O D (L w LID) H Y G N-C P- N ,CN

Highlights:

1. Energy yield performance: the energy yield gain of n-type TOPCon (Group 1) versus p-type PERC (Group 2) with fixed axis **3.69%**

2. Degradation: the average degradation of Group 1 (TOPCon with fixed axis) and Group 2 (PERC with fixed axis) is **0.51%** **1.38%**,

Experimental Photovoltaic Test Facility

(38°34′57.77″N, 106°0′55.72″E) Ningxia, north western of China.

Two groups of total 20 pieces of bifacial modules of two differ

bifacial module contains 144 pieces of the half-cut cell, as shown in Table 1)

Group	Module	Number	Type	Mounting System
1#N-TOPCon	JKM555N-72HL4-BDV	10		Fixed axis
2#P-PERC	JKM540M-72HL4-BDVP	10		Fixed axis

Table 1: Sample information

cy at 60kWh/m² were also measured and calculated. The out

1-min interval.

installed on a fixed axis with a tilt angle of 40° (as shown in Figure 1) Moreover, the pitch and clearance of each array were 10 m.

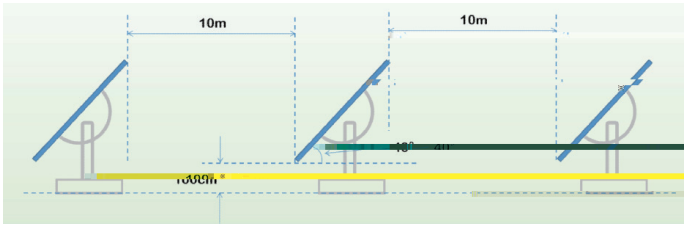

Figure 1. Fixed axis

ing groups (measured from September 2022 - March 2023) are shown in Table 2 and Figure 3.

Month	Fixed Axis- Cumulative Irradiation(kWh/m²/month)		Reflectance (%)
	Front side	Rear side	
2022-09	175.44	20.25	11.54
2022-10	137.67	15.02	10.91
2022-11	123.39	11.86	9.61
2022-12	119.57	10.51	8.79
2023-01	153.75	14.36	9.34
2023-02	103.42	12.15	11.75
2023-03	197.15	22.64	11.48

Table 2: Irradiation and reflectance

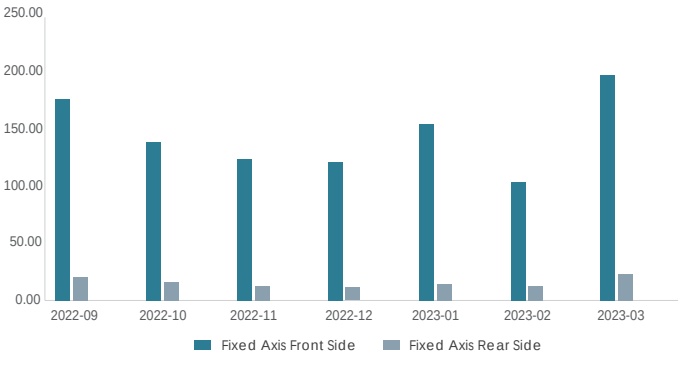

Figure 3. Monthly cumulative irradiation

tember 2022-March 2023) were shown in Table 3 and Figure 4. And the energy yield per watt (Wh/W) was calculated according to Formula 1 was indicated in Table 3 and Figure 4.

Calculator:

Formula 1:

$$\text{Power generation per watt(Wh/W)} = \frac{\text{Cumulative power generation(kWh) x 1000}}{\text{Average test power of array modules(W) x modules quantity}}$$

Formula 2:

$$\text{Power degradation(\%)} = \frac{\text{Initial Test Power (W)- Period Test Power (W)}}{\text{Initial Test Power (W)}}$$

Month	Group 1-Power generation per watt (Wh/W)	Group 2-Power generation per watt (Wh/W)
2022-09	5.64	5.44
2022-10	4.57	4.39
2022-11	4.45	4.29
2022-12	4.90	4.74
2023-01	5.01	4.81
2023-02	4.35	4.19
2023-03	6.11	5.88
Average	5.00	4.82

Table 3: Power generation per watt

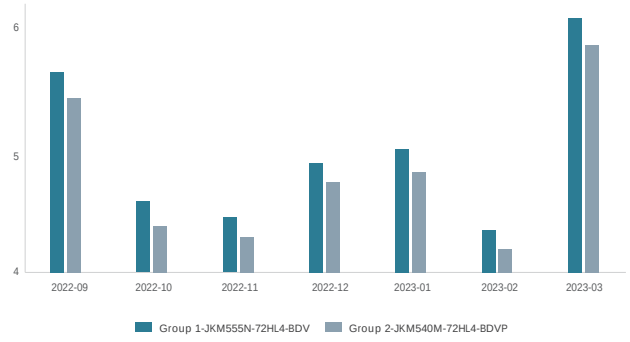

Figure 4. Power generation per watt

4 and Table 5,respectively.

	Isc(A)	Voc(V)	Imp(A)	Vmp(V)	Pmax(W)	FF(%)	Eff.(%)
Group 1	13.59	51.41	12.93	43.45	561.8	80.44	21.77
Group 2	13.68	49.54	13.00	41.33	537.3	79.30	20.82

Table 4: Initial results of laboratory test data (mean)

	Isc(A)	Voc(V)	Imp(A)	Vmp(V)	Pmax(W)	FF(%)	Eff.(%)
Group 1	13.57	51.57	12.90	43.34	558.9	79.90	21.66
Group 2	13.63	49.14	12.94	40.95	529.9	79.14	20.53

Table 5: Period results of laboratory test data (mean)

Conclusions:

1. Energy yield performance: the energy yield gain of n-type TOPCon (Group 1) versus p-type PERC (Group 2) with fixed axis was **3.69%.**

2. Degradation: the average degradation of Group 1 (TOPCon with fixed axis) and Group 2 (PERC with fixed axis) is **0.51%** **1.38%**,

-J K (2022.09-2023.3)

Group 1. N-type Test Site

Group 2. P-type Test Site