TOPCon Comparison Field Tests Tracing Results

High-Efficiency, Reliable, and Sustainable Green Energy Solution

JinkoSolar Co., Ltd.

Kagoshima, Japan Outdoor Field Test

TOPCon Achieves 7.1% Long-Term Energy Yield Gain Over N-type BC Modules

Project Location: Kagoshima, Japan (32°3’ 57”N, 130°19’ 53”E)

Site Selection: Kagoshima’ s coastal location and subtropical marine climate—with high humidity, salt exposure, and seasonal variation—makes it an ideal site to test solar module durability, corrosion resistance, and performance in challenging conditions. It also provides valuable data for nearshore and offshore PV applications.

Project Overview: The field test installed two types of modules: N-type TOPCon and N-type BC. Two modules from each manufacturer were mounted on fixed racks 1.2 meters above the ground at a tilt angle of 32 ° . Initial power was measured using a transient simulator (SAT method), without spectral correction in the results. DC power output of each module was collected using a high-precision CR1000X data acquisition system, with a sampling interval of one minute. In parallel, irradiance on module surfaces, backsheet temperature, ambient temperature and humidity, and atmospheric pressure were also recorded every minute.

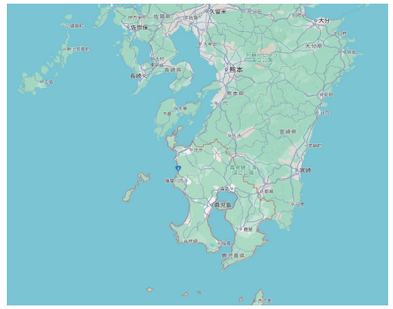
Technology	Size(mm)	Type
N-type TOPCon	2278x1134x30	Bifacial
N-type BC	2278x1134x30	Monofacial

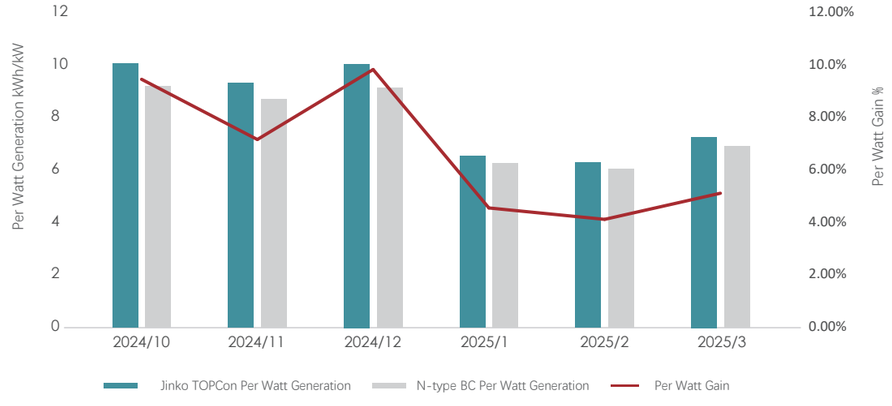
Test Results: Between October 2024 and March 2025, comprehensive performance tests were conducted on the two module types. Results showed that TOPCon modules delivered a six-month normalized energy yield of 495.36 kWh/kW, while N-type BC modules yielded 462.54 kWh/kW. This translates to an average long-term per-watt energy yield gain of 7.1% for TOPCon. Key insights include:

1. From October to December 2024, Kagoshima experienced frequent rainy and cloudy days, with few sunny days. Under these low-irradiance conditions, TOPCon modules demonstrated superior low-light performance. For example, during a 15-day cloudy period from October 15 to 29, the average daily per-watt gain reached 9.13%.

2. In sunny conditions, TOPCon’ s high bifaciality of up to 80%+ boosted energy yield. This benefit was particularly prominent in Kagoshima, where gravel surfaces with high albedo helped reflect more light onto the module backsides. Higher bifaciality allows TOPCon modules to capture more reflected light, significantly increasing generation.

3. Located 2km away from the coast, the test site exposed modules to high humidity and salt mist. This made reliability critical. The test confirmed TOPCon’ s excellent durability and stability in nearshore and offshore environments, maintaining high output and extending system lifespan even under harsh conditions.





Laizhou, Shandong Ourdoor Field Test

Up tp 4.77% Monthly Yield Gain of TOPCon Over P-Type BC

Project Location: Laizhou, Shandong Province, China (34°50’ N, 112°33’ E)

Site Selection: Laizhou is a coastal city with abundant sunlight and a marine climate. This site was selected for pilot testing of PV modules under different environmental conditions. This case specifically evaluates the power generation performance of TOPCon versus P-type BC modules in a real residential solar power plant scenario.

Project Overview: This is a rooftop residential PV project located 2km away from the coastline in Laizhou, Shandong. Two types of modules were installed: Jinko’ s N-type TOPCon modules (rated at 575W) and P-type BC modules (ratedat 580W). The modules are south-facing, installed at a 20 ° tilt. Each type used 15 modules per string and shared the same model of inverter from the same manufacturer. The modules were installed approximately 10cm above the rooftop surface, with no shading at the test site.

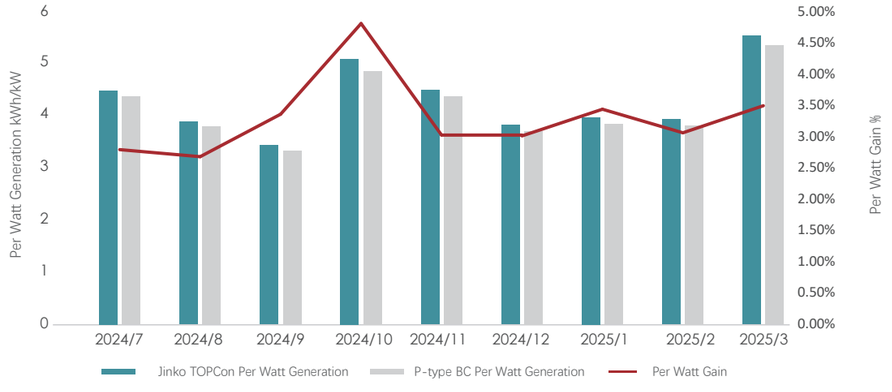
	Jinko N-type TOPCon Module	P-type BC Module
Technology	TOPCon	BC
Specification	2278X1134X30mm	
Quantity	16 pcs	16 pcs
Power	575	580
Installation Scenario	Rooftop Mounting	
Starting Time	2024-6-23	

Test Results: From July 2024 to March 2025, Jinko’ s N-type TOPCon modules achieved an average daily power output of 4.27 kWh/kW, compared to 4.13 kWh/kW for the P-type BC modules—an energy yield gain of 3.31%. Under low-light conditions, TOPCon modules showed even more pronounced advantages. Data from clear mornings and afternoons in October and November (7:00–9:00 AM and 3:00–5:00 PM) showed that TOPCon modules outperformed P-type BC modules by 8.29%. Key insights include:

1. During hot summer months (July–September) in Shandong, Jinko’ s TOPCon modules demonstrated superior heat dissipation, leading to significantly lower power degradation than P-type BC modules. This thermal stability allowed TOPCon to maintain higher efficiency and improve annual system output.

2. In low irradiance conditions, such as early morning and late afternoon (7:00–9:00 AM and 3:00–5:00 PM), TOPCon generated 8% more electricity than P-type BC. This shows TOPCon’ s excellent weak-light performance, delivering stable and higher energy yields even under cloudy or low-sunlight conditions.

3. Backed by multiple field studies and offshore PV projects, Jinko’ s TOPCon modules have proven their high durability and reliability in nearshore and marine environments. Even under harsh conditions like high humidity and salt mist, TOPCon maintains strong performance and significantly extends system lifespan.



Haikou, Hainan Outdoor Field Test

TOPCon Demonstrates 5.11% Higher Energy Yield Gain Compared to N-type BC Modules

Project Location: Haikou, Hainan Province, China (19°31’ 32”N, 110°07’ 22”E)

Site Selection: Haikou is located in the northern part of Hainan Island, situated on the northern edge of the tropical zone. It features a tropical monsoon climate with no harsh winters or scorching summers. The climate is warm and pleasant year-round with evergreen conditions. The area has long annual sunshine hours and high solar radiation, with an average annual total irradiance of 2043.8 kWh/m², average annual temperature of 25.2°C, average wind speed of 2.9 m/s, and relative humidity of 89.3% RH.

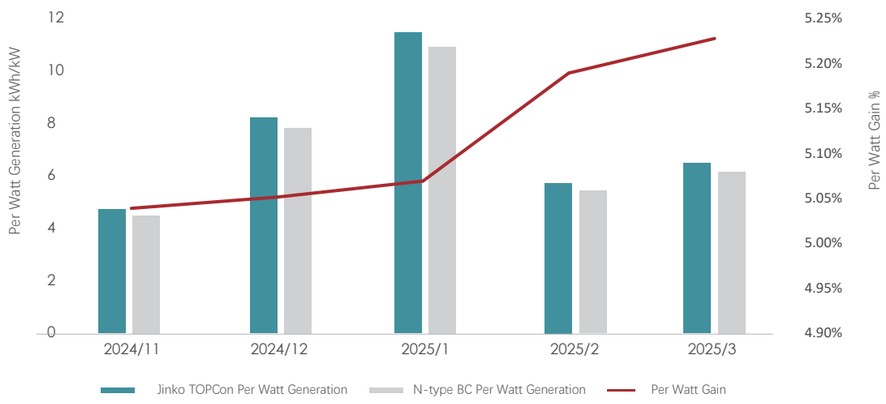
Project Overview: This field test involved Jinko’ s N-type TOPCon modules with an average bifaciality of 83.0% and another manufacturer’ s N-type BC modules with an average bifaciality of 68.7%. Each type had 10 modules installed. All were mounted on fixed racks (≈20 ° tilt) on a rooftop, with the lowest edge of the modules 0.5 meters above the concrete surface. Each module was equipped with high-precision sensors to monitor real-time power output and ensure accurate and reliable test results.

	Jinko N-type TOPCon Module	BC Module
Technology	TOPCon	BC
Specification	2278X1134X30mm	
Quantity	18 pcs	18 pcs
Power	575	575
Installation Scenario	Rooftop Mounting	
Installation height	0.5m	
Starting Time	2024-11-14	

Test Results: The report compares the energy yield and thermal performance of Jinko’ s N-type TOPCon modules and N-type BC modules over a one-quarter test period from November 15, 2024, to March 31, 2025. Key insights include:

1.The data shows that Jinko’ s TOPCon modules outperformed N-type BC modules in terms of energy yield, achieving a 5.11% higher yield.

2.The performance ratio (PR) of Jinko’ s TOPCon modules reached 95.48%, while the PR of the BC modules was 90.89%. The significantly higher PR indicates that Jinko’ s TOPCon modules experienced lower overall system losses—including losses due to temperature, wiring, and dust—resulting in better system efficiency during actual operation.



Mengzhou, Henan Outdoor Field Test

Monthly Energy Yield Gain of up to 4.71% for TOPCon Compared to P-type BC Modules

Project Location: Mengzhou City, Henan Province (34°50’ N, 112°33’ E)

Site Selection: This project was conducted as part of an owner’ s actual power generation project, meaning the results reflect the actual performance of the modules in use. Mengzhou, Henan, has a warm temperate continental monsoon climate, with hot and rainy seasons overlapping. The test period covered the winter season, during which the low solar altitude placed particular emphasis on evaluating the modules’ bifacial performance.

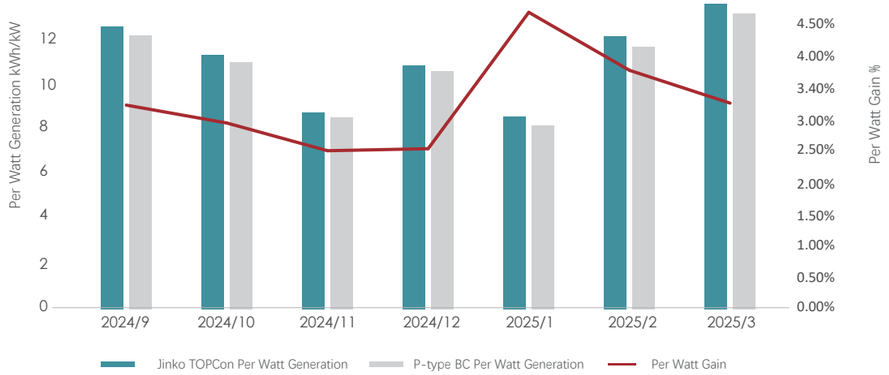
Project Overview: The two types of modules used in this field test were 575W N-type TOPCon modules and 575Wp P-type BC modules from another manufacturer. Each type included 18 modules. They were installed on fixed mounting racks at a tilt angle of 35° . All modules were equipped with high-precision sensors to monitor real-time energy yield data and ensure the accuracy and reliability of the test results.

	Jinko N-type TOPCon Module	BC Module
Technology	TOPCon	BC
Specification	2278X1134X30mm	
Quantity	18 pcs	18 pcs
Power	575	575
Installation Scenario	Ground Mounted	
Installation height	1.5m	
Starting Time	2024-8-14	

Test Results: An analysis of performance data from September 2024 to March 2025 showed that JinkoSolar’ s TOPCon modules demonstrated excellent energy yield capability, producing an average per-watt yield 3.27% higher than that of the P-type BC modules. Notably, in January—when sunlight conditions were weaker—TOPCon modules, with a bifaciality exceeding 80%, effectively utilized ground-reflected light to further improve efficiency. During this period, their per-watt energy yield was 4.71% higher than that of the P-type BC modules, fully demonstrating the advantage of high bifaciality.

Throughout the test period, the operating temperature of TOPCon modules remained consistently lower than that of P-type BC modules. The P-type BC’ s rear-contact design tends to trap heat on the back surface, causing the module temperature to rise and reducing power output efficiency. This issue may be even more pronounced in bifacial P-type BC modules, as both sides are glass-covered. Combined with the rear-contact design, this leads to greater heat accumulation, further increasing the risk of reduced efficiency and accelerated module aging.

The bifaciality of TOPCon modules ranges from 75% to 85%, significantly higher than the 55% to 65% of P-type BC modules. In Mengzhou, this difference is particularly important, as the sandy ground with high reflectivity can effectively bounce extra light onto the module’ s rear surface. A higher bifaciality allows the module to capture more of this reflected light, significantly enhancing overall power generation.



Italy Outdoor Field Test

Tiger Neo 3.0 Delivers 2.04% Higher Average Energy Yield over TBC Modules

Project Location: Basilicata region, Southern Italy (40.42°N, 16.16°E)

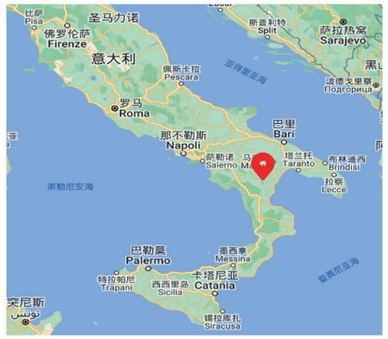
Site Selection: This region features both a Mediterranean climate and typical environmental conditions of European PV power plants. It receives an average annual irradiance of 1800 kWh/m², with extreme summer temperatures exceeding 45 ° C and significant humidity fluctuations during winter. These conditions provide an effective environment to evaluate the long-term reliability of PV modules under combined stress factors such as high temperature, high humidity, and irradiance variability.

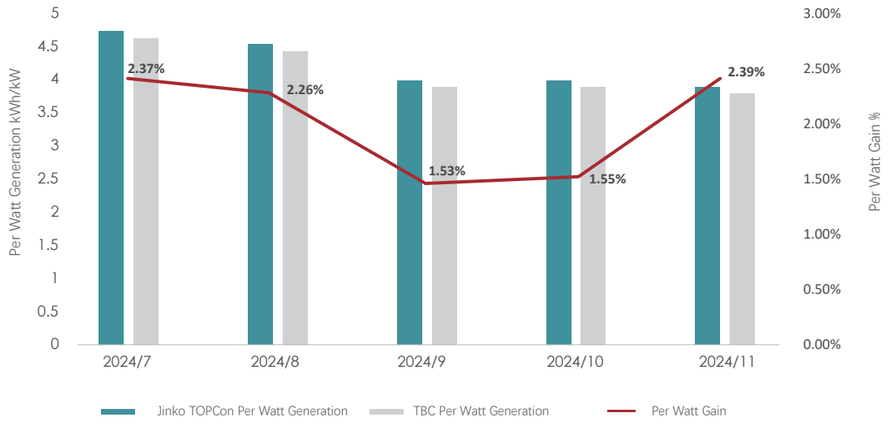
Project Overview: The European photovoltaic market accounts for 15–20% of global demand, ranking as the second-largest PV market in the world. This specific region in Southern Italy offers a mix of Mediterranean climate traits and standard European utility-scale PV conditions, making it well-suited for stress testing under variable irradiance and extreme weather. Each string in the comparative test group consisted of 16 bifacial modules. The installation angle was 33 ° , the ground surface was grass, and the distance between the bottom of the modules and the ground was 1 meter.

Technology	Power(W)	Size(mm)	Type
N-type TOPCon	605	2278x1134x30	Bifacial
TBC	610	2278x1134x30	Bifacial

Test Results: Data from the July to November 2024 test period show that the Tiger Neo 3.0 modules achieved an average daily energy output of 4.21 kWh/kW, while the TBC modules averaged 4.13 kWh/kW. This represents a power yield gain of 2.04%.

Month	Jinko TOPCon Per Watt Generation	TBC Per Watt Generation	Per Watt Gain
Jul	4.75	4.64	2.37%
Aug	4.52	4.42	2.26%
Sep	3.98	3.92	1.53%
Oct	3.94	3.88	1.55%
Nov	3.86	3.77	2.39%
Total	**4.21**	**4.13**	**2.04%**





Putian, Fujian Outdoor Field Test

TOPCon Achieves Monthly Energy Yield Gain of up to 2.65% Compared to P-type BC Modules

Project Location: Tidal flat area of Putian, Fujian Province (24°59' N, 118°27' E)

Site Selection: With the rapid global growth in PV installations, offshore photovoltaics have emerged as an innovative approach to energy utilization and resource development. Known for high energy yield and minimal land use, offshore PV offers an effective solution to increasingly limited land resources. However, for PV modules to operate reliably in marine environments, they must endure harsh conditions such as strong winds, extreme temperatures, seawater immersion, saltwater corrosion, and marine organism attachment.

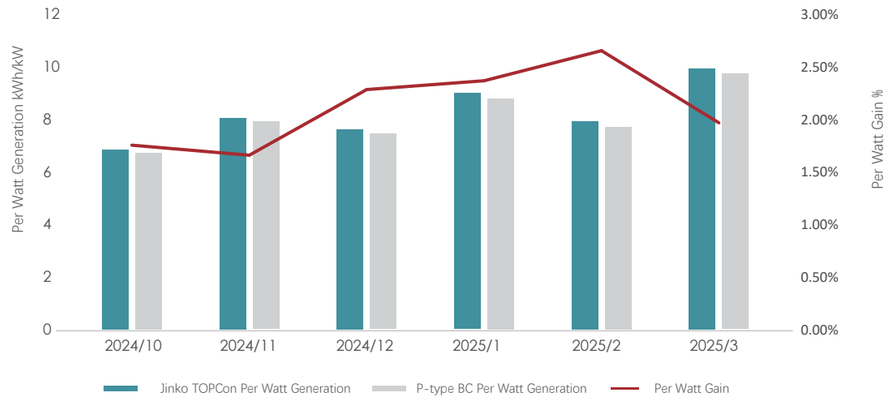
Project Overview: The tidal flat area of Putian features unique marine climate conditions, including tides, humidity, and salt mist, making it an ideal testing ground for evaluating PV module performance. This test deployed 26 Jinko N-type TOPCon bifacial modules and 26 P-type BC bifacial modules from another manufacturer. All modules were installed on fixed racks with a tilt angle of 20 ° , positioned about 5 meters above the ground and approximately 100 meters from the coastline.

Technology	Power(W)	Size(mm)	Type	Quantity
N-type TOPCon	575	2278x1134x30	Bifacial	26
P-type BC	580	2278x1134x30	Bifacial	26

Test Results: During the test period from October 2024 to March 2025, the Jinko N-type TOPCon modules generated a total of 492.81 kWh/kW, while the P-type BC modules produced 482.60 kWh/kW. The per-watt power yield gain for Jinko's TOPCon modules reached 2.12%. Notably, in February, which had only six sunny days, Jinko's TOPCon modules showed a significant advantage under limited sunlight, delivering a 2.65% higher energy yield per watt than P-type BC modules. Even under cloudy conditions throughout the rest of the period, TOPCon's average yield gain consistently remained above 2%. Key insights include:

1.In offshore installation scenarios, intense solar radiation over the sea can raise module temperatures to 50 ° C, which can easily cause power degradation. Jinko's TOPCon modules, with excellent heat dissipation, operated at lower temperatures than P-type BC modules, significantly reducing heat-induced power loss.

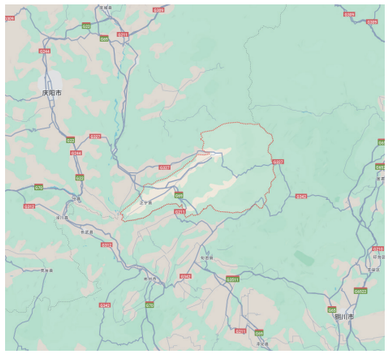
2.In coastal-light environments, morning fog, evening twilight, or intermittent cloud cover often reduce irradiance. Under these conditions, weak-light performance becomes critical. TOPCon's advantage in low-light environments makes it particularly suitable for offshore applications. In cloudy or rainy conditions, its energy yield gain over P-type BC modules can exceed 2%.



Zhengning, Gansu Outdoor Field Test

TOPCon Achieves Monthly Maximum Energy Yield Gain of 2.06% Compared to P-type BC Modules

Project Location: Qingyang City, Gansu Province (35°14’ 40”N, 107°57’ 38”E)

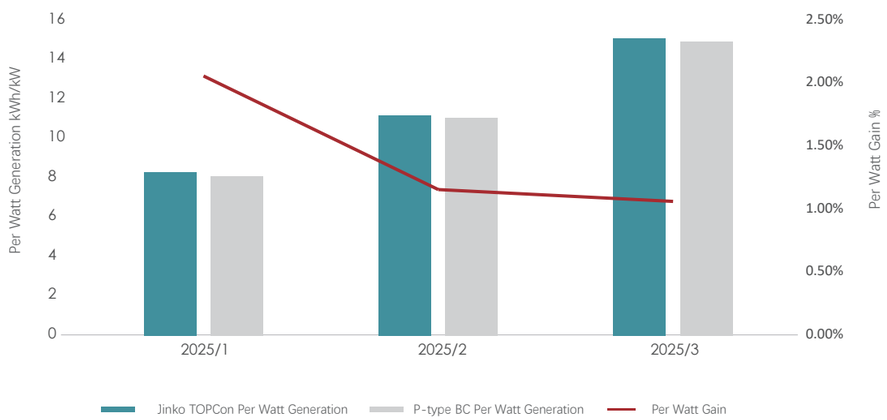


Site Selection: Qingyang is located in the southern part of Gansu and features a temperate continental monsoon climate with humid and semi-humid characteristics. It has distinct seasons, with cold and dry winters, mild and humid summers, and fluctuating temperatures in spring and autumn. The average annual temperature is 8.7 ° C, average annual precipitation is 616 mm, and the average annual sunshine duration exceeds 2,400 hours. The establishment of this demonstration power plant provides valuable data for studying PV system performance in industrial and commercial applications in Northwest China.

Project Overview: This test compared TOPCon modules with BC modules produced by another manufacturer. All modules were installed on the rooftop of a local primary school to ensure the accuracy and consistency of measurements. The main goal was to assess and compare the real-world performance of both module types to offer efficient and reliable solar solutions for clients. Two types of modules were tested: Jinko’ s N-type TOPCon modules rated at 575W, and the other manufacturer’ s BC modules rated at 580W. Each module type consisted of 18 panels, mounted on fixed racks with a tilt angle of 20 ° . All modules were equipped with high-precision sensors to monitor power output in real time, ensuring the reliability and accuracy of the results.

	Jinko N-type TOPCon Module	BC Module
Technology	TOPCon	BC
Specification	2278X1134X30mm	
Quantity	18 pcs	18 pcs
Power	575	575
Installation Scenario	Rooftop Mounting	
Starting Time	2024-12-24	

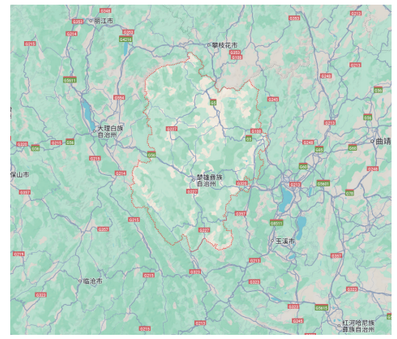
Test Results: From December 2024 to March 2025, several notable climatic and performance trends were observed. Taking February 2025 as an example, average daytime temperatures ranged between 2 ° C and 4 ° C, and the total irradiance for the month was recorded at 329.3 MJ/m². Due to shorter daylight hours and low solar elevation in winter, the PV modules operated under generally low irradiance conditions. Under these conditions, the per-watt energy yield of TOPCon modules was 1.33% higher than that of BC modules, demonstrating TOPCon’ s superior low-light response capability, which allowed it to maintain better performance in weak sunlight. Furthermore, due to the region’ s large temperature fluctuations between day and night and frequent wind and dust, the results reflect that TOPCon modules are more capable of delivering stable power output compared to same-size BC modules in complex climatic environments.



Chuxiong, Yunnan Outdoor Field Test

TOPCon Delivers Over 7.65% Higher Average Energy Yield Compared to N-type BC Modules

Project Location: Chuxiong City, Yunnan Province (25°2’ N, 101°32’ E)



Site Selection: Chuxiong in Yunnan Province is located in a subtropical monsoon climate zone. The test period spans both the dry and wet seasons, covering three representative weather patterns: continuous rainy days (15 average rainy days in November), mostly cloudy conditions (average 4.2 sunshine hours/day in December), and sunny periods (average 7.8 sunshine hours/day in January). With an annual average solar radiation of 5,800 MJ/m² and UV intensity over 30% higher than in lowland areas, this location provides valuable conditions for evaluating the comprehensive energy performance of different PV technologies, particularly in terms of low-light performance and UV-induced degradation.

Project Overview: Two types of modules were tested in this project: 610W N-type TOPCon modules and 610W N-type BC modules from another manufacturer. Each type consisted of 26 modules. The modules were installed on fixed ground-mounted racks elevated at 4.5 meters, with an effective clearance from the ground of 3.8 meters, and a tilt angle of 10° . The ground surface had an approximate reflectivity of 20%. All modules were equipped with high-precision sensors for real-time energy monitoring to ensure data accuracy and test reliability.

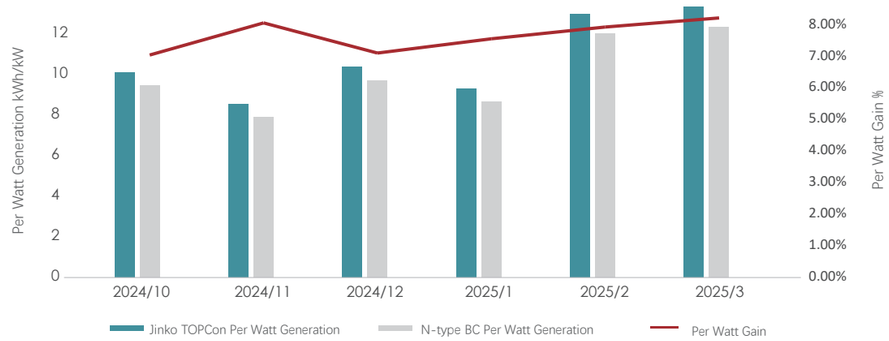
	Jinko N-type TOPCon Module	BC Module
Technology	TOPCon	BC
Specification	2278X1134X30mm	
Quantity	26 pcs	26pcs
Power	610	610
Installation Scenario	Rooftop Mounting	
Starting Time	2024-9-14	

Test Results: The results of the field study indicate that between October 2024 and March 2025, Jinko’ s N-type TOPCon modules demonstrated significantly better overall energy performance in Chuxiong compared to N-type BC modules, achieving an average yield gain of 7.65%. Thanks to their higher bifaciality, excellent low-light performance, and superior resistance to UV degradation, the TOPCon 3.0 modules delivered higher energy yield and more stable performance in real-world conditions. Key insights include:

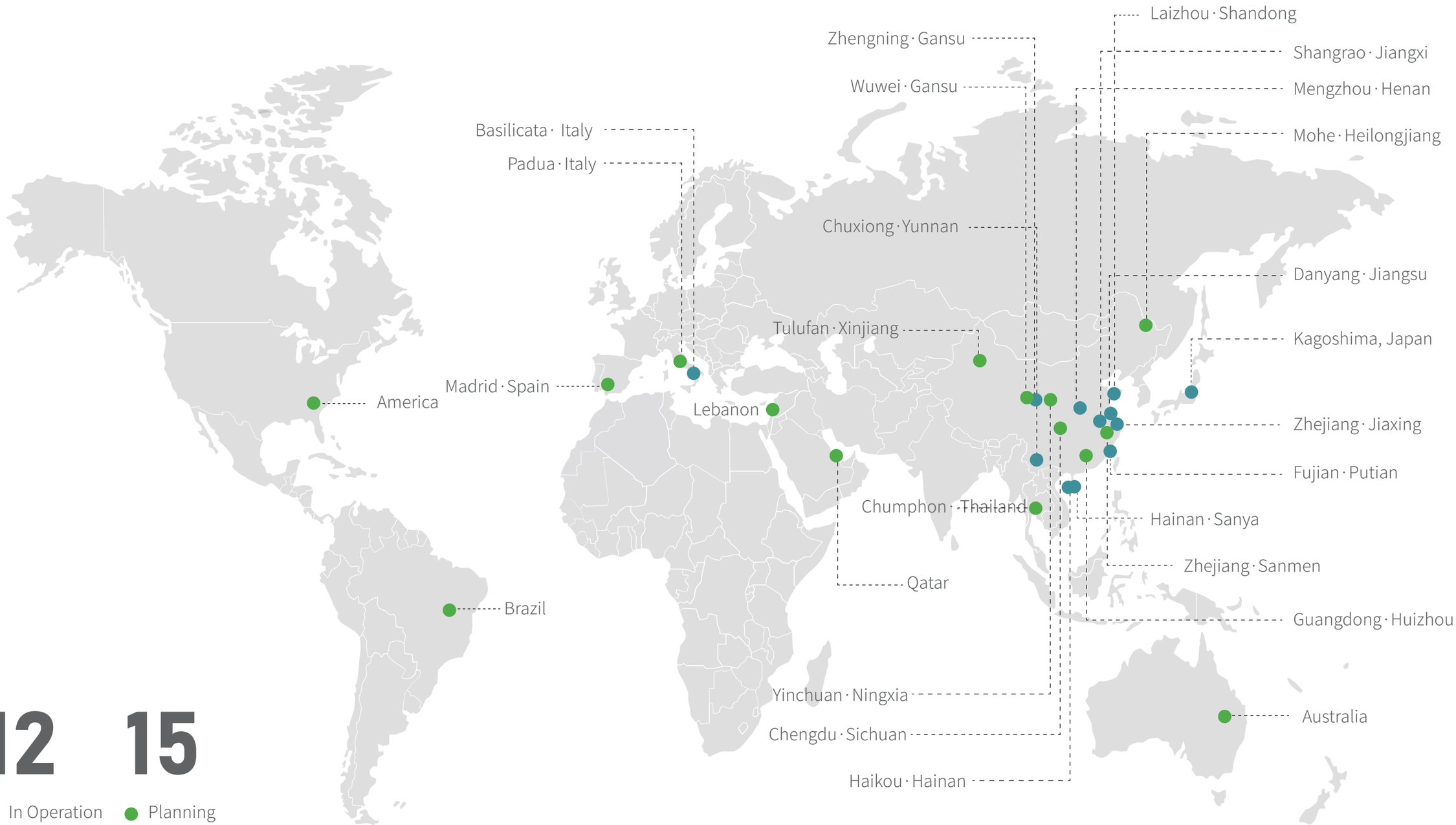
1.The high bifaciality advantage of TOPCon was further validated in this field test as a key factor in improving energy yield for ground-mounted systems. Jinko’ s TOPCon dual-glass modules feature a bifaciality of up to 85%, compared to approximately 65% for BC modules—a 15% to 25% advantage. When installation height, tilt angle, and ground conditions are factored in, this contributes to an additional energy gain of about 3.28%.

2.TOPCon modules also performed exceptionally well under low-light conditions. On cloudy and rainy days, their daily energy yield was about 7% to 9% higher than BC modules. Particularly during the prolonged rainy period in November, the daily output of TOPCon consistently stayed at a higher level, exceeding BC modules by more than 9% on certain days.

3.In UVID90 kWh/m² testing (equivalent to 6 times the IEC61215 standard of UV15 kWh/m²), Jinko’ s TOPCon modules exhibited outstanding UV resistance, with degradation kept within 2%. This characteristic is particularly valuable for Yunnan, where UV radiation is significantly stronger than in lowland regions, providing solid assurance for the long-term efficiency and operational stability of solar plants under complex climate conditions.



Tiger Neo Outdoor Performance Test



12 In Operation

15 Planning

*The field tests above involve JinkoSolar TOPCon modules and BC modules, covering third-party testing sites and client field test sites