



All modules were equipped with high-precision sensors to monitor power generation data in real time to ensure the accuracy and credibility of the test results. During the test, a number of key data were collected at in interval of 6 minutes, including DC voltage, current, power, module temperature, front irradiance etc. These data provide detailed information, allowing us to conduct in-depth analysis and comparison of the performance of the modules.

Some significant irradiance and performance changes were observed in initial days from July 29 to August 31, 2025. The daily average irradiance recorded in was 455.9 W/m², and the ambient temperature recorded was 30.22 ° C. The most observed irradiance range was 100-200W/m² occurred in 7am-8am and 5pm-6pm, which in turn affected the power generation of the modules.

Under such conditions, the power generation of TOPCon modules was 141.07 kWh/kW, versus BC of 137.26 kWh/kW,

The experiment group included eight pieces of TOPCon bifacial modules (630 Wp) and eight pieces of N-type BC bifacial panel (640Wp), both from tier-1 manufacturers. The modules were installed in two carports, with each connected to an inverter operated at maximum power point tracking (MPPT). The testing field was located in Mkalles, Lebanon (33.8623190N, 35.5508300E), with a carport near-flat tilt of 5 degrees, facing southeast, and with about 2.5 meters above the ground.

This comparison test, characterized by monitoring and tracing the generation changes of N- type TOPCon and N-type BC modules across the daytime, low and high irradiance, elevated temperatures, intense and unintended ground reflection, provides an ideal environment to gain critical

