

Technical Paper · U.S. Market Edition

November 2026

Weather-Corrected Performance Ratio of a Utility-Scale PV Plant

U.S. practice (IEEE · ASTM · NREL) · Case: 2.5 MWac PV Plant

Solstice Performance Solutions LLC d/b/a Solstice Energy

Mr. Vinicius Rafael Palaveri Leoni, Chief Executive Officer

solsticepes@gmail.com

Contents

Abstract **3**
1 Introduction and Scope **3**
2 Fundamentals of the Method **4**
2.1 Yields and performance ratio 4
2.2 Weather-corrected performance ratio 4
2.3 Reference temperature from PVsyst 4
2.4 Acceptance criterion 5
3 Standards and References Applicable (U.S. Market) **5**
3.1 How to use these documents together 6
3.2 Where IEEE fits 6
3.3 Reference values 6
4 Plant and Monitoring Data **7**
4.1 Plant characteristics 7
4.2 Data channels 7
4.3 Sensors and measurement accuracy 8
4.4 Module temperature coefficient 8
4.5 Evaluation period 8
5 Calculation Procedure **9**
5.1 Data acceptance criteria 9
5.2 Calculation steps 10
5.3 Measurement uncertainty 10
6 Results **10**
6.1 Data screening 10
6.2 Period results 11
6.3 Power–irradiance behavior and clipping 12
6.4 Acceptance 13
7 Notes on the Results **13**
8 Common Errors and Best Practices **14**
8.1 Quick checklist 14
9 Minimum Report Content **14**
References **15**
Standards (U.S. market) 15
Technical material consulted 16
Field data 16
Annex A: Test Record Template **17**

Abstract

This paper presents the method used by Solstice Energy to calculate the weather-corrected performance ratio (WCPR) of a utility-scale photovoltaic (PV) plant from SCADA data, and applies it to an anonymized PV plant (3,416 kWp DC / 2,500 kW AC, Brazil) over April 6–13, 2025.

The calculation follows the NREL weather-corrected performance ratio [7], with the irradiance-weighted annual array temperature from the PVsyst simulation (T_{array} = 43.94 °C) as the comparative reference temperature and the measured module temperature corrected to cell temperature (ΔT = 3 °C at 1,000 W/m²). Data acceptance follows the range, dead-value and abrupt-change criteria of the IEC 61724 series [4]–[6], which U.S. practice uses together with ASTM E2848 [8] for capacity testing. Interconnection operating limits that constrain active power are taken from IEEE Std 1547 [1] and IEEE Std 2800 [3].

Over the 359 accepted 15-minute intervals, the plant delivered 131.9 MWh with 49.28 kWh/m² of plane-of-array insolation. The WCPR is **79.58%**. That is 1.9% below the expected PR for April from PVsyst (81.11%) and 1.1% above the guaranteed PR of 78.68%, which is the expected PR less a 3% contract margin (assumed, as no contract value was available). Result: **MEETS GPR**. Inverter clipping, a consequence of the 1.37 DC/AC ratio, accounts for about 0.33% of the energy. The paper also lists the minimum report content and the monitoring upgrades needed for a contractual test in the U.S. market.

Keywords: performance ratio, weather-corrected PR, PVsyst T_{array}, IEEE 1547, ASTM E2848, IEC 61724, PV plant, commissioning, SCADA.

1 Introduction and Scope

Performance ratio (PR) is the standard indicator of PV plant quality. It compares the energy delivered with the energy the nameplate capacity would produce under the measured solar resource. In the U.S. market, owners, lenders, independent engineers and EPC contractors use PR, and the related capacity tests, at commissioning, at final completion and when checking performance guarantees.

A PR calculated over a short period depends on the weather of that period, especially module temperature. The weather-corrected PR removes this dependence by referring the temperature correction to the typical annual condition. The result can then be compared directly with the annual PR predicted by the energy simulation.

Scope: this paper covers the calculation of the WCPR from 15-minute SCADA data, the data acceptance criteria, and the comparison with the PVsyst expectation. It does not cover long-term degradation analysis, soiling measurement, or a formal capacity test, which are separate procedures.

Audience: performance engineers, commissioning engineers and asset managers who calculate, review or audit PR results.

Normative basis: U.S. practice (IEEE, ASTM, ANSI and NREL), together with the IEC 61724 series, which ASTM E2848 complements and which U.S. contracts commonly cite. Section 3 lists each document and what it contributes. Acceptance limits for each project come from the contract and the energy simulation, not from this paper.

2 Fundamentals of the Method

2.1 Yields and performance ratio

For each 15-minute interval i (τ = 0.25 h), the reference yield Y_r, the final yield Y_f and the performance ratio are:

$$Y_r = \Sigma\, G_{POA,i} \cdot \tau \,/\, G_{STC} \qquad Y_f = \Sigma\, E_{AC,i} \,/\, P_{STC} \tag{1}$$

$$PR = Y_f \,/\, Y_r \tag{2}$$

where G_{POA} is the plane-of-array irradiance, G_{STC} = 1,000 W/m², E_{AC} is the AC energy at the point of interconnection (POI) meter, and P_{STC} is the DC nameplate capacity at standard test conditions.

2.2 Weather-corrected performance ratio

The NREL method [7] corrects the expected energy of each interval for the difference between the measured temperature and the typical annual temperature of the array:

$$E_{DC,i} = P_{STC} \cdot (G_{POA,i} \,/\, G_{STC}) \cdot [1 - (\delta/100) \cdot (T_{array} - T_{cell,i})] \cdot \tau \tag{3}$$

$$WCPR = \Sigma\, E_{AC,i} \,/\, \Sigma\, E_{DC,i} \tag{4}$$

where δ is the power temperature coefficient of the module (%/°C, negative), T_{array} is the reference temperature and $T_{cell,i}$ is the cell temperature of interval i (Section 2.3). When the module is hotter than the reference, the expected energy goes down, so the WCPR is not penalized for a hot week, and the reverse holds for a cold week.

2.3 Reference temperature from PVsyst

The reference temperature is the irradiance-weighted annual average array temperature from the PVsyst simulation of the plant (T_{array} = 43.94 °C). Using the same simulation that produced the expected PR keeps the comparison consistent. As in the other Solstice PR reports, the annual T_{array} is the temperature reference, and the PVsyst PR of the test month (April, 81.11%) is the expected PR from which the guaranteed PR is derived (Section 2.4).

PVsyst T_{array} is a cell (array) temperature, while the plant sensor measures the back of the module. The measured value is therefore corrected to cell temperature before it is compared with T_{array}:

$$T_{cell,i} = T_{mod,i} + (G_{POA,i} / G_{STC}) \cdot \Delta T, \qquad \Delta T = 3\ °C \tag{5}$$

The 3 °C difference between cell and back of module at 1,000 W/m² is the value of the Sandia Array Performance Model [12], used by NREL [7], for glass/cell/polymer-sheet modules on open racks. It is the same correction applied in the other Solstice PR reports, so results are comparable between plants.

2.4 Acceptance criterion

The performance ratio is accepted when:

$$WCPR_i \geq GPR \tag{6}$$

$$GPR = PR_{exp} \cdot (1 - m) \tag{7}$$

where WCPR_i is the weighted performance ratio over the test duration i. PR_exp is the expected PR for the month of the test, taken from the PVsyst base simulation. m is the contract margin. When the contract states a fixed guaranteed PR, that value is used as GPR instead of Eq. (7). U.S. contracts usually set the guarantee 2–5% below the P50 simulation, to absorb modeling and measurement effects. When no contract value is available, Solstice Energy uses m = 3%.

The result is reported as **MEETS GPR** when Eq. (6) holds and **BELOW GPR** otherwise. The measurement uncertainty (Section 5.3) is reported as technical information and does not change the result.

3 Standards and References Applicable (U.S. Market)

The documents below form the basis of the method. Always check each standard against its most recent edition before citing an edition, item or clause in a report.

Normative documents

Document	What it provides for this analysis
IEEE Std 1547-2018 / 1547a-2020	Interconnection of distributed energy resources (DER). Defines voltage, reactive-power and active-power limiting functions that can constrain plant output; those intervals must be identified before PR is interpreted.
IEEE Std 1547.1-2020	Conformance test procedures for IEEE 1547 functions. Reference for the plant control modes recorded during the test period.
IEEE Std 2800-2022 / 2800.2-2026	Requirements and test and verification procedures for inverter-based resources connected to transmission. Applies to larger U.S. plants; same principle of constrained operation.
ANSI C12.20	Accuracy classes of revenue meters (0.2 and 0.5). Basis of the energy measurement uncertainty.
IEC 61724-1:2021	Monitoring classes, sensors and definitions of Y_r, Y_f and PR. Data quality checks.

Document	What it provides for this analysis
IEC TS 61724-2:2025	Short-term capacity test (power performance index). Unconstrained operation and data filtering.
IEC TS 61724-3:2016	Long-term energy evaluation. Framework for extending this analysis beyond the test period.
ASTM E2848-13(2023)	Regression-based capacity at reporting conditions, the most cited U.S. capacity test.
ASTM E2939-13(2023)	Selection of reporting conditions and expected capacity for ASTM E2848.
ASTM G183 / G213	Field use of pyranometers and evaluation of their measurement uncertainty.
NREL/TP-5200-57991	Weather-corrected performance ratio method (Eqs. 3 and 4 of this paper).
Sandia SAND2004-3535	Array performance model; cell-to-module temperature difference ΔT (Eq. 5).

3.1 How to use these documents together

- **IEEE 1547** (or **IEEE 2800** for transmission-connected plants) defines the operating modes of the plant. Intervals in which output was limited by a control function or by curtailment are not representative of the plant's capability.
- **IEC 61724-1** and **ASTM G183** define what must be measured, with which sensors and at which resolution.
- The **NREL WCPR** defines how to calculate a PR that can be compared with the annual simulation.
- **ASTM E2848** or **IEC TS 61724-2** is used when a contract requires a formal capacity test. The PR of this paper is a performance indicator, not a substitute for that test.

3.2 Where IEEE fits

There is no IEEE standard that defines the performance ratio of a grid-connected PV plant. IEEE Std 1526-2020 covers performance testing of stand-alone PV systems only. In U.S. practice the IEEE standards act on PR indirectly: they set the interconnection requirements (IEEE 1547, IEEE 2800) that define when the plant is allowed to deliver full power, while the PR and capacity calculations come from ASTM, IEC and NREL. This paper follows that division.

3.3 Reference values

None of these documents imposes a minimum PR. The reference value comes from the energy simulation of the project and from the contract. Always record the expected PR and its source next to the measured value.

4 Plant and Monitoring Data

4.1 Plant characteristics

Case-study PV plant (anonymized)

Item	Value
Location	Brazil (site not identified)
DC capacity (P_{STC})	3,416.00 kWp
AC capacity	2,500 kW (12 × 200 kW + 1 × 100 kW inverters)
DC/AC ratio	1.37
Temperature coefficient of Pmax (δ)	−0.300 %/°C (module datasheet)
Reference temperature (T_{array})	43.94 °C (PVsyst simulation provided by the plant owner)
Expected PR, April (PR_exp)	81.11% (PVsyst monthly result)
Guaranteed PR (GPR)	78.68% (PR_exp × (1 − 3%); margin assumed, no contract value available)
Monitoring platform	SCADA supplied by Sunop Autônoma

4.2 Data channels

Three SCADA channels were used, exported as 15-minute averages directly from the plant data server:

- **POA irradiance:** ESTM.POA.IRAD (W/m²).
- **Module temperature:** ESTM.PNL_1.TEMP (°C), back-of-module sensor.
- **AC power:** CABINE.MEDIDOR.GERAL.P_TOT (kW), plant revenue meter at the POI.

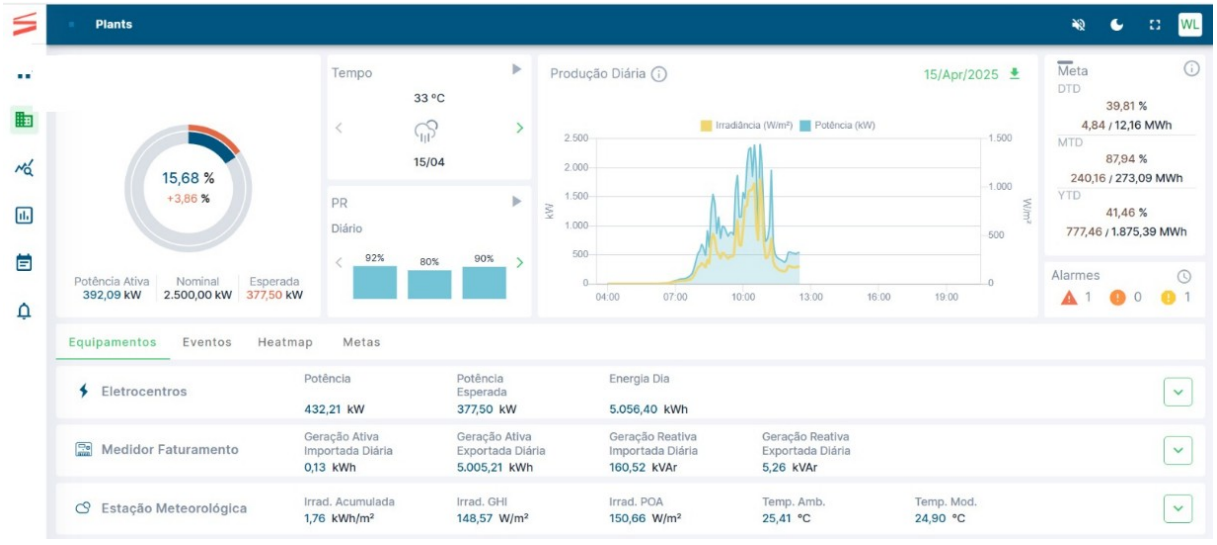


Figure 1. SCADA supervisory screen of the case-study plant (identification removed).

4.3 Sensors and measurement accuracy

The table below lists the sensors used, their position and their accuracy. The accuracy of the irradiance sensor is the main term of the measurement uncertainty (Section 5.3).

Sensors used in the calculation

Quantity	Sensor / channel	Accuracy
POA irradiance	Pyranometer in the plane of the array, weather station (ESTM.POA.IRAD)	±2.5% of reading or ±5 W/m² (supplier manual; same sensor model as another PV plant adopted for comparison)
Module temperature	Back-of-module sensor (ESTM.PNL_1.TEMP); corrected to cell temperature with Eq. (5)	±1 °C (assumed)
AC energy	Revenue meter at the POI (CABINE.MEDIDOR.GERAL.P_TOT)	ANSI C12.20 class 0.5 (assumed)

4.4 Module temperature coefficient

Power Tolerance	0~+5W
Temperature Coefficient of Isc(α_Isc)	+0.046%/℃
Temperature Coefficient of Voc(β_Voc)	-0.260%/℃
Temperature Coefficient of Pmax(γ_Pmp)	-0.300%/℃
STC	Irradiance 1000W/m²,cell temperature 25℃, AM1.5G

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer.They only serve for comparison among different module types.

Figure 2. Temperature coefficients from the module datasheet; δ = −0.300 %/°C is used in Eq. (3).

4.5 Evaluation period

The evaluation covers April 6, 2025 00:00 to April 13, 2025 23:45: eight full days, 768 consecutive records, with no gaps or duplicate timestamps (Figure 3).

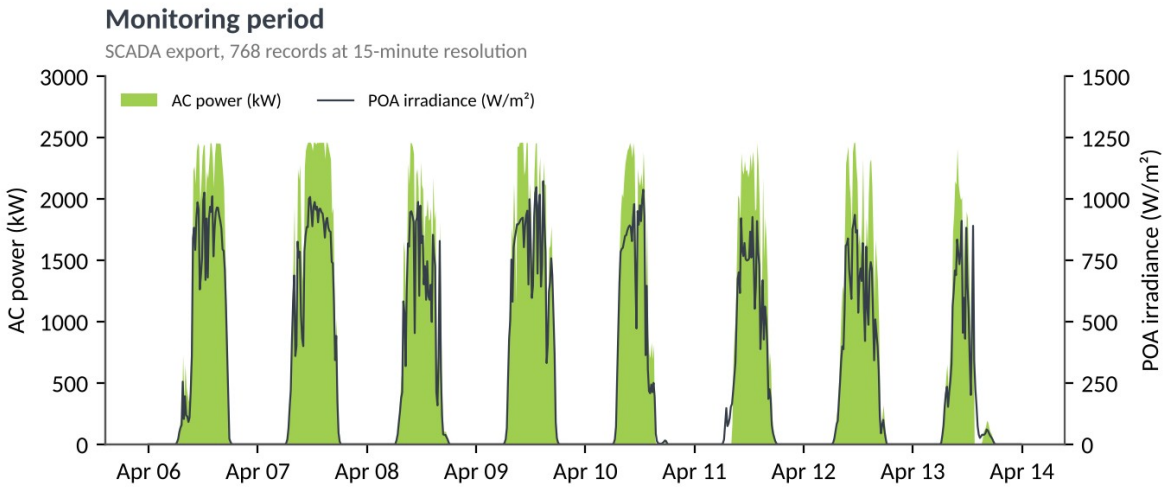


Figure 3. AC power and POA irradiance over the evaluation period.

5 Calculation Procedure

5.1 Data acceptance criteria

Each record is checked against the criteria below, based on IEC 61724-1/-2 and kept identical to those of the original assessment. A record that fails any criterion is removed from both the numerator and the denominator of Eq. (4).

Data acceptance criteria

Flag	Description	POA irradiance	AC power
Range	Value outside reasonable limits	< −6 or > 1,500 W/m²	≤ 0 kW (no generation)
Dead value	Value stuck over time	$\|\Delta\| < 0.0001$ while G > 5 W/m²	—
Abrupt change	Unacceptable change between records	$\|\Delta\| >$ 800 W/m²	$\|\Delta\| >$ 80% of AC capacity

Reasons for the exclusions:

- **Negative or near-zero irradiance:** thermopile pyranometers report small negative values at night (thermal offset). These records carry no solar resource and are removed.
- **AC power ≤ 0:** at night and at start-up the meter records zero or negative power, because the plant imports energy for its auxiliary loads. These records do not represent generation and are removed so that the auxiliary consumption does not distort the ratio.
- **Dead values and abrupt changes:** they indicate a communication freeze or a sensor fault rather than a physical change.

5.2 Calculation steps

1. **Export the data.** Download the 15-minute averages of POA irradiance, module temperature and meter AC power for the whole period.
2. **Apply the acceptance criteria** of Section 5.1 and record how many intervals each criterion removed.
3. **Calculate the AC energy** of each accepted interval: $E_{AC,i} = P_{AC,i} \times 0.25$ h.
4. **Calculate the expected DC energy** of each interval with Eq. (3), using P_{STC} = 3,416 kWp, δ = −0.300 %/°C, T_{array} = 43.94 °C and the cell temperature of Eq. (5).
5. **Sum both energies** over the accepted intervals and divide (Eq. 4) to obtain the WCPR.
6. **Identify constrained intervals:** inverter-limited intervals (AC power ≥ 98% of capacity) and any interval with curtailment or a non-default IEEE 1547 control mode.
7. **Apply the acceptance criterion** of Section 2.4: calculate the GPR, compare it with the WCPR, and report MEETS GPR or BELOW GPR. Give the measurement uncertainty as technical information.

Practical tip: keep the acceptance criteria in a separate worksheet from the calculation, with one column per flag. Reviewers can then see why each interval was removed.

5.3 Measurement uncertainty

A simplified root-sum-square estimate, at about 95% confidence, combines: POA irradiance ±2.5% of reading (supplier manual; evaluation per ASTM G213), revenue meter ±0.5% (ANSI C12.20 class 0.5), temperature ±1 °C (±0.3% in power) and temperature coefficient ±0.1%. The combined uncertainty is about ±2.6% of the value, or **±2.0 pp** on the WCPR. Sensor representativeness and soiling of the reference sensor are not included. The uncertainty is reported for information and does not change the acceptance result.

6 Results

6.1 Data screening

No record failed the irradiance range, dead-value or abrupt-change criteria. 409 records were removed by the AC power criterion, almost all of them at night. 359 intervals (89.75 h) were accepted for the calculation.

6.2 Period results

Results for April 6–13, 2025

Metric	Value	Basis
Accepted intervals	359 (89.75 h)	Section 5.1
AC energy at POI	131.9 MWh	Revenue meter
POA insolation (Y_r)	49.28 kWh/m²	Eq. (1)
Final yield (Y_f)	38.61 kWh/kWp	Eq. (1)
Irradiance-weighted module temperature	46.8 °C	Measured
Irradiance-weighted cell temperature	49.0 °C	5.1 °C above T_{array}, Eq. (5)
PR, uncorrected	78.36%	Eq. (2)
WCPR	**79.58%**	**Eq. (4), reference T_{array}**
WCPR with module temperature (Rev. 0A basis)	79.03%	Sensitivity
Expected PR, April (PR_exp)	81.11%	PVsyst, monthly
Guaranteed PR (GPR)	78.68%	Eq. (7), m = 3% (assumed)
WCPR vs. GPR	+1.1% relative	—
WCPR vs. expected PR	-1.9% relative	—
Result	**MEETS GPR**	**Eq. (6)**
Measurement uncertainty (information)	±2.6% (±2.0 pp)	Section 5.3

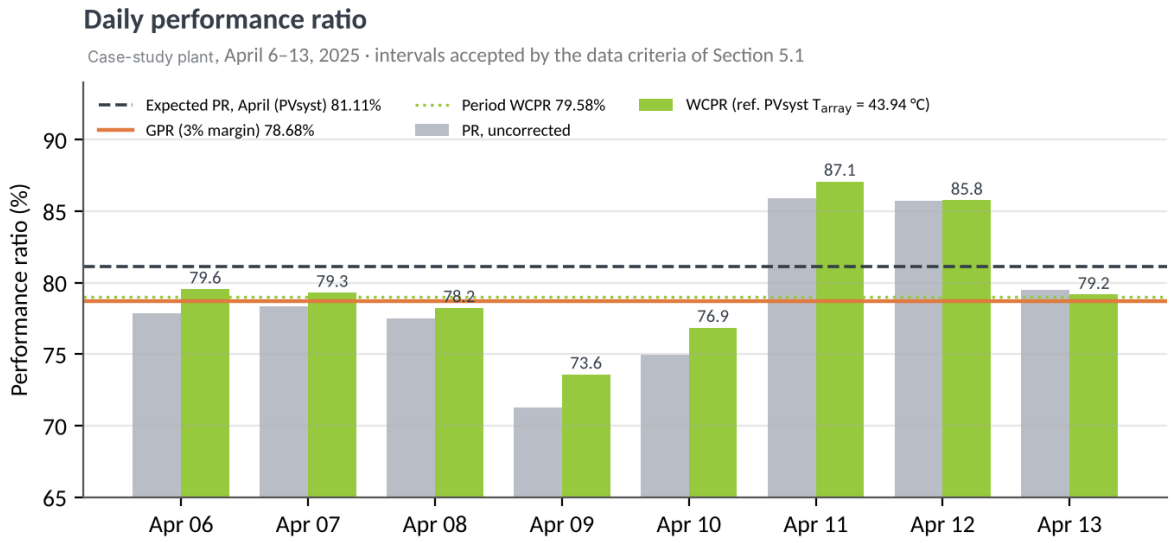


Figure 4. Daily uncorrected PR and WCPR compared with the PVsyst expectation.

Daily results

Date	Energy (MWh)	POA (kWh/m²)	Y_f (kWh/kWp)	PR (%)	WCPR (%)	$T_{cell,w}$ (°C)
Apr 06	18.67	7.02	5.47	77.9	79.6	51.0
Apr 07	21.24	7.94	6.22	78.3	79.3	48.0
Apr 08	16.00	6.04	4.68	77.5	78.2	47.1
Apr 09	19.57	8.04	5.73	71.3	73.6	54.5
Apr 10	14.85	5.80	4.35	75.0	76.9	52.1
Apr 11	15.39	5.24	4.51	85.9	87.1	48.4
Apr 12	16.54	5.65	4.84	85.7	85.8	44.0
Apr 13	9.63	3.55	2.82	79.5	79.2	42.6

6.3 Power–irradiance behavior and clipping

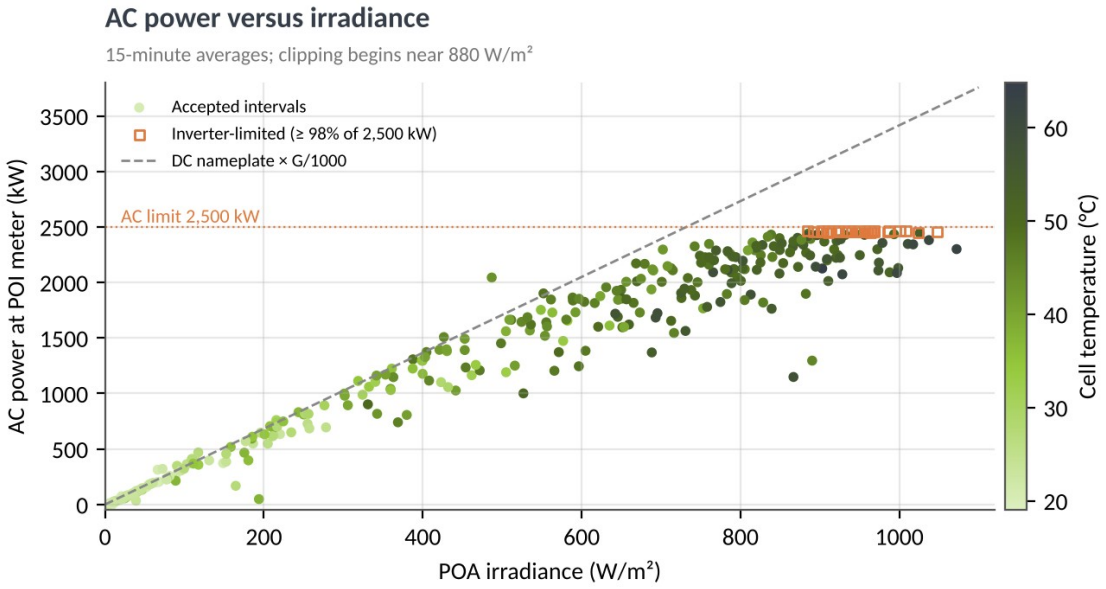


Figure 5. AC power versus POA irradiance, colored by cell temperature; inverter-limited intervals highlighted.

Accepted intervals follow the expected linear trend, and output falls as cell temperature rises, as δ predicts. Clipping begins near 880 W/m². 37 intervals were inverter-limited, with an estimated 0.43 MWh (0.33% of the period energy) not delivered. This loss is part of the design (DC/AC ratio 1.37) and is already included in the PVsyst PR, so these intervals stay in the WCPR. With them excluded the WCPR is 79.78%.

6.4 Acceptance

The guaranteed PR is GPR = 81.11% × (1 − 3%) = 78.68% (Eq. 7). The WCPR of 79.58% is 1.1% above the GPR, so the result is **MEETS GPR**. Compared with the expected PR of 81.11%, the WCPR is 1.9% lower. A difference of this size is normal for a plant performing as designed. PVsyst assumes full availability and modeled losses, and the WCPR corrects for temperature only, not for soiling, angle-of-incidence, spectral effects or auxiliary loads measured at the POI meter. The 3% margin is an assumption, because no contract value was available. The result stays MEETS GPR for any margin of 1.9% or more.

7 Notes on the Results

1. The adopted result is the WCPR over the accepted intervals: **79.58%**, which **meets the GPR** of 78.68%. Replace the assumed 3% margin with the contract value when it becomes available; the result stays MEETS GPR for any margin of 1.9% or more.
2. Daily WCPR ranges from 73.6% (April 9) to 87.1% (April 11). A spread this large between consecutive days points to changing sky conditions and to the limited representativeness of a single POA sensor under broken clouds, not to a change in the plant.
3. Six intervals with POA irradiance above 100 W/m² recorded zero export (April 11, 07:00–08:15, and April 13, 13:30–14:15). The AC power criterion removed them. Their cause (outage, grid event or curtailment) should be confirmed in the inverter and protection logs.
4. No ambient temperature, wind speed, inverter status or curtailment flags were available. A formal ASTM E2848 capacity test would need these channels.
5. The original assessment (Rev. 0A, April 15, 2025) reported 79.03%, using the module temperature directly. This edition keeps the same data, criteria and T_{array} and adds the cell temperature correction of Eq. (5), as in the other Solstice PR reports; the WCPR becomes 79.58% (+0.55 pp).

8 Common Errors and Best Practices

Common error	Effect on the result	Best practice
Using the PVsyst P50 PR directly as the guarantee	Plants performing as designed miss the target about half the time	Apply the contract margin (Eq. 7) or the contract GPR
Comparing a short-period PR with the annual PVsyst PR	A hot or cold week biases the comparison	Use the WCPR with T_{array} from the same simulation
Using module temperature as cell temperature	Cell temperature underestimated by up to 3 °C	Apply Eq. (5) before comparing with T_{array}
Using a temperature coefficient different from the datasheet	Temperature correction over- or under-estimated	Record δ and its source in the report
Keeping night records with negative power	Auxiliary consumption reduces the PR	Apply the AC power criterion of Section 5.1
Not flagging curtailment or IEEE 1547 control modes	Plant penalized for limits it did not choose	Export control mode and curtailment flags with the data
Single POA sensor without cross-check	Sensor error goes directly into the PR	Install redundant POA sensors and record calibration
Reporting PR without uncertainty	Small differences read as real deviations	State the uncertainty next to the result
Mixing time zones or DST shifts	Irradiance and power out of step	Use one time base for all channels

8.1 Quick checklist

- Data period, resolution and channel names recorded.
- Datasheet δ and PVsyst T_{array} recorded with their sources.
- Acceptance criteria applied and intervals removed by each criterion counted.
- Clipped and curtailed intervals identified.
- WCPR calculated and compared with the GPR (contract value, or expected PR less the margin).
- Uncertainty stated and sensor calibration recorded.

9 Minimum Report Content

The report must allow another engineer to repeat the calculation with the same data. Recommended minimum content:

- **Identification:** plant, capacity (DC and AC), location, period, analyst and reviewer.
- **Data source:** monitoring platform, channel names, resolution and export date.
- **Parameters:** P_{STC}, δ, T_{array} and expected PR, each with its source document.
- **Criteria:** data acceptance criteria and number of intervals removed by each.
- **Results:** Y_r, Y_f, PR, WCPR and daily values, with the expected PR next to them.

- **Constraints:** clipping, curtailment and IEEE 1547 or IEEE 2800 control modes active during the period.
- **Uncertainty:** components and combined value.
- **Normative references:** editions of the standards used.
- **Limitations:** missing channels or deviations from the procedure, and their justification.

Keep the result as the **baseline** for the plant. In later periods, calculate the WCPR the same way and investigate any relevant drop.

References

Always check each standard against its most recent edition before citing it in a formal document.

Standards (U.S. market)

1. IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, with amendment IEEE Std 1547a-2020.
2. IEEE Std 1547.1-2020, *IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Energy Resources with Electric Power Systems and Associated Interfaces*.
3. IEEE Std 2800-2022, *IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems*; and IEEE Std 2800.2-2026, recommended practice for test and verification procedures.
4. IEC 61724-1:2021, *Photovoltaic system performance – Part 1: Monitoring*.
5. IEC TS 61724-2:2025, *Photovoltaic system performance – Part 2: Power performance index and capacity evaluation method*.
6. IEC TS 61724-3:2016, *Photovoltaic system performance – Part 3: Energy evaluation method*.
7. T. Dierauf, A. Growitz, S. Kurtz, J. L. B. Cruz, E. Riley and C. Hansen, *Weather-Corrected Performance Ratio*, NREL/TP-5200-57991, National Renewable Energy Laboratory, 2013.
8. ASTM E2848-13(2023), *Standard Test Method for Reporting Photovoltaic Non-Concentrator System Performance*.
9. ASTM E2939-13(2023), *Standard Practice for Determining Reporting Conditions and Expected Capacity for Photovoltaic Non-Concentrator Systems*.
10. ASTM G183, *Standard Practice for Field Use of Pyranometers, Pyrheliometers and UV Radiometers*; ASTM G213-17(2023), *Standard Guide for Evaluating Uncertainty in Calibration and Field Measurements of Broadband Irradiance with Pyranometers and Pyrheliometers*.
11. ANSI C12.20, *American National Standard for Electricity Meters – 0.1, 0.2, and 0.5 Accuracy Classes*.
12. D. L. King, W. E. Boyson and J. A. Kratochvil, *Photovoltaic Array Performance Model*, SAND2004-3535, Sandia National Laboratories, 2004.

13. IEEE Std 1526-2020, *IEEE Recommended Practice for Testing the Performance of Stand-Alone Photovoltaic Systems* (cited to define its scope; not applicable to grid-connected plants).

Technical material consulted

- PV Performance Modeling Collaborative (Sandia National Laboratories), IEC 61724 workshop, 2025: status of the revisions of the IEC 61724 series.
- pvlib / pvanalytics, metrics.performance_ratio_nrel: open-source implementation of the NREL WCPR.

Field data

- SCADA export of the case-study plant, April 6 to 13, 2025 (15-minute data, 768 records) and PVsyst simulation provided by the plant owner.
- Original assessment: Performance Ratio Report of the case-study plant, Rev. 0A, April 15, 2025.
- Reference for sensors and acceptance criterion: Performance Ratio Report of another PV plant, Rev. 00, November 12, 2024.

Annex A: Test Record Template

The record below summarizes the choices made in this analysis and can be reused for other plants.

Item	Case-study plant
Plant / capacity	Anonymized · 3,416 kWp DC / 2,500 kW AC
Period / resolution	April 6–13, 2025 · 15-minute averages
Test boundary	PV array to POI revenue meter
Irradiance input	Single POA sensor (ESTM.POA.IRAD)
Temperature input	Back-of-module sensor (ESTM.PNL_1.TEMP) + Eq. (5), ΔT = 3 °C
Reference temperature	PVsyst T_{array} = 43.94 °C
Temperature coefficient	δ = −0.300 %/°C (datasheet)
Acceptance criteria	Section 5.1 (range, dead value, abrupt change, AC power ≤ 0)
Intervals accepted	359 of 768
Constrained operation	37 clipped intervals; curtailment / IEEE 1547 mode not available
Expected PR / GPR	81.11% (PVsyst, April) / 78.68% (m = 3%, assumed)
Result	WCPR = 79.58% · MEETS GPR
Executed by / date	
Reviewed by / date	