Indoor Electrical Performance Testing

Laboratory electrical performance tests on N-type modules prior and after this field test carried out at CGC Jiaxing Laboratory. The test is purposed to test the degradation of modules and their criteria are shown in table 4

	No.	Test item	Test standard/method	Clause
Test items & Test standards/ methods	1	Visual inspection	IEC 61215-2:2021Crystalline silicon photovoltaic modules for terrestrial applications - design qualification and sizing	4.1 MQT01
	2	STC test		4.2 MQT06.1
	3	EL test	IEC TS 60904-13:2018	
Assessed measurement uncertainty	Urel(Isc)=2.3%(k=2) Urel(Voc)=0.8%(k=2) Urel(Pmax)=2.5%(k=2)			

Table 4. Summary of indoor electrical performance tests

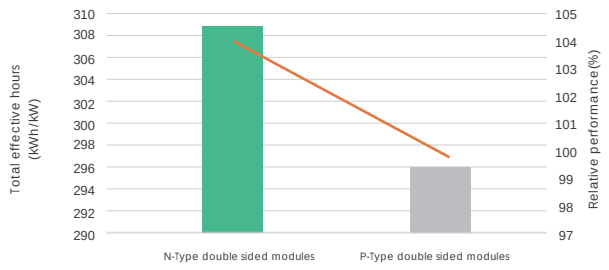
Result:

1.Power generation performance (Period: 2023.2~2023.4)

Comparison of the power generation performance of N-type bifacial and P-type bifacial module is shown in table 3-1 and Figure 1. The daily power generation data from 8:00-17:00 is selected and the P-type double-sided module is used as the performance baseline. From the data in Figure 1, it can be seen that the power generation performance of N-type double-sided module is better than that of P-type double-sided modules, with the cumulative power generation of N-type double-sided module reaching 1740.52kWh and the cumulative power generation of P-type double-sided modules reaching 1611.07kWh. Compared to the power generation performance of the P–type double sided module, the N-type double sided module achieves a power generation gain of 4.22 %.

Experimental group	Type	Cumulative electricity production (kWh)	Total effective hours (kWh/kW)	Relative performance (%)
A	N-type bifacial	1740.52	308.88	104.22
B(Baseline)	P-type bifacial	1611.07	296.37	100.00

Table 5. Comparison of the power generation performance of N-type bifacial modules and P-type bifacial modules



Total effective hours (kWh/kW)	308.88	296.37
Relative performance(%)	104.22	100.00

Figure 1. Comparison of the power generation performance of N-type double-sided modules and P-type double-sided modules

2.Module Operating Temperature

In order to accurately monitor and analyze the temperature changes of Jinko modules during the field test process, thermocouples were attached to the top and bottom of one module at the same location in each array to monitor the module operating temperature changes through thermocouple sensors. The temperature data is selected from 8:00-17:00 daily, and the abnormal data points were screened out and statistically analysed. The temperature variations of the modules in the experimental group at the Haikou base in the third quarter are shown in table 6.

Experimental group	Type	Average temperature/°C	Max. temperature/°C	Average temperature/°C
A	N-type bifacial	34.81	69.10	-0.56
B(Baseline)	P-type bifacial	35.37	69.10	0.00

Table 6. Temperature variation of the experimental group component operation at the Haikou base

Using the P-type double module as the temperature reference, the average operating temperature of both the N-type double module and the N-type single-sided module is lower than that of the P-type double module, with the average operating temperature of the N-type double module being 0.56℃ lower than that of the P-type double module and the average operating temperature of the N-type single-sided module being 0.66℃ lower than that of the P-type double module. The average operating temperature of N-type single-sided modules is 0.10℃ higher than that of N-type single-sided modules, and the operating temperatures are basically the same.

Before (July 01, 2022) and after the field test (April 30, 2023), the experimental group samples were statistically tested for electrical performance under standard conditions and their test results are shown in table 7

560N sample serial#	Initial Power Test at July 01,2022（W）	Period Power Test at April30,2023 （W）	Degradation
1	561.65	560.39	-0.22%
2	563.85	560.04	-0.68%
3	561.32	561.11	-0.04%
4	563.48	559.73	-0.67%
5	564.55	559.89	-0.83%
6	564.18	560.52	-0.65%
7	563.47	559.14	-0.77%
8	564.2	559.74	-0.79%
9	564.26	559.68	-0.81%
10	564.16	560.81	-0.59%
Subtotal	**5635.12**	**5601.05**	**-0.60%**

Table 7. Electrical performance test results of the experimental group samples under STC

Conclusion:

1) The power generation performance of N-type bifacial modules being **4.22 %** higher than that of P-type bifacial modules.

2) The average operating temperature of N-type bifacial is **0.56** lower than that of P-type bifacial modules

3) The degradation of N-type TOPCon modules in first year is **0.60%**