Short Form Energy Performance Index (EPI) Test vs Capacity Testing:

A Legitimate Alternative to Industry Standard Milestone Testing

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Empirical Comparison Across 10 Utility-Scale Projects (Figure 1)

Proj.	Region	AC	DC/AC	Module	Tracker	Season	CT%	EPI%	Batch%	Δ*	ΔB
A	Mississippi	99.0	1.40	FS S7 535W	GameChange 1P	Summer	98.1	100.9	103.8	2.8	5.8
B	Arkansas	250.0	1.25	FS S6+ 470W	ATI	Fall	101.1	100.7	101.2	0.4	0.1
C	Virginia	83.0	1.30	FS S6+ 470W	NEXTRACKER	Spring	97.1	99.1	99.0	2.0	1.9
D	Florida	74.9	1.33	CS 695–705W	GameChange 1P	Summer	101.6	97.1	97.3	4.4	4.2
E	Florida	74.9	1.34	FS S6+ 465W	GameChange 1P	Spring	102.8	97.5	100.4	5.2	2.3
F	Florida	74.9	1.42	FS S6 450W	ATI DURATRACK	Summer	99.3	98.4	102.4	0.9	3.1
G	Florida	74.9	1.69	Hanwha 475/480W	SOL Fixed	Summer	97.1	100.8	101.2	3.8	4.2
H	Florida	74.9	1.29	Hanwha 425W	ATI	Fall	100.2	102.1	102.8	1.9	2.6
I	Florida	74.8	1.18	FS FS-4120A-3	ATI	Summer	97.9	98.4	99.2	0.5	1.3
J	Florida	74.5	1.38	Hanwha 360/365W	SOL Fixed	Summer	96.4	98.5	99.2	2.2	2.9

Figure 1: Energy Performance Index (EPI) and Capacity Test (CT) scores are closely aligned across 10 projects. Deviations as low as **0.09%** confirm the 7-day EPI provides comparable certainty. *Δ represents the absolute delta between the standard EPI and Capacity Test (CT) Scores. **Batch%** is a modified EPI test using batch simulations to better capture sub-hourly clipping. ΔB represents the refined delta between the high-resolution Batch score and the CT. Projects A, C, E, and F all have incomplete Capacity Test Datasets.

Abstract & Motivation

This is an exercise to compare a typical capacity test methods (ASTM Standard E2848 and E2939, or IEC 61724-2) to that of short duration (7-day) Energy Performance Index (based on IEC 61724-3). The EPI allows final milestone testing to be performed with greater operational realism, increased efficiency, less statistical uncertainty, all while providing equivalent certainty to a capacity test. The evidence compiled indicates the EPI is a legitimate alternative to the typical Capacity test as a project closeout milestone.

The Performance Relationship

Ultimately both a short form EPI and a Capacity Test are evaluating the same thing: the ability of the plant to convert sunlight into revenue at the point of interconnect. With a properly modeled plant both a short duration EPI and a Capacity test highlight the performance relationship between produced energy / power and available irradiance. The project examples (Figure 1) illustrate the alignment of these two approaches and their pass / fail outcomes.

Operational Realism

EPI allows the milestone testing for project closeout to be done under a condition of operational realism. Capacity test ultimately requires several parallel or prerequisite availability assessments to prove the systems beyond the DC elements are also working as expected. During a short duration EPI, the test is administered during fully operational plant conditions, whether it be the inverter, trackers, or substation elements. This operational condition uses the net energy exported as an indicator of the full system's functionality and efficiency. Further EPI leverages measured weather data from the test period to model expected plant performance vs Capacity test where the comparison and reporting conditions are often calculated from TMY data.

Reducing Uncertainty

Utilizing the EPI approach reduces uncertainty by limiting the need for excessive data filtering, increasing the quantity of observable data, and stabilizing model inputs using on-site measured data. A typical Capacity test requires the collection of 750 1-minute data periods. This comes out to 12.5 hours of observable operation. In contrast, a 7-day EPI provides 70 hours of continuous data, capturing a wider operating envelope that spans various irradiance levels, temperatures, and sun angles that would otherwise be excluded. Data is not filtered during this duration unless there are time periods where the full plant is not in operation. Using the measured onsite weather data also reduces uncertainty by allowing the comparison of plant performance to actual conditions, instead of an idealized average.

Conclusions

- **Holistic Confirmation:** Owners receive confirmation of real performance at the POI across all operating states with data from varied irradiance.
- **Reduced Uncertainty:** Uncertainty in the EPI test results are reduced by a host of factors: Using measured onsite weather data, Avoiding data filtering, and expanding the observable data to encompass all irradiance angles and levels.
- **Schedule Impact:** A dramatic reduction in schedule (7 days vs. 30+ days) provides a significant impact on project closeout.
- **Recommendation:** The 7-day EPI is an equivalent alternative to the typical capacity test with reduced uncertainty and reduced schedule impact.

EPI vs Capacity Test Score: Comparable Results; Reduced Uncertainty (Figure 2)

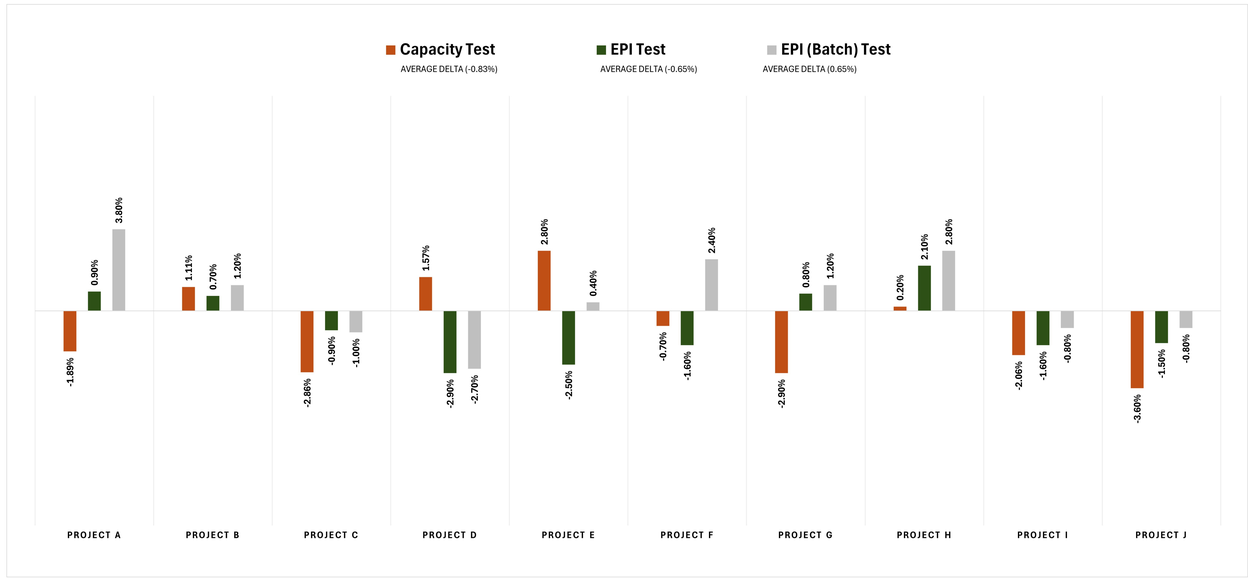

Figure 2: EPI and Capacity Test scores near **100%** represent a mutually agreeable performance level, minimizing uncertainty risk for both the EPC and the Owner. Comparing the results of EPI to Capacity test scores demonstrates the correlation between the passing results. The comparability coupled with EPI's reduced uncertainty make a compelling case for EPI as equivalent, if not superior,

Data Collection Duration Comparison (Figure 3)

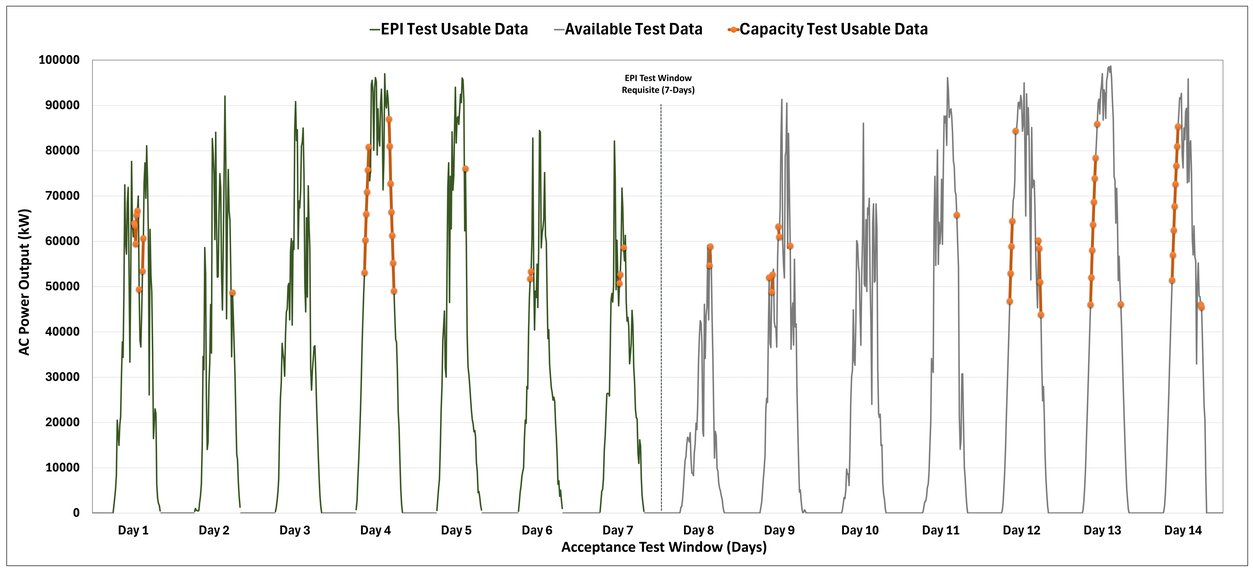

Figure 3: Over a 14-day acceptance window, the EPI test (green) captures significantly more usable data than the highly-filtered Capacity Test (orange). The dashed line marks the 7-day EPI qualification threshold, after which the EPI test is complete while the Capacity Test continues accumulating data. The reduction in time required to execute the final milestone test offer substantial risk reduction to the owner, the EPC and the off taker.

EPI Test Procedure Overview

Baseline Model

Develop PVsyst model from TMY or Owner-provided meteorological data.

Align all system configurations and assumptions between Owner & Contractor.

Data Collection

Extract SCADA data to generate site-specific meteorological inputs.

Key parameters: POA irradiance, ambient temperature, and wind speed.

Quality Control

QC screening for outages, missing data, and curtailment events.

Verify sensor calibration and flag invalid intervals.

Meteo Files: Standard/Batch

A single file is generated reflecting minutely weather data from the test period.

60 one-minute interval weather files representing each minute offset generated for Batch simulation.

Simulation: Standard/Batch

Run standard PVSYST with minutely site weather file.

Run batches with 60 files to determine total expected energy for the test period.

Measured Energy

Sum total exported energy at the POI from revenue-grade meter.

Exclude periods where the plant is not operational or under external curtailment.

EPI Result: Standard/Batch

$$\mathrm{EPI}_{\mathrm{std}} = \frac{E_{\mathrm{meas}}}{E_{\mathrm{exp,std}}} \times 100$$

Standard EPI using single PVsyst simulation.

$$\mathrm{EPI}_{\mathrm{batch}} = \frac{E_{\mathrm{meas}}}{E_{\mathrm{exp,batch}}} \times 100$$

Batch EPI using averaged expected energy across 60 offset simulations.