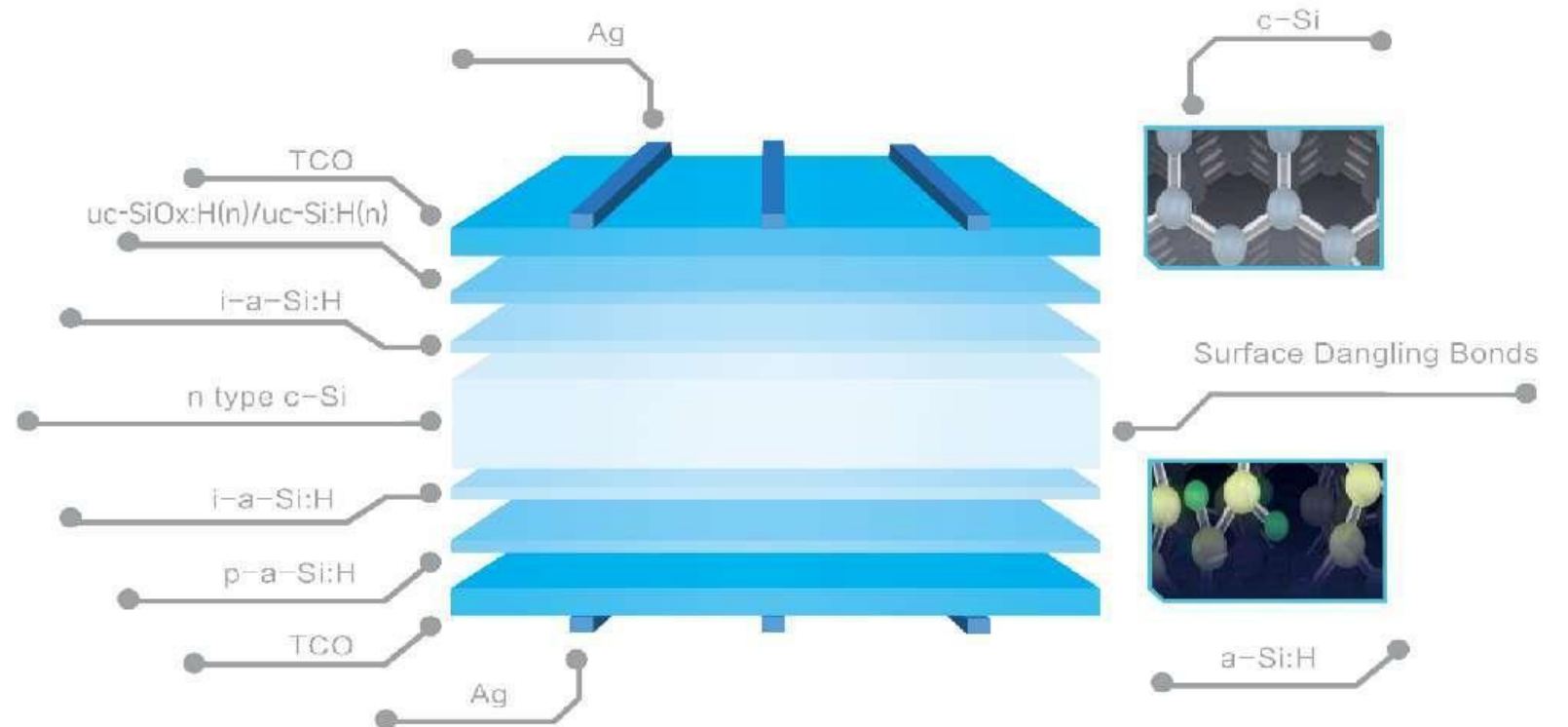
Heterojunction

Latest Generation Tech

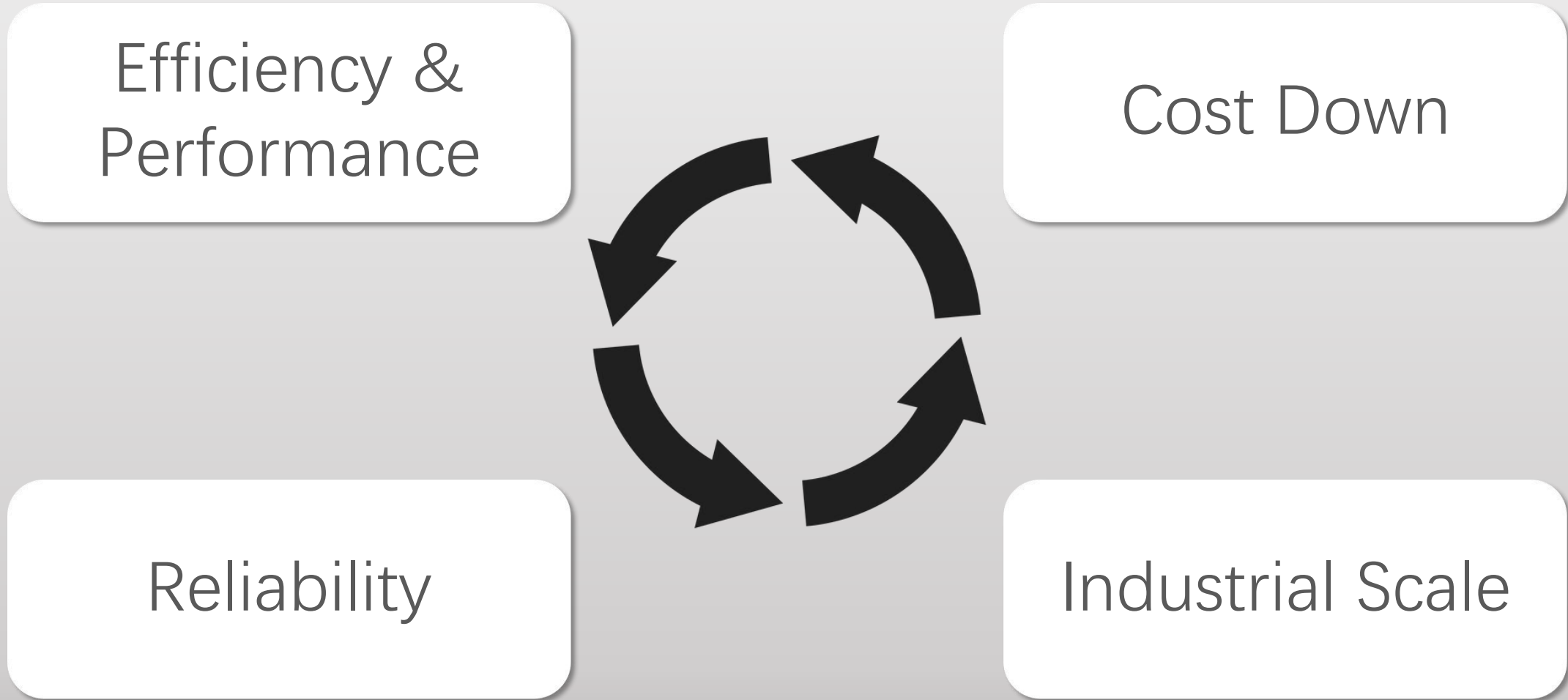
HJT



- n-type silicon
- Passivation with a-Si, u-Si and n-Si
- Cell bifaciality up to 97%
- Simple cell process
- (excellent) Field experience since 1997 (SANYO/Panasonic)



What makes heterojunction in 2023 fit for utility scale?



... and ESG, bankability, certificates, track record, etc / but that is the same for all!

Cost Down in Heterojunction



Factory CAPEX

Wafer

Silver/Indium

Other

Cost Down in Heterojunction

Factory CAPEX

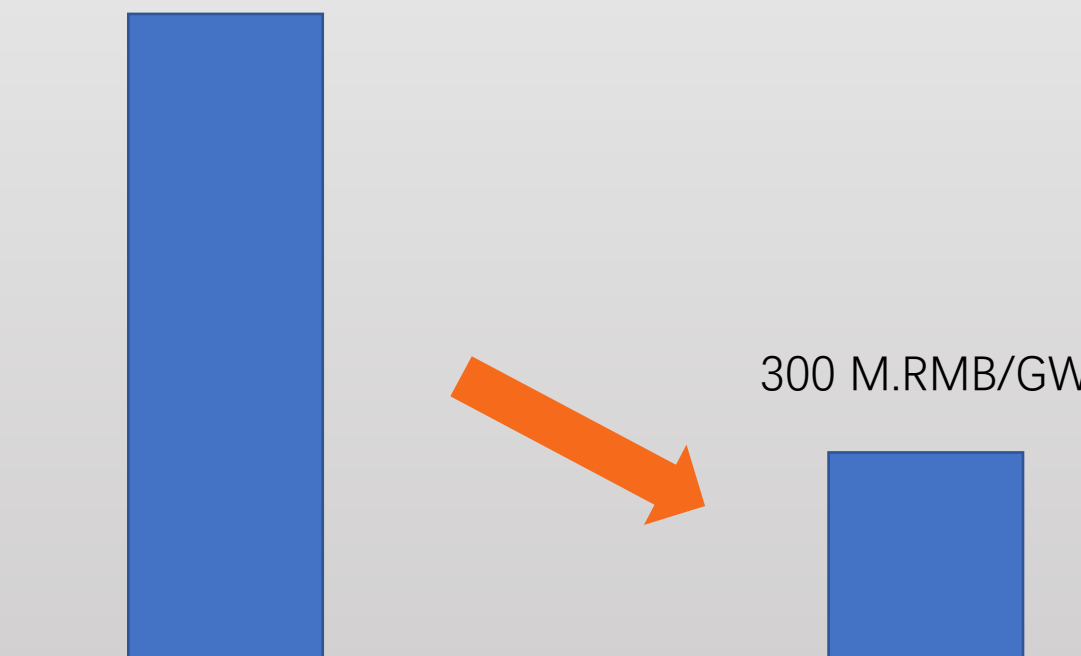
Wafer

Silver/Indium

Other



1000 M.RMB/GW



300 M.RMB/GW

2019

2023

Source: Taiyangnews, 2023/11

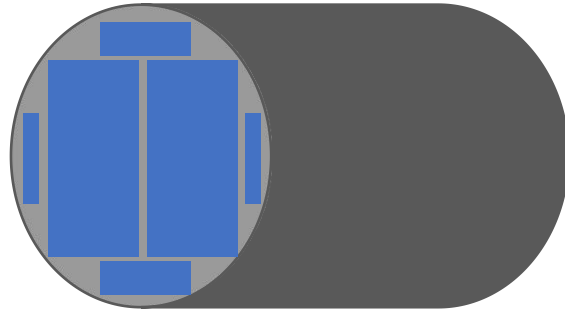
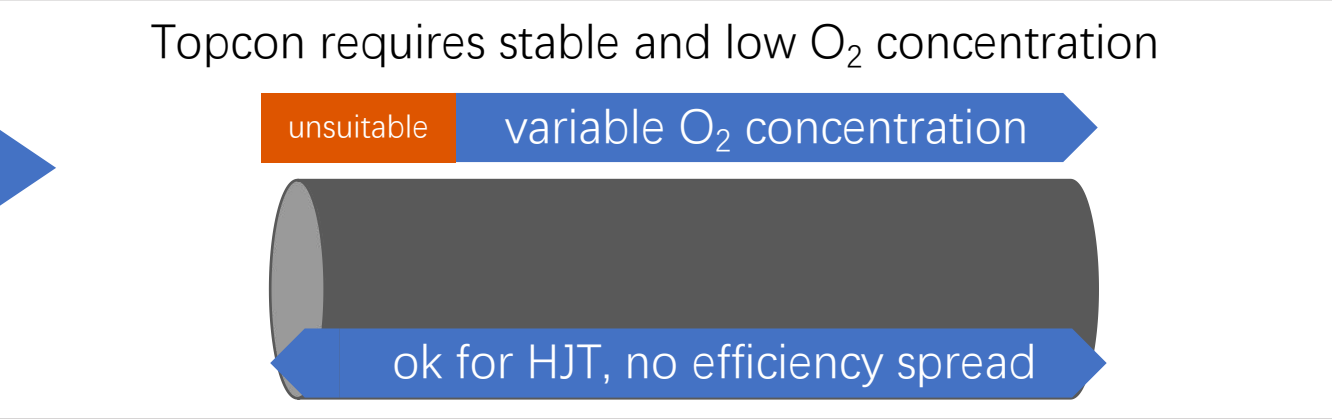
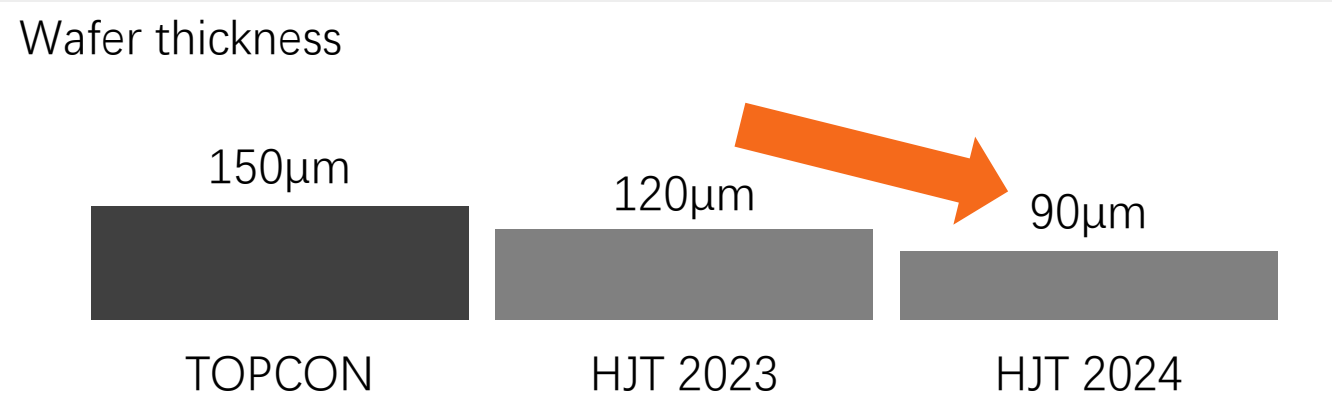
Cost Down in Heterojunction

Factory CAPEX

Wafer

Silver/Indium

Other



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

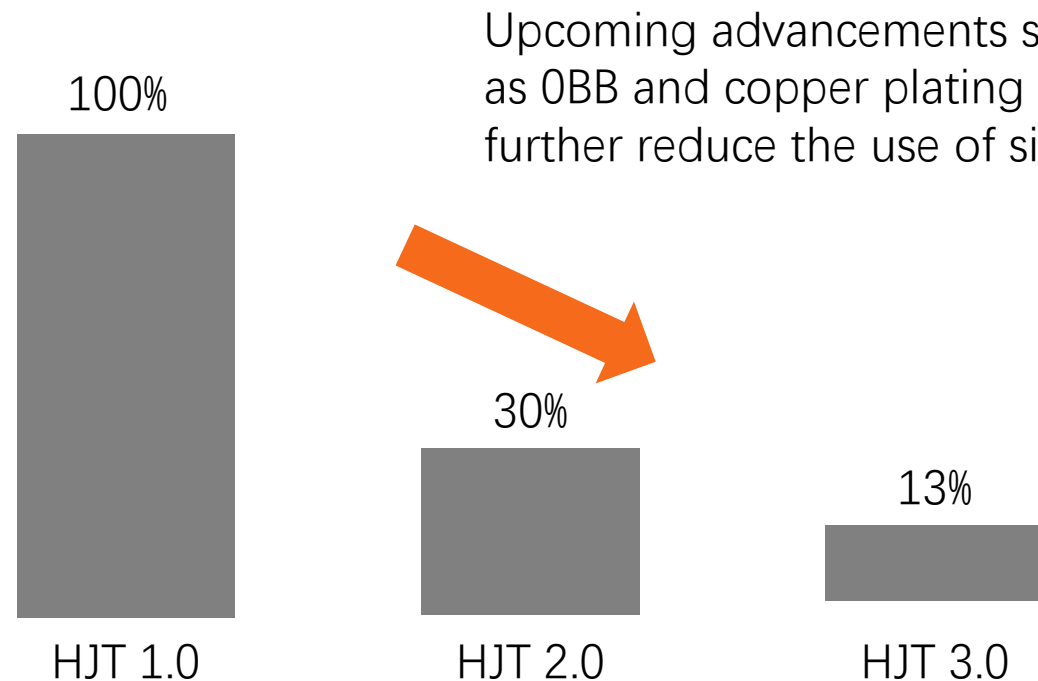
Wafer

Silver/Indium

Other



Silver consumption per Wp



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

Cost Down in Heterojunction

Factory CAPEX

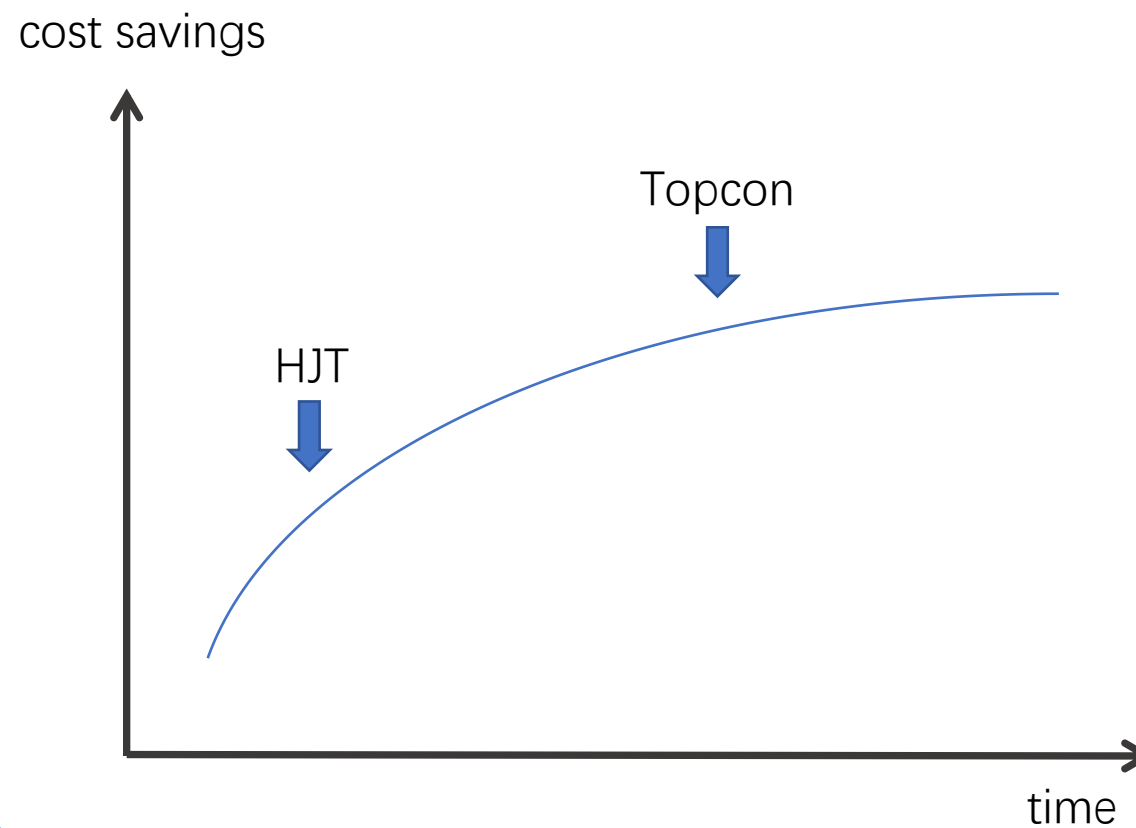
Wafer

Silver/Indium

Other



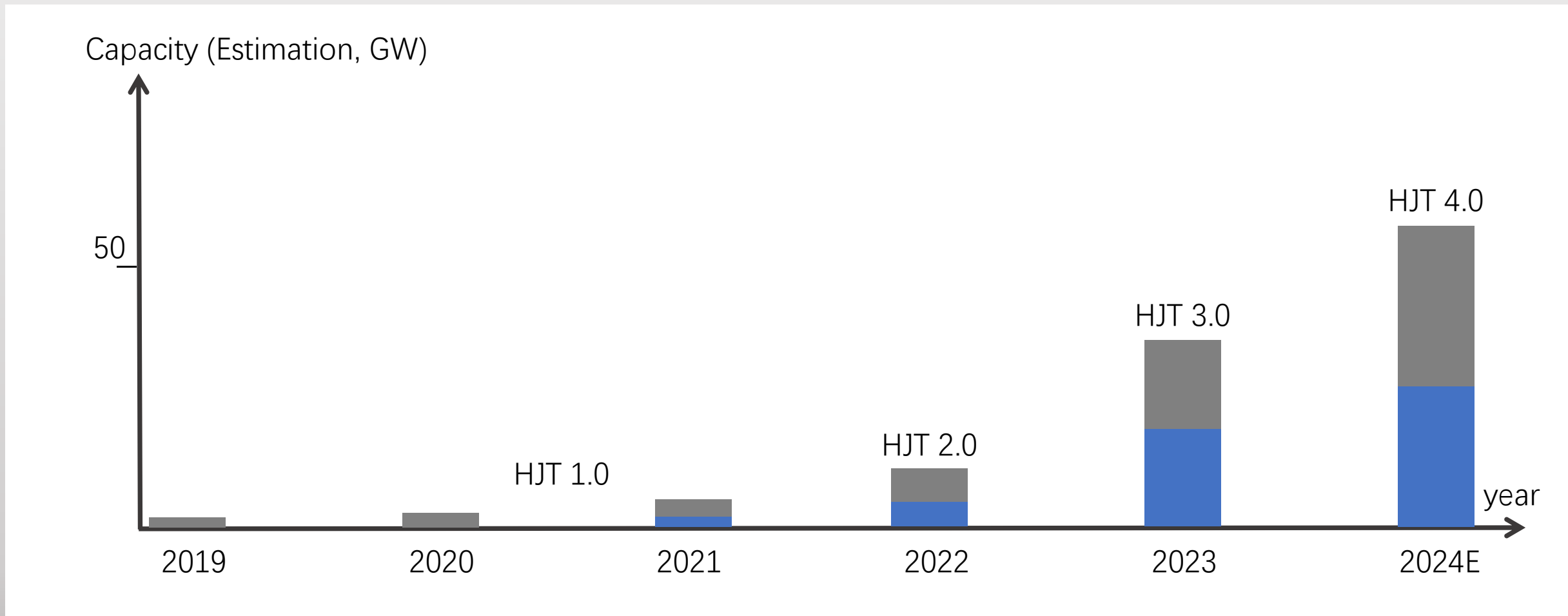
HJT is at a stage of rapid innovation pace



Industrial Scale Manufacturing



Huasun HJT 3.0: utilization rate > 70%



Reliability and durability / handling the main degradation sources



LID

NO BORON



LeTID

n-type silicon



Contact Ageing

TC2000



PID

TCO surface

MICROCRACKS

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

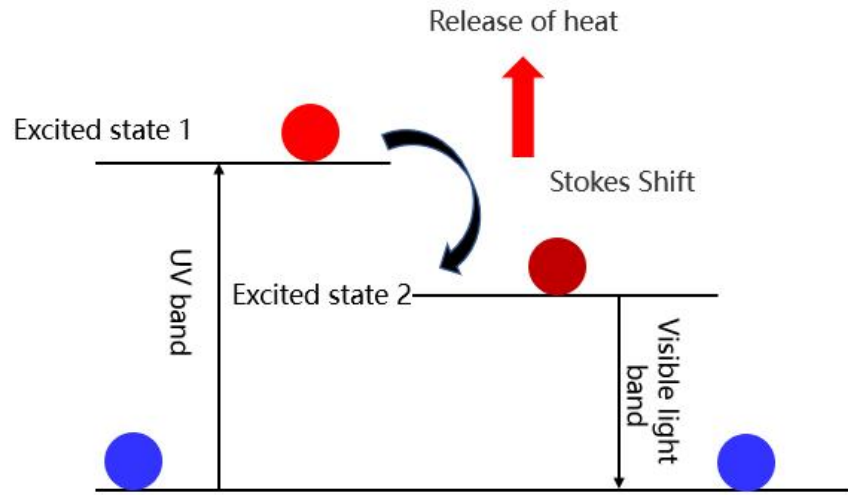


- Wafer of 120 μm (2023),
<100 μm (2024)
- No laser damage
- Flexible without breaking
- Symmetrical structure
- Glass/glass module

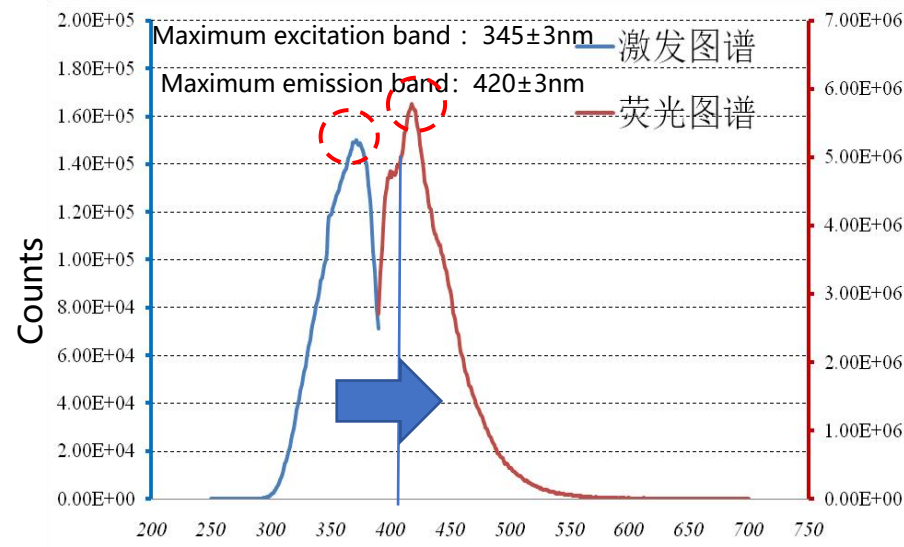
- For Huasun HJT, cells are not prone to crack through mechanical stress

Ultra-violet irradiance (high-energy photons)

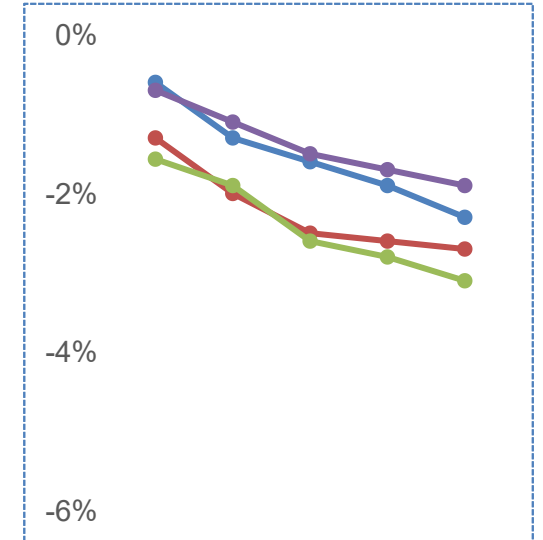
- Light made of photons with **shorter wavelength than 415 nm** (UV) may cause the split of the compound Si-H present in the passivation layers of n-type cells
- The conversion film **increases the wavelength** of photons with originally higher frequency, increasing efficiency and reducing degradation



Light conversion principle



Absorption and emission of light conversion film

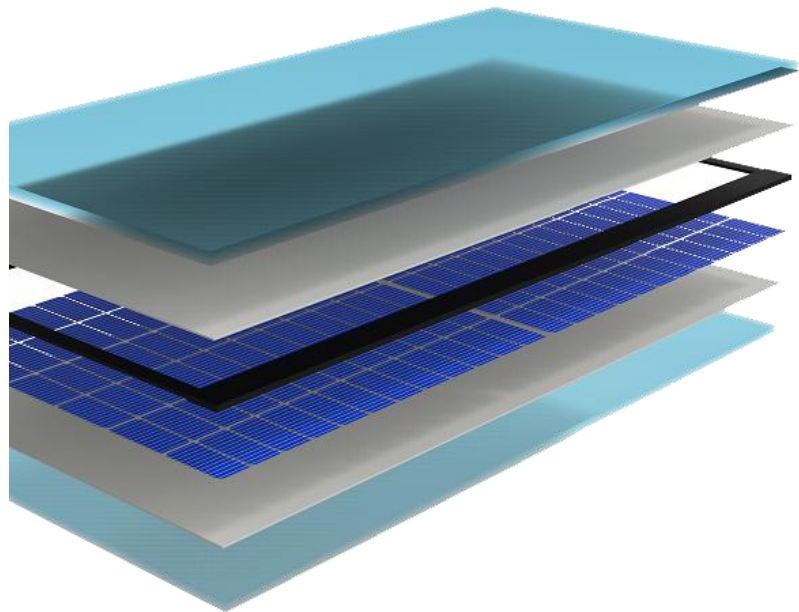


UV180 < 3%

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) 10x better than the best current option (POE/EPE), in terms of resistance to water penetration
- We have ran 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)



10 times

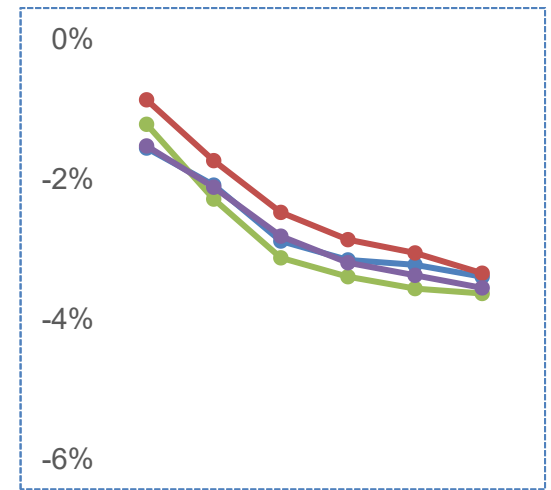
Water penetration resistance

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

Efficiency / utility scale module types (2023)



POWER BINS	
	595
	590
	585
580	580
575	
570	
	565
	560
	555

HJT 23%

22% TOPCON

PERC 21%

POWER BINS	
	605
	600
	595
590	590
585	
580	
	575
	570
	565

HJT

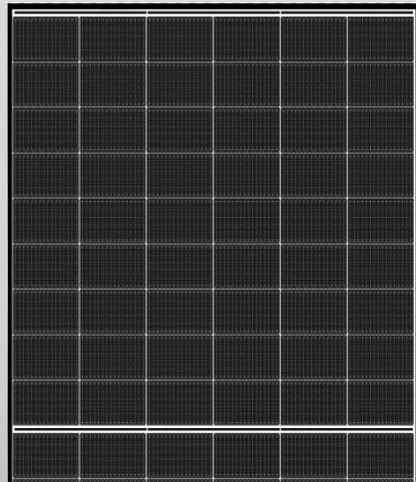
22% TOPCON

PERC 21%

POWER BINS	
	710
	700
690	690
680	
670	670
	660
	650

HJT 23%

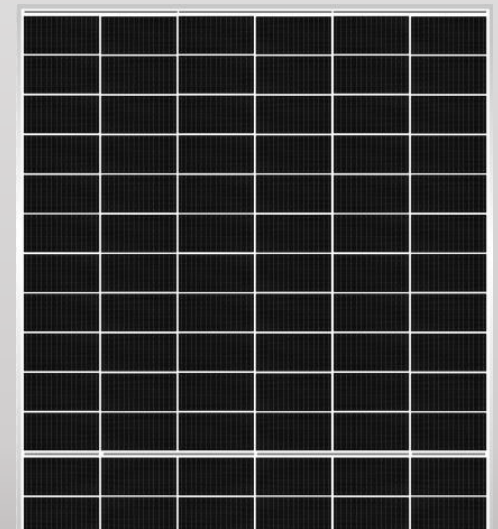
PERC 21%



G10-144



G10R-132



G12-132

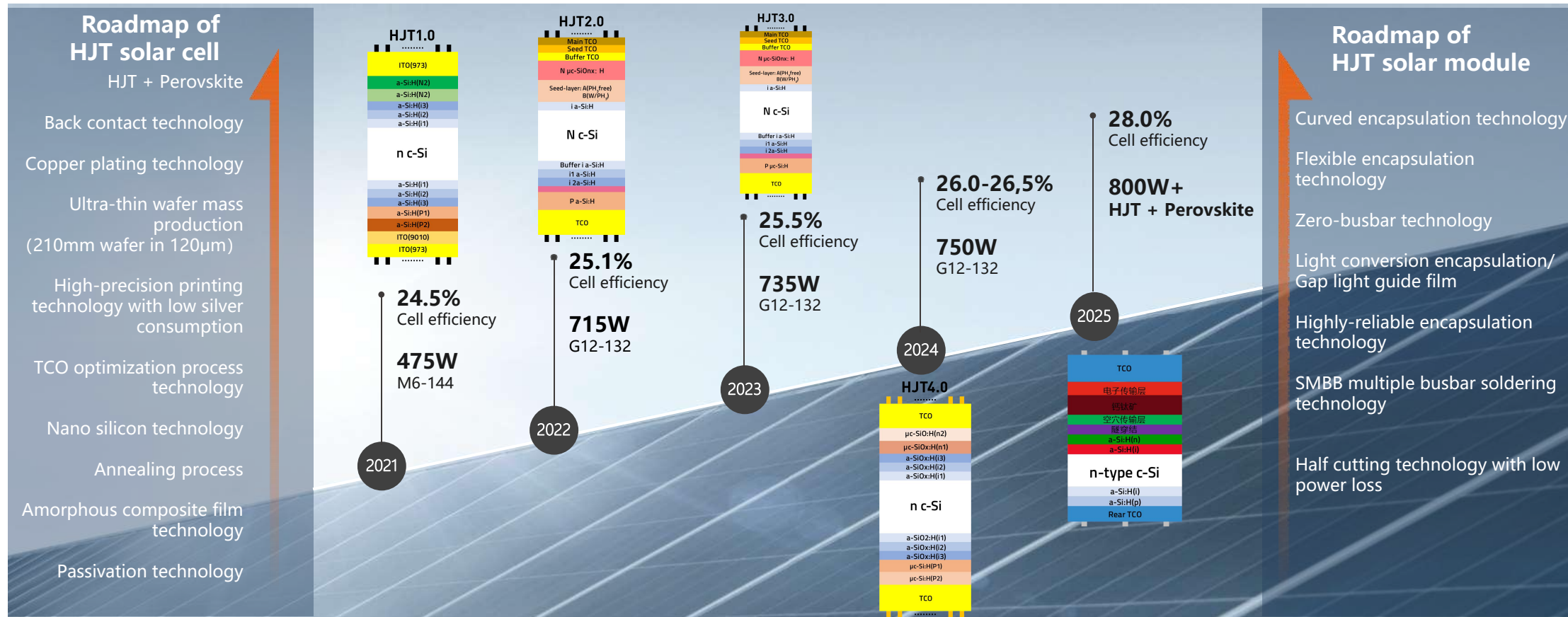
Efficiency roadmap

We expect an efficiency increase of 0.5% [abs] yearly

From 2025, based on HJT, perovskite will jump efficiency by >1% [abs]

800w+

HJT+Perovskite+210mm wafer
Module power over 800W



LCOE advantage: higher efficiency

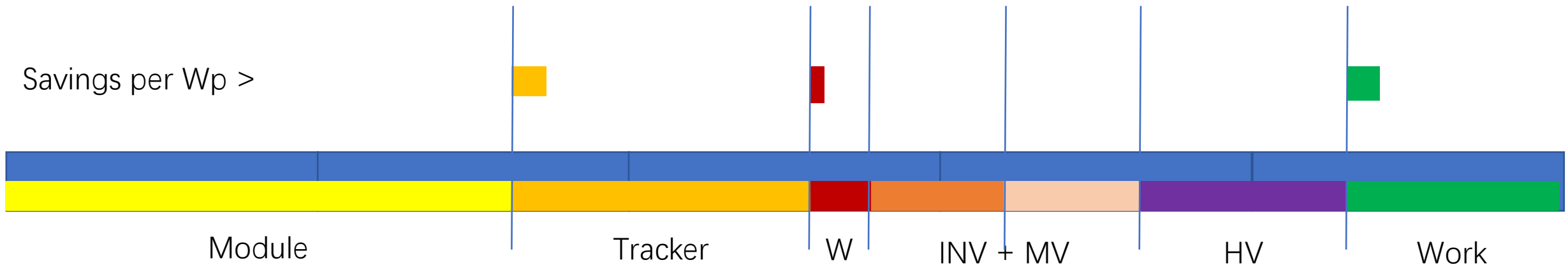


We can compare equal configurations (Spain, 100MW)

- G10 * 72 cells (144) - 580W vs. 595W
- G10R * 66 cells (132) - 605W vs. 620W
- G12 * 66 cells (132) - 685W vs. 705W

HJT savings vs. Topcon: USDc 0.49

Cost reductions applicable for system design with same AC power, same DC/AC ratio, same total land use
AC side considered turn-key (i.e. including work)



LCOE advantage: higher yield equals higher value



System Type:

Italy, 1P tracker, 0.62c/Wp

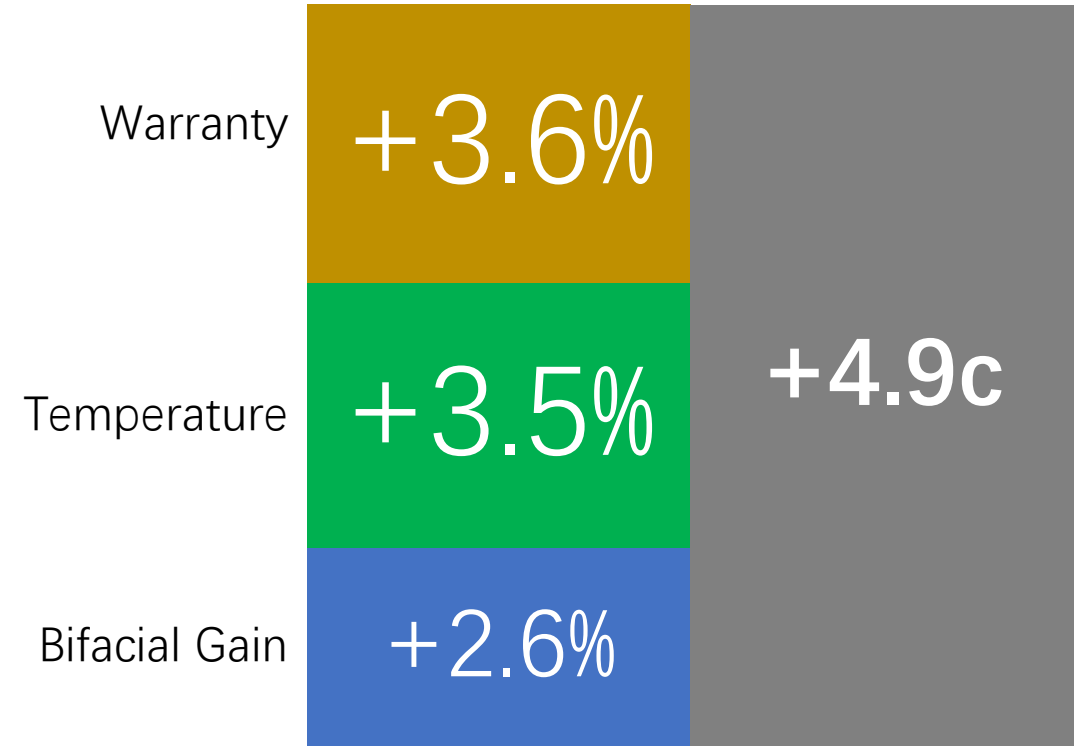
Baseline Yield PERC:

9% Bifacial Gain

10% Temperature Loss



Huasun vs. TOPCON



Huasun vs. PERC



Test systems - yield results

Yinchuan - 210mm HJT vs TOPCon / 1P tracker

Module	PCS	Power
HJT 210-132 BF	8	670
TOPCon 182-144 BF	8	570

System	
Max. Inclination	40°
Height	1m
Row Spacing	10m

Advantage HJT vs. Topcon	DC Energy (kWh/kWp)
Concrete Ground	+1.89%
White Paint Ground	+4.42%

CTC - 166mm HJT vs PERC / fixed tilt

Module	PCS	Power
HJT 166-144 BF	7	460
PERC 158-156 BF	7	445

System	
Installation angle	15.5°
Height	1.2m
Row Spacing	4m

Advantage HJT vs. PERC	DC Energy (kWh/kWp)
Concrete Ground	+8.31%
White Pain Ground	+9.27%

Xuancheng - 210 HJT vs 182 TOPCon vs 210 PERC / Fixed Tilt, Albedo 20%, optimizer

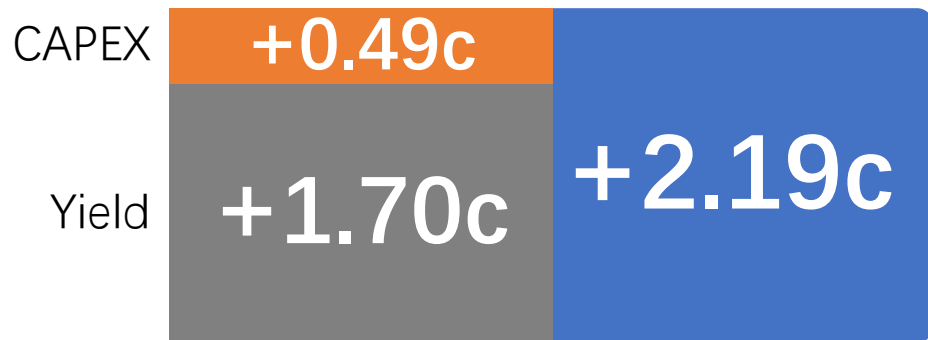
Module	PCS	Power
HJT 210-132 BF	1	670
PERC 210-132 BF	1	650
TOPCon 182-144 BF	1	570

Advantage HJT	DC Energy (kWh/kWp)
vs. TOPCON	+1.18%
vs. PERC	+3.33%

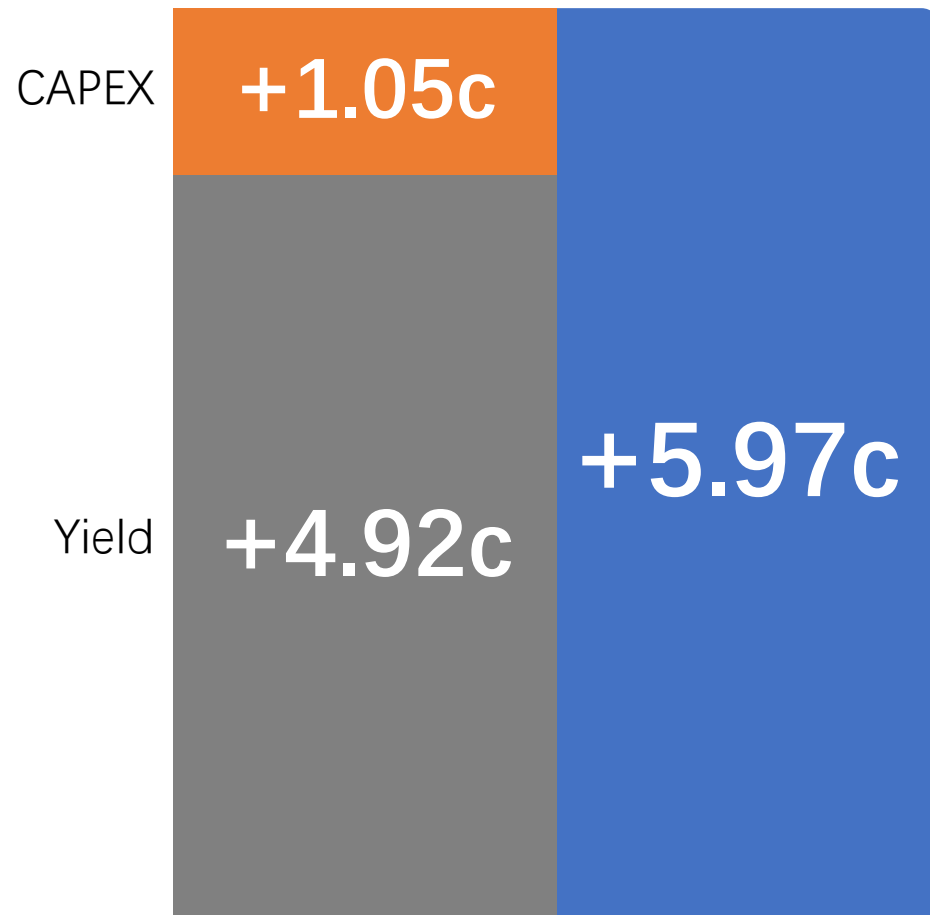
LCOE advantage: typical case (1P SAT)



The price of Huasun HJT is lower than its LCOE-adjusted value compared to both TOPCON and PERC, for utility-scale PV plants.



Huasun vs. TOPCON



Huasun vs. PERC



Build a ZERO Carbon World

Intelligently Produce Clean Energy
Together Share The Warm Sunshine



www.huasunsolar.com



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Project Reference:

Pazardzhik, Bulgaria, 350MW

Intelligently Produce Clean Energy
Together Share The Warm Sunshine

Anna Paskalova
Sr. Sales Manager, Europe
anna@huasunsolar.com



Bulgaria

350MW

Utility Project

World's LARGEST HJT utility solar project to present.

Location: **Pazardzhik, Bulgaria**

Capacity: **350MW**

Annual power generation:

650,000,000 kW·h

Annual coal saving:

260,000 tons

Annual CO₂ emission reduction:

648,000 tons



350MW

Bulgaria

INERCOM Apriltsi Village



Site Aerial View, August 2023

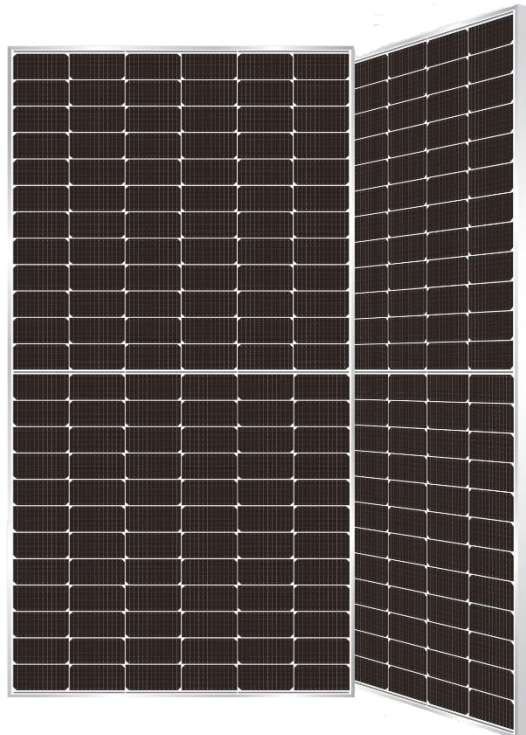
Photo credit: Apriltsi project technical team

Project Apriltsi: Technical Parameters



Solar PV modules:

Module technology: N-type HJT
Bifacial or monofacial: Bifacial
Structure: Glass-glass
Power output: 465W and 470W
Model: Himalaya M6, 166 144-cell
Manufacturer: Huasun Energy



Model HS-166-B144-DS_460-480
Bifacial Glass-glass N-type HJT Module

Tracking system:

Most of the modules are mounted on trackers (single-axis) and some are mounted on fixed structures (no trackers).



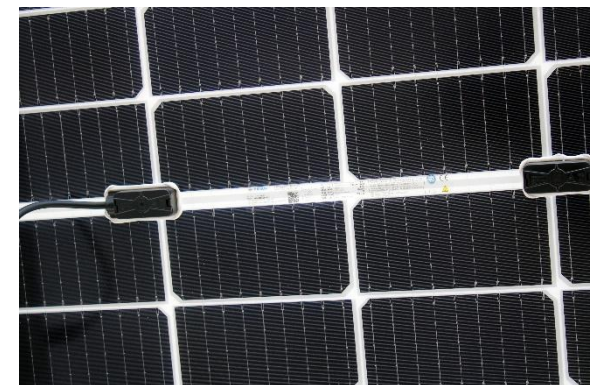
Fixed structures



With trackers



The solar panels on project Apriltsi are mounted at a certain height allowing for agricultural production below (agrivoltaics or agrisolar).



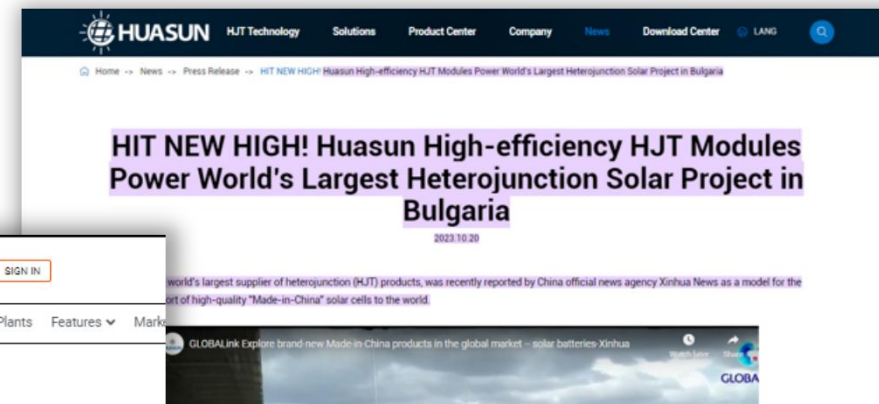
Attention to detail: the labels are transparent, minimizing the impact to the module's functioning.

Project Apriltsi on the International News

Gigawatt-scale breakthrough: Huasun and INERCOM boost Bulgarian solar projects

SUSTAINABILITY - Collaboration between Huasun and INERCOM will expand the Bulgarian PV industry significantly.

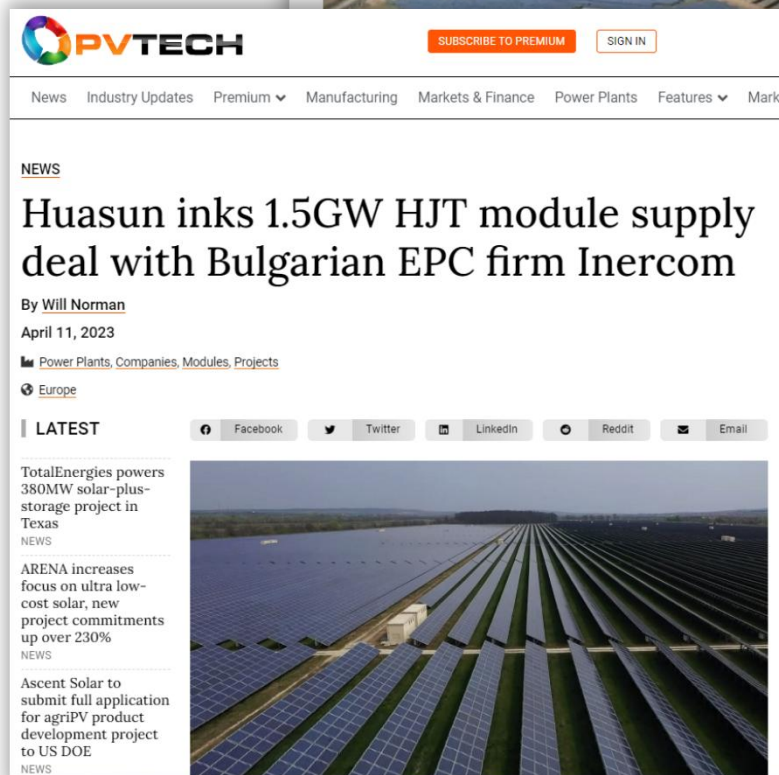
NEWS 12 APRIL 2023

HIT NEW HIGH! Huasun High-efficiency HJT Modules Power World's Largest Heterojunction Solar Project in Bulgaria

2023.10.20

world's largest supplier of heterojunction (HJT) products, was recently reported by China official news agency Xinhua News as a model for the export of high-quality "Made-in-China" solar cells to the world.



Huasun inks 1.5GW HJT module supply deal with Bulgarian EPC firm Inercom

By Will Norman
April 11, 2023

Power Plants, Companies, Modules, Projects

Europe

LATEST

TotalEnergies powers 380MW solar-plus-storage project in Texas

ARENA increases focus on ultra low-cost solar, new project commitments up over 230%

Ascent Solar to submit full application for agriPV product development project to US DOE




Huasun high efficiency HJT modules contribute to Bulgarian energy transformation

By Huasun Energy
April 15, 2022

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Based on the EU's stated green energy objectives, Bulgaria has incorporated renewable energy as a key national development blueprint, which has seen a recent proliferation of photovoltaic projects. In the south of the country, in the village of Apriltsi, construction of the world's largest HJT solar farm is underway.



Bulgaria's Inercom in 1.5 GW solar panels supply deal with Huasun

Author: Antonio Kokalov-Gray

Published: Apr 11, 2023 11:48 EEST, SOFIA



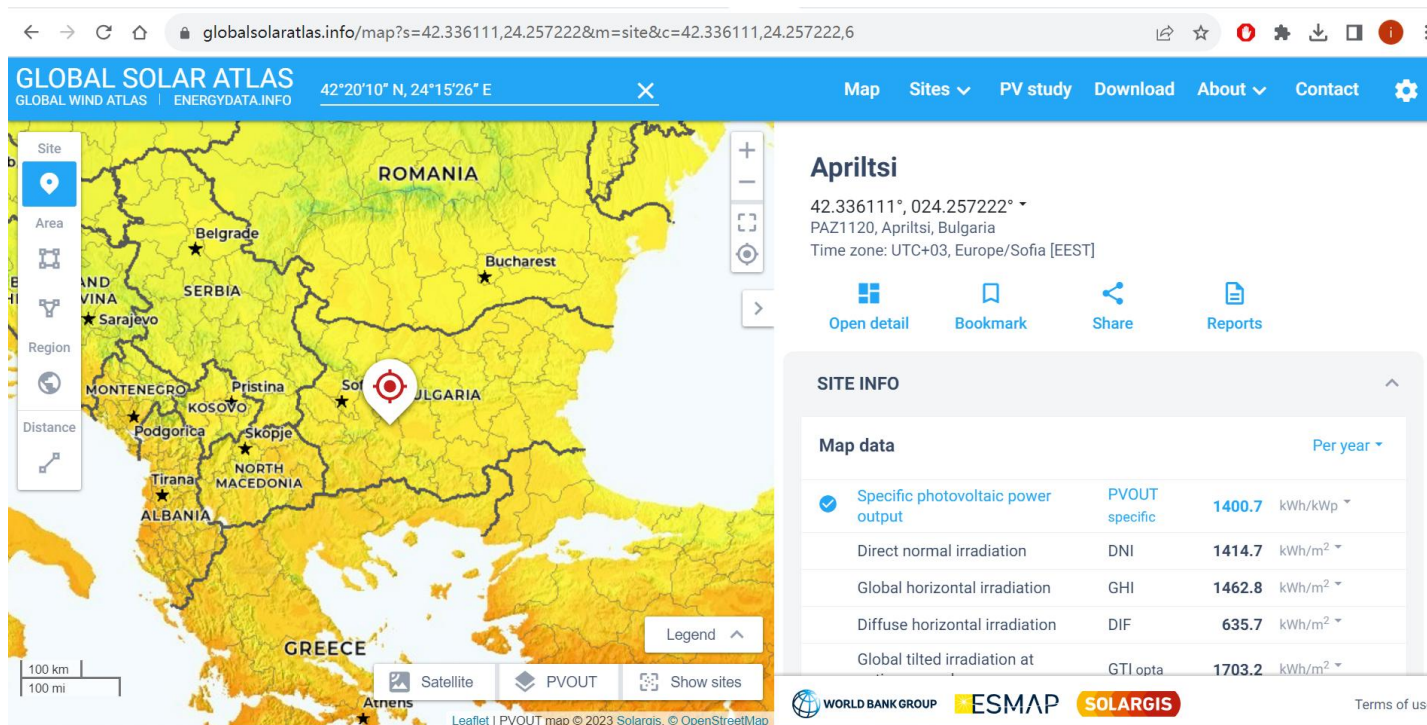
<https://www.pv-tech.org/huasun-inks-1-5gw-hjt-module-supply-deal-with-bulgarian-epc-firm-inercom/>

<https://www.pv-tech.org/industry-updates/huasun-high-efficiency-hjt-modules-contribute-to-bulgarian-energy-transformation>

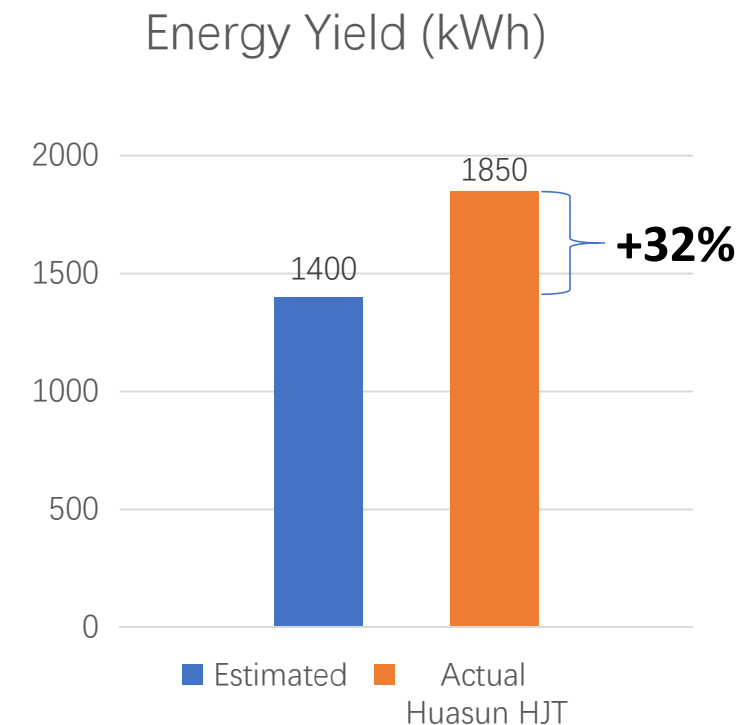
<https://seenews.com/news/bulgarias-inercom-in-15-gw-solar-panels-supply-deal-with-huasun-819962>

Project Apriltsi & Huasun HJT: High Energy Yield

Global Solar Atlas PV power output estimation at the project location:



Source: <https://globalsolaratlas.info/map?s=42.336111,24.257222&m=site&c=48.464438,20.390625,4>



Estimated PV power output at the Project Location: **1400 kWh/ kW installed capacity***
Actual PV power output with Huasun HJT modules: **1850 kWh/ kW installed capacity****

The client is reporting 32% higher energy yield than expected based on initial calculations.

* Source: Global Solar Atlas (link: <https://globalsolaratlas.info/map?s=42.336111,24.257222&m=site&c=48.464438,20.390625,4>)

** Source: Apriltsi Project owner's data

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Q&A



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by Ralph Diermann



Install grid-connected solar, rinse, repeat
by Max Hall



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Many more to come!

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cracking – a
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overcurrents**

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