

# TNC<sup>3.0</sup> WHITE PAPER

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# 01 Company Introduction and Integrated Layout

## 1.1 Company Introduction

Tongwei Co., Ltd., a subsidiary of the Tongwei Group, is a large private technology-oriented listed company specializing in green agriculture and green energy. The company currently operates more than 200 branches and subsidiaries across China and overseas, with an annual feed production capacity of approximately 13 million metric tons, an annual high-purity polysilicon production capacity of approximately 900,000 metric tons, and a N-type solar cell production capacity exceeding 150 GW; its module production capacity is approximately 90 GW. The company has developed and constructed 56 photovoltaic power plants, primarily featuring "Fishery-PV Integration," in multiple provinces and cities across China, with a cumulative installed and grid-connected capacity exceeding 5 GW. Over the years, the company has undergone rapid development, becoming a leading national enterprise in agricultural industrialization. It is now a global leader in the production of aquaculture feed, a major producer of livestock and poultry feed, a global leader in high-purity polysilicon, and a global leader in solar cells.

Tongwei's entry into the photovoltaic industry in 2006 marked a significant milestone in the company's growth trajectory. Following over a decade of rapid development, the company has become a global leader in integrated photovoltaics. It has established a complete industrial chain, spanning from the production of silicon to the end-user photovoltaic power plant. The company possesses significant competitive advantages that lead the industry in terms of production capacity, R&D, cost control, quality, and branding. The company has successfully retained its leading global market share in high-purity polysilicon and solar cell businesses for a number of consecutive years. Its module shipments are consistently in the top five worldwide. The company remains firmly committed to its long-term strategic goal of "building a world-class clean energy operator." The company's strategic focus areas include core technological innovation and cost reduction, enhancing efficiency, vigorous market expansion, and strengthening cooperation with upstream and downstream clients. Consequently, its comprehensive competitiveness continues to improve, and its market position continues to solidify.

\*The latest figures show that as of the end of December 2025



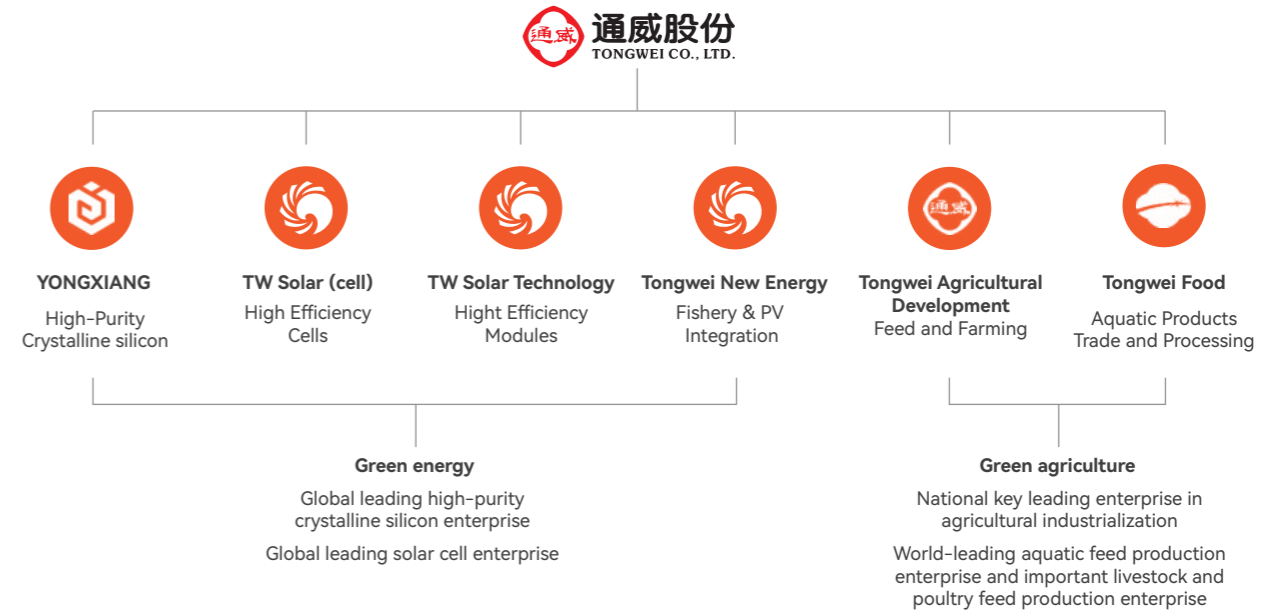
200+ Subsidiaries

**TOP 1** High-purity crystalline silicon ranks first in global market share and shipment for five consecutive years

**TOP 1** High-efficiency cells rank first in global shipment for nine consecutive years  
\*The latest figures show that as of the end of December 2025

**TOP 5** High-efficiency modules rank fifth in global shipment for three consecutive years

## 1.2 Tongwei's Integrated Photovoltaic Industry Chain Strategy



### High-purity crystalline silicon

The core process technology has been iteratively upgraded and applied to the "8th Generation Yongxiang Method"  
Product purity reaches 99.999999999%  
Electronic-grade crystalline silicon has been supplied in batches at home and abroad

Production capacity  
**Over 900,000 tons**

### Crystalline silicon cell

World-leading high-efficiency crystalline silicon solar cell enterprise  
The first "lighthouse factory" in the global PV cell industry

Production capacity  
**150+GW**

### High-efficiency modules

TW Solar's module products fully cover various application scenarios

Production capacity  
**90+GW**

### "Fishery-PV integration"

The world's first innovative development model of "fishery-PV integration" to achieve "a triple-win outcome" of fishery, electricity, and environmental protection

Cumulative installed and grid-connected capacity  
**5GW**

Data source: InfoLink Consulting

# 9 CONSECUTIVE YEARS NO.1 IN CELL SHIPMENT VOLUME

HIGH-EFFICIENCY MODULE PRODUCED BY TONGWEI CELLS

## Ultra-high-purity Silicon

At TongWei's Lighthouse Factory, the manufacturing process utilizes silicon wafers derived from 11N (99.999999999%) ultra-high-purity silicon. From the moment the wafers enter the facility, the entire production lifecycle is strictly conducted within an ultra-clean environment. The seamless integration of rigorous cleaning protocols and advanced manufacturing processes ensures that impurity levels within the cells are comprehensively minimized.

## Wafer-level Traceability

Tongwei continuously refines its traceability management framework. Through targeted training, it actively supports external suppliers in upgrading their traceability practices, thereby elevating the transparency and traceability of the entire industry supply chain. Tongwei successfully passed traceability audits conducted by authoritative independent third parties, STS (Senergy Technical Services) and TÜV Rheinland. Tongwei's traceability encompasses the entire lifecycle of PV modules and has achieved complete internal integration, spanning from polysilicon to modules. Through vertical integration, Tongwei is the first company to successfully complete the TÜV Rheinland audit in a single assessment, securing an A-grade or higher across the entire PV supply chain. Crucially, PV modules, wafers, ingots, and silicon were awarded the highest possible AA rating. This milestone unequivocally validates Tongwei's industry-leading position in supply chain transparency and rigorous traceability management.

## Digital Manufacturing

The end-to-end digital monitoring at Tongwei's Lighthouse Factory optimizes the performance of every TNC cell to its design limits while ensuring exceptional electrical consistency. This eliminates mismatch risks caused by the premature degradation of individual cells, thereby guaranteeing ultra-low lifecycle degradation for the entire module.

## The First PV Cell "Lighthouse Factory" in the World

On September 16, 2025, the World Economic Forum (WEF) released its latest cohort of the Global Lighthouse Network. Tongwei Solar's Meishan facility was the sole manufacturing site from the global PV industry selected in this cohort, officially becoming the world's first "Lighthouse Factory" in the PV cell manufacturing sector. This milestone underscores China's PV industry as a global vanguard in intelligent manufacturing and digital transformation. The Tongwei Solar Meishan facility has deployed over 50 AI-driven Fourth Industrial Revolution (4IR) application cases. In the highly competitive solar cell market, Tongwei focused its digital transformation on improving power conversion efficiency (PCE) and quality. The site deployed over 50 4IR use cases, mostly based on AI-machine learning to drive process optimization, genAI-enabled maintenance, and advanced AI algorithms to analyse defects. The transformation improved PCE by 12%, cut defect rates by 41%, reduced conversion costs by 37% and lowered CO<sub>2</sub> emissions by 33%.

Data source: InfoLink Consulting

# 02 Product Series

## 2.1 TNC Product Roadmap

Amid the accelerating transition to renewable energy, global demand for highly efficient and reliable PV modules is surging. Committed to maximizing customer value through technological innovation, Tongwei has thoroughly evaluated market trends, supply chain stability, and technical feasibility. Consequently, Tongwei has adopted the TOPCon technology route, establishing the TNC series as our core product.

Building on years of technological expertise, Tongwei launched the TNC 1.0 series in 2022. Through continuous innovation, we have subsequently introduced the TNC 2.0 and TNC 3.0 series, achieving significant upgrades in module power and performance. Tongwei comprehensive product portfolio not only serves mainstream residential, C&I, and utility-scale markets, but also offers scenario-specific solutions. These advanced modules are engineered to meet extreme geographical and climatic demands, providing high performance in desert regions, offshore PV installations, and high-hail environments.

### TNC 1.0

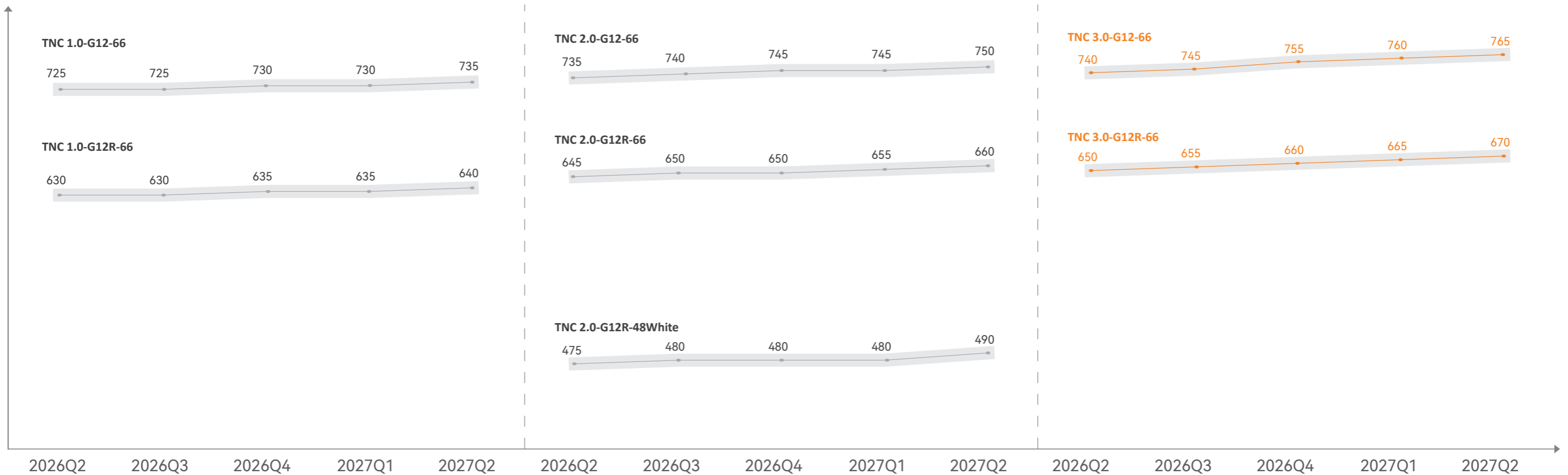
Module efficiency: 23.0%    Bifaciality: 80±5%

### TNC 2.0

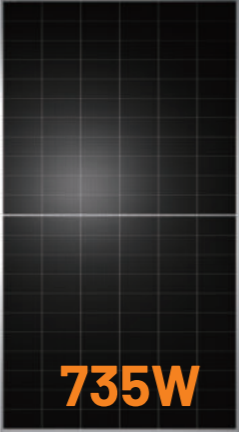
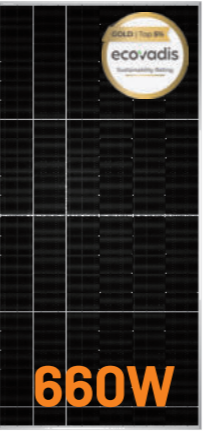
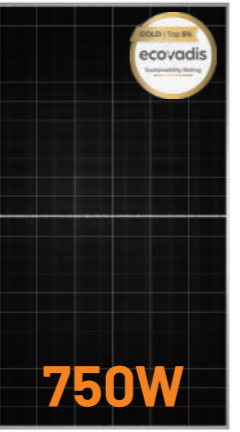





Module efficiency: 24.1%    Bifaciality: 85±5%

### TNC 3.0

Module efficiency: 24.8%    Bifaciality: 85±5%



**2.2 TNC Product Portfolio and Technical Features**

	TNC 1.0		TNC 2.0				TNC 3.0			
Scenario	C&I, Utility		Residential		C&I, Utility		C&I, Utility			
Product										
Module	G12R-66 Bifacial	G12-66 Bifacial	G12R-48 Monofacial White	G12R-48 Monofacial Full-black	G12R-66	G12-66	G12R-66	G12-66		
Module Type	TWMNH-66HD	TWMNF-66HD	TWMNH-48HW	TWMNH-48HE	TWMNH-66HD	TWMNF-66HD	TWMNH-66QD	TWMNF-66QD		
Dimension	2382×1134×30mm	2384×1303×33mm	1762×1134×30mm	1762×1134×30mm	2382×1134×30mm	2384×1303×33mm	2382×1134×30mm	2384×1303×33mm		
Technical Features	 Multi-Busbar	 High-Efficiency Cell	 TPE				 0BB		 Quarter-cut	 Louvred Interconnection
	 High-Density Packaging	 Non-Destructive Cutting	 Poly Tech				 Stencil Printing		 N-type wafer 360° Passivation	

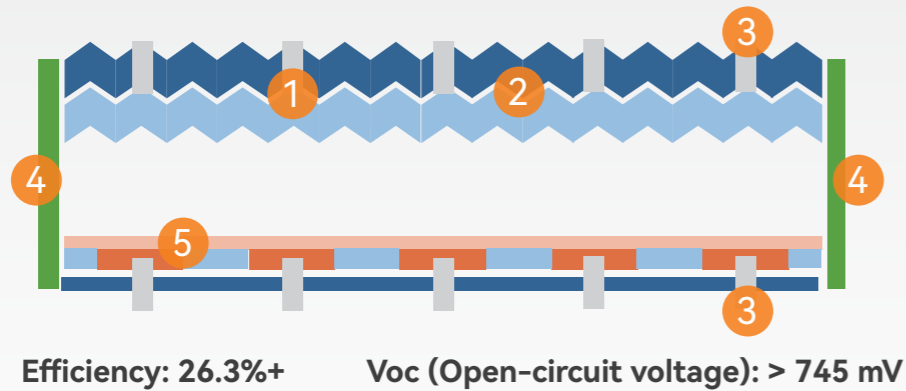
# 03 Technology Application and Advantages

## 3.1 Technology Application

### High-Efficiency Cell with 360° All-Around Passivation

The TNC 3.0 is Tongwei's latest flagship product, equipped with high-efficiency quarter-cut cells featuring 360° All-around Passivation Technology, an innovative circuit design, and Louvred Interconnection Technology. By integrating cell efficiency upgrades with advanced packaging, it achieves new breakthroughs in mass-production efficiency. The product's system compatibility is perfectly balanced with its strict product reliability, which establishes it as a premier module engineered for customers who demand ultimate value.

At the cell level, the TNC 3.0 leverages 360° All-around Passivation Technology. By applying distinct passivation layers, it precisely protects the front, edges, and rear surfaces of the cell. This effectively enhances the outward transport of photo-generated carriers, boosting the conversion efficiency to over 26.3%.



#### Front Passivation Layer

##### 1 Advanced MCR Cell Technology

Utilizing targeted infrared lasers, this technology creates optimal electrical contact between the fingers and the cell while minimizing damage to the front passivation layer. This reduces current transfer losses from the Si matrix to the fingers.

##### 2 Photon-Hydrogen Steady-State Passivation Technology

Synchronous adjustment of the thickness of the front AlOx and SiNx layers reduces the cell's sensitivity to high-energy short-wavelength light. This enhances overall photon absorption and minimizes surface reflection losses.

##### 3 Ultrafine Fingers

Leveraging 100% open Stencil Printing Technology, finger width is significantly reduced while maintaining a uniform morphology. This minimizes surface shading, allowing more incident light to reach the Si substrate to generate current.

#### Edge Passivation Layer

##### 4 TPE Technology

Through a specific passivation repair process, this technology repairs edge damage caused by laser cutting when dividing full cells into quarter-cut cells, maximizing the retention of initial cell efficiency.

#### Rear Passivation Layer

##### 5 Poly Tech

The Poly layer improves interfacial conductivity between the fingers and the cell. By removing the unnecessary Poly layer outside the finger footprint, it reduces light absorption losses from the rear passivation layer and increases rear transmittance, simultaneously boosting module power and bifaciality.

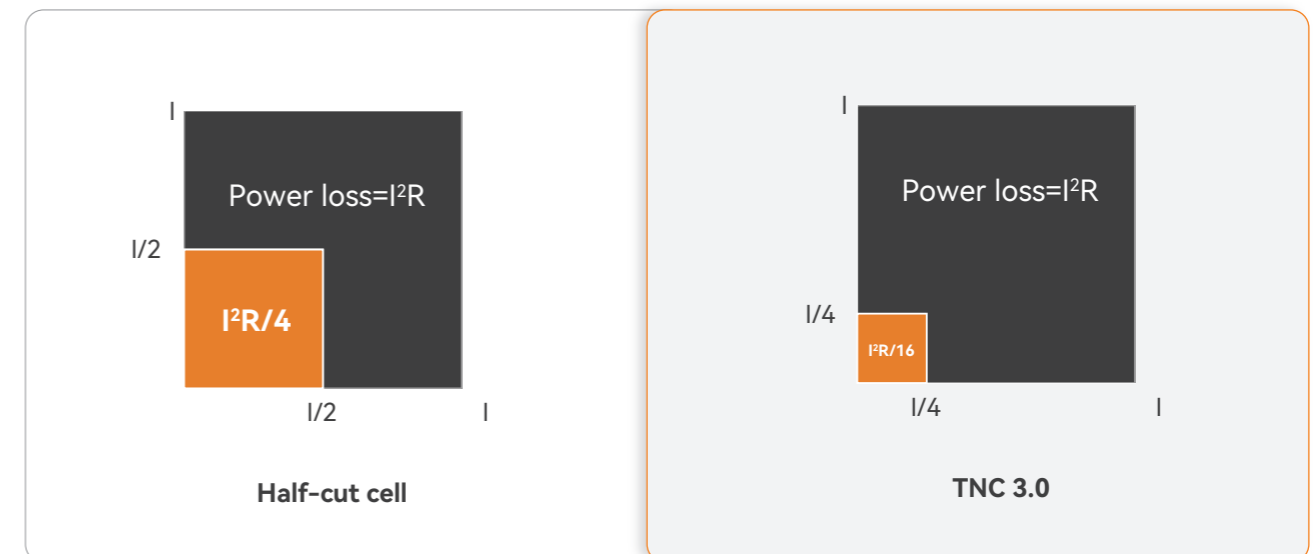
Data is sourced from Tongwei's internal tests and calculations.

The TNC 3.0 module utilizes quarter-cut technology (combining quarter-cut cells with an optimized circuit design). This reduces internal operating losses while improving power output and reliability under abnormal conditions like localized downtime, achieving a simultaneous optimization of quality and efficiency.

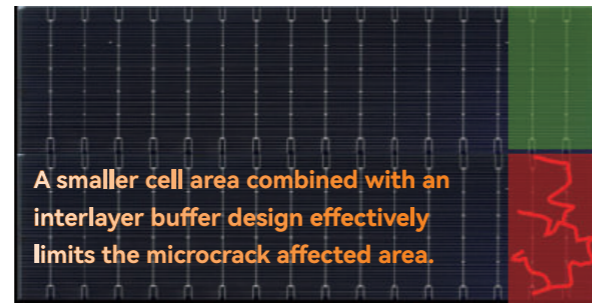
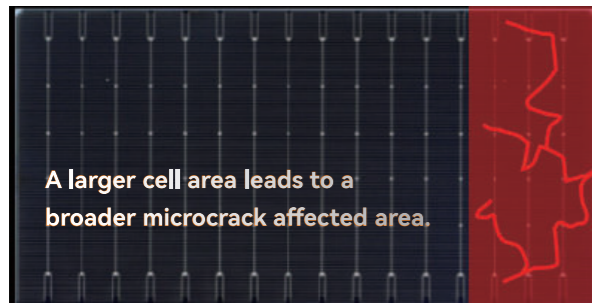
### Quarter-cut Cell

A quarter-cut cell is created by dividing a full-size cell into four, thereby reducing its operating area to 1/4 of the original. With a smaller area, the cell absorbs 1/4 the number of photons, thereby decreasing its operating current to 1/4 of a full-size cell. This characteristic provides the TNC 3.0 module with the following advantage:

- Compared to half-cut modules, internal resistive loss is reduced to 1/4, increasing power output by over 4W.



· Reducing the area of the internal minimum operating unit improves microcrack resistance by over 50%

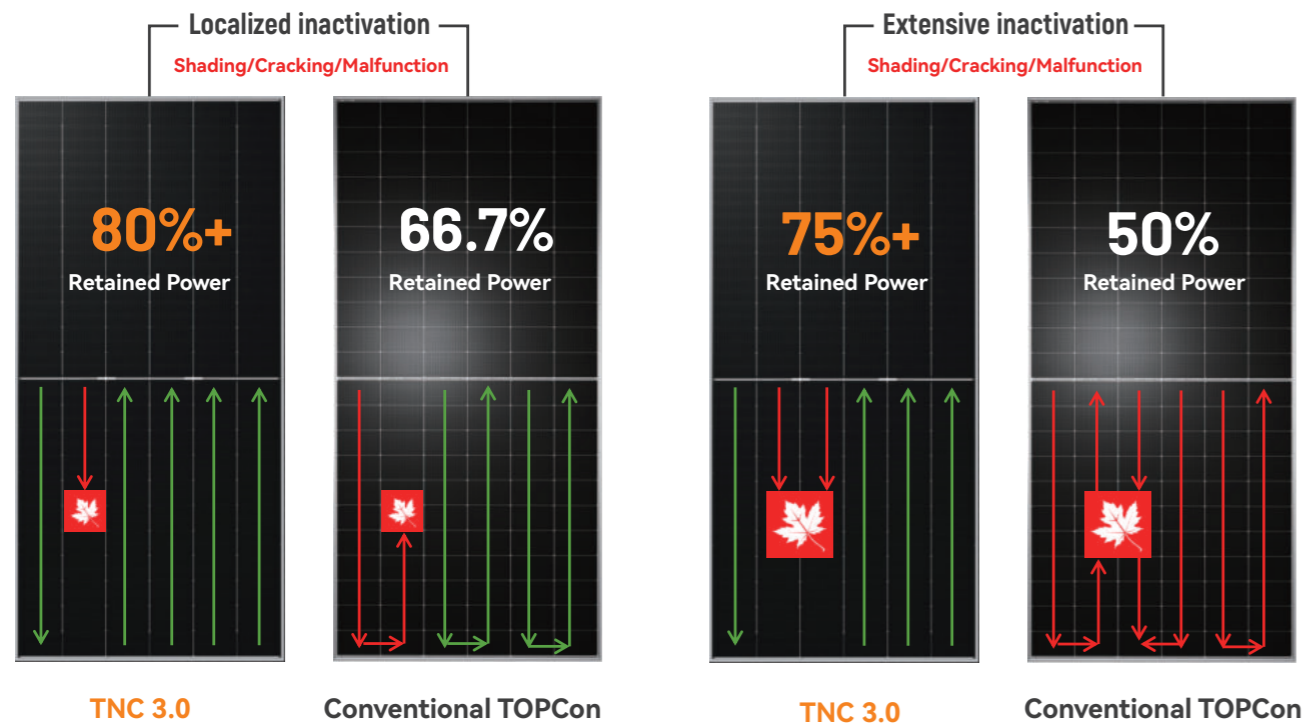


### Quarter-cut Circuit Design

The core design of the TNC 3.0 involves dividing full cells into quarter-cut cells. To maintain the module's overall output voltage and current for compatibility with mainstream inverters, an advanced circuit design connects the cell strings in parallel pairs. This configuration provides superior anti-shading, crack resistance, and fault tolerance compared to conventional half-cut modules.

In complex outdoor environments, localized shading from clouds or trees is common. Traditional half-cut modules use a two-section parallel structure; like a "two-lane road," localized shading or faults can disable half the module's output.

The TNC 3.0 redesigns the internal current pathways, upgrading from two to four parallel sections. Operating like a "four-lane highway," if localized shading occurs, current bypasses the blocked section and flows through the remaining three unobstructed pathways. This high-redundancy circuit design minimizes power loss from individual shaded cells, significantly improving the module's anti-shading performance under non-ideal conditions.

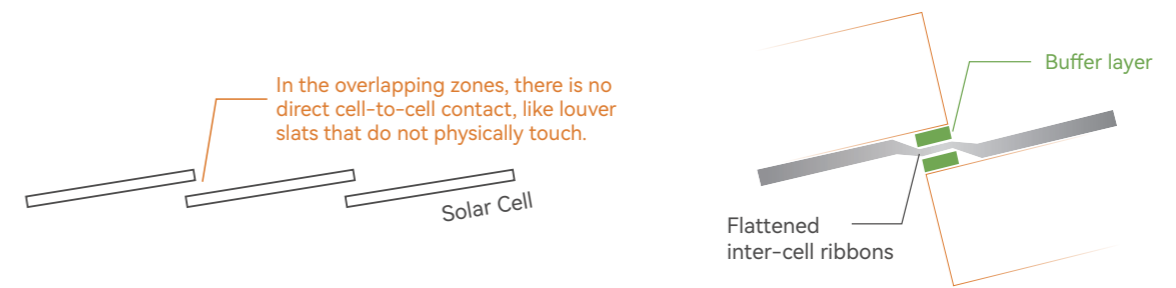


### Louvred Interconnection Technology

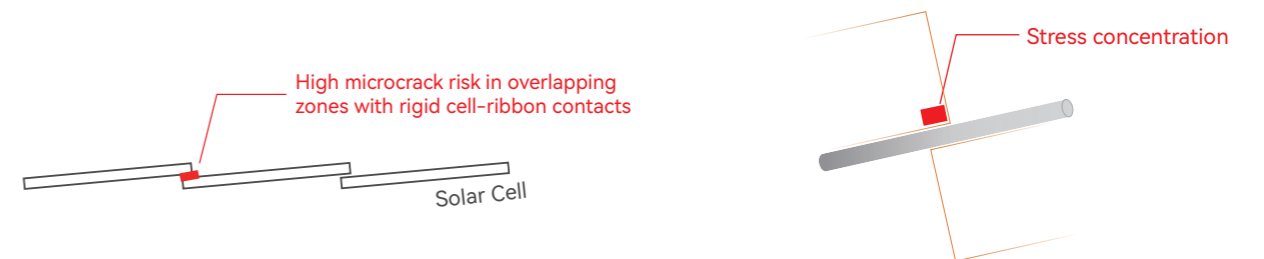
The TNC 3.0 module utilizes Louvred Interconnection Technology, organizing cells in a configuration reminiscent of closed louvers. This eliminates the non-power-generating cell gaps found in TOPCon half-cut modules. By reclaiming this space, it adds the equivalent active area of 0.4 cells per module, effectively increasing energy density.

Combining Louvred Interconnection with high-density packaging maximizes the active module area to boost power output. Concurrently, precise structural design eliminates any introduced operational risks.

#### TNC 3.0 Louvred Interconnection Technology



#### Conventional Overlapped (Half-cut)



Within the overlapping zones, Louvred Interconnection Technology adds an insulating buffer layer between cells. Combined with flattened ribbons, it transforms traditional point contacts and rigid connections into surface contacts and flexible interconnections. This ensures a uniform distribution of stress, thereby reducing the risk of microcracks in the module during transportation, installation, wind loads, and thermal expansion and contraction.

### 3.2 Technical Advantages

#### Ultra-High Bifaciality

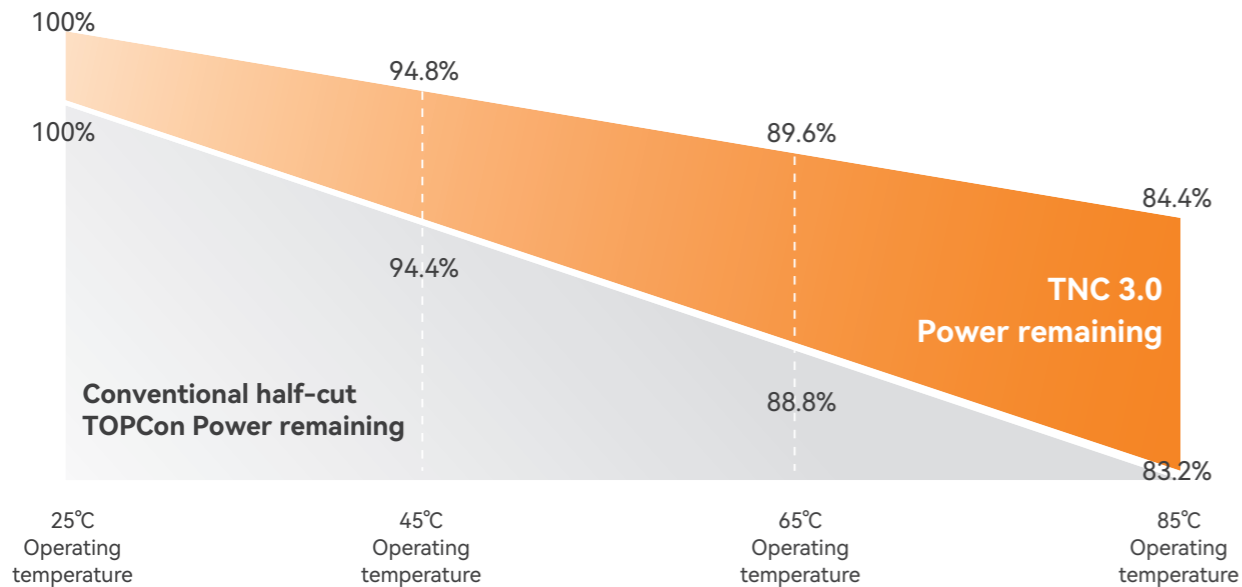
The TNC 3.0 achieves an 85% bifaciality through dual optimizations in cell technology and junction box design. From an optical perspective, integrating Poly Tech minimizes obstruction from the Poly-Si layer, allowing more light to pass through the rear surface. Structurally, upgrading from the conventional 3-part split junction box to a 2-part split junction box reduces the overall shading area, which is particularly effective under oblique light incidence.

High bifaciality enables the module's rear surface to capture additional solar energy in high-reflectivity scenarios including snow, sand, and concrete. This bifacial energy gain translates every extra kilowatt-hour of electricity into tangible returns, maximizing customer value.

#### Low Temperature Coefficient

The optimization of the TNC 3.0's temperature coefficient is driven by Tongwei's proprietary 360 ° All-around Passivation Technology. This technology optimizes the micro-surface structure, significantly reducing surface carrier recombination and increasing the open-circuit voltage (Voc) by over 10mV. For identical wafers (e.g., n-type), a higher Voc corresponds to a lower absolute temperature coefficient of Pmax. Consequently, even under intense midday heat and high irradiance, the TNC 3.0 maintains "cool operation," ensuring stable and continuous high-power output. This advantage is especially pronounced in hot, high-irradiance climates.

Empirical data highlights this advantage: at an operating temperature of 85°C, a 670W module with a -0.26%/°C temperature coefficient delivers over 8W of additional power compared to a module with a -0.28%/°C coefficient.



Data is sourced from Tongwei's internal tests and calculations.

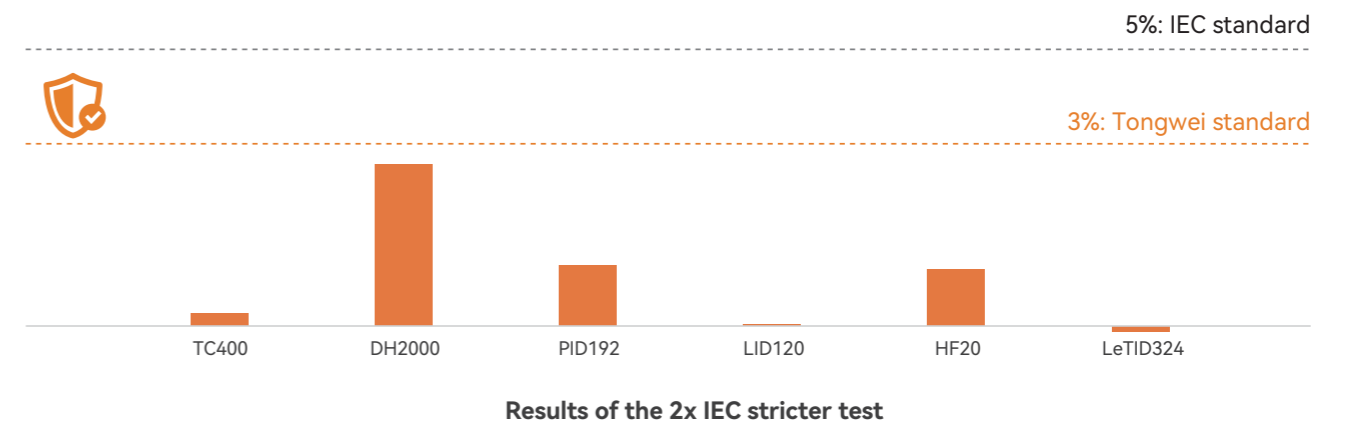
#### Low Annual & Linear Degradation

The TNC 3.0 utilizes quarter-cut technology to reduce module internal power losses, which lowers the operating temperature by approximately 0.4 ° C. This temperature reduction effectively delays the aging of the encapsulation materials. Additionally, quarter-cut cells are less sensitive to microcracks, limiting the impact of microcracks caused by transportation, installation, or mechanical vibration on long-term power output. Combined with the interlayer buffer design, external vibrations are effectively dampened, further reducing microcrack risk.

As a result of these optimizations, the TNC 3.0 achieves an annual linear degradation rate of 0.35%, an improvement over the 0.4% of conventional modules. Consequently, the retained power after 30 years exceeds 88.85%.

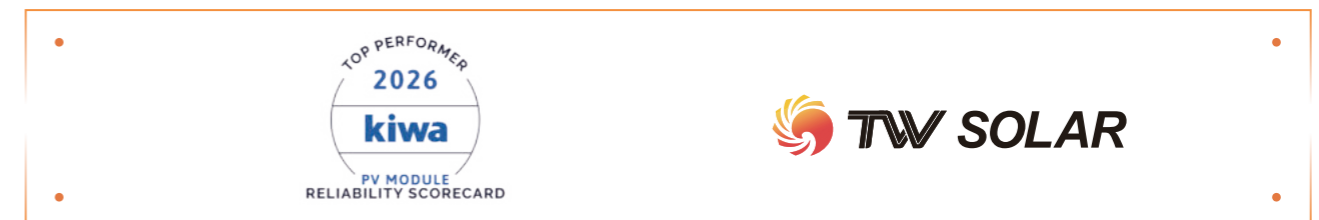
#### Reliability

The TNC 3.0 module maintains Tongwei's proven reliability. Going beyond conventional baseline requirements, the module is subjected to Tongwei's rigorous extended tests. The TNC 3.0 is guaranteed to deliver industry-leading performance, as evidenced by its strict compliance with all internal control standards.



"Kiwa PVEL (hereafter referred to as PVEL), a world-leading PV module reliability and performance testing laboratory, annually conducts extended reliability testing that exceeds standard IEC requirements to simulate module performance under various extreme environmental conditions. This serves as a trusted industry resource for evaluating the long-term reliability and performance of PV modules.

Recently, PVEL released its 2026 PV Module Reliability Scorecard. Tongwei's TNC modules achieved outstanding results, earning Top Performer status across 7 rigorous test sequences. Having been recognized as a PVEL 'Top Performer' for the 3rd consecutive year, this achievement thoroughly validates that TNC modules not only comply with standard IEC requirements but also withstand the most severe environmental conditions, vividly demonstrating the exceptional reliability and performance advantages of Tongwei modules."



# 04 All-Scenario Solution Products Advantages

## Scenario-Focused, Quality-Renewed

### Wave Master

Offshore Scenario

- World's 1st TÜV NORD Certification for Offshore PV
- Passed Salt Mist 8

### Desert Max

Desert and Gobi Scenario

- High wear resistance & high load capacity
- High bifacial energy gain

### Clear Top

Dust-Prone Environment

- Short A-side frame: Anti-Dust
- Triple protection: Damp-heat resistant

### Hail Resistant

Hailstorm Environment

- Superior impact resistance: Minimized damage & long-term reliability

### 2000V

High String Voltage

- High system voltage: Optimized system value

### Anti-glare

Light-Sensitive Environment

- Glare control: Enhanced safety for urban transportation

### G12 Tracker Solution

Optimized String Layout

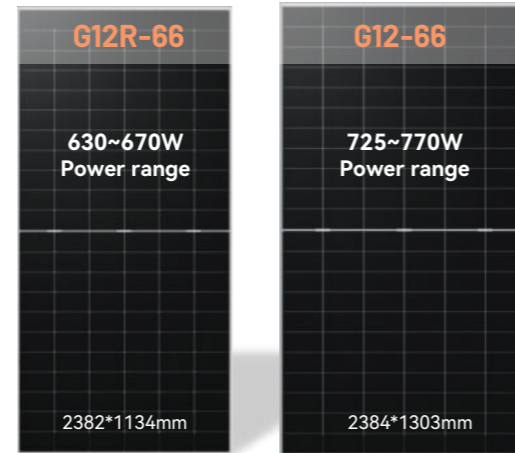
- Tailored for tracking brackets: Reduced G12 system costs

**BIFI MAX** — HIGH REAR-SIDE POWER GENERATION | **90%** BIFACIAL RATIO

## Wave Master Offshore Module

**Offshore PV Challenges:** In comparison with onshore environments, offshore applications are subject to higher salt mist concentration, stronger winds, intensified UV radiation, and elevated humidity. Additionally, they face unique environmental stressors including wave impacts, biofouling, and the synergistic corrosion of complex media.

**Core requirements:** In order to withstand these harsh offshore climates, it is essential to guarantee the long-term reliability and durability of both PV modules and mounting systems in high-salinity and high-humidity conditions.



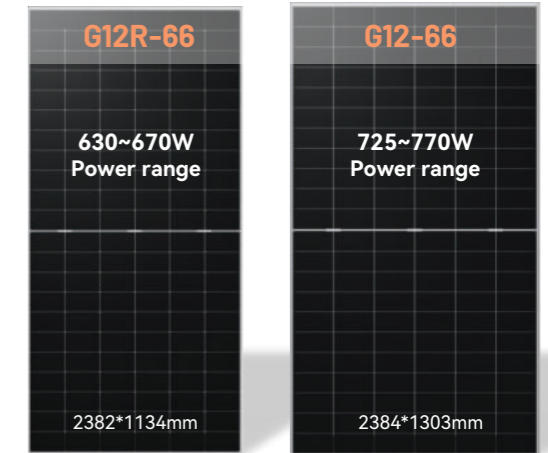
**Tongwei Solution:** Material optimization and extended, differentiated reliability assessments to meet severe offshore PV requirements.



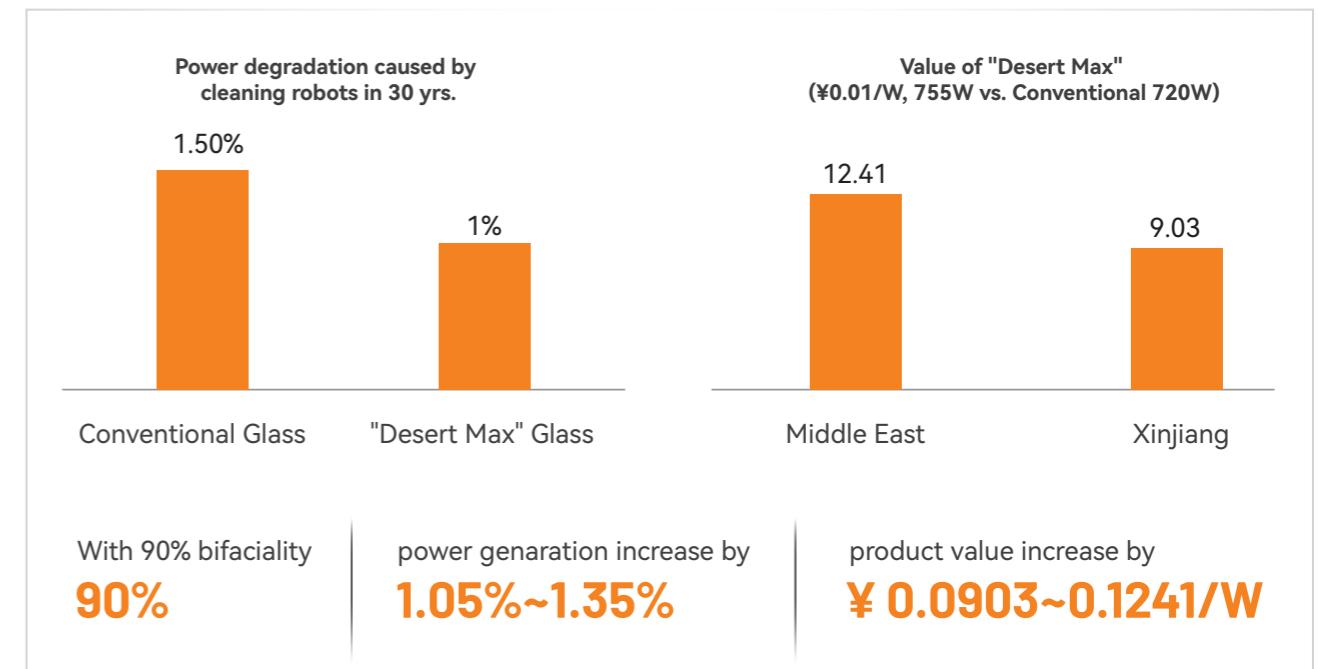
## "Desert Max" for Desert and Gobi Scenario

**Desert and Arid PV Challenges:** Desert and arid environments endure high wind speeds, heavy sandstorms, and extreme diurnal temperature variations, leading to module surface abrasion and dust accumulation. Furthermore, the widespread adoption of robotic cleaning in overseas utility-scale plants places higher demands on the wear resistance of glass coatings.

**Core requirements:** To adapt to these harsh conditions, the glass must be highly wear-resistant toward withstand sand abrasion, and the modules must have high load capacity to endure extreme wind loads.



**Tongwei solution:** The glass pencil hardness is upgraded from 3H to 5H, enhancing resistance to sand abrasion and optimizing compatibility robotic cleaning systems. Furthermore, a maximum bifaciality of 90% delivers superior bifacial energy gain, making the module perfectly tailored for desert and arid environments.

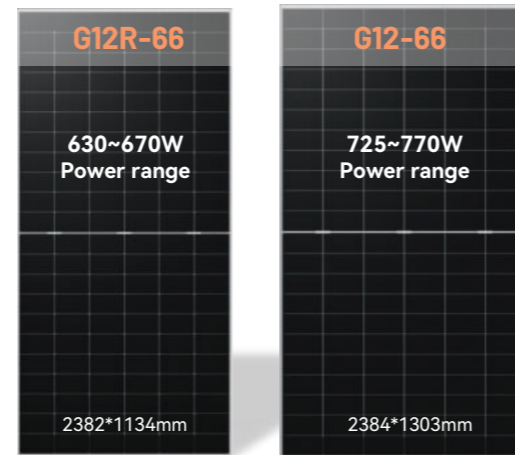


Data is sourced from Tongwei's internal tests and calculations. The calculation results may vary depending on the value selected for the price coefficient.

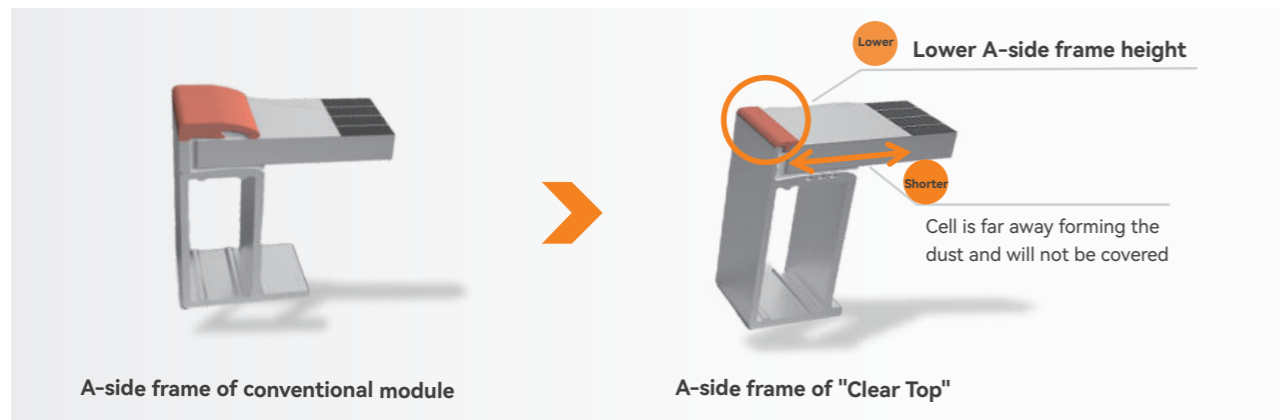
## Anti-dust module "Clear Top"

**C&I PV Challenges:** Industrial particulate emissions led to rapid dust accumulation and persistent soiling on module surfaces. Furthermore, high electricity consumption and peak-to-valley price spreads require maximizing system capacity and power generation on limited rooftops, while ensuring structural load and fire safety.

**Core requirements:** It is vital to mitigate bottom-edge module soiling to ensure long-term efficiency. The use of high-power modules and optimized layouts is key to maximizing power generation per unit area, thus ensuring the project's optimal IRR.

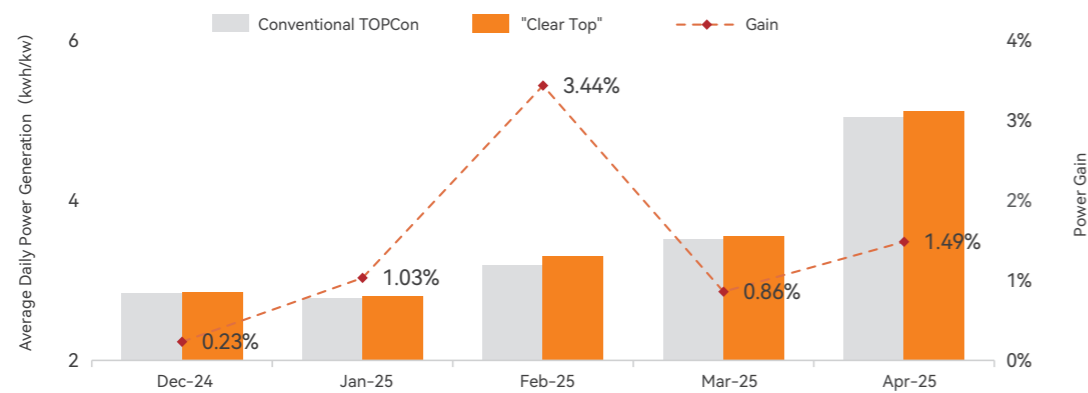


**Tongwei solution:** Redesigning the bottom frame to reduce the length and height of the short A-side.



### "Clear Top" vs. Conventional module

Power generation increased by **1.45%+** value of "Clear Top" **¥ 0.033/W**

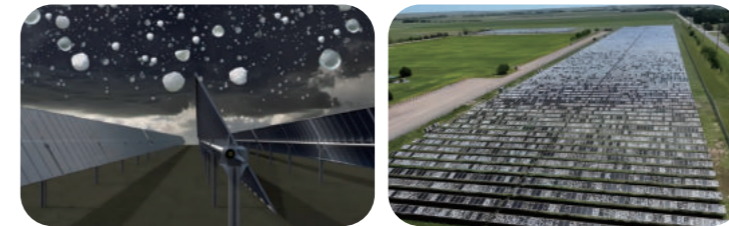


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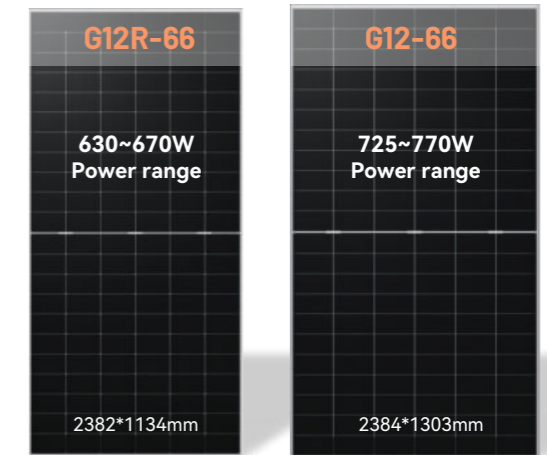
## Anti-hail module

**Hail-Prone PV Challenges:** Frequent extreme weather subjects PV plants to severe hail and wind threats. Consequently, deploying conventional modules in these regions leads to surging insurance premiums.

**Core requirements:** Upgrading hail resistance to withstand 45mm impacts.



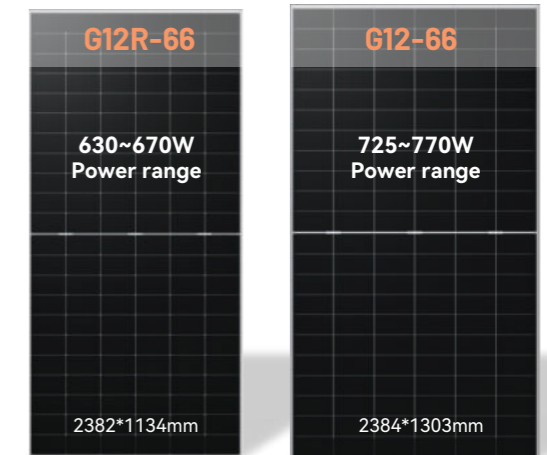
**Tongwei solution:** Thickening the front glass to successfully pass extended 45mm hail test.



## 2000V-system module

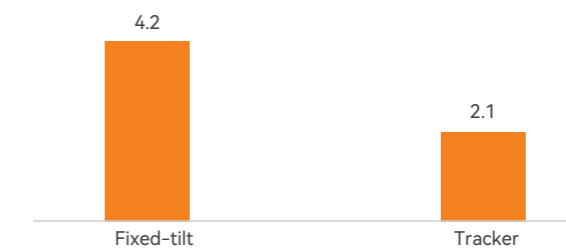
Declining tariffs and module price volatility drive the adoption of lower CAPEX and optimized LCOE solutions. Consequently, 2000V systems are deployed to effectively reduce overall system costs and enhance efficiency.

	1500V	2000V
No. of modules per string	26-30	36-40
String power	Baseline	+6.5-7.5KW



**Tongwei's solution:** The product utilizes high-insulation encapsulation to strictly meet creepage distance requirements, while maintaining standard module dimensions for seamless global logistics.

### 2000V vs 1500V CAPEX Gain (¥0.01/W)



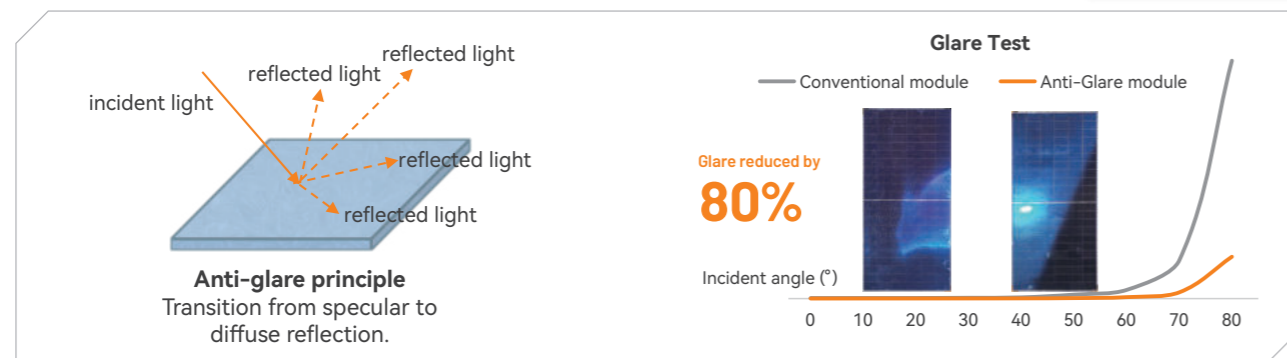
Data is sourced from Tongwei's internal tests and calculations. The calculation results may vary depending on the value selected for the price coefficient.

## Anti-glare module

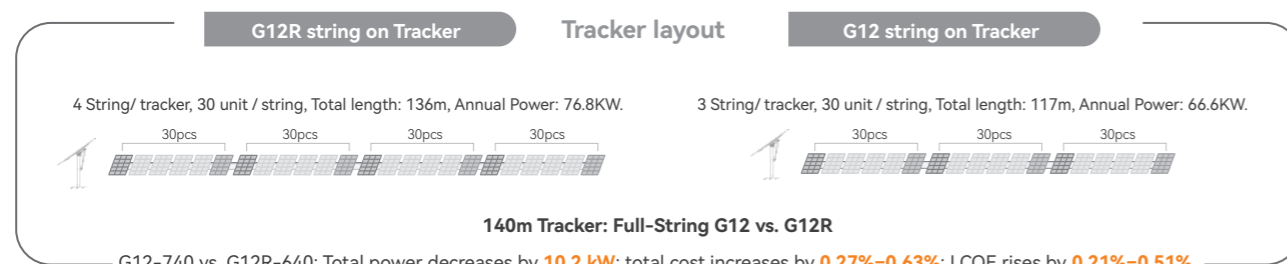
**Urban Transportation PV Challenges:** Installations along airport perimeters, highways, and transit hubs require strict guarantees for flight safety and driver visual comfort.

**Core requirements:** Effectively mitigating light pollution and glare to ensure all-weather transit safety, while maintaining module power generation and long-term weather resistance.

**Tongwei solution:** The use of anti-glare glass is an effective method of reducing light reflection, thereby achieving optimal glare control.



## Tongwei G12 Tracker Solution



**Tongwei solution:** Deploying 27 G12 modules per string (1-3 modules fewer than conventional setups) while adding one extra string.

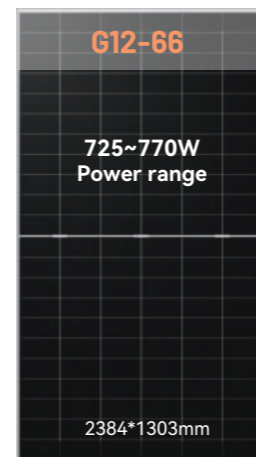


**4 strings, Length: 143 m Power: 79.9KW**

G12 Tongwei tracker solution is <b>3KW/Tracker</b> higher than conventional	BOS reduced by <b>0.89% ~ 1.73%</b>	LCOE reduced by <b>0.43%~1.24%</b>
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Please refer to "TONGWEI Solution for G12-Tracker Compatibility" for details

Data is sourced from Tongwei's internal tests and calculations. The calculation results may vary depending on the value selected for the price coefficient.



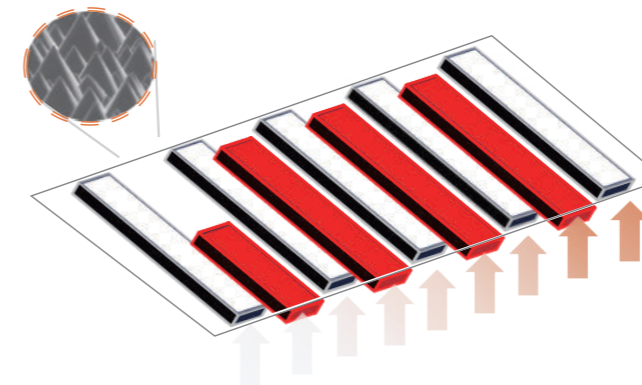
## "Bifi Max" high-bifaciality module

Infrared light fails to penetrate the passivation layer, causing conversion efficiency losses and restricting rear-side power generation. Additionally, practical bifacial energy gain is frequently constrained by ground albedo, mounting height, and array pitch.

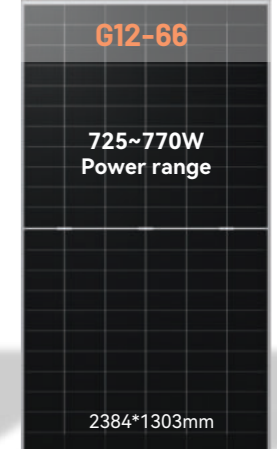
**Core requirements:** Breaking through the module 's rear SR (spectral response) bottleneck to enhance overall power generation and bifaciality, thereby maximizing returns across all scenarios.

**Tongwei solution:** Achieving up to 90% bifaciality through a dual optical strategy:

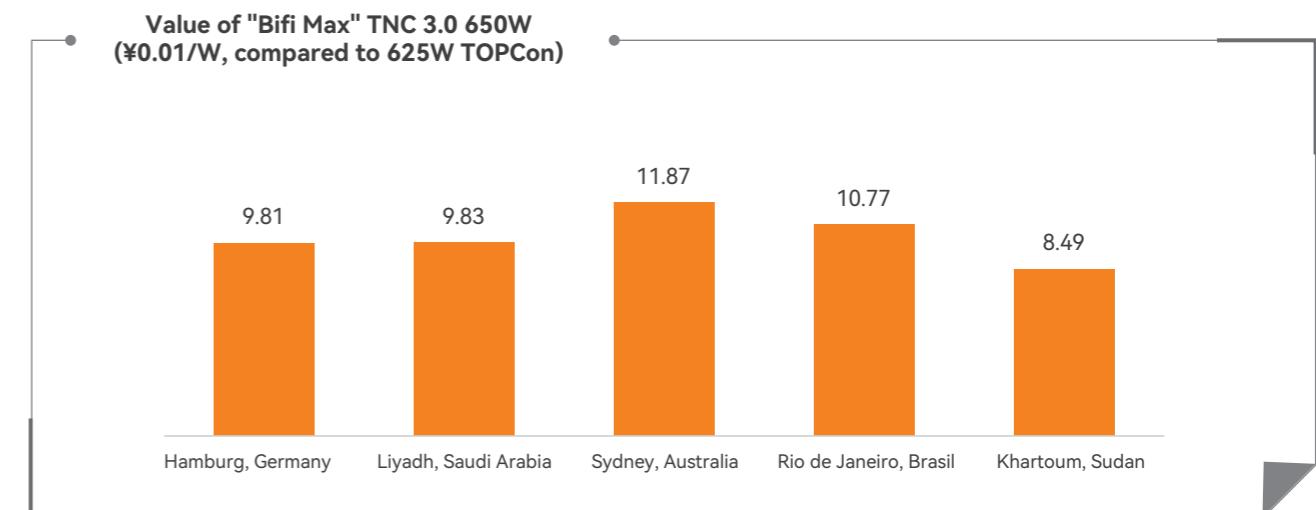
- Zebra Line Technology (Precise Subtraction): Minimizing rear-side shading.
- Rear-Side Light Trapping (Smart Addition): Maximizing incident light absorption.



- Non-electrode-area Poly (red) removed
- Reserved area



"Bifi Max" seamlessly integrates into Tongwei's all-scenario solution products, consolidating a diverse technology matrix that encompasses desert and gobi, offshore PV, 2000V systems, and hail resistance. Through differentiated customization, it systematically enhances the plant's lifecycle power generation and asset returns.



Data is sourced from Tongwei's internal tests and calculations. The calculation results may vary depending on the value selected for the price coefficient.

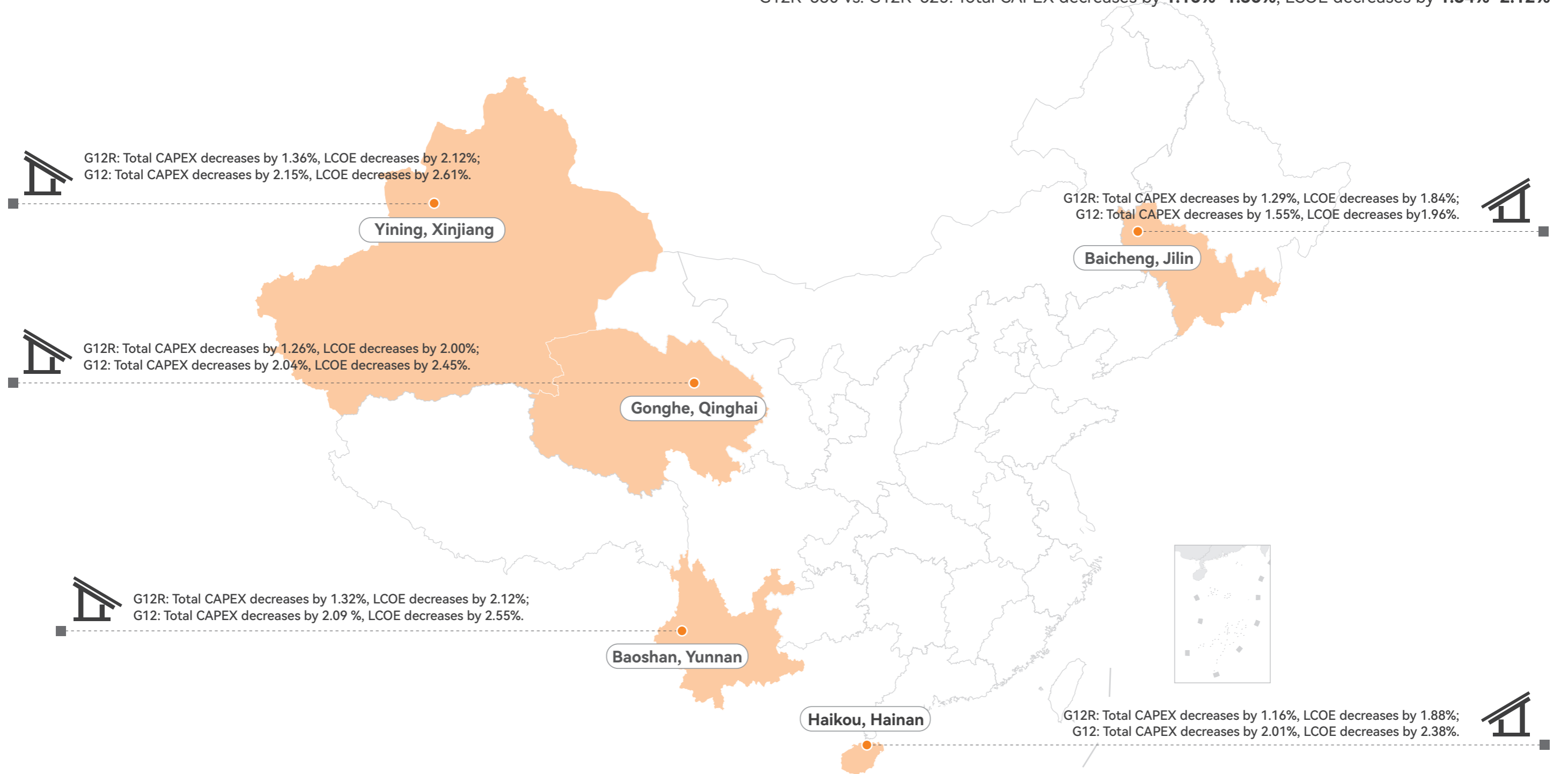
# 05 Value Evaluation and Generation Plant

Fixed-tilt scenarios 

## 5.1 Value Evaluation-China

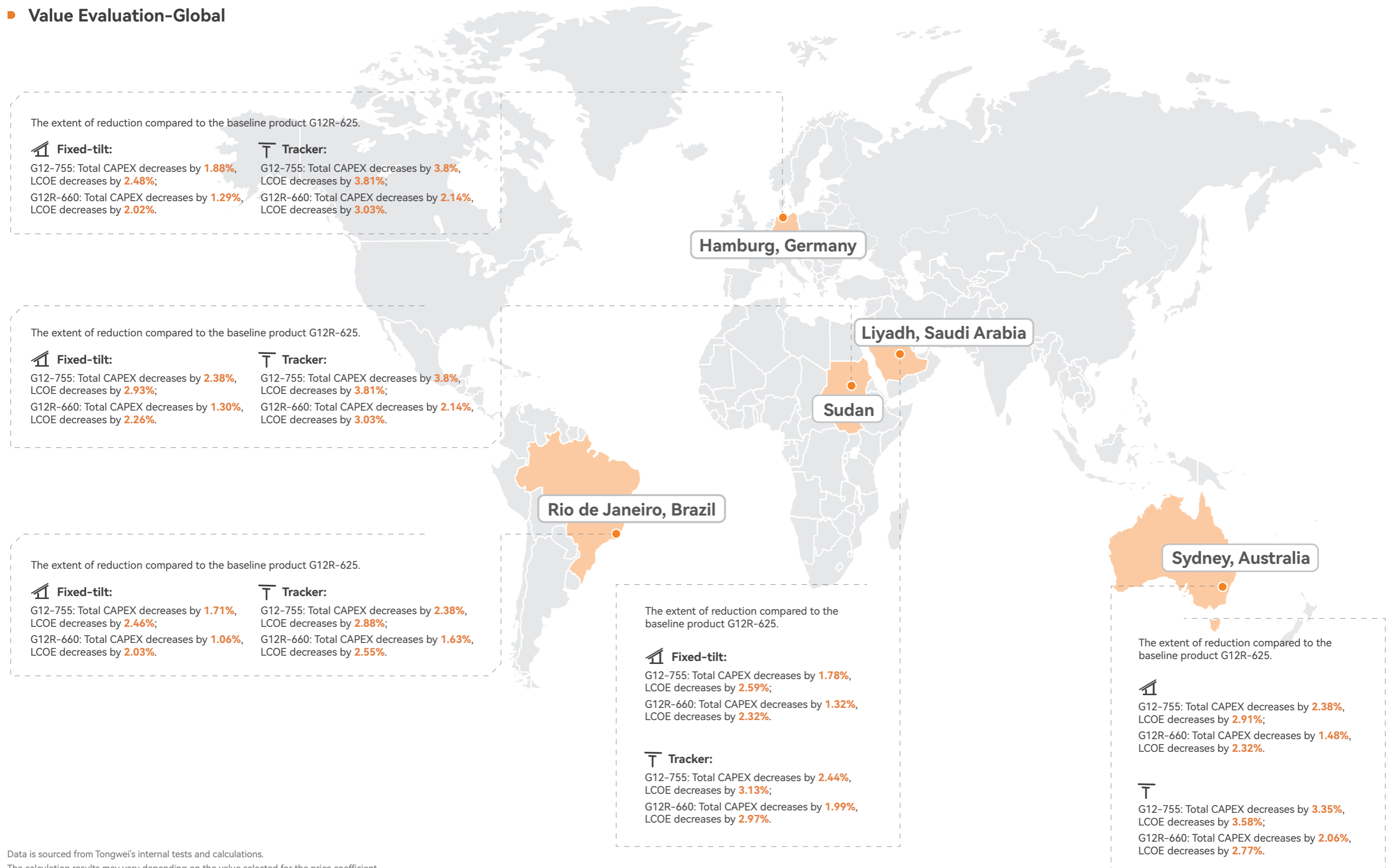
G12-755 vs. G12R-625: Total CAPEX decreases by **1.55%–2.15%**; LCOE decreases by **1.96%–2.61%**

G12R-660 vs. G12R-625: Total CAPEX decreases by **1.16%–1.36%**; LCOE decreases by **1.84%–2.12%**



Data is sourced from Tongwei's internal tests and calculations.  
The calculation results may vary depending on the value selected for the price coefficient.

Value Evaluation-Global

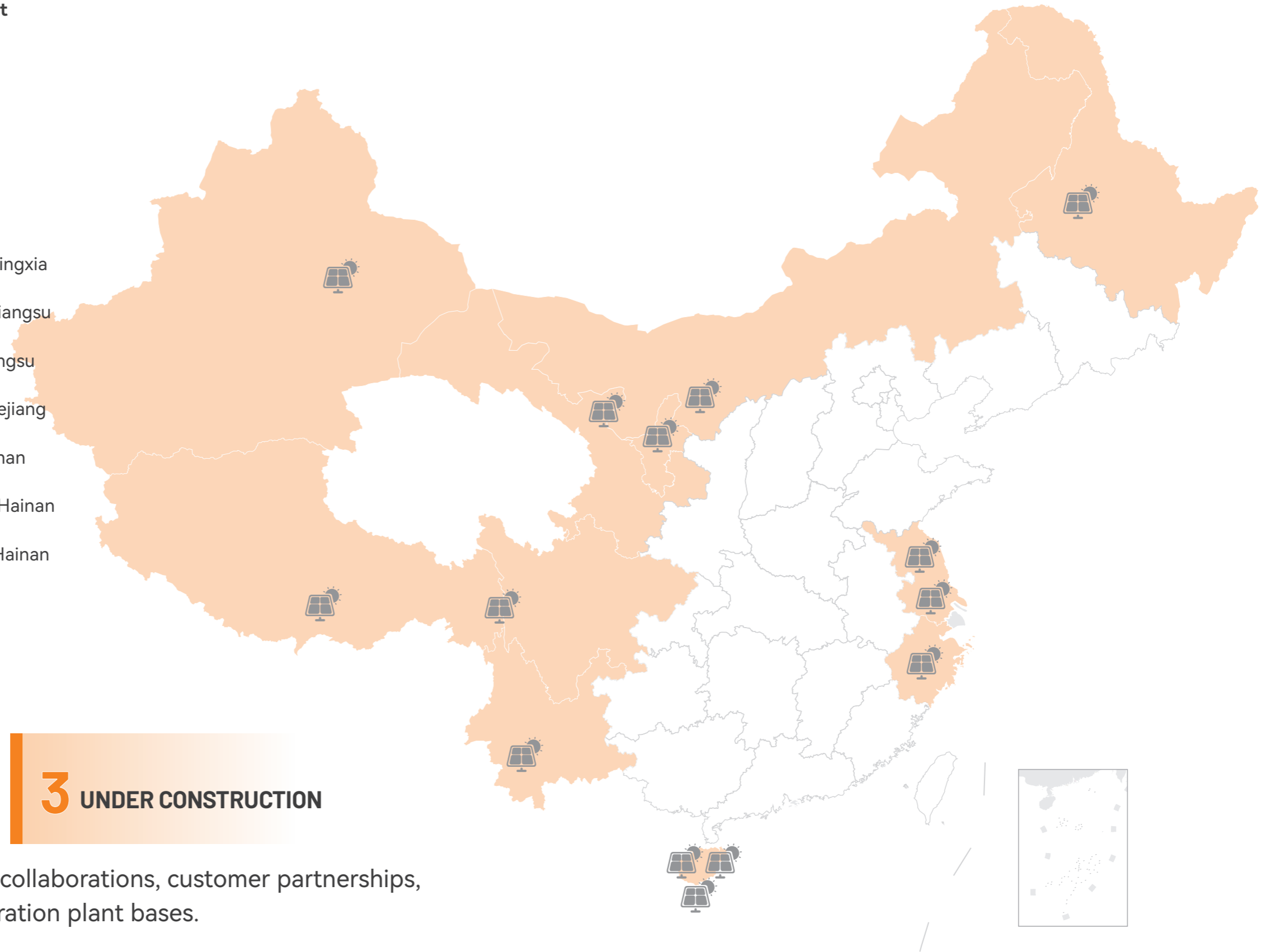


Data is sourced from Tongwei's internal tests and calculations. The calculation results may vary depending on the value selected for the price coefficient.

### 5.2 Field Test: Tongwei's Generation Plant

## Location

Turpan, Xinjiang	Yinchuan, Ningxia
Wuwei, Gansu	Yancheng, Jiangsu
Nimu, Xizang	Nanjing, Jiangsu
Derong, Sichuan	Sanmen, Zhejiang
Xishuangbanna, Yunnan	Haikou, Hainan
Daqing, Heilongjiang	Wenchang, Hainan
Kubuqi, Inner Mongolia	Dongfang, Hainan



**12** PLANT OPERATIONAL

**3** UNDER CONSTRUCTION

These plant include third-party collaborations, customer partnerships, and Tongwei's proprietary generation plant bases.

### Hainan Dongfang Generation Plant



TNC vs. Conventional TOPCon: 0.64% Per-Watt Power Generation Gain

**Location:** Dongfang, Hainan (108.72°E, 19.03°N)

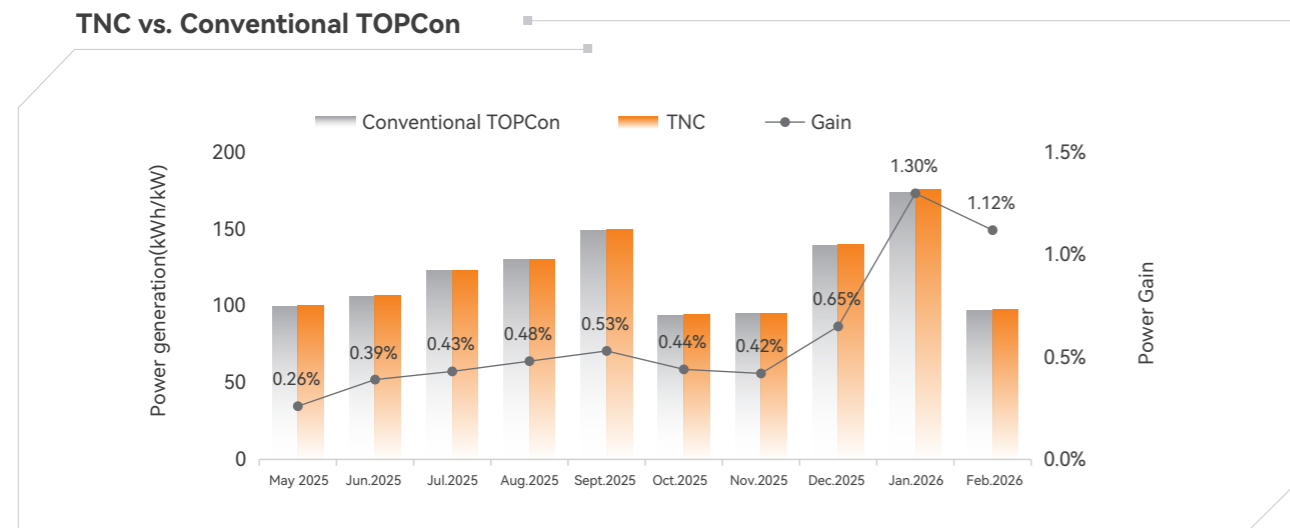
**Climate Profile:** Typical hot and humid climate at 19°N latitude. Features year-round high temperatures and moisture (Annual average: 25°C, 87.7% RH). Annual irradiation at optimal tilt: ~1880 kWh/m<sup>2</sup>.



#### Project Information

Module Type	TNC	Conventional TOPCon
Module Product	G12R-66	G12R-66
Installation	Fixed-tilt, 10°, 1m above the ground	
No. of module (pcs)	12	12

Over a 10-month period, TNC modules delivered a 0.64% per-watt power generation gain compared to conventional TOPCon products.



The data is derived from the CPVT Hainan Dongfang Generation Plant

### Ningxia Yinchuan Generation Plant



TNC vs. Conventional TOPCon: 0.66% Per-Watt Power Generation Gain

**Location:** Yinchuan, Ningxia (106.03°E, 38.59°N)

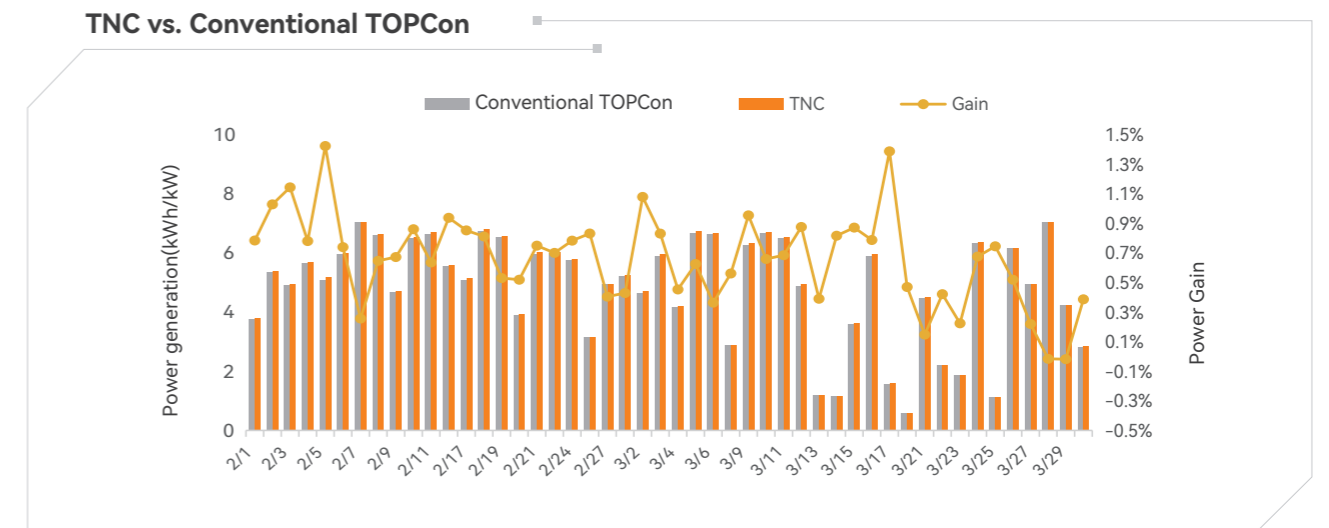
**Climate Profile:** Temperate continental climate featuring dry, hot conditions and extreme temperature variations. Class I solar resource zone with high cumulative UV radiation. The solar spectrum closely matches the standard AM 1.5 (95.47% match). Annual irradiation at optimal tilt: >2000 kWh/m<sup>2</sup>.



#### Project Information

Module Type	TNC	Conventional TOPCon
Module Product	G12R-66	G12R-66
Installation	Fixed-tilt, 1m above the ground	
No. of module (pcs)	10	10

Over a 2-month period, TNC modules delivered a 0.66% per-watt power generation gain compared to conventional TOPCon products.



The data is derived from the CPVT Ningxia Yinchuan Generation Plant

### Sichuan Derong Generation Plant

TNC vs. Conventional TOPCon: 0.55% Per-Watt Power Generation Gain

**Location:** Derong, Sichuan (97.17°E, 30.54°N, Elevation: 4600m)

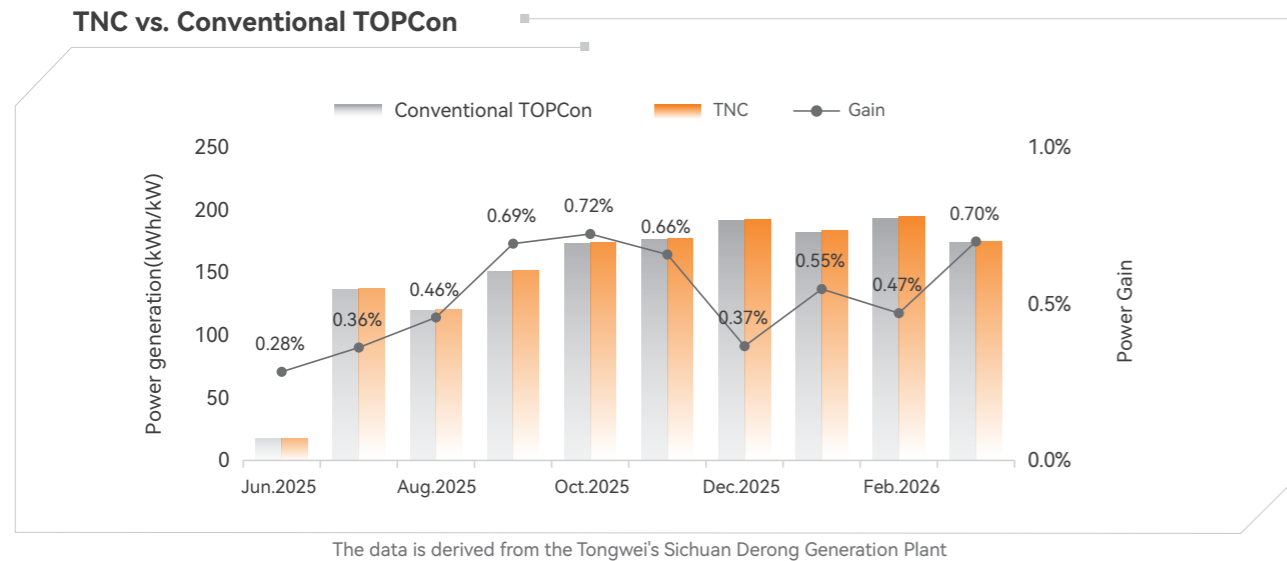
**Climate Profile:** Plateau continental monsoon climate. Features high elevation, extreme temperature variations, high irradiance, and strong UV intensity (UV accounts for ~7.5%). Annual irradiation at optimal tilt: >2100 kWh/m<sup>2</sup>.



#### Project Information

Module Type	TNC	Conventional TOPCon
Module Product	G12-66	G12-66
Installation	Fixed-tilt, 27°, 2m above the ground	
No. of module (pcs)	12	12

Over a 10-month period, TNC modules delivered a 0.55% per-watt power generation gain compared to conventional TOPCon products.



### Jiangsu Yancheng Generation Plant

TNC vs. Conventional TOPCon: 0.36% Per-Watt Power Generation Gain

**Location:** Yancheng, Jiangsu (120.29°E, 33.35°N)

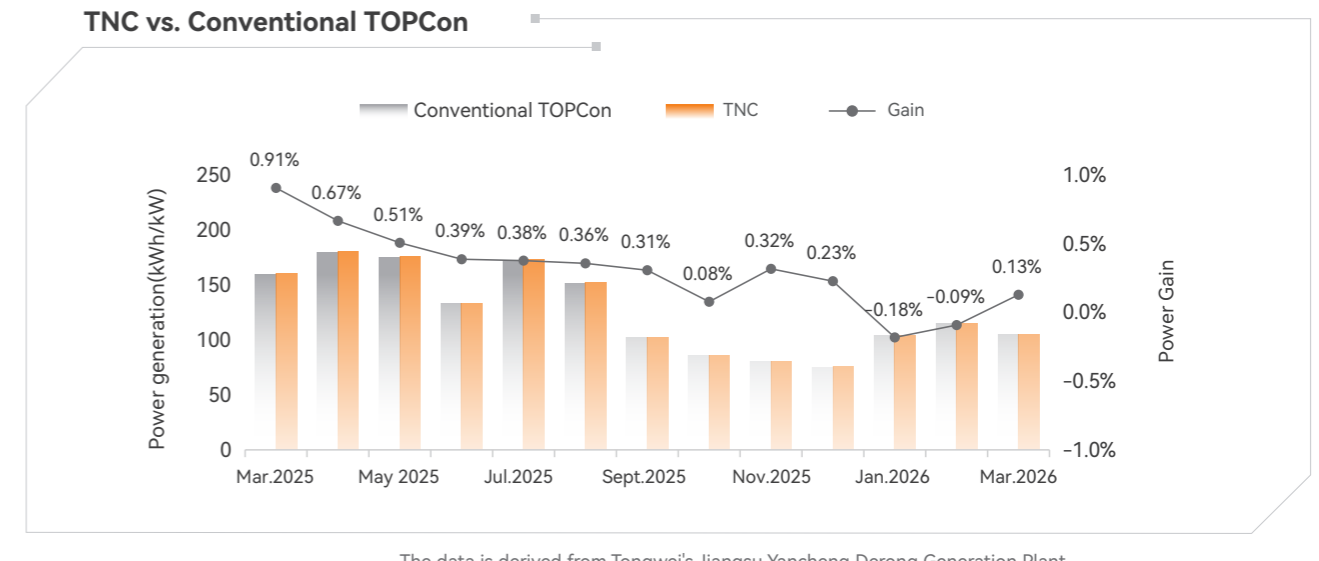
**Climate Profile:** Subtropical monsoon climate with marine regulation. Features humid conditions, distinct seasons, coincident rain and heat, and abundant sunshine. Annual irradiation at optimal tilt: ~1400 kWh/m<sup>2</sup>.



#### Project Information

Module Type	TNC	Conventional TOPCon
Module Product	G12-66	G12-66
Installation	Fixed-tilt, 40°, 1m above the ground	
No. of module (pcs)	12	12

Over a 1-year period, TNC modules delivered a 0.36% per-watt power generation gain compared to conventional TOPCon products.

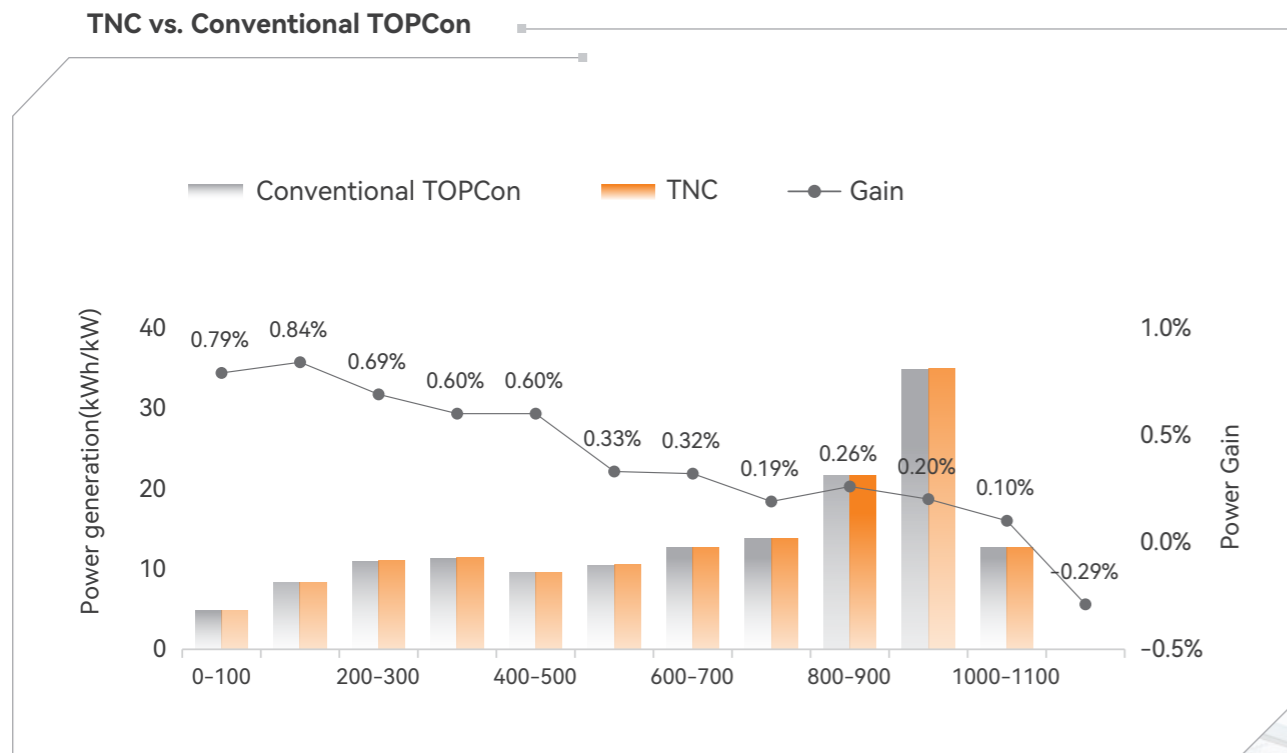


### Jiangsu Yancheng Generation Plant

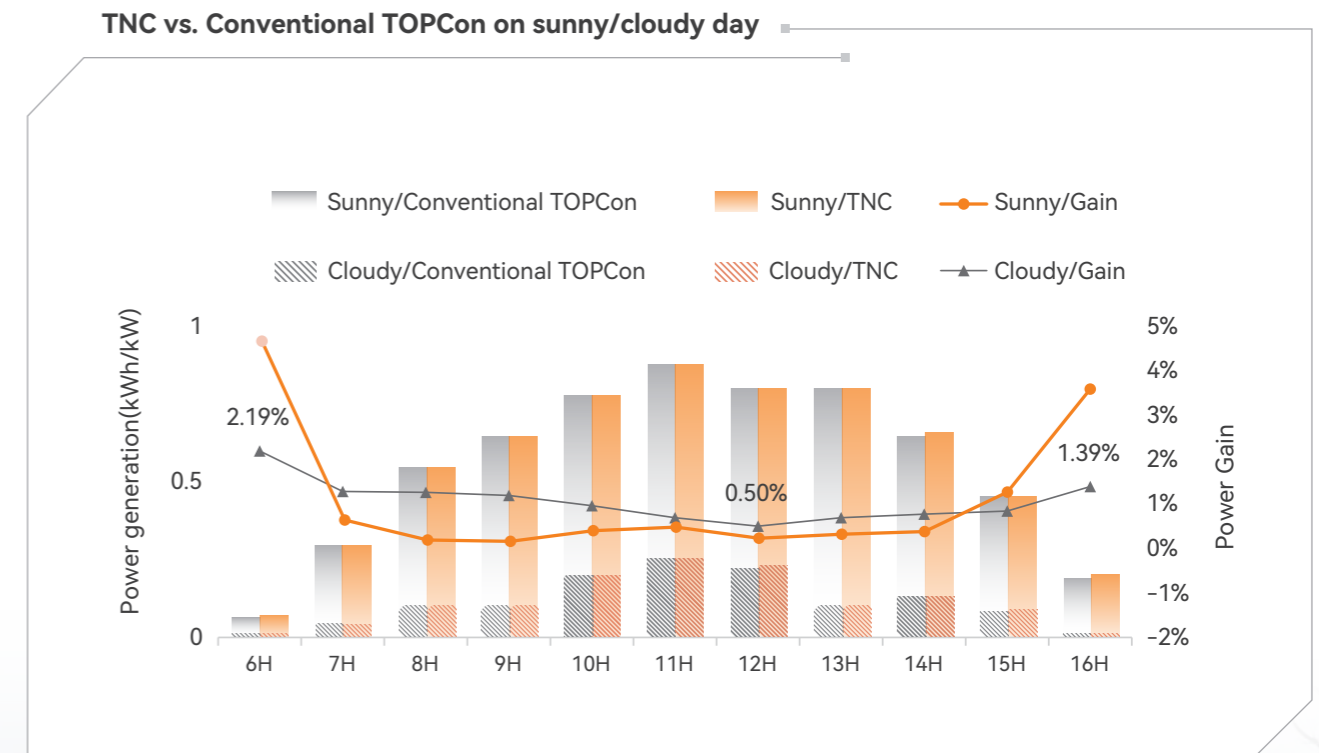
Tongwei TNC products outperform conventional TOPCon products in low-light power generation.

Compared to conventional TOPCon products, Tongwei TNC modules deliver superior low-light performance, achieving a >0.6% power generation gain at irradiance levels  $\leq 500 \text{ W/m}^2$ .

In comparison to conventional TOPCon products, Tongwei TNC modules achieve a >3.5% power generation gain during morning and evening hours on sunny days, with an overall daily gain exceeding 1.0%. In conditions where there is a lack of sunlight, they consistently generate more than 0.5% of power for the duration of the day. This results in an average daily gain of more than 1.5%.



The data is derived from Tongwei's Jiangsu Yancheng Derong Generation Plant



The data is derived from Tongwei's Jiangsu Yancheng Derong Generation Plant



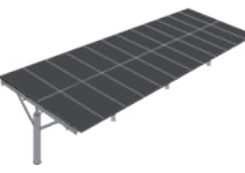
# 06 System Compatibility

## 6.1 Mounting System Compatibility

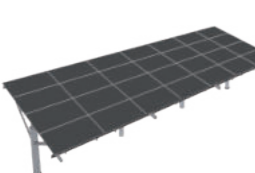
### Fixed-tilt

Tongwei TNC 3.0 modules retain the dimensions design of the TNC series. Featuring industry-standard dimensions and support diverse mounting options. For detailed mechanical load specifications, please refer to the Tongwei PV Module Installation Manual.

Standard Mounting Method for Products supplied by Tongwei:

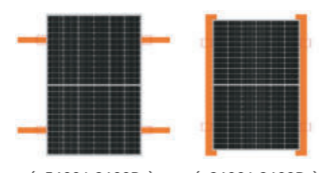


Vertical Installation



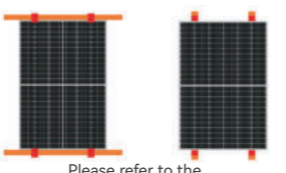
Horizontal Installation

Long Side Mounting (Bolt/Clamp)



(+5400/-2400Pa) (+3600/-2400Pa)

Shor Side Mounting (Clamp)



Please refer to the Tongwei PV Module Installation Manual.

### Floating Mounting Systems

Driven by land conservation and high adaptability, FPV is rapidly expanding from inland freshwater to near-shore offshore environments. Tongwei TNC 3.0 modules have completed compatibility simulation testing with leading floating mounting system manufacturers.









For near-shore floating applications, the TNC 3.0 "Wave Master" series employs material optimization and extended tests to enhance reliability, effectively withstanding the high UV, severe salt-mist corrosion, and high wind loads typical of offshore PV environments.



### Tracker Scenario Applications

Driven by the growing demand for clean energy, trackers have become a vital mounting application, experiencing rapid market growth. Tongwei TNC 3.0 modules have completed compatibility testing with leading tracker manufacturers, delivering tested mechanical loads superior to the industry average. (For detailed tracker compatibility and load specifications, please contact Tongwei's technical support team.)



Manufacturer	Model
ARCTECH 	Skyline II
ANTAI 	AT-Spark
Trinasolar 	Vanguard
PVH 	AXONEDUO INFINITY
NextPower 	NX Horizon

### Flexible Mounting Systems

Traditional rigid are not well-suited to meeting the demands, high clearances, and extended row spacing. Flexible mounting systems effectively resolve the adaptability and economic challenges inherent to these applications.



Inheriting the high mechanical load design of the TNC series, Tongwei TNC 3.0 modules have successfully passed static load, dynamic excitation, and wind tunnel tests specifically for flexible mounting applications in collaboration with TÜV NORD, comprehensively validating their structural reliability.



## 6.2 Inverter Compatibility

Matching PV modules with inverters goes beyond simple power rating alignment. It is a systematic engineering process involving voltage, current limits, MPPT logic, DC/AC ratio design, and safety protections. Optimal compatibility is the foundation for high efficiency, safety, and profitability. Conversely, improper matching can trigger current limiting, equipment overloads, safety hazards and power generation losses, which can significantly reduce project lifecycle profitability.

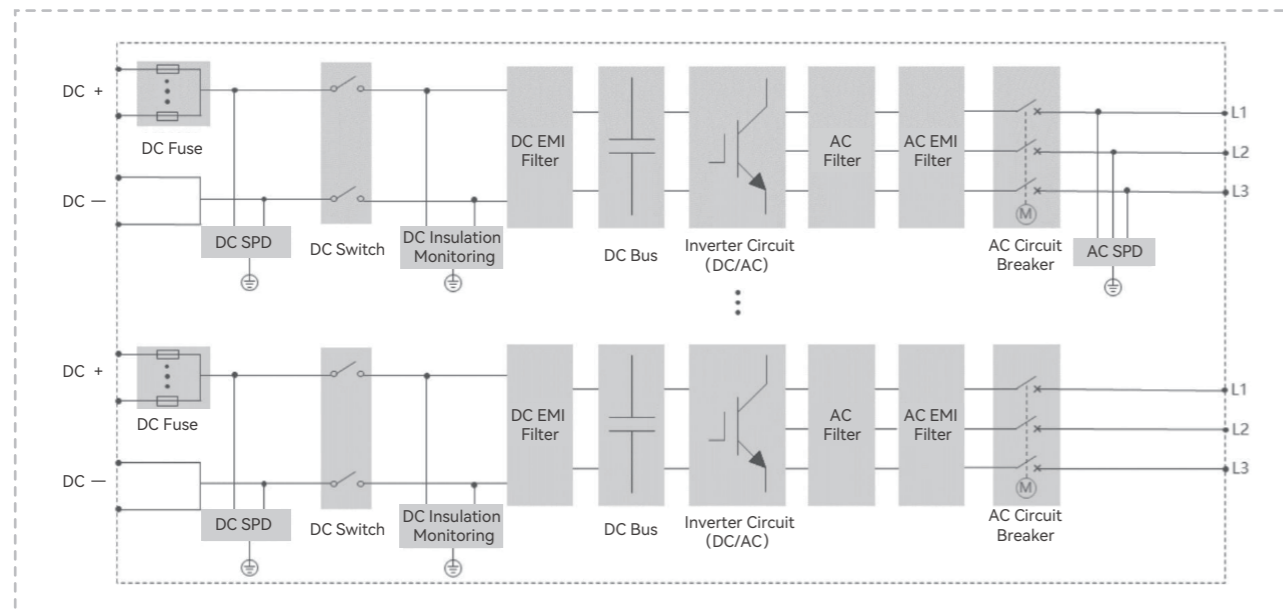
### Central Inverter Compatibility

Central inverters inherently offer broad current adaptability. By simply selecting DC combiner boxes with appropriate current ratings, TNC modules guarantee full compatibility with all central inverter models.

Central inverter datasheet

Input (DC)		
Max. PV input voltage	1500 V	
Min. PV input voltage / Startup input voltage	895V/905 V	
MPPT voltage range	895V-1500 V	
No. of independent MPPT inputs	3	4
No. of DC inputs	15(optional: 21)	20(optional: 28)
Max. PV input current	3*1435 A	4*1435 A
Max. DC short-circuit current	3*3528 A	4*3528 A

Central inverter circuit block diagram



### String and Hybrid Inverters

Inverter-module matching calculations vary by region. Research confirms that TNC modules are compatible with over 95% of mainstream string and hybrid inverters. Incompatibility is limited to a few older-generation inverters where low current limits trigger current limiting.

Area	Requirement	Module Information	Compliance ratio
Australia	$I_{sc} \times 1.25 \leq \text{Inverter MPPT max. DC short-circuit current}$	G12R-48 Imp: $\approx 15.3A$ Isc: $\approx 16A$	99.53%
Europe	$I_{sc} \leq \text{Inverter MPPT max. DC short-circuit current}$	G12R-66 Imp: $\approx 15.8A$ Isc: $\approx 16.64A$	100%
Other regions	$I_{mp} \leq \text{Inverter MPPT max. DC short-circuit current}$	G12-66 Imp: $\approx 17.95A$ Isc: $\approx 19.05A$	96.02%

### Mainstream compatible brands:

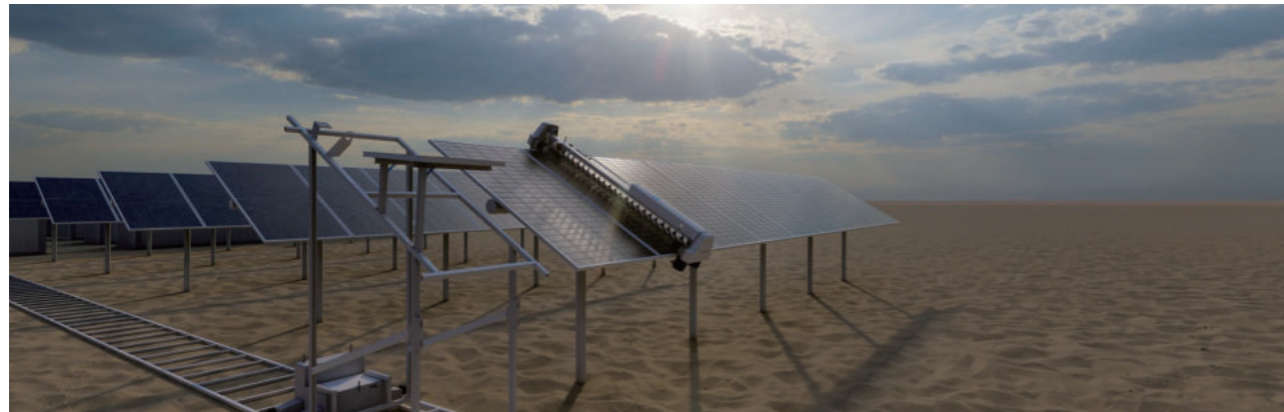
Note: Partial list of compatible inverter brands. Listed in no particular order.

### 6.3 Robot Compatibility

#### ▀ Cleaning Robot Compatibility

As utility-scale PV plants expand across desert, Gobi, and arid regions, soiling losses have become a prominent issue. Dust and pollutant deposition decreases power generation by 4%–8% on average, with losses exceeding 15% in extreme arid, high-dust, or coastal environments. Concurrently, manual cleaning is inadequate for the requirements of GW-scale projects, driving the widespread deployment of automated PV cleaning robots.

Through joint testing with leading cleaning robot manufacturers simulating 30 years of mechanical wear, the average power degradation of Tongwei TNC modules is maintained within 1%. This mechanical durability outperforms the industry average, ensuring full-lifecycle reliability for utility-scale power plants.



Cleaning robot: 11,000 cleaning cycles (equivalent to 30 years)

**Power degradation ≤1.0%**

Note: Power degradation data of modules is from Tongwei's internal laboratory.



#### ▀ Installation Robot Compatibility

As utility-scale PV plants expand and construction schedules tighten, manual module installation faces increasing physical and technical constraints. To ensure efficient deployment and timely grid connection, automated installation robots have become the preferred solution for utility-scale plant owners. Mainstream installation robots achieve an efficiency of 600–1,000 modules per day—4 to 5 times the rate of manual installation. This approach significantly mitigates labor dependencies and decreases comprehensive installation costs by 20%–70%.

Measurement case of a 200MW project: (Duration: 100 days Robot requirement: 5 units)

Fully manual installation 60 persons , ¥ 4.027 million

Robotic installation 15 persons , ¥ 2.48 million



**75%**  
Labor demand reduced by



**38.4%**  
total installation cost reduced by

Tongwei TNC modules have passed TÜV third-party compatibility testing with mainstream installation robot manufacturers. Robotic deployment significantly accelerates installation efficiency while ensuring zero quality risks.



# 07 Company Ratings and Product Certifications

## 7.1 International Sustainability Initiative Response



Tongwei Co., Ltd. joined the United Nations Global Compact (UNGC).



Tongwei Co., Ltd. joined RE100.

In support of



Established by UN Women and the UN Global Compact Office

Tongwei Co., Ltd. signed the UN Women's Empowerment Principles (WEPs).



China ESG Alliance

Tongwei Co., Ltd. joined the China ESG Alliance.



Tongwei Co., Ltd. joined the ISSB International Sustainability Disclosure Standards Early Learning Partnership Program.



Tongwei Co., Ltd. Joined the world economic forum (WEF)



Supply Chain ESG Stewardship Initiative

Tongwei Co., Ltd. Launches the Supply Chain ESG Stewardship Initiative (SCSI)



Tongwei Co., Ltd. joined the International Renewable Energy Agency (IRENA) Action Coalition.



Tongwei and Leading PV Enterprises Jointly Release the Global Solar Sustainable Alliance (GSSA) Initiative



Tongwei Co., Ltd. Joined the Solar Stewardship Initiative (SSI)

## 7.2 Mainstream Rating Performance in 2025

### S&P Global

S&P Global Corporate Sustainability Assessment (CSA)

2025	↑ 61 points	2024	57 points
		2023	53 points

### ecovadis

EcoVadis Corporate Social Responsibility Rating

(Tongwei Solar (Hefei) Co., Ltd.)

2025	↑ Gold 83 points	2024	Gold 78 points
		2023	Silver 67 points

### Wind ESG

Wind ESG Rating

2025	↑ AA	2024	AA
		2023	A

### CDP






CDP Global Environmental Disclosure

2025	Climate Change B	2025	Water Security B	2025	Supplier Engagement A Rating
2024	Climate Change B	2024	Water Security B	2024	Supplier Engagement A Rating
2023	Climate Change B	2023	—		

### 7.3 Product Carbon Footprint Certification

In 2025, Tongwei Co., Ltd. secured 56 new carbon footprint certifications across its various product series—including two EPDs and three IEC 62994 certifications—bringing its cumulative total to 124.

New Product Carbon Footprint Certifications Obtained by Tongwei Co., Ltd. in 2025

Certification Type		Number of Certifications
ISO 14067 Product Carbon Footprint Certification		7
Simplified Carbon Assessment (ECS)		42
Life Cycle Assessment (LCA)		2
Environmental Product Declaration		2
IEC 62994 Environmental Health and Safety (EH&S) Risk Technical Assessment Certification		3

As the global PV industry transitions toward green development, the Carbon Footprint of a Product (CFP) has become a core sustainability metric and a mandatory entry threshold for high-standard markets in Europe. The French Environment and Energy Management Agency (ADEME) provides an authoritative carbon footprint certification renowned for its stringent full Life Cycle Assessment (LCA) methodology. This framework demands systematic carbon accounting across raw material procurement, manufacturing, logistics, product usage, and end-of-life disposal, necessitating standardized, transparent, and fully traceable data management.

As subsidiaries of Tongwei Co., Ltd., Tonghe New Energy (Jintang) Co., Ltd. secured the ADEME carbon footprint certification for its monocrystalline silicon wafer products, while Tongwei Solar (Meishan) Co., Ltd. obtained the certification for its TOPCon products. As the first Lighthouse Factory in the global PV cell industry, Tongwei Solar (Meishan) Co., Ltd. excels in digital manufacturing, refined energy management, and process control. Its full-process data collection and intelligent analytics provide robust support for high-standard CFP accounting.



• Certificate Awarded to Tonghe New Energy (Jintang) Co., Ltd.



• Certificate Awarded to Tongwei Solar (Meishan) Co., Ltd.

## 7.4 WEEE (Waste Electrical and Electronic Equipment) Certification



France



Finland



Portugal



Portugal



Britain



Germany, etc.



Italy, etc.



Ireland



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