TIGER Neo III

JinKO Solar
ur Trust in Solar

Yantai, Shandong Field Test Report: TOPCon Shows an Average 3.16% Performance Gain Over BC

Key Findings

1. Consistent Lead in Cumulative Power Generation Gain

During the nearly four-month monitoring period from November 6, 2025, to February 28, 2026, high-power TOPCon modules achieved an average power generation gain of 3.16% per watt compared to BC modules of the same power rating. (Cumulative generation per watt reached **310.26 kWh/kW** for the 650W TOPCon module, compared to **300.76 kWh/kW** for the 650W BC module serving as the control.). Month-by-month data shows that the cumulative power generation gain of TOPCon modules remained positive in every month, with no instances of negative gain, validating their reliable performance during autumn and winter and under various weather conditions. For power plant investors, stable positive gains and cumulative returns over the entire lifecycle are the core metrics for evaluating module value.

2. Significant Amplification Effect During Low-Irradiance Periods

From November to December, the Yantai region of Shandong experienced frequent cloudy and hazy weather typical of autumn and winter, resulting in a significant increase in the proportion of low-irradiance periods. According to data from the Yantai Meteorological Bureau (Fushan National Basic Meteorological Station), the number of days with irradiance <400 W/m² in Yantai during November–December was approximately 43–47 days, accounting for 70%–77% (based on a comprehensive estimation of the meteorological station' s sunshine, weather, and irradiance data). During this period, the 650W TOPCon modules demonstrated strong low-light performance, with a per-watt gain of up to **5.39%** in November and **4.30%** in December. These figures directly confirm the superiority of TOPCon technology in controlling leakage current under low-irradiance conditions.

3. Effective Utilization of Bifaciality Advantages

The project employs fixed-mount structures with the lower edge of the modules positioned 1.5 meters above ground level, allowing the rear side to fully capture ground-reflected light and air-scattered light. Leveraging their high bifaciality, TOPCon modules capture additional ground-reflected light resources under low-angle winter sunlight, making a significant contribution to cumulative power generation gains. Based on calculations using a ground albedo of 22%–25% in a sandy terrain scenario, the high bifaciality ratio can deliver significant additional power output to the power plant, effectively enabling the customer to achieve higher overall power generation capacity with the same module capacity.

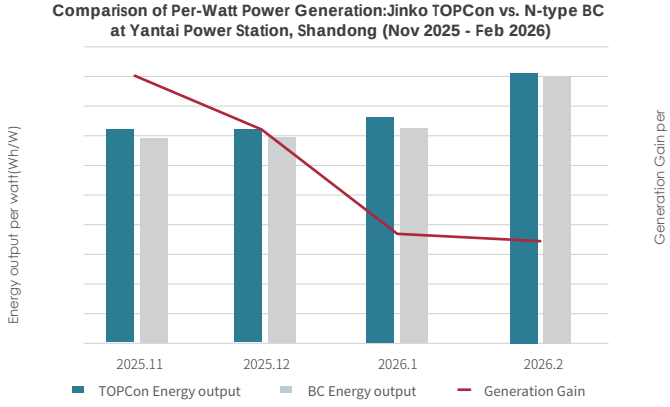

Figure 1: Project Picture

Project Background

characterized by four distinct seasons, a warm and humid climate, and abundant rainfall. In autumn and winter, influenced by cold air masses, the region experiences a high proportion of cloudy and hazy days, with prolonged periods of low light; by late winter and early spring, sunlight conditions gradually improve, and irradiance levels rise. These typical climatic characteristics provide an ideal natural testing ground for evaluating performance differences in photovoltaic modules under varying light conditions.

To objectively quantify the long-term performance of TOPCon modules in a typical northern monsoon climate zone, this field test was conducted at a small ground-mounted power station (distributed project) in Yantai City, involving nearly four months of string-level comparative testing. The monitoring period spanned from late autumn to late winter, encompassing complex operating conditions such as a high proportion of low-light hours, low solar angles, and relatively low temperatures, thereby providing reproducible and comparable empirical data to support the selection of PV modules for North China and regions with similar climates.

Project Design

Mounting Method: Fixed mounting brackets, south-facing, with a tilt angle of 15°.

Height Above Ground: The lower edge of the modules is 1.5 meters above the ground, providing ample space for backside reflection.

Test Samples: 15 TOPCon modules (rated power 650W) and 15 competing BC modules of the same power rating (rated power 650W); the total capacity of both module types is 9.75 kW.

	TOPCon	N-type BC
Power (W)	650	650
Size (mm)	2382X1134	2382X1134
Capacity (kW)	9.75	9.75

Electrical Configuration: Two string circuits are connected to independent MPPT channels of the same model of string inverter, with power generation data collected simultaneously.

Monitoring Period: November 6, 2025, to February 28, 2026, covering late autumn, winter, and early spring, for a total of nearly four months.

Data Collection: The system continuously records parameters such as power generation (Wh) for each module string, irradiance on the module surface, backplate temperature, and ambient temperature and humidity, with a sampling interval of 1 minute to ensure data integrity and comparability.

Core Monitoring Metrics: Monthly power generation per watt (Wh/W), cumulative power generation per watt (Wh/W), and relative power gain (%).

Project Results

This nearly four-month field test in Yantai, Shandong, has fully demonstrated the performance advantages of TOPCon modules under typical northern climate conditions. The key conclusions are as follows:

First, they lead in both cumulative yield and monthly stability. During the monitoring period, the cumulative energy yield per watt of TOPCon modules was 3.16% higher than that of BC modules of the same power rating, and positive gains were achieved in every month. Even during January and February, when sunlight intensity increased and the proportion of low-light periods decreased, the gain remained positive (1.82% and 1.69%, respectively), with no performance reversal observed in any month. For power plant investors, sustained positive gains and cumulative returns over the entire lifecycle are the core criteria for selecting modules.

Second, the technological mechanism underpins the low-light advantage. From a cell structure analysis, the positive and negative electrodes in TOPCon cells are distributed on the front and back sides of the cell, respectively, with leakage current pathways primarily concentrated in a small area along the edges, resulting in stronger overall leakage current control. In contrast, N-type BC modules, due to the complex finger-like cross-electrode structure on the back and the numerous process steps involved, have a denser distribution of potential leakage points. Under low-irradiance conditions, they are more prone to additional losses, which consequently have a sustained impact on daily power generation. This mechanism directly explains the source of their performance, with monthly gains as high as 4.30% to 5.39% during the frequent periods of low-irradiance weather—such as cloudy and hazy conditions—in November and December.

Third, overall value: consistent monthly returns, with cumulative returns being the ultimate measure of success. For power plant investors, sustained positive power generation gains and cumulative returns over the entire lifecycle are the core criteria for selecting modules. TOPCon modules demonstrate clear advantages in three key areas: cumulative power generation returns, low-light performance, and monthly stability. Their structural advantages in leakage control and high bifaciality design provide a fundamental guarantee for their sustained leadership across all scenarios. The solar industry is shifting from a "price war" to a "value war," and bifacial power generation represents an underappreciated area of high value. In Yantai, Shandong, and similar warm-temperate monsoon climate regions, high-power TOPCon modules can effectively harness off-peak sunlight resources and extend effective power generation duration, delivering quantifiable long-term yield improvements for end users.