Japan Kagoshima Field Test Data Released: TOPCon Achieves 8.82% Long-Term Energy Yield Gain Over N-Type BC Modules

A recent field test conducted by TÜV Nord in Kagoshima, Japan, reveals that the latest generation of N-Type TOPCon modules demonstrated significantly higher energy yield per watt compared to N-type BC modules over a three-month period from October to December 2024 (part of a year-long study). The TOPCon modules generated an average of **8.82%** more energy per watt than N-type BC modules, with the highest monthly gain reaching **9.84%**. Key findings include:

1. The rainy season in Kagoshima from October to December 2024 resulted in predominantly cloudy and low-irradiance conditions, providing an ideal setting to showcase the superior low-light performance of TOPCon modules. For instance, during a continuous 15-day stretch of rain from October 15 to October 29, TOPCon modules achieved a remarkable average daily energy gain of 9.13% per watt.

2. On sunny days, the high bifaciality of up to 80% gave TOPCon modules a distinct edge. The reflective gravel surfaces in Kagoshima amplified this advantage, bouncing more light onto the rear of the modules and boosting energy production.

3. Installed just 2 km from the coastline, the modules endured challenging environmental conditions, including high humidity and salt spray. Reliability is particularly important under such conditions. TOPCon modules have proven their high reliability and durability in nearshore and offshore scenarios, maintaining efficient energy yield and extending the system's lifespan in such demanding settings.

Background of the project:

Currently, many PV manufacturers are actively transitioning to technologies centered on N-type TOPCon and promoting them to mainstream markets. In recent months, the industry has engaged in extensive discussions about the XBC technology pathway. XBC manufacturers claim that their busbar-free cell design improves rated power and front-side efficiency. With TOPCon and XBC being gradually deployed in multiple field projects, we can now observe their actual performance under varying climatic conditions. Evidence so far indicates that TOPCon modules consistently demonstrates better yield performance.

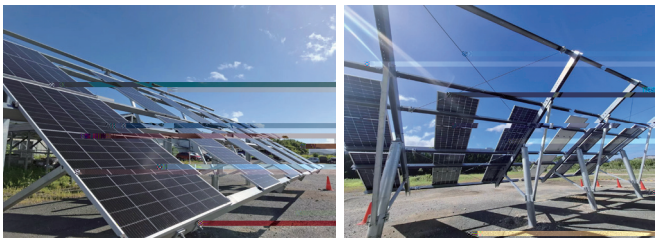

Figure 1: Project Picture

Project Introduction:

This field test was conducted at the Kagoshima Field Testing Base in Japan (32° 3′ 57″ N, 130° 19′ 53″ E). Two types of modules were installed: N-type TOPCon modules and N-type BC modules. The test setup consisted of two modules from each manufacturer installed on fixed mounts at a height of 1.2 meters from the ground and a tilt angle of 32° . The initial power of the modules was measured using the SAT method, and spectral correction was not considered in the test results. Energy yield (DC) data were collected using the high-precision CR1000X acquisition system, with a sampling interval of one minute. Additionally, module plane irradiance, backsheet temperature, ambient temperature, humidity, atmospheric pressure, and other data were recorded at the same sampling interval.

Cell Technology	Module Size(mm)	Module type
N-type TOPCon	2278x1134x30	Dual Glass
N-type BC	2278x1134x30	Single Glass

Test Results:

From October 1 to December 31, 2024, the performance of the two types of modules was comprehensively tested. Results showed that the normalized energy yield of TOPCon modules reached 294.2 kWh/kW over the three months, compared to 270.2 kWh/kW for N-type BC modules. On average, the long-term energy yield gain per watt for TOPCon modules was 8.82%.

Month	N Type TOPCon Normalized Energy Yield kWh/kW	N Type BC Normalized Energy Yield kWh/kW	Gain Per Watt
October	100.6	91.9	9.46%
November	93.2	86.9	7.17%
December	100.4	91.4	9.84%

When analyzing energy yield performance under different irradiance levels, it was found that for most of the testing period, irradiance levels were below 1000 W/m². Under these conditions, the average energy yield gain of N-type TOPCon modules reached 8.05%. Under high irradiance conditions (above 1000 W/m²), the total three-month energy yield of TOPCon modules was 174.04 kWh, with a yield gain per watt of 8.10% compared to N-type BC modules.

This indicates that TOPCon modules can deliver higher yield under both low-irradiance rainy weather and high-irradiance sunny weather, thanks to their excellent low-light performance and high bifaciality coefficient.

Further evidence supporting the test results can be found in the Performance Ratio (PR) values. PR is a metric obtained by comparing actual energy yield with the theoretical yield based on rated power and specific weather conditions. Test results showed that the PR value of TOPCon modules reached 97.8%, while that of N-type BC modules was 89.9%. This demonstrates that bifacial TOPCon modules with high bifaciality offer significant advantages in energy yield efficiency for ground-mounted power stations.