

TOPCon Modules Outperform HPBC by Up to 6.92% in Energy Yield Tests by TÜV Nord

A study by TÜV Nord in Kagoshima shows that the latest generation of tunnel oxide passivated contact (TOPCon) modules surpass HPBC modules on energy yield over the initial month of a 1-year period. The TOPCon product showed an average energy yield of **2.19%** and maximum **6.92%** higher than its HPBC counterpart.

Background of the Project:

Most PV manufacturers are now well underway with the switch to n-type primarily TOPCon technology, rolling out to mainstream installations. In the past few months, the photovoltaic industry has debated over technical route of XBC. The manufacturers promised more rated power and front-side efficiency because there is no grid line on the front of the product. And as they make their way into some pilot projects, we can see how these claims play out in the field under various climate conditions. Many studies have been carried out already, and the signs so far are good for TOPCon.

One such study recently confirmed an average 2.19% (up to 6.92%) gain of TOPCon versus HPBC in normalized energy yield (energy generated per unit of capacity) over an initial one month period of September 12 to October 11, 2024. German company TÜV Nord carried out the study at a test installation in Kagoshima (31°35'2.8"N, 130°32'32.9"E), Japan

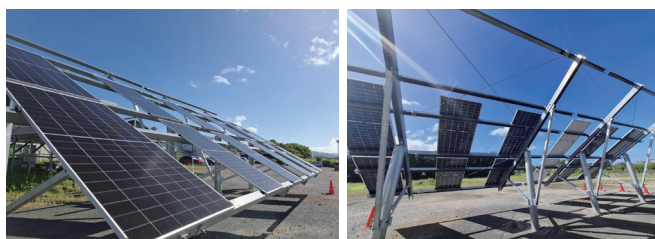


Figure 1: Project Picture

Project Introduction:

Three module types were installed at the site: A n-type TOPCon module rated power 575W from Jinkosolar, a 580W HPBC manufactured by Longi and a 605W ABC from Aiko, both using 182 mm half cells. The test installation comprised two modules of each type, installed on fixed tilt racking 20 °) 1.2 meter above the ground and connected via micro inverters.

Test Results:

Performance of each module was carefully measured over September 12- October 11. During the period, TOPCon module generated **151.47 kWh/kW**, HPBC **148.21 kWh/kW**, ABC **143.52 kWh/kW**. Thanks to its higher bifaciality and lower temperature coefficient, when normalized based on each module power rating, the module achieved a yield 2.19% higher than HPBC and 5.54% higher than XBC.

In sunny and cloudy days during the period, TOPCon modules energy yield consistently remains 2%-3% higher than HPBC modules and 5%-6% higher than ABC modules. The highest yield gain of TOPCon modules over HPBC occurred on October 2, a rainy day, generating 6.92% more electricity per kilowatt than the HPBC modules. While TOPCon outperformed ABC up to 9.8% on October 6, still a rainy day. It proves that even in low light condition, TOPCon demonstrates better generation capability due to less current leakage compared to XBC counterparts.

Jinko' s TOPCon module also achieved the highest performance ratio of the three. Performance ratio compares the actual energy yield to a calculation based on the power rating and weather conditions. TÜV Nord measured a 95.01% performance ratio for the TOPCon module, with the other two trailing slightly behind, 92.6% for HPBC and 90.01% for ABC.

Date	Jinko TOPCon	ABC	HPBC	VS ABC	VS HPBC	MaxT	MinT	Weather
9.12	6.398988	6.086851	6.220883	5.13%	2.86%	32 C	24 C	Sunny
9.13	7.032675	6.752257	6.800899	4.15%	3.41%	31 C	24 C	Cloudy
9.14	4.181060	3.894840	4.163005	6.89%	0.43%	30 C	24 C	Light Rain
9.15	4.747012	4.483044	4.704291	5.89%	0.91%	31 C	26 C	Overcast
9.16	3.906246	3.714227	3.739598	5.17%	4.46%	31 C	25 C	Light rain
9.17	6.604398	6.155603	6.433041	7.29%	2.66%	32 C	24 C	Light rain
9.18	6.38312	6.098052	6.215087	4.67%	2.70%	32 C	25 C	Cloudy
9.19	4.796877	4.480227	4.643243	7.07%	3.31%	31 C	26 C	Cloudy
9.20	4.831553	4.589342	4.685353	5.28%	3.12%	31 C	25 C	Cloudy
9.21	5.406449	5.130972	5.323082	5.37%	1.57%	30 C	24 C	Moderate rain
9.22	0.84122	0.828839	0.787138	1.49%	6.87%	27 C	24 C	Torrential rain
9.23	3.780254	3.592866	3.694588	5.22%	2.32%	25 C	21 C	Light rain
9.24	5.474552	5.098604	5.392808	7.37%	1.52%	28 C	21 C	Moderate rain
9.25	3.789664	3.596079	3.65597	5.38%	3.66%	28 C	22 C	Sunny
9.26	6.802809	6.584096	6.643144	3.32%	2.40%	29 C	22 C	Sunny
9.27	6.217378	5.974597	6.047822	4.06%	2.80%	31 C	21 C	Cloudy
9.28	3.993454	3.763985	3.890584	6.10%	2.64%	29 C	23 C	Light rain
9.29	5.625255	5.313951	5.604991	5.86%	0.36%	29 C	23 C	Cloudy
9.30	6.693182	6.315824	6.56191	5.97%	2.00%	28 C	22 C	Light rain
10.1	10.11077	9.708575	9.87095	4.14%	2.43%	28 C	21 C	Light rain
10.2	1.456464	1.448425	1.362243	0.56%	6.92%	23 C	21 C	Torrential rain
10.3	3.633687	3.510033	3.5218	3.52%	3.18%	22 C	20 C	Moderate rain
10.4	2.160239	2.092416	2.047714	3.24%	5.50%	23 C	21 C	Torrential rain
10.5	6.925891	6.394527	6.896856	8.31%	0.42%	26 C	20 C	Light rain
10.6	6.403917	5.832132	6.387469	9.80%	0.26%	28 C	22 C	Light rain
10.7	3.534667	3.411578	3.44201	3.61%	2.69%	27 C	22 C	Light rain
10.8	0.744837	0.714775	0.713592	4.21%	4.38%	26 C	20 C	Cloudy
10.9	6.722295	6.400842	6.611099	5.02%	1.68%	25 C	17 C	Light rain
10.10	6.706093	6.435122	6.584362	4.21%	1.85%	25 C	17 C	Sunny
10.11	5.392796	5.076108	5.334912	6.24%	1.08%	25 C	18 C	Light rain

