JOLYWOOD

Same sunshine, more value

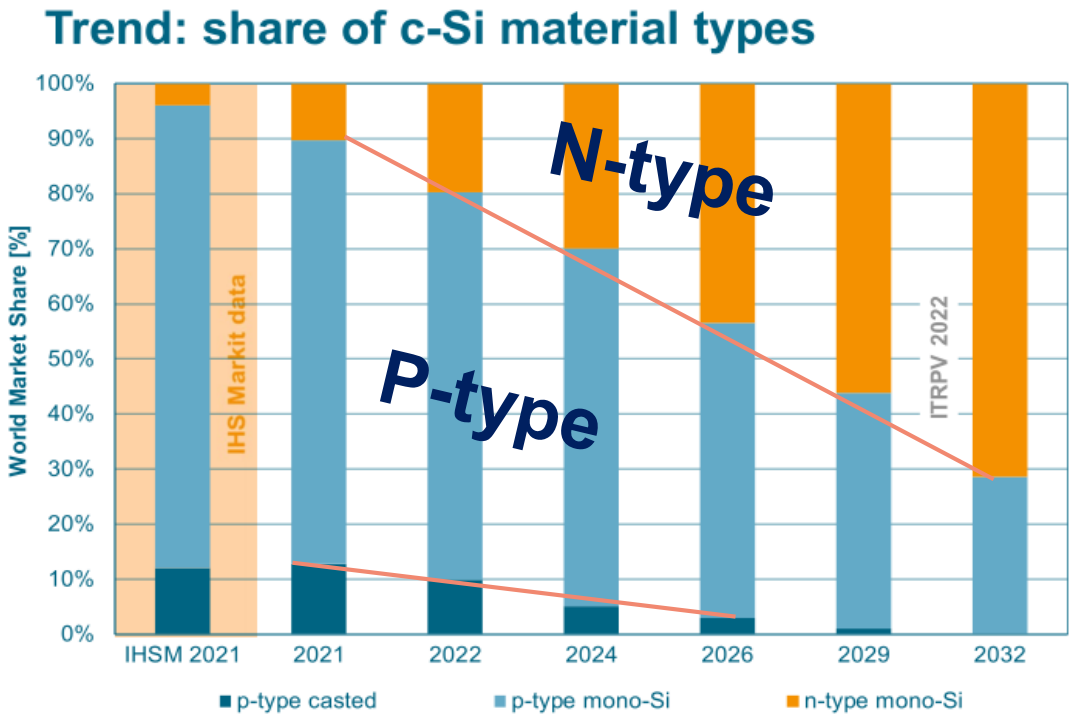
Jolywood N-Type TOPCon Module Introduction 2023

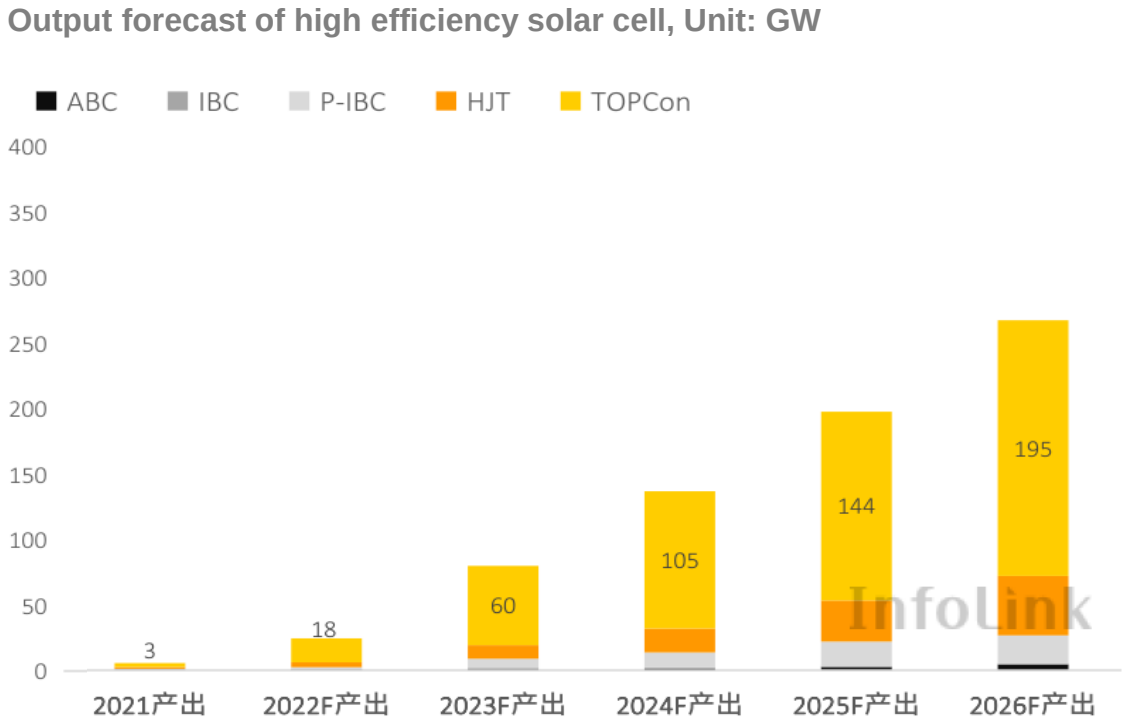
Lei Xiaofei

Feb 1st 2023

Content

Solar Cell Technical Classification





Source: InfoLink技术趋势调研报告_Aug-22

- N type technology market share increases sharply and will become the mainstream in the **next three** years.
- Among the n-type cell technologies, **TOPCon cell will be the dominance**.

Solar Cell Technical Classification

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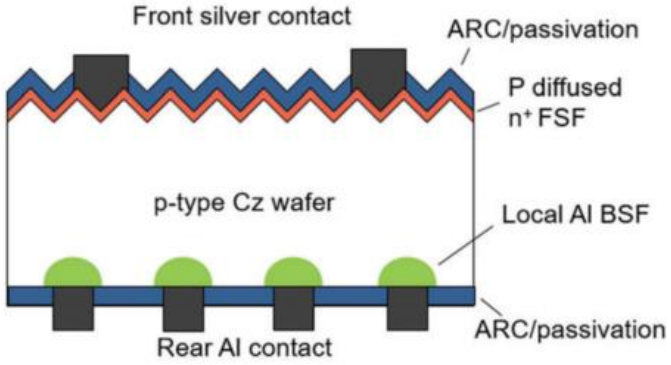
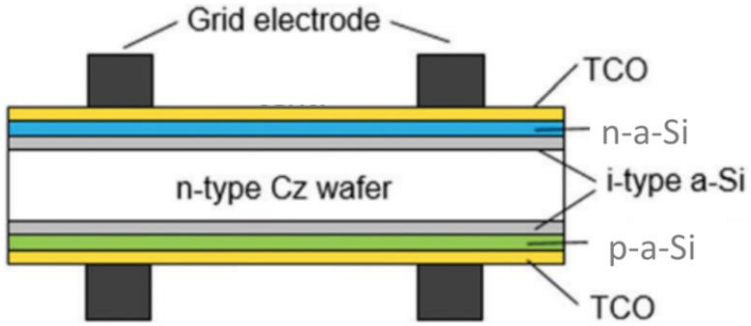
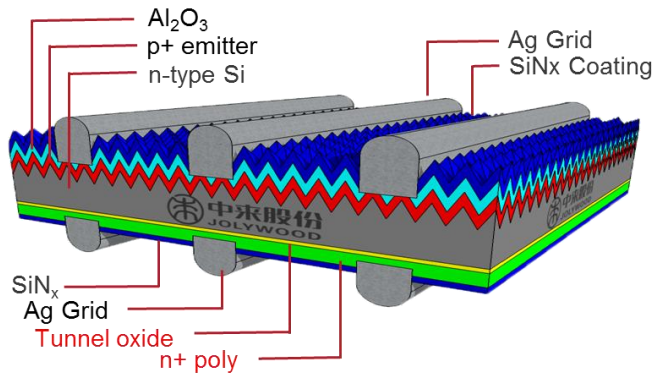
PERC

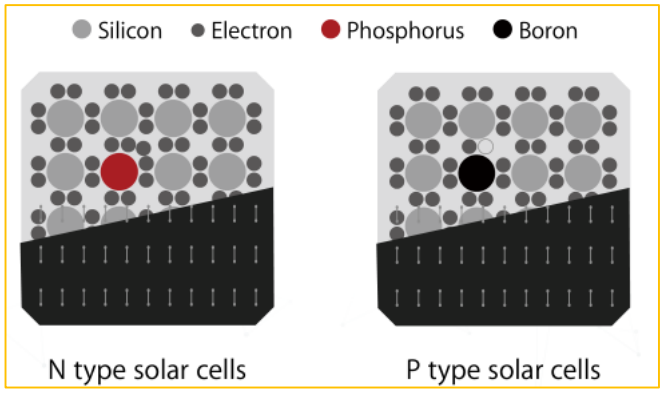


HJT



TOPCon

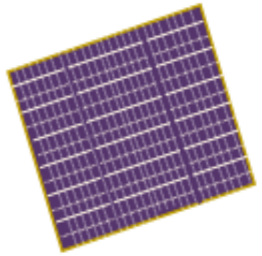




- PERC cell is based on P-type wafer.
- HJT and TOPCon cells are based on N-type wafer.

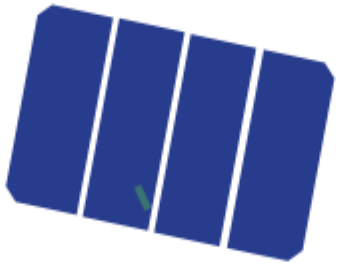
- Both TOPCon and HJT cell achieve high efficiency through passivation.
- TOPCon uses tunnel oxide layer.
- HJT uses intrinsic amorphous silicon layer.
- In mass production, TOPCon cell (24.5%) has an absolute efficiency of 1.5% than PERC cell (23%) .

Cell, Module Technology Trend



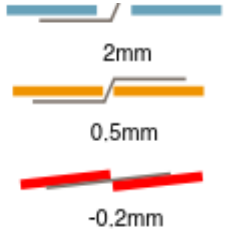
High efficiency cell

- PERC remains mainstream, but there's limited room to improve efficiency.
- TOPCon and HJT emerged.
- Back-contact cells receive increasing attentions.



Cell-cutting design

- Significantly reduce loss incurred by currents.
- Help accelerate thinning progress of large sized cells.
- **Half-cut design** remains mainstream.



High-density assembling technique

- Narrowing cell gaps to increase the number of cells assembled.
- **Narrowed-spacing layout** is the most widely adopted as its technique is simple.

Large wafers

- Bring significant cost advantage.
- M10/G12 become mainstream.

Multi-busbar

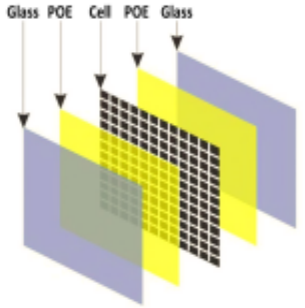
- Multi-busbar is the solution as wafer becomes bigger.
- Significantly reduce silver paste consumption and inactive area.

Non-destructive cutting

- Reduce risks of micro cracks and ensure yield rates.
- Improve mechanical load.

Bifacial

- Additional power gains on rear side
- Prevalent in ground-mounted PV



Jolywood Modules for Different Scenarios

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Utility-scale plant

JW series

Power: >620W
Best LCOE product

C&I market

JW series
NIWA series

Power: >570W/465W
The most-effective scenario

Residential market

NIWA series

Power: >430W
Maximum installation capacity
Superior appearance

JOLYWOOD

JW Series

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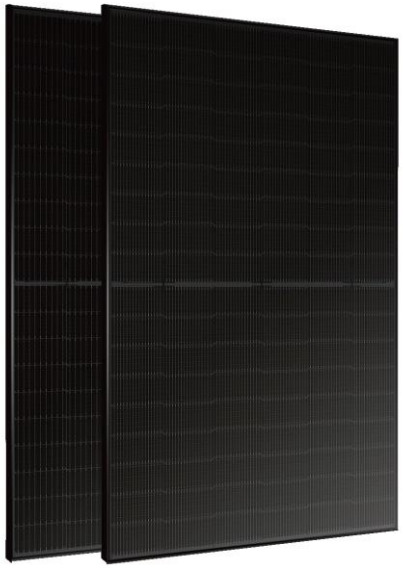
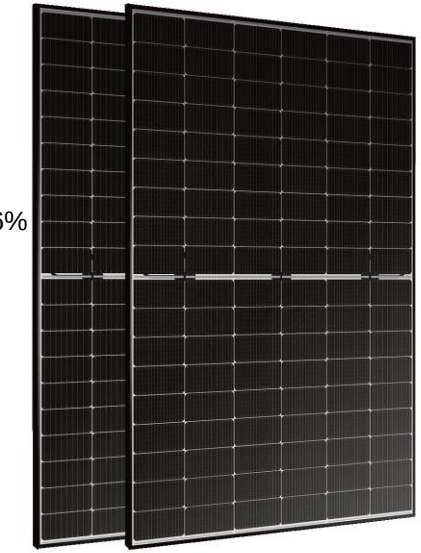
NIWA Series

- Suitable size modules
- High efficiency power modules
- The weight of modules ranges from 20~24.5kg



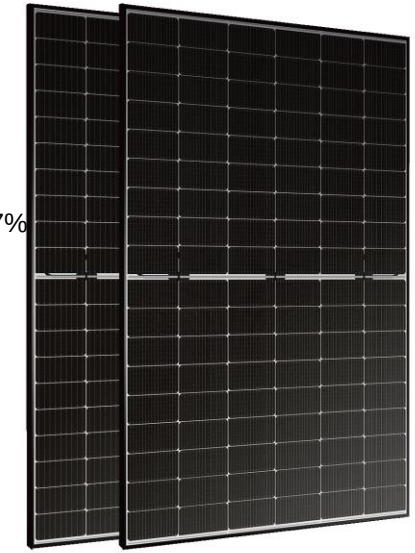
NIWA Black

- Maximum power: 425W
- Maximum efficiency: 21.76%
- **Real black modules**
- Type: HD108N-M10
  HD120N-M6
  HT108N-M10
  HT120N-M6



NIWA Pro

- Maximum power: 435W
- Maximum efficiency: 22.27%
- Type: HD108N-M10
  HD120N-M6



NIWA Light

- Maximum power: 440W
- Maximum efficiency: 22.53%
- **Weight: 20kg**
- Type: HT108N-M10
  HT120N-M6

Advantages of TOPCon Module

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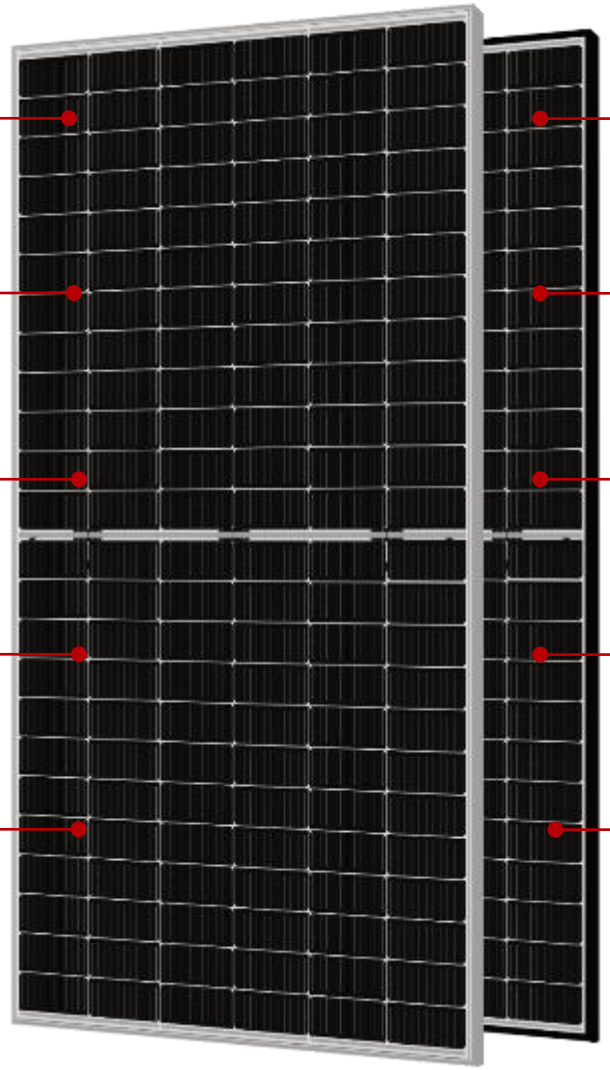
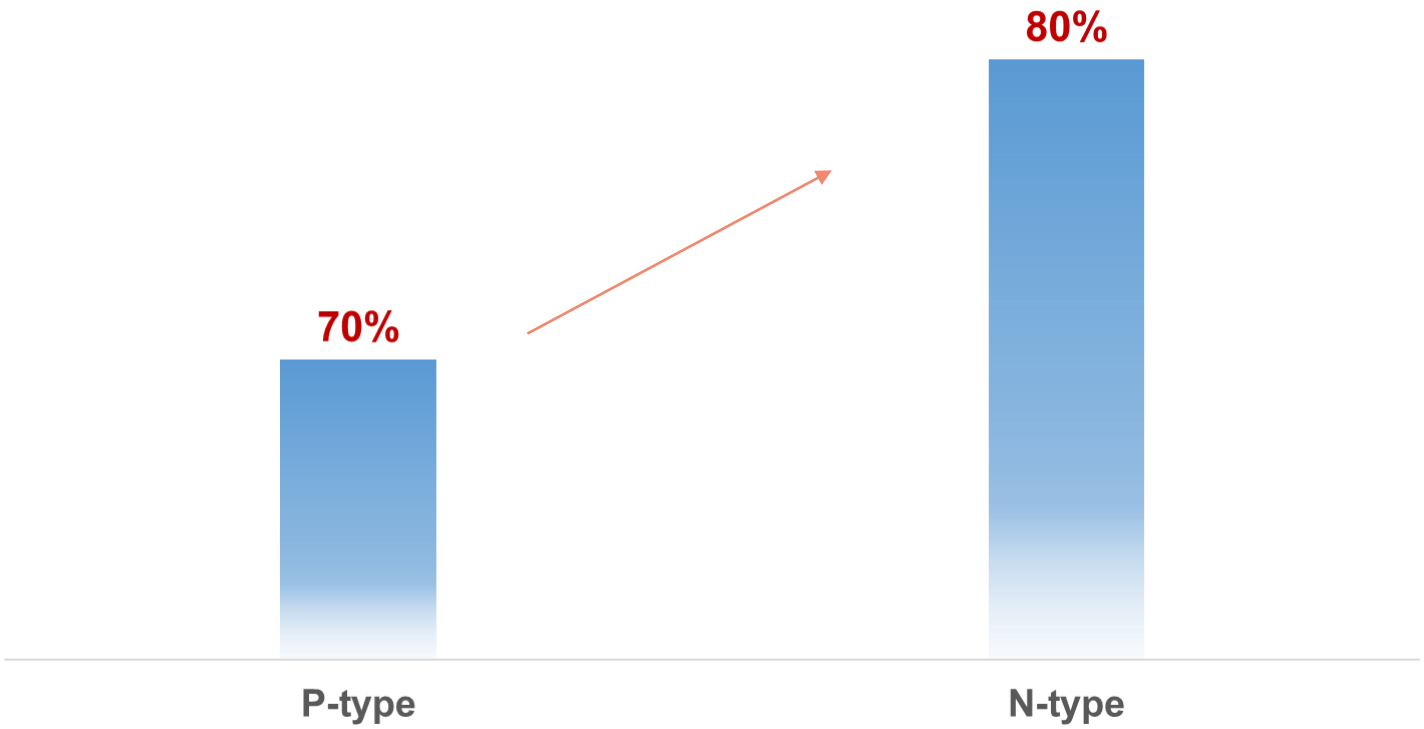
- High power
- High bifaciality
- High reliability
- Low degradation
- Low temperature coefficient



- Near zero LID
- Good low illumination response
- Low working temperature
- Good anti-PID property
- Compatible with current module technology

TOPCon Advantage__*High Bifaciality*

- N-type's higher bifaciality will bring a significant power gain of **1% ~ 2%**.



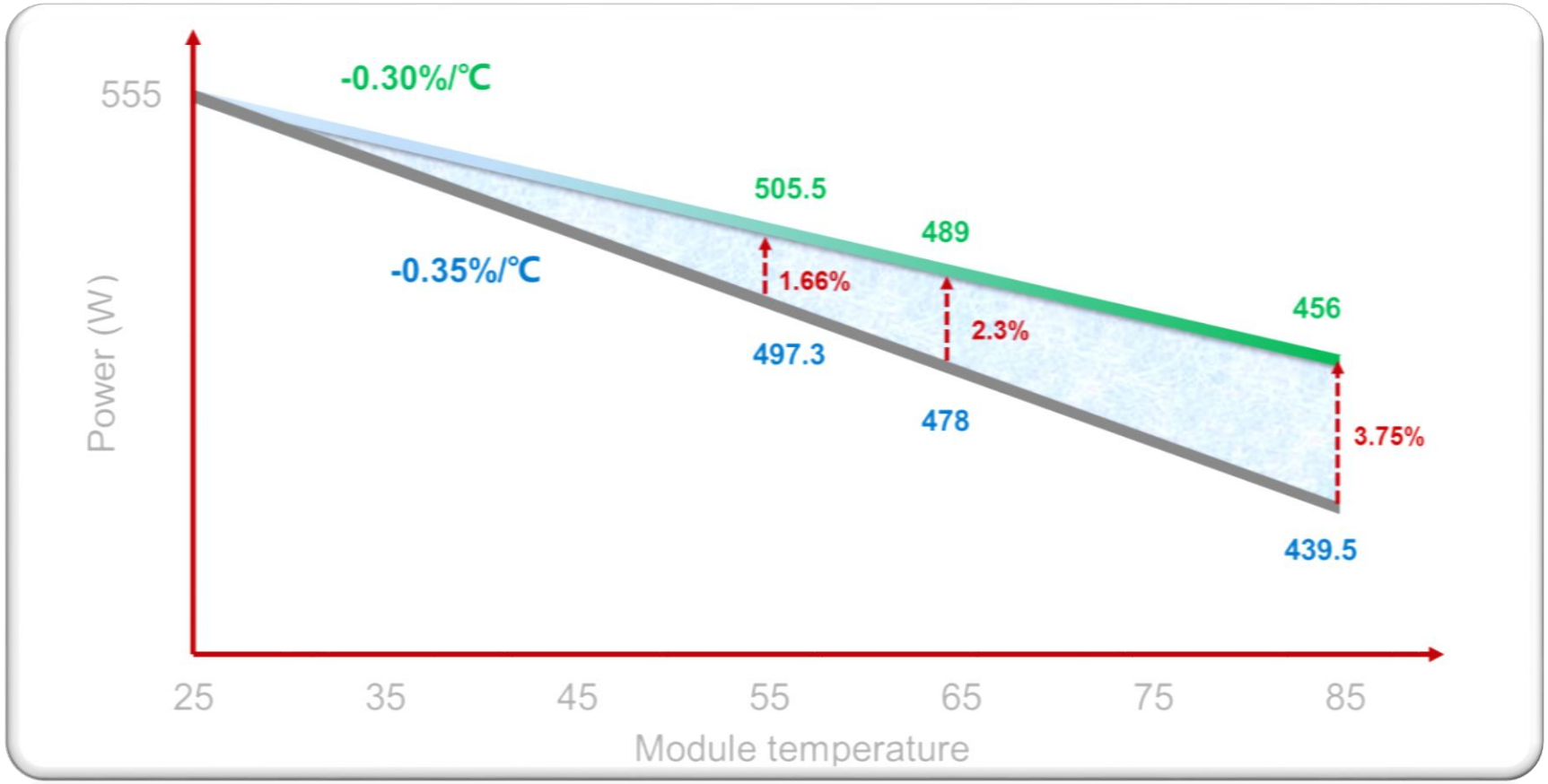
α	10%	20%
PERC	7.0%	14.0%
TOPCon	8.0%	16.0%
Power gain	**1.0%**	**2.0%**

$$Pmax_{BiFi} = Pmax_{front} \times (1+ \alpha \times Bifi)$$

*Bifi: Module bifacial factor
*α: Bifacial stress irradiance coefficient (depend on irradiance & ground albedo)

TOPCon Advantage__*Low Temperature Coefficient*

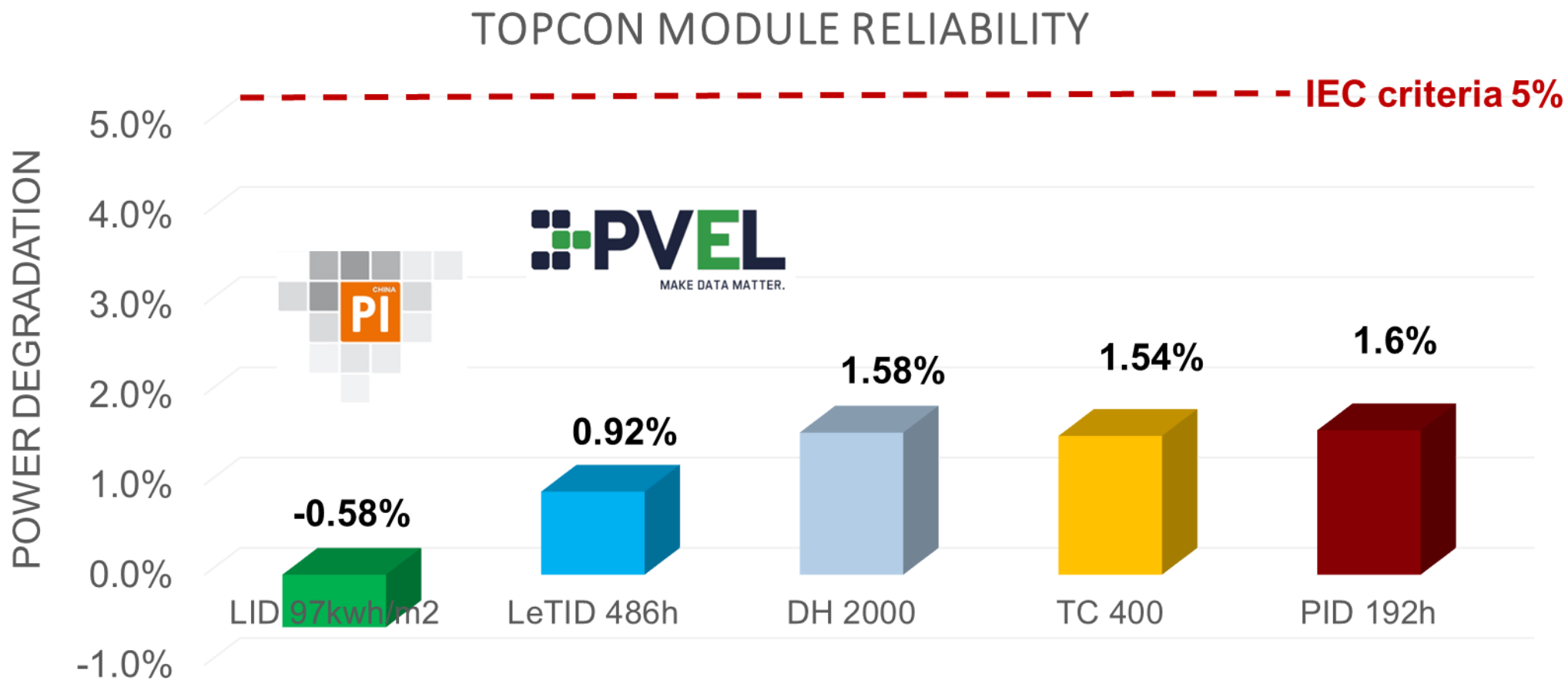
- P-type：**-0.35**%/℃
- N-type：**-0.30**%/℃



- TOPCon module power output will increase of **0.9%** with the better temperature coefficient.
- Under high temperature environment, the benefit will expand to **3.75%.**

TOPCon Advantage__*High Reliability*

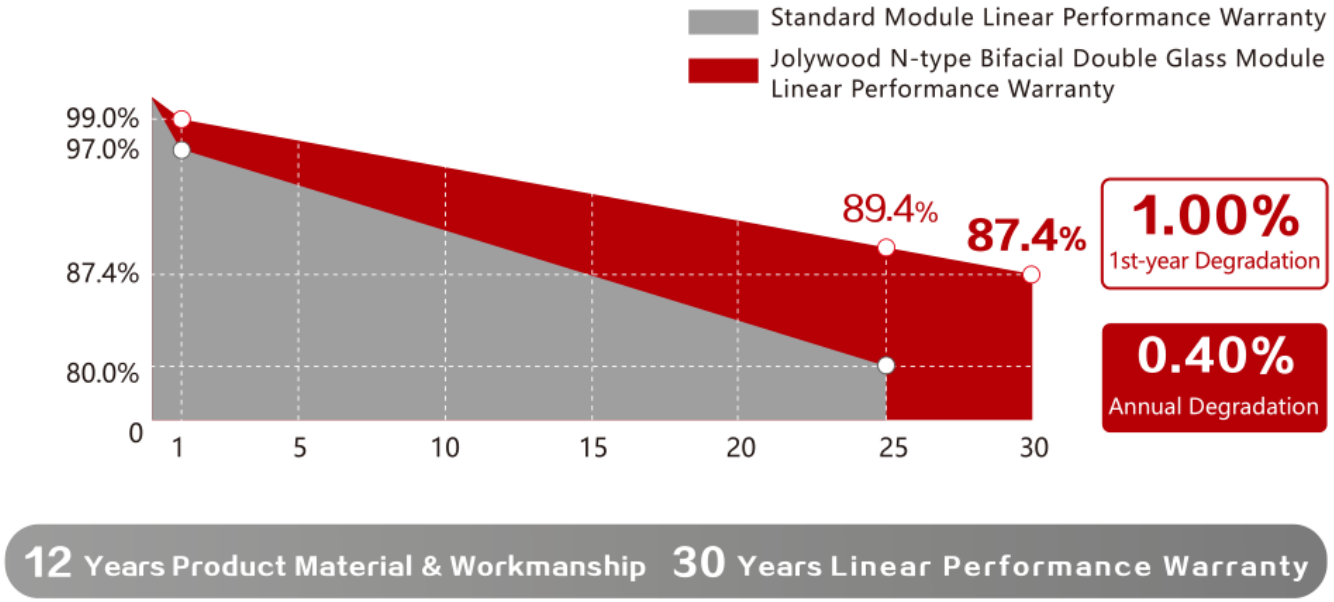
- TOPCon module has a better performance than IEC standard, even under enhanced test sequence.



TOPCon Advantage__*Warranty*

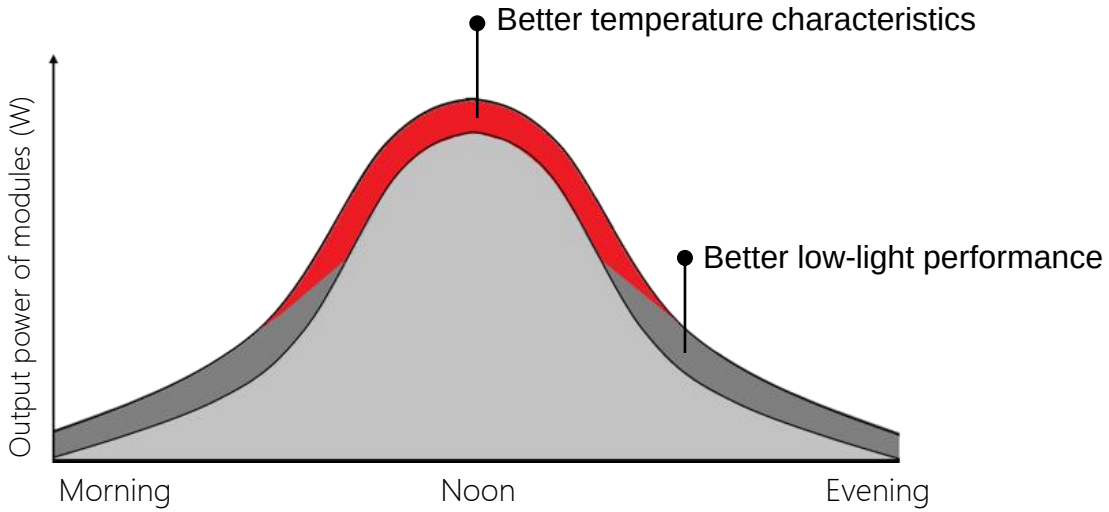
- The 1st year degradation **1%**
- Annual degradation **0.4%**

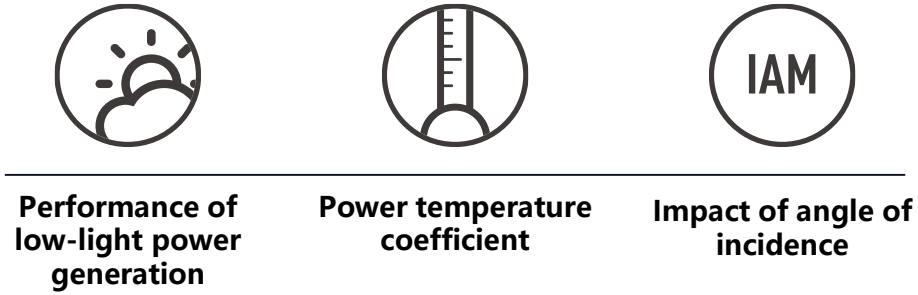
- TOPCon module power output remain over **89.4%** at the 25th year and over **87.4%** at the 30th year.



TOPCon Advantage__*Good low-illumination response*

- TOPCon module works longer during the whole day.
- TOPCon module has a higher power output under low-light environments like on cloudy or foggy days.





TOPCon Advantage__*Improved Energy Generation*

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- Base line: PERC bifacial module.

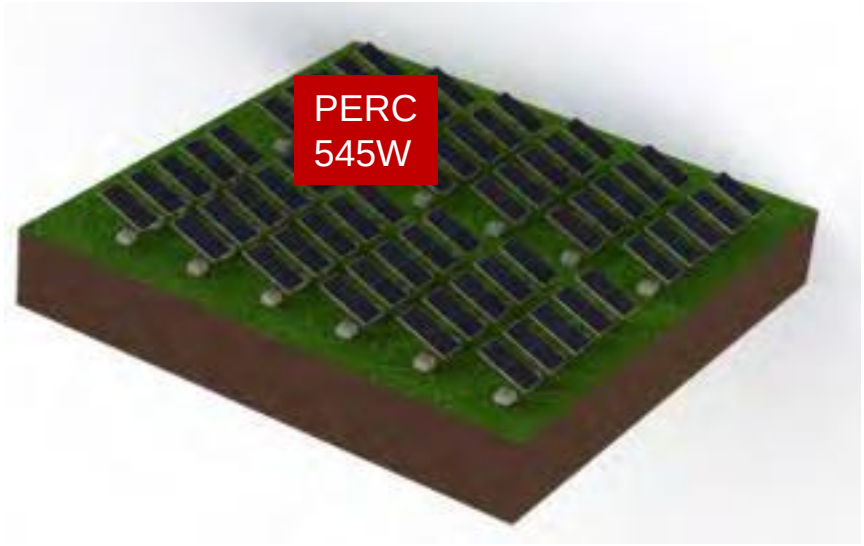
TOPCon module improved Energy Generation

	Energy gain
First year	**3.37%**
30 years	**4.18%**

- *PVsyst simulaiton*
- *1MW, Single axis tracker, Middle East*
- *TOPCon module: 1st year degradation 1%, annual degradation 0.4%*
- *PERC module: 1st year degradation 2%， annual degradation 0.45%*

- **Bifaciality**
- **Degradation**
- **Temperature coefficient**
- **Low illumination response**

TOPCon Advantage__*High Value Return*



- With the same power grade, compared with perc bifacial module, TOPCon bifacial module has a additional energy gain of 3% ~ 5%.
- TOPCon module has a higher power of 3.7% ~ 5.5% compared with perc module, which reduce PV system area related cost, like land area, tracker, cable, installation cost and operation cost, etc.

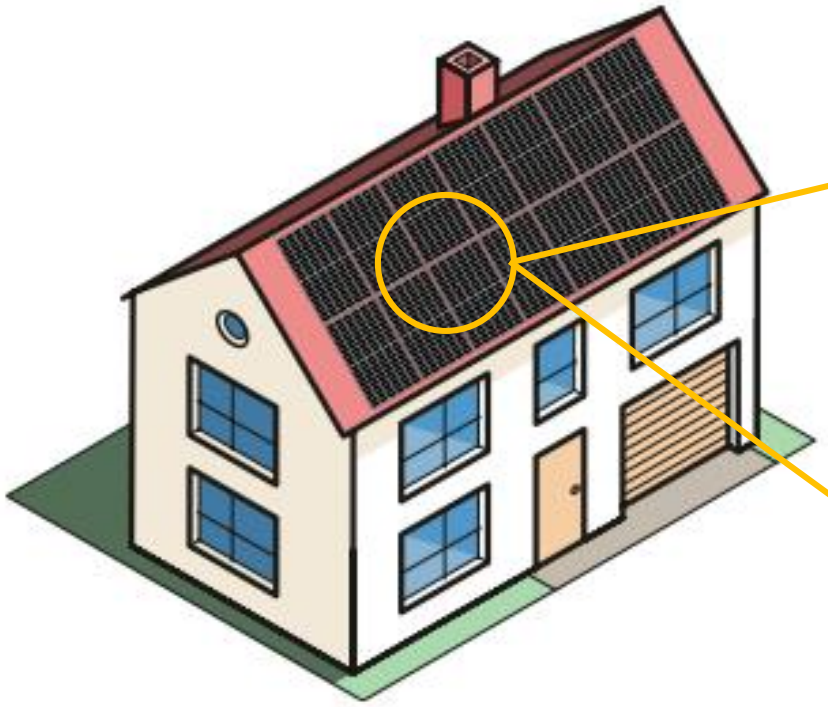
TOPCon Advantage__*High Value Return*

Item	Unit	PERC bifacial	TOPCon bifacial	TOPCon bifacial
Annual effective irradiation hours	h/year	2000	2000	2000
Module power	Wp	545	545	575
Module price	**$/Wp**	**0.272**	**0.29**	**0.302**
Effective power	Wp	512	525	554
Total cost per watt in life (discounted)	$/Wp	0.701	0.720	0.72
Initial investment per watt	$/Wp	0.592	0.61	0.615
BoS	$/Wp	0.32	0.32	0.313
LCOE	$/kWh	**0.0189**	**0.0189**	**0.0189**

- *50MW project, Abu Dahbi*

- Suppose the LCOE is the same,
- TOPCon module has a premium of **1.8 USC/Wp** Vs. P-PERC module.
- TOPCon module has a higher power of 30W, which brings a premium of **3.0 USC/W**.

TOPCon Advantage__*High Value Return*



PERC	TOPCon	TOPCon
14x405 Wp	14x420 Wp	14x425 Wp
5.67 kW	5.88 kW	5.95 kW
--	**3.7%** more power in the same area	**4.9%** more power in the same area

- With the same power grade, compared with perc monofacial module, TOPCon module has a additional energy gain of 7% ~ 10%.
- TOPCon module has a higher power of 3.7% ~ 4.9% compared with perc module, which maximize the solar power system capacity, producing more electricity and increasing the customer's economic benefits.

TOPCon Advantage__*High Value Return*

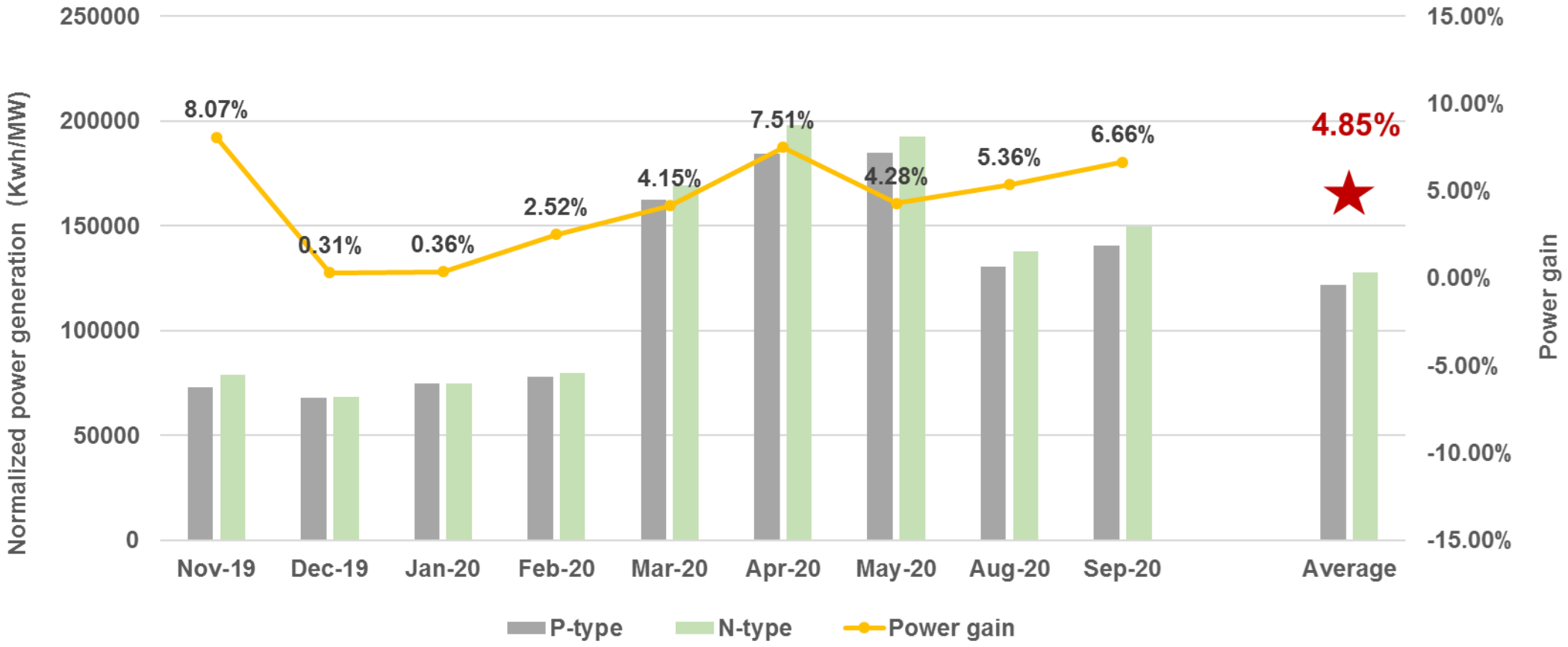
Item	Unit	PERC bifacial	TOPCon bifacial	TOPCon bifacial	TOPCon bifacial
Annual effective irradiation hours	h/year	1200	1200	1200	1200
Module power	Wp	405	415	420	425
Module price	**$/Wp**	**0.279**	**0.305**	**0.308**	**0.311**
Effective power	Wp	370	387	392	396
Total cost per watt in life (discounted)	$/Wp	0.817	0.837	0.837	0.837
Initial investment per watt	$/Wp	0.729	0.750	0.751	0.752
BoS	$/Wp	0.45	0.445	0.443	0.441
LCOE	$/kWh	**0.0382**	**0.0382**	**0.0382**	**0.0382**

- Suppose the LCOE is the same,
- TOPCon module has a premium of **2.59 ~ 3.2 USC/Wp** Vs. P-PERC module.

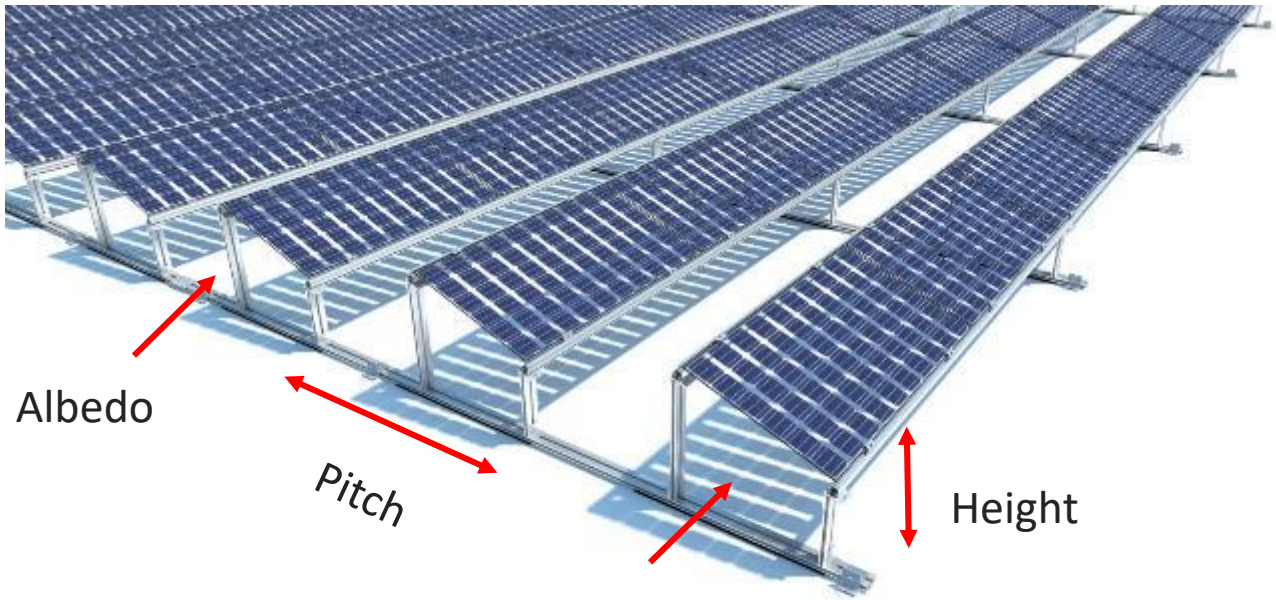
- *1MW project, Germany*

Plant Power Generation Data---*TOPCon VS PERC*

- Haixing Top-Runner project
- Compared with PERC bifacial module, TOPCon bifacial module has a higher power generation, with a average power gain **4.85%**.



TOPCon Module Application



↑ **Bifacial Gain**

- ↑ Bifaciality — PV module feature
- ↑ G_{rear}
  - ↑ $G_{diffuse}$
  - ↑ $G_{reflected}$
- ↑ Albedo — Soil feature
- ↑ Pitch — Layout feature
- ↑ Height
- ↓ Rear shadow

Racking feature

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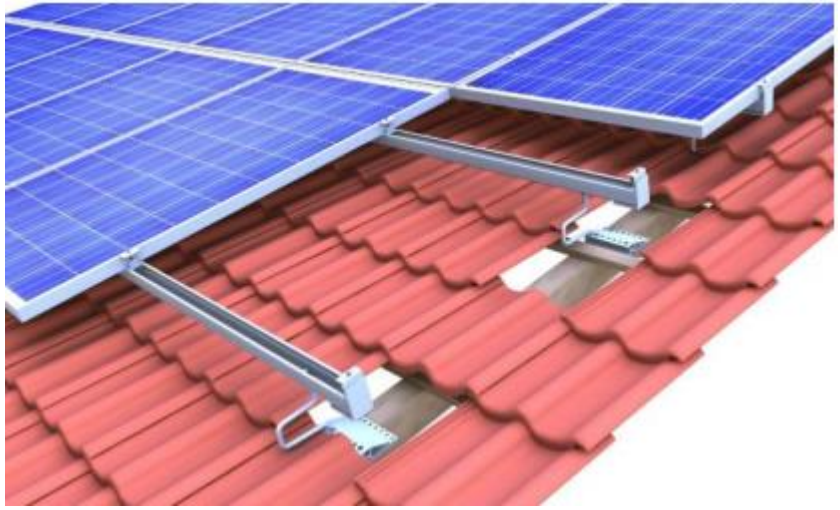
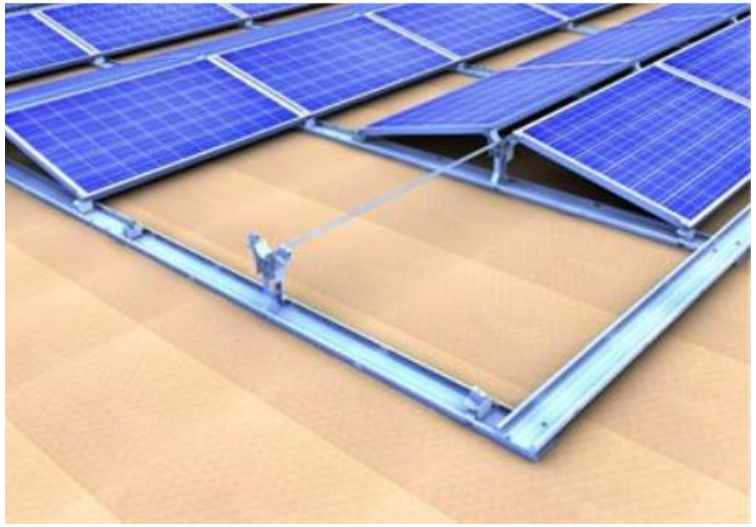
TOPCon module compatible with solutions from main tracker manufactures

- TOPCon module can be installed with racking system, 1V and 2P tracking system.
- Compatible with the main stream trackers.

nextracker ARCTECH soltec GAMECHANGE SOLAR REPOWERING THE PLANET

TOPCon module compatible with rooftop racking system





- TOPCon module can be installed on rooftop racking system.
- Compatible with the main stream racking systems.

TOPCon module compatible with inverters from leading manufactures across multi scenarios

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HUAWEI

SUNGROW

GOODWE

SMA

Fronius

solis

SOFAR

GROWATT

Domestic Utility-Scale Cases


Datong, Shanxi 29.2 MW


Sihong, Jiangsu 110 MW


Qinghai 153 MW


Yangquan, Shanxi 100 MW


Sihong, Jiangsu 104 MW

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Oversea Utility-Scale Cases


Amin, Oman 125 MW


Ibri II, Oman 458 MW


Khmelnitskiy, Ukraine 1.8 MW


Baden-Württemberg, Germany 1 MW


Rilland, Netherland 11.75 MW

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Overseas Residential Cases


Poland 6 kW


Germany 7 kW


Poland 10 kW

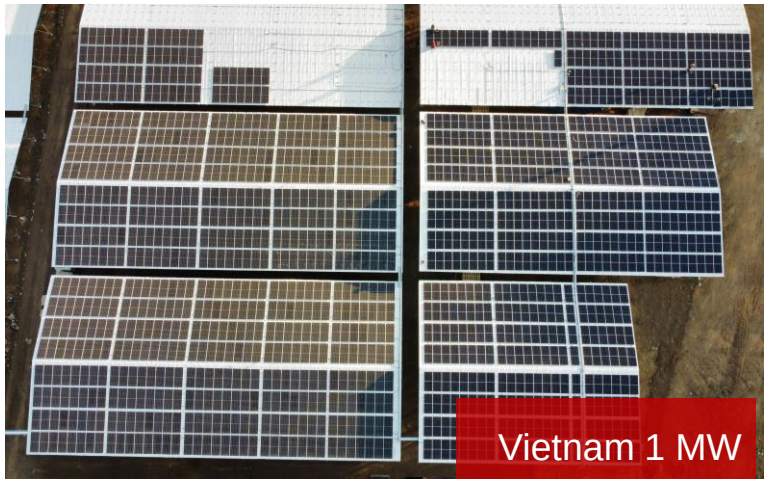

Poland 50 kW

Overseas C & I Cases


France 240.7 kW


France 258.6 kW


France 258.61 kW


Vietnam 1 MW


Poland 120 kW


France 227.3 kW

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Jolywood: Industry-Leading Capacity of N-type High-Efficiency Cell

Launched 36 N-type TOPCon high-efficiency cell production lines

BNEF **Tier 1** Module Manufacture

Annual capacity of **16GW** (end of 2023)

5.8GW
Global module shipments (2022)

7.6GW
Capacity of TOPCon cells (2022)

3.6GW
Capacity of TOPCon modules (2022)

Strength

- Launched 36 N-type TOPcon high-efficiency cell production lines
- Annual capacity of 16GW, with the annual output value of RMB 12 billion
- Built by IT Electronics Eleventh Design & Research Institute Scientific and Technological Engineering Corporation Limited

Technical Advantages

- Adopt the latest N-type TOPCon 2.0 technology developed by Jolywood
- Increase the overall efficiency of products by 1.5% and the yield by 3%
- Reduce production costs and improve product competitiveness in the market

Intelligent Factory

- The largest unmanned AI battery factory in the world
- Equipped with fully automated production equipment, 5G intelligent AGV material and product transmission system
- Adopt fully digital information-based MES management system

Contribution to Reduce Carbon Emission

- Generate more than 20 billion kWh of green power annually
- Equal to 2.55 million tons of standard coal equivalent
- Reduce carbon dioxide emissions by 16 million tons per year

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JOLYWOOD