Comparison Test by TÜV Rheinland in Saudi Arabia: 5.14% Yield Gain of N-TOPCon bifacial over PERC bifacial

Experiment summary:

This comparison has been conducted by TÜV Rheinland Solar GmbH (TRSol) in the coastal desert climate of Thuwal, Saudi Arabia (22°18'15.5"N 39 ° 06'29.7"E) since June 2022. The project deals with energy yield (EY) measurements of Photovoltaic (PV) modules and presents the initial PV module measurements, the meteorological measurements as well as the results of the outdoor performance.

1. Test samples

Test sample	Nominal power at STC (W)	Measured power at STC (W)	Area (m^2)
JKM550N-72HL4-BDV	550	561	2.58
XXX-645DEG XXXX	645	655	3.11

2. Setting of tasks, description of methodology and metrology

Within the framework of this project the electrical performance of PV modules is analyzed and compared. The assessment takes place at the outdoor test side of TÜV Rheinland Solar GmbH (TRSol) in Thuwal/Saudi Arabia. The energy yield (EY) performance of the PV modules as well as the meteorological conditions are monitored during the entire exposure period.

Figure 1. Outdoor test site location of TÜV Rheinland Solar GmbH

After the transfer to the test fields, the PV modules were mounted on the open rack with the mounting conditions as described in Table 1.

Location	Thuwal, Saudi Arabia
GPS coordination	22°18'15.5"N 39°06'29.7"E
Surroundings & Environment	University ground, gravel
Tilt angle	25°
Mounting condition	Fixed-Facing south

Table 1. Module mounting conditions

The test samples were connected to identical measuring instrumentation with the same data acquisition frequency. Each PV module was equipped with two Pt100 sensors on the back, one in center and one in the upper corner to measure the back of module temperature (TBoM) with a sample rate of 30 seconds. Individual electronic DC loads were installed in order to have all test samples operate synchronously in their maximum power point (MPP-Tracking) with a data acquisition frequency of 30 seconds. Current-Voltage (I-V) curves were recorded in regular time intervals of 10 minutes.

The in-plane global irradiance (GPoA), the horizontal global (GHor) and diffuse horizontal (Gd), as well as global rear irradiance (Grear) were measured with pyranometers. In addition, the ambient temperature (Tamb) was measured. The on-site data acquisition is shown in Table 2:

Parameter	Equipment/Technique	Frequency
T_{BoM}	2x Pt 100 temperature sensors	30 sec
I-V curve measurements	Electronic loads	10 min
P_{MPP}	MPP tracker	30 sec
G_{PoA} G_{Hor} G_{direct} G_d G_{rear}	Pyranometer	30 sec
T_{amb}	Sensors (instantaneous measurements)	30 sec

Table 2. Equipment and data acquisition frequency of field measurements

3. Meteorological data at the outdoor test site

This chapter contains data about irradiances and ambient temperatures at the chosen test sites.

3.1 Data for Thuwal/Saudi Arabia

This section contains data about irradiances and ambient temperatures at the outdoor test site in Thuwal/Saudi Arabia (Latitude 22.3043473; Longitude 39.1083107; Azimuth 0 ° ; Tilt: 25 °) for the period under review (June 2021 to August 2022). Only data with an in-plane irradiance higher than 15 W/m2 were considered.

3.2 Irradiance and irradiation

The recorded irradiances (G) for the test site in Thuwal/Saudi Arabia are shown in Figure 2.

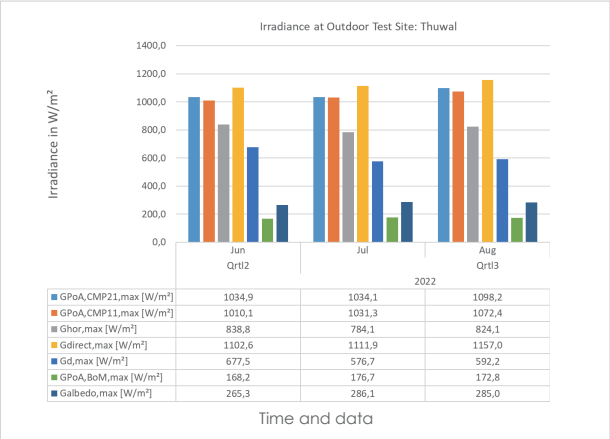


Figure 2. Maximum irradiances at the test site Thuwal/Saudi Arabia

3.3 Ambient temperatures

The recorded temperatures for the test site in Thuwal/Saudi Arabia are shown in Figure 3.

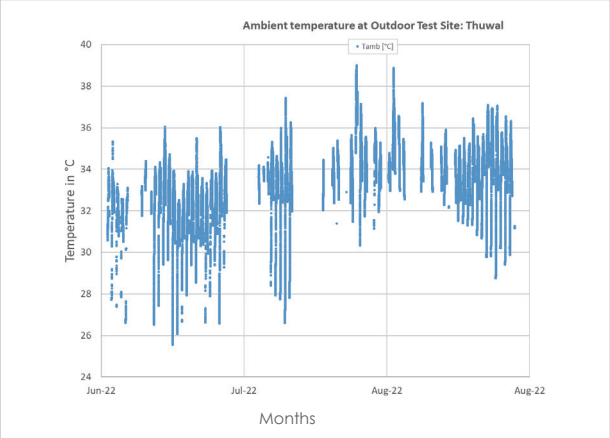


Figure 3. Ambient temperature measurements at test site Thuwal/Saudi Arabia

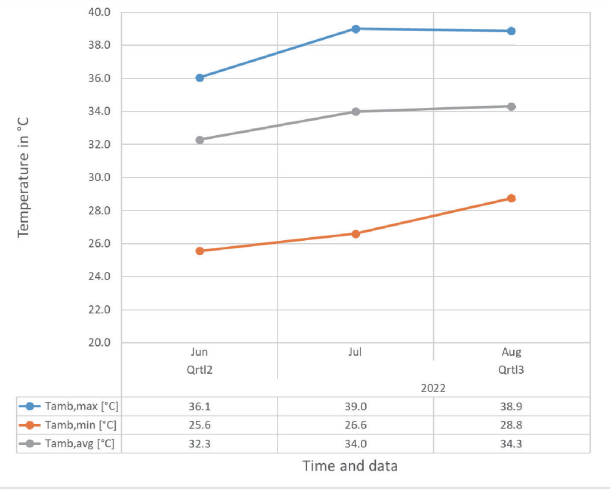


Figure 4. Monthly ambient temperature at test site Thuwal/Saudi Arabia

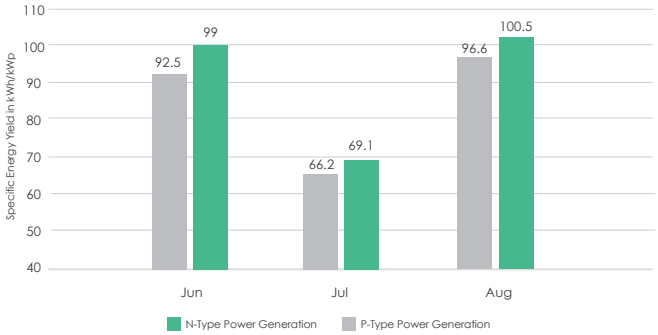
4. Comparison of energy yield

The specific energy yield describes the ratio of the module' s energy output to the indoor measured power output at standard test conditions (STC) and is calculated by applying the following equation:

$$EY_{spec} = \frac{\sum_{i=0}^{n}(P_{mpp,measure,i} \cdot t_{sample})}{P_{max}}$$

Where:

EYspec	is the specific energy yield
Pmpp,measured,i	are the measured P mpp data
tsample	is the sample time
Pmax	is the module power either acc. to type labor or measured at STC in laboratory



* Note: The specific energy yield (kWh/kWp) in July is lower than the data in June and August. This is because that the amount of data collection is less due to its equipment commissioning in July, and also the weather in July is mostly cloudy while the weather in June and August is mainly sunny.

Figure 5. Monthly specific energy yield of the PV samples in Thuwal/Saudi Arabia

Conclusion:

The result showed that the TOPCon bifacial module has an average 5.14% higher energy yield over PERC bifacial module, the majority of the contribution from lower degradation, optimized temperature coefficients, high bifaciality and advanced low-light performance. The study is devoted to the assessment of TOPCon bifacial module of 550W nominal power based on 182" size wafer (JKM550N-72HL4-BDV) and PERC bifacial module of 645W on 210"wafer (XXX 645DEG XXX). The data was collected starting from June.