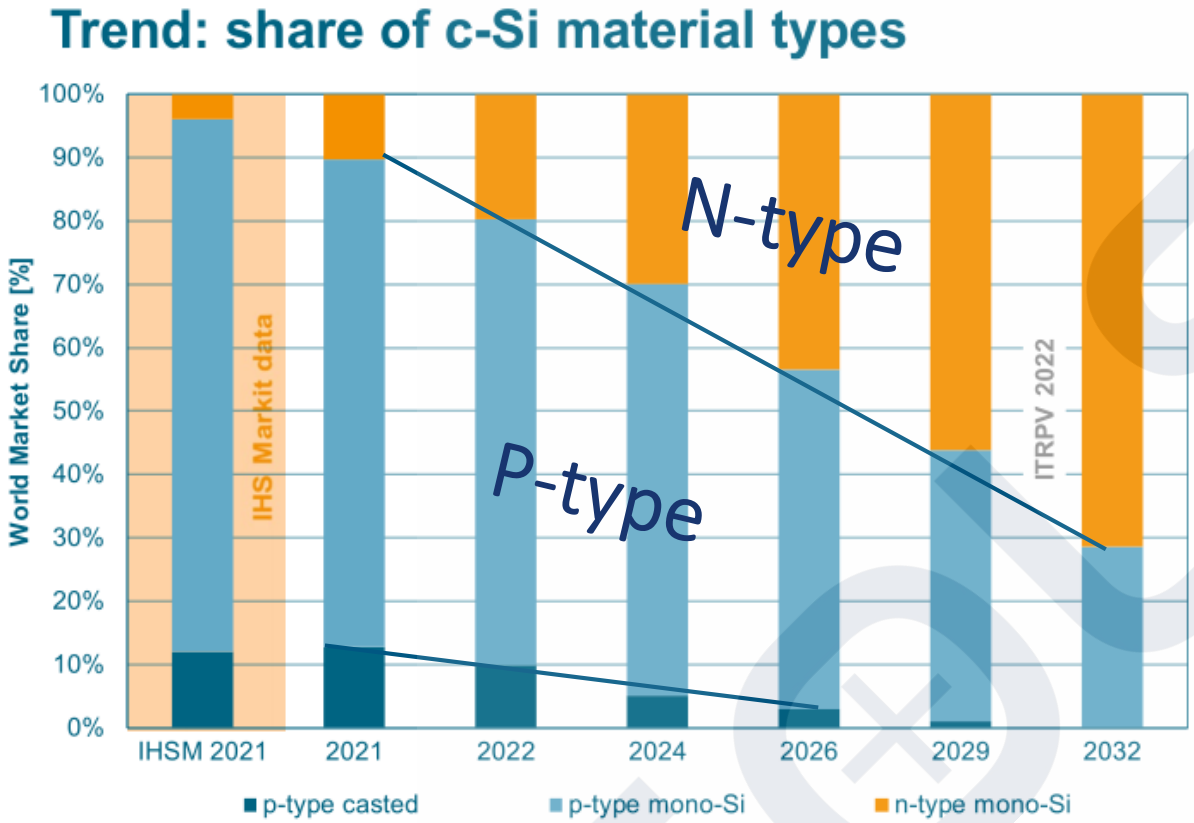
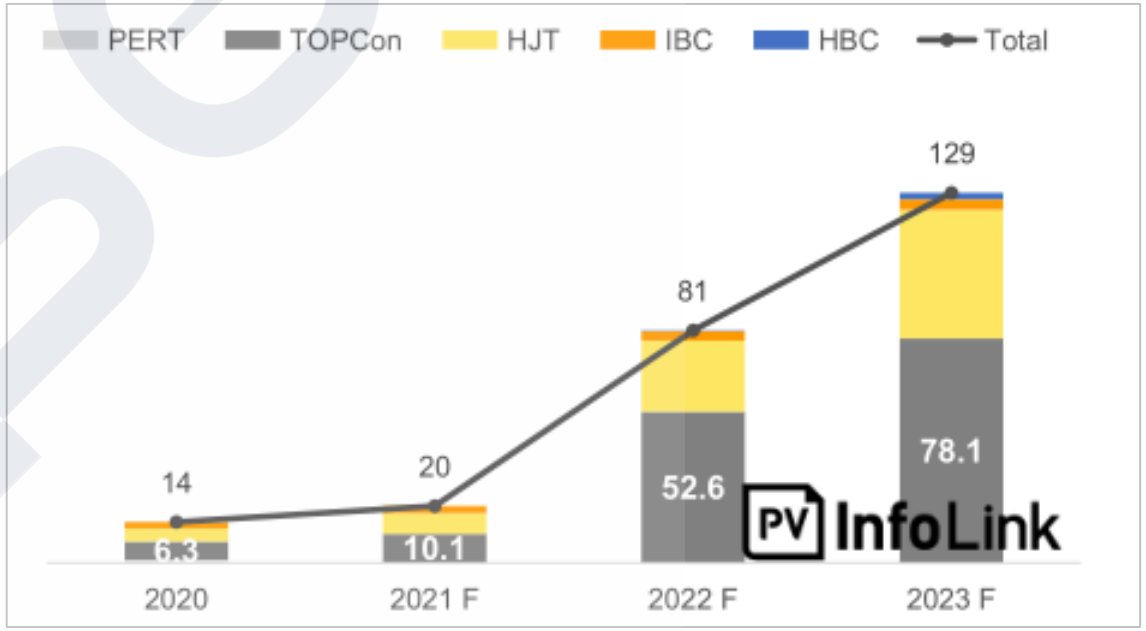
Jolywood N-Type TOPCon Product 2022

Lei Xiaofei, Sep 2022

Content

Solar Cell Technical Classification

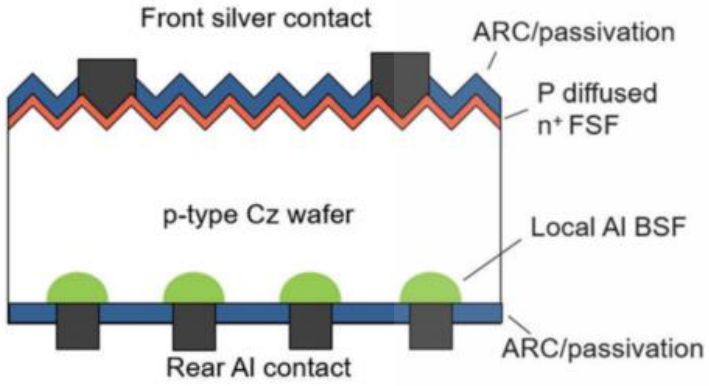




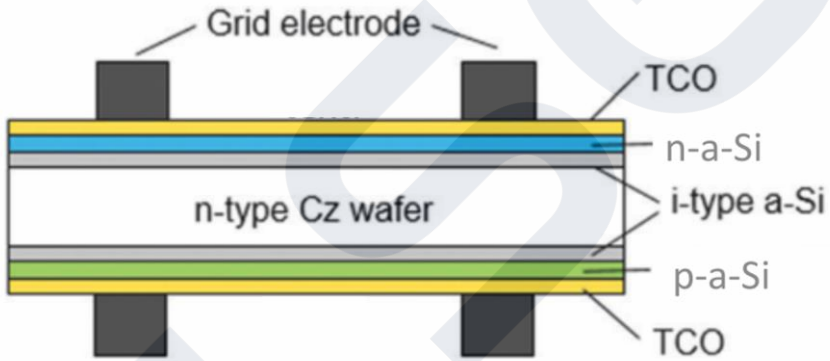
- N type technology market share increases sharply and will become the mainstream in the next five years.
- Among the n-type cell technologies, TOPCon cell will be the dominance.

Cell Technology Comparison

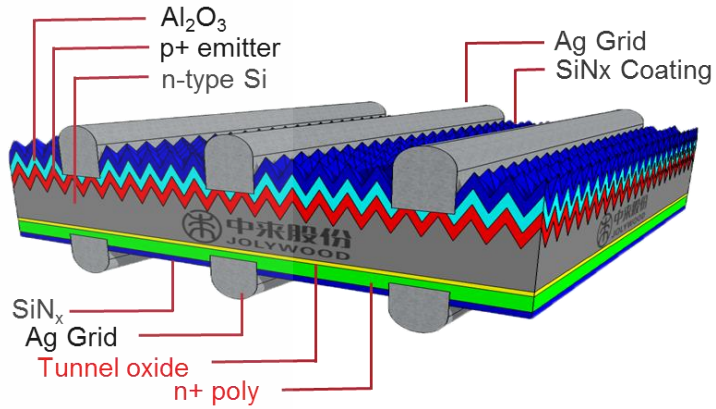
PERC



HJT



TOPCon



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

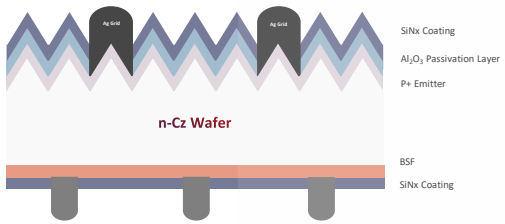
- Both TOPCon and HJT cell achieve high efficiency through passivation.
- TOPCon uses tunnel oxide layer.
- HJT uses intrinsic amorphous silicon layer.

Cell Technology Comparison

Cell technology	P-PERC	N-TOPCon
Cell efficiency	~ 23%	~ 24.5%
Theoretical limit value of efficiency	24.50%	28.70%
Bifaciality	65%-70%	80%-85%
Temperature Coefficient of Pmax	-0.35%/℃	-0.30%/℃
LID	Yes	Near zero
LeTID	High risk	Low risk
Degradation	1st year: ≤2% 2nd to 30th year: ≤0.5%	1st year: ≤1% 2nd to 30th year: ≤0.4%
Low illumination response	Normal	Good
Compatible with PERC production line	Same	Upgrade
Cost-efficiency	Middle	High

Jolywood N-type Cell Technology

21.5%-22%
N-PERT cell



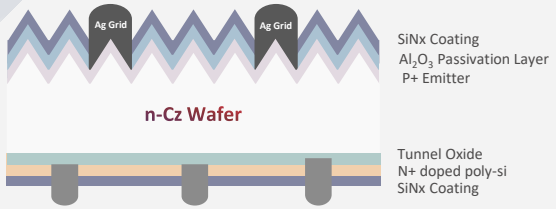
2016 — 22% — 2018

Average production line efficiency 22%

Mass production efficiency of cell achieved 24.5%,
Cell efficiency with large size wafer achieved 25.4% in the lab, broke the industrial record in Sep. 2021

2019 — 25.4% — 2022

23.5%-25.4%
J-TOPCon 2.0



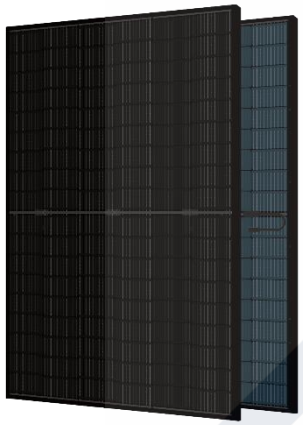
>26%
J-TOPCon 3.0

26% — 2025

Less silver consumption
Shorter process

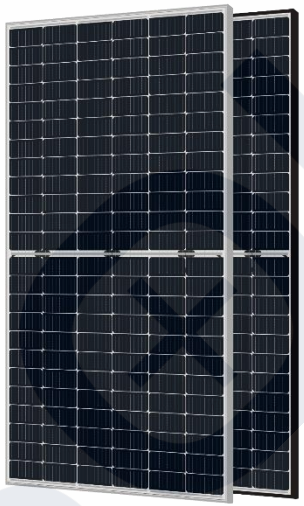
Jolywood N-type Module Categories

- Wafer size: 166mm, 182mm, 210mm
- Power grade: 400W+, 560W+, 600W+, 670W+
- Meet the diversified requirements of all categories: residential, C&I and utility



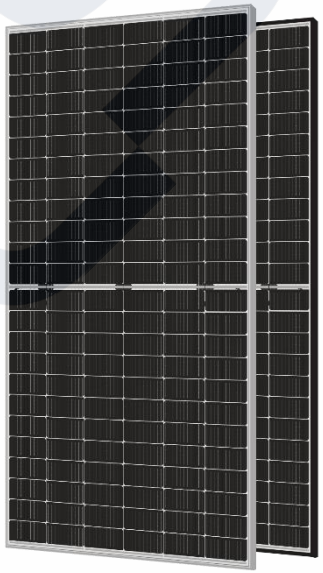
Niwa Black

182mm size wafer



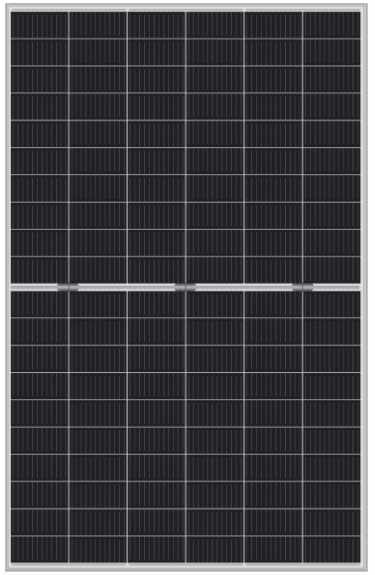
JW

166mm size wafer



JW Pro

182mm size wafer



JW Max

210mm size wafer

Meet Different Application Scenarios

Utility-scale plant

JW Max series
JW Proseries

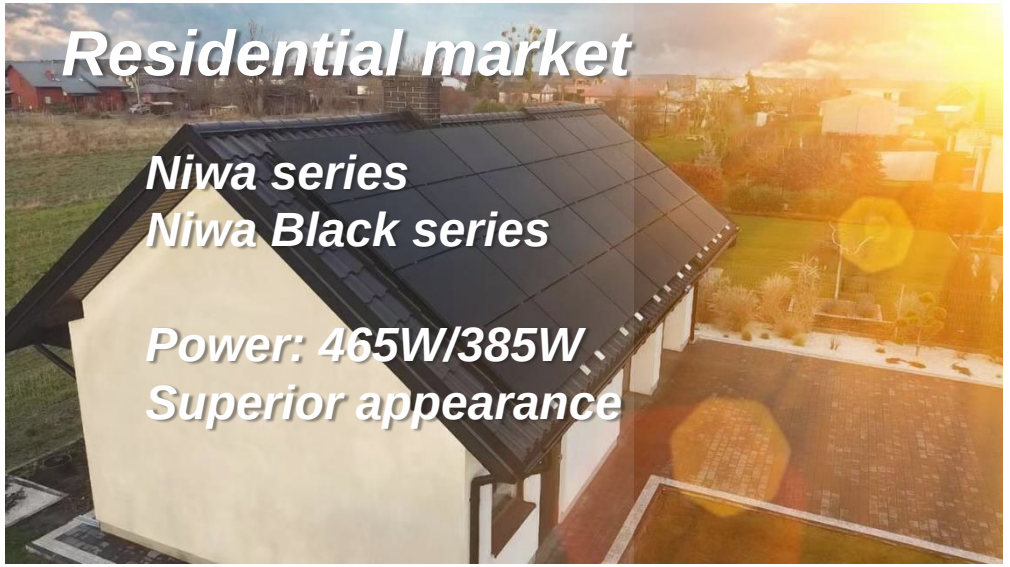
Power: >600W
Best LCOE product

C&I market

JW Proseries
Niwa series

Power: 565W/465W
Flexible size selection

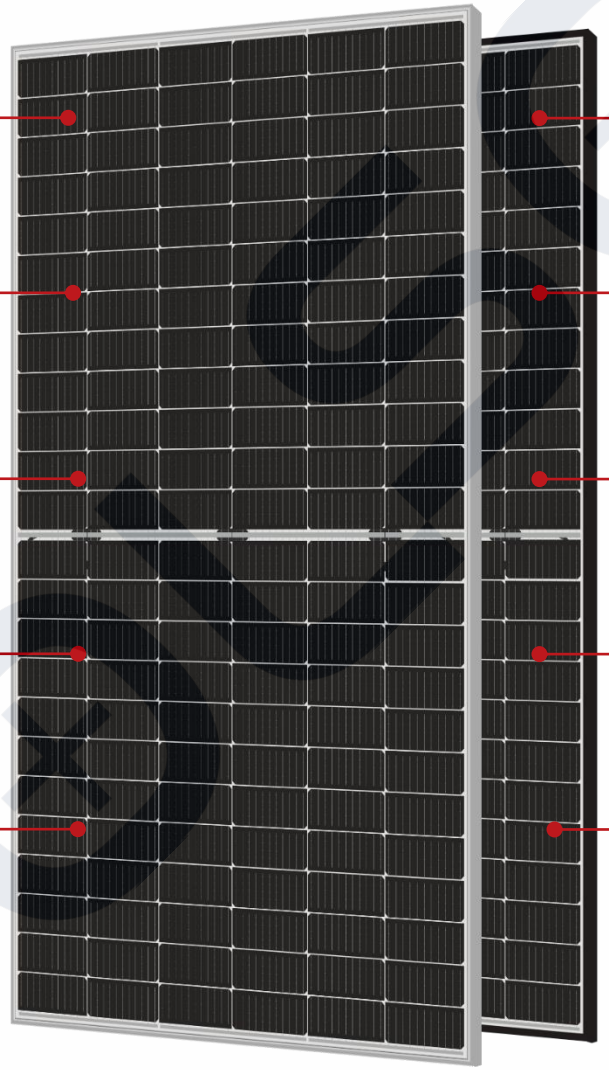
Residential market



Niwa series
Niwa Black series

Power: 465W/385W
Superior appearance

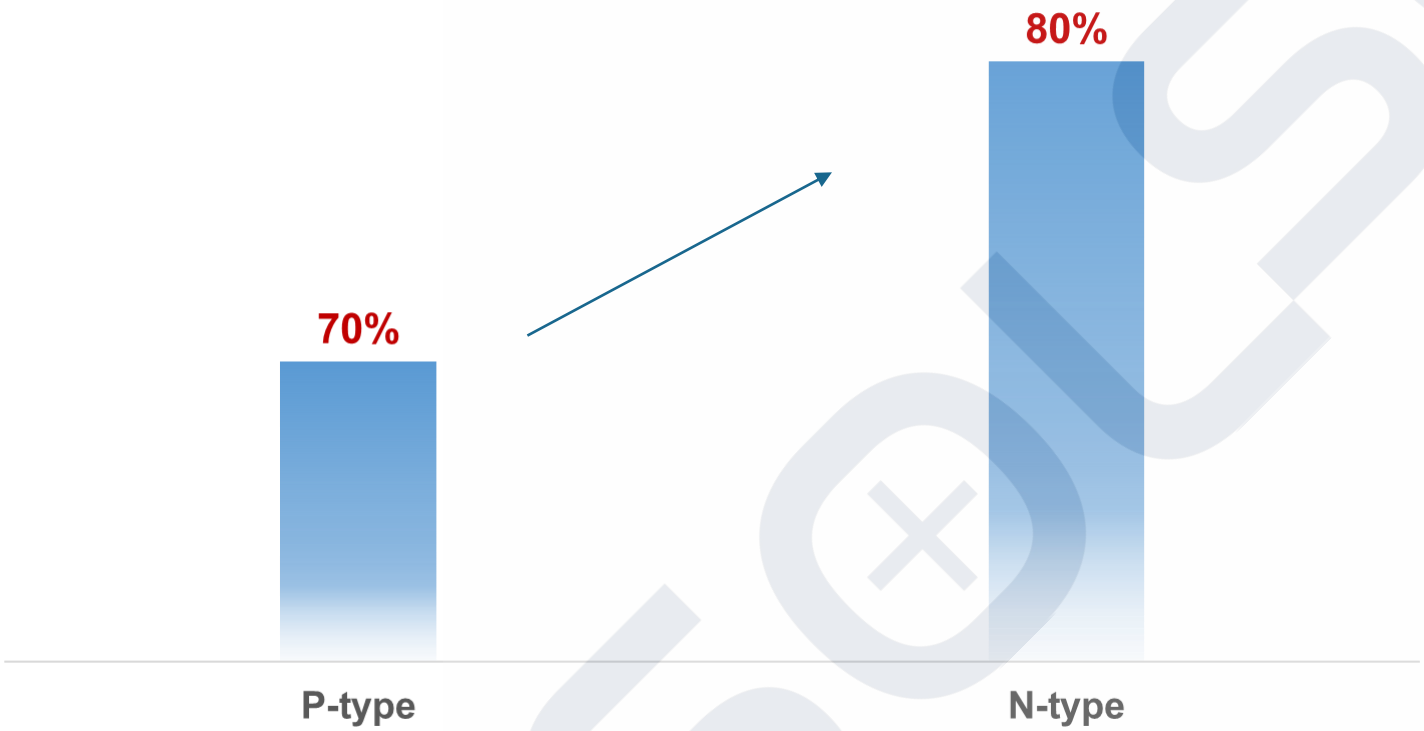
Advantages of N-TOPCon Modules



- High power
- High bifaciality
- High reliability
- Low degradation
- Low temperature coefficient
- Near zero LID
- Better 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%**.



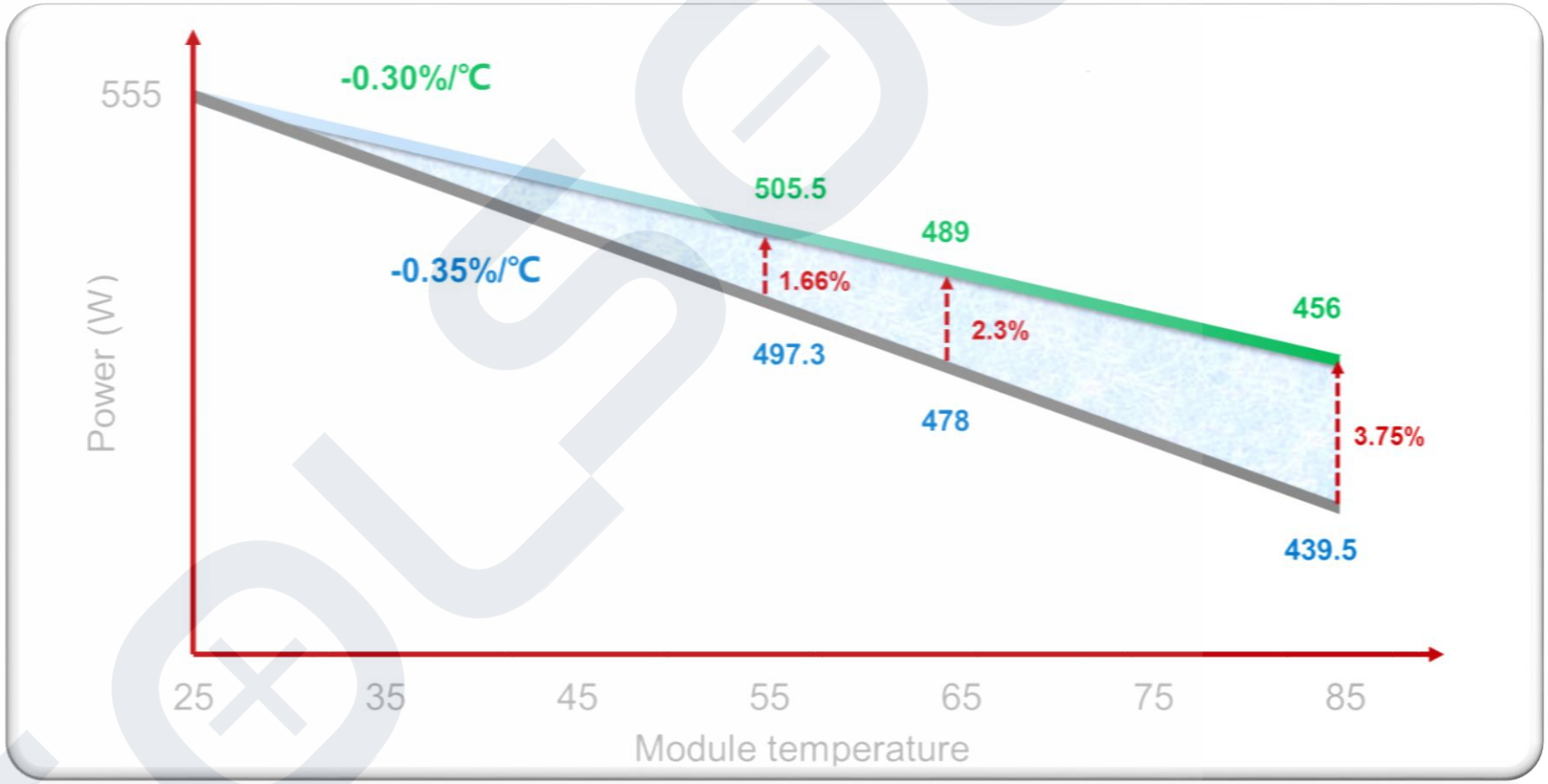
α	10%	20%
PERC	7.0%	14.0%
TOPCon	8.0%	16.0%
Power gain	1.0%	2.0%

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

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

TOPCon Advantage----Low Temperature Coefficient

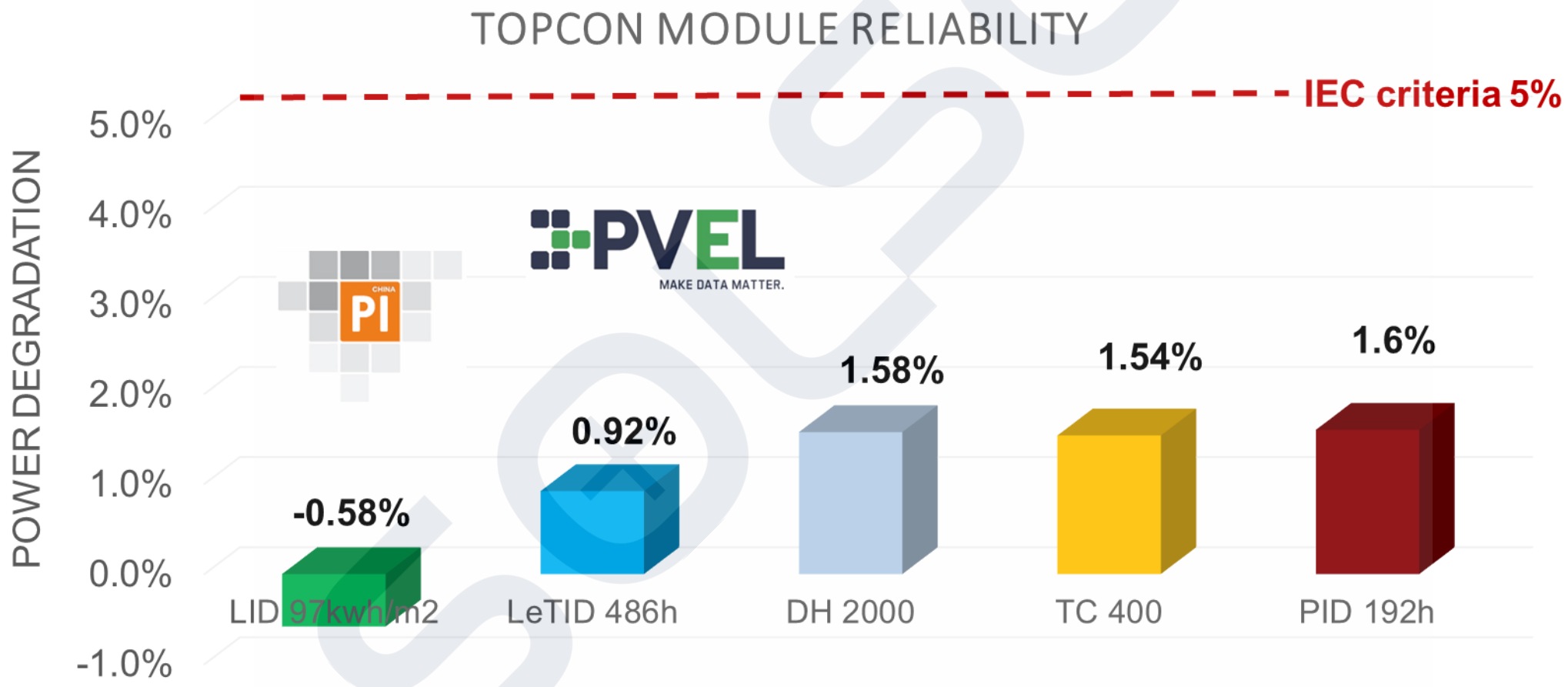
- P-type：**-0.35**%/℃
- N-type：**-0.30**%/℃



- 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

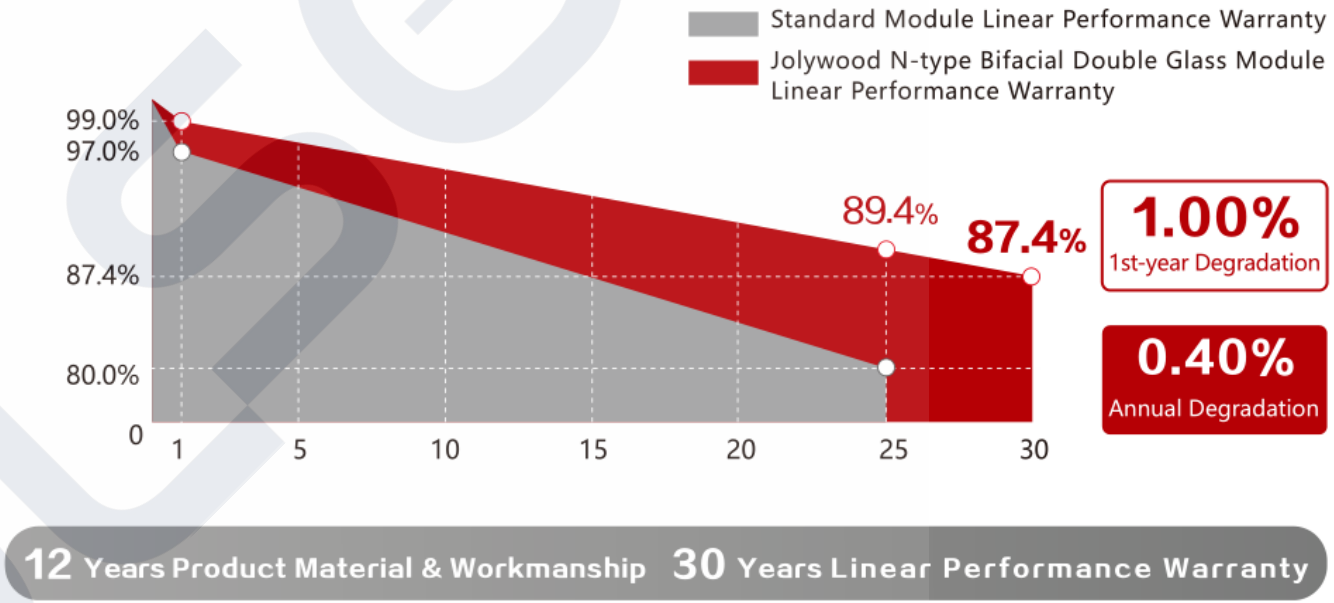
- TOPCon module has a better performance than IEC standard, even under enhanced test sequence.



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.



➢ *Product warranty can be extended to **25** Years for NIWA Black module.*

TOPCon Advantage----Improved Energy Generation

- Base line: PERC bifacial module.

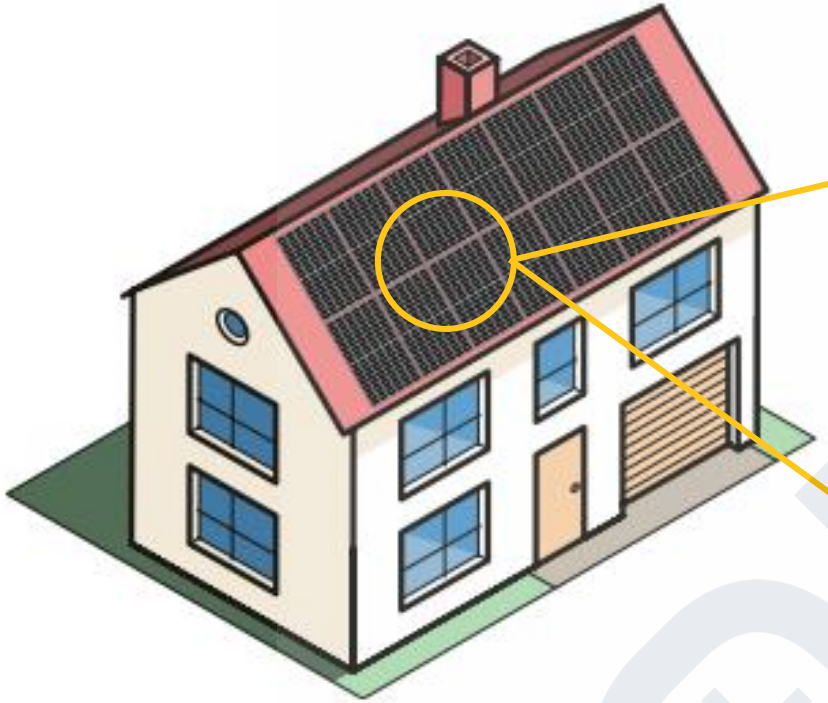
TOPCon module improved Energy Generation

	Energy gain
First year	3.37%
30 years	4.18%

- *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%*
- *HJT module: 1st year degradation 1%, annual degradation 0.4%*

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

TOPCon Module---High Value Return__*Rooftop*



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 Module---High Value Return__*Rooftop*

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. PERC module.

- *1MW project, Germany*
- *TOPCon module bifaciality 75%, temperature coefficient -0.32%/℃, 1st year degradation 1%, annual degradation 0.4%*
- *PERC module:, bifaciality 65% , temperature coefficient -0.34%/℃ , 1st year degradation 2% , annual degradation 0.45%*

TOPCon Module---High Value Return__*Utility-scale*

- **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 Module---High Value Return__*Utility-scale*

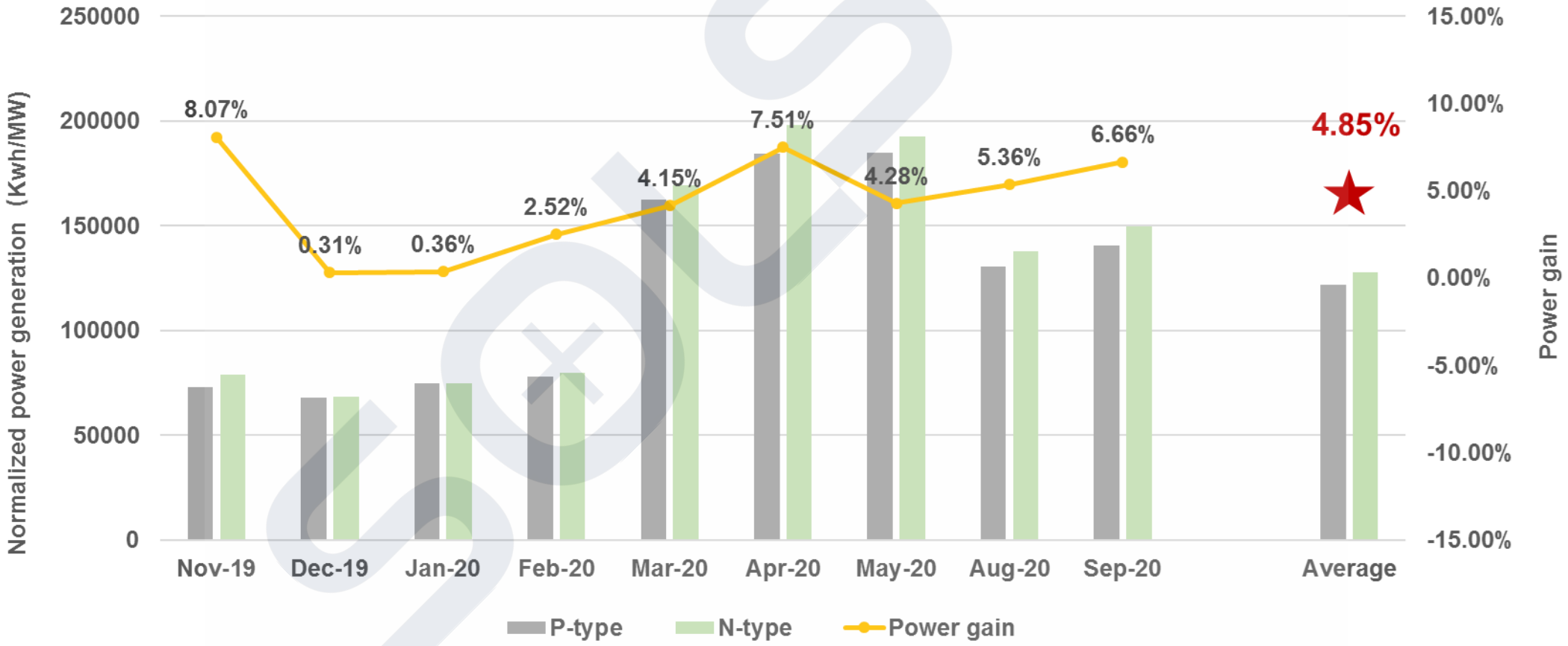
Item	Unit	PERC bifacial	TOPCon bifacial	TOPCon bifacial
Annual effective irradiation hours	h/year	2000	2000	2000
Module power	Wp	**545**	**545**	**575**
Module price	**$/Wp**	**0.272**	**0.29**	**0.302**
Effective power	Wp	512	525	554
Total cost per watt in life (discounted)	$/Wp	0.701	0.720	0.72
Initial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

- **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.**

- *50MW project, Abu Dahbi*
- *NTOPCon module bifaciality 75%, temperature coefficient -0.32%/℃, 1st year degradation 1%, annual degradation 0.4%*
- *PERC module:, bifaciality 65% , temperature coefficient -0.34%/℃ , 1st year degradation 2% , annual degradation 0.45%*

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%**.



Overseas Residential Projects

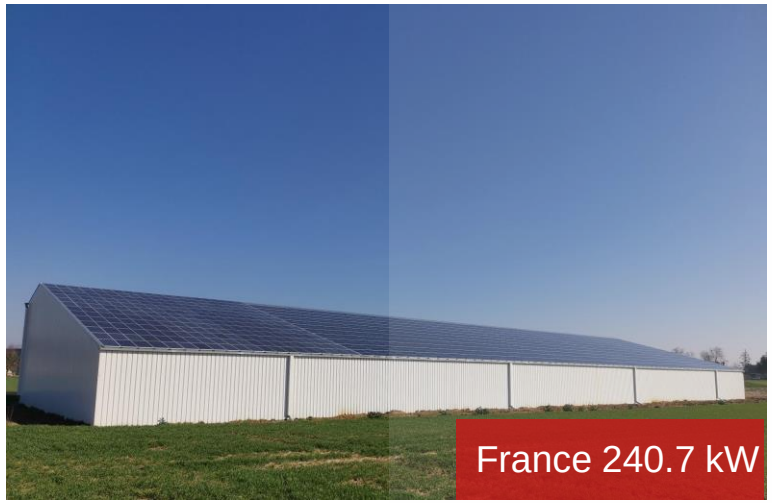

Poland 6 kW


Germany 7 kW

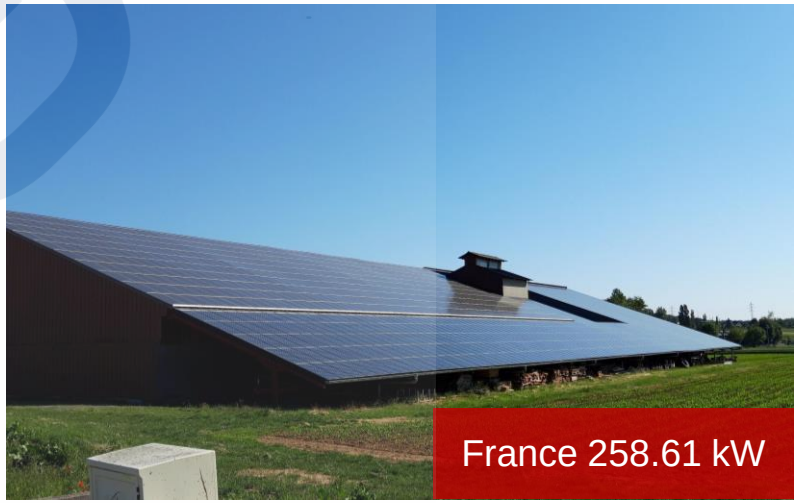

Poland 10 kW

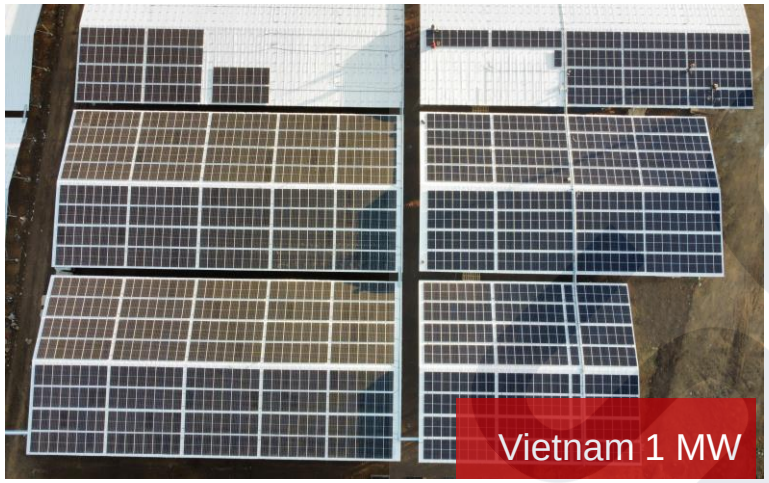

Poland 50 kW

Overseas C&I Projects


France 240.7 kW


France 258.6 kW

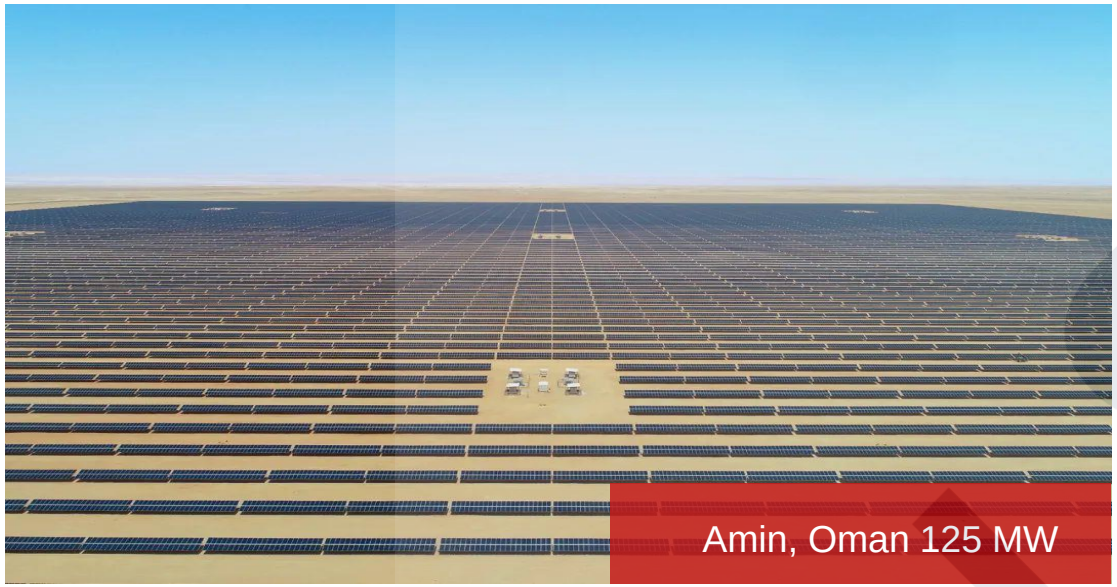

France 258.61 kW


Vietnam 1 MW


Poland 120 kW


France 227.3 kW

Overseas Utility-Scale Projects



Amin, Oman 125 MW

Ibri II, Oman 458 MW

Khmelnitskiy, Ukraine 1.8 MW

Baden-Württemberg, Germany 1 MW

Rilland, Netherland 11.75 MW

Domestic Utility-Scale Projects


Datong, Shanxi 29.2 MW


Sihong, Jiangsu 110 MW


Qinghai 153 MW


Yangquan, Shanxi 100 MW


Sihong, Jiangsu 104 MW

Jolywood Solar N-type products have been installed more than

5.8GW globally

THANK YOU

www.jolywood.cn

Leader of n-type bifacial technology

SOLSOL s.r.o. Králova 298/4, Brno, 616 00, Czech Republic, E-mail: sales@solsol.cz, www.solsol.cz