

# High-Efficiency n-type Module Roadmap for the PV Industry

**Jason Xia**

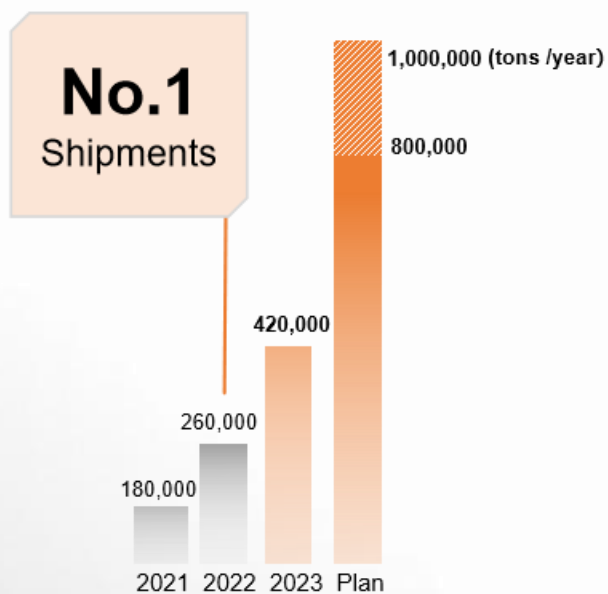
**PV Module R&D Director, Tongwei**

Dec. 5, 2023

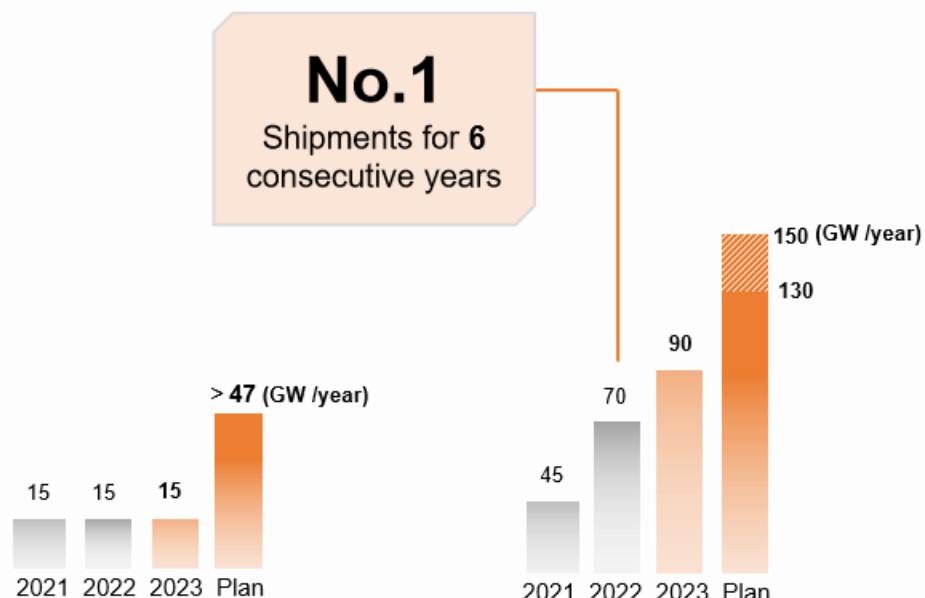
# Contents

- 1. Tongwei PV Chain and R&D Profile**
- 2. Tongwei High-efficiency n type Modules**
  - New TNC modules
  - New THC modules
- 3. SUMMARY**

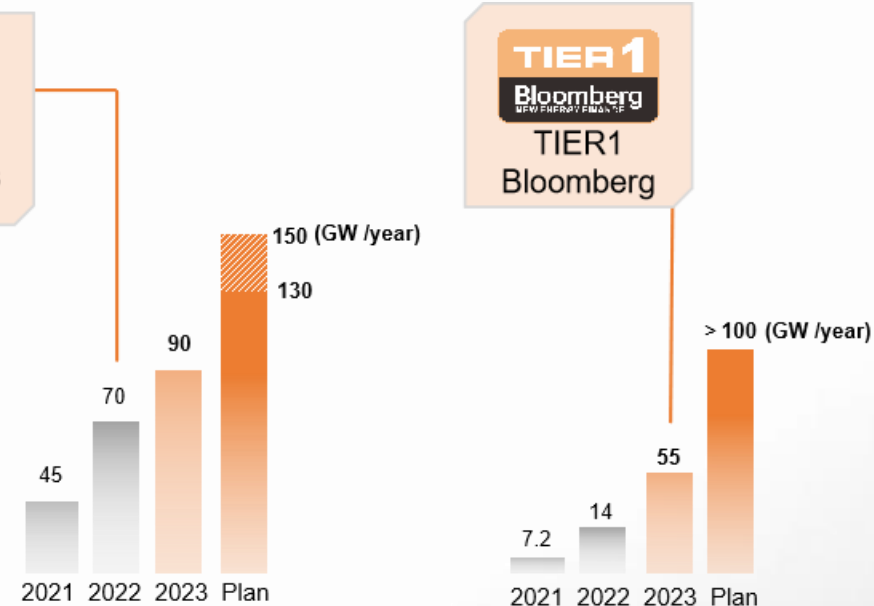
# PV industry chain capacity roadmap



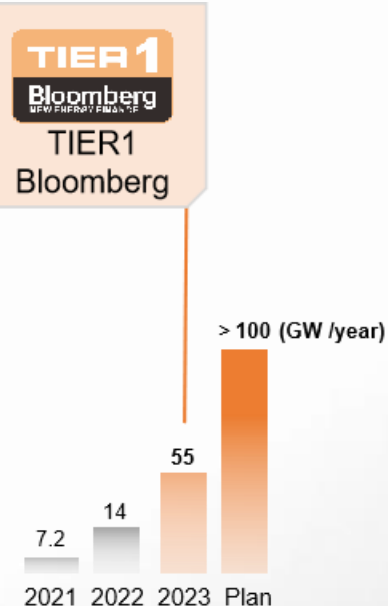
**Polysilicon**



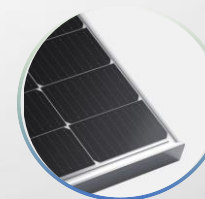
**Mono-crystalline wafer**



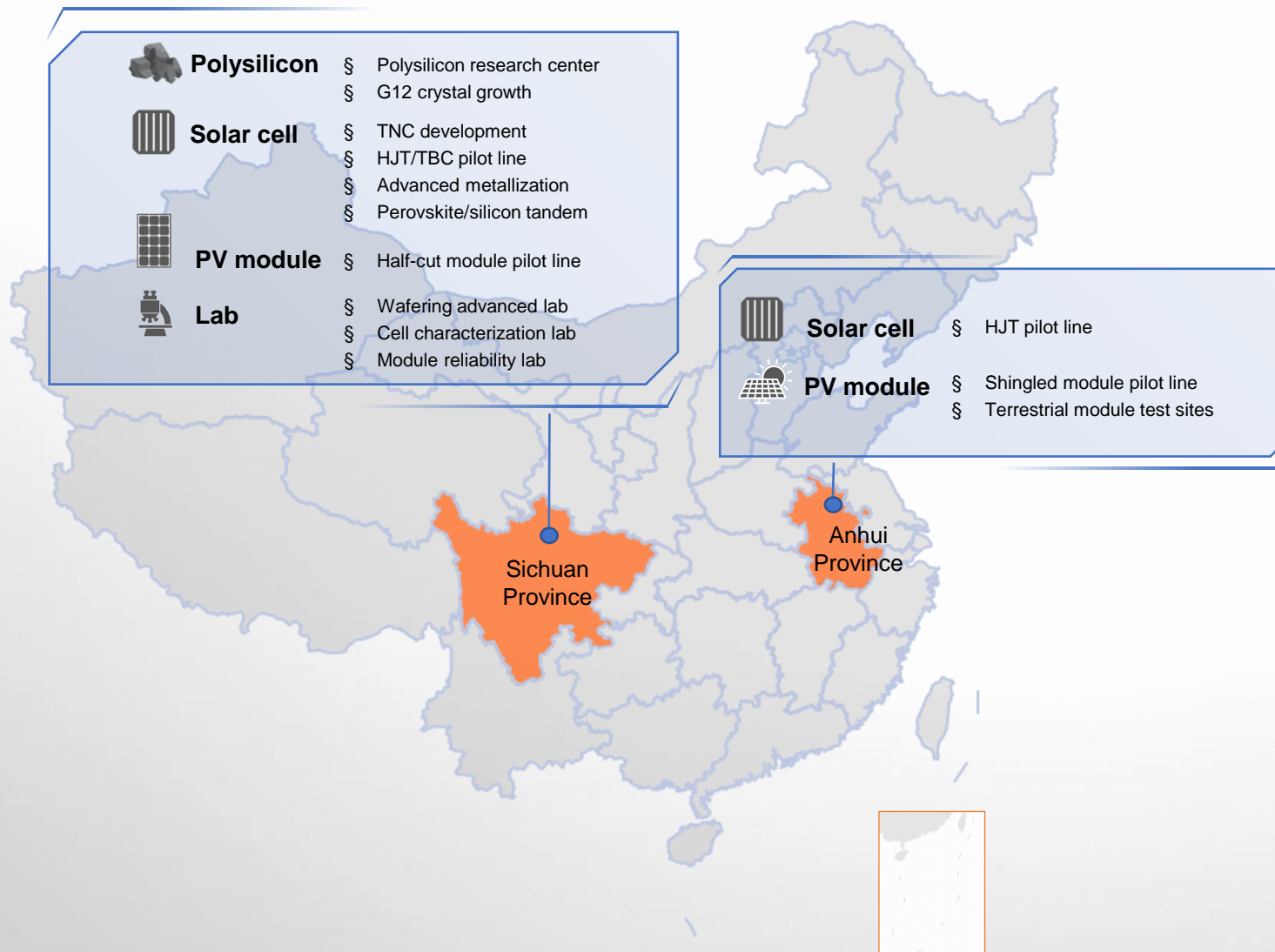
**Solar cell**



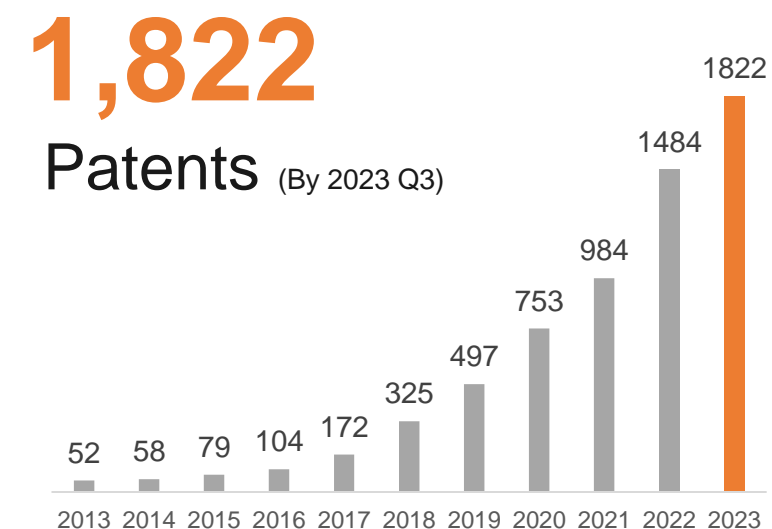
**PV module**



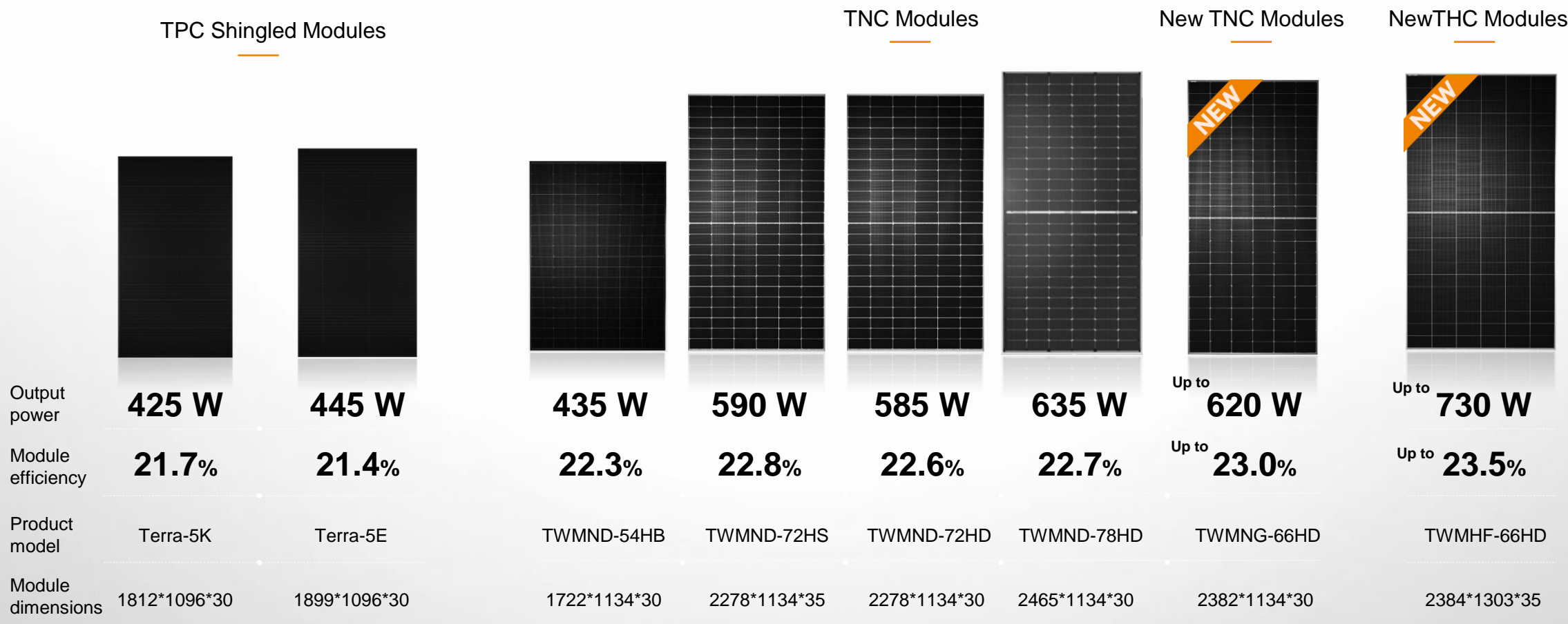
# Tongwei PV R&D profile



Over **600** R&D researchers  
Covering all PV technology fields

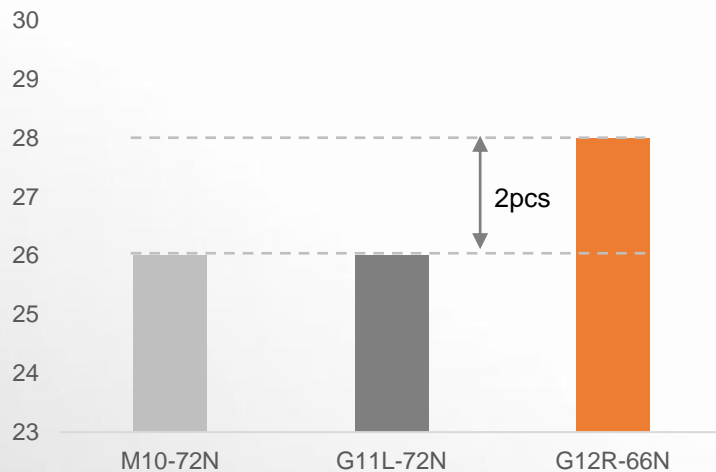


# Tongwei modules - Overview



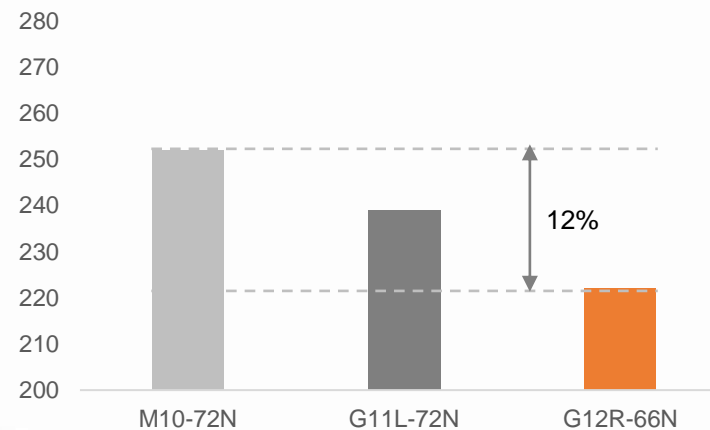
# System Advantages of G12R module

### Number of Modules in String



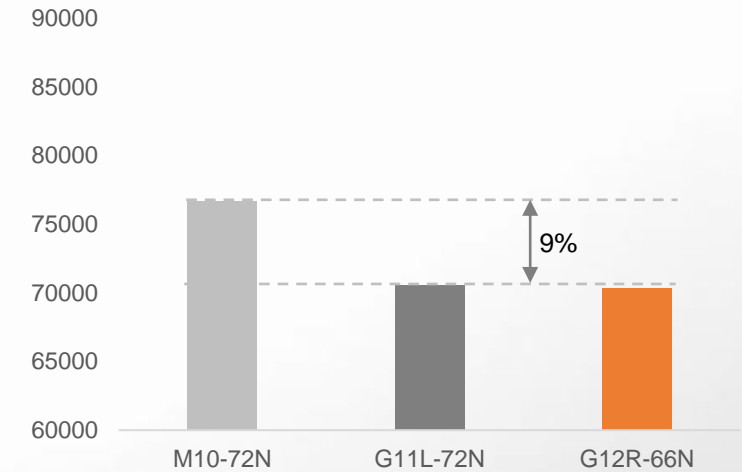
More number of modules could be installed in a string, for 1500VDC it will be 2 pcs compared to M10-72N.

### Number of Strings for a 380MW field



Number of inverters, cables and system components can be reduced by 12% compared to M10-72N.

### System Area for a 380MW field



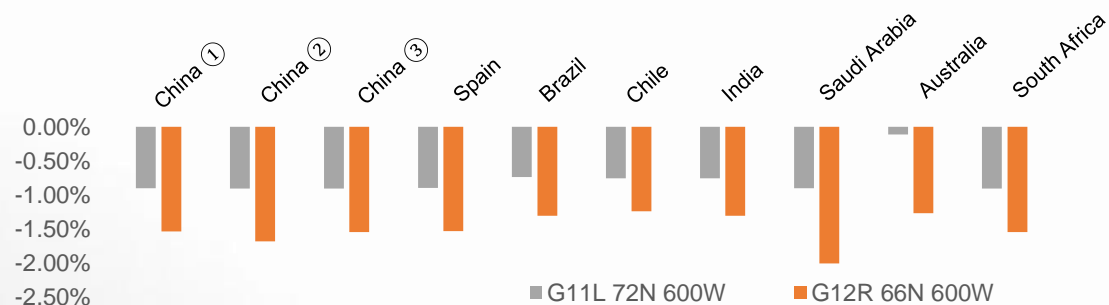
The power field area can be reduced by 9% compared to M10-72N.

\*Using M10-72N Bifacial Module with 580W, G11L-72N with 610W and G12R-66N with 610W.

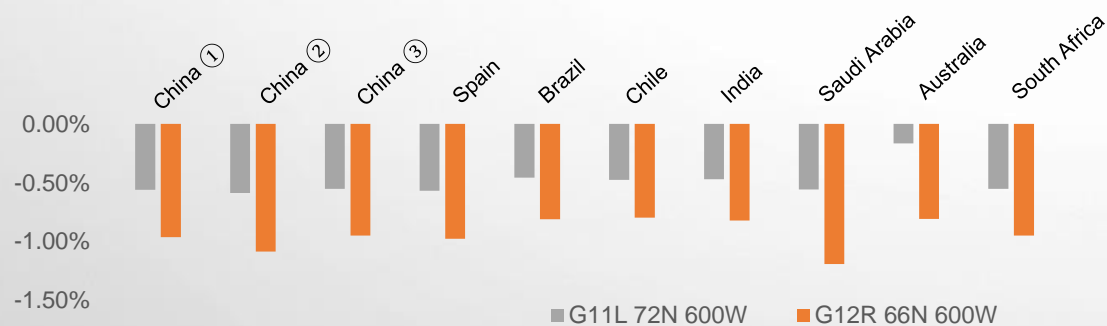
# Application Value of G12R module

Based on calculations from 10 typical project locations, BOS and LCOE comparison shows that G12R brings higher system value.

**BOS: G12R vs G11L, ↓1.11% ; G12R vs M10, ↓2.01%.**

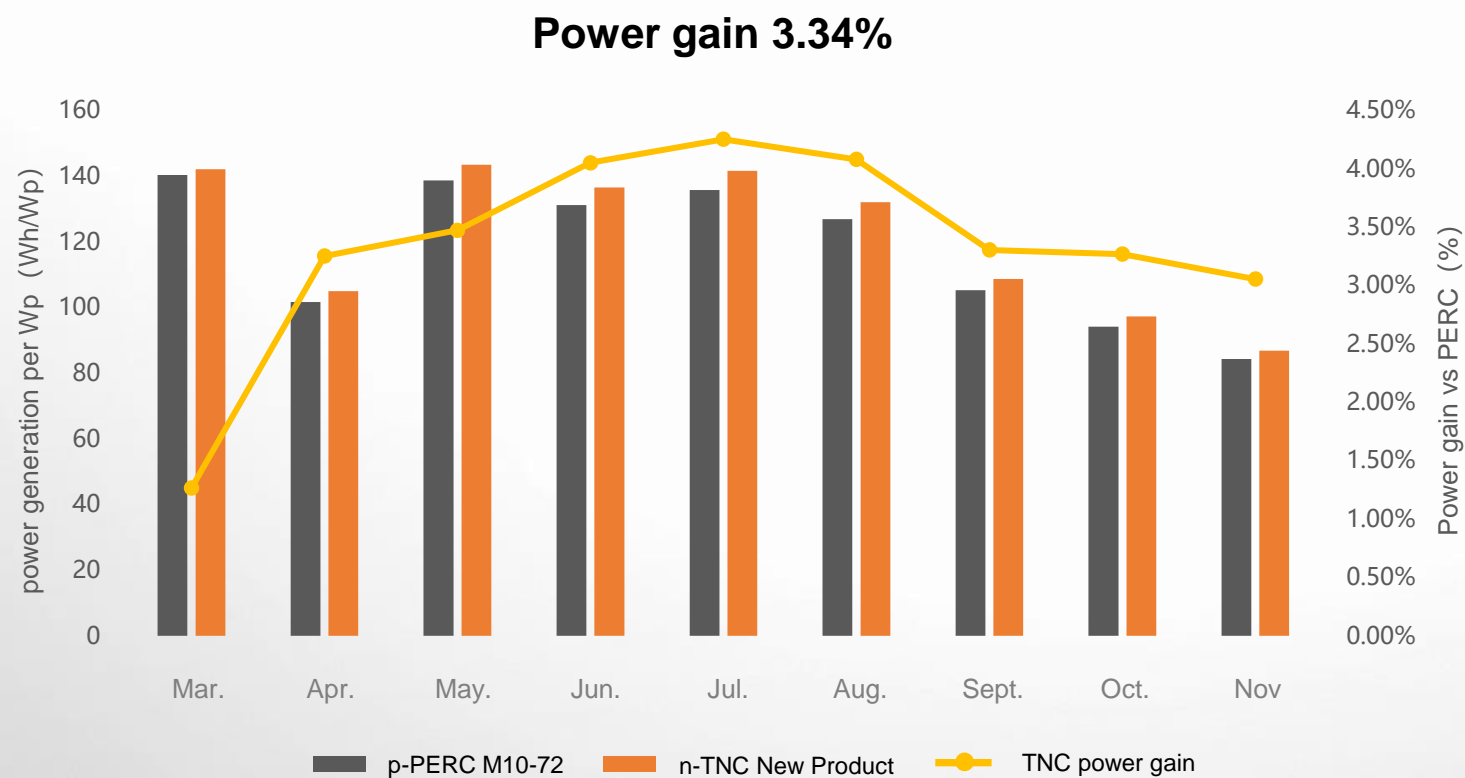


**LCOE : G12R vs G11L, ↓0.63% ; G12R vs M10, ↓1.19%.**



\*Using TOPCon M10-72 Bifacial Module as BSL

# Field test: 3.34% actual power generation gain than PERC



- **Monitoring period:**  
2/15/2023-19/11/2023
- **Field test location:**  
Sanya (18°31N;109°56E),  
Hainan province, China
- **Modules compared:**  
**New TNC bifacial module**  
M10-72 series PERC bifacial module
- **Climate type:**  
Tropical monsoon climate
- **Average temperature:** 25.7°C
- **Average daily irradiation:** 5.35 kWh/m<sup>2</sup>

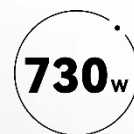


# New THC module

# 730W

G12-66 series THC bifacial module

## Advantages



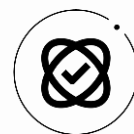
Maximum Power up to 730W



Silver-free technology, cost-effective & high-efficiency



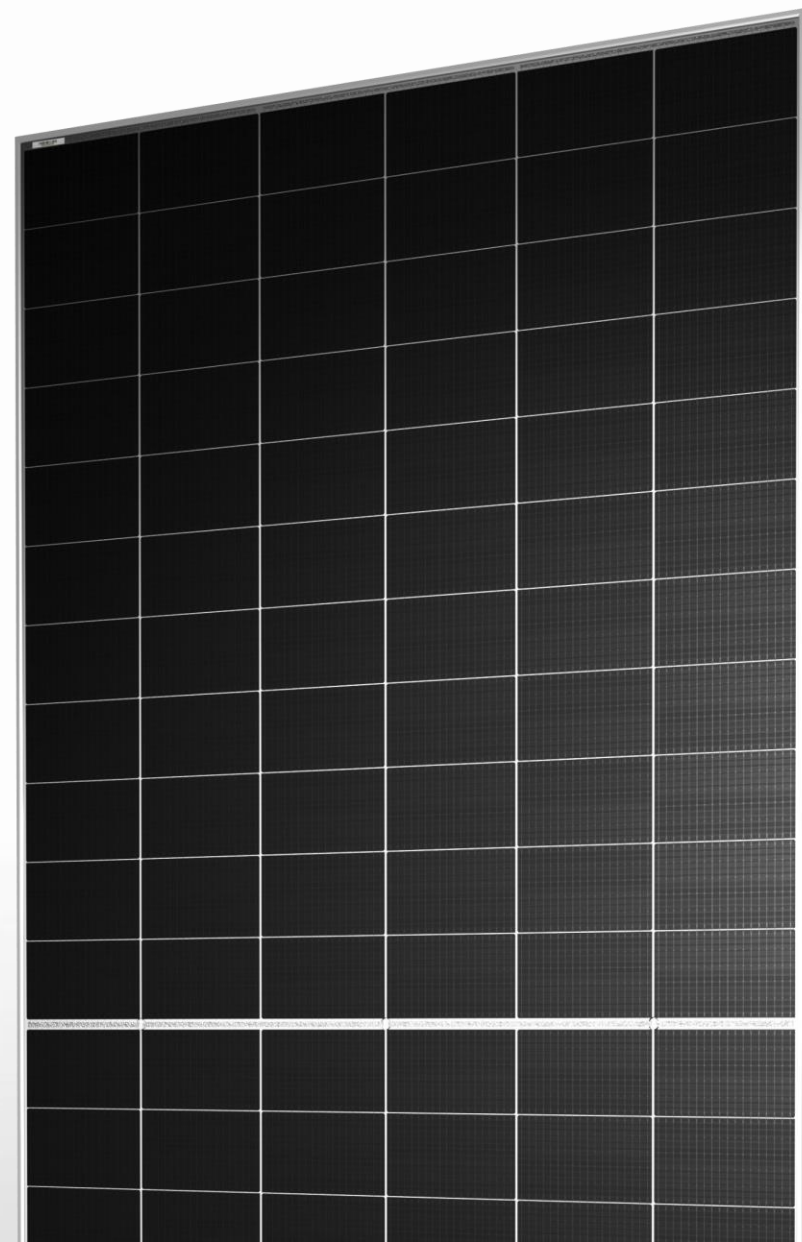
Ultra-high output, higher returns



Ultra-low degradation, higher reliability

Power	Up to <b>730W</b>
Efficiency	Up to <b>23.5%</b>
Dimensions	2384*1303*35 mm
Weight	38.7 kg

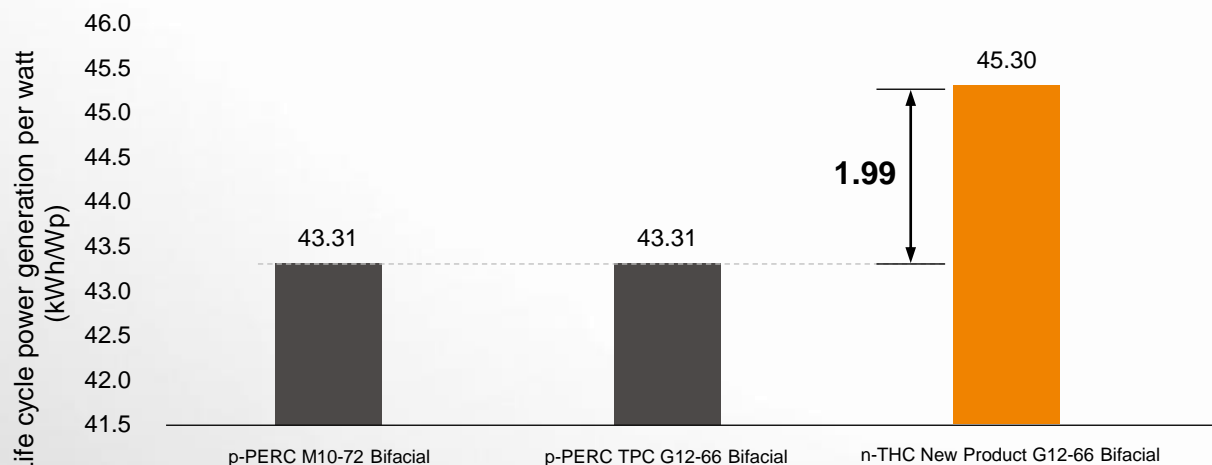
Note: There is a tolerance in module dimensions, where the long side is  $\pm 2$ mm and the short side is  $\pm 2$ mm.



# Higher power generation and lower LCOE

**↑ 4.60%**

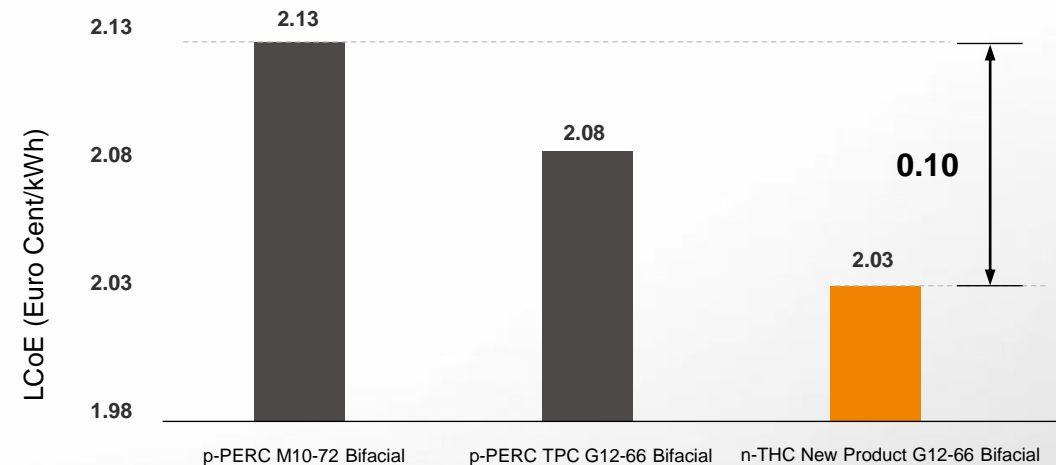
Power generation per Wp (within life cycle)



Power generation per Wp (kWh/Wp) within life cycle

Class II area (Gonghe Base in Qinghai, China), system capacity 120.0 MWp, capacity ratio 1.20, fixed support bracket, module angle 33°, ground centralized string inverter system.

**↓ 4.53%** LCOE



LCOE (Euro Cent/kWh)

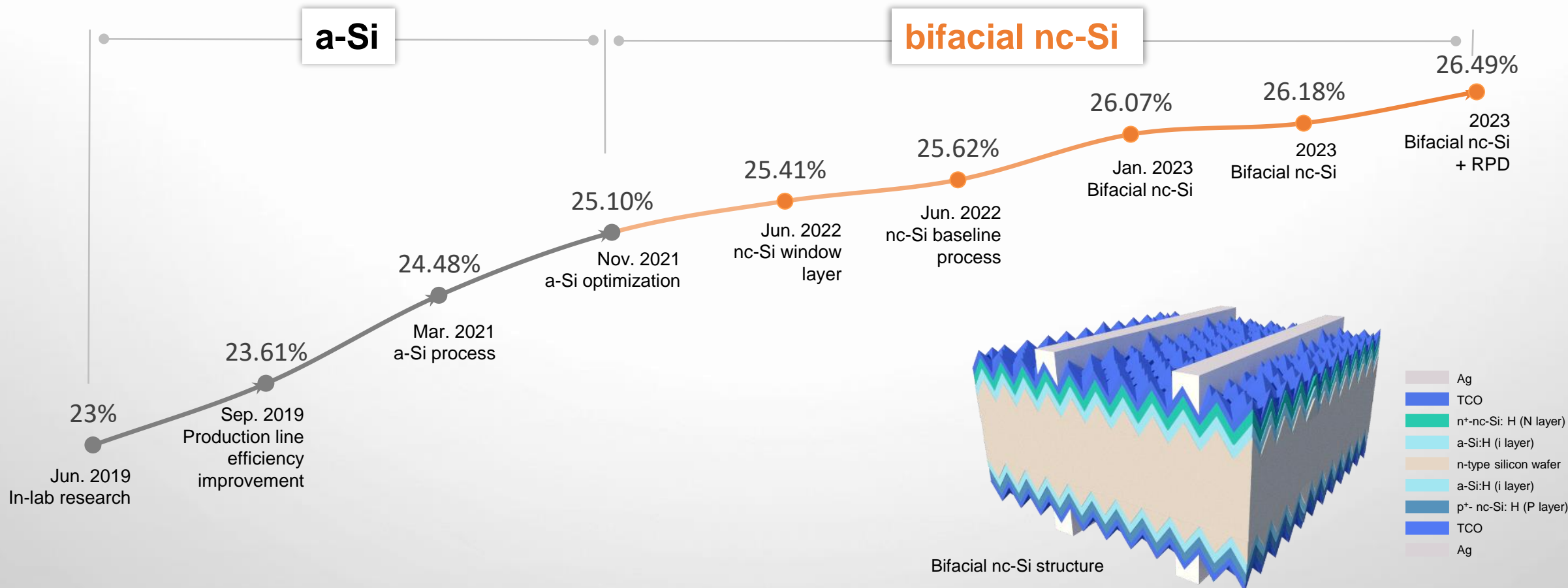
Based on EUR/RMB exchange rate of 1:7.6185 on 06/02/2023.  
The percentage data is calculated in RMB

# THC: Bifacial nanocrystalline-Si HJT cell

Tongwei began develop HJT technology in 2018, building its first GW-level HJT production line in China in 2021.

Tongwei pioneered the introduction of bifacial nc-Si into HJT.

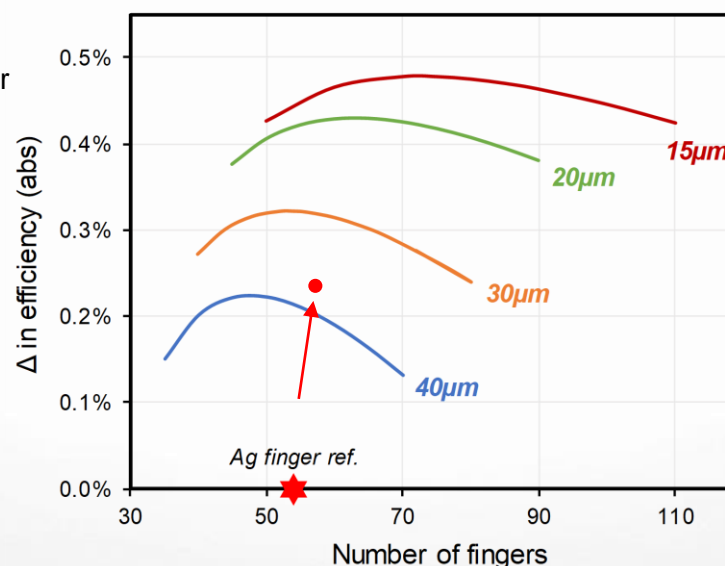
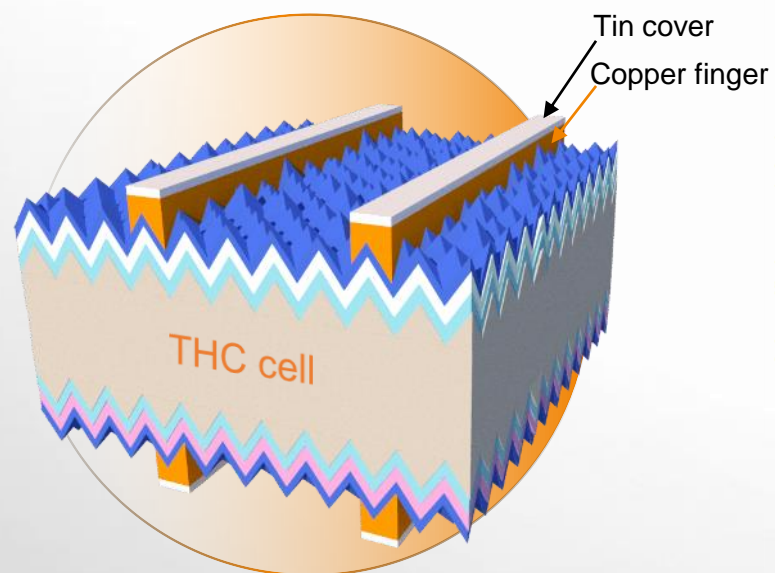
By Q1 2023, HJT champion efficiency reached **26.49%** (aperture area).



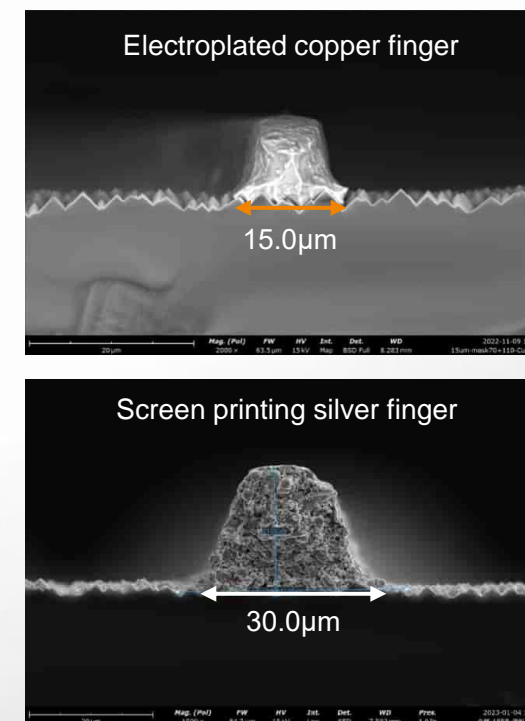
# THC : Silver-free, plus >0.2% efficiency bonus

Tongwei built the first pilot plant to implement and develop copper interconnection technology, realized silver free.

Currently, the width of the fingers has been reduced to less than **15μm**, enhancing the efficiency by **0.2%** in comparison to the printing process.



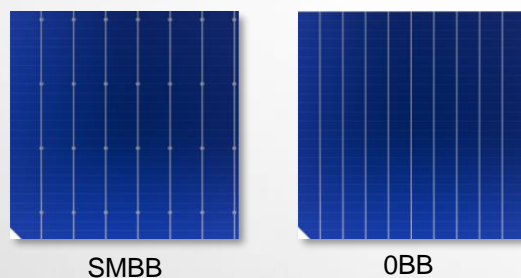
Copper grid line has greater efficiency improvement potential compared to screen printed silver grid line



# THC Module: Advanced module technology

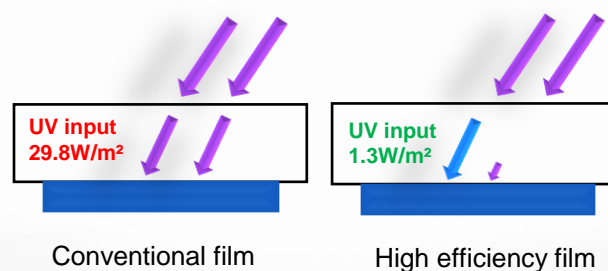
## Zero-busbar (0BB) technology

None welding pad to reduce the shading by the silver paste, further enhance the PCE of the cell, and 0BB technology have no infrared welding process, more friendly for thinning wafer.



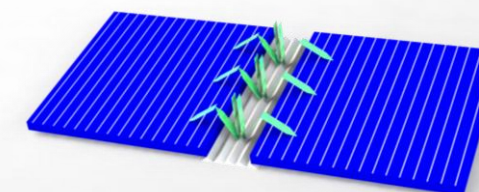
## UV utilization technology

UV conversion technology is used to convert higher energy UV light into visible blue light, avoiding UVID and further increasing the power of the module, the power gain of the module is more than 2W with high transmittance film.

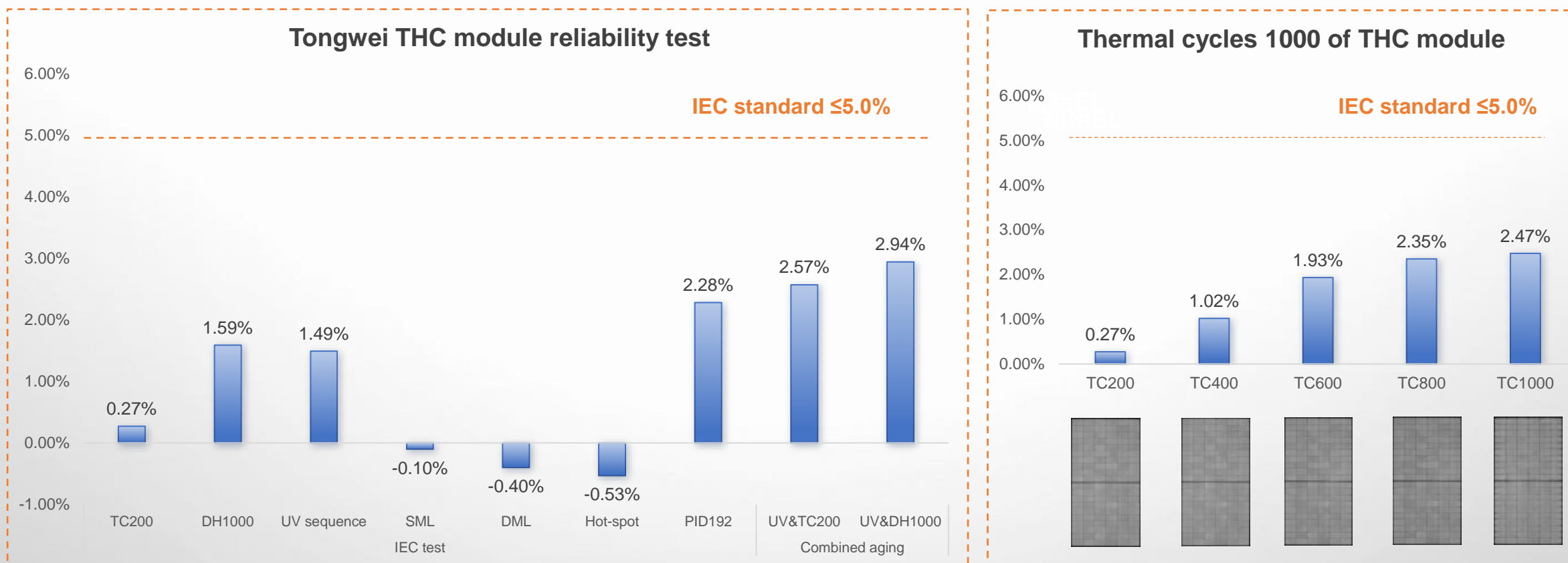


## Directional reflection technology

The diffuse reflection gain of glazed back glass in the gap between cells is adjusted to directional reflection gain, the power of the module is increased by 1W+, and the strength of the backplane glass is enhanced.



# Excellent Reliability of THC module



# Progress of THC module Power in R&D

# 745.62W

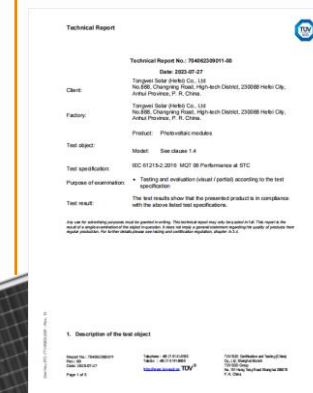
Certified by TÜV SÜD

Recent record

$P_{max}$  745.62W  
 $\eta$  24.00%

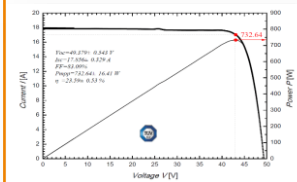
07/27/2023

$P_{max}$  743.68W  
 $\eta$  23.94%



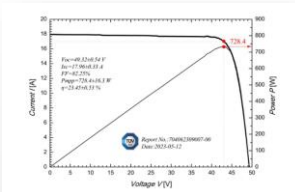
05/15/2023

$P_{max}$  732.6W  
 $\eta$  23.59%



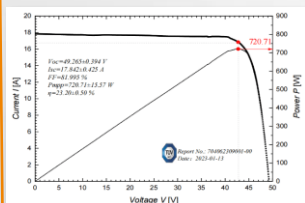
05/12/2023

$P_{max}$  728.4W  
 $\eta$  23.45%



01/18/2023

$P_{max}$  720.7W  
 $\eta$  23.20%



## Summary

- TW will put G12R-TNC module and G12-THC module new products into the market in next year.
- G12R will further reduce BOS and LCOE in comparison to not only M10, but also G11L.
- THC module packaged series of TW HJT technologies and will bring higher power-output, more reliability, lower LCOE values to the customers.





# PV CHANGES THE WORLD

---

TONGWEI SOLAR

