



nPERT technology and its application

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Jolywood (Taizhou) Solar Technology Co., Ltd.

2017-10-25

Outline

- **Introduction**
- **Roadmap of Jolywood products and technology**
- **Current Status of nPERT products in Jolywood**
- **Performance improvement**
- **Summary**

Introduction of Jolywood Sunwatt



- Headquarter established in March, 2008
- Located in Changshu City, Jiangsu
- Listed company in Changshu (Stock Code:SZ300393)
- Market value: RMB 10.4 Billion
- Top 1 PV back sheet manufacturer, 20% market share worldwide and 16GW back sheet revenue in 2016
- Owns “N-bifacial” technology and initiates the industrialized mass production of bifacial cell and module in 2016

Introduction of Jolywood (Taizhou) Solar Technology



- Established in February 2016
- A wholly-owned subsidiary of Jolywood Sunwatt
- Located in Taizhou, Jiangsu
- Main product: N-bifacial mono cell and module
- Current cell capacity: 2.4GW
- Top 1 “N” Bifacial cell manufacturers in the world
- Sales Revenue 17’ is estimated RMB3 Billion

**14
Production
Lines**

N-type mono bifacial solar
cell production lines

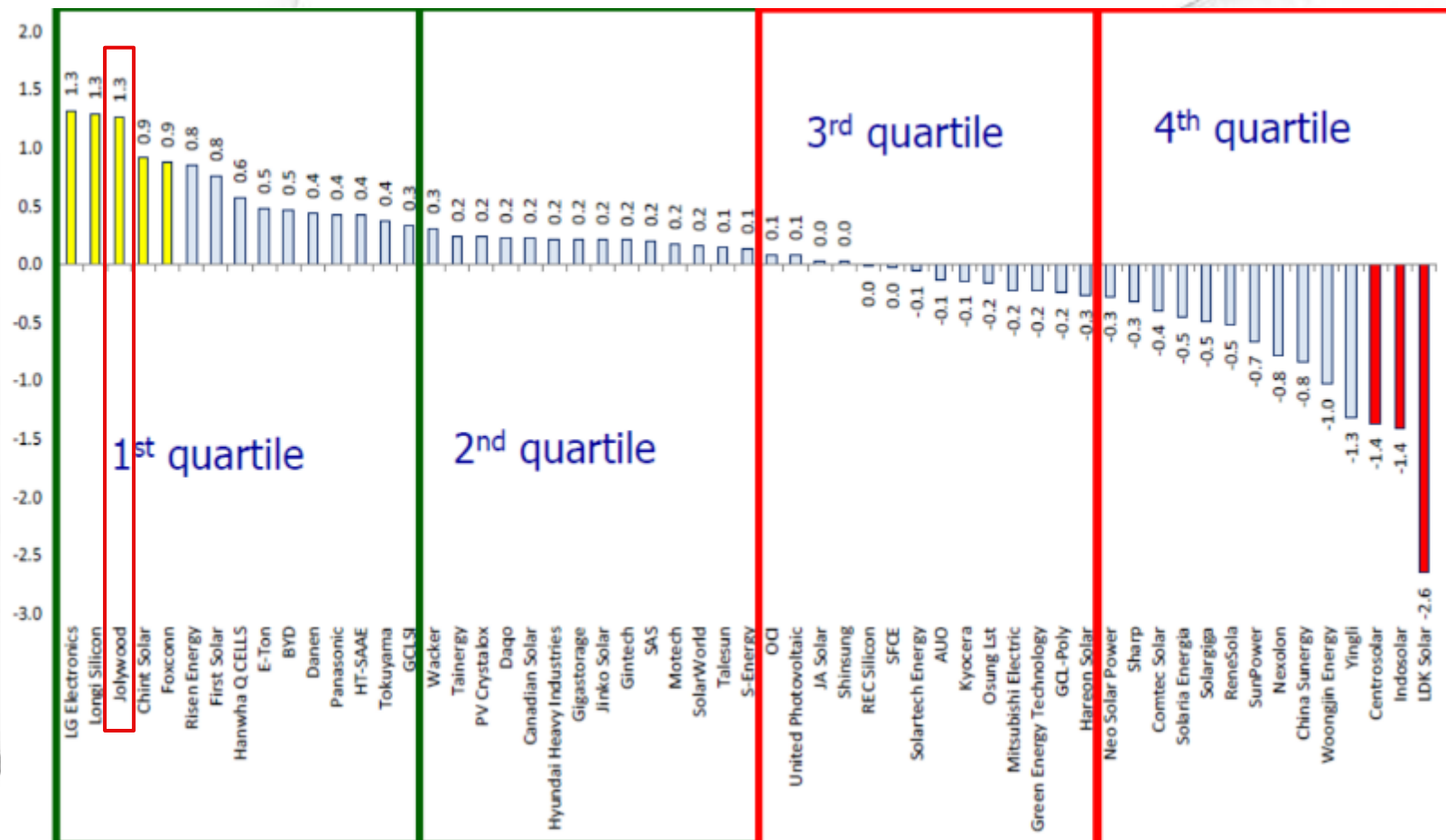
2.4 GW

2.4GW production
capacity

PHOTON RANKING LIST (FINANCIAL HEALTY)

Jolywood ranked **Third**

(In terms of financial health ranking, there are 57 companies involved and Jolywood was included for the first time.)



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Current Status of nPERT cells in jolywood

Process flow

Texturing

BBr₃ diffusion

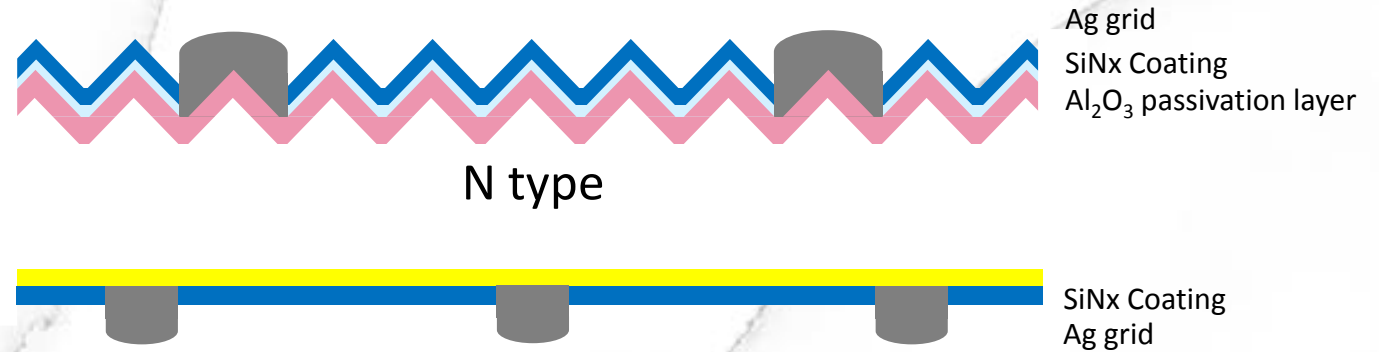
Emitter removal

IMP

Annealing

Passivation & AR Coating

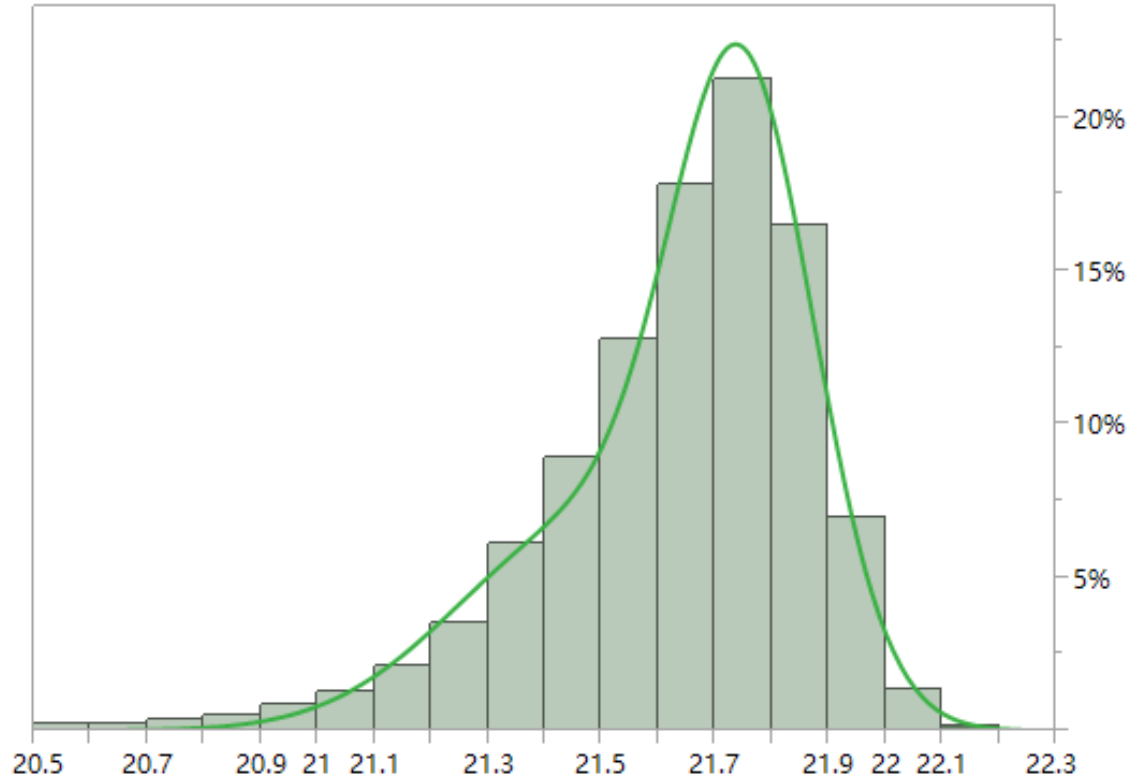
Printing



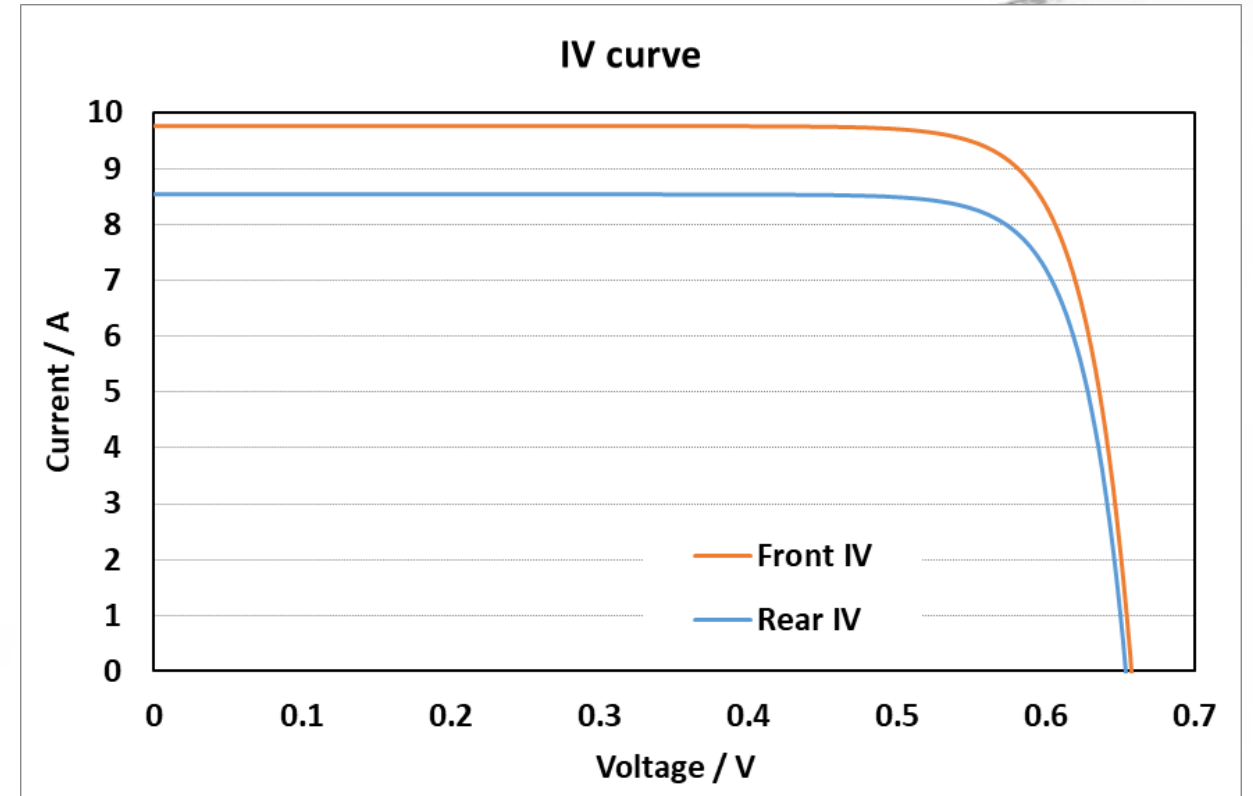
- N-type 6 inch monocrystalline Cz wafer
- Thermally diffused p⁺ emitter and implanted n⁺ BSF
- Screen-printed electrical contacts with floating busbars
- Bifacial structure

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nPERT cell performance

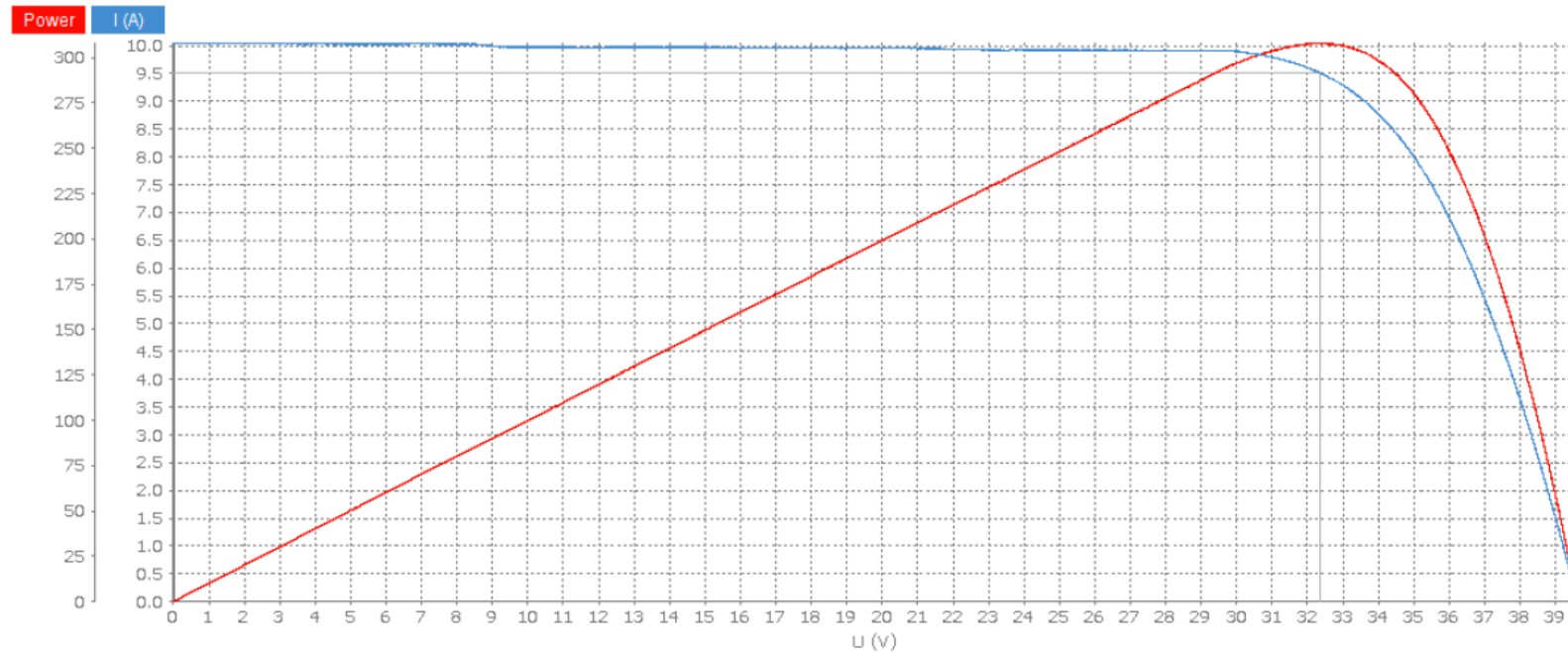


- Cell efficiency distribution of production, data from one production line for one day, nearly 90,000 cells;
- Fit with a mixture of three normal distributions.



- Typical IV curve with illumination from front or rear.

Bifacial module performance @STC



- Sample 1# (Exposure on the front side)
- Confirmed by TUV
- Report No. TRSHV08026/17/01

Sample #	Voc [V]	Vmpp [V]	Isc [A]	Impp [A]	Pmpp [W]	FF [%]
1	39.645	32.336	10.054	9.523	307.95	77.26

Reliability test

World first TUV NORD 3 times IEC tests on N bifacial

TC600 1.55%

DH3000 3.63%

UV45 3.05%

HF30 0.72%



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Reliability tests

TUV SUD most stringent low temp dynamic mechanical loading test

DML -40°C , ±1000Pa , 1000次

Front side 0.42%

Back side 0.35%

ZERTIFIKAT ◆ CERTIFICATE ◆ 证书注册 ◆ CERTIFICADO ◆ CERTIFICAT

 **CERTIFICATE**
No. Z2 17 05 98081 005

Holder of Certificate: **Jolywood (Taizhou) Solar Technology Co., Ltd.**
Kaiyang Rd.
Jiangyan Economic Development Zone
225500 Taizhou, Jiangsu
PEOPLE'S REPUBLIC OF CHINA



Certification Mark:  

Product: **Crystalline Silicon Terrestrial Photovoltaic (PV) Modules**
Mono-Crystalline Silicon Photovoltaic Module

The product was tested on a voluntary basis and complies with the essential requirements. The certification mark shown above can be affixed on the product. It is not permitted to alter the certification mark in any way. In addition the certification holder must not transfer the certificate to third parties. See also notes overleaf.

Test report no.: 704061709104-01 

Valid until: 2022-05-26

Date, 2017-06-02 (Zhulin Zhang)
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TÜV SÜD Product Service GmbH · Zertifizierstelle · Ridlerstraße 85 · 80339 München · Germany 

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Reliability tests

6 times PID tests

±1500V , 576h

Highest power degradation 0.94%

Average power degradation 0.52%



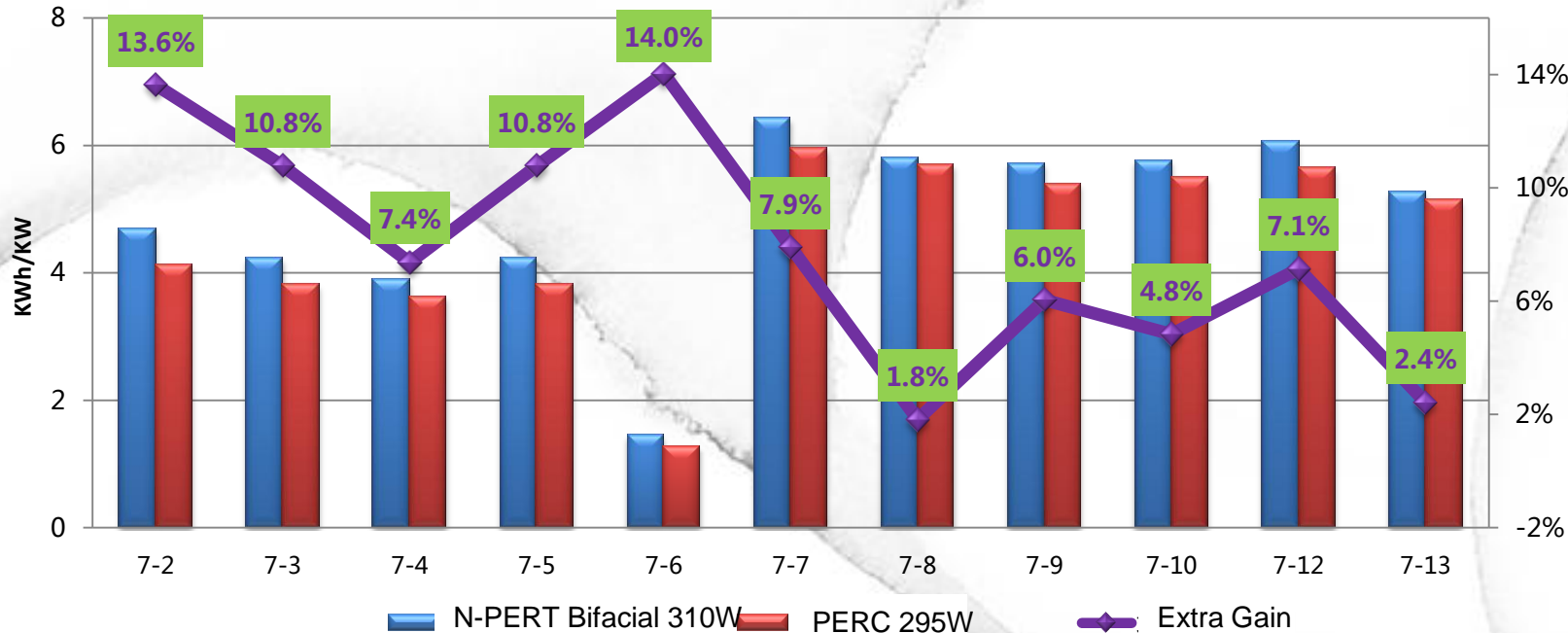
Bifacial module performance in field

Case

- The first "Panda" Solar Plant consists of 29.21MW of Jolywood bifacial modules. Each panel with label power 310Wp (**Front Side Power 285W+ 10%* Rear side Power**)
- Compared to P Perc 295wp, after we take 10% from rear side, the N-PERT bifacial modules still achieved 7.1% extra gain in average.



Comparison of Performance P-PERC vs. N-PERT Bifacial



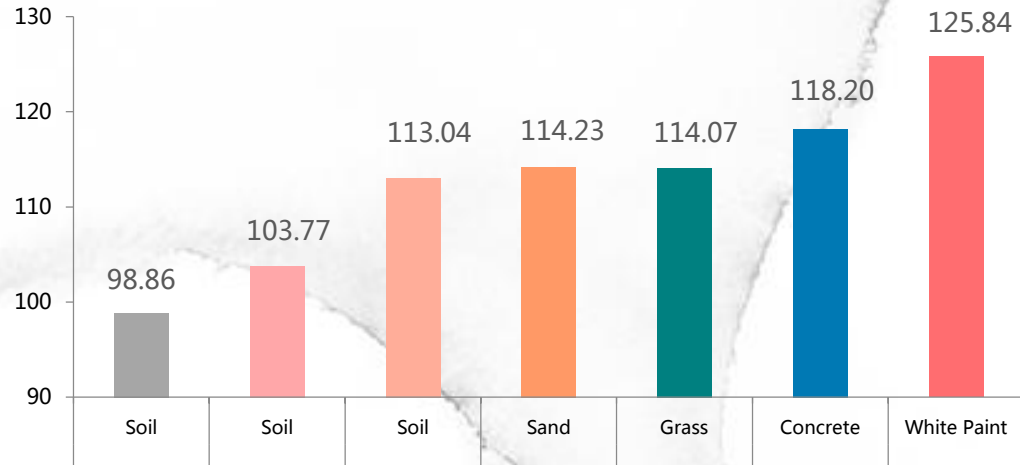
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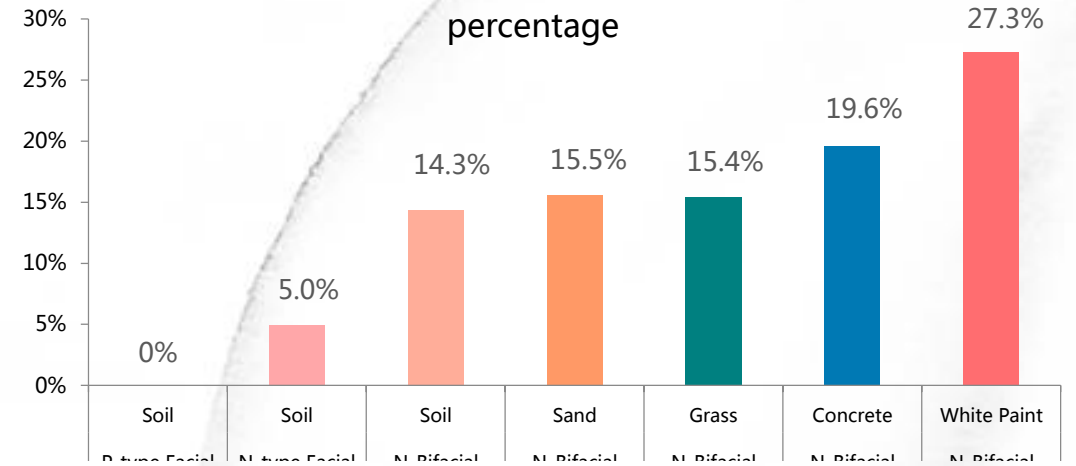
TUV-NORD LAB PROJECT

- TUV NORD Outdoor Tests Field in NingXia, Northeast China
- To monitor and evaluate actual generation by bifacial modules under different albedos.

Generating Capacity under Different Albedos



Generating Capacity under Different Albedos in percentage

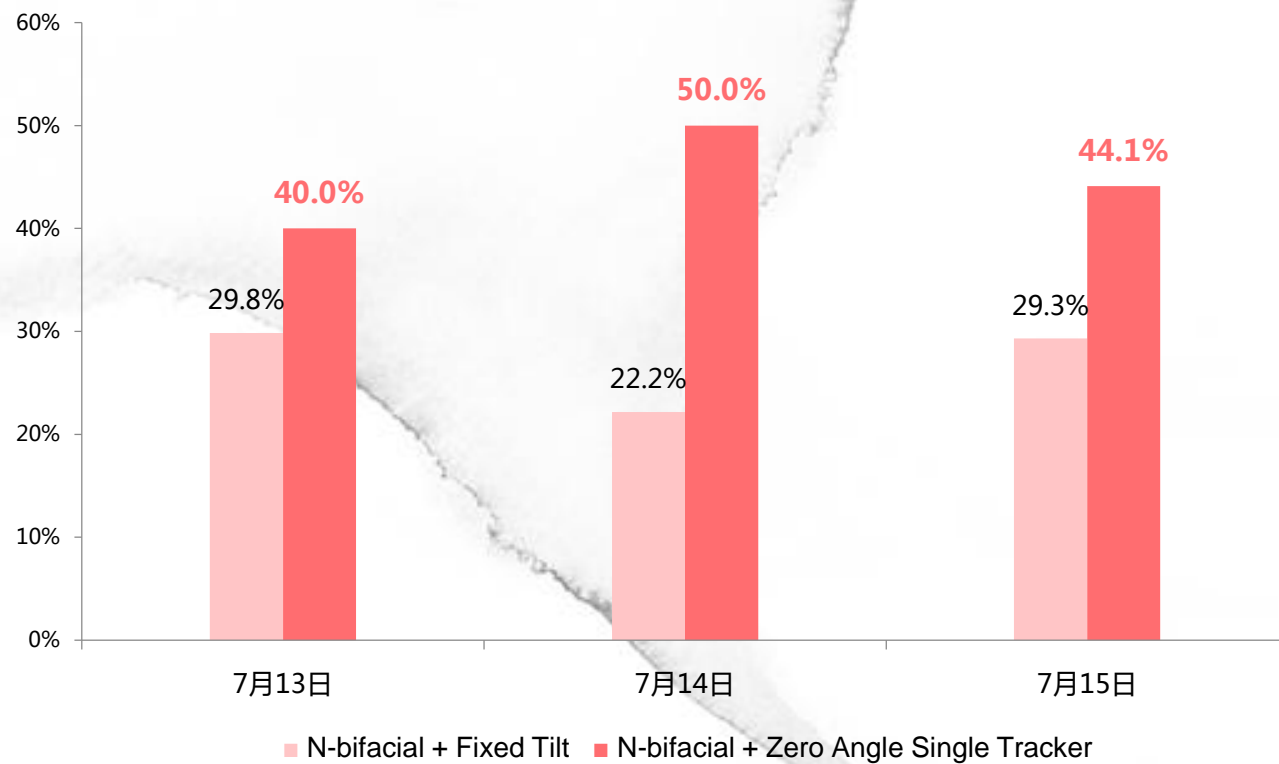


Resources : TUV NORD Outdoor Tests Field in NingXia



ECOLOGICAL PARK

- Guzhen, Anhui, China
- 100-mu sized ecological park generated by 3.9MW Jolywood N-bifacial Products
- The combination of Eco-agriculture, Solar Industry, agricultural machining and e-commerce.



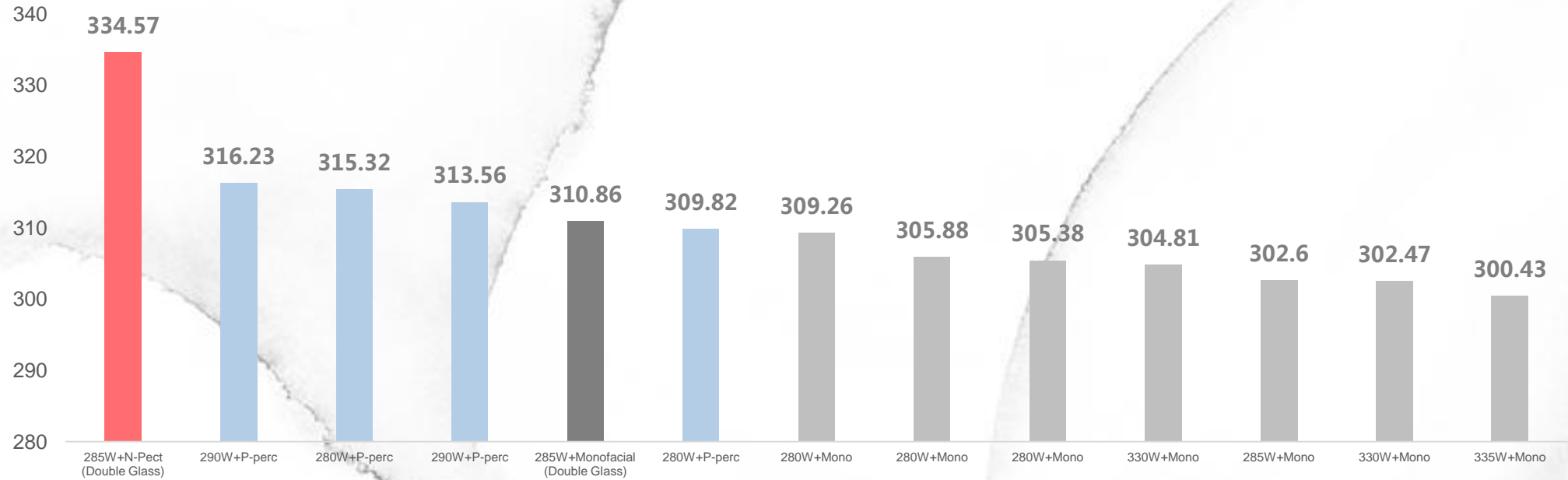
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THE PIONEER PROJECT, PHASE I

Comparison of Different Types of Mono Products Under 37° Temperature

Generation Duration

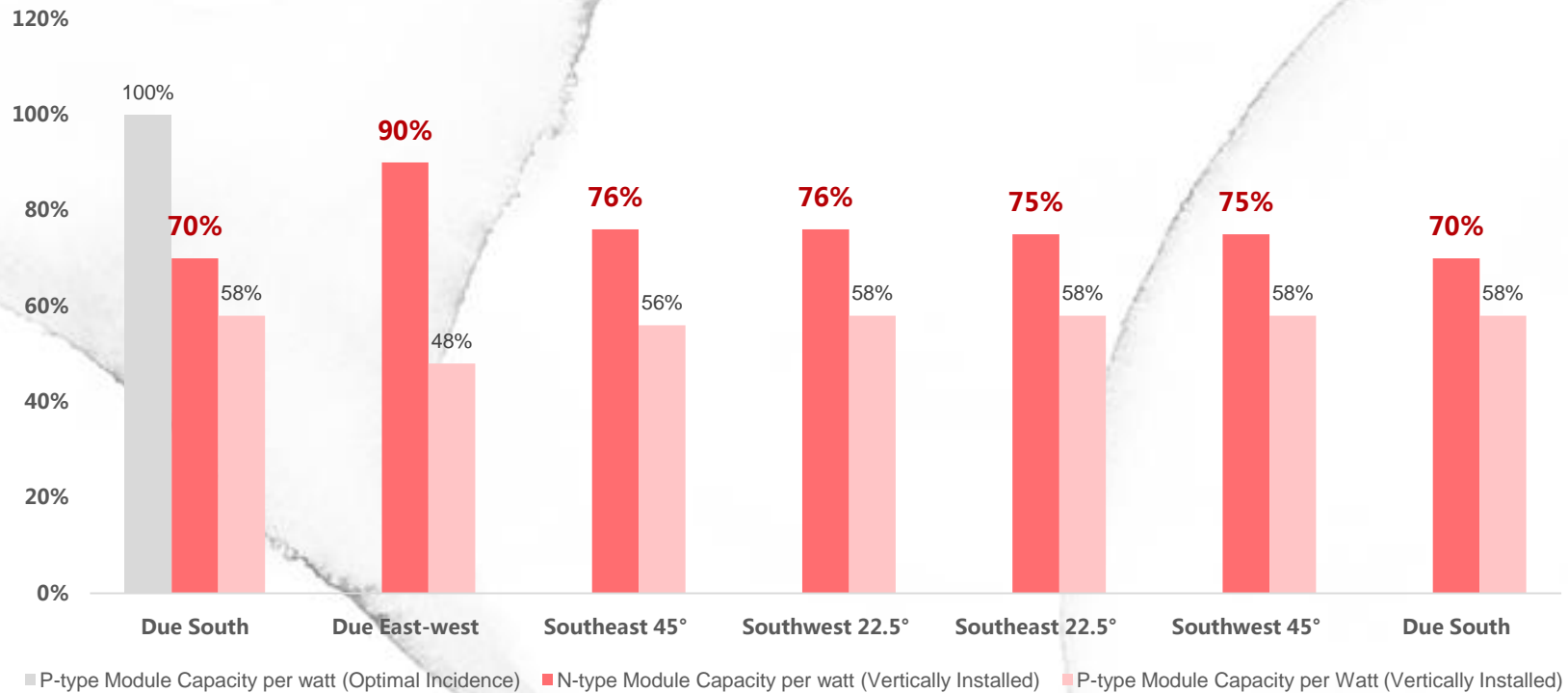


- N-bifacial products show much more higher performance than any other types of mono modules.

CHANGSHU, JIANGSU (VERTICAL INSTALLATION)

Comparison of Capacity per watt-hour (vertical installation)

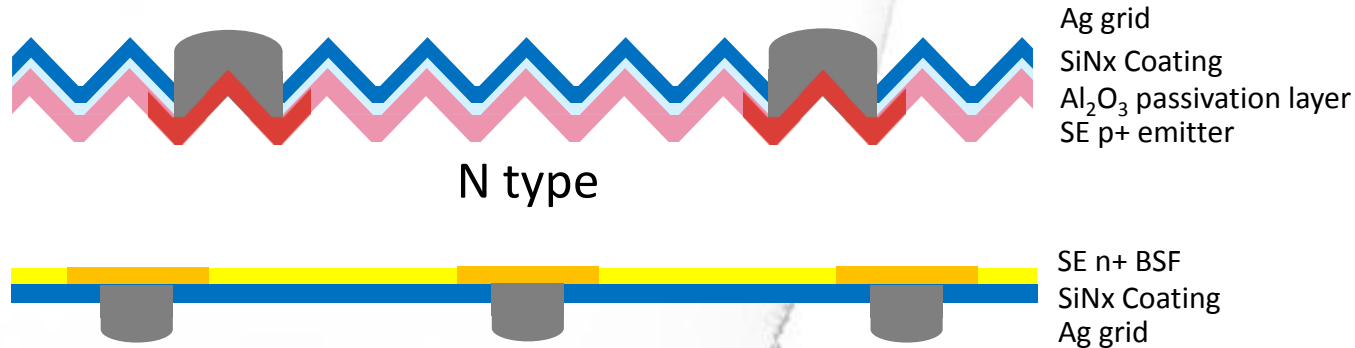
N-type Module: Front Side Power Output 290W, Rear Side Power Output 250W
P-type Module: Front Side Power Output 290W, Rear Side Power Output **None**



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Performance improvement - nPERT

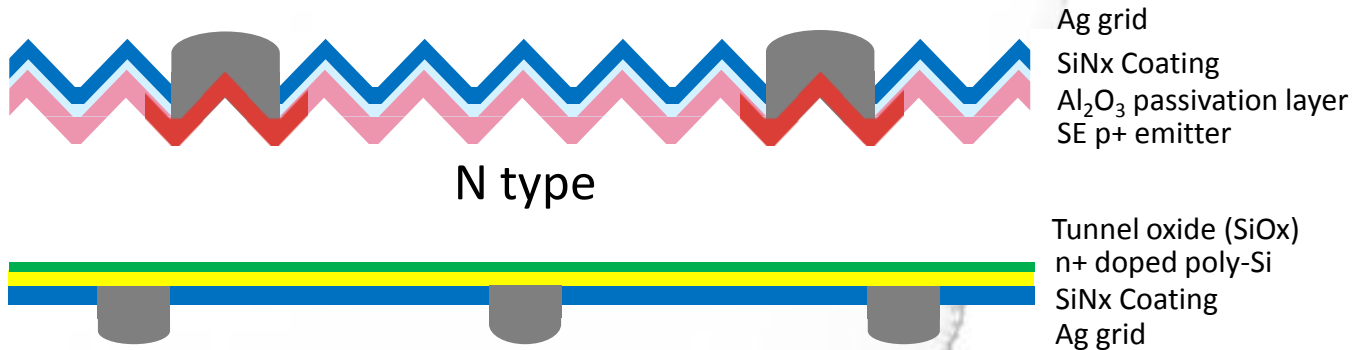


Target 22%

- Light doping and front-side Al₂O₃&SiNx passivation to reduce the surface recombination:
 - p+ emitter: $J_{0p+pass} = 20 \text{ fA/cm}^2$
 - n+ BSF: $J_{0n+pass} = 20 \text{ fA/cm}^2$
 - Bulk recombination: $J_{0bulk} = 15 \text{ fA/cm}^2$
- SE structure and point ohmic contact to reduce Ag-Si recombination
 - Selective p++ emitter: $J_{0p++metal} = 24 \text{ fA/cm}^2$ (area weighted)
 - Selective n++ BSF: $J_{0n++metal} = 36 \text{ fA/cm}^2$ (area weighted)
- Total $J_0 = 20+20+15+24+36 = 115 \text{ fA/cm}^2 \Rightarrow V_{oc} \sim 680 \text{ mV}$

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Performance improvement – Passivated metal contact

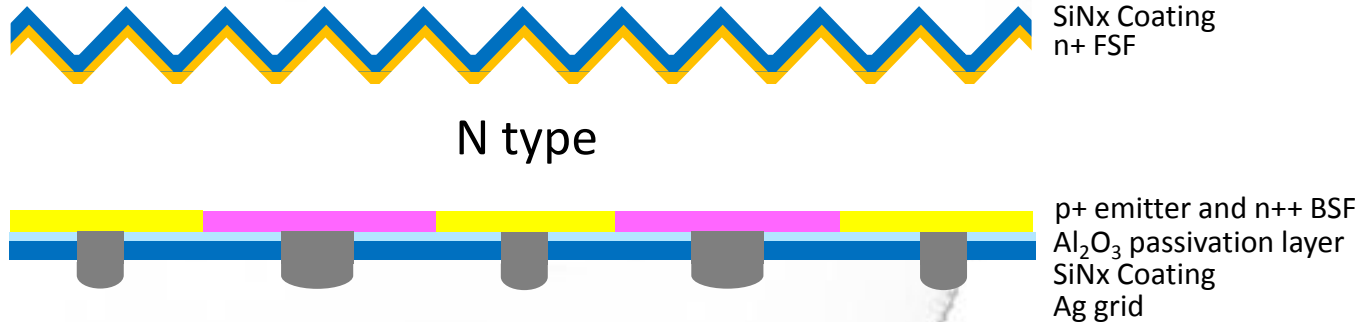


Target 22.5%

- Light doping and front-side Al₂O₃&SiNx passivation to reduce the surface recombination
 - p+ emitter: $J_{0p+pass} = 20 \text{ fA/cm}^2$
 - Bulk recombination: $J_{0bulk} = 15 \text{ fA/cm}^2$
- Well passivated rear surface and low Ag-Si recombination with TOPCon structure
 - n+ BSF: $J_{0n+pass} = 10 \text{ fA/cm}^2$
 - n+ BSF: $J_{0n+metal} = 15 \text{ fA/cm}^2$ (area weighted)
- Front side SE structure and point ohm contact to reduce Ag-Si recombination
 - Selective p++ emitter: $J_{0p++metal} = 24 \text{ fA/cm}^2$ (area weighted)
- Total $J_0 = 20+15+10+15+24=84 \text{ fA/cm}^2 \Rightarrow \text{Voc} \sim 695\text{mV}$

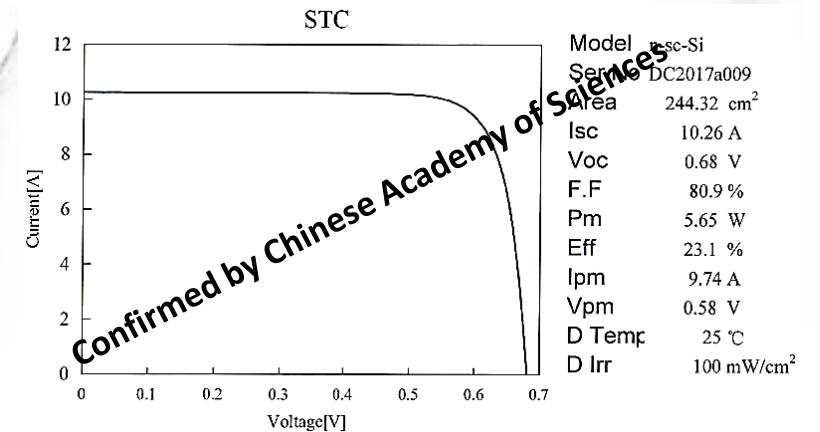
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Performance improvement – IBC Cell



Target 23%

- Shadow FSF doping and rear side Al_2O_3 & SiNx passivation to reduce surface recombination
 - n+ FSF: $J_{0n+pass} = 25 \text{ fA/cm}^2$
 - p+ emitter: $J_{0p+pass} = 15 \text{ fA/cm}^2$ (area weighted)
 - n++ BSF: $J_{0n++pass} = 20 \text{ fA/cm}^2$ (area weighted)
 - Bulk recombination: $J_{0bulk} = 15 \text{ fA/cm}^2$
- Point ohm contact to reduce the Ag-Si recombination
 - p+ emitter: $J_{0p+metal} = 20 \text{ fA/cm}^2$ (area weighted)
 - n++ BSF: $J_{0n++metal} = 20 \text{ fA/cm}^2$ (area weighted)
- Total $J_0 = 25+15+20+15+20+20 = 115 \text{ fA/cm}^2 \Rightarrow \text{Voc} \sim 680\text{mV}$



Best Cell 23.1% achieved

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Summary

- Average efficiency above 21.5% was achieved in mass production on M2 Cz wafers with good efficiency distribution.
- Module power higher than 305Wp @STC is achievable in mass production.
- 10%-30% extra energy gain in average was achieved in field.
- Clear technology roadmap and improvement scheme were established, which is feasible for mass production.
- IBC cell with efficiency of 23.1% was achieved in standard M2 Cz wafers using R&D production equipment.



谢谢观看



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