REC'S PERFORMANCE RATIO IN INDIAN CONDITIONS SURPASSES SIMULATED PREDICTIONS

As part of an initiative to continuously monitor field data and study the performance ratios of plants throughout the world, REC has analysed recorded data from a well-maintained site at Pandit Deen Dayal University (PDPU), located in the sun-drenched north west corner of India. The study showed the REC panels have outperformed the predicted yield by 2% with a high performance ratio for Indian conditions.

Background

Gujarat Power Corporation Ltd established the Indian state's first R&D funded, grid-connected solar project of 1 MWp at the PDPU campus in the city of Gandhinagar. The aim of the project is to better understand the performance characteristics of a working solar power plant for research and design purposes. As part of this system, a 250 kW REC array was installed and put under continuous monitoring.

The complete system installed at PDPU campus

The plant was commissioned in January 2011 and REC has analysed the first 19 months of performance data (February 2011 to August 2012). The high-calibre pyranometer and temperature recordings used, have enabled the production of accurate performance ratio measurements at the inverter output.

Table 1: System details

Site Details	System	Source
System location	Gandhi Nagar Gujarat	23.22° N 72. 68°E
EPC contractor	M/s SunEdison Energy India Pvt. Ltd	
Module type	250.42 kW	REC 225JM Series
Inverter	250 kW	ABBPVS 800-57-250 KWA
Irradiation data	Global at tilt	Recorded at 15 minute intervals by Pyranometer (ISO secondary standard)
Orientation of panels	24° to horizontal	PDPU
Panel temperature	Sensor	Recorded at 15 minute intervals

Performance ratio as a system performance measure

Performance ratio (PR) is one of the most transparent measures for comparing system performances from one location to another, independent of irradiance. It is defined as the ratio of actual measured output over a given period of time divided by the nominal power (nameplate rating) multiplied by the irradiance during that time.

The formula below is used to calculate the PR. REC has a strong reputation for high PRs when compared to other leading brands. In a Fraunhofer ISE Performance Test, REC panels demonstrated superior PR relative to the competition by producing 4.8% more power than the leading Chinese module tested and 1% more than the leading European panel tested. REC's propensity for high yield has also been proven at the Photon laboratory test site, where tests in 2010 and 2011 saw REC highly placed and in 2011, generating more energy than all other competitors and 6% more yield than the test average. This consistently high performance level is due to REC's anti-reflection treatment and excellent low-light performance.

$$PR = \frac{E_{OUT}}{kW_{DC} \times G_{POA}}$$

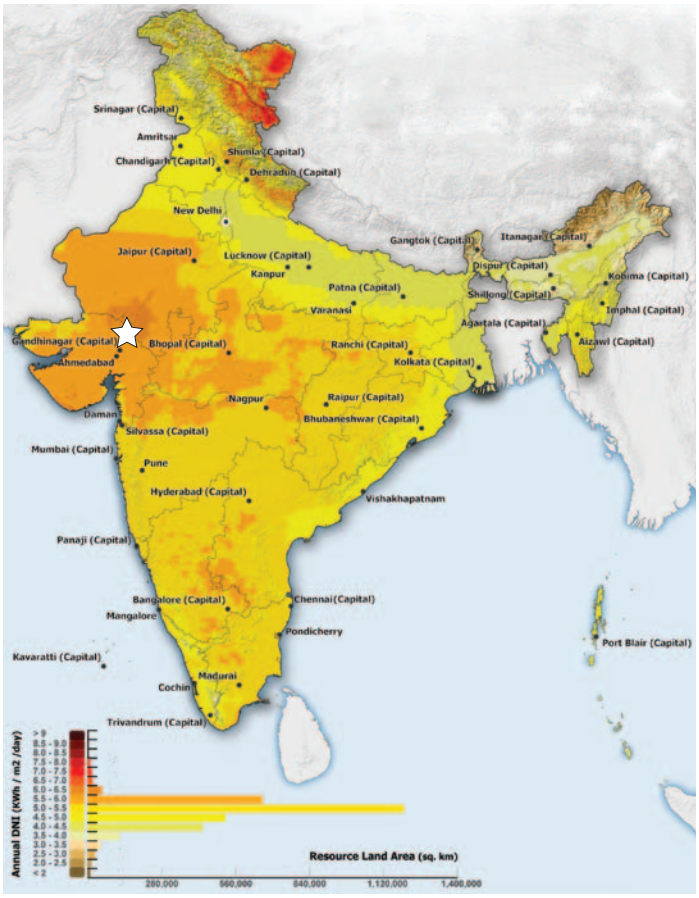
Where:

E_{OUT} = Measured electrical output of the system in kWh

kW_{DC} = DC nameplate capacity of the system

G_{POA} = Irradiation on the plane of array

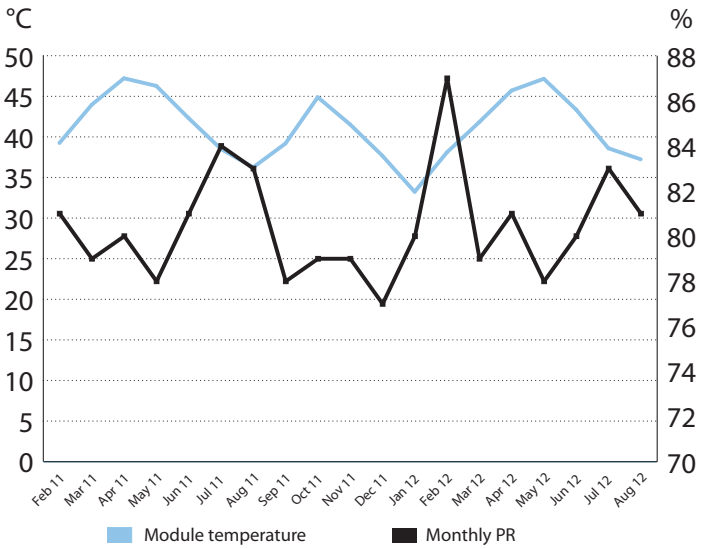
Location of PDPU, Gandhingar



80.2% Performance Ratio

The performance and climate data for the PDPU site was recorded at 15 minute intervals and was measured at the output of the inverter. Data was filtered for accurate reporting and excluded periods of grid unavailability, unexplained production between sunset and sunrise and hours with missing data (roughly 5% per year).

Over the 19 month analysis the system's PR was 80.2% and monthly PRs varied between 77 - 87% over the period. Bearing in mind the hot and dusty conditions seen on site, these results demonstrate a strong performance in a demanding climate.



Monthly variation between performance ratio and average panel temperature

PR is dependent on the quality of selected system components, operation and maintenance and is affected by changes in temperature; the hotter the environment, the lower the expected performance. As the graph above shows, there is an inverse relationship between the PR and the module temperature. In a module's technical specification, this relationship is represented by the temperature coefficients: the lower the coefficient, the less energy is lost for every 1°C increase in module temperature. For this reason, the PR of systems in hotter climates, such as India, will be lower than those in cooler climates, as found in Europe for example.

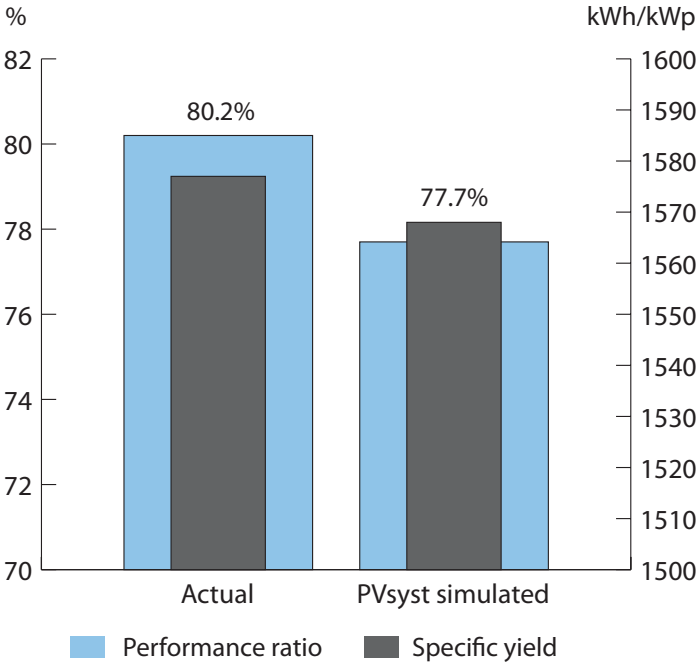
Table 2: Key inputs used in the PVSYST simulation

Input variable	Value
Module mismatch loss	0.3 %
Module efficiency loss	1.1 %
DC cabling loss	1.5 %
NOCT	43.9°C
Temperature coefficient of Pmpp	-0.50 %/°C
Reflection profile	Anti-reflective coating
Soiling loss	2%
Yearly degradation (used for months 13 - 19)	0.7%

Predicted Performance

For comparison, the predicted PR was simulated in PVsyst by importing the recorded weather data consisting of plane-of-array irradiance and module temperature to create a weather file.

The assumptions shown in Table 2 were entered into V5.60 of PVsyst to perform the yield prediction for the REC modules. The below graph shows the simulated vs actual performance figures.



Simulated versus actual performance

The term capacity utilization factor (CUF) is often used to measure how well a plant is utilized. This is the ratio of energy generated by a system (during one year) to the energy output at rated capacity. The CUF for this site is 18.2%, one of the highest recorded in India when compared to contemporary systems[1] and very healthy given the grid failures evident during the analysis period. The factors which affect the CUF of a PV system are the insulation characteristics of the site and operating conditions - especially irradiance and temperature - but the ability of the REC panels to achieve a high CUF such as this is a testament to high quality manufacturing and good design.

Conclusion

The actual PR of 80.2% is 2.5% higher than predicted. This is further confirmation of REC's reputation for surpassing the expectations of prediction softwares and delivering high performance systems.

The module type installed at PDPU has since been superseded in design by the REC Peak Energy Series. Continuous product improvements at REC ensure that Peak Energy Series modules offer a superior PR and yield by enhancing performance at low-light efficiencies and through a lower temperature coefficient of power. Simulating performance at the same site using REC Peak Energy modules and the same parameter inputs, a PR of 83.4% is obtained. REC has a proven reputation for outperforming expected PVsyst simulations so a PR in excess of this figure is to be expected.

1 *Central Electricity Regulatory Commission, India.*
http://www.cercind.gov.in/2011/Whats-New/PERFORMANCE%20OF%20SOLAR%20POWER%20PLANTS.pdf

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