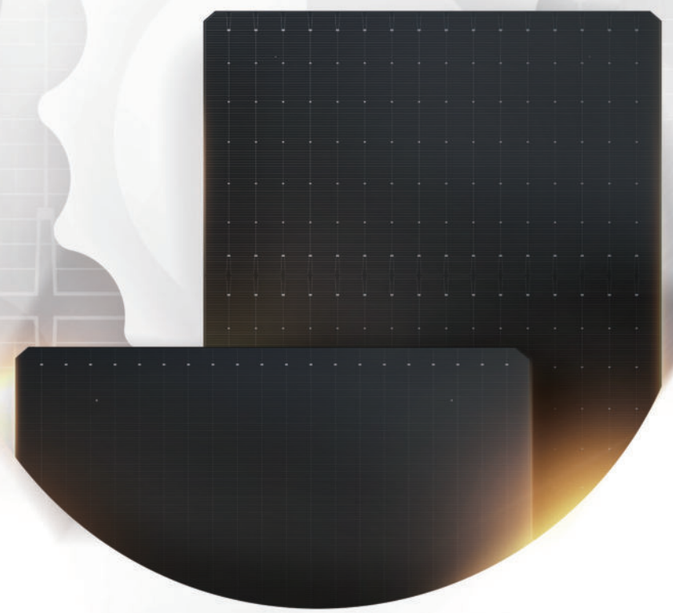
Tongwei Solar Co., Ltd.
Address: No. 588, Middle Section of Tianfu Avenue,
High-tech Zone, Chengdu, Sichuan
Postal Code: 610000
Pre-sales Email: sale02@tongwei.com
Customer Service Hotline: 028-60666661
Official Website:https://en.tongwei.cn/

TONGWEI



WHITE PAPER OF TW TNC CELL

CHOOSE TONGWEI CELLS

PRODUCE HIGH-EFFICIENCY MODULES

Traceable Quality, Reliable Products

FOR 9

CONSECUTIVE YEARS-GLOBAL CELL SHIPMENTS RANKING TOP 1

Our cell shipments have been the world's largest for nine consecutive years since 2017, making Tongwei the first company in the industry to achieve cumulative shipments exceeding 400GW.

Source: InfoLink CONSULTING

THE FIRST "LIGHTHOUSE FACTORY" IN GLOBAL PV CELL MANUFACTURING

In 2025, we continued to advance carbon footprint certification, reducing the LCA value by

35.4% ↓

2024

25.004kg CO^2 eq/ kwp

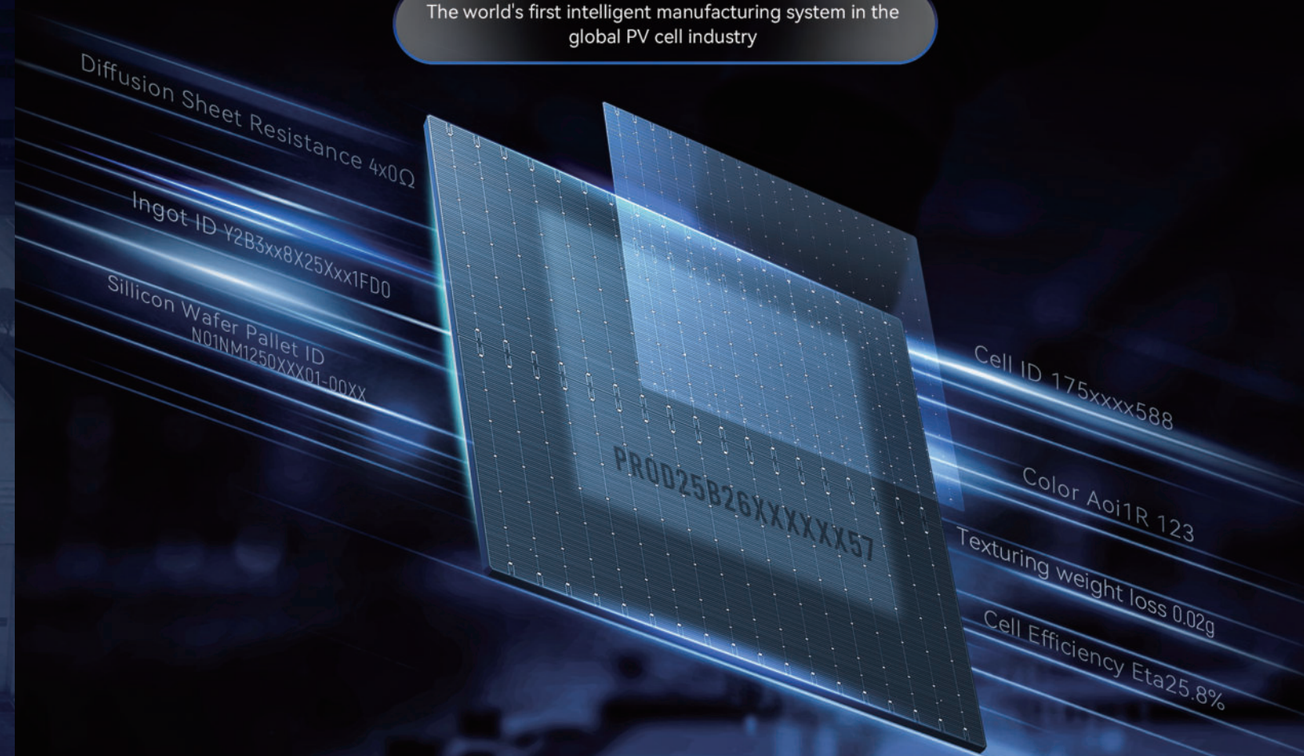
2025

16.153kg CO^2 eq/ kwp

CELL-LEVEL TRACEABILITY

Making Every Cell More Trustworthy

The world's first intelligent manufacturing system in the global PV cell industry



Sensor + Data + Algorithm
Data-driven decisions for transparent, trustworthy manufacturing.

Wafer-level Digital Identity
Unique wafer ID for full-process traceability.

Full-link Records
Performance comparison, quality verification, process optimization.

Smart Manufacturing
Empowers supply chain collaboration, customer service, and lifecycle quality management.

CONTENTS

PART 1 Chapter 1 | Company Profile /01

- 1.1 Tongwei Co., Ltd. /02
- 1.2 Integrated Layout of Tongwei PV Industry Chain /03
- 1.3 Tongwei Solar /04

PART 2 Chapter 2 | High Quality /05

- 2.1 Tongwei Gene /06
- 2.2 Smart Factory /15

PART 3 Chapter 3 | High Efficiency /24

- 3.1 Leading the Industry /25
- 3.2 Breaking through and Innovating /28

PART 4 Chapter 4 | Value Addition /35

- 4.1 Power Gain /36
- 4.2 Green and Low-Carbon /39
- 4.3 ESG /41

PART 5 Chapter 5 | Win-Win Cooperation /42

- 5.1 Global Partners /43

Version: TW-C-68/5

PART 1

Chapter 1
Company Profile

1.1 Tongwei Co., Ltd.

1.1.1 About Tongwei

500
FORTUNE GLOBAL
The first and only one in the PV industry
Fortune Global 500 enterprise

TOP1
High-purity crystalline silicon ranks first in global market share and shipment for five consecutive years

TOP1
High-efficiency cells rank first in global shipment for nine consecutive years

200+
Subsidiaries

TOP5
High-efficiency modules rank fifth in global shipment for three consecutive years

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 andgrid-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 May 2026

1.2 Integrated Layout of Tongwei PV Industry Chain

通威股份
TONGWEI CO., LTD.

- **YONGXIANG** — High-Purity Crystalline silicon
- **TW Solar (cell)** — High Efficiency Cells
- **TW Solar Technology** — Hight Efficiency Modules
- **Tongwei New Energy** — Fishery & PV Integration
- **Tongwei Agricultural Development** — Feed and Farming
- **Tongwei Food** — Aquatic Products Trade and Processing

Green energy
Global leading high-purity crystalline silicon enterprise
Global leading solar cell enterprise

Green agriculture
National key leading enterprise in agricultural industrialization
World-leading aquatic feed production enterprise and important livestock and poultry feed production enterprise

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

永祥股份 YONGXIANG CO.,LTD.
Production capacity
Over 900,000 tons

High-quality silicon wafer

Independently produce high-quality silicon wafers and sign long-term cooperation agreements with leading silicon wafer manufacturers, relying on the advantage of silicon materials, to ensure supply quality

通威太阳能 TW SOLAR
Production capacity
40+GW

Crystalline silicon cell

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

通威太阳能 TW SOLAR
Production capacity
150+GW

High-efficiency modules

TW Solar's module products fully cover various application scenarios

通威太阳能科技 TW SOLAR TECHNOLOGY
Production capacity
90+GW

"Fishery-PV integration"

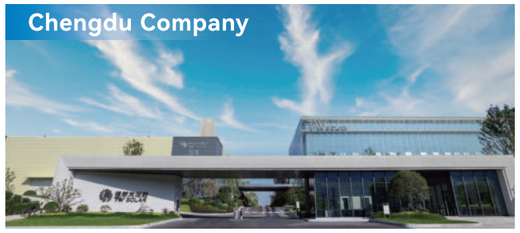
The world's first innovative development model of "fishery-PV integration"
to achieve "a triple-win outcome" of fishery, electricity, and environmental protection

通威新能源 TW NEW ENERGY
Cumulative installed and grid-connected capacity
5+GW

1.3 Tongwei Solar

1.3.1 About TW Solar

TW Solar deeply engages in the R&D, manufacturing, and promotion of core products for solar power generation, and is a world-leading crystalline silicon cell production enterprise. After 13 years of leapfrog development, the Company has achieved the transformation from "following" and "keeping pace" to "leading", with zero major safety accidents and zero major environmental accidents for 13 consecutive years. Up to now, TW Solar has owned Chengdu, Meishan, Jintang, Tonghe, Pengshan, and Zhongwei Companies, with more than 10,000 on-the-job employees and an annual production capacity of over 150 GW. The Company has remained No.1 in the world in terms of cell shipment for eight straight years (statistics from InfoLink Consulting), and has become the first enterprise in the industry with cumulative cell shipment exceeding 300 GW. In 2025, Meishan Company became the first "lighthouse factory" in the global PV cell industry.


Chengdu Company

Meishan Company

Jintang Company

Tonghe Company

Pengshan Company

Zhongwei Company

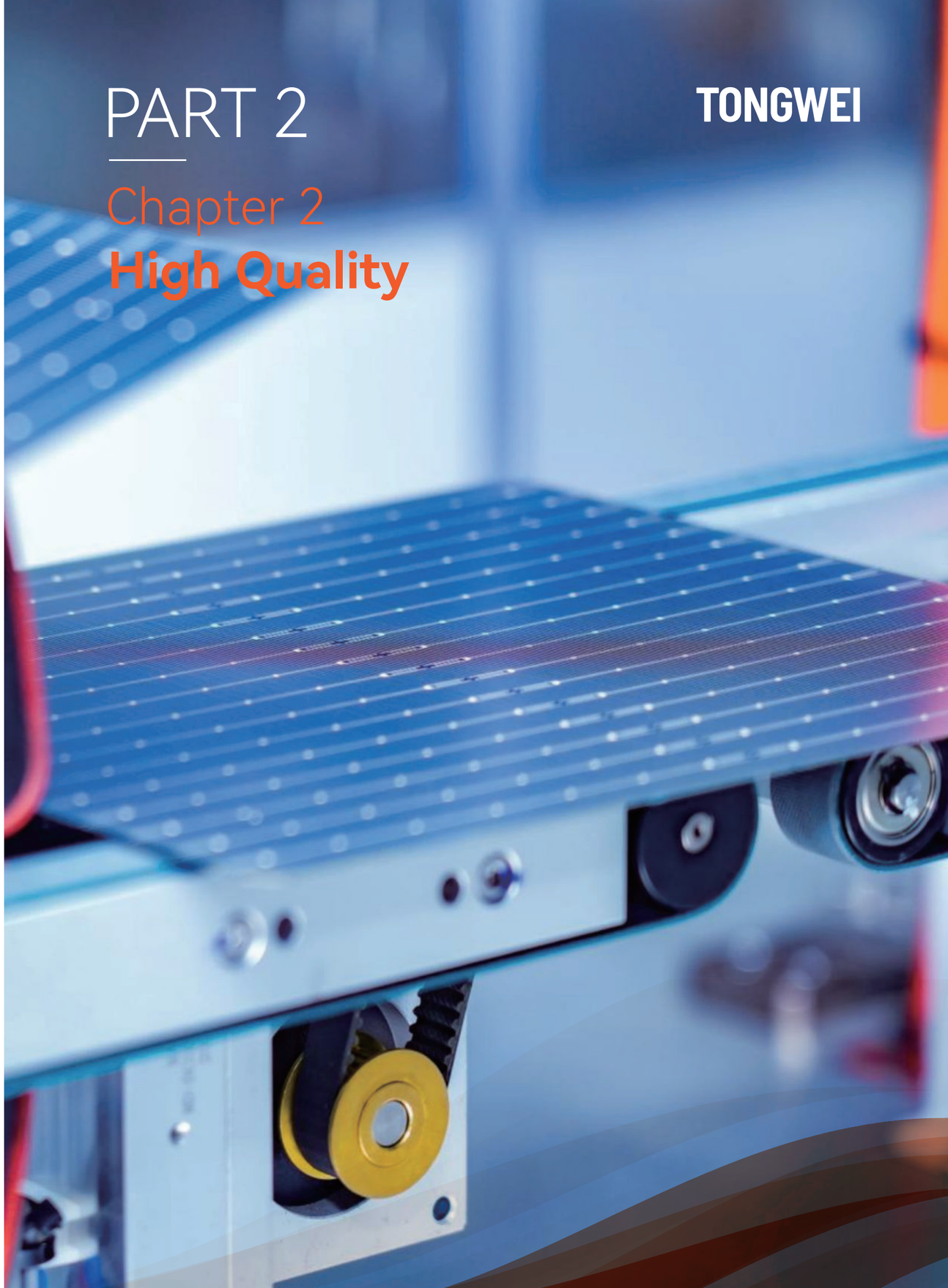
1.3.2 Corporate Culture of TW Solar

Corporate Mission

PV changes the world

Corporate Vision

Build a world-class clean energy enterprise
Let solar energy benefit mankind



PART 2

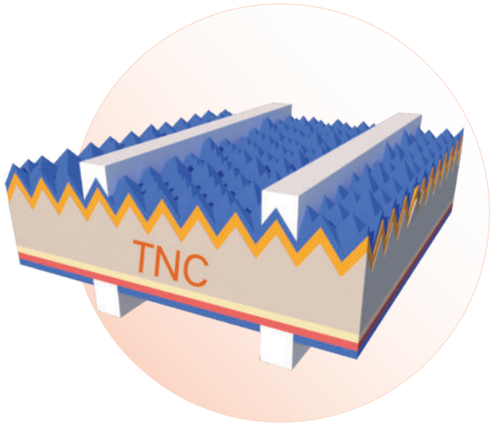
Chapter 2
High Quality

TONGWEI

2.1 Tongwei Gene

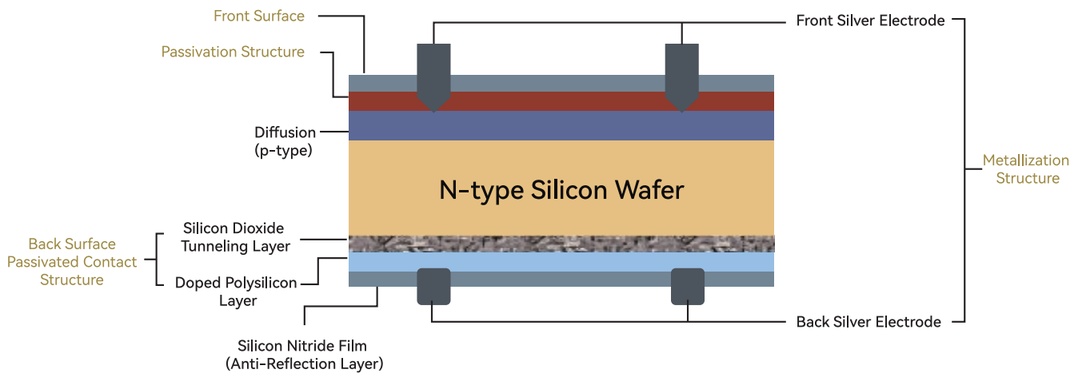
2.1.1 TNC Cell: Product Background

TNC (Tongwei N-type Passivated Contact Technology) refers to a high-efficiency N-type passivated contact cell technology independently developed by Tongwei. Tongwei started the development of TNC technology in 2020, established the industry's first 210mm large-size PECVD-Poly cell pilot line in 2021, pioneering the industrial application of large-size PE-Poly technology, and bridging a key technological gap.



In 2023, Tongwei's TNC technology was successfully included in the 2023 Catalogue of Photovoltaic Industry Innovation Achievements due to its industry-first breakthroughs and technical leadership. It remains the only listed N-type passivated contact cell technology, distinguished by its superior customer value, product performance, and mass production feasibility.

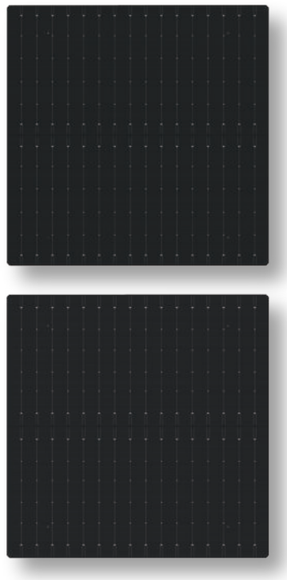
In 2025, Tongwei upgraded TNC technology and launched TNC 2.0 product series, forming an innovative product closed loop of "core process breakthrough, manufacturing system upgrade, product performance leap."



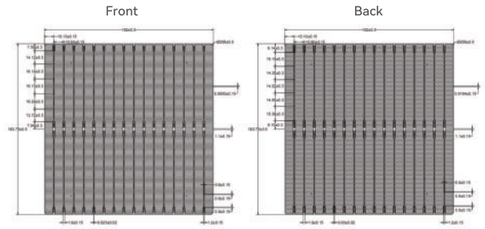
2.1.2 TNC Cell Product Overview

TNC "Tongwei Gene" cell products are designed based on the SMBB (Super Multi-Busbar) cell technology platform and cover the mainstream sizes (M10, G12R, and G12).

TNC -M10



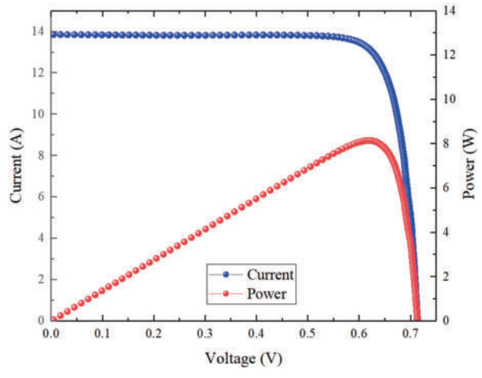
Product Appearance (mm)



Product Design

Dimension	182±0.5*183.75±0.5mm Φ256mm±0.5mm	TkVoltage: -(0.255±0.010)%/K
Thickness	130±13μm	TkCurrent: +(0.041±0.004)%/K
Front	16 busbars (silver), 192 fingers Blue anti-reflective coating (silicon nitride)	TkPower: -(0.305±0.025)%/K
Back	16 busbars (silver), 200 fingers Blue anti-reflective coating (silicon nitride)	Rsh≥50Ω Irev2≤0.5A

IV Curve



Front Electrical Performance Parameters

Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
25.7	8.60	0.635	13.550	0.722	14.119	84.38
25.6	8.57	0.634	13.525	0.721	14.101	84.28
25.5	8.54	0.633	13.488	0.720	14.087	84.15
25.4	8.50	0.632	13.454	0.719	14.066	84.06
25.3	8.47	0.631	13.423	0.719	14.031	83.95
25.2	8.43	0.630	13.387	0.718	14.005	83.88
25.1	8.40	0.629	13.359	0.717	13.983	83.79
25.0	8.37	0.628	13.325	0.716	13.969	83.66
24.9	8.33	0.628	13.272	0.715	13.956	83.51
24.8	8.30	0.627	13.236	0.714	13.936	83.42
24.7	8.27	0.626	13.203	0.713	13.917	83.32
24.6	8.23	0.625	13.174	0.711	13.910	83.26
24.5	8.20	0.623	13.163	0.709	13.906	83.18

Back Electrical Performance Parameters

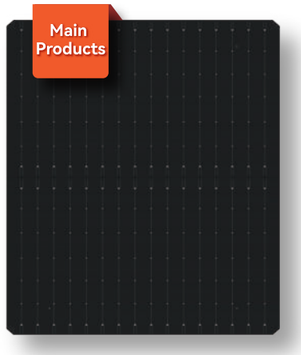
Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
> 20.5	6.86	0.589	11.644	0.692	12.932	76.68
20.3-20.5	6.79	0.587	11.569	0.691	12.866	76.43
20.1-20.3	6.73	0.584	11.527	0.690	12.819	76.10
< 20.1	6.69	0.582	11.496	0.689	12.799	75.87

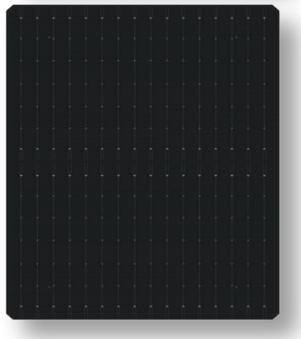
STC (Standard Testing Conditions): 1000W/m², AM1.5, 25°C

26.08.05

Statement: With technological progress and product iteration, deviations may exist between the technical parameters of Tongwei's cell products and those stated in the specification. Tongwei reserves the right to adjust technical parameters at any time without prior notice to customers. The final interpretation of the technical specification shall vest in Tongwei.

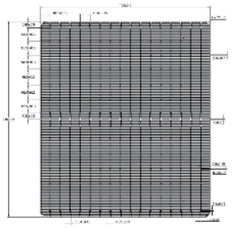
TNC -G12R



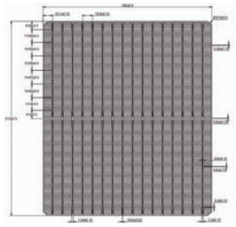


Product Appearance (mm)

Front



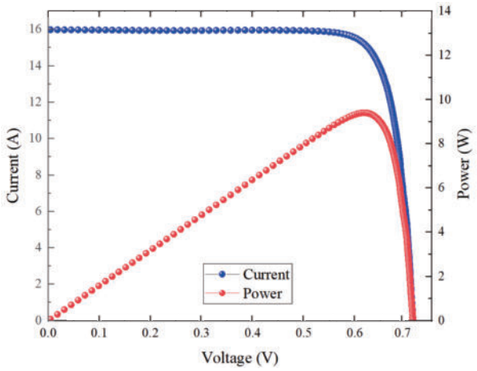
Back



Product Design

Dimension	182mm*210mm±0.5mm Φ272±0.5mm	TkVoltage: -(0.25±0.010)%/K
Thickness	130±13μm	TkCurrent: +(0.04±0.004)%/K
Front	16 busbars (silver), 310 fingers Blue anti-reflective coating (silicon nitride)	TkPower: -(0.29±0.025)%/K
Back	16 busbars (silver), 252 fingers Blue anti-reflective coating (silicon nitride)	Rsh≥50Ω Irev2≤0.5A

IV Curve



Front Electrical Performance Parameters

Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
26.1	9.97	0.628	15.875	0.745	15.987	83.71
26.0	9.93	0.627	15.831	0.744	15.961	83.59
25.9	9.89	0.627	15.768	0.744	15.938	83.41
25.8	9.85	0.626	15.734	0.743	15.919	83.30
25.7	9.81	0.625	15.695	0.742	15.906	83.16
25.6	9.78	0.624	15.672	0.740	15.891	83.14
25.5	9.74	0.623	15.636	0.739	15.872	83.01
25.4	9.70	0.622	15.590	0.738	15.868	82.83
25.3	9.66	0.621	15.553	0.737	15.861	82.64
25.2	9.62	0.620	15.517	0.736	15.851	82.48
25.1	9.58	0.619	15.480	0.735	15.842	82.30
25.0	9.55	0.618	15.453	0.734	15.826	82.20
24.9	9.51	0.617	15.406	0.733	15.824	81.98
24.8	9.47	0.616	15.369	0.732	15.820	81.78
24.7	9.43	0.615	15.332	0.731	15.813	81.59
24.6	9.39	0.614	15.295	0.730	15.811	81.38

Back Electrical Performance Parameters

Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
≥ 21.5	8.21	0.620	13.242	0.735	13.408	83.31
21.0-21.5	8.02	0.614	13.062	0.730	13.258	82.87
20.5-21.0	7.83	0.609	12.857	0.725	13.213	81.74
< 20.5	7.64	0.604	12.649	0.720	13.177	80.53

STC (Standard Testing Conditions): 1000W/m², AM1.5, 25℃

26.08.05

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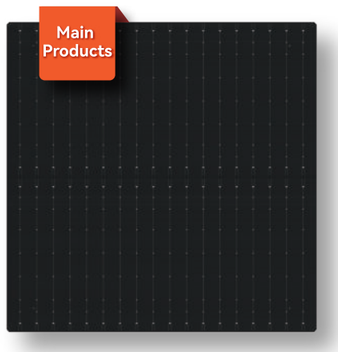
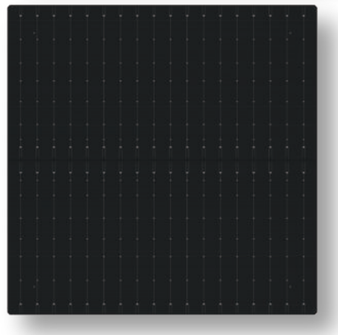
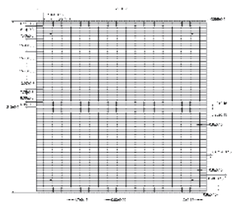
TNC -G12



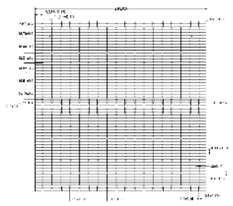


Product Appearance (mm)

Front



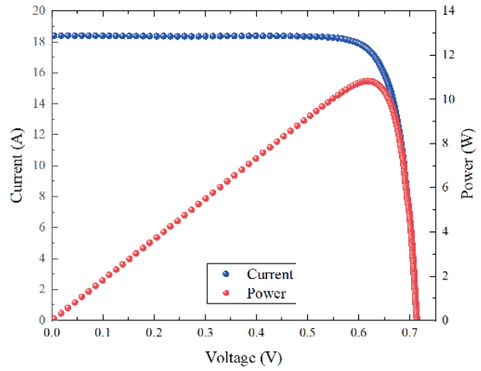
Back



Product Design

Dimension	210mm*210mm±0.5mm Φ295±0.5mm	TkVoltage: -(0.25±0.01)%/K
Thickness	130±13μm	TkCurrent: +(0.04±0.004)%/K
Front	18 busbars (silver), 240 fingers Anti-reflective coating (silicon nitride)	TkPower: -(0.29±0.025)%/K
Back	18 busbars (silver), 232 fingers Anti-reflective coating (silicon nitride)	Rsh≥50Ω Irev2≤0.5A

IV Curve



Front Electrical Performance Parameters

Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
26.4	11.64	0.657	17.719	0.736	18.515	85.43
26.3	11.60	0.657	17.652	0.736	18.503	85.16
26.2	11.55	0.656	17.611	0.736	18.484	84.92
26.1	11.51	0.656	17.544	0.736	18.469	84.67
26.0	11.46	0.656	17.477	0.735	18.442	84.58
25.9	11.42	0.656	17.410	0.735	18.437	84.28
25.8	11.38	0.656	17.342	0.735	18.426	84.00
25.7	11.33	0.655	17.302	0.735	18.417	83.72
25.6	11.29	0.655	17.235	0.734	18.408	83.55
25.5	11.24	0.655	17.167	0.734	18.394	83.28
25.4	11.20	0.655	17.100	0.734	18.383	83.01
25.3	11.16	0.654	17.058	0.734	18.366	82.76
25.2	11.11	0.654	16.991	0.733	18.351	82.61
25.1	11.07	0.654	16.923	0.733	18.339	82.33

Back Electrical Performance Parameters

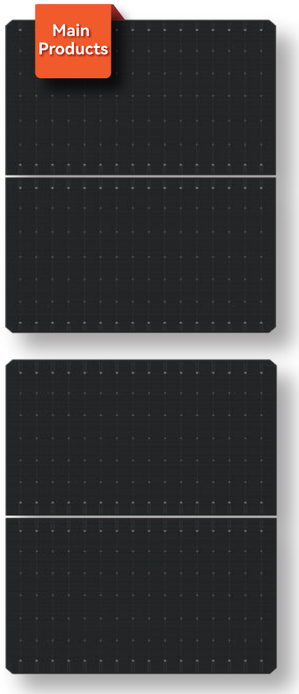
Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
≥ 21.5	9.48	0.621	15.266	0.722	16.052	81.80
21.0-21.5	9.26	0.619	14.960	0.722	16.034	79.99
20.5-21.0	9.04	0.618	14.628	0.721	16.022	78.26
< 20.5	8.82	0.616	14.317	0.72	16.004	76.54

STC (Standard Testing Conditions): 1000W/m², AM1.5, 25℃

26.08.05

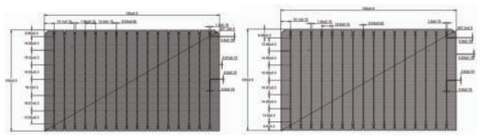
Statement: With technological progress and product iteration, deviations may exist between the technical parameters of Tongwei's cell products and those stated in the specification. Tongwei reserves the right to adjust technical parameters at any time without prior notice to customers. The final interpretation of the technical specification shall vest in Tongwei.

TNC 2.0 -G12R



Product Appearance(mm)

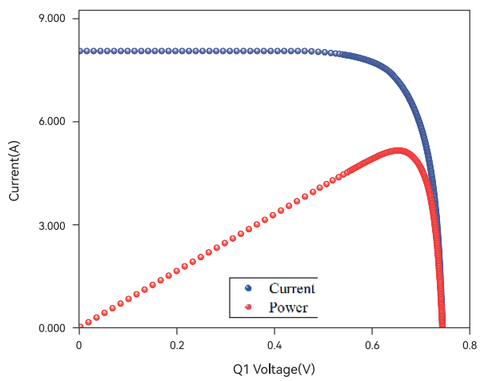
Front Back



Product Design

Dimension	182±0.5*105±0.5mm Φ207.3±0.5mm	TkVoltage: -(0.25±0.01)%/K
Thickness	130±13μm	TkCurrent: +(0.04±0.004)%/K
Front	16 busbars (silver), 155 fingers Blue anti-reflective coating (silicon nitride)	TkPower: -(0.29±0.025)%/K
Back	16 busbars (silver), 126 fingers Blue anti-reflective coating (silicon nitride)	Rsh≥50Ω, Irev2≤0.5A

IV Curve



Front Electrical Performance Parameters

Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
26.7	5.10	0.633	8.053	0.740	8.215	83.84
26.6	5.08	0.633	8.023	0.740	8.191	83.79
26.5	5.06	0.632	8.005	0.739	8.177	83.73
26.4	5.04	0.632	7.975	0.739	8.156	83.62
26.3	5.02	0.631	7.958	0.739	8.138	83.49
26.2	5.00	0.630	7.940	0.739	8.118	83.37
26.1	4.98	0.629	7.922	0.739	8.106	83.18
26.0	4.96	0.628	7.904	0.738	8.100	83.03
25.9	4.94	0.627	7.879	0.738	8.086	82.85
25.8	4.93	0.626	7.869	0.738	8.070	82.72
25.7	4.91	0.625	7.851	0.737	8.062	82.58
25.6	4.89	0.624	7.833	0.737	8.050	82.39
25.5	4.87	0.623	7.815	0.737	8.043	82.12
25.4	4.85	0.622	7.796	0.737	8.031	81.94
25.3	4.83	0.621	7.778	0.736	8.026	81.77

Back Electrical Performance Parameters

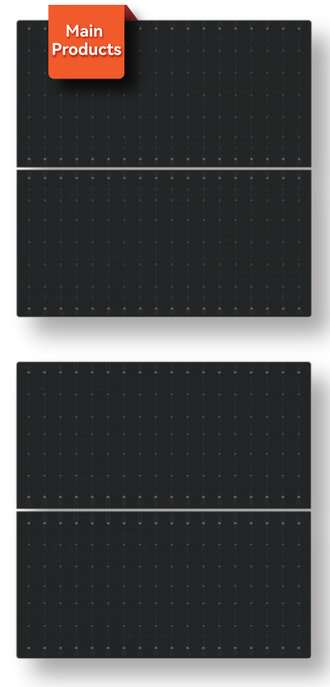
Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
> 22.5	4.36	0.590	7.387	0.701	7.2932	85.28
21.5-22.0	4.13	0.580	7.117	0.695	7.2697	81.80
21.0-21.5	4.03	0.571	7.054	0.695	7.1954	80.63
< 21.0	3.95	0.565	6.988	0.693	7.1534	79.71

STC (Standard Testing Conditions): 1000W/m², AM1.5, 25℃

26.08.05

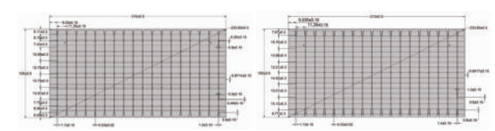
Statement: With technological progress and product iteration, deviations may exist between the technical parameters of Tongwei's cell products and those stated in the specification. Tongwei reserves the right to adjust technical parameters at any time without prior notice to customers. The final interpretation of the technical specification shall vest in Tongwei.

TNC 2.0 -G12



Product Appearance(mm)

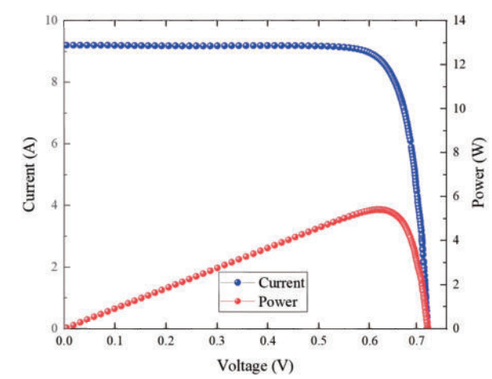
Front Back



Product Design

Dimension	210*105±0.5mm Φ233.85±0.5mm	TkVoltage: -(0.25±0.01)%/K
Thickness	130±13μm	TkCurrent: +(0.04±0.004)%/K
Front	18 busbars (silver), 120 fingers Blue anti-reflective coating (silicon nitride)	TkPower: -(0.29±0.025)%/K
Back	18 busbars (silver), 116 fingers Blue anti-reflective coating (silicon nitride)	Rsh≥50Ω, Irev2≤0.5A

IV Curve



Front Electrical Performance Parameters

Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
26.4	5.82	0.656	8.871	0.744	9.281	84.28
26.3	5.80	0.656	8.841	0.742	9.277	84.25
26.2	5.78	0.655	8.821	0.742	9.252	84.16
26.1	5.75	0.655	8.786	0.742	9.245	83.89
26.0	5.73	0.655	8.753	0.741	9.231	83.82
25.9	5.71	0.655	8.719	0.741	9.229	83.51
25.8	5.69	0.655	8.684	0.741	9.223	83.23
25.7	5.67	0.654	8.664	0.741	9.219	82.95
25.6	5.64	0.654	8.631	0.740	9.214	82.79
25.5	5.62	0.654	8.597	0.740	9.202	82.57
25.4	5.60	0.654	8.562	0.740	9.202	82.23
25.3	5.58	0.653	8.544	0.740	9.193	82.01
25.2	5.56	0.653	8.510	0.739	9.186	81.86
25.1	5.53	0.653	8.475	0.739	9.180	81.58

Back Electrical Performance Parameters

Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
≥ 21.5	4.74	0.622	7.621	0.723	8.031	81.64
21.0-21.5	4.63	0.620	7.468	0.723	8.022	79.83
20.5-21.0	4.52	0.619	7.303	0.722	8.016	78.11
< 20.5	4.41	0.617	7.147	0.721	8.007	76.38

STC (Standard Testing Conditions): 1000W/m², AM1.5, 25℃

26.08.05

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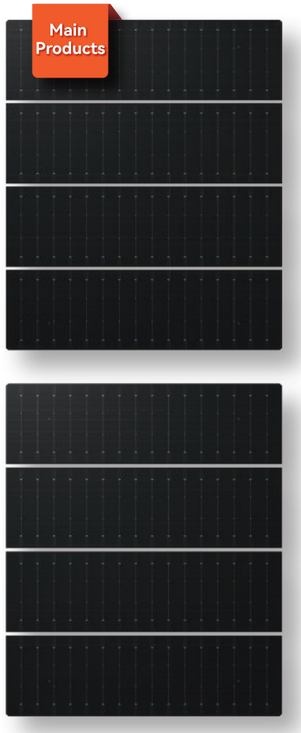
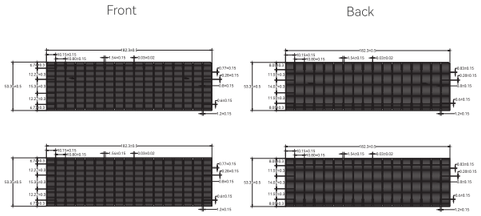
TNC 3.0 -G12R



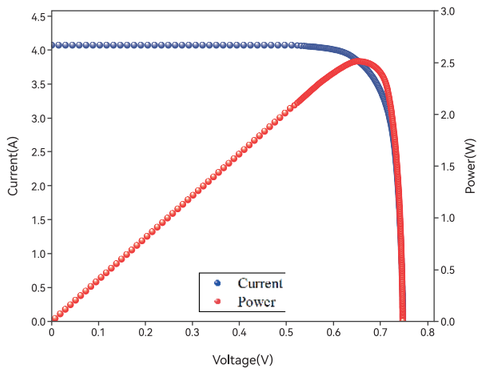
Product Appearance (mm)



Product Design

Dimension	182.55*53.35±0.5mm	TkVoltage: -(0.25±0.01)%/K
Thickness	130±20 μm	TkCurrent: +(0.04±0.004)%/K
Front	16 busbars (silver), 69 fingers Anti-reflective coating (silicon nitride)	TkPower: -(0.29±0.025)%/K
Back	16 busbars (silver), 64 fingers Anti-reflective coating (silicon nitride)	Rsh≥50Ω, Irev2≤0.5A

IV Curve



Front Electrical Performance Parameters

Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
26.8	2.61	0.661	3.948	0.745	4.107	85.29
26.7	2.60	0.66	3.939	0.744	4.105	85.12
26.6	2.59	0.659	3.931	0.744	4.102	84.88
26.5	2.58	0.658	3.922	0.744	4.099	84.62
26.4	2.57	0.657	3.913	0.743	4.096	84.47
26.3	2.56	0.656	3.904	0.743	4.094	84.19
26.2	2.55	0.656	3.890	0.743	4.091	83.95
26.1	2.54	0.656	3.874	0.743	4.087	83.69
26.0	2.53	0.655	3.866	0.742	4.081	83.62
25.9	2.52	0.654	3.856	0.742	4.085	83.20

Back Electrical Performance Parameters

Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
≥ 22.8	2.22	0.632	3.513	0.733	3.553	85.25
22.7	2.21	0.631	3.503	0.731	3.548	85.23
22.6	2.20	0.630	3.494	0.732	3.542	84.90
< 22.5	2.19	0.629	3.484	0.730	3.541	84.78

STC (Standard Testing Conditions): 1000W/m², AM1.5, 25℃

26.08.05

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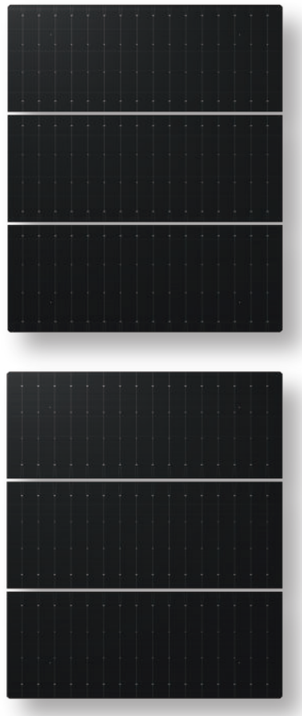
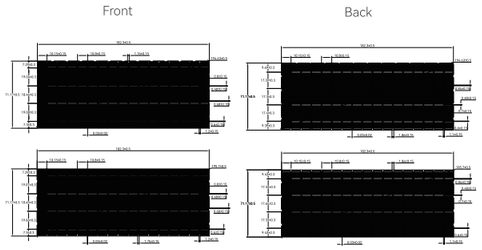
TNC 3.0 -G12R



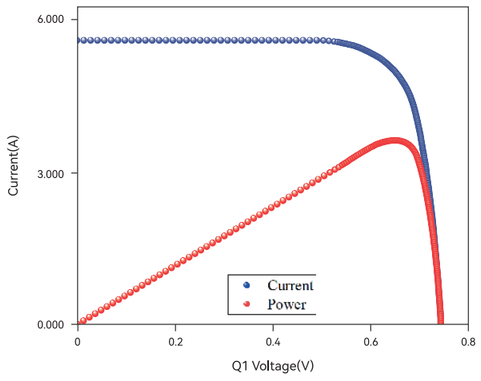
Product Appearance (mm)



Product Design

Dimension	182.3mm*71.17mm±0.5mm Φ194.63mm±0.5mm, Φ195.7mm±0.5mm	TkVoltage: -(0.25±0.01)%/K
Thickness	130±13μm	TkCurrent: +(0.04±0.004)%/K
Front	16 busbars , 104 fingers Anti-reflective coating (silicon nitride)	TkPower: -(0.29±0.025)%/K
Back	16 busbars , 84 fingers Anti-reflective coating (silicon nitride)	Rsh≥50Ω Irev2≤0.5A

IV Curve



Front Electrical Performance Parameters

Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
26.6	3.45	0.633	5.452	0.740	5.579	83.60
26.5	3.44	0.632	5.440	0.739	5.568	83.56
26.4	3.43	0.632	5.420	0.739	5.555	83.46
26.3	3.41	0.631	5.408	0.739	5.540	83.35
26.2	3.40	0.630	5.396	0.739	5.526	83.24
26.1	3.39	0.629	5.383	0.739	5.520	83.01
26.0	3.37	0.628	5.371	0.738	5.517	82.85
25.9	3.36	0.627	5.359	0.738	5.506	82.69
25.8	3.35	0.626	5.347	0.738	5.496	82.52
25.7	3.33	0.625	5.335	0.737	5.493	82.36
25.6	3.32	0.624	5.323	0.737	5.482	82.20
25.5	3.31	0.623	5.310	0.737	5.479	81.93
25.4	3.30	0.622	5.298	0.736	5.475	81.78
25.3	3.28	0.621	5.286	0.736	5.470	81.53

Back Electrical Performance Parameters

Eff (%)	Pmpp (W)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)	FF (%)
> 23.5	3.10	0.595	5.208	0.704	5.146	85.53
22.5-23.0	2.94	0.585	5.030	0.698	5.137	82.07
22.0-22.5	2.87	0.576	4.990	0.698	5.090	80.91
< 22.0	2.82	0.571	4.939	0.696	5.066	79.99

STC (Standard Testing Conditions): 1000W/m² , AM1.5G, 25℃

26.08.05

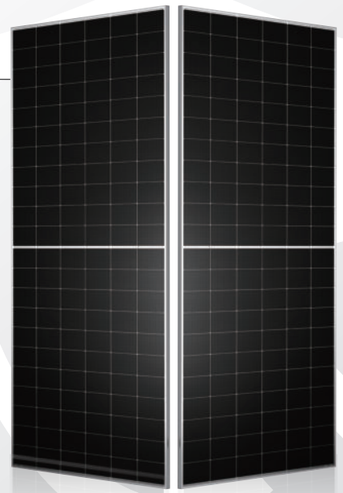
Statement: With technological progress and product iteration, deviations may exist between the technical parameters of Tongwei's cell products and those stated in the specification. Tongwei reserves the right to adjust technical parameters at any time without prior notice to customers. The final interpretation of the technical specification shall vest in Tongwei.

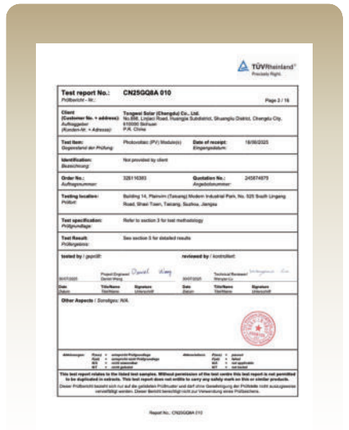
2.1.3 Tongwei TNC Cells: Enabling High-Reliability Module Products

"Tongwei Intelligent Manufacturing: Safe and Reliable". Tongwei modules equipped with TNC cells meet twice the requirements of the IEC reliability standards, thus positioning them at the industry's forefront.

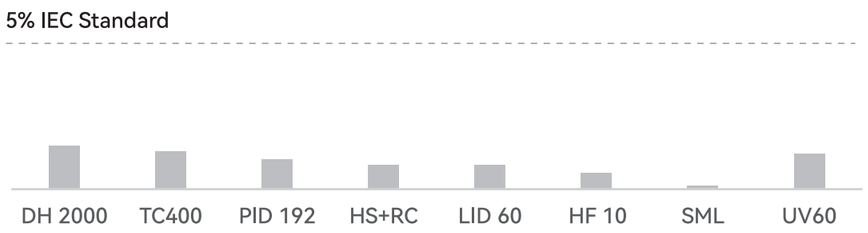
TNC Module

TNC series modules are equipped with TNC cells and multiple cell quality and efficiency enhancement technologies. Tongwei module products undergo stringent reliability tests, with all performance metrics enforced according to Tongwei's internal control standards that double the requirements of IEC standards, achieving benchmark-level performance in the industry.





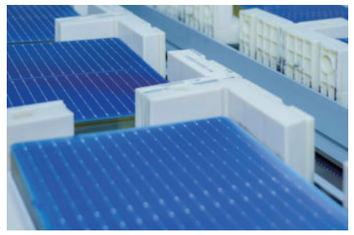
Reliability Certified, Trusted Globally (TÜV Rheinland Certification)

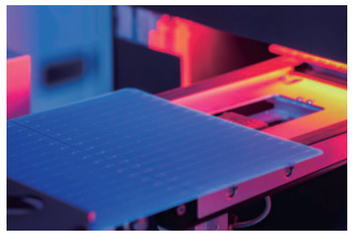


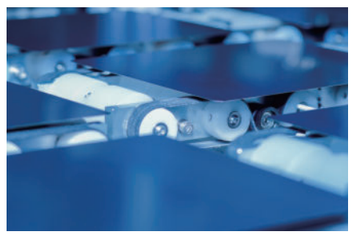
Reliability Performance of TNC Products (Power Degradation: %)

2.2 Smart Factory

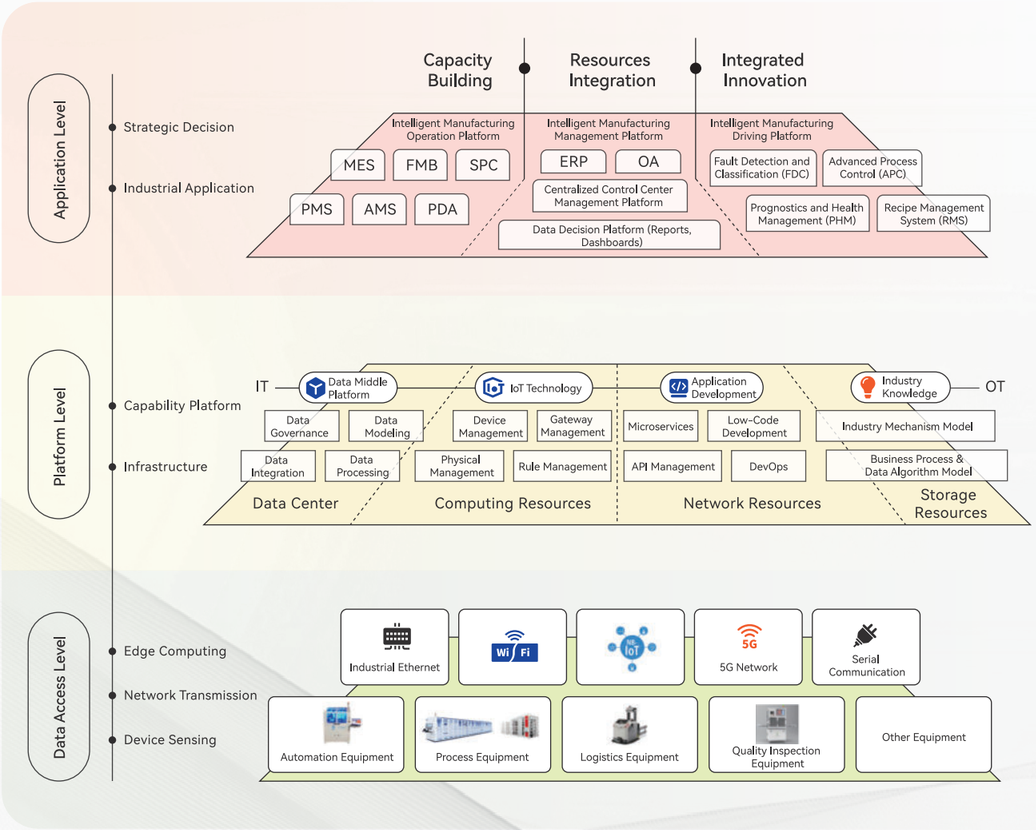
Centering around the construction of smart factories, TW Solar continuously promotes the digital and intelligent upgrading of its production system. Through automated equipment collaboration, real-time collection and intelligent analysis of production data, it achieves efficient collaboration and lean management and control in the manufacturing process, continuously improves product consistency, production efficiency and operational stability, and provides solid support for large-scale and high-quality manufacturing.







2.2.1 Overall Architecture of the Digital Intelligent Factory and the "1+1+3+3" Strategy



* Overall Architecture of the Digital Intelligent Factory of TW Solar

"1" Foundational Platform

The Company has established an industrial internet foundational platform encompassing infrastructure, a data middle platform, IoT technology, application development, and integrated industry knowledge. It aims to achieve three key enhancement objectives: informatization foundation, core platform, and collaborative integration, thereby supporting the efficient development and operation of industrial applications.

"1" Access System

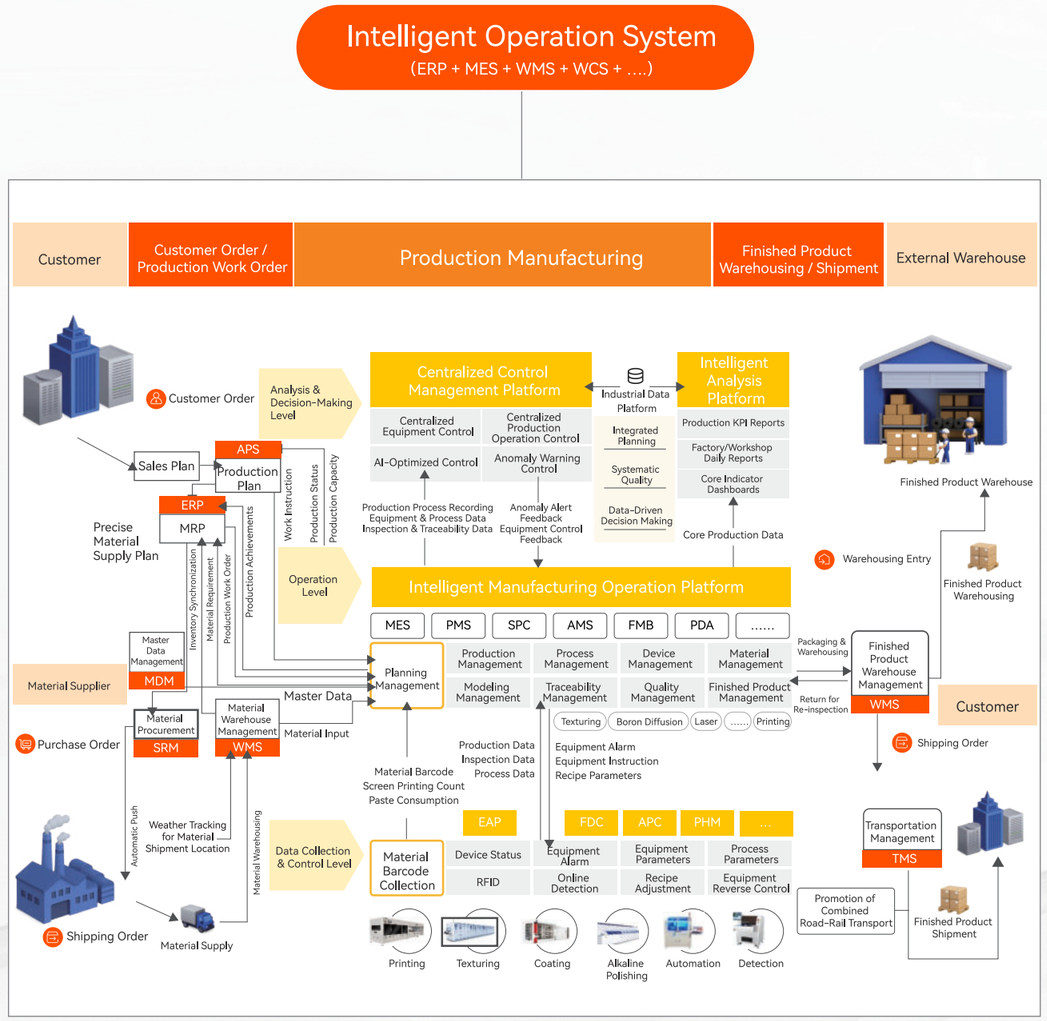
Through the EAP system and digital transformation of equipment, the Company has unified the equipment access standards and specifications to achieve data collection and cell-level traceability. It has also built an industrial control network to enable rapid access and interconnection of automated equipment, process equipment, inspection equipment, and other devices.

"3" Improvement Stages

The entire digital transformation process progresses through three enhancement stages: capability building, resource integration, and integrated innovation, accompanied by organizational optimization and transformation within the Company.

"3" Intelligent Manufacturing Application Platforms

Starting from the improvement of digital basic capabilities and based on the industrial Internet platform, the transformation and upgrading of the enterprise's intelligent manufacturing has been promoted through the three major application segments of intelligent manufacturing operation, management, and empowerment, which are formed based on the integration of existing systems and the development of new industrial applications.



*** TW Solar Intelligent Platform**

2.2.2 TW Solar: Industry 4.0 Cell Production Workshop

As a company dedicated to integrating the entire PV industry chain as the new "King of PV," Tongwei Co., Ltd. demonstrates industry-leading comprehensive strength in TNC cell manufacturing technology. As early as mid-2021, Tongwei pioneered the industry's first PECVD Poly deposition N-type cell technology route compatible with large-size cells, achieving large-scale mass production in 2022. Tongwei's cell production lines fully adopt an Industry 4.0 intelligent manufacturing system, ensuring standardized, unified, and automated product manufacturing processes, with products being safe, stable, and highly reliable.

Digital Production Workshop in the Industry 4.0 Smart Park

200+
Intelligent Manufacturing Lines

3000+
Intelligent Transport Robots

Industry 4.0
High-Efficiency Automated Cell Production Line

Globally Leading
5G Application Base in the PV Industry

5G Dedicated Frequency Band
Stability up to 99.999%

2.2.3 Panoramic View of Digital Use Cases

Cost Reduction

- Full-process multi-objective intelligent scheduling based on operational research models
- Flexible rework processing based on AOI image recognition and AGV collaboration
- Tubular equipment automatic closed-loop optimization

Workshop mechanical gauge automatic inspection system

Automatic handling system for graphite boats

Automatic handling system for quartz boats

Automatic unpacking machine

FQC finished product automatic collection machine

Coating vacuum pump exhaust automatic control system

In-house production of desktop paper

Cleaning equipment hydrogen content automatic detection and control system

Efficiency Improvement

- End-to-end cell efficiency optimization driven by billion-level big data models
- Closed-loop efficiency control based on intelligent analysis
- Deep learning models for optimizing the use of high-value materials

Intelligent management for predicting the lifespan of high-value consumables

Wafer ID traceability at the cell level based on data collection

Digital monitoring and automated implementation of key processes

- Intelligent inspection of process parameters

Square resistance model prediction

- SMBB testing renovation project

Quality Control

- Intelligent detection of coating thickness based on CNN/DNN and optimization control empowered by big data.
- Closed-loop management of quality issues based on wafer-level tracking
- Monitoring system for incoming material quality across the entire process
- Advanced process anomaly diagnosis
- Comprehensive image diagnosis across the entire process
- Big data EL intelligent image sorting
- EL intelligent reconfirmation

Automated screen inspection

Automatic square resistance test and analysis

Automatic weight loss test and analysis

Equipment

- Digital energy management system based on advanced analytics
- Equipment OEE management based on GenAI expert systems
- Diagnosis based on equipment proactive alarms
- Machine health assessment and predictive maintenance recommendations

Alert notification push to functional wristbands

Electronic process work orders

Supply Chain

- Intelligent palletizing of cell products
- IGV trolley process material transfer
- Outdoor 5G unmanned forklifts
- Smart Park Management
- Intelligent warehousing management

Smart financial management

- Digital ERP4.0

Plant & EHS

- Factory intelligent operation and maintenance system

EHS safety platform

Timely push of alarm information

- Energy management system

Water balance system

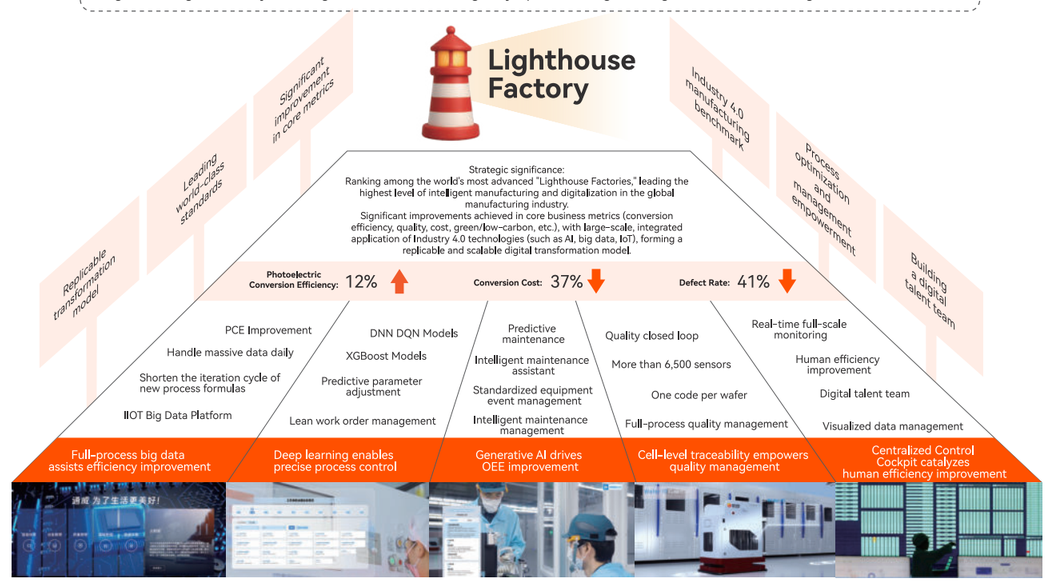
Efficiency improvement of the refrigeration system

Consumable consignment management system

Intelligent Office

- PV Cloud Disk
- i Tongwei
- Innovation Center
- FBC Process Center
- PV Learning Center

Through outstanding practices in intelligent manufacturing and excellent enterprise management, we have built an Industry 4.0 digital intelligent factory, creating a data-driven, intelligently operated "Digital Tongwei" and "Smart Tongwei."

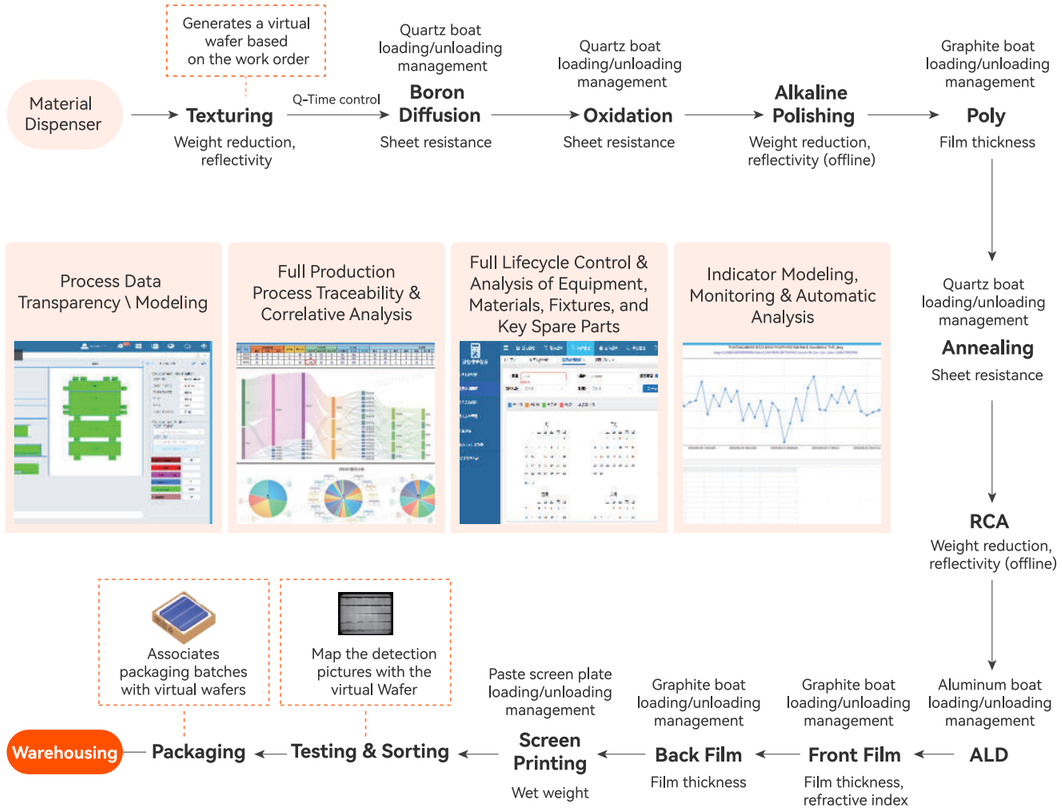


* TW Solar Lighthouse Factory Intelligent Manufacturing System Diagram

Cell-Level Traceability

Traditional solar cell traceability operates at the batch or cassette level, resulting in data that is too coarse to pinpoint specific issues. Analyzing and investigating anomalies requires lengthy manual backtracking, hindering rapid root cause analysis.

TW Solar has developed a Wafer-Level Traceability Management System. Through real-time interaction between EAP and equipment, the MES generates virtual IDs for wafers based on predefined rules. It tracks the physical location changes of wafers relative to their virtual IDs, creating comprehensive production records for cells.



* TW Solar Single-cell Traceability Management System

This system achieves information traceability down to the individual cell level, capable of pinpointing the specific furnace tube and boat used. It integrates all production data for each cell up to the point of in-factory testing and sorting:

1. On-site personnel can use the single-cell traceability system to quickly locate the position of abnormal cells , enabling rapid response. The average time for root cause localization is <30 seconds. This system significantly improves the accuracy of defect tracking, allowing for timely investigation and handling of anomalies, thereby reducing the continuous production of defective products during the localization period.

2. The system continuously collects big data correlating "product characteristics" with "process characteristics," providing high-quality data support for building and training AI models. It drives the continuous optimization of process and production models, aiding the company's cost reduction and efficiency improvement initiatives.

2.2.4 Case Study of Lean Management

Cases of Improving Cell Efficiency

Improving cell efficiency is a core objective in PV cell manufacturing, and the approaches to achieve this goal are diverse.

Broadly speaking, there are four main dimensions:

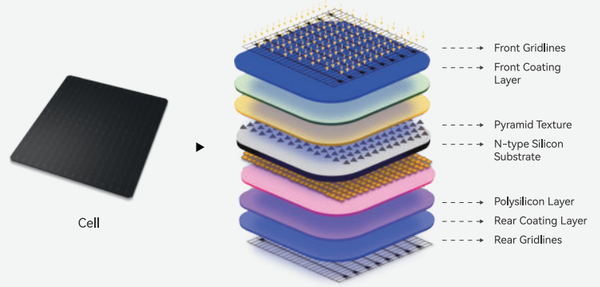
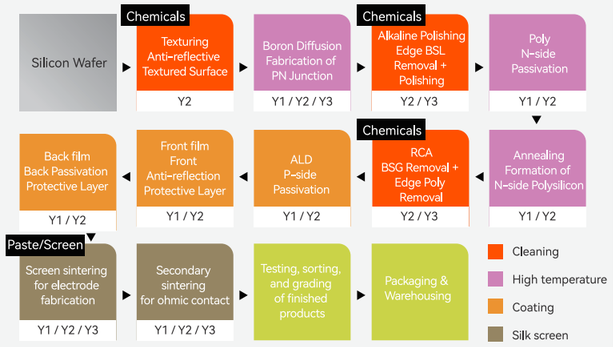
1. Optimization of structure and materials at the design end
2. Technological optimization and innovation at the process end
3. Optimization and stabilization of process parameters at the manufacturing end
4. Collaborative optimization of the supply chain

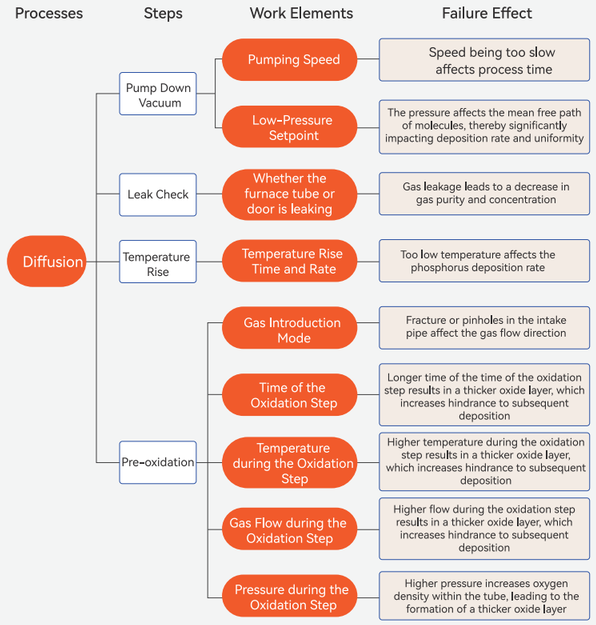
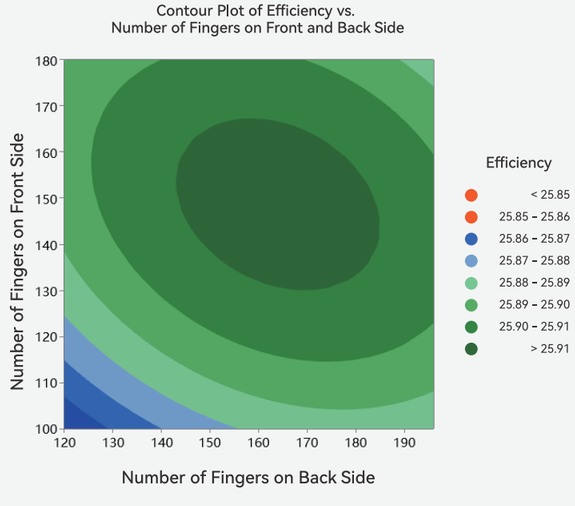
This case study discusses how to improve efficiency from the manufacturing dimension, while also considering the impact on metrics such as UV reliability and wet weight.

Solution Logic:

1. Explode the cell structure 2. Identify corresponding efficiency factors 3. Pinpoint the range of manufacturing processes and process factors for improvement. 4. Verify the impact on efficiency

Core Tool Recommendations: Exploded view diagram + Microscopic flowchart + Source of Variation (SOV) analysis + Hypothesis testing + Design of Experiments (DOE)

Methodology	Techniques	Tools	Example
D	Definition and Decomposition of Target Y (Efficiency)		Y: Conversion Efficiency = $\frac{\text{Cell power}}{\text{Cell area} \times \text{Illumination intensity}} = \frac{\text{Open-Circuit Voltage (Voc)} \times \text{Short-Circuit Current (Isc)} \times \text{Fill Factor (FF)}}{\text{Cell area} \times \text{Illumination intensity}}$ Note: The cell area and the illumination intensity per unit area are fixed values.
M	Analyze the Cell Structures Related to Target Y (Efficiency) Analyze the main structures affecting Y1: Voc (Open-Circuit Voltage) Analyze the main structures affecting Y2: Isc (Short-Circuit Current) Analyze the main structures affecting Y3: FF (Fill Factor) **Based on the cell structures affecting efficiency, identify the relevant manufacturing processes and prioritize them to define the project scope.**	Exploded View Diagram Flowchart	 

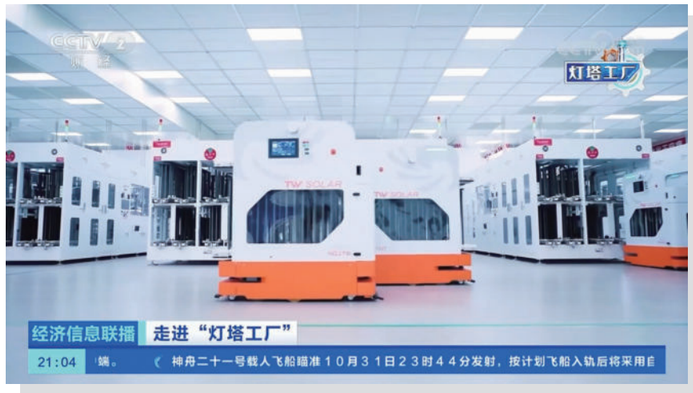
A	Identifying efficiency impact factors (Xs) from a professional perspective, integrating process principles for each segment	System Diagram	
I	Screening and Identifying Key Factors (Xi)	Hypothesis testing for SOV analysis	/
C	Response optimization to find the optimal parameter combination	Regression analysis, design of experiments (DOE), etc.	

Primary reference: 2023 Q3 Meishan Company TOPCon SE Efficiency Improvement Project. (Internal document, used with authorization)

2.2.5 Tongwei's "Lighthouse Factory"

On September 16, the World Economic Forum (WEF) unveiled its latest batch of "Lighthouse Factory" designations, with 12 new factories worldwide earning this prestigious recognition. Among them, Meishan Company stands out as the sole representative from the global PV industry in this cohort, marking the birth of the first "Lighthouse Factory" in the global PV cell manufacturing sector. This achievement not only represents the first "Lighthouse Factory" among local enterprises in Sichuan Province also signifies that China's PV industry has once again taken the lead globally in intelligent manufacturing and digital transformation.

Meishan Company has deployed over 50 Fourth Industrial Revolution (4IR) application cases, most of which are based on artificial intelligence: utilizing machine learning for process optimization, leveraging generative AI for maintenance, and employing advanced AI algorithms for defect analysis. This transformation has increased the cell photoelectric conversion efficiency by 12%, reduced the defect rate by 41%, lowered conversion costs by 37%, and decreased carbon dioxide emissions by 33%.



CCTV Finance Highlights Tongwei Solar Meishan's "Lighthouse Factory" in Its Visiting "Lighthouse Factories" Series (Oct 30, 2025).

PART 3

Chapter 3

High Efficiency

3.1 Leading the Industry

3.1.1 Core Manufacturing Technologies

Tongwei N-Type Cell Technology

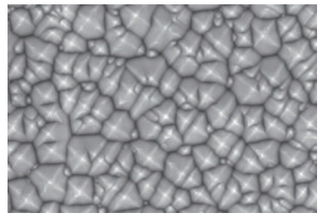
TNC cells use N-type silicon wafers as substrates, which display excellent minority carrier lifetime and strong resistance to light-induced degradation. The front surface is coated with SiN_x anti-reflective coating (ARC) and AlO_x passivation layer to optimize light absorption and surface passivation. The back surface incorporates a passivated contact structure, consisting of an ultra-thin tunneling silicon oxide layer and a doped polysilicon layer, significantly reducing surface recombination and metal contact recombination while improving conversion efficiency.

Three Key Characteristics of Tongwei **TNC** Cells

Core Technologies in TNC Cell Manufacturing

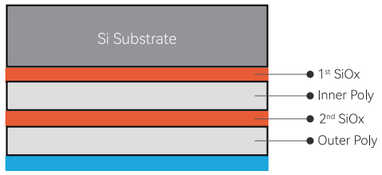
Since the mass production of the TNC series began in 2022, TW Solar has continuously optimized its independently developed N-type cell platform, achieving remarkable results in conversion efficiency and reliability.

Advanced Texturing Technology



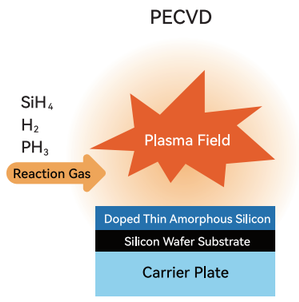
Tongwei's independently developed advanced secondary texturing technology effectively optimizes the pyramid microstructure on the cell surface, resulting in a more uniform distribution, reducing reflectivity to below 9%, thereby enhancing the light absorption capacity and improving the cell efficiency.

Dual Tunneling Technology



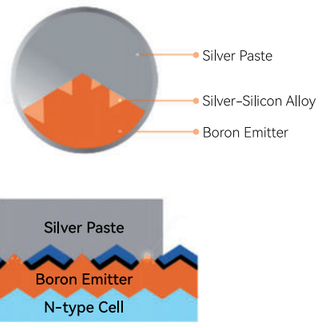
The duel tunneling technology effectively reduces the risk of film explosion and the internal diffusion of doped atoms. The ratio of cells with light-dark variation decreases by over 50%, the efficiency increases by 0.05%, and at the same time, the product reliability can be significantly improved.

PE-Poly Mass Production Technology



Tongwei's PECVD technology route has become the mainstream route for TOPCon cells. Compared with the LPCVD technology, Tongwei's PE-Poly mass production technology offers higher efficiency, lower energy consumption, and higher yield.

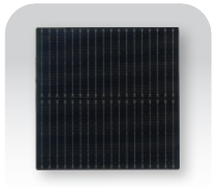
Secondary Sintering Technology



Relying on the advantages of Tongwei's self-developed specialized sintering equipment in terms of energy concentration and controllability, it reduces metal recombination and contact resistance, increasing cell efficiency by 0.3%-0.4%.

3.1.2 TNC Cell Technology Platform

TW Solar provides customized high-efficiency cell solutions for module customers



TNC
Cell Efficiency Upgrade!

Relying on the collaborative advantages of the entire PV industry chain, TW Solar advances coordinated improvement and upgrade plans from silicon material, silicon wafers, cells, to module technology, flexibly responding to and meeting customer demand for high-power cell products.

In the future, Tongwei will keep enhancing its TNC cell technology and is dedicated to improving the quality and efficiency of TNC cells!

TNC High-Efficiency Cell Technology Platform

Man ——Professional Team

Tongwei's quality system is supported by a team of professionals covering the entire chain of R&D, process, testing, quality control, and customer service. With systematic training and competency certification, the team ensures that every steps is controllable, robust, and professional.

Machine ——Advanced Equipment & Automation Capability

Through automated and 5G intelligent production equipment, product consistency, high efficiency and large-scale stable output are ensured.

Material ——Material Quality Management System

A strict material quality control system is established for the entire process from supplier selection to incoming inspection, ensuring stable and reliable input for cell production.

Method ——Process & Quality Control Methods

Centered on standardization, process orientation, and digitalization, systematic methods ensure process stability, product consistency, and production line controllability.

Environment ——Manufacturing Environment & Cleanliness Management

A high-quality manufacturing environment is the prerequisite for high consistency and efficiency of cells. Tongwei ensures product quality from the environmental aspect through environmental, cleanliness, and safety controls.

Measurement ——Tongwei PV Testing Center

Built in accordance with CNAS standards, TW PV Testing Center has a complete testing capability covering materials, cells, and modules, and serves as a crucial foundation for product quality stability.

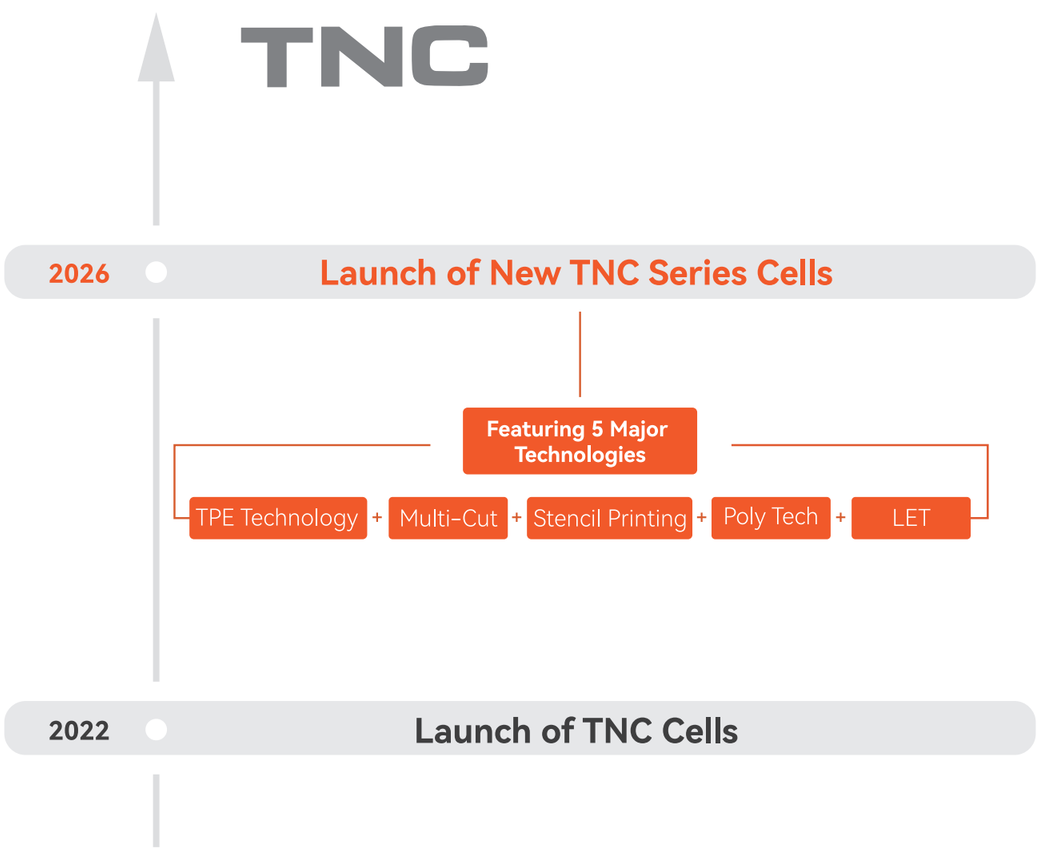
Multiple cell quality and efficiency improvement plans to satisfy customers' customized requirements for high-efficiency cells. Please contact TW Solar's cell technology team for specific efficiency improvement plans and details.

3.2 Breaking through and Innovating

3.2.1 The High-Quality, High-Efficiency, Value-Added Product Roadmap of TNC Cells

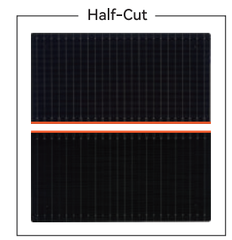
TW Solar will continue to focus on enhancing the quality, efficiency, and value of TNC cell products. It is projected that TNC cell efficiency will surpass 27% by December 2026.

TNC Series
Conceptual Diagram of Cell Products



TPE Half-Cut Cell

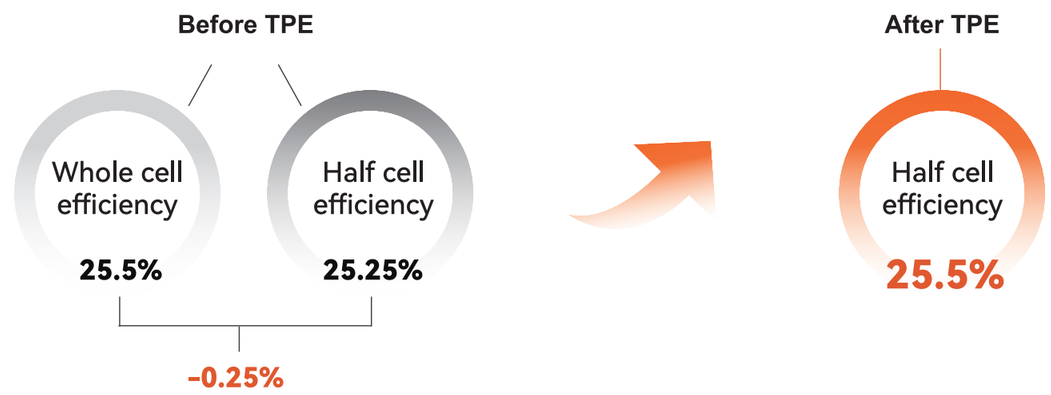
Suitable for module customers with a direct demand for half-cut cells



Conventional module manufacturing process requires cell cutting, which causes edge damage to the cell and leads to module power loss.

To address this issue, Tongwei innovatively developed the TPE (Tongwei Passivated Edge) half-cut cell technology. The cutting process is completed during the cell production, and a passivation film is deposited on the sidewalls of the cut edges, completely repairing the dicing damage.

Products utilizing TPE half-cut cell technology have seen a 0.25% increase in label efficiency. Furthermore, the passivation protective layer shields the cell edges from environmental factors, thereby extending the cell's service life.

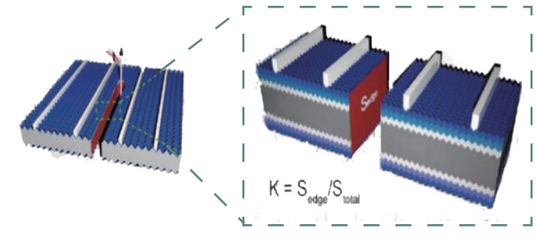


Half-Cut TNC Cells with TPE Technology

Compared with Conventional Whole TOPCon Cells

- Half-cut cell delivery omits the cutting process during module production
- Absolute efficiency of half-cut cells increases by **0.25%**
- Comprehensive manufacturing cost per watt decreases by approximately **0.003** RMB/W
- Weather resistance and reliability significantly improved

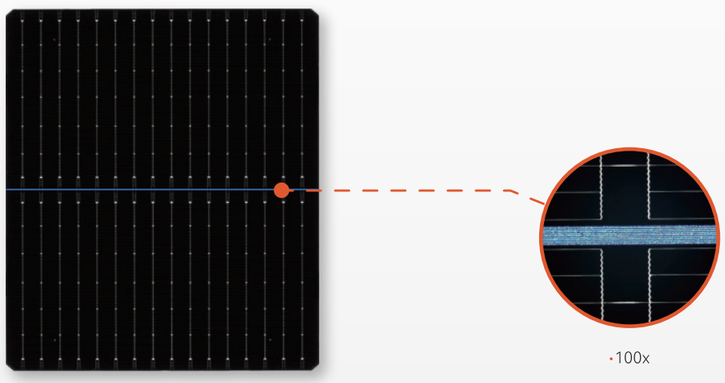
TPE Half-Cut Cell Schematic Diagram



Note: The data is sourced from Tongwei's internal laboratory.

LET

TW Solar provides customized high-efficiency cell solutions for module customers



Laser grooving is applied at the cell cutting positions, and subsequent deposition and passivation on these grooves help mitigate the damages on modules caused by cutting.

The cells are delivered as whole pieces, and the module side does not need additional modification.

The module power is increased by 2W.

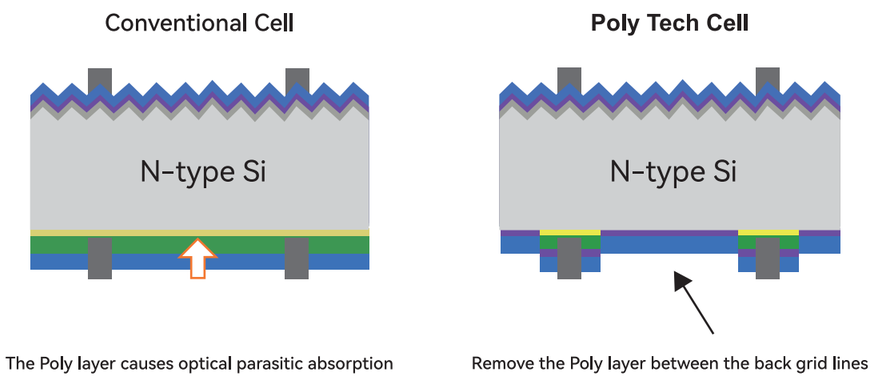
Poly Tech High Bifaciality Cell Technology

TW Solar provides customized high-bifaciality N-type cell product solutions for module customers.

The polysilicon film layer on the back of the TOPCon cell will cause optical parasitic absorption, resulting in a decrease in the long-wavelength light response and optical loss.

To solve this problem, Tongwei has developed Poly Tech technology. By removing the excess polysilicon between the grid lines, the optical loss caused by parasitic absorption is reduced, and the back passivation film layer is added to ensure the reliability of the product.

The efficiency of the TNC cell using Poly Tech technology is increased by 0.15%, while the module bifaciality increases by 5%.

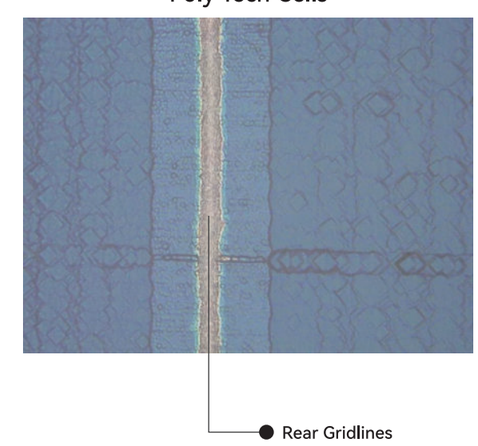


TNC Cells with Poly Tech Technology

Compared with Conventional TOPCon Cells

- Cell efficiency increases by **0.15%**
- Module bifaciality increases by **5%**
- Module manufacturing cost per watt decreases by approximately RMB **0.002**/W

Rendering of the Back of Poly Tech Cells

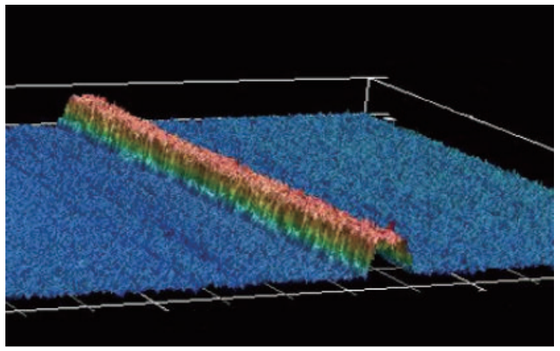


Note: The data is sourced from Tongwei's internal laboratory.

Stencil Printing

TW Solar provides customized high-efficiency cell solutions for module customers

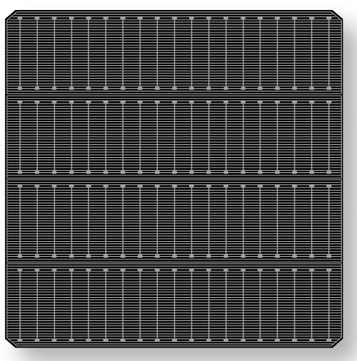
"Tongwei Gene" TNC Cell Manufacturing Core Technology



- Grid lines with stencil printing are fuller in shape and have lower line resistance
- Printing with steel stencils allows for narrower line widths and lower shading.
- Results in higher cell efficiency and better reliability.

Tongwei employs more advanced stencil printing technology with finer and more precise printing quality for cell manufacturing. Compared with conventional screen printing processes, stencil printing enhances the current conduction capability of the grid lines and effectively reduces the shading area of the front grid lines, significantly improving the electrical performance of the cells.

Introduction to Multi-Cut



Increase Power

The power loss in a module is $Q=I^2R$. The multi-cut technology reduces current, leading to a power increase of **> 10W**.

Enhance Safety

The hot-spot temperature is reduced by 10-20°C, lowering the risk of thermal runaway and achieving inherent module safety.

3.2.2 The High-Quality, High-Efficiency, Value-Added Product Roadmap of TNC Cells

PV Technology R&D Layout · Sichuan

Chengdu Shuangliu Global Innovation R&D Center

TNC R&D line
HJT/THL Pilot Line
TBC Pilot Line
Perovskite/c-Si Tandem Cell Laboratory
Module R&D Center
Wafer R&D Line
Material Physical and Chemical Laboratory
Cell Test Laboratory
PV Test Center (Module)

Leshan

Yongxiang Silicon Material R&D Center
Crystal Growth R&D Line

Yancheng Terrestrial Module Test Site
Hainan Terrestrial Module Test Site

PV Technology R&D Platforms & Qualifications

National Enterprise Technology Center
Engineering Technology Research Center in Sichuan Province
Sichuan Provincial Engineering Research Center
Chengdu PV Testing Center (CNAS Certified)
Hefei PV Experimental Center (CNAS Certified)

PV Technology R&D Intellectual Property

3521 Authorized Patents
(as of December 2025)

National Intellectual Property Advantageous Enterprise

China Patent Excellence Award

First Prize of Sichuan Provincial Patent Award

R&D Team

Dr. Xing Guoqiang, Chief PV Technology Officer of Tongwei Co., Ltd.: A well-known technical expert in the industry, who served as the person-in-charge and chief expert of the National 863 Program.

Tongwei has gathered over 1,300 senior R&D technicians, forming a core technology innovation team with comprehensive expertise, strong technical capabilities, exceptional R&D skills, and a forward-looking perspective.

*As of the end of 2025, our R&D system includes 25 PhDs and 146 Master's degree holders.

3.2.3 Patent Certificates

CD2320422-2023112890963-250923
Certificate of Invention Patent
Preparation method of perovskite thin film, thin film, perovskite cell and tandem cell

CD2421237-2025105624086-250923
Certificate of Invention Patent
Solar cell and its preparation method, PV module

AH2210353-2022114818481-250411
Certificate of Invention Patent
Laser grooving processing system and its processing method

AH2210362-2022115188395-250121
Certificate of Invention Patent
Solar cell and its preparation method

AH2210360-2022110662188-241011
Certificate of Invention Patent
Texturing and cleaning process of silicon wafer, solar cell and its preparation method

Certificate of Invention Patent
-2021101773967
An HJT cell with high photoelectric conversion efficiency and its preparation method

*Overseas Patent Coverage
Covering more than **20 countries** and regions, including China, the US, Germany, France, the UK, the Netherlands, Austria, Japan, SouthKorea, Australia, India, Turkey, Saudi Arabia, etc.

*Covered Technical Fields
Encompassing multiple areas such as TOPCon, BC, HJT, perovskite tandem, half-cut modules, 0BB modules, etc.

*As of December 2025, the PV sector has a total of **3521** authorized patents.

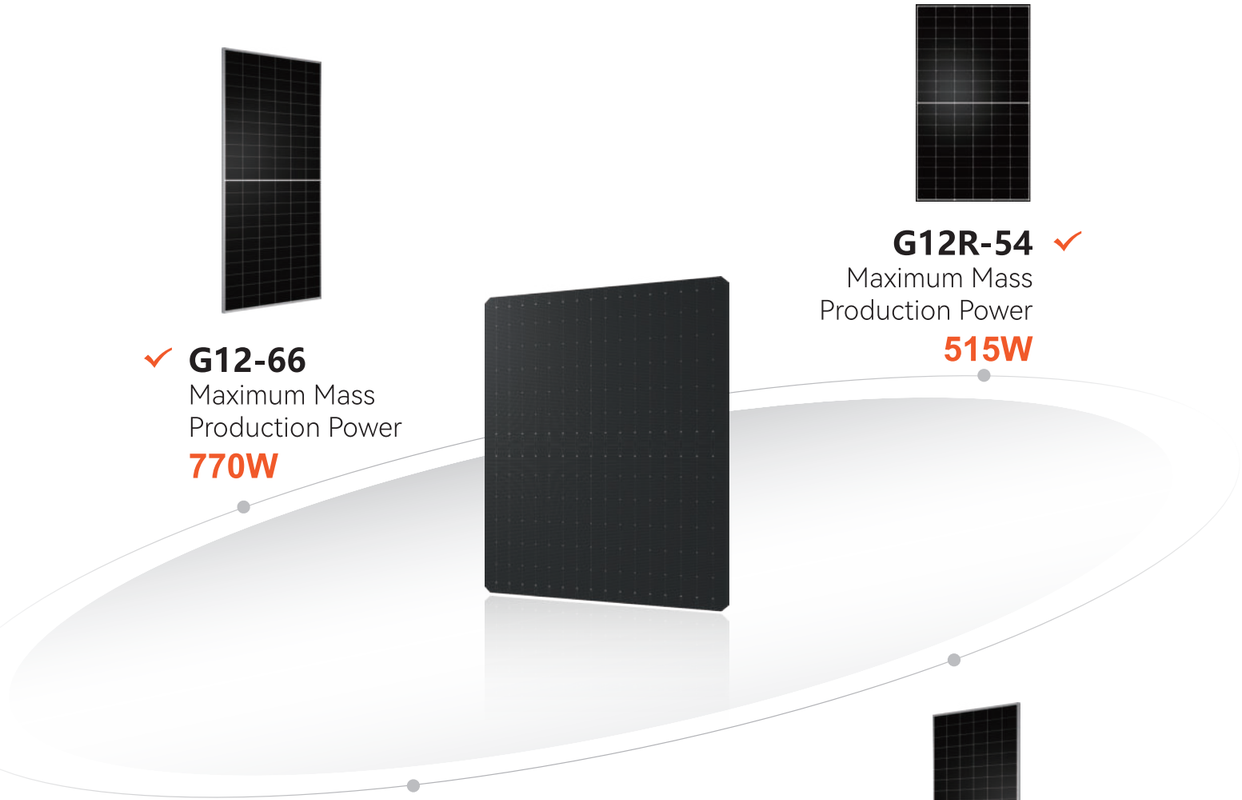
PART 4

TONGWEI

Chapter 4
Value Addition

4.1 Power Gain

4.1.1 Adding Value for Customers



4.1.2 Application Scenarios

Residential

Guangxi Skyworth Xiaoyang Building PV Project

Project Capacity | 199.8kW

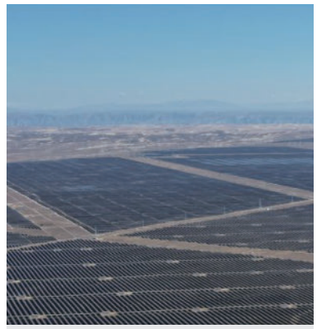
New Zealand Residential Rooftop Project

Project Capacity | 240.78kW

Australian Commercial Shop Rooftop Project

Project Capacity | 30.71kW

Utility



900,000 kilowatts Qinghai Gonghe PV Project

Project Capacity | 900MW

Netherlands Ground Power Station Project

Project Capacity | 13.62MW

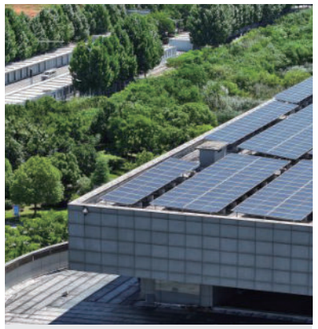
China Huadian Maizhokunggar Zhaxue Pastoral-Solar Complementary PV Project

Project Capacity | 100MW

Industrial & Commercial

China Huadian Suining Anju JAC Phase I PV Project

Project Capacity | **194.5kW**



Anhui Tongling Enterprise and Institution PV Project

Project Capacity | **10MW**

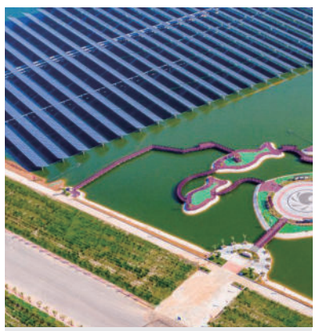
Switzerland Industrial and Commercial Rooftop Project

Project Capacity | **1MW**

Fishery-PV Integration

Jiangsu Nanjing Longpao Power Station

Project Capacity | **53MW**



Shandong Dongying Yellow River Estuary Power Station

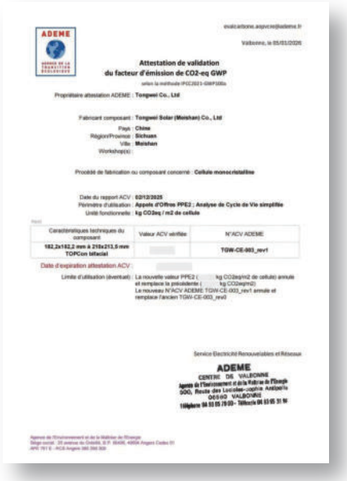
Project Capacity | **195.5MW**

Tianjin Dagang Power Station

Project Capacity | **72MW**

4.2 Green and Low-Carbon

4.2.1 Tongwei Carbon Footprint Certification



ADEME

Attestation de validation du facteur d'émission de CO2-eq GWP

Propriétaire attestation ADEME : Tongwei Co., Ltd

Fabricant composant : Tongwei Solar (Meishan) Co., Ltd

Pays : Chine

Région/Province : Sichuan

Ville : Meishan

Procédé de fabrication ou composant concerné : Cellule monocristalline

Date du rapport ACV : 02/12/2025

Périmètre d'utilisation : Appels d'Offres PPE2 ; Analyse de Cycle de Vie simplifiée

Unité fonctionnelle : kg CO2eq / m2 de cellule

Caractéristiques techniques du composant	Valeur ACV vérifiée	N°ACV ADEME
182.2x182.2 mm à 210x213,5 mm TOPCon bifacial		TGW-CE-003_rev1

Date d'expiration attestation ACV :

Limite d'utilisation (éventuel) : La nouvelle valeur PPE2 (kg CO2eq/m2 de cellule) annule et remplace la précédente (kg CO2eq/m2)
Le nouveau N°ACV ADEME TGW-CE-003_rev1 annule et remplace l'ancien TGW-CE-003_rev0

Service Electricité Renouvelables et Réseaux

ADEME
CENTRE DE VALBONNE
Agence de l'Environnement et de la Maîtrise de l'Energie
500, Route des Lucioles - «sophia Antipolis»
06560 VALBONNE
Téléphone 04 93 95 79 00 - Télécopie 04 93 65 31 54

French ADEME Carbon Footprint Certificate

Bureau Veritas Certification

产品碳足迹核查意见书

致：

通威太阳能（眉山）有限公司

必维认证（北京）有限公司（以下简称"必维"）受通威太阳能（眉山）有限公司的委托，对通威太阳能（眉山）有限公司的产品碳足迹进行独立的第三方核查，本核查意见是用于下文所述工作范围内的相关信息。

核查边界：

- 产品名称：单晶硅太阳能电池片
- 生产地址：四川省眉山市彭山区青龙街道工业大道北段 666 号
- 声明单位：1 片 182.2x182.2 单晶硅太阳能电池片
- 系统边界：通威太阳能（眉山）有限公司生产的 1 片 182.2x182.2 单晶硅太阳能电池片生命周期内（从提取到工厂入门）的相关过程。包括原材料获取及预加工过程，原材料运输过程，产品生产过程。
- 参比数据期限：2024 年 04 月 01 日 – 2024 年 09 月 30 日

重新核查条件：产品生命周期内温室气体排放量高出 8%-10%以上，计划内的变化或高于 10%以上计划外的变化，并且持续超过 3 个月时，必须进行重新核查。

核查标准：

- ISO 14067:2018 温室气体 – 产品碳足迹 – 量化要求和指南
- ISO 14064-3:2019 温室气体 – 第3部分：温室气体声明的查证和审定规范及指南

保证等级：

- 合理保证

核查方法：

- 访谈相关人员；
- 评审提供的文件证据；
- 评估用于数据收集、汇总、分析和报告的量化方法和信息系统；
- 核查抽样场所和数据源。

核查结论：

- 1 片 182.2x182.2 单晶硅太阳能电池片的生命周期内（从提取到工厂入门）的温室气体排放量为：1.2783 kgCO2e

基于核查工作范围过程和核查发现，通威太阳能（眉山）有限公司报告的 1 片 182.2x182.2 单晶硅太阳能电池片的碳足迹量化方法和结果，与 ISO 14067:2018 温室气体 – 产品碳足迹 – 量化要求和指南是相符的。

致：，在采购和投资方严肃。

必维集团是一家拥有 190 多年历史，在质量、环境、职业健康安全和社会责任领域提供独立验证服务的机构。必维独立国际与通威太阳能（眉山）有限公司及其管理人员不存在其它的商业关系。

认证机构地址：中国北京市朝阳区东三环南路甲 56 号广电国际一办公楼B2单元，邮编：100738
联系一步到位业务系列特别查询服务，可直接向本报告对接专家
要获证书请发送至以上有效联系邮箱。+86 10 59403003

签名：，北京

Bureau Veritas Certification

TÜV Rheinland Carbon Footprint Certificate

CQC

产品碳足迹证书

证书编号：PCF-2023-DZ-0167

发证日期：2023年12月13日
有效期至：2025年12月12日

中国质量认证中心根据相关核查程序发布本证书，对如下内容的真实性和有效性予以证明：

产品名称/型号：单晶硅太阳能电池片/210*210mm

委托人名称/地址：通威太阳能（眉山）有限公司
四川省眉山市东坡区修文镇进修路8号附1号

生产者名称/地址：通威太阳能（眉山）有限公司
四川省眉山市东坡区修文镇进修路8号附1号

生产企业名称/地址：通威太阳能（眉山）有限公司
四川省眉山市东坡区修文镇进修路8号附1号

数据时间边界：2022年09月01日-2023年08月31日

功能单位：每片 单晶硅太阳能电池片/210*210mm

每功能单位产品碳足迹数值：2.39 千克二氧化碳当量

核查所依据的标准及规范：ISO14067及PAS2050相关规范

系统边界：摇篮到大门

产品各阶段碳排放比例：

签发：谢肇照

CQC 中国质量认证中心

CQC Carbon Footprint Certificate

4.2.2 Capable of Various Traceability Orders

Order (Clean Supply Chain)

- In principle, our company can trace from the module back to the silicon material. Based on specific order requirements, traceability can extend to silicon powder/metallurgical grade silicon;
- Considering production schedules across various processes, confirmation of order traceability feasibility generally needs to be finalized 30 days prior to order placement.

Documentation (Digitalized Traceability Management)

- Documentation Logic: The purchase and sales contracts link each process; within the process, the "batch number" links the procurement, production, and sales links.
- Level of Informatization: The procurement, production, sales, and transportation links can be traced through information systems such as ERP, MES, and WMS.

Factory Audits (Recognition of Traceability Capability by Authoritative Bodies)

Successfully passed traceability audits conducted by multiple authoritative organizations:

- TÜV Rheinland
- PI BERLIN
- STS
- SINOVOLTAICS

4.3 ESG

Environmental Performance

Environmental Protection Investment RMB **1.245** billion

Carbon Footprint & EPD
26 Certifications

Proportion of Recycled & Reused Water
98.04%

Increase of Renewable Energy Electricity Usage (YoY)
28.00%

Proportion of Renewable Energy Electricity Used
64.01%

Reduction of the Total Carbon Emissions of Scope 1, 2 & 3 (YoY)
16%

Reduction of the Hazardous Pollutant Emissions (YoY)
27.97%

Reduction of the Wastewater Pollutant Emissions (YoY)
33.96%

Reduction of the Total Waste Discharge (YoY)
19.98%

Social Performance

Increase of R&D Personnel (YoY)
26.94%

Average Employee Training Hours per Person
82.03 hours

R&D Investment
RMB **2.673** billion

Increase of New Authorized Invention Patents (YoY)
88.66%

Proportion of Key Raw Material Suppliers for PV Business Signing Social Responsibility Commitments
100%

Proportion of Key Raw & Auxiliary Material Suppliers for PV Business Signing Conflict Minerals Procurement Commitments
100%.

Governance Performance

Proportion of Female Board Directors
33.33%

Proportion of Independent Board Directors
33.33%

Business Ethics Audits Conducted
117

Resolution Rate of Internal Audit Issue
100%

Litigation Cases Related to Unfair Competition
0

ISO 37301 Compliance Management System Certifications Obtained
6

Response to International Sustainable Development Initiatives

United Nations	Tongwei Co., Ltd. joined the UN Global Compact (UNGC)
UN WOMEN	Tongwei Co., Ltd. signed the UN Women's Empowerment Principles (WEPs)
IFRS Sustainability	Tongwei Co., Ltd. joined the "ISSB Partnership for Early Awareness of Sustainability-Disclosure Today" (P4EAST)
中国供应商 ESG评级平台 CHINA SUPPLIER ESG RATING PLATFORM	Supplier ESG Rating SHOW | Tongwei Co., Ltd. (5-Star Outstanding)
CLIMATE GROUP RE100	Tongwei Co., Ltd. joined RE100
China ESG Alliance	Tongwei Co., Ltd. joined the China ESG Alliance
CCNA	Tongwei Co., Ltd. joined the Corporate Carbon Neutrality Action (CCNA)

- Tongwei Co., Ltd. co-initiated and signed the International Climate Action Initiative for Digital Ecological Civilization
- Tongwei Co., Ltd. co-launched the "Capacity Building Project for Sino-Africa Collaboration on Renewable Energy Development."
- Tongwei Co., Ltd. co-initiated and signed the "Synergistic Empowerment Plan for Pollution Reduction, Carbon Mitigation and Efficiency Improvement"

PART 5

Chapter 5

Win-Win Cooperation

5.1 Global Partners

HONORS AND AWARDS GRANTED BY CUSTOMERS (RECENT YEARS)

DOMESTIC HONORS

And more...

OVERSEAS HONORS

And more...