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Risen Energy

pv magazine webinars

Kicking off the heterojunction era

31 January 2023

9:00 am – 10:00 am | GMT, London
10:00 am – 11:00 am | CET, Berlin
1:00 pm – 2:00 pm | Dubai

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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. 👀 💡

Production Revolution of Risen:

700W+ HJT Hyper-ion enters a new era of mass production

31.01.2023
Jerzy Rudnicki
Senior Product Manager – Risen Energy

Content

PART ONE

BACKGROUND

- About Risen Energy
- EU Energy Crisis
- Technology Outlook
- Technology Development
- Technology Challenges

Risen Energy

Founded 1984

Tier 1 since 2015

Bankability A

Production Base 7

Delivery in 2022 16GW

Capacity in 2023 45GW

2016
Double Glass Module
1500V modules
Half Cell Module

2017
MBB module
N-Type double sided
158 modules

2018
P-type double-sided
Tandem cell modules
166 large wafer modules

2019
Diversified solutions
Large Size(158, 163, 166)
TITAN 500Wp Era

2020
PERC/HJT/Topcon
Large Size (158, 166, 210)

2021
Diversified solutions
Large Size(158, 166,210)
TITAN 670Wp Era

2022
Diversified solutions
Large Size(158, 166, 210)
HJT 700Wp Era

2023
New Era of HJT

Europe Energy Crisis

Carbon peak by 2030 Carbon neutral by 2060 Zero Carbon Factory

Double Reduction Policy Carbon Credits Net zero target

Global Goal

Low carbon

Energy Saving

Fit for 55

- Reduce emissions in EU at least 55% by 2030
- 40% of renewable energy in the energy mix by 2030.
- By 2030, the EU Commission requested 900 GWAC of renewable capacity (480GW wind, and 420GW Solar).

Due to unstable situation caused by post covid supply chain disruptions and Ukraine War, EU Commission increased the targets of "Fit for 55".

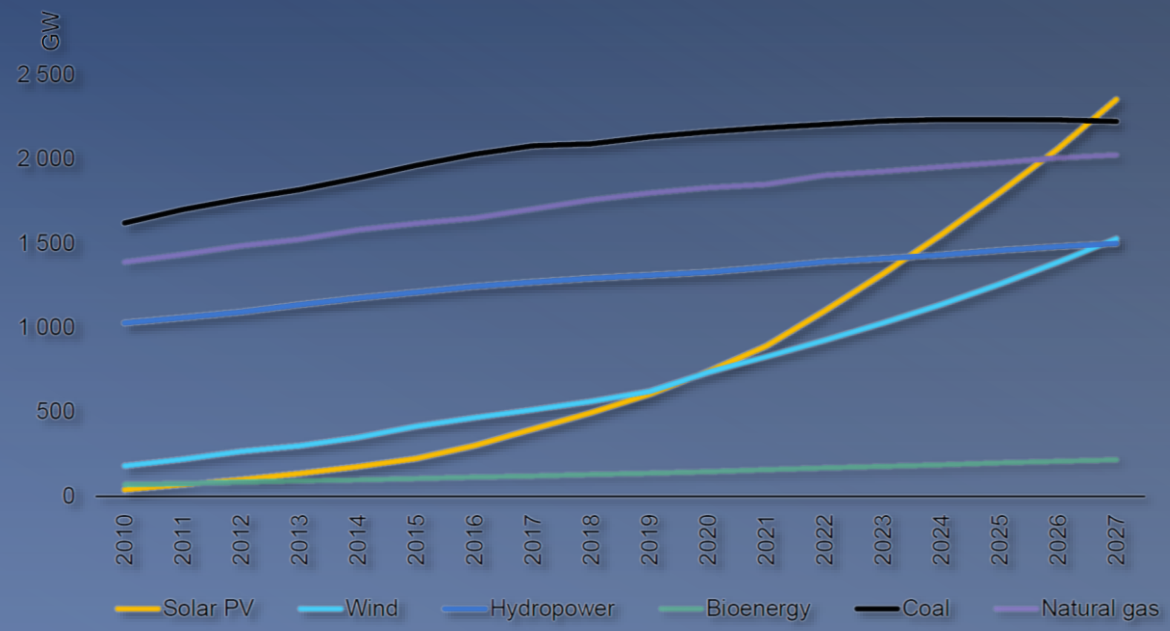
RePowerEU

- Increased tempo of RE deployment comparing to 2021
- 45% of RES in the mix by 2030
- 1,236 GWAC by 2030. That is 3x of what we have at the moment.
- Deployment responsibility by member states.

Elevated commodity prices, high freight costs and ongoing supply chain disruptions have caused onshore wind investment costs to increase by 15-25% and solar PV by 10-20% from pre-Covid levels.

Technology Outlook

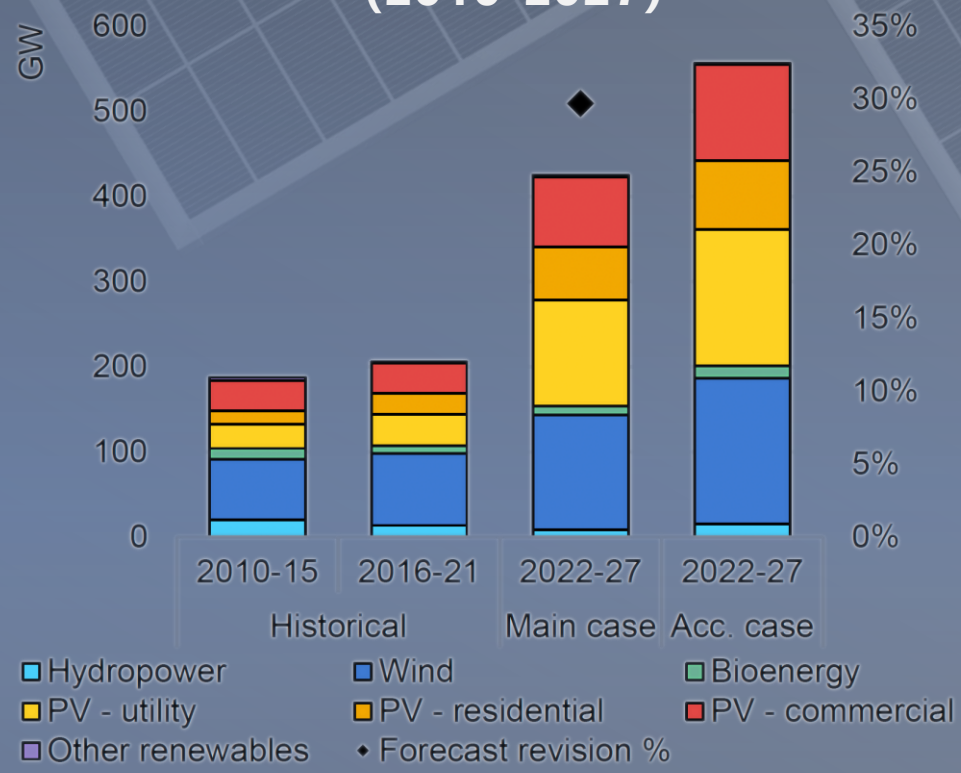
Cumulative power capacity by technology (2010-2027)



Source: IEA analysis based on World Energy Outlook 2022. (2022), Fossil fuel capacity

Solar PV will prevail in capacity growth among other RES, thanks to shorter lead times and scalability and location flexibility compared to wind.

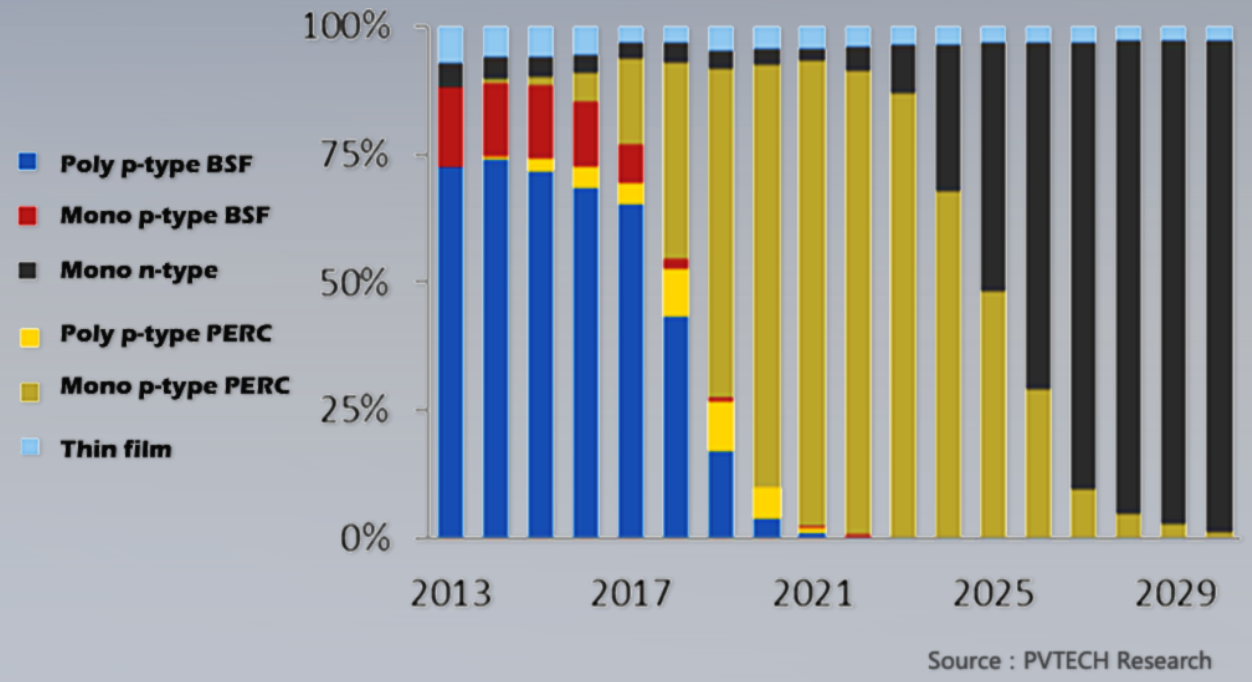
Europe renewable electricity capacity additions (2010-2027)



Source: IEA: Renewables 2022: Analysis and forecast to 2027

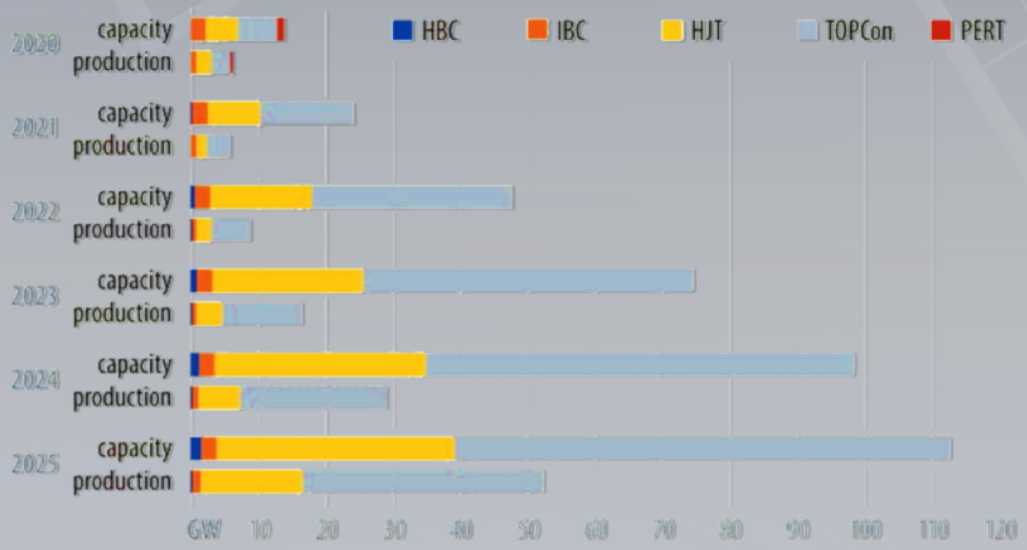
Technology Outlook

Forecast of market share of solar cells (2022-2030)



Source : PVTECH Research

Forecast of production capacities and shipment of n-type modules (2020-2025)



Source: PV INFOLINK

Technology Challenges

01

COST

Cost is the deciding factor (equipment, silver consumption, wafer thickness)

Efficiency: Mass production average efficiency > 26%

Efficiency

02

03

Reliability

Reliability needs to be ensured (anti-UV performance, water vapor influence, single glass solution)

Sustainability is a great challenge not only for the PV industry. Carbon footprint is important

Sustainability

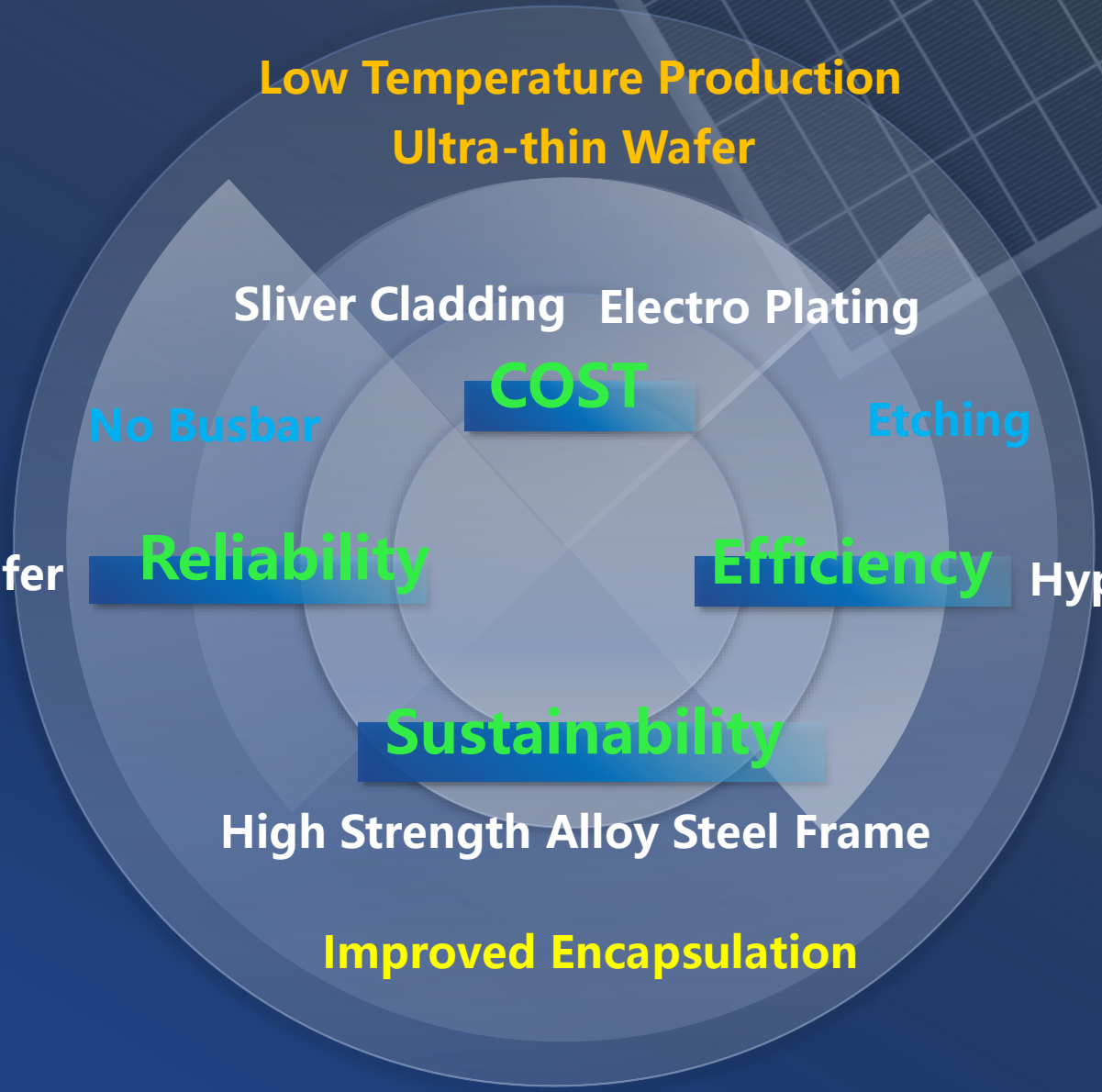
04

PART TWO

HYPER-ION HJT DEVELOPMENT

- Development Roadmap
- Ultra-thin Wafer
- No Busbar Cell Technology
- Hyper-link
- Encapsulation

DEVELOPMENT ROADMAP



N-type Efficiency

Cell Efficiency 25.5%

Module Efficiency 22.5%

N-type Heterojunction

High power, high efficiency

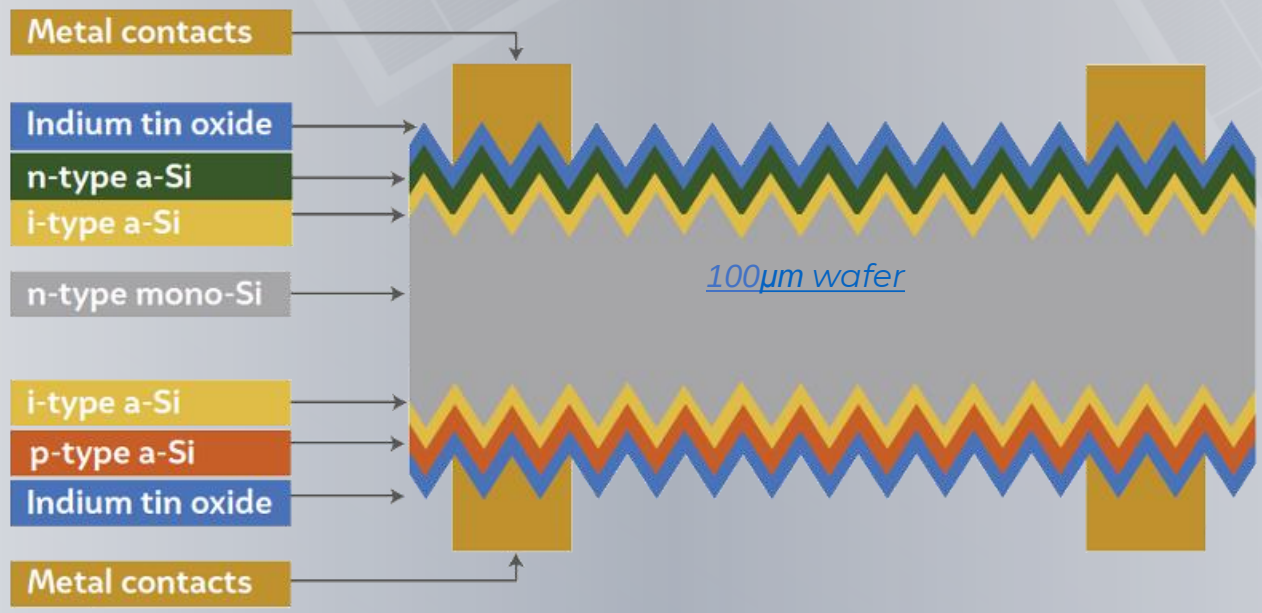
Ultra-thin cell

Low temperature technology

High cost-effective & Low LCOE

Bifacial by nature

High reliability

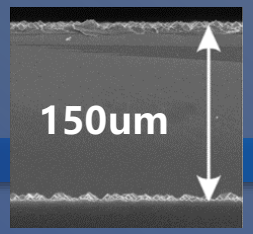


Source: Wilson et al. 2020. "The 2020 Photovoltaic Technologies Roadmap." Journal of Physics D: Applied Physics and Louwen et al. 2016. "A Cost Roadmap for Silicon Heterojunction Solar Cells." Solar Energy Materials & Solar Cells

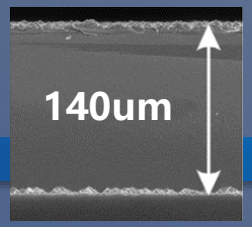
Ultra-thin Wafer

The Ultra-thin wafer of 100μm reduces the usage of raw materials, provides additional elasticity resulting in improved reliability.

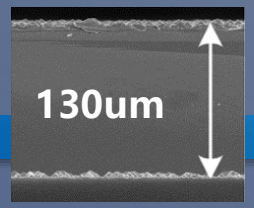
Fragmentation rate ≤ 0.3%
Yield ≥ 99.7%



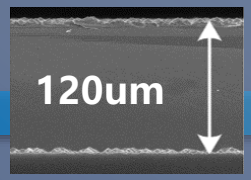
- Soldering temp.
- Pipeline
- Flux
- Ribbon



- Sheet spacing
- Welding point
- Pipeline
- Fixture

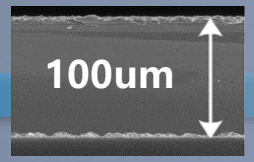


- Cell screen
- Welding machine
- Tape machine
- Stitch Welder

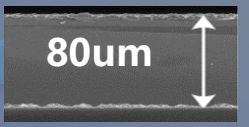


- Equipment upgrade
- Flexible Ribbon
- Lamination

Fragmentation rate ≤ 0.35%
Yield ≥ 99.5%



- Stress-free interconnection
- Incoming half piece
- Busbar less technology



- Ultrathin sectioning technique

Target Technology: 210mm+80um ultra-thin silicon wafer

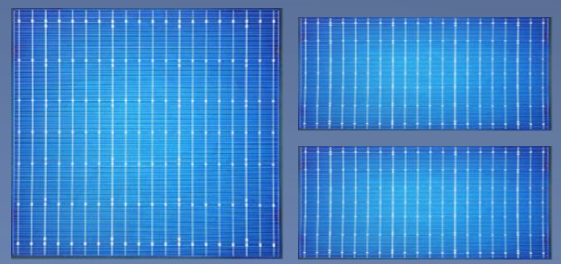
Ultra-thin Wafer

Cell Size

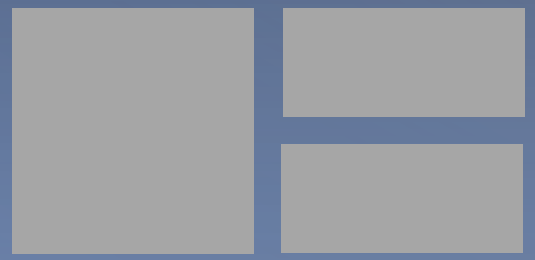
The Hyper-ion production lines are based on Half-ingot 210mm wafers, which facilitates **cost reduction** and **efficiency improvement** for the whole industry.

Half-ingot and slicing

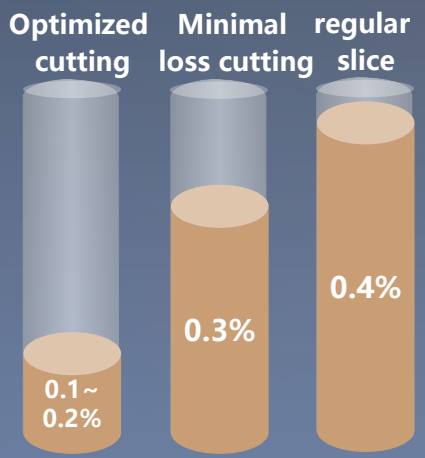
- The low-temperature characteristics of heterojunction cells conflict with the high-temperature cutting of lasers, **and conventional laser slicing brings large power losses**.
- Even the optimal cell slicing technology will have large efficiency loss as cell efficiency increases.
- Incoming **silicon half-wafer** has become standard equipment for the new HJT cell factory line.



Cell slicing



Wafer slicing



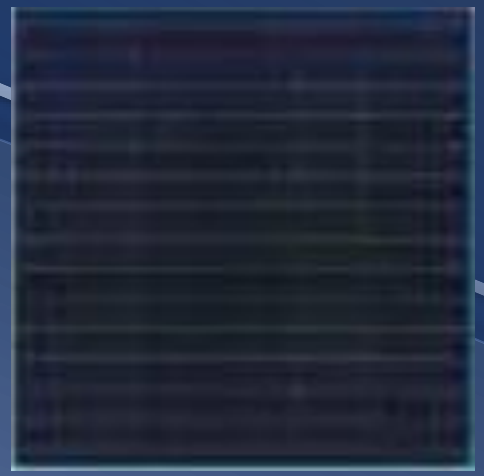
slice loss

No Busbar Technology

Silver in a C-Si PV module is the second largest cost generating component (9-23%) after silicone.

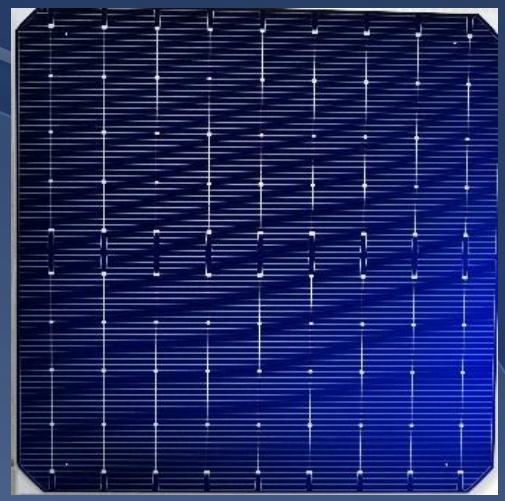
Q: How to maintain low temperature (<200℃) cell manufacturing process and reduce the amount of silver used ?

2023: 0BB



2023: 12-20BB

2019: 9BB

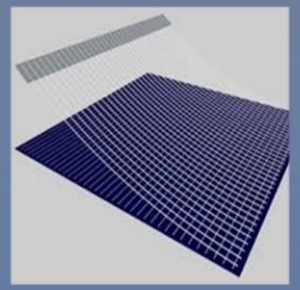
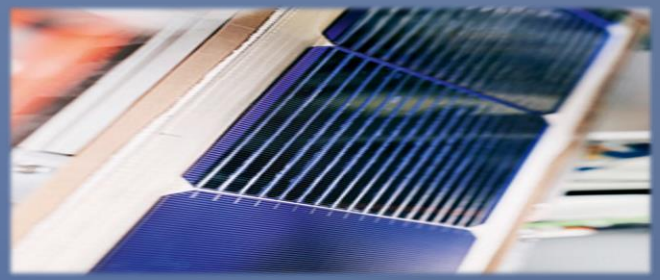


At the cell production stage only fingers are provided.
No BB are implemented.

Hyper-link Interconnection

The biggest technical difficulty and challenge in reducing silver consumption for heterojunction solar cells rely not on solar cell, but module.
How to achieve effective interconnection of low silver consumption solar cells?

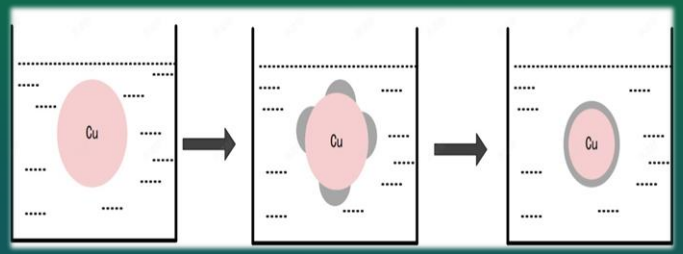
SWCT

Patent issues / High cost

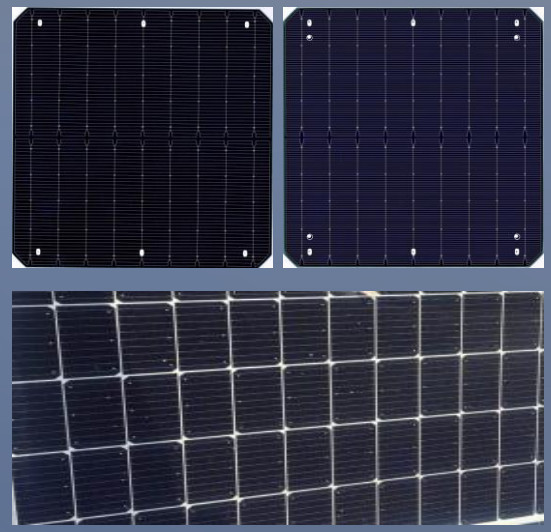
Silver-coated copper

Production of silver-coated copper



Ag:Cu=5:5→2:8, the lower the silver content, the more difficult the cell interconnection welding.

Copper plating

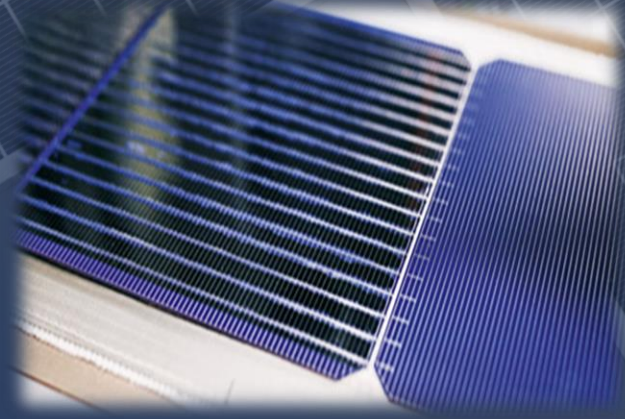


Difficulty in cost breakthrough
Environmental restrictions

Hyper-link Interconnection

- Heterojunction solar cell welding technology requires cell interconnection **welding temperature < 200℃**
- **Low cost heterojunction** → less silver, no Busbar → cell IR soldering reliability with high risk → stress-free low temperature interconnection
- Low temperature interconnection change: infrared low-temperature welding → SWCT → **stress-free interconnection**

Hyper-link
First adopted in mass production



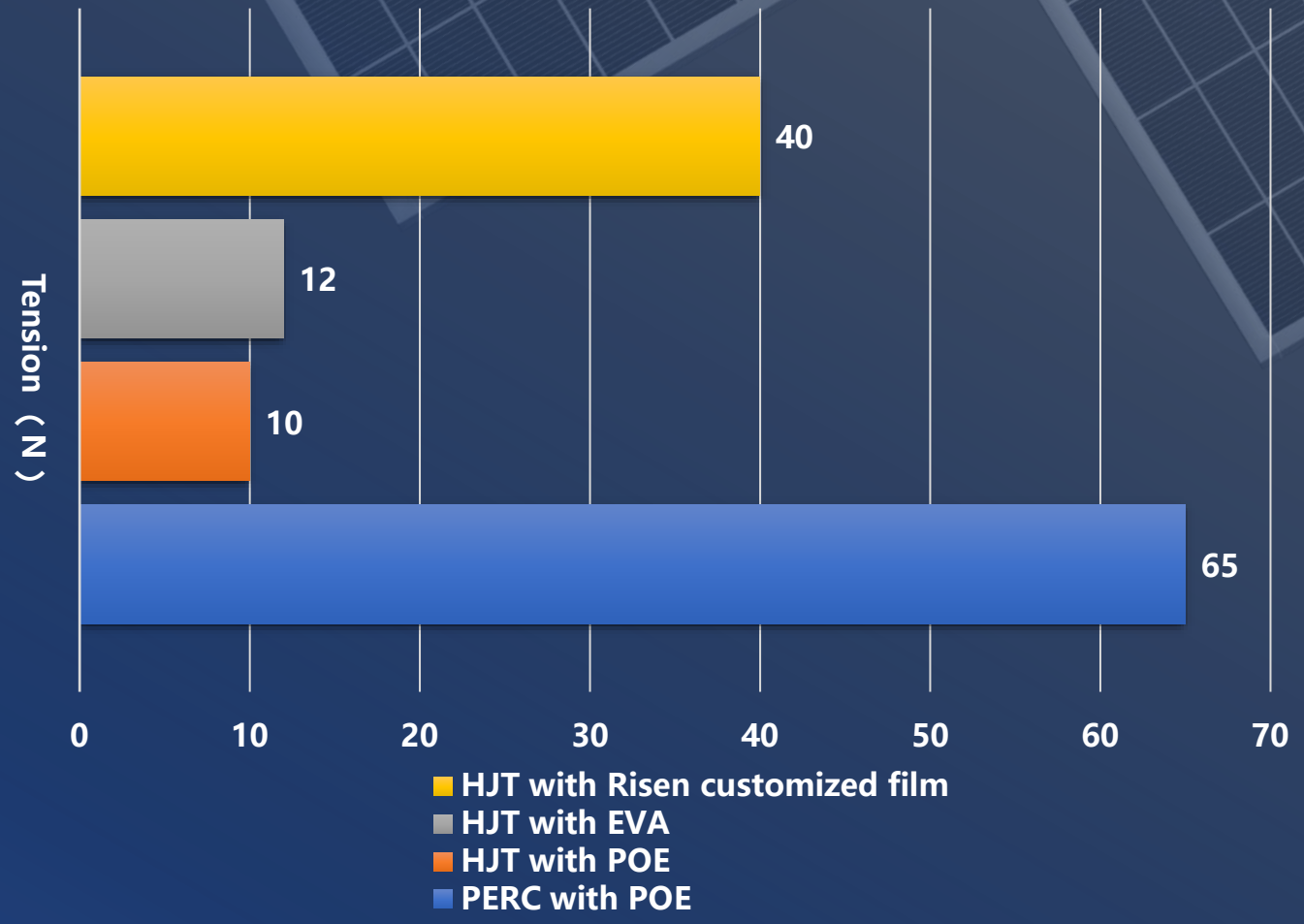
Interconnection Technology	Interconnection Temperature	Number of Busbar	Interconnection reliability with lower silver content	Cost
Infrared low temperature welding	190℃	9~20	Low	High
SWCT	100~150℃	0	High	High
Hyper-Link (Risen's Patent)	25℃	0	High	Low

Encapsulation Material

The surface layer of heterojunction solar cell is TCO conductive film, which is of **poor adhesion with conventional module encapsulation adhesive**, in extreme high temperature and hot spot, it is easy to delaminate.

Heterojunction-specific encapsulation films need to be developed to ensure high-temperature reliability

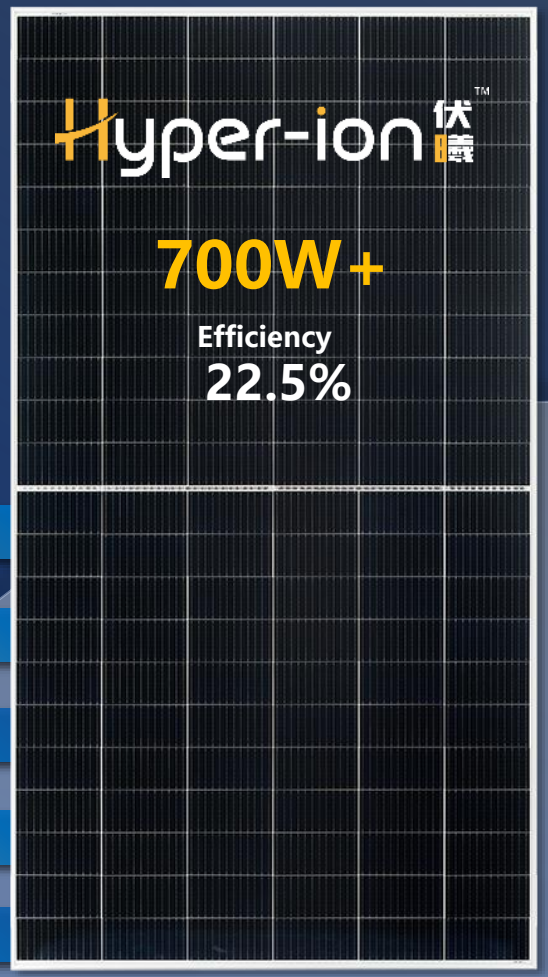
The new Hyper-ion modules have both improved encapsulation process and materials



Hyper-ion Portfolio

risen

RSM132-8-xxxBHDG



680-700Wp

21.9-22.5%

2384*1303*35mm

41kg(Steel)

38.5(Aluminum)

RSM110-8-xxxBHDG

565-585Wp

21.6-22.4%

2384x1096x30mm

35kg(Steel)

32.7kg(Aluminum)

12/30
year warranty

PART THREE

HYPER-ION ADVANTAGES

- Higher Bifaciality
- Lower Temperature Coefficient
- Lower Overall Degradation
- Higher Strength/Lower CO2

Higher Bifaciality

	PERC	TOPCon	HJT
Bifacial factor Cell	≈75%	≈85%	>90%
Bifacial factor Module	≈70%	≈80%	≈85%

Precondition

Work under STC

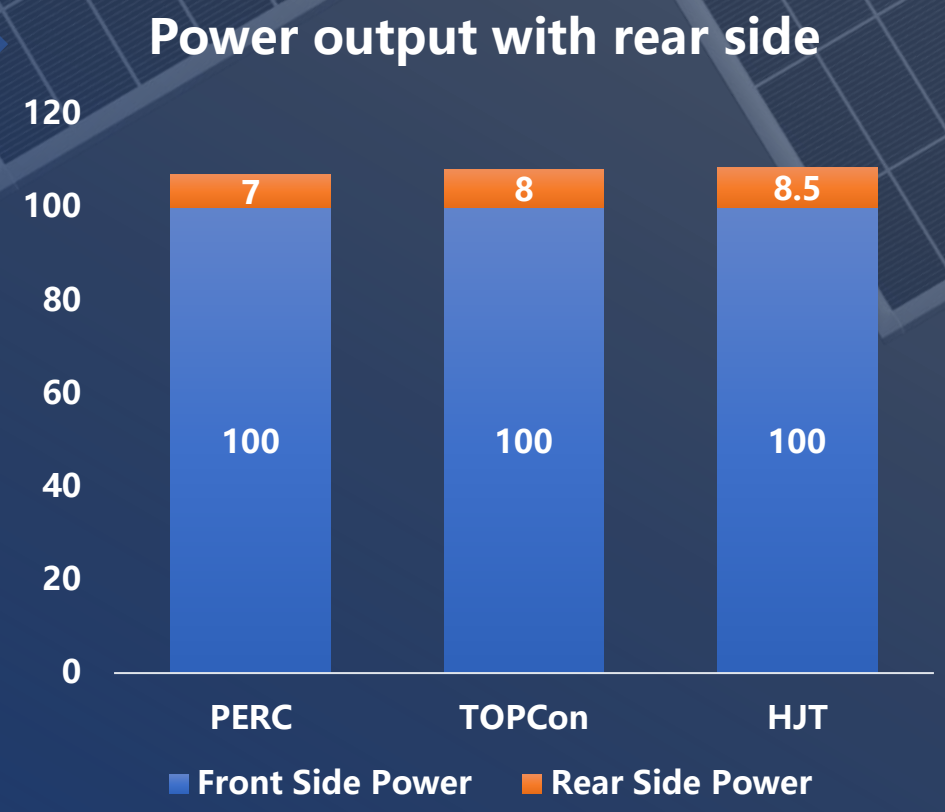
Rated Power = 100W

Albedo = 10%

$P_{PERC} = 100+100*70\%*10\% = 107.0W$

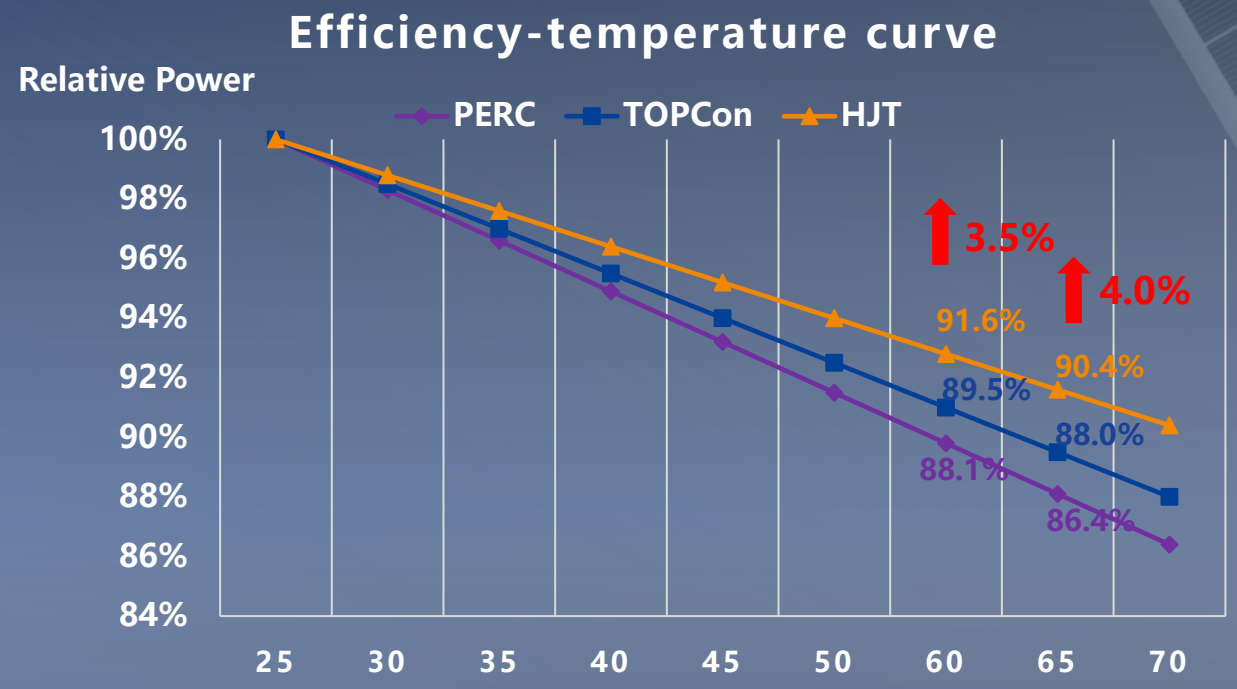
$P_{TOPCon} = 100+100*80\%*10\% = 108.0W$

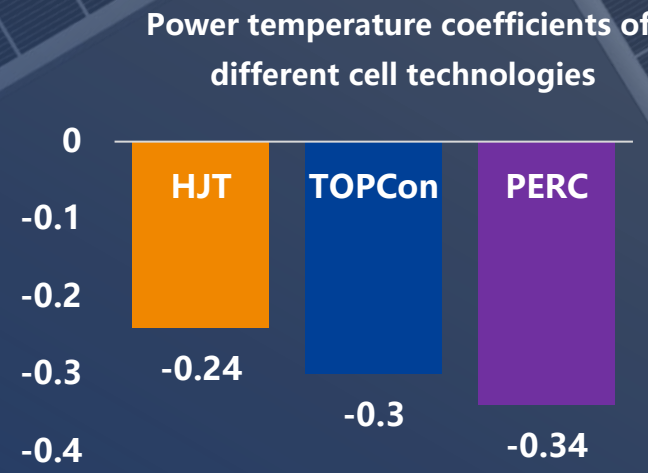
$P_{HJT} = 100+100*85\%*10\% = 108.5W$



The higher the albedo and bifacial factor, the greater the power generation gain of HJT PV modules

Stable Temperature Coefficient





Precondition

- Rated Power = 100W

Operation environment

- Tair = 30℃ (Summer)
- Toper = 60/65℃

(usually 30-35 ℃ than air temperature)

Power output at work

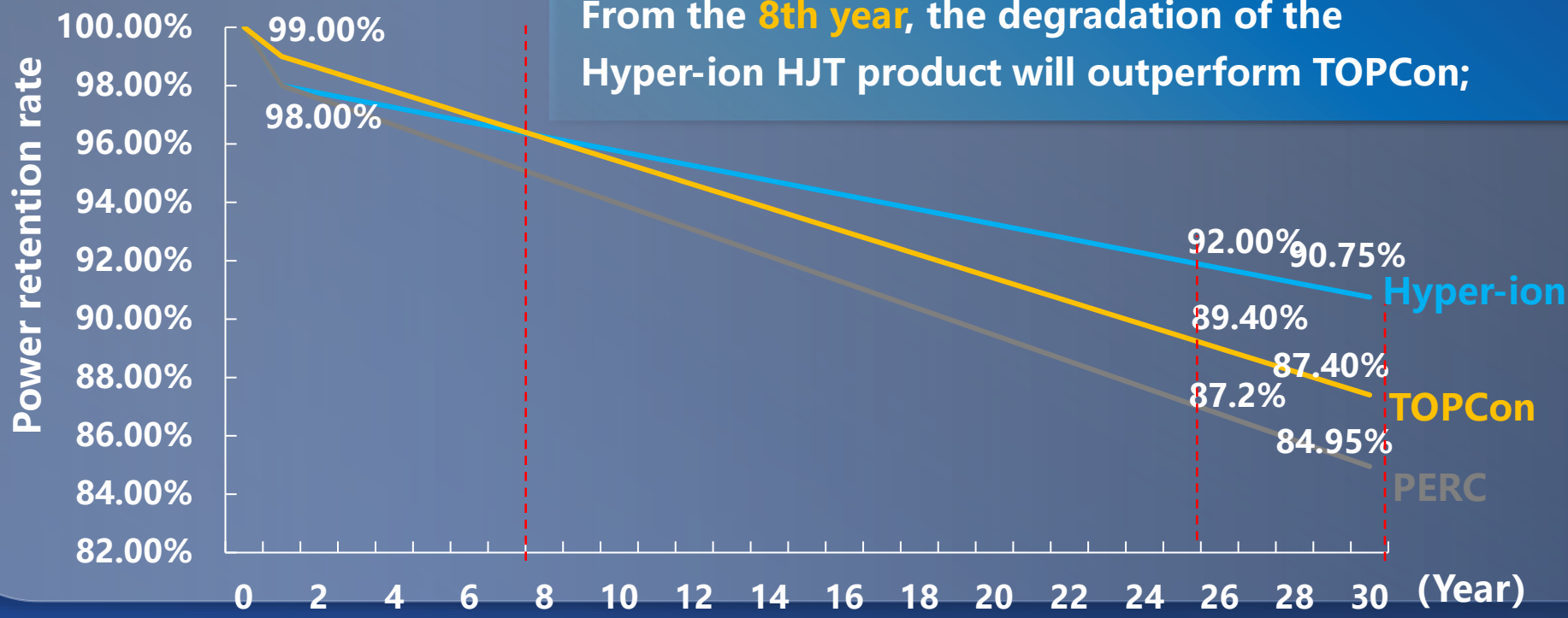
- P_{PERC} = 88.1.6W
- P_{TOPCon} = 88.8W
- P_{HJT} = 91.6W

Lower Overall Degradation

Module type	Degradation	
	First year	Annual
Bifacial HJT	2%	0.25%
Bifacial TOPCon	1%	0.40%
Bifacial PERC	2%	0.45%

No B-O LID, excellent anti-LeTID & anti-PID performance. low power degradation = high energy yield.

From the 8th year, the degradation of the Hyper-ion HJT product will outperform TOPCon;



By the end of the 30th year, only the Hyper-ion HJT has a power retention rate above 90%;

High Strength Alloy Steel Frame

risen

Steel and aluminum life cycle carbon emissions comparison:

Relative Carbon emissions throughout material lifetime (unit: ton)

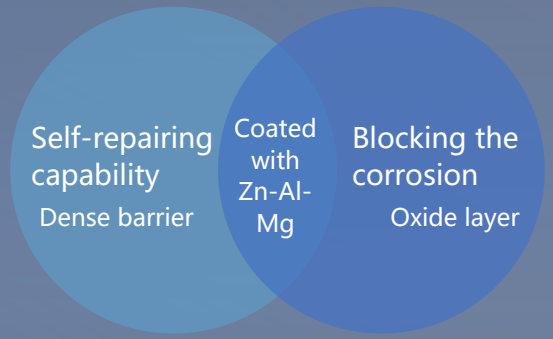
	Mining	Production	Ocean shipping	Recycle	Life cycle carbon emissions
Steel(t.)	0.11	1.76	/	0.12	1.99
Aluminum(t.)	0.01	14.58	/	0.03	14.62

For 1GW, 650W modules, shipped by sea, transported over 10,000 kilometers:
(Total weight of steel frame 8461 tons, total weight of aluminum frame: 5307 tons)

Carbon emissions in all aspects of the whole life (unit: ton)

	Mining	Production	Ocean shipping	Recycle	Life cycle carbon emissions
Steel (1GW PV)	931	14891	165	1015	17002
Aluminum (1GW PV)	53	77376	93	159	77691

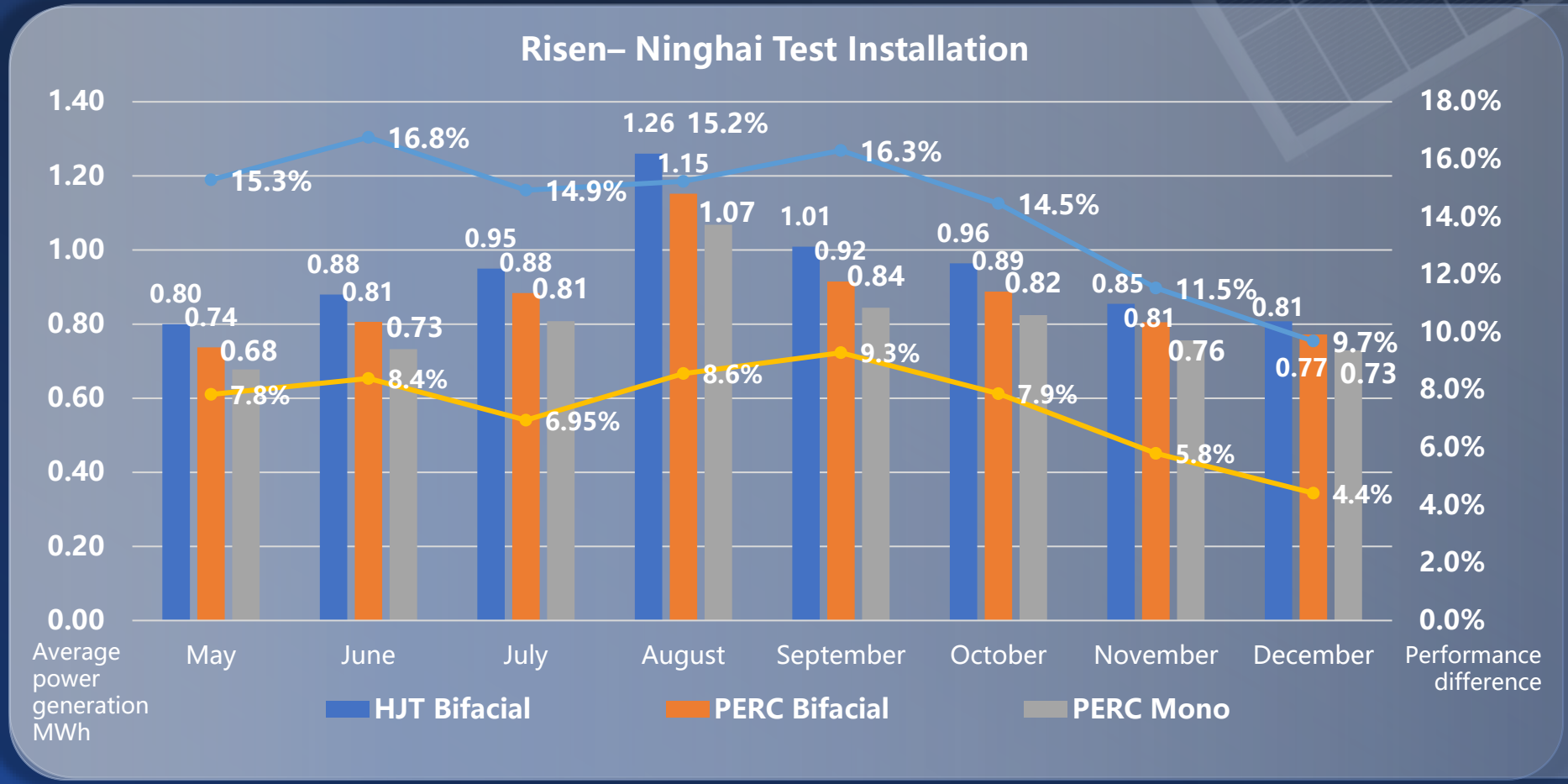
- **1.3x higher tear resistance for mounting holes and bolts**
- **1/3 of production energy consumption**
- **Lifecycle carbon emissions reduced by 77%**
- **Stable raw material supplies and prices**
- **Excellent corrosion resistance**



DH 5000H < 3%
PID 288H < 3%

Field Results: Power Generation In The Field

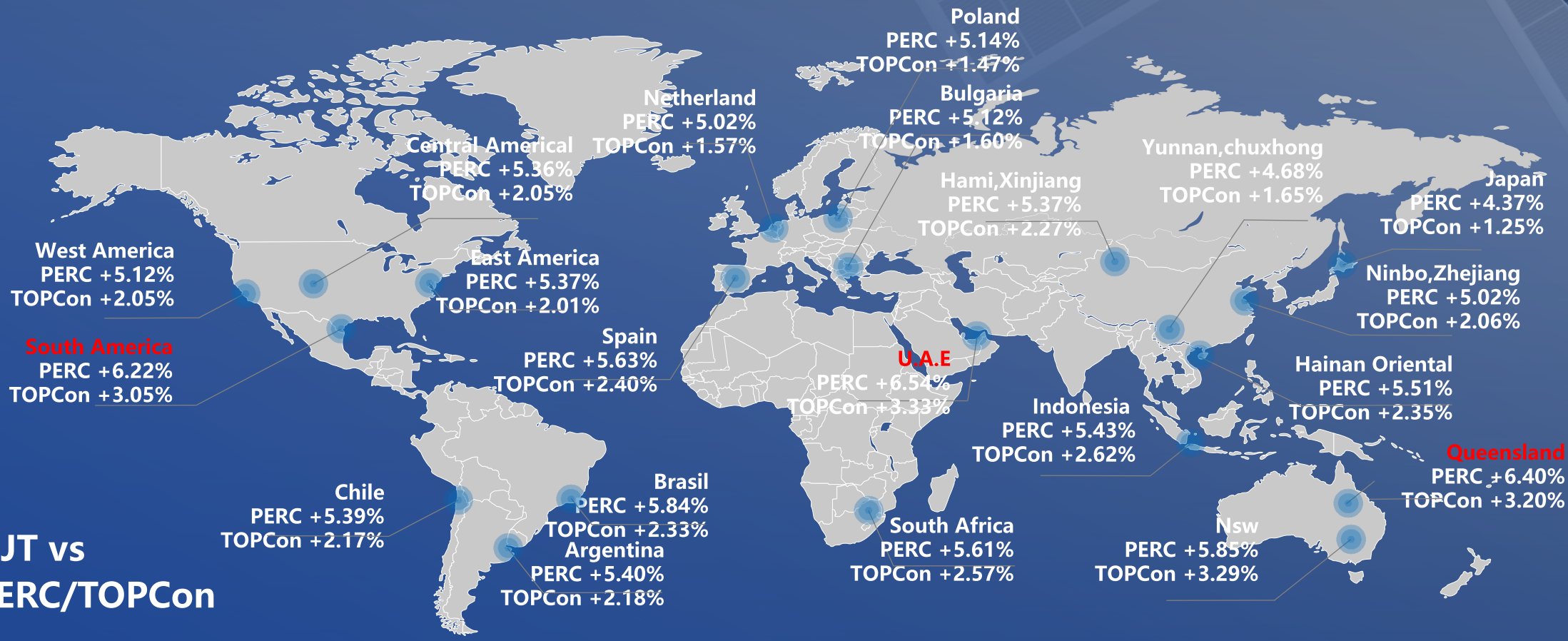
HJT bifacial modules improve yield per watt by 7.5% vs. PERC bifacial modules
HJT bifacial modules improve yield per watt by 14.4% vs. PERC single-sided modules



Capacity: 3kw×3
Location: Ninghai
Mounting Method: Fixed tilt

Field Results: Global Power Generation Gain Map

- Generally, HJT is of 4.37%-6.54% higher power generation than PERC and 1.25%-3.33% higher than TOPCon
- In high temperature regions (e.g. Middle East, Australia and Southern U.S., etc.), PV modules perform even better in terms of power generation, with 6%+ gain compared to PERC products and 3%+ gain compared to TOPCon products.



Sustainability: Carbon Footprint Reduction

The carbon footprint of Hyper-ion module can be lower than 400kg eq CO2/kWc

Low energy consumption in production

- ✓ Only 4 production steps
- ✓ Temperature in the whole production process below 200℃
- ✓ Lower energy consumption

+

Application of low carbon materials

- ✓ Ultra-thin 100μm wafer saved a lot the use of silicon material
- ✓ Life-cycle carbon emissions reduced by 77% with steel frame

+

High Power High Efficiency High Power Generation

- ✓ 6%+ higher vs Perc
- ✓ 3%+ higher vs Topcon

Higher carbon reduction can be achieved within the plant of same capacity

Field Results: Improved IRR & LCOE

Compared to other mainstream utility-scale products:

The BOS cost of Hyper-ion products can be reduced by 4.45%, LCOE can be reduced by 5.40%, and IRR can be improved by 12.95%.

Type	Power(Wp)	BOS	LCOE	IRR
182-72 PERC	550	Baseline	Baseline	Baseline
182-72 TOPCon	570	-1.77%	-4.42%	+10.99%
182-78 TOPCon	610	-2.17%	-4.37%	+10.84%
210-66 PERC	660	-2.57%	-3.19%	+7.97%
210-66 Hyper-ion	695	-4.45%	-5.40%	+12.95%

Capacity: 100MW

Site: Hainan, China

Installation: Fixed Tilt

BOS and LCOE is related to system design. For different types of modules, there are always optimal matching solutions, which cannot be calculated and compared with a particular setup (e.g. a specific inverter, a specific length of bracket). However, the Hyper-ion series is still the product that can make the biggest reduction in BOS and LCOE!

Field Results: Economics Analysis

Hyper-ion Products – economics analysis

Modules	PERC Bifacial 550W(Baseline)	Topcon Bifacial 580W	210 HJT Bifacial 700W
DC capacity	1.4256MW	1.41984MW	1.4112MW
Installation	Fixed	Fixed	Fixed
System voltage	1500V	1500V	1500V
Life time	30years	30years	30years
First year degradation	2.00%	1.0%	2.0%
Annual degradation	0.45%	0.40%	0.25%
Yield (KWh/KW)	1173	1197	1251
Yield Gain	0	2.1%	6.6%

LCOE calculation (USD/W)					
Cost	PERC 550W (Baseline)	Topcon 580W	HJT 700W	Topcon 580W	HJT 700W
Module	0.279	0.279	0.279	0.303 (max price)	0.344 (max price)
BOS	0.263	0.259	0.252	0.259	0.252
System cost	0.542	0.539	0.531	0.562	0.596
LCOE (USD/kWh)	0.059	0.057	0.054	0.059	0.059
LCOE decrease	/	3.55%	9.45%	/	/

For the same module price, Topcon is 3.5% lower than PERC module LOCE and HJT is 9.5% lower than PERC module LCOE

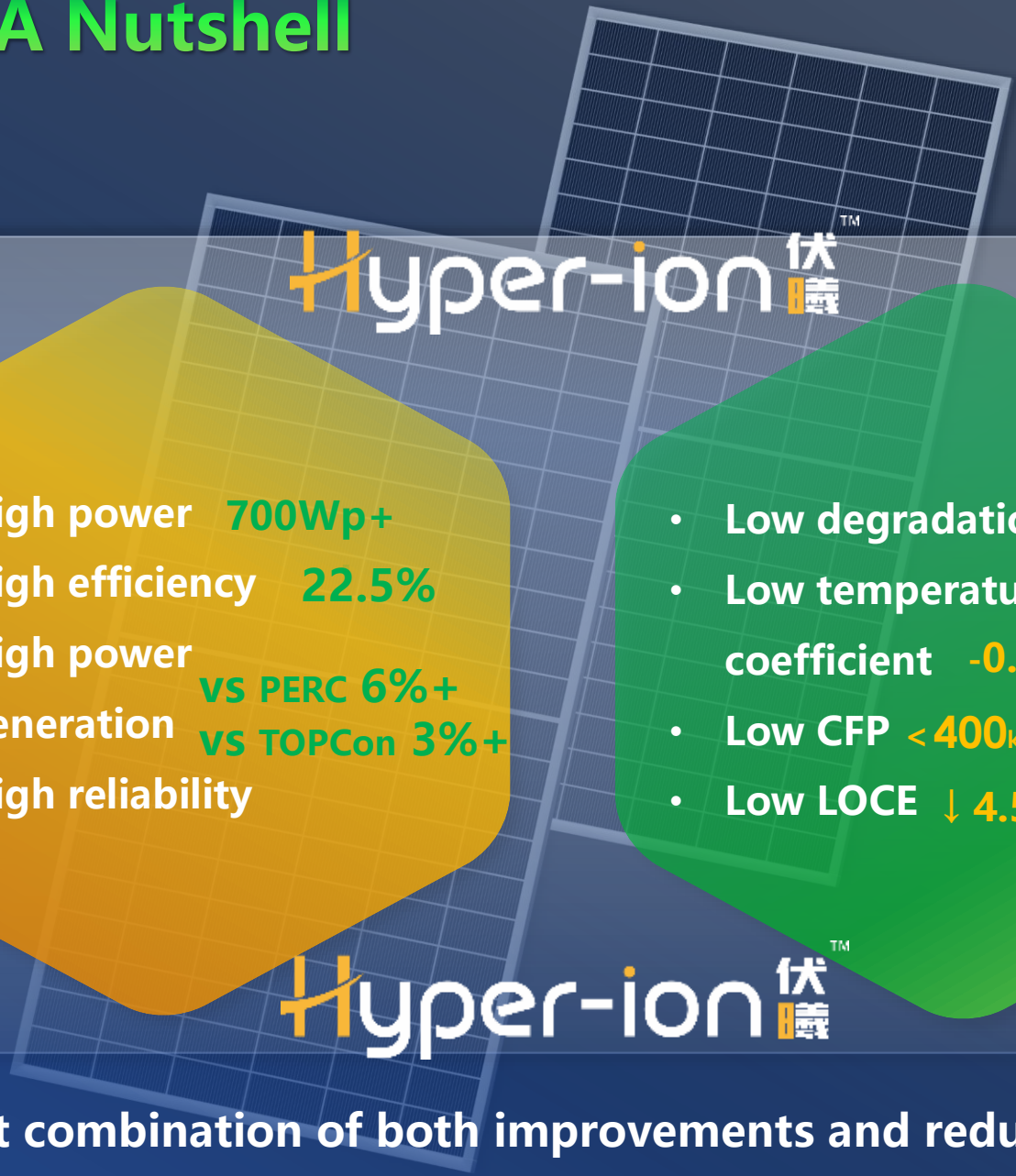
If based on the same LCOE, 580W TOPCon and 700W HJT have a price premium of 2.4 ¢USD and 6.5 ¢USD respectively, compared to 550W PERC modules

PART FOUR

ODER INFORMATION

- Hyper-ion In A Nutshell
- Certification & Mass Production
- Scaling Up

Hyper-ion In A Nutshell



EXTREME

- High power 700Wp+
- High efficiency 22.5%
- High power generation VS PERC 6%+ VS TOPCon 3%+
- High reliability

MINIMUM

- Low degradation -0.25%
- Low temperature coefficient -0.24%/℃
- Low CFP <400kg eq CO2/kWc
- Low LOCE ↓4.52%

Best combination of both improvements and reductions

Hyper-ion Certification & Mass Production

General Certification	
Item	RSM132-8-BHDG
IEC61215&61730	√
3X-LeTID	√
CSA-UL61730	√
Hail test	√
IEC60068-2-68-Sand	√
IEC61701-Salt 6	√
IEC62716-Ammonia	√
IEC62782-DML	√
LID	√
LIP	√
PID96~288H	√
Bifacial	√
IEC61853-PANfile	√
IEC62759-Transportation	2023.02
UL61730-CSA	√

2384x1134x35mm

March

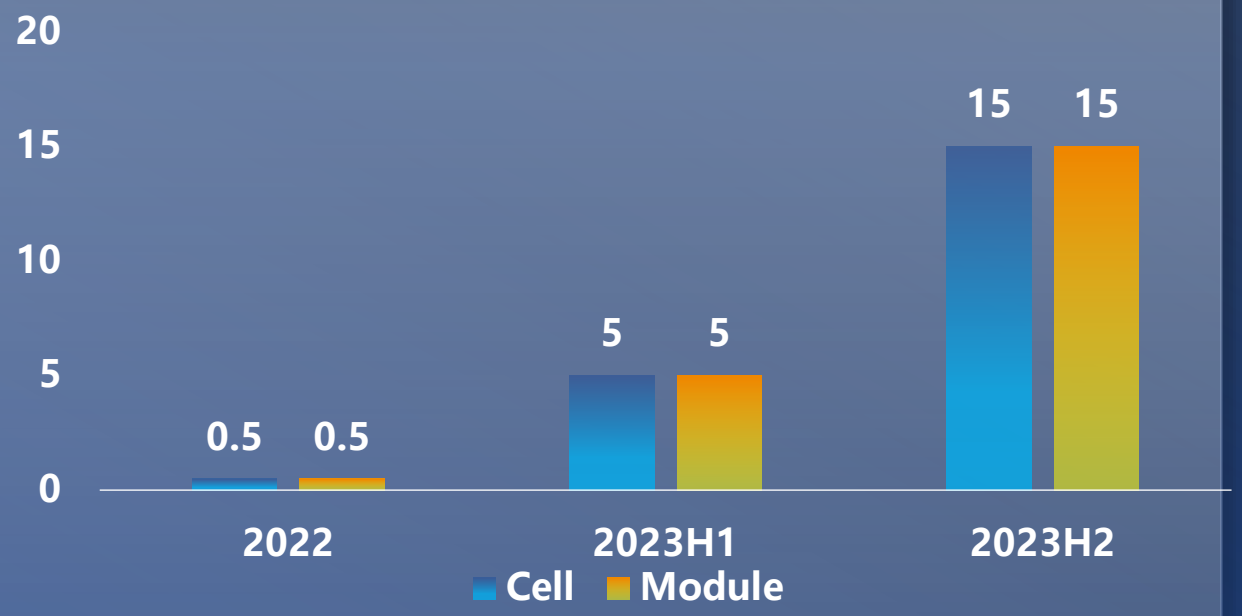
2384x1096x30mm

April

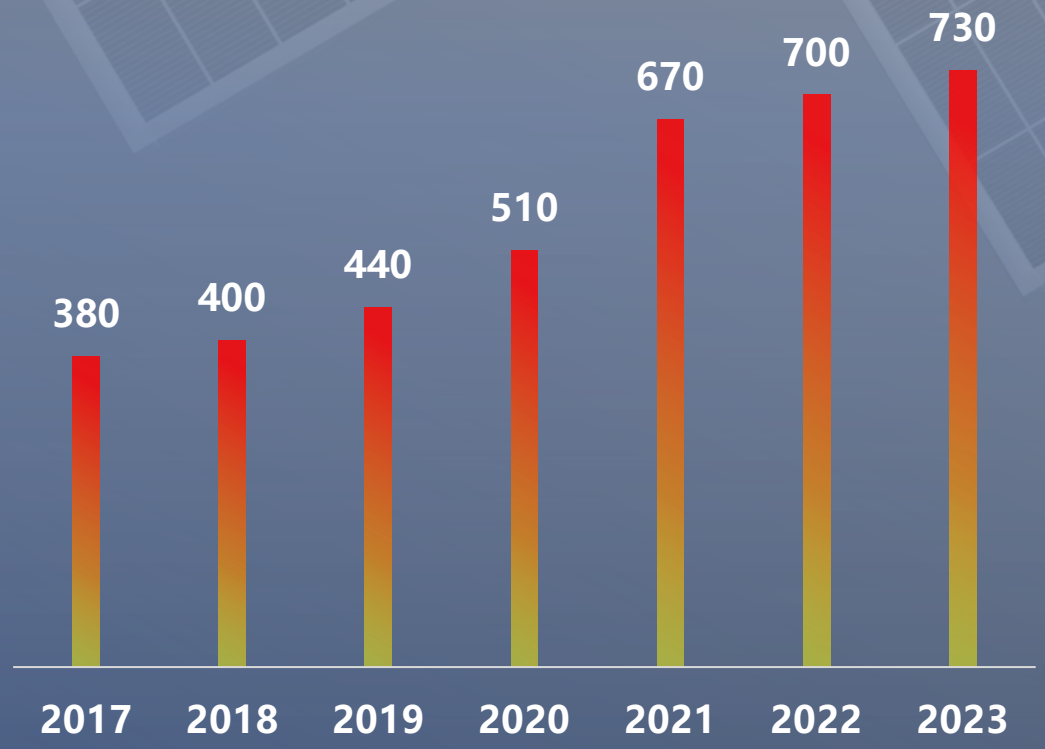
To ensure excellent reliability performance of module products, the modules are subjected to rigorous aging tests designed by DFMEA, which confirm less than 2% module power degradation after enhanced aging tests

Hyper-ion: Scaling Up

Hyper-ion product capacity planning



Photovoltaic module power roadmap



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7:00 pm – 8:00 pm CET, Berlin, Paris, Madrid

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