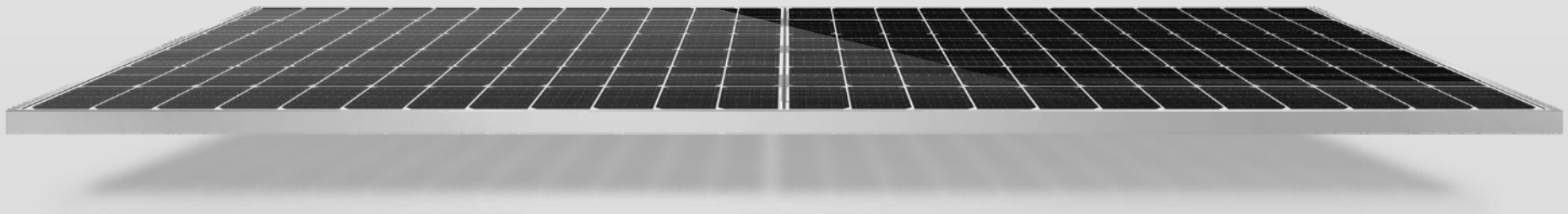
HUASUN

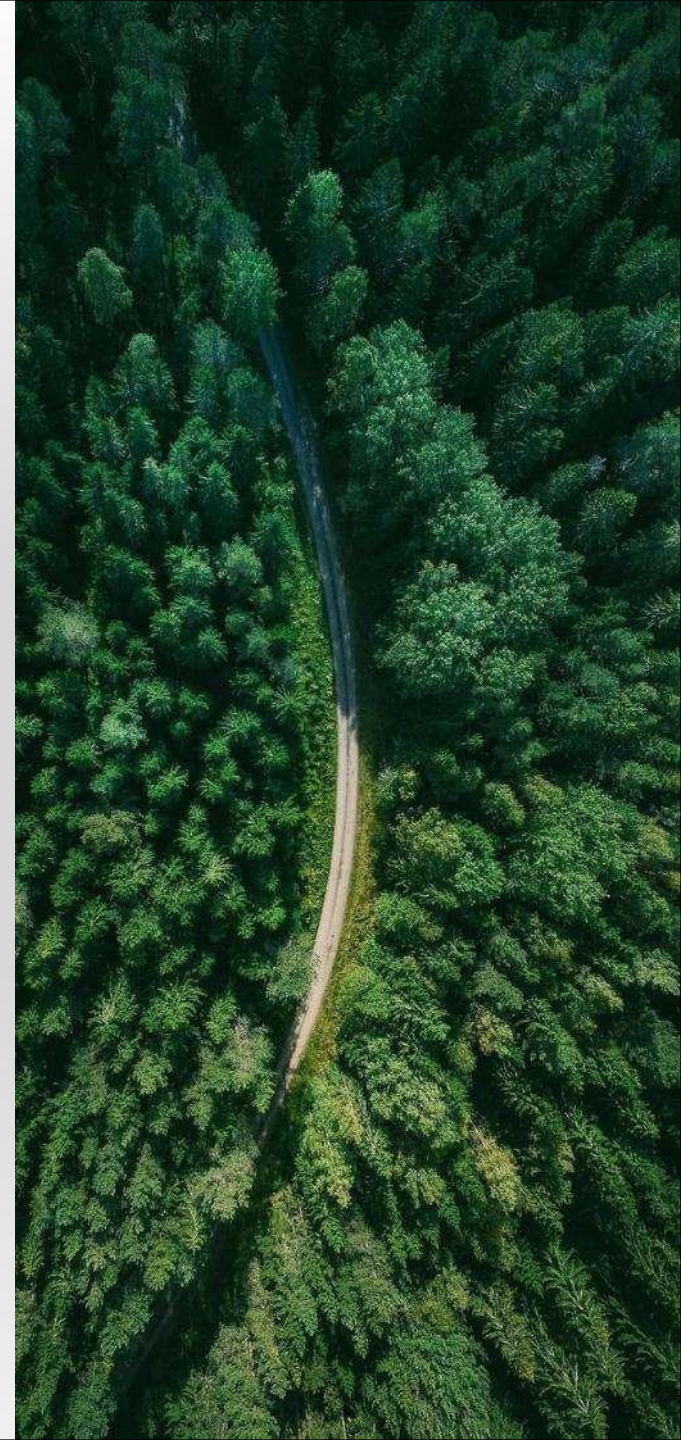
HETEROJUNCTION for UTILITY SCALE PV

HJT



Anhui Huasun Energy Co., Ltd

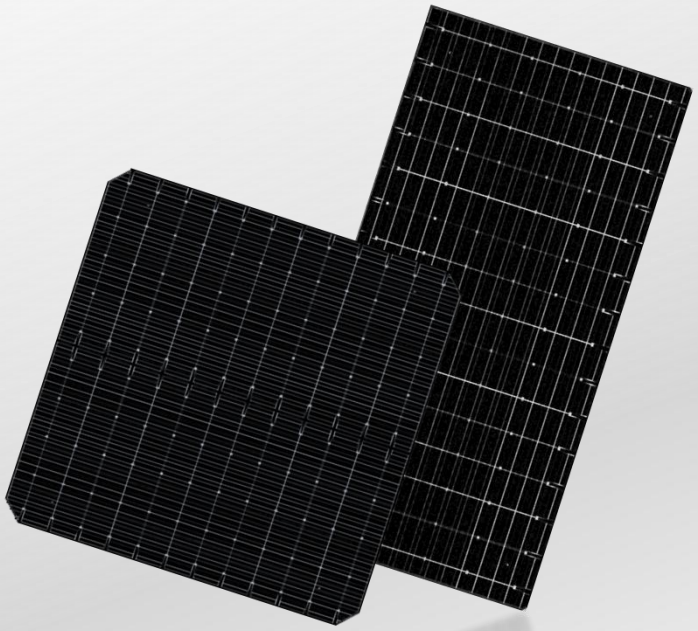
Contents - Heterojunction for utility scale PV



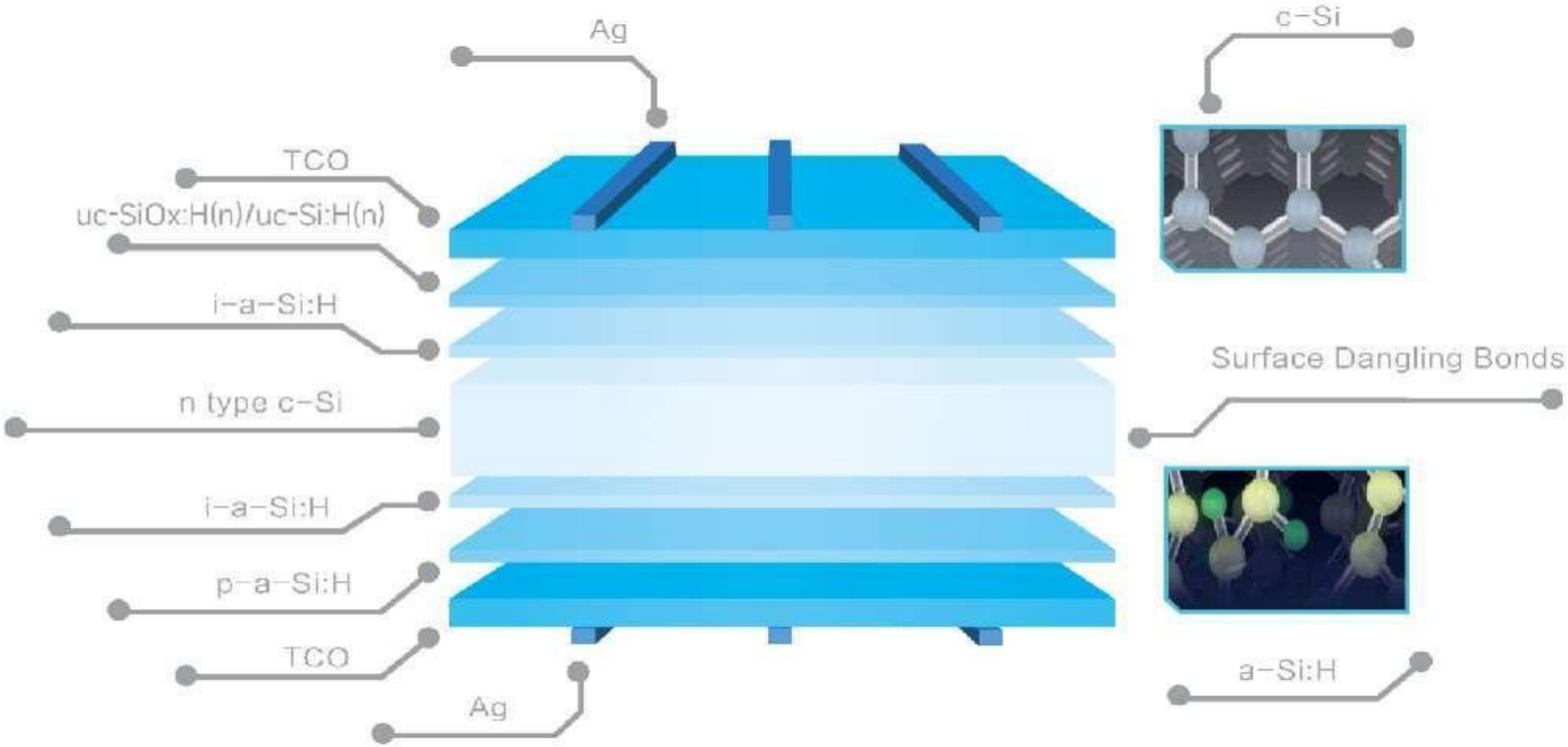
Heterojunction

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?

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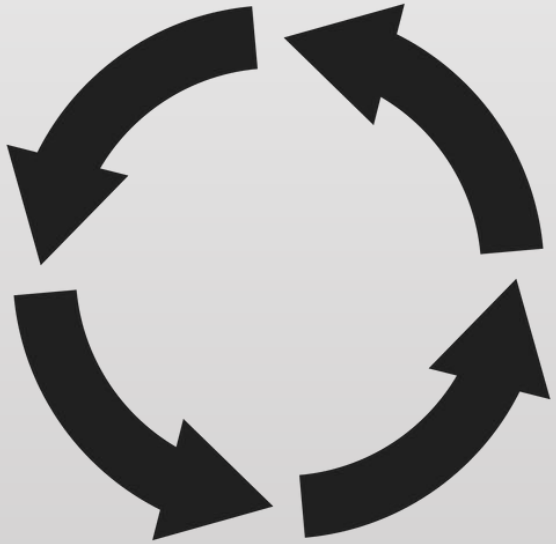
Efficiency & Performance

Cost Down



Reliability

Industrial 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

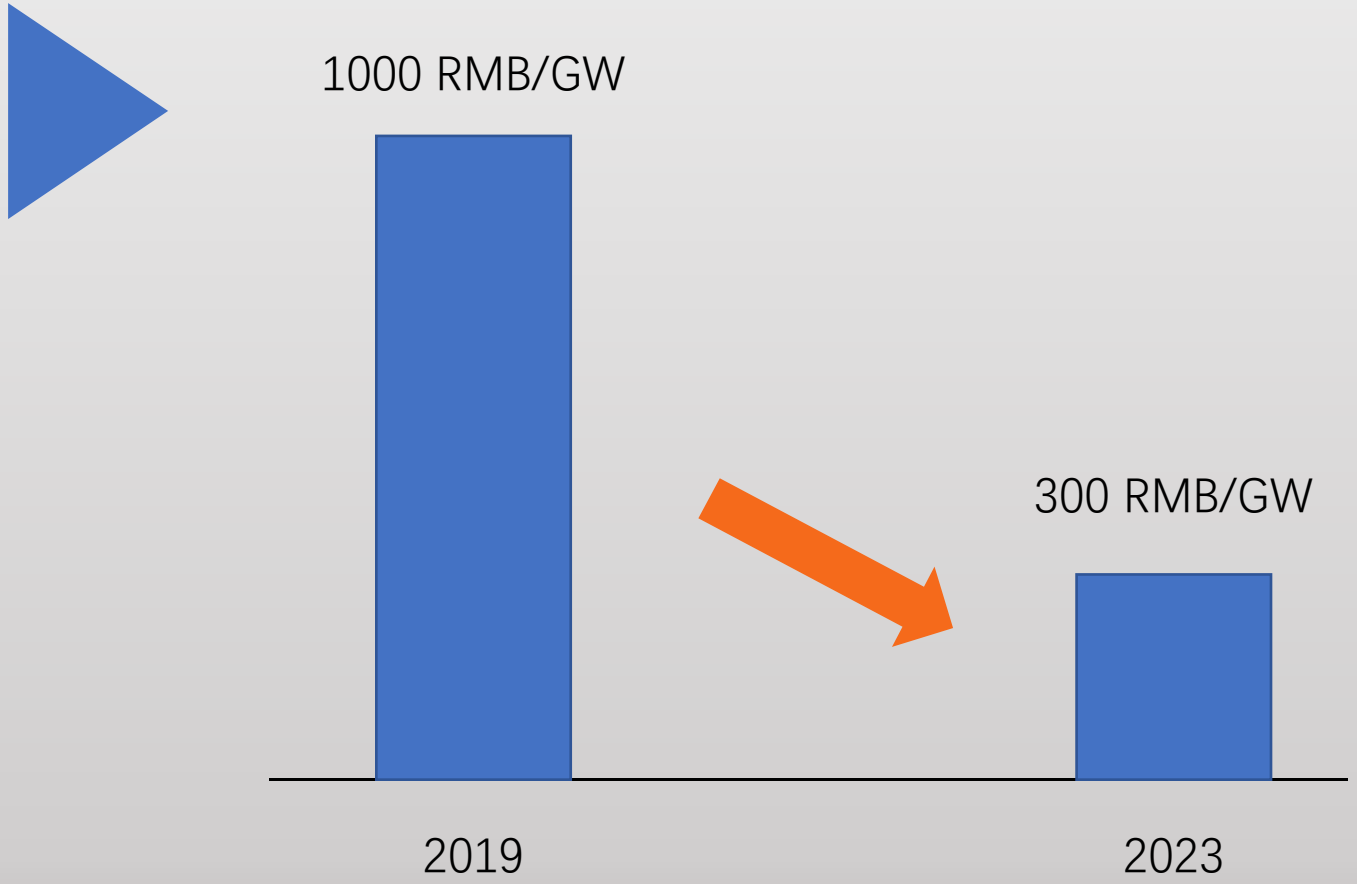
Cost Down in Heterojunction

Factory CAPEX

Wafer

Silver/Indium

Other

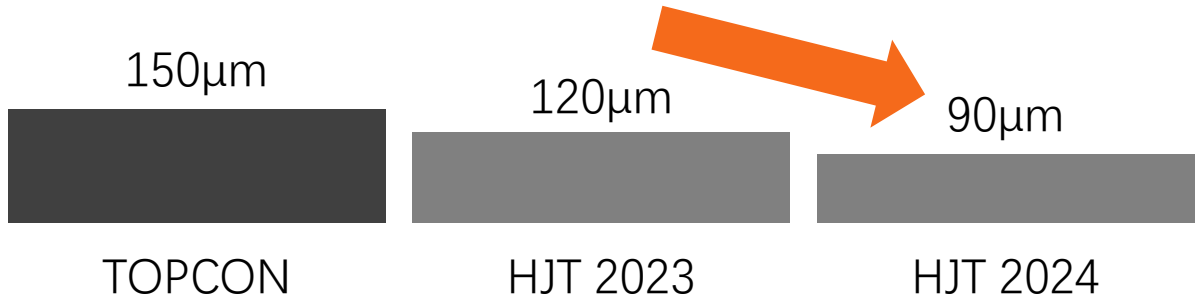


Source: Taiyangnews, 2023/11

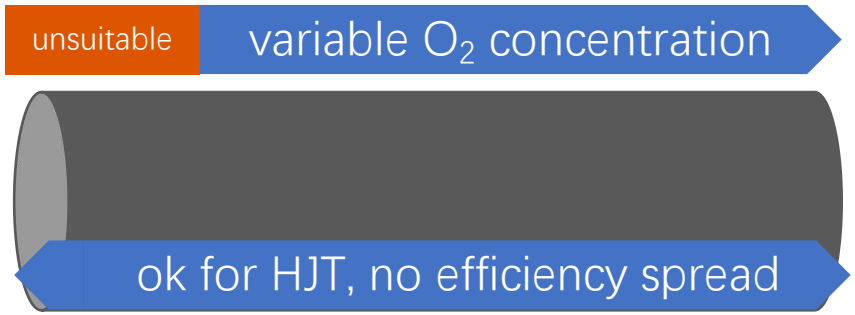
Cost Down in Heterojunction

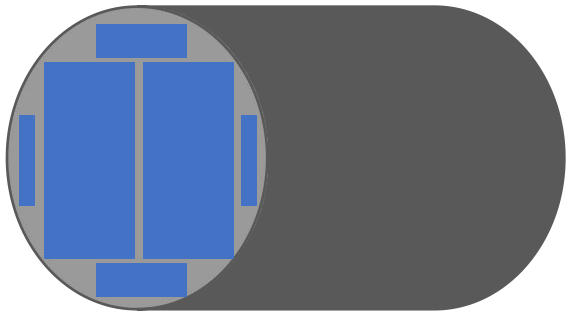
- Factory CAPEX
- Wafer
- Silver/Indium
- Other

Wafer thickness



Topcon requires stable and low O_2 concentration



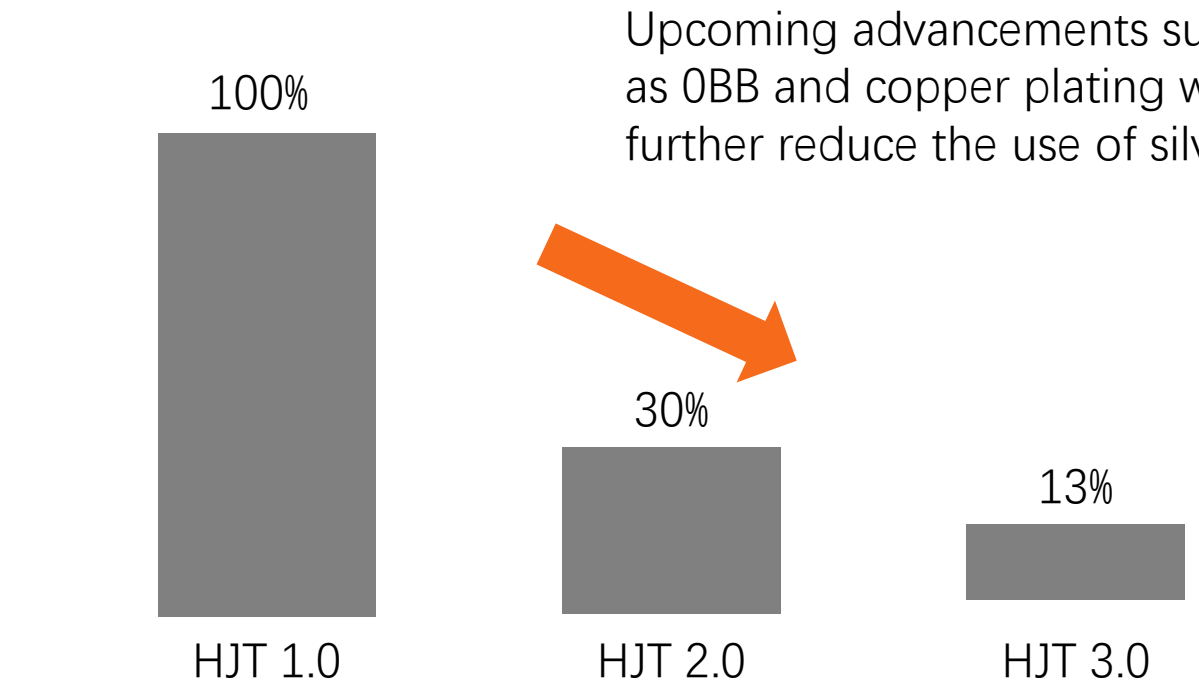


With half-cut wafers, we can make 1/2 size slabs from the rest of the original ingot to utilize more and waste less

Cost Down in Heterojunction

- Factory CAPEX
- Wafer
- Silver/Indium
- Other

Silver consumption per Wp



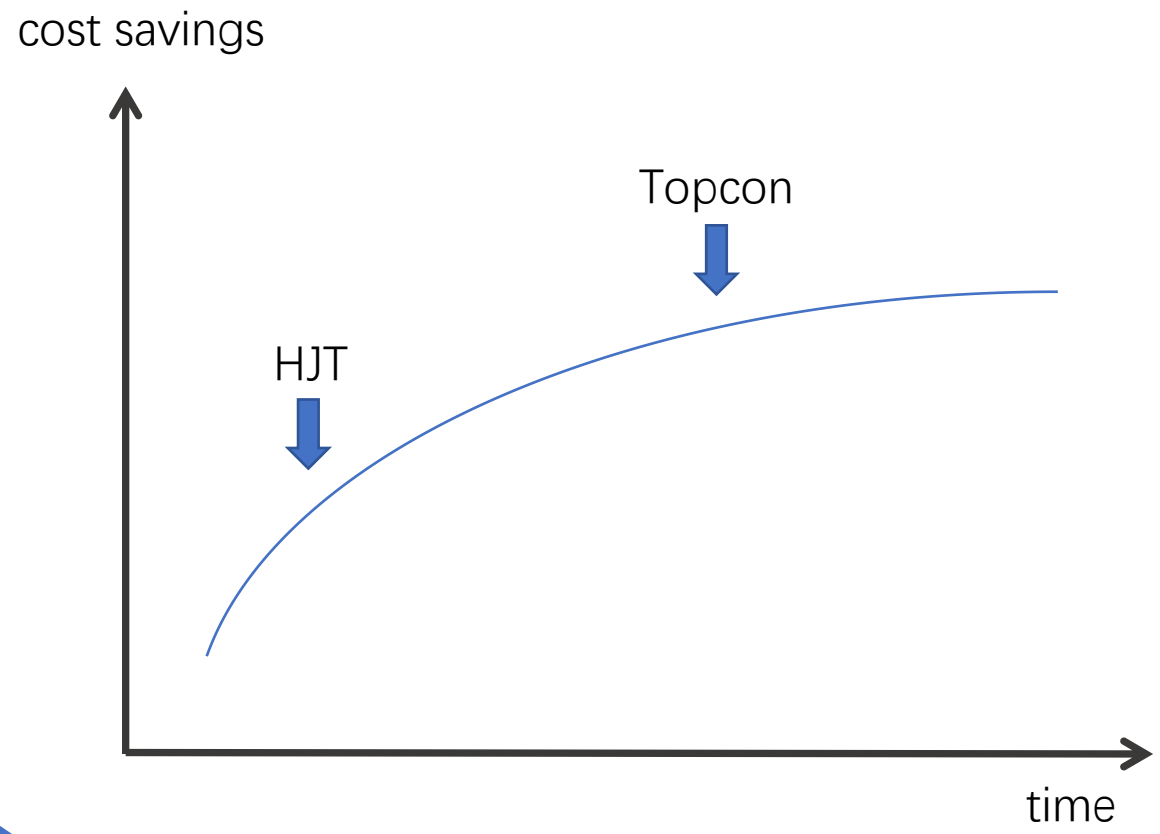
Upcoming advancements such as 0BB and copper plating will further reduce the use of silver

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

Cost Down in Heterojunction

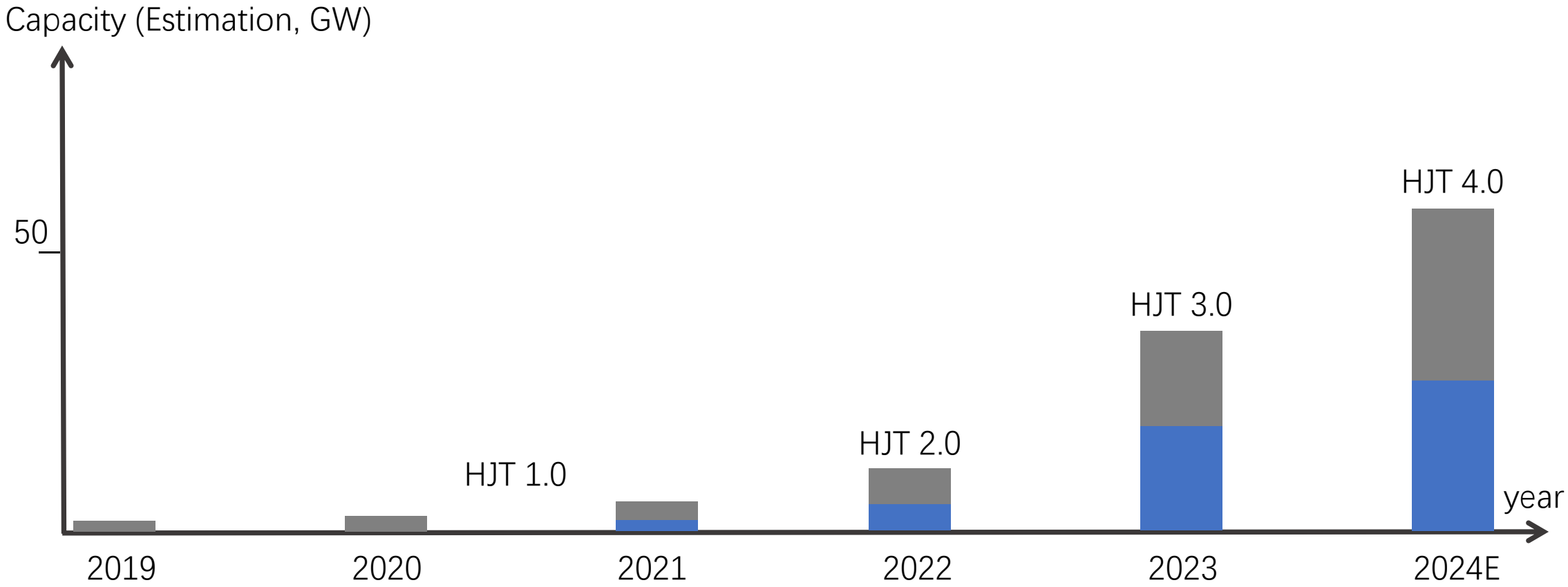
- Factory CAPEX
- Wafer
- Silver/Indium
- Other

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

HUASUN

✓ 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

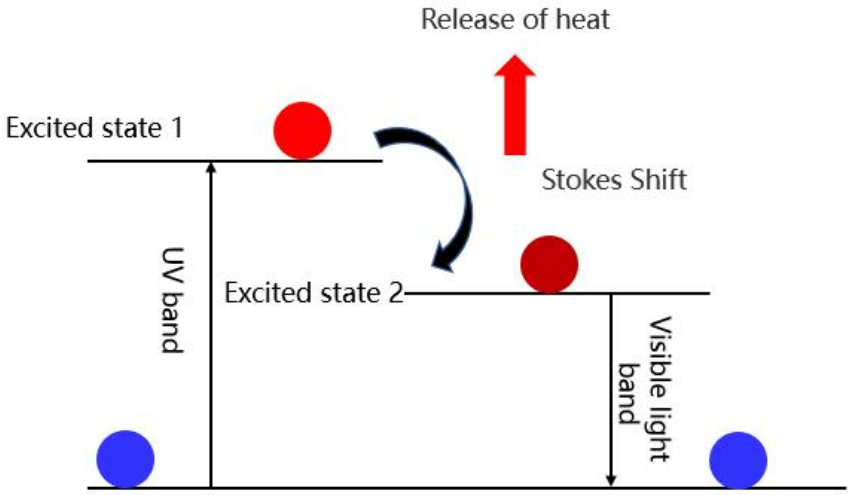
Microcracks

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

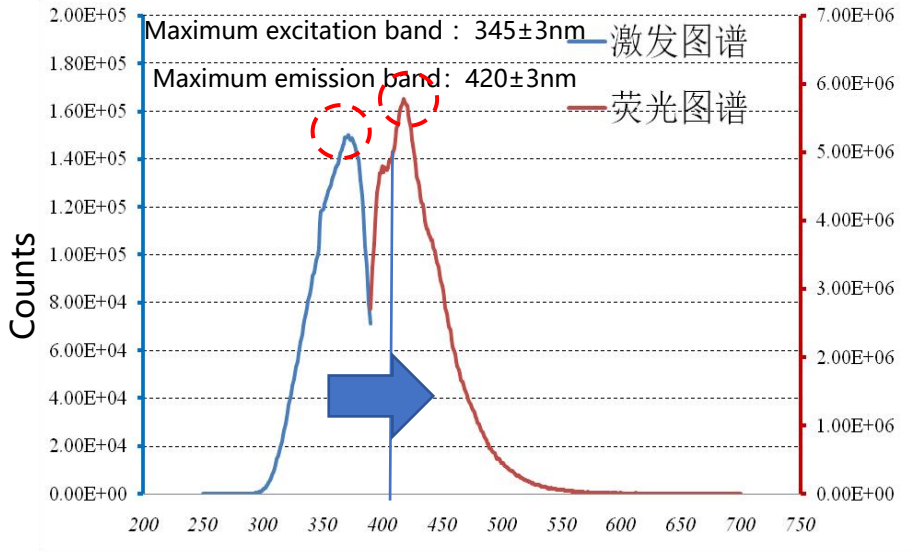
- **For Huasun HJT, cells are not prone to crack through mechanical stress**

Ultra-violet irradiance (high-energy photons)

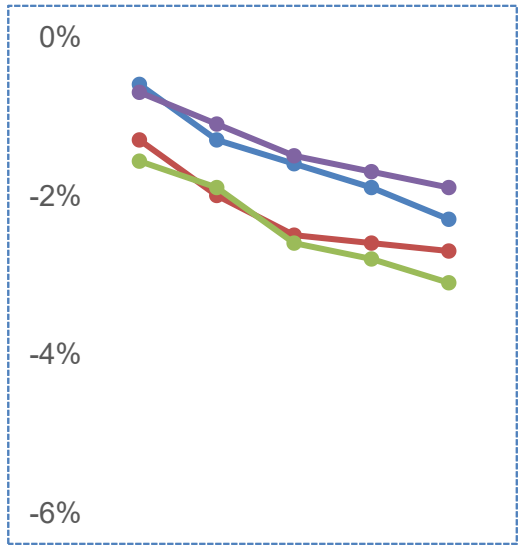
- Light made of photons with **shorter wavelength than 415 nm** (UV) may cause the split of the compound Si-H present in the passivation layers of n-type cells
- The conversion film **increases the wavelength** of photons with originally higher frequency, increasing efficiency and reducing degradation



Light conversion principle



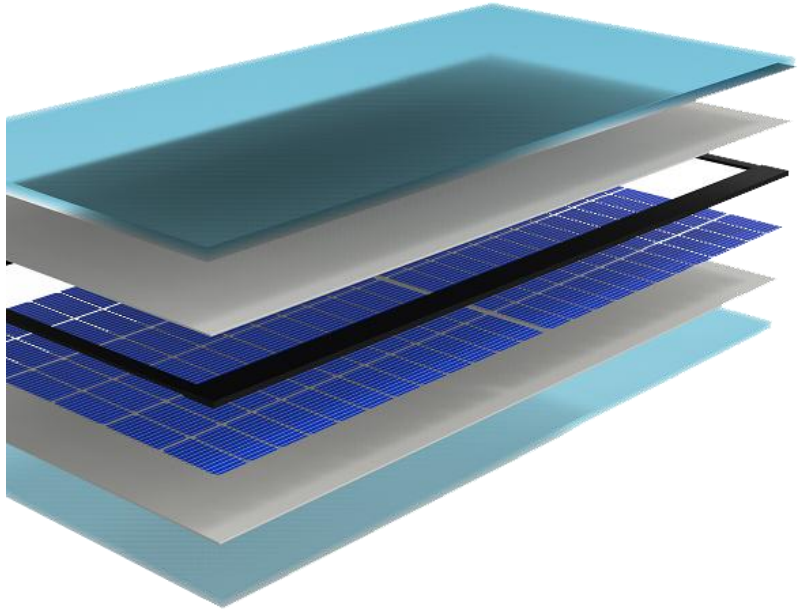
Absorption and emission of light conversion film



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

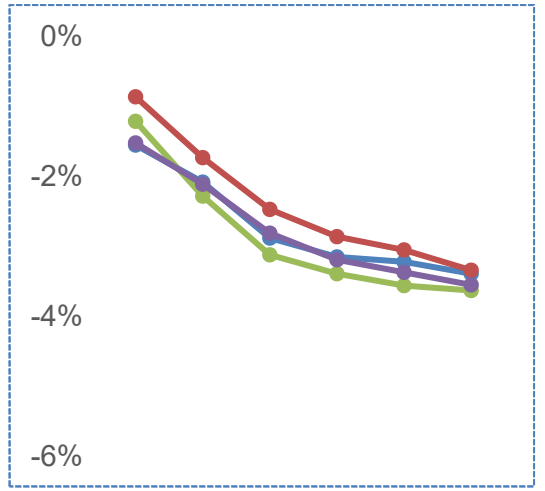
Water penetration resistance

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

HUASUN

✓ 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)

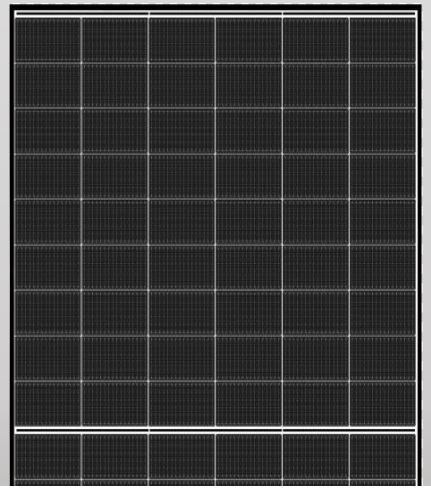
HUASUN

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

22% TOPCON

HJT 23%

PERC 21%



G10-144

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

22% TOPCON

HJT

PERC 21%

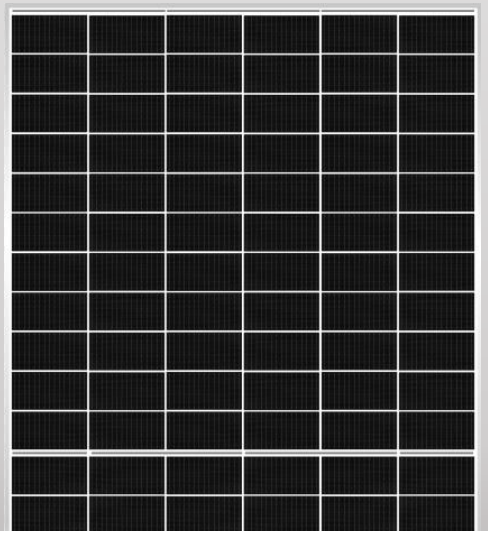
G10R-132

POWER BINS	
	710
	700
690	690
680	
670	670
	660
	650

22% TOPCON

HJT 23%

PERC 21%



G12-132

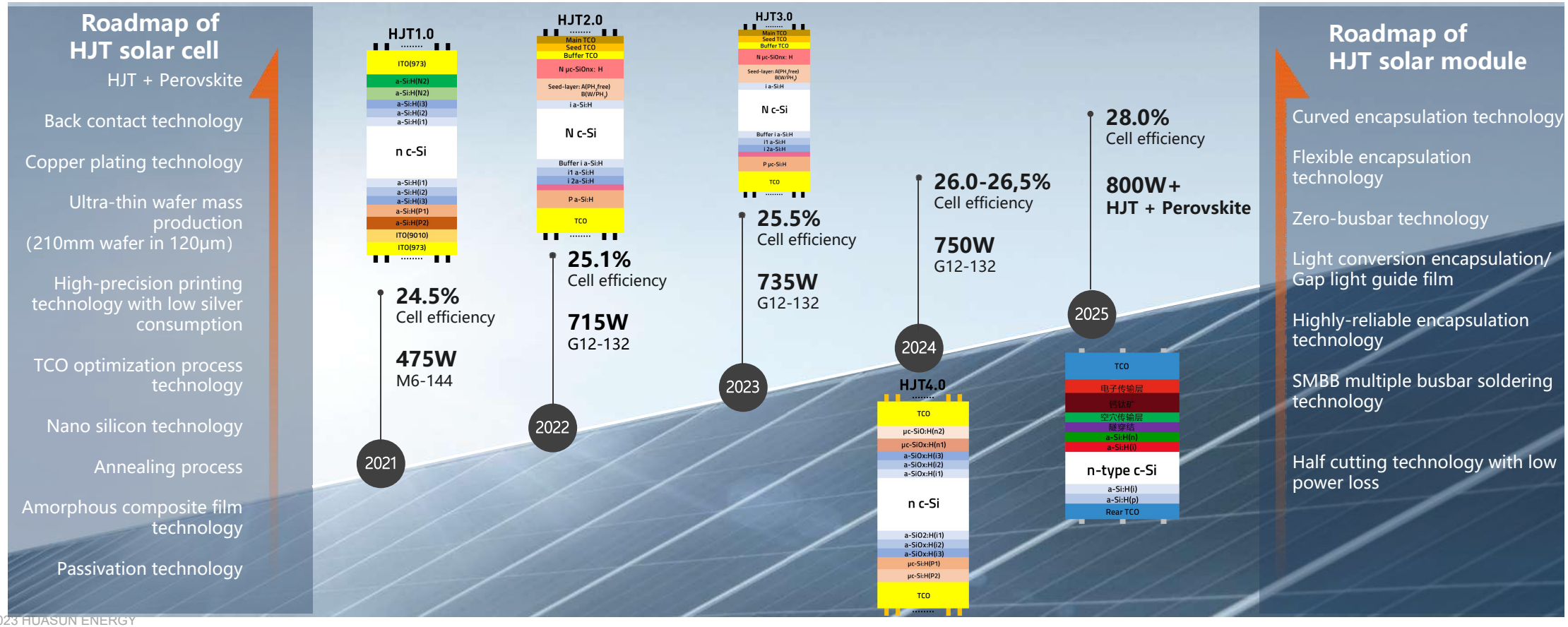
Efficiency roadmap

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



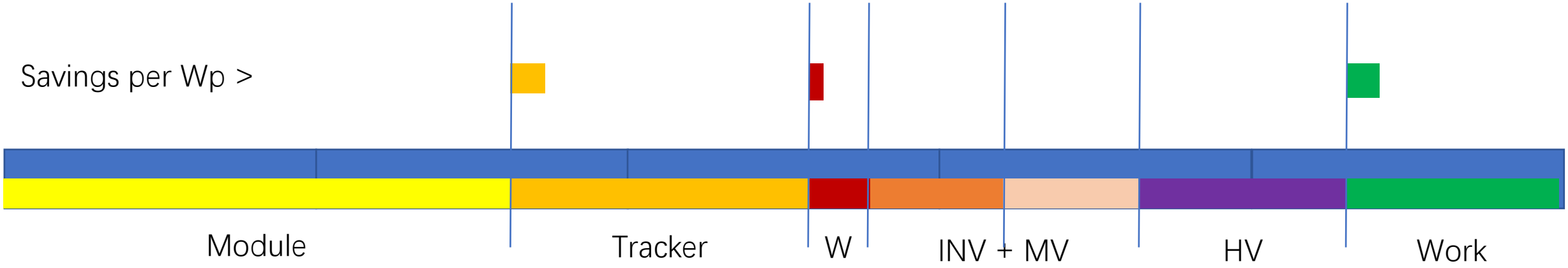
LCOE advantage: higher efficiency

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

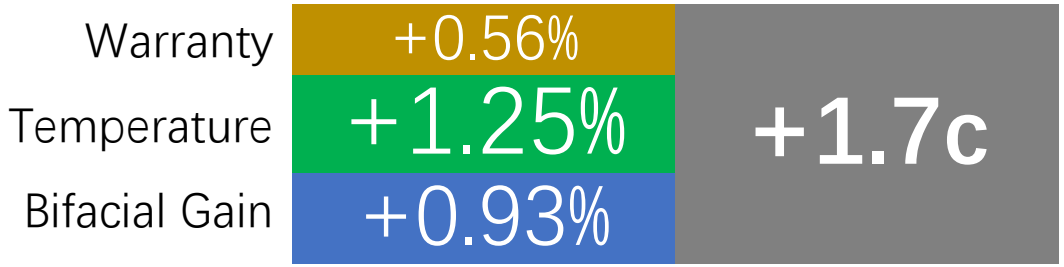
Cost reductions applicable for system design with same AC power, same DC/AC ratio, same total land use
AC side considered turn-key (i.e. including work)



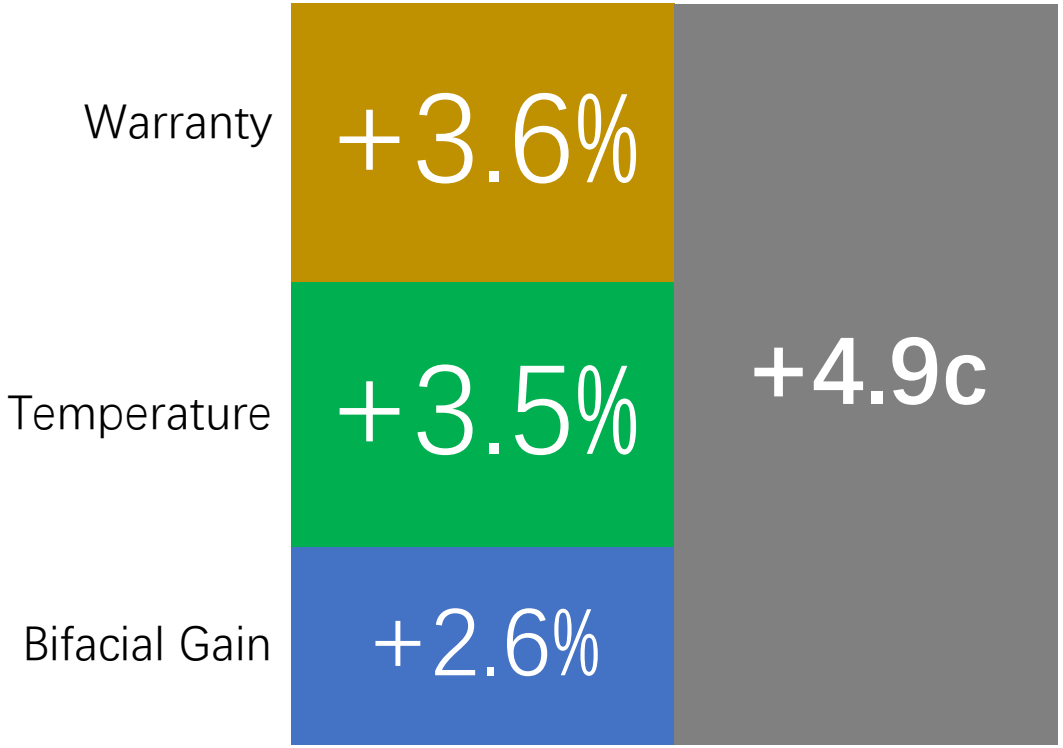
LCOE advantage: higher yield equals higher value

System Type:
Italy, 1P tracker, 0.62c/Wp

Baseline Yield PERC:
9% Bifacial Gain
10% Temperature Loss

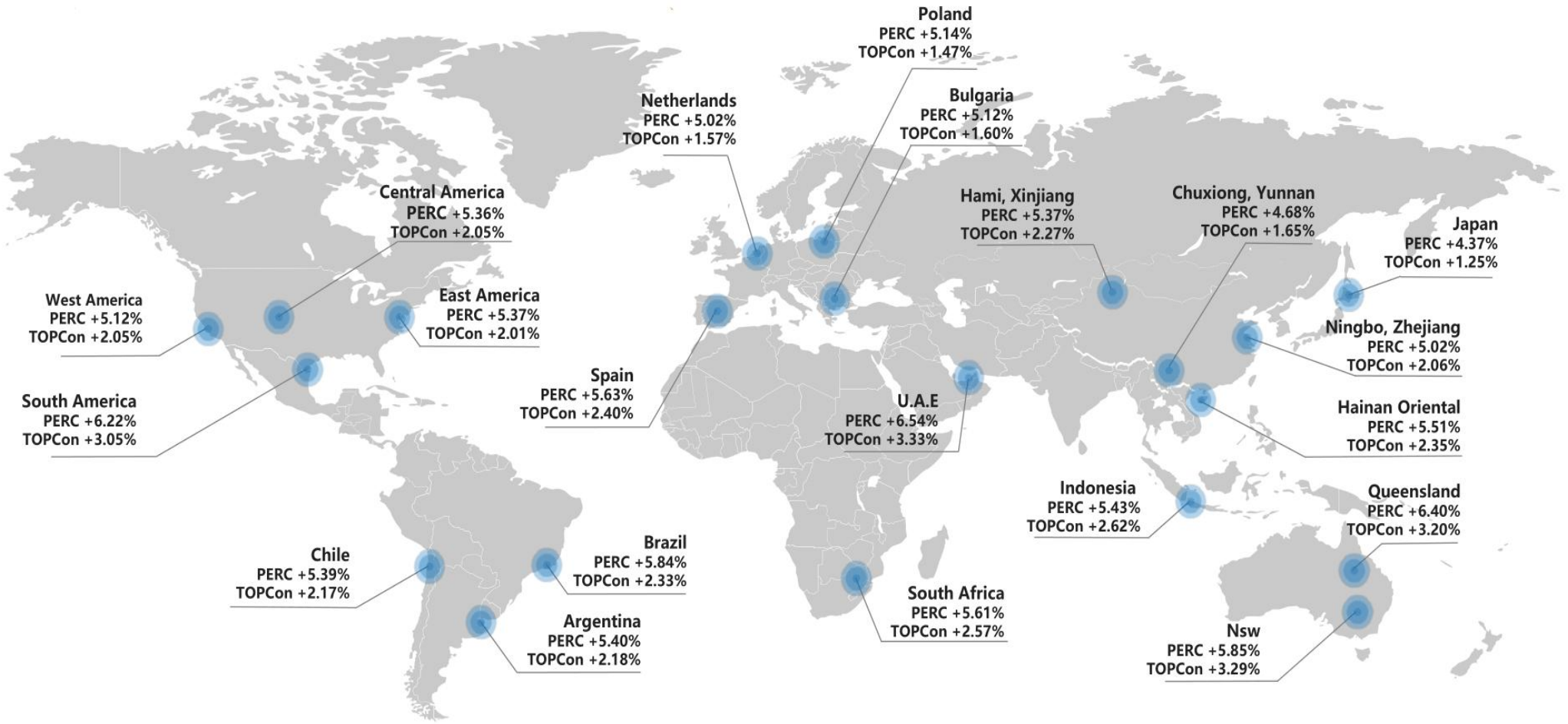


Huasun vs. TOPCON



Huasun vs. PERC

LCOE advantage: higher yield all over the world



Note: The comparison data were stimulated based on PVsyst.

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%**

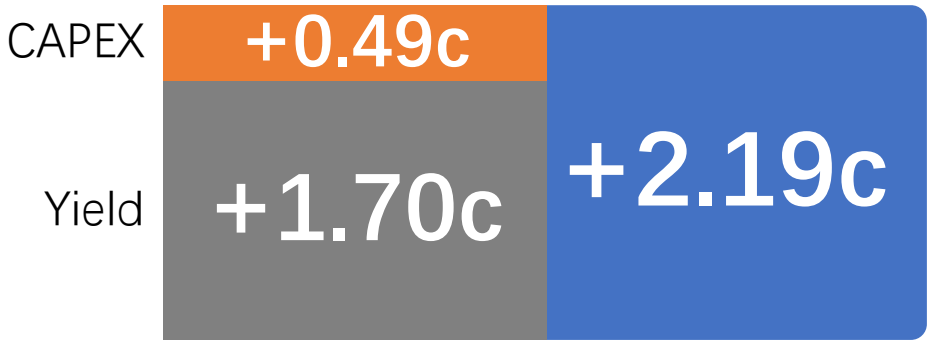
Xuancheng - 210 HJT vs 182 TOPCon vs 210 PERC / Fixed Tilt, Albedo 20%, optimizer

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

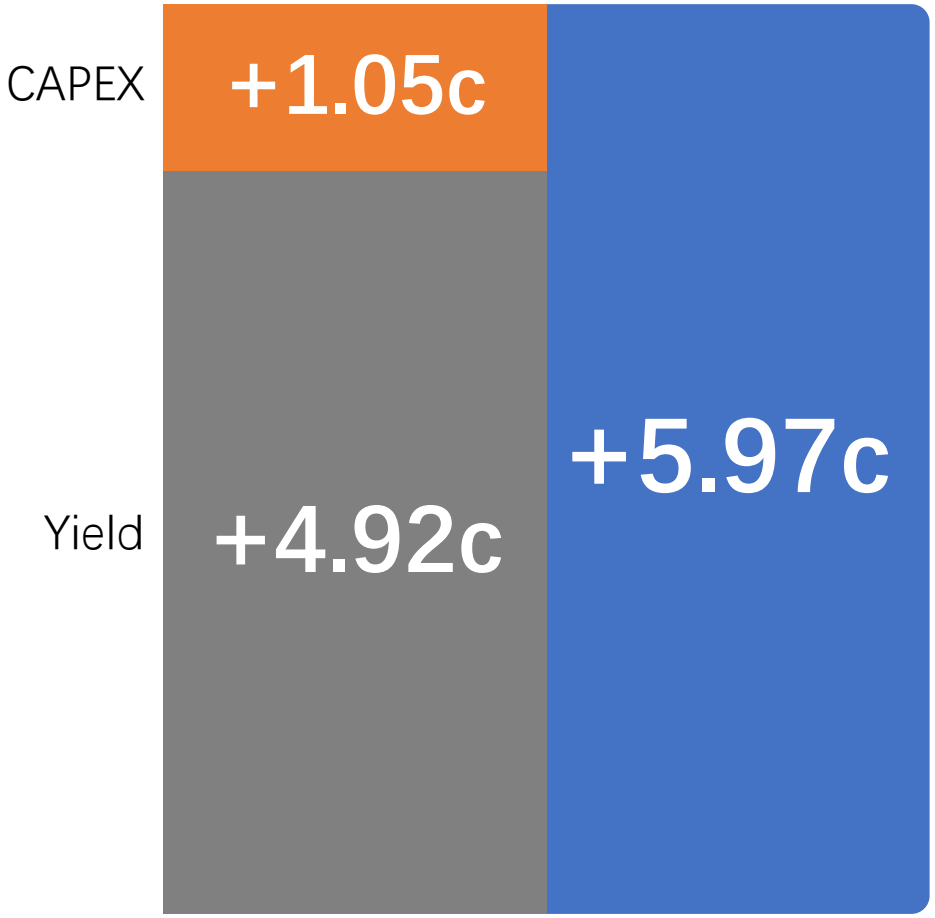
Advantage HJT	DC Energy (kWh/kWp)
vs. TOPCON	**+1.18%**
vs. PERC	**+3.33%**

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