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Highlights:

1. Energy yield performance

was **3.69%**.

2. Degradation

0.51% and **1.38%**, respectively. Light induced degradation of TOPCon is much less than PERC.

The PERC solar cells are rapidly approaching the upper practical limit of achievable efficiency for that cell architecture. Additionally, the PERC design uses p-type silicon wafers, which are susceptible to light-induced degradation (LID) caused by boron oxygen (BO) defects. Due to the fast-approaching efficiency threshold and BO LID, the solar industry has impressively transited away from PERC towards N-type which uses n-type silicon wafers, doped with phosphorus, rather than the p-type wafers commonly used in PERC cells.

In recent years, TOPCon technology has been transferred from laboratory to manufacturing, which is more crucial to investigate it in outdoor performance. Thematically, N-type TOPCon solar cells do not suffer BO LID, several laboratory test reports and studies have proven that far less presence of light-(LID) and elevated temperature-induced degradation (LeTID) in n-type cells than PERC cells. But whether the performance of PV modules in real-world conditions may differ from laboratory test results, especially for the degradation, which are highly sensitive to the surrounding environment, such as irradiance, temperature, humidity. Therefore, an outdoor energy yield and performance stability comparison study performed on PERC and TOPCon modules was conducted by CPVT (National Photovoltaic Quality Inspection Center) in Yinchuan

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ent technologies were selected from JinkoSolar, and each

Group	Module	Number	Type	Mounting System
			Bifacial	
			Bifacial	

The PASAN Sun simulator measured the front and rear sides' electrical characteristics. The bifaciality and the light efficien-

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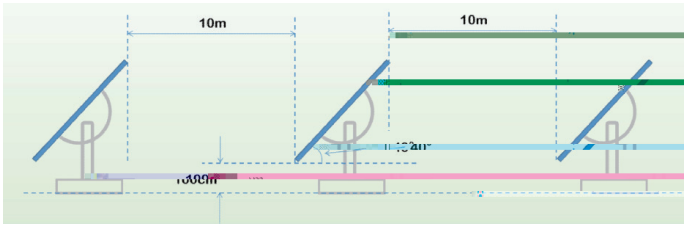
door energy generation was measured by DC meters in a

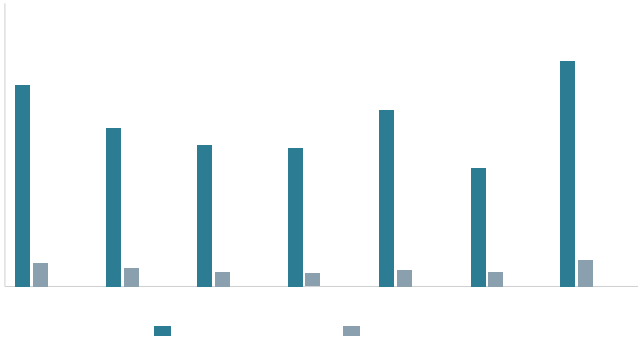
Experimental Photovoltaic Test Facility

Two groups of TOPCon and PERC bifacial modules were



The monthly irradiation of front and rear side and albedo of test-

Month	Fixed Axis- Cumulative Irradiation(kWh/m²/month)		Reflectance (%)
	Front side	Rear side	



The monthly energy yield of two groups (measured from Sep-

Calculator:

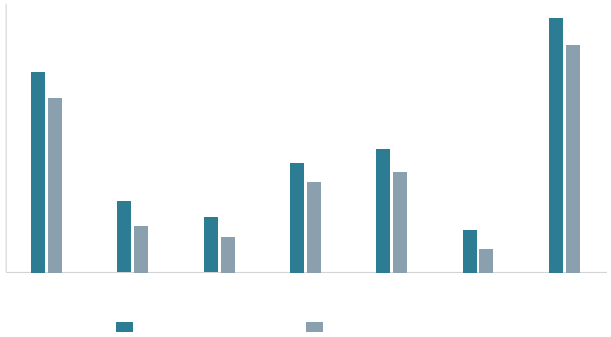
Formula 1:

$$\text{Power generation per watt(Wh/W)} = \frac{\text{Cumulative power generation(kWh) x 1000}}{\text{Average test power of array modules(W) x modules quantity}}$$

Formula 2:

$$\text{Power degradation(\%)} = \frac{\text{Initial Test Power (W)- Period Test Power (W)}}{\text{Initial Test Power (W)}}$$

Month	Group 1-Power generation per watt (Wh/W)	Group 2-Power generation per watt (Wh/W)
Average		



The performance degradation of N-type and PERC were shown in Table

	Isc(A)	Voc(V)	Imp(A)	Vmp(V)	Pmax(W)	FF(%)	Eff.(%)

	Isc(A)	Voc(V)	Imp(A)	Vmp(V)	Pmax(W)	FF(%)	Eff.(%)

Conclusions:

1. Energy yield performance

3.69%.

2. Degradation:

0.51% and **1.38%**, respectively. Light induced degradation of TOPCon is much less than PERC.

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