

Introduction

Capacity testing in the solar PV industry commonly follows ASTM 2848-13 and ASTM 2939-13, both of which require historical or site-measured meteorological data—at minimum, plane-of-array irradiance (POAI), ambient temperature, and wind speed—to determine Reporting Conditions (RC), Expected Capacity (EC), and Measured Capacity (MC). While historical datasets enable advance calculation of RC and Expected Capacity (typically using monthly values or a ±15-day window around the test period), actual test-day weather conditions often deviate substantially, particularly under increasingly variable climate patterns. These discrepancies can necessitate extrapolation of measured data to assess performance, introducing additional uncertainty into capacity test results.

An alternative approach incorporates the site-measured meteorological data directly into a PVsyst model and reruns the simulation for the test period. In this method, transposed POAI from the model can be debiased against measured POAI, further minimizing mismatch between modeled and measured conditions.

This study compares these two methodologies — measured data versus historical data-based RC, Expected Capacity, and resultant test result using plant performance datasets from real projects. The analysis highlights the strengths and limitations of each approach and provides guidance on their applicability under varying site and climatic conditions.

Alternative Method

Expected Capacity and RC are determined using measured site data combined with an as-built PVsyst energy model to ensure a fair, weather-normalized performance comparison. The 1-minute measurements of Global Horizontal Irradiance (GHI), ambient temperature, wind speed, and relative humidity are checked for validity and averaged into hourly value and then imported into the as-built PVsyst model to simulate test-period performance. Latest PVsyst update even allows sub-hourly modeling which will negate the need for hourly averages and allow finer model resolution.

The modeled POAI (GlobInc) and measured POAI are then correlated to calculate a POAI de-bias factor. In the example shown in Figure 1 from Project 1, the model POAI is reduced by the calculated de-bias factor of 0.92%. From the filtered, de-biased dataset, the RC are established in accordance with ASTM E2939-13, using the 60th percentile of POAI and the arithmetic means of ambient temperature and wind speed. A multivariable regression fitting Equation 1 is then performed inclusive of the PVsyst predicted plant output (E_Grid), and the regression coefficients (a₁, a₂, a₃, a₄) are solved at the Reporting Conditions, to calculate the Expected Capacity.

$$P = E (a_1 + a_2 \times E + a_3 \times T_a + a_4 \times v) \quad \text{[Equation 1]}$$

If the test period is only a few days long, the model side filtered hourly dataset may have only a limited number of points. In such a case, measured data from days preceding the test period can also be included in the PVsyst import, assuming the previous days had similar weather conditions as the test period.

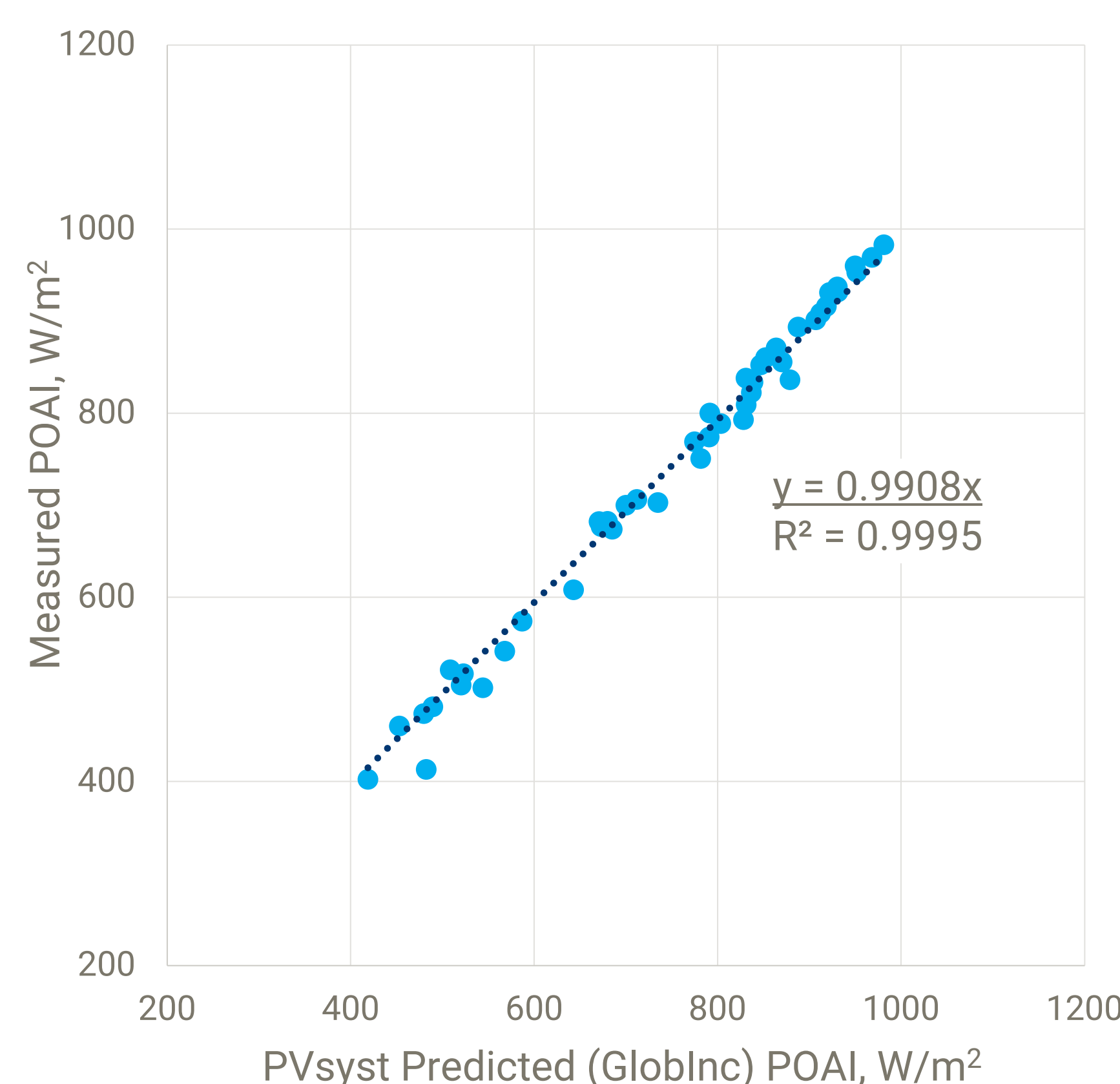


Figure 1: Measured vs. PVsyst POAI

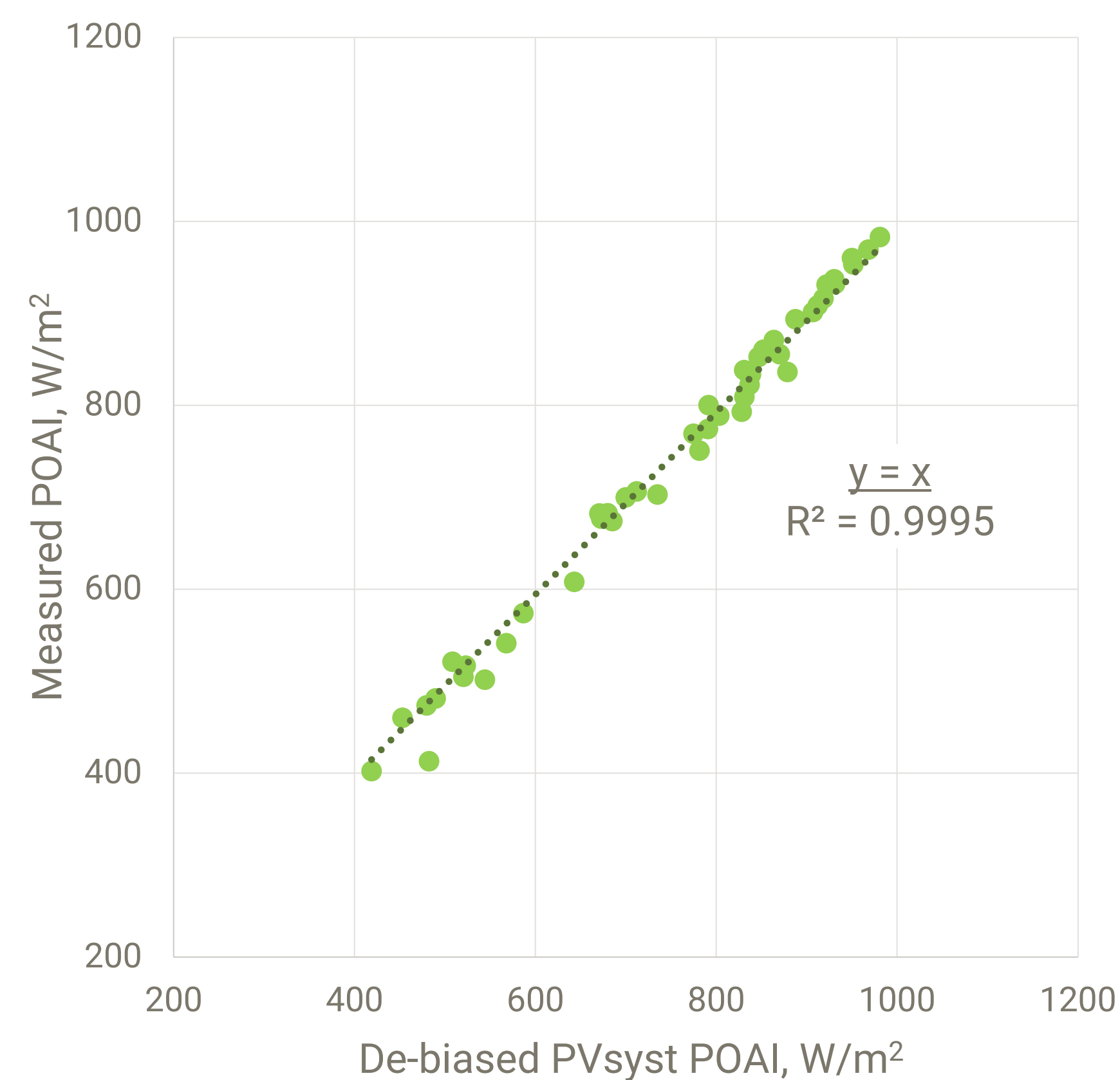


Figure 2: Measured vs. De-biased PVsyst POAI

Results

The calculated RC and Expected Capacity using measured historical data vs. measured data (not de-biased and de-biased) is presented in the table below for three reference projects.

- It is observed that the difference in the measured and historical RC values affects the test result. The historical method consistently overpredicts the performance. This is a known shortfall of the ASTM test method.
- The historical method may cause extrapolation of the Measured Capacity. Using the measured data for RC and in the Expected Capacity model, avoids extrapolation for either Measured Capacity and Expected Capacity.

Parameter	Project 1			Project 2			Project 3		
	I	II	III	I	II	III	I	II	III
RC – POAI (W/m ²)	812.0	836.4	828.7	729.6	760.0	752.5	612.7	595.7	595.8
RC – Amb. T (°C)	23.3	23.9	23.9	21.2	25.7	25.7	19.9	25.9	25.9
RC – WS (m/s)	5.2	3.3	3.3	3.6	2.3	2.3	3.3	2.3	2.3
EC (kWac)	59,180	62,275	62,275	55,151	57,957	57,957	14,067	13,684	13,684
MC (kWac)	60,233	62,461	61,646	56,308	57,749	57,226	14,052	13,523	13,525
Capacity Test Ratio	101.8%	100.3%	99.1%	102.1%	99.6%	98.7%	99.9%	98.8%	98.8%

Source for RC and EC: I = Historical TMY, II = Measured (POAI not debiased), III = Measured (POAI debiased)

Take-aways

The two methods for determining RC and EC were examined in this study:

Historical TMY Data Method: This method allows the EC to be calculated in advance of the test period. However, a mismatch between historical RC and actual test-period measurements can skew pass/fail results and may require extrapolation of the MC. Long-term climate change effects further increase the likelihood of such mismatches.

Measured Data Method: Using this method, the Reporting Conditions and Expected Capacity are not known until the test period is completed. In addition, the test period duration may be insufficient to generate enough hourly data points for a robust EC calculation. However, this approach minimizes mismatches between RC, EC, and MC by maintaining internal consistency.

Parties involved in the test should clearly understand the benefits and risks associated with each method for deriving RC and EC.

POAI De-biasing

POA de-biasing refers to adjusting modeled plane-of-array irradiance so that it is statistically consistent with measured POA irradiance during the actual test period, rather than relying solely on transposition models or long-term meteorological assumptions. Research has shown that modeled POA irradiance derived from GHI/DNI/DHI transposition can introduce bias of several percent relative to site-measured POAI, particularly for tracking systems, high tilt angles, and bifacial arrays. As a result, correlating modeled POAI to measured POAI and applying a correction factor has become a common practice in utility-scale acceptance testing.

Advantages:

1. Reduces Systematic Modeling Error
2. Improves Fairness in Acceptance Testing
3. Reduces Regression Uncertainty
4. Beneficial for Trackers and Bifacial Systems

Disadvantages:

1. Dependence on Sensor Quality and Placement
2. Potential for Masking Real Underperformance
3. Not Explicitly Prescriptive in ASTM Standards
4. Increased Process Complexity

Across industry practice and research, POA de-biasing is best viewed as a controlled uncertainty-reduction technique rather than a performance enhancement. When applied transparently, using high-quality sensors and a clearly documented methodology—as in your procedure—it generally improves the statistical robustness and fairness of ASTM-based capacity testing. However, when applied inconsistently or without contractual clarity, it can become a source of contention rather than resolution.