CPVT Yinchuan PV Module Low-Light Performance Verification: TOPCon Shows Up to 4.38% Higher Gain Than BC

Highlights:

1. Weak light yield: During 6am-9am & 5pm-8pm, the energy yield gain of n-type TOPCon (Group 1) over n-type BC (Group 2) was 3.89% in cloudy and rainy days, 2.33% in sunny days.

2.Low irradiation yield:TOPCon shows up to 4.38% higher gain that n-type BC.

Irradiance (W/m²)	Jinko TOPCon (Wh/W)	N-type BC (Wh/W)	Yield Gain
0-100	4.044094143	3.874520349	**4.38%**
100-200	7.401870447	7.257179848	**1.99%**
200-300	10.90503322	10.75731289	**1.37%**
300-400	12.1287118	12.01851403	**0.92%**

From TOPCon to n-type BC, each type of solar panel responds differently to various amounts of light intensity.While solar panels are often tested using a standardized level of irradiation, the outdoor application of solar panels never involves a consistent light level. Outdoor-installed solar panels are often in low-light conditions and research has shown the performance of solar panels in these conditions is a primary driver of variation in a photovoltaic system.

To conduct an in-depth study on the real performance of modules under low-light conditions, JinkoSolar commissioned the National Photovoltaic Quality Inspection Center (CPVT) to carry out an outdoor empirical study in Yinchuan, Ningxia, northwest China, in June 2025. The study compared the power generation performance of JinkoSolar's TOPCon modules and N-type BC modules under low irradiance. The purpose of this test study is to go deep into the contributors of yield gain in low-light conditions, including early morning, late afternoon, cloudy or foggy or rainy days. During these times, all research solar modules can' t work as well as in strong sunlight, but which are impacted less and can keep making good power.

Figure 1: Project Picture

Experimental Design:

Two groups of total 20 pieces of TOPCon and n-type BC bifacial modules were installed on a fixed axis (as shown in Table 1)

Technology	Power/W	Module type
Jinko TOPCon	635W	Dual Glass
N-type BC	640W	Dual Glass

Table 1:Product Information

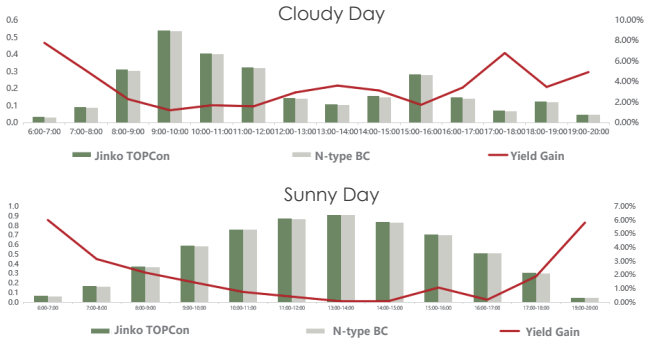
The HALM Sun simulator measured the front and rear sides' electrical characteristics. The bifaciality and the light efficiency at 60kWh/m² were also measured and calculated. The out-door energy generation was measured by DC meters in a 30-seconds interval. The data measured from June 01 - June 30 2025, 6am-9am & 5pm-8pm.

Results:

1. During June 1 to June 30, production in low irradiation (0-400W/m²) period accounts for 24% of total, representing the importance of low light performance affecting overall energy yield.
2. The poorer the light intensity, the more advantage of TOPCon shows. During two period per day 6am-9am & 5pm-8pm.

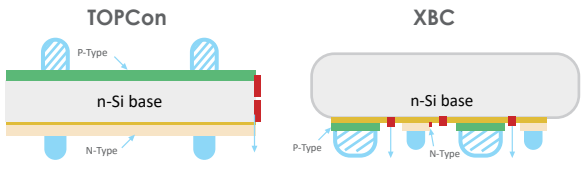
* The single-watt power generation gain of TOPCon over n-type BC in cloudy days: **3.89%**
* The single-watt power generation gain of TOPCon over n-type BC in sunny days: **2.33%**

Energy Yield Comparison between Jinko TOPCon and N-type BC Modules Across Time Periods



Conclusions:

1. In real world, solar modules still generates energy during low light or dull climate, but will reduce more or less. The productivity and negative impact depends on what modules used.
2. The low-light functionality of a solar cell is primarily reliant on the shunt resistance, fill factor and recombination loss of leakage current. The large amount of leakage current path existing across BC cells and FF disadvantage leads to poorer energy yield particularly in low light conditions.



Leakage current paths are mainly distributed around the periphery of the cell

Large number of potential leakage paths—over 200 on a single cell—making process control difficult, and resulting in high leakage currents