n-type

Technology

Jolywood n-type Bifacial Technology and Progress in the Development of IBC cells

GENHUA JI

2018 Bifacial PV Workshop, Sept 10, 2018

中来股份 JOLYWOOD

Content

About Jolywood

About Jolywood Group

Jolywood (Suzhou) Sunwatt Co., Ltd.

- Group headquarter
- Global largest solar backsheet manufacturer
- 20% market share around the world

Jolywood (Taizhou) Solar Technology Co., Ltd.

- 100% wholly owned subsidiary
- **Global largest N-type solar cell and module manufacturer**

Zoomlight (Suzhou) Solar Power Co., Ltd.

- Partially controlled subsidiary
- One-stop EPC services (investment, financing, operations and services)

About Jolywood Solar

Established in February **2016**

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

Specialized in

high efficiency

photovoltaic technology

with 16 production lines

Global largest

N-type Bifacial Product

Manufacturer

Capacity **> 2.4 GW**

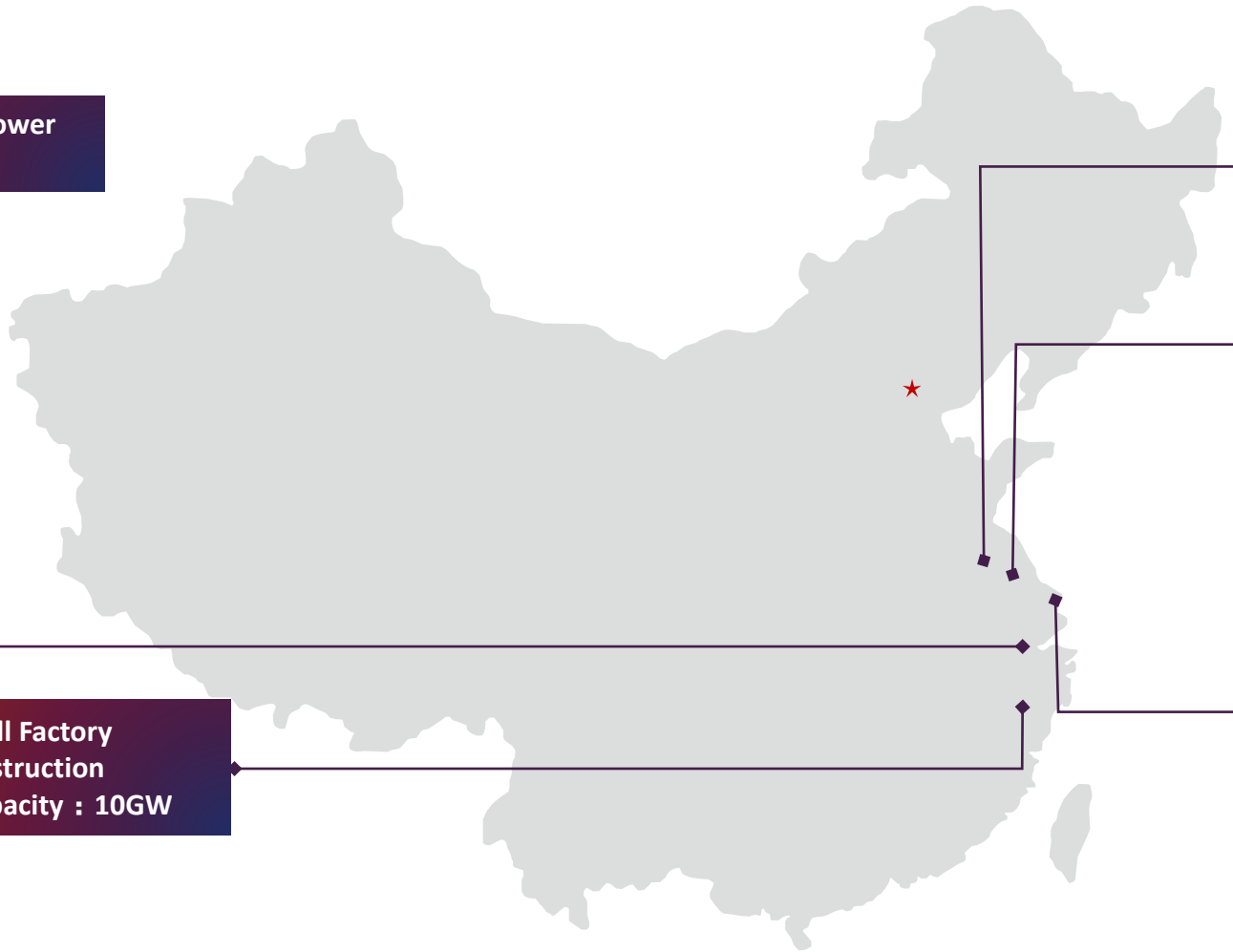
Higher power and

sufficient reliability

from Jolywood

Solar Cell and Module

Jolywood Network



Suzhou Zoomlight Power Company

Yangzhou Module Factory
Under construction
Project Capacity：2.8GW

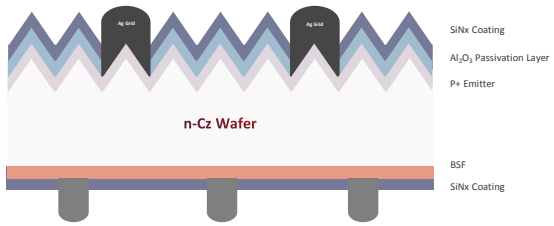
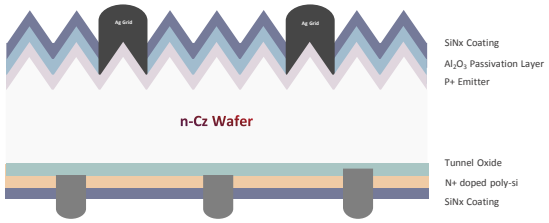
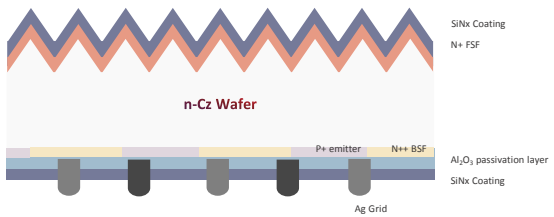
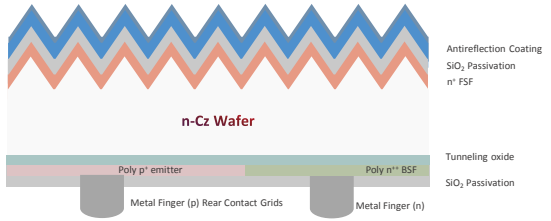
Taizhou Factory
Cell：2.4GW
Module：0.3GW(Project capacity:1.3)

Suzhou BS Factory & HQ

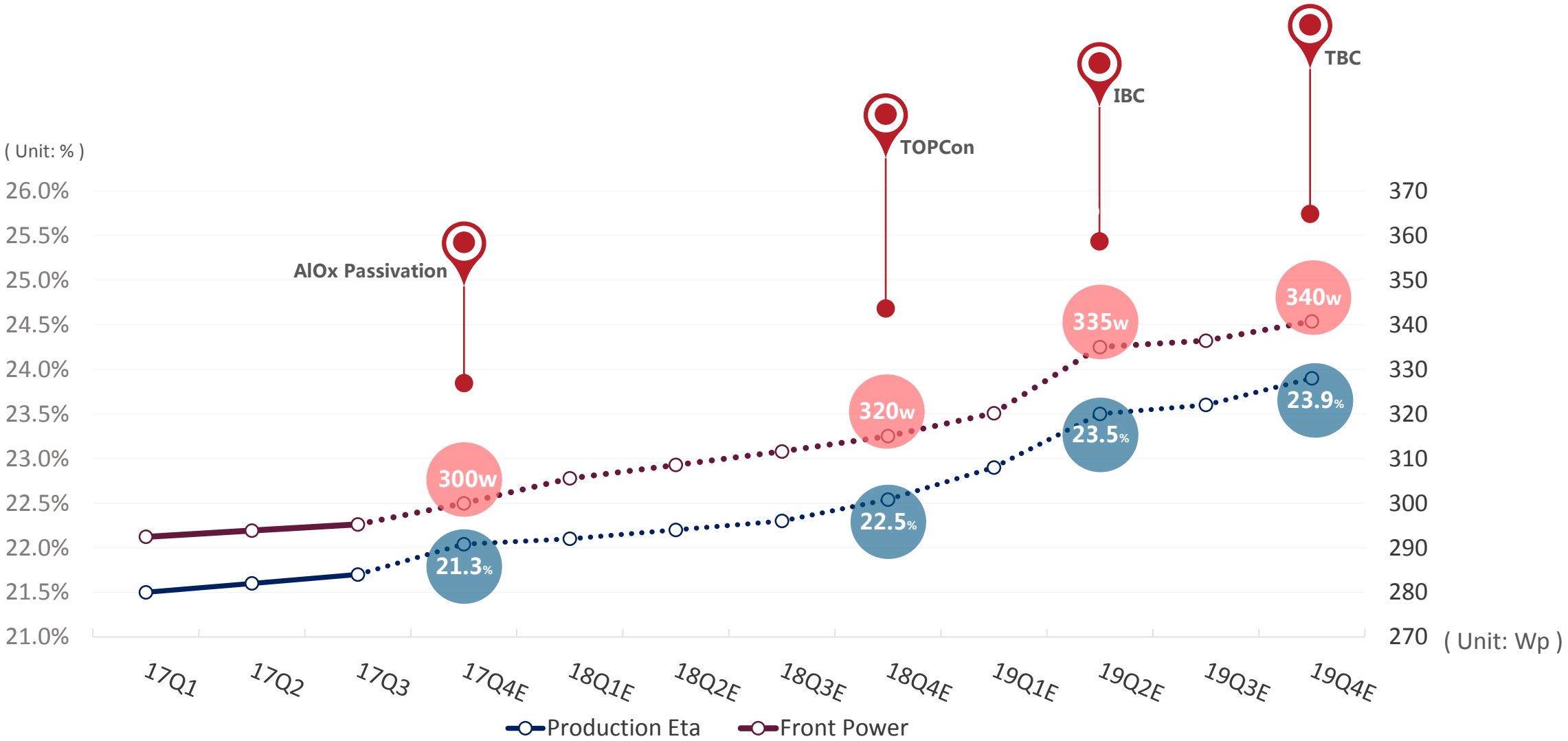
Quzhou Cell Factory
Under construction
Project Capacity：10GW

Jolywood n-type Technology Roadmap

Roadmap of Jolywood n-type solar cells

>22.0% Efficiency	>23.0% Efficiency	>23.5% Efficiency	>24.5% Efficiency
			
N-type Bifacial Mono Solar Cell **(Bifacial n-PERT Cell)** **Mass-production, 21.5%**	Tunnel Oxide Passivated Contact Cell **(TOPCon Cell)** **Pilot-line, 22.5-23%**	Interdigitated Back Contact Cell **(IBC Solar Cell)** **Pre pilot-line, 23%**	Topcon Back Contact Cell **(TBC Solar Cell)** **Under development**

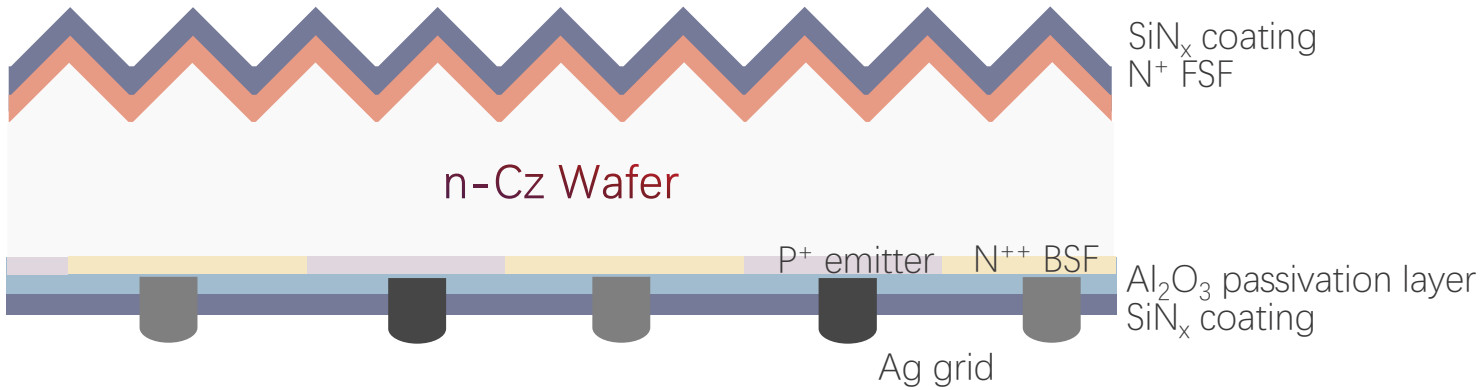
Jolywood n-type technology roadmap (17Q1~19Q4, 60-cell Module)



Jolywood IBC Progress

Jolywood n-IBC process flow

- **Simplified process flow using industrial technology**
  - N-type 6 inch monocrystalline Cz
  - Two high temperature steps
  - Thermally diffused p+ emitter, ion implanted n+ FSF and n++ BSF regions
  - Mask locally opened by laser
  - Screen-printed electrical contacts with floating busbars



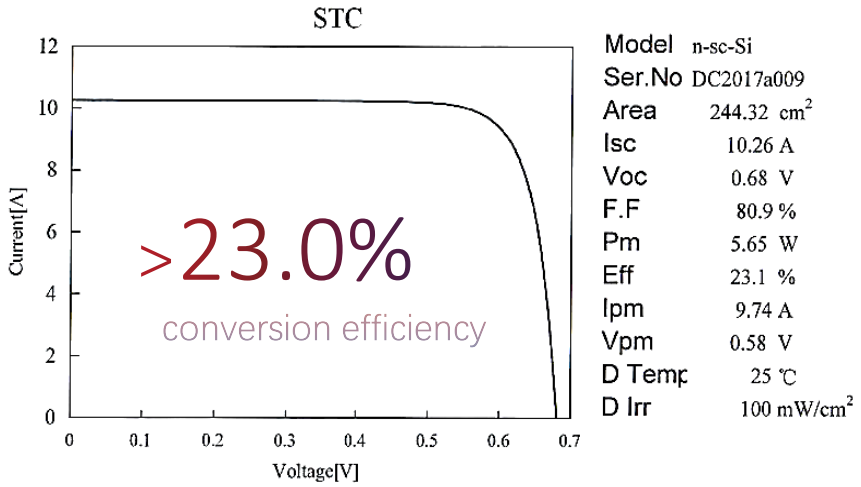
Process Flow

- Texturing
- Front implantation
- Mask
- Cleaning
- BBr3 diffusion
- Rear laser opening
- Rear implantation
- Annealing
- Cleaning
- Al2O3 deposition
- SiNx coating
- Printing

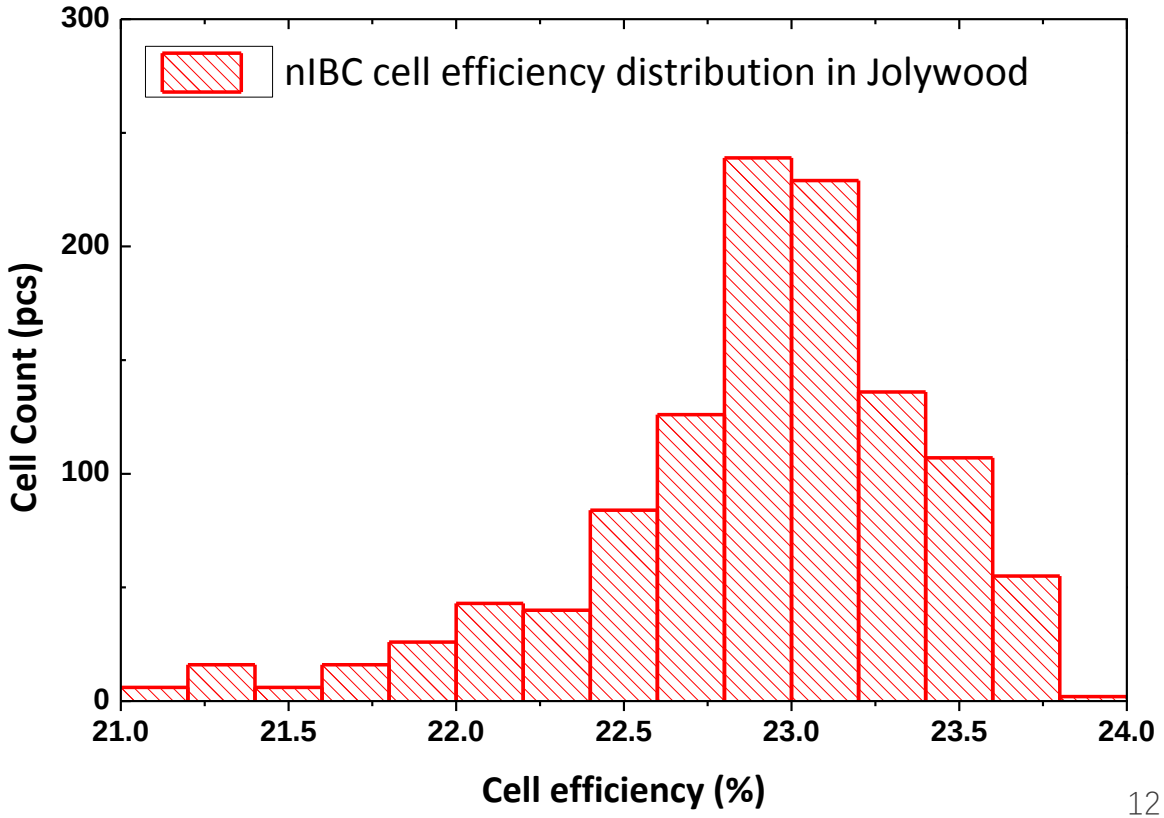
Jolywood n-IBC result

- **Results in Jolywood pilot line**
  - Standard M2 wafer
  - Based on the existing nPERT production line except the laser step
  - Highest efficiency of 23.1% certified, and average efficiency of 22.9% achieved on large scale batch

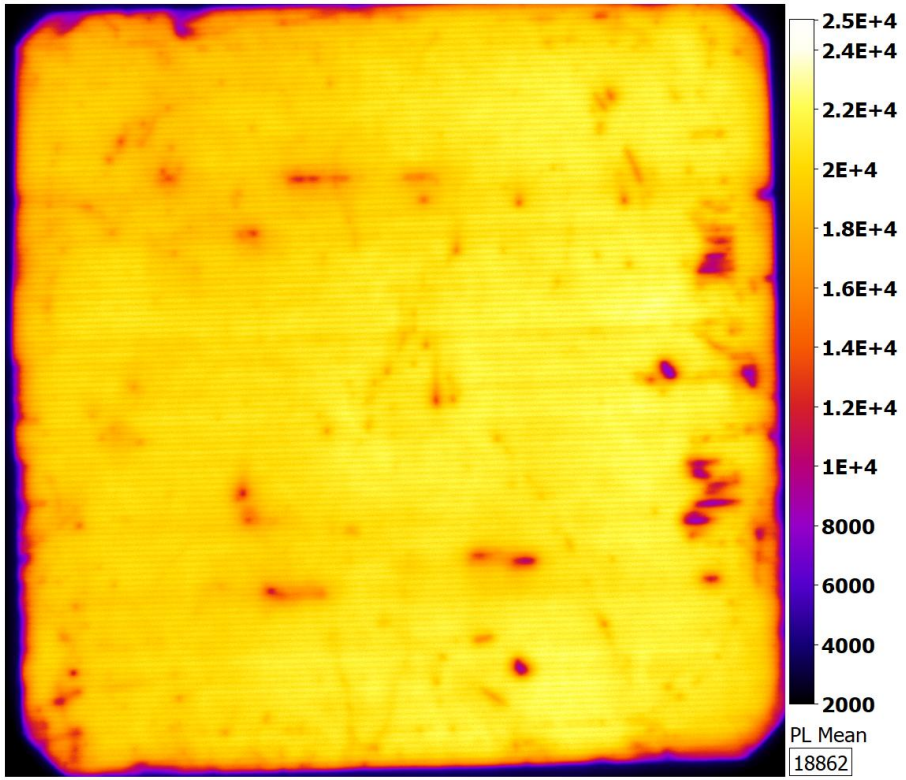
	Isc (A)	Voc (V)	FF (%)	Eta (%)	Count (pcs)
Avg	10.18	0.679	80.8	22.9	1148
Std	*0.15*	*0.006*	*0.76*	*0.47*	

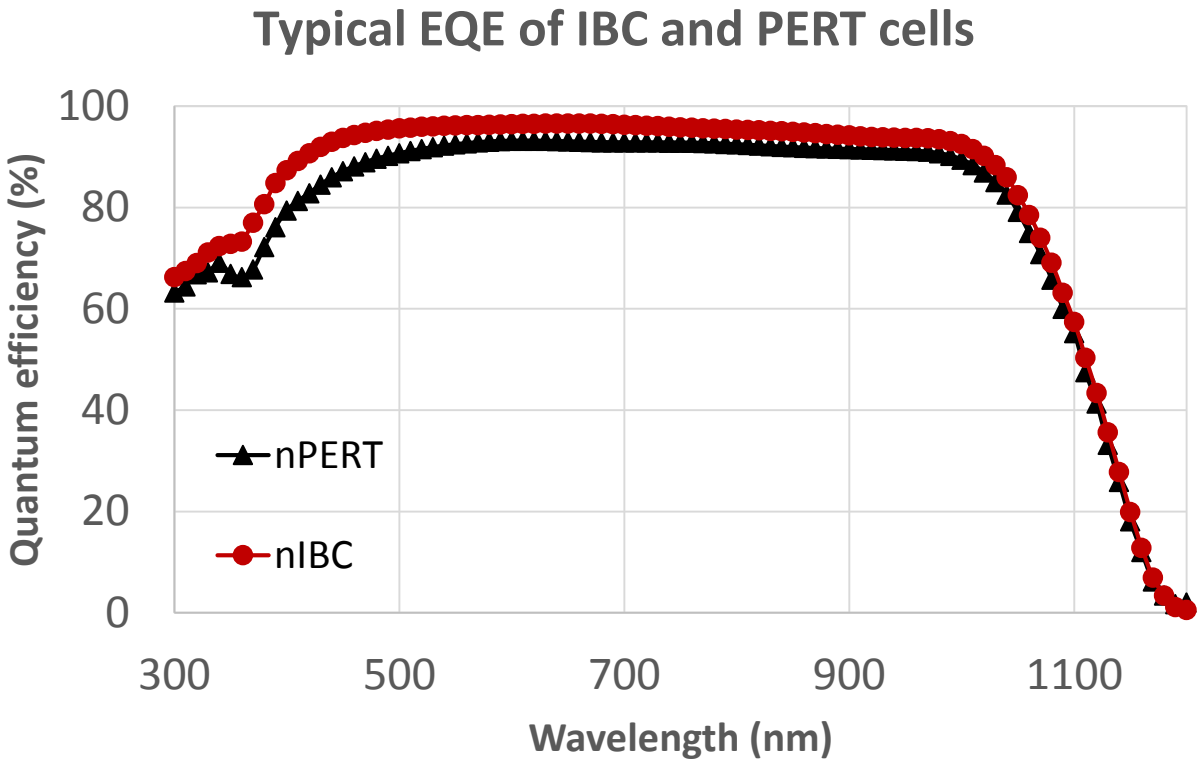


- Third party certification of 23.1% efficiency



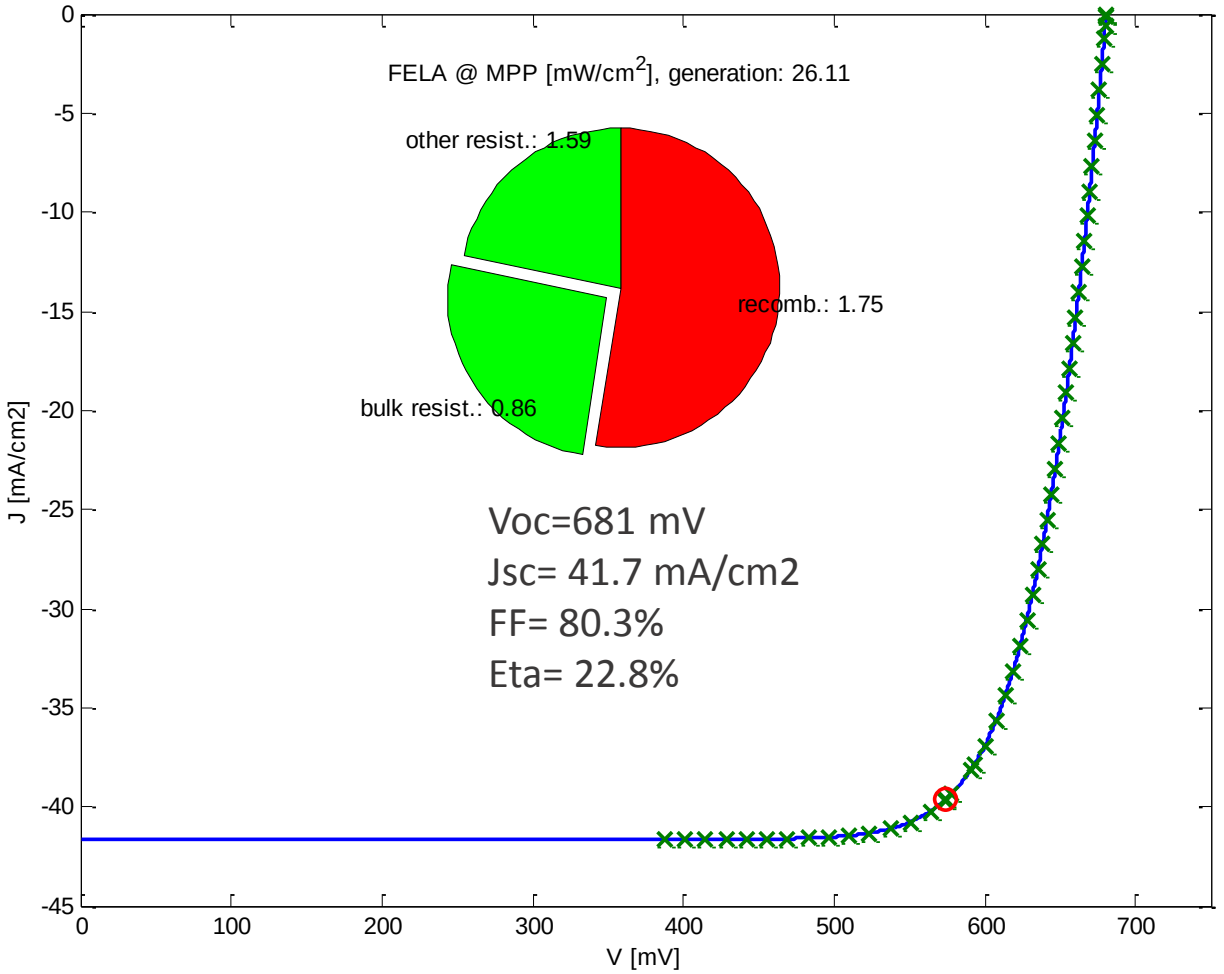
Jolywood n-IBC result

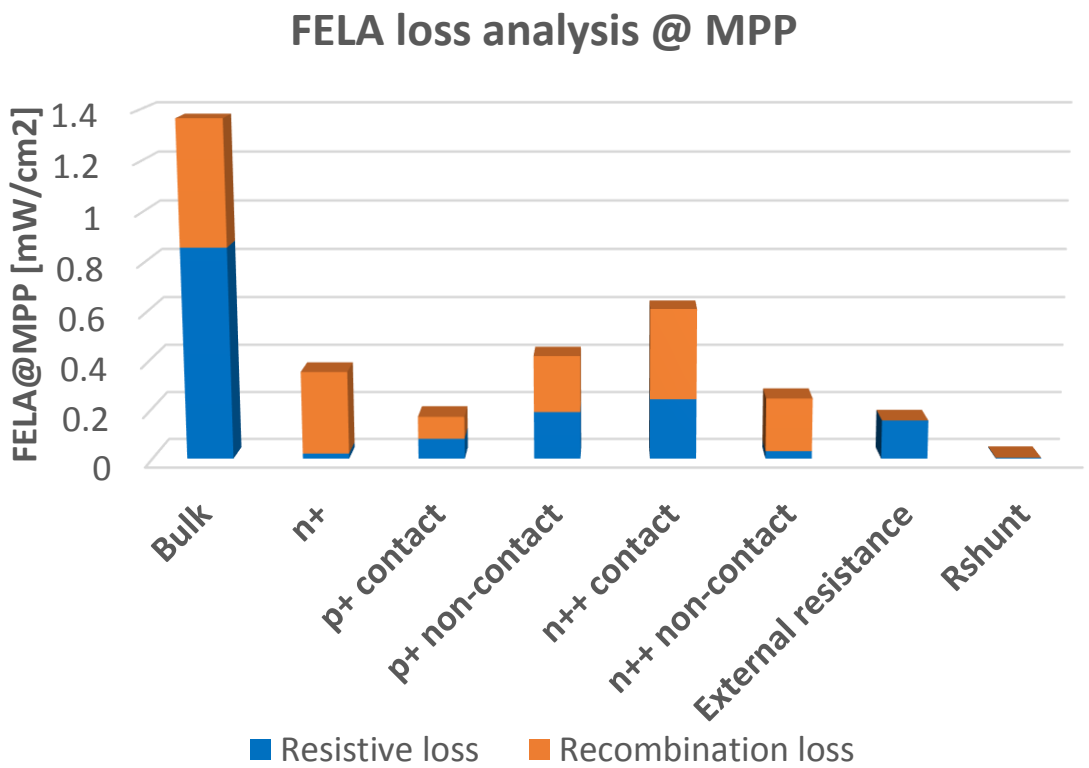




- Homogenous and high PL value
- Excellent optical response with Jsc around 42 mA/cm^2

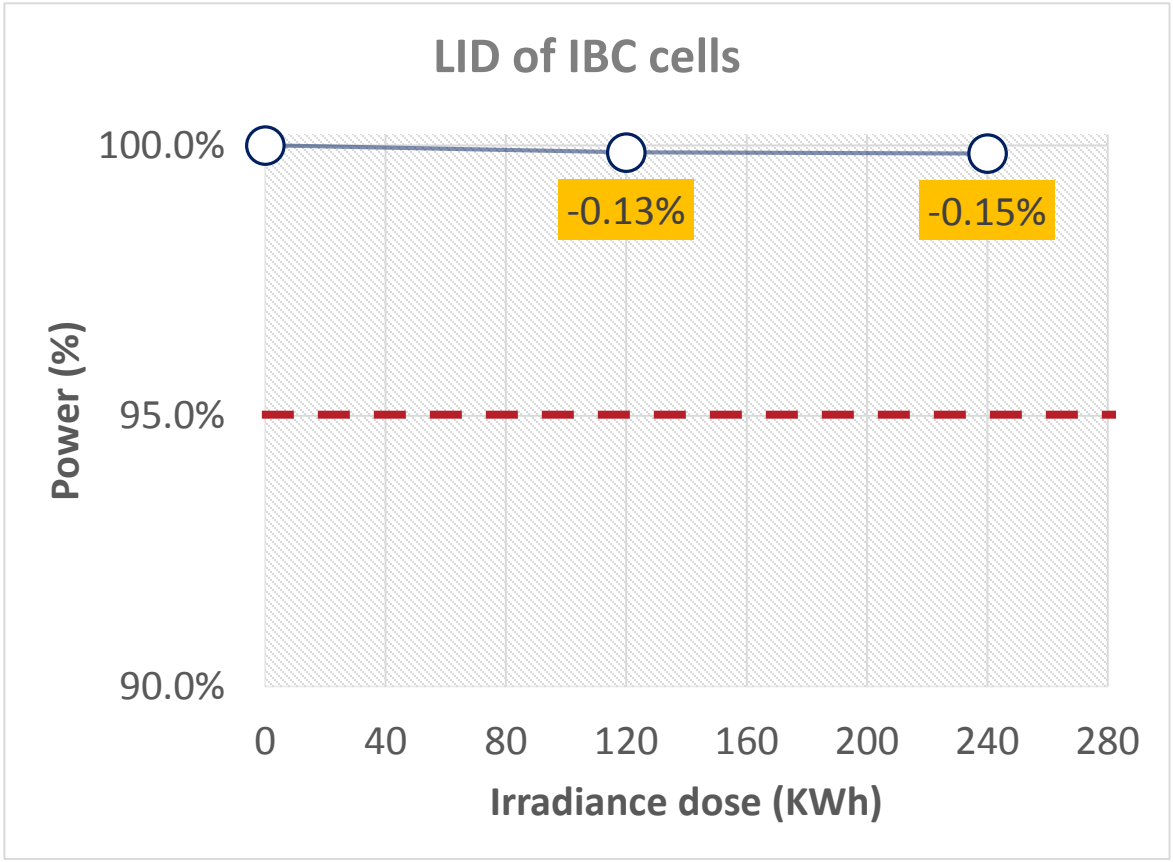
Simulation and FELA loss analysis using Quokka2

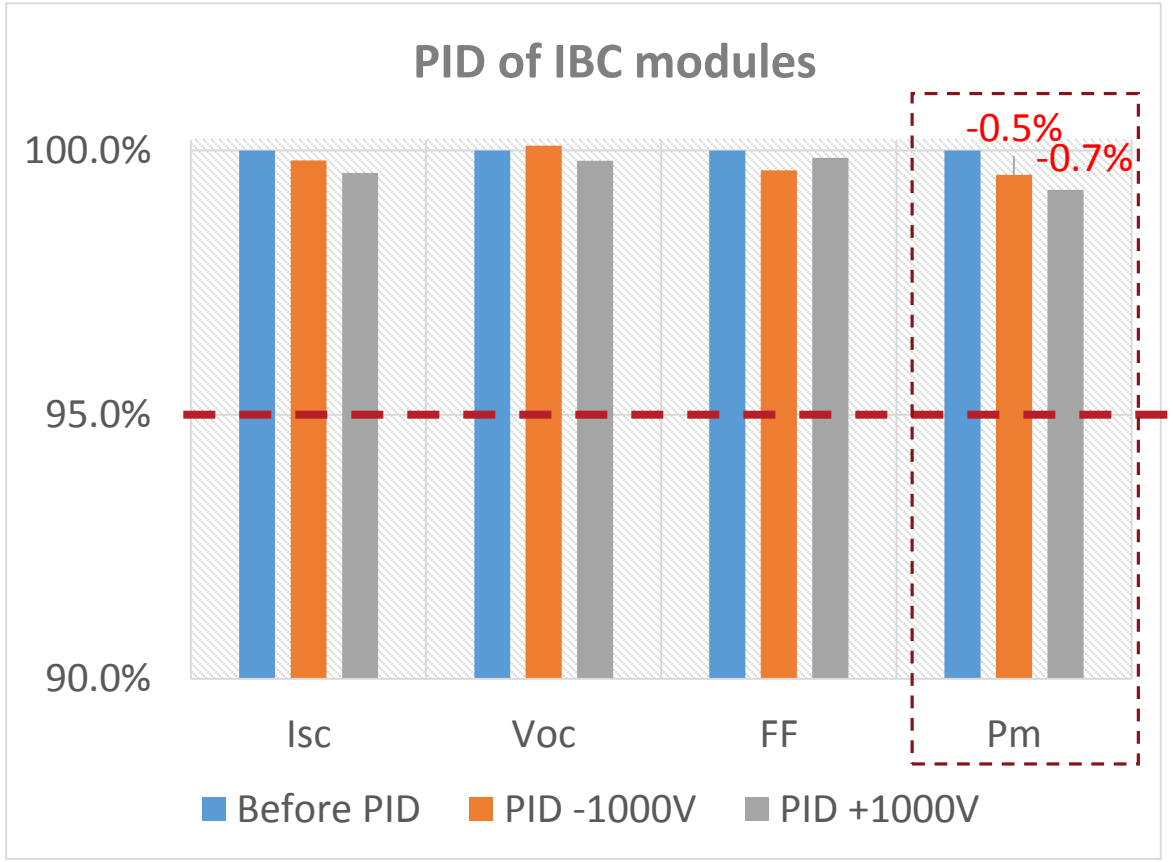




- The loss is mainly on bulk, n++ contact and p+ non-contact region.

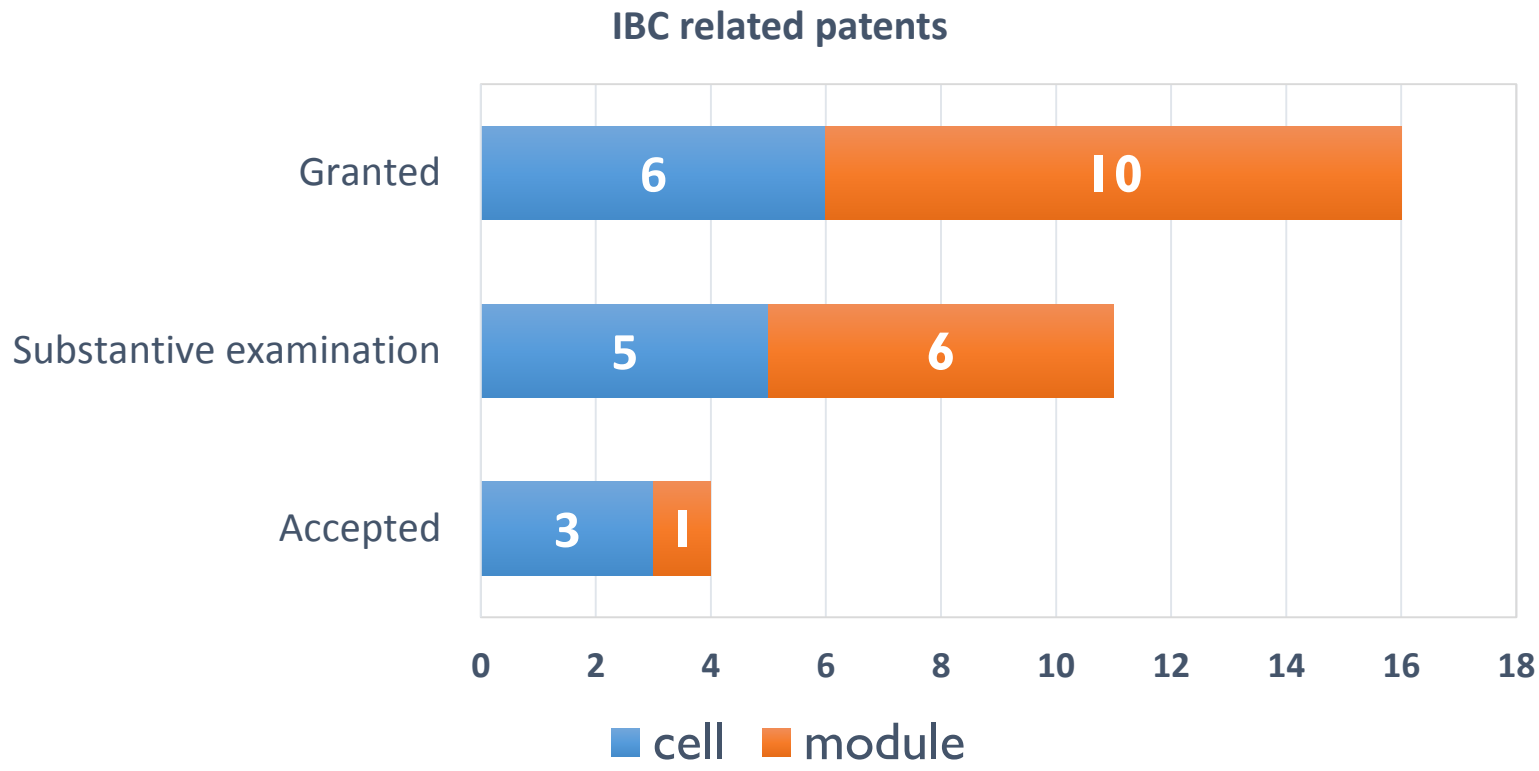
LID and PID test





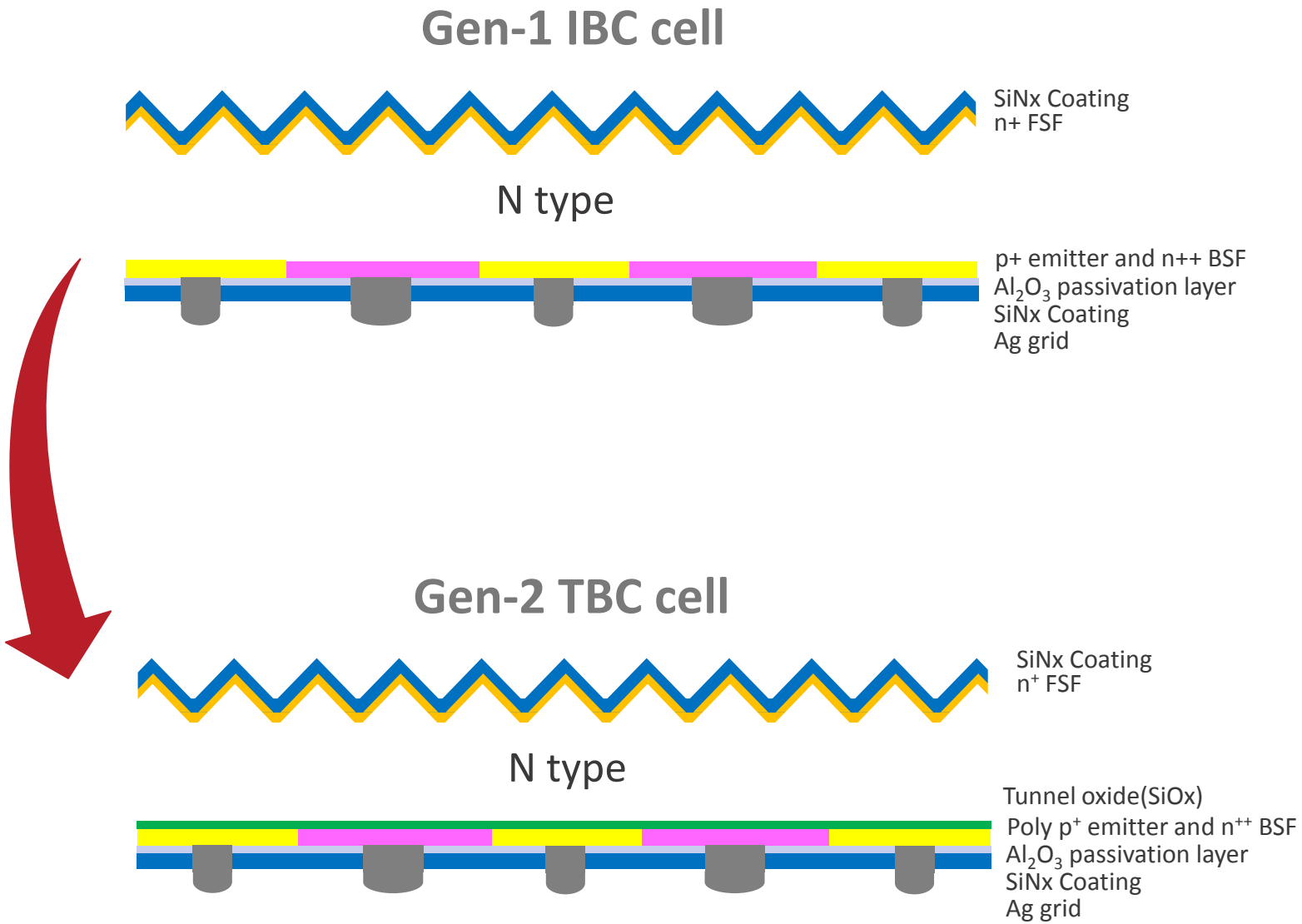
- Nearly LID free due to the absence of B-O in n-Si
- Test condition: 60℃, 85%RH, ±1000V

Jolywood n-IBC patent



- Totally 31 IBC related patents, 16 granted, 11 under substantive examination and 4 accepted.

Jolywood n-IBC roadmap



Target:

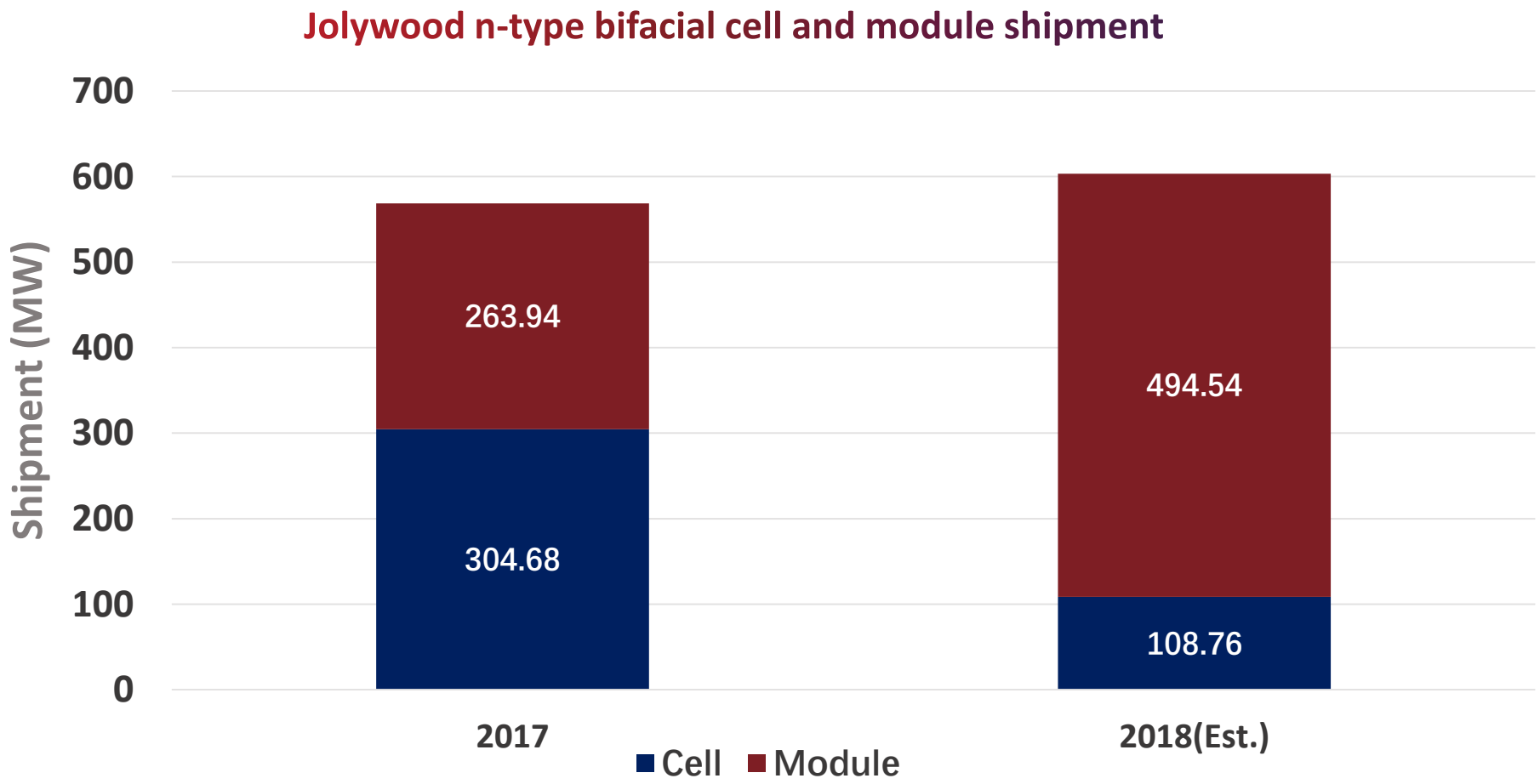
- **Improved FSF doping profile and passivation**
  - $J_{0n+,pass}$: 25 → 10 fA/cm²
- **Well passivated rear surface with tunnel oxide**
  - $J_{0rear,pass}$: 35 → 10 fA/cm²
- **Optimized contact ratio and lower Ag-Si recombination**
  - $J_{0rear,met}$: 40 → 16 fA/cm²

➔ **Total J_0 below 50 fA/cm²**

➔ **Voc above 700mV, Eta above 23.5%**

Shipment and examples of bifacial system

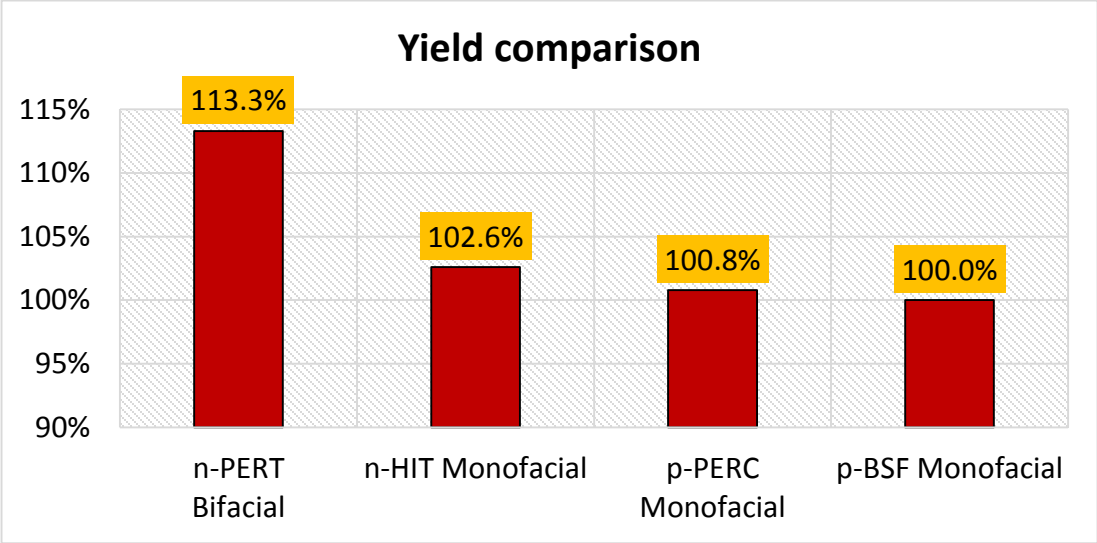
Jolywood n-type bifacial cell and module shipment

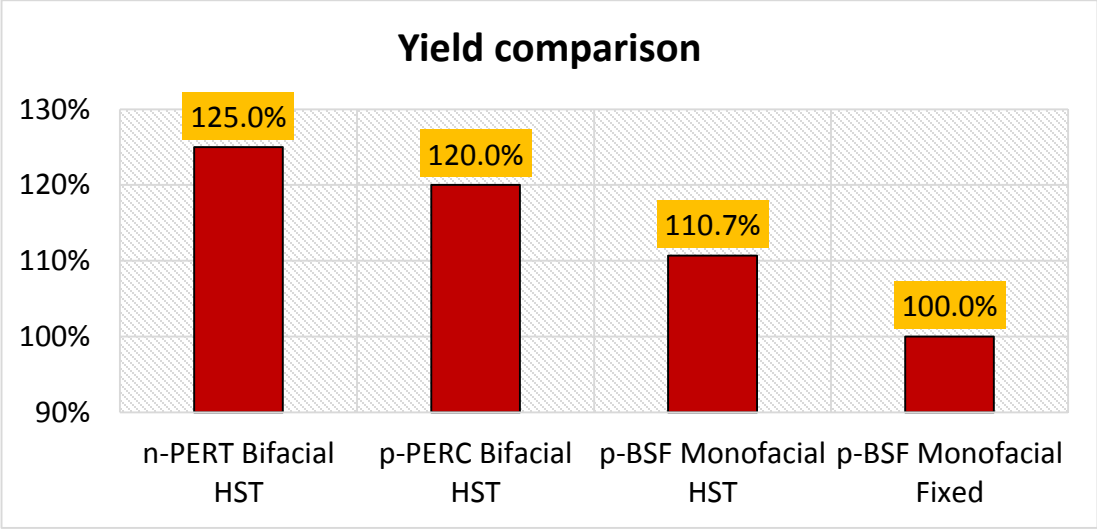


Qinghai Gonghe Demo bifacial system

Qinghai Gonghe Demo Base 100MW, 2016

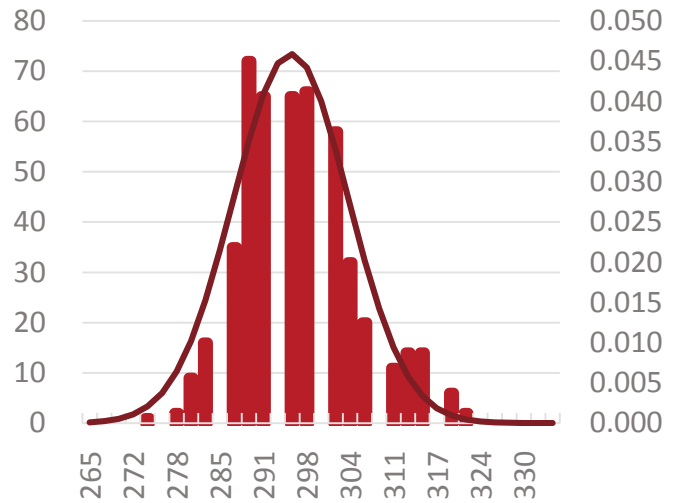
- Use Jolywood bifacial n-PERT modules
- Yield=power generation/installed capacity





Hebei Zhangjiakou Shanneng

Hebei Zhangjiakou Shanneng, 44MW, Aug. 2018



- n-PERT bifacial module 300Wp (STC).
- Average GHI 1052 W/m^2. PV module average output: 295.3W
- Performance Ratio: 295.3/300*(1000/1052)=93.6%, measured at the input port of the string inverter.

Conclusion

Any question, please feel free to let me know.

jigh@jolywood.cn