



Exceptional service in the national interest

O&M KPIS

You get what you pay for

Kevin Anderson

Sandia National Laboratories

2026-05-13

PVPMC Workshop - Albuquerque, NM



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SAND2026-21156C

KEY PERFORMANCE INDICATORS



Last year

KPIs



This year



Performance monitoring



O&M prioritization

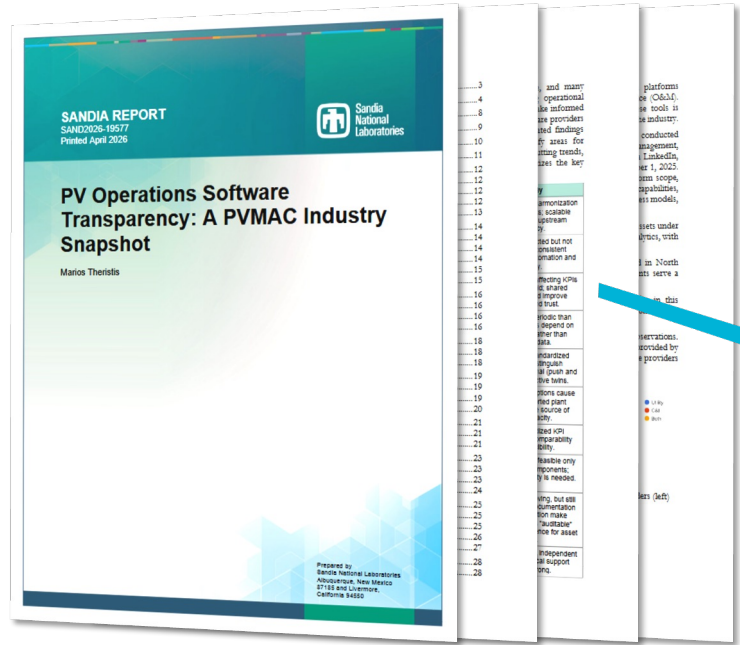


Performance guarantees

2025 PVPMC, [O&M KPIs: Uncertainty Due to Data Loss and Operational Issues](#)



KEY PERFORMANCE INDICATORS



[SAND 2026-19577](#)

9.1. Technical KPIs

Commonly reported performance KPIs include:

- ~80% Performance Ratio (PR)
- ~80% specific yield (kWh/kWp)
- ~75% time-based availability
- ~60% energy performance index
- ~50% weather adjusted PR
- ~50% energy-based availability
- ~40% capacity factor

KEY PERFORMANCE INDICATORS



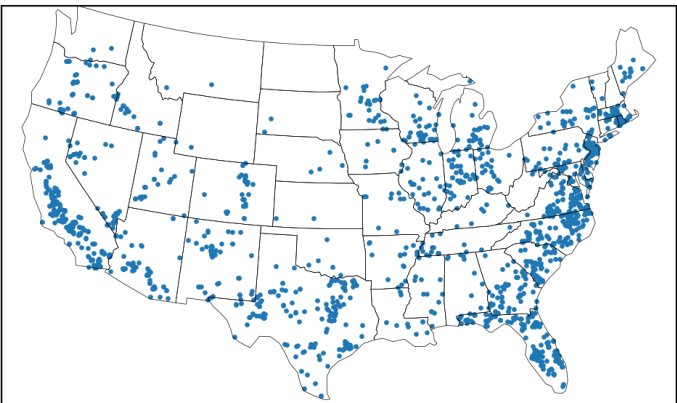
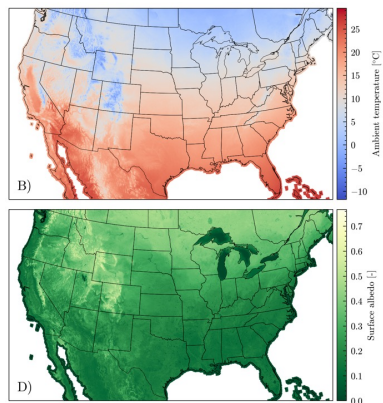
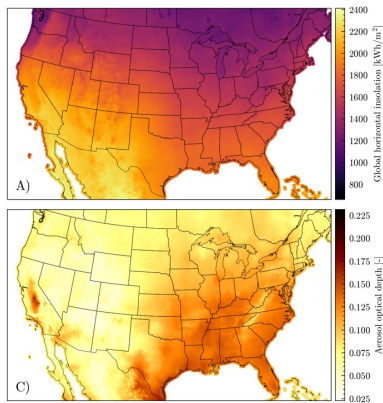
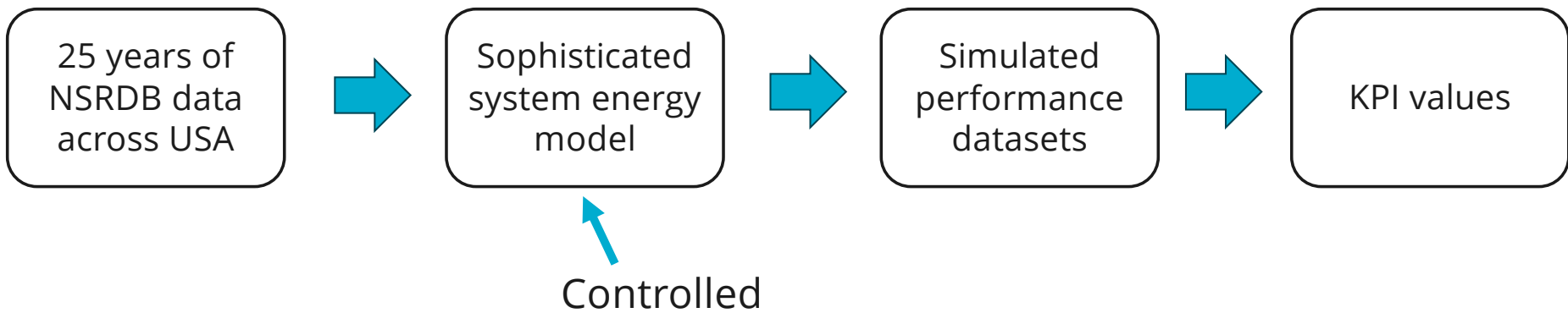
$$\text{PR} = \frac{E_{\text{measured}}}{\sum P_{\text{stc}} \cdot (G_{\text{poa}}/G_{\text{stc}})}$$

Expected energy models?

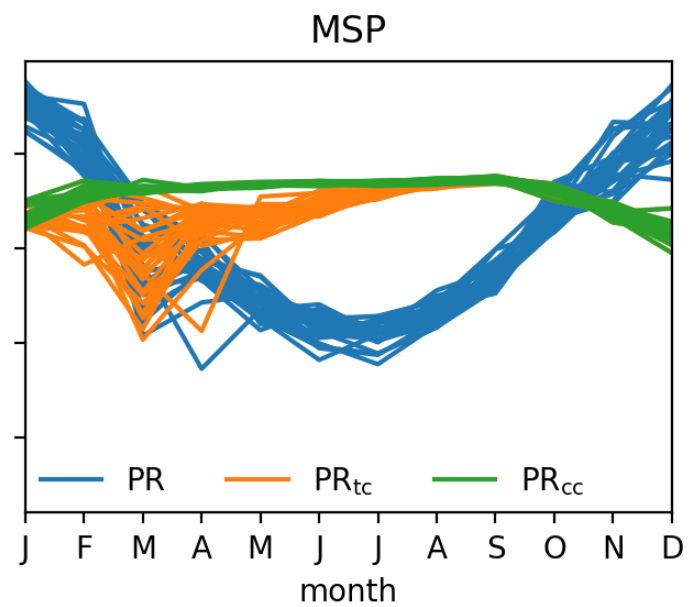
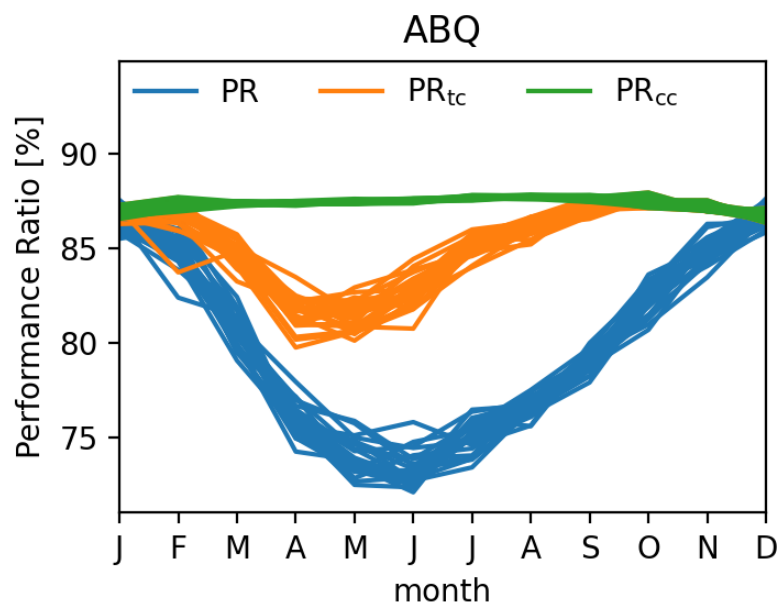
$$\text{PR}_{\text{tc}} = \frac{E_{\text{measured}}}{\sum P_{\text{stc}} \cdot (G_{\text{poa}}/G_{\text{stc}}) \cdot (1 + \delta \cdot (T - T_{\text{stc}}))}$$

Crude "model" $\stackrel{?}{=}$ problem

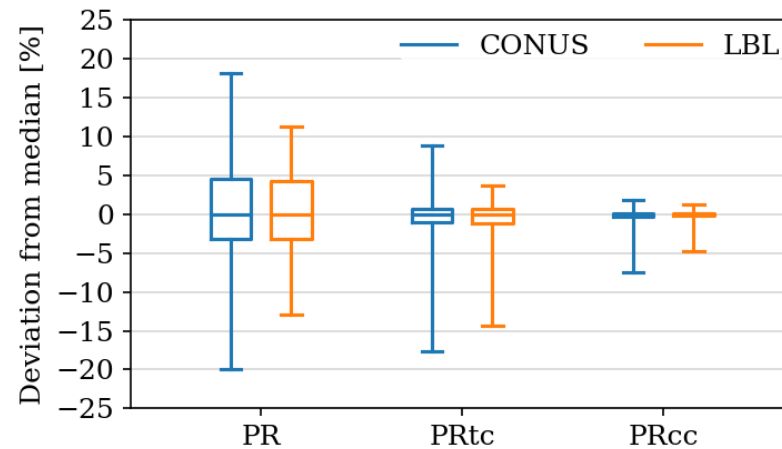
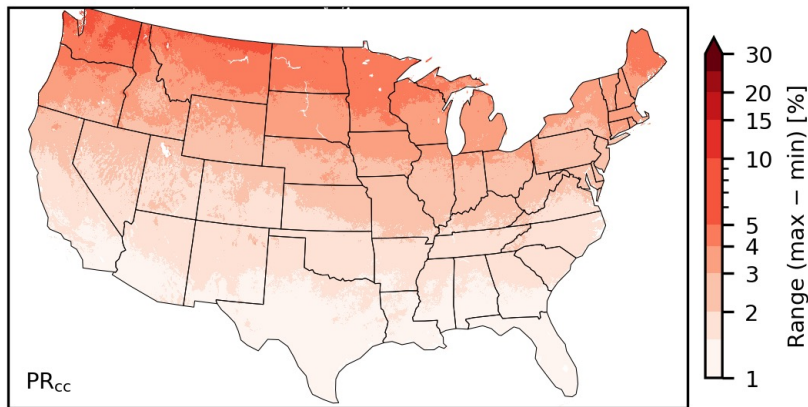
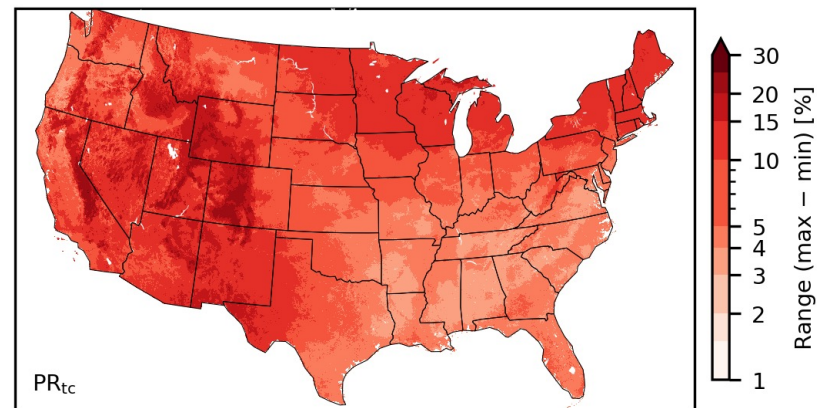
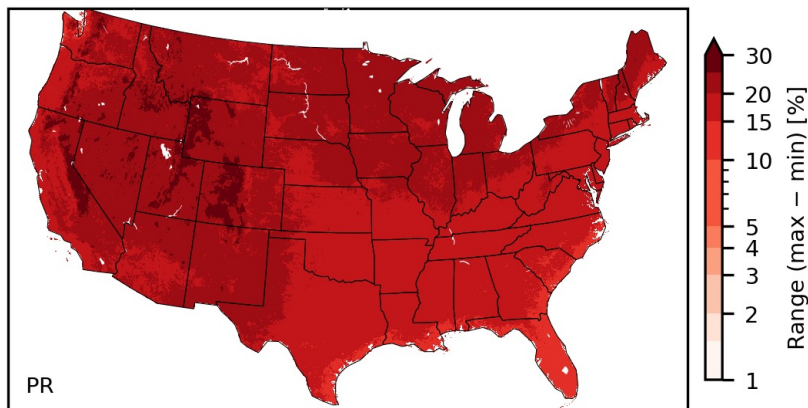
HOW?



PERFORMANCE RATIO - EXAMPLE



PERFORMANCE RATIO - RESULTS



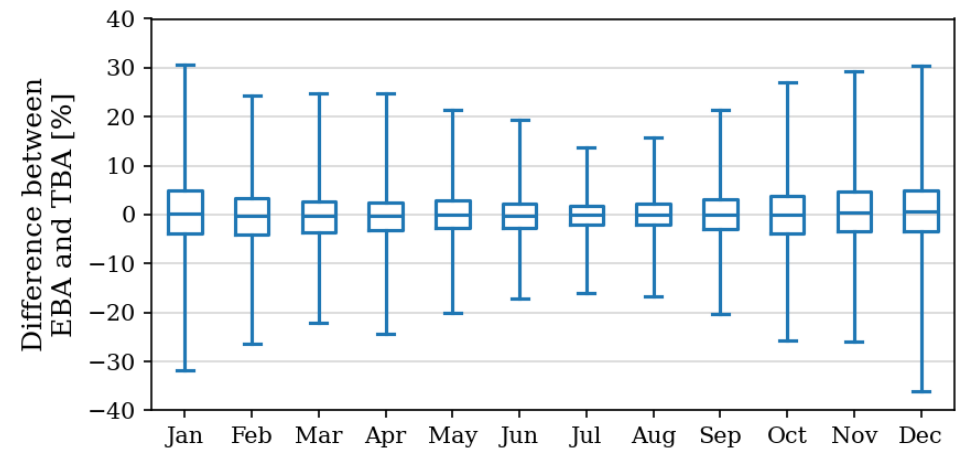
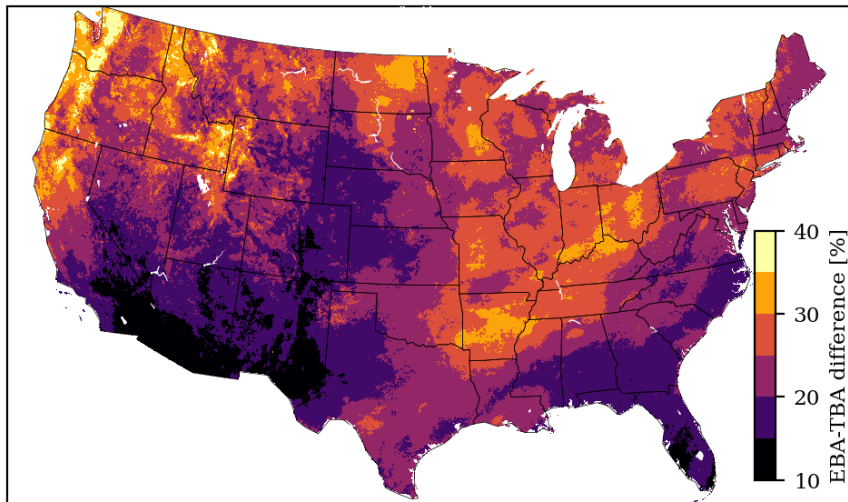
INVERTER AVAILABILITY



$$\text{TBA} = \frac{T_{\text{daytime}} - T_{\text{offline}}}{T_{\text{daytime}}}$$

$$\text{EBA} = \frac{E_{\text{expected}} - E_{\text{offline}}}{E_{\text{expected}}}$$

INVERTER AVAILABILITY

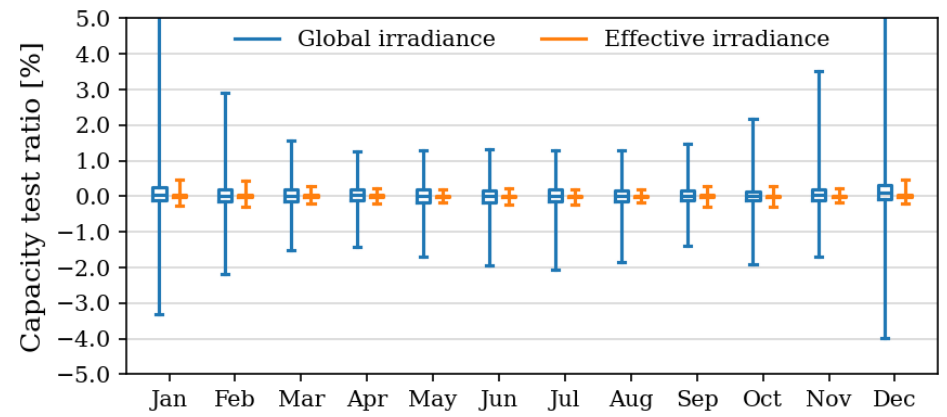
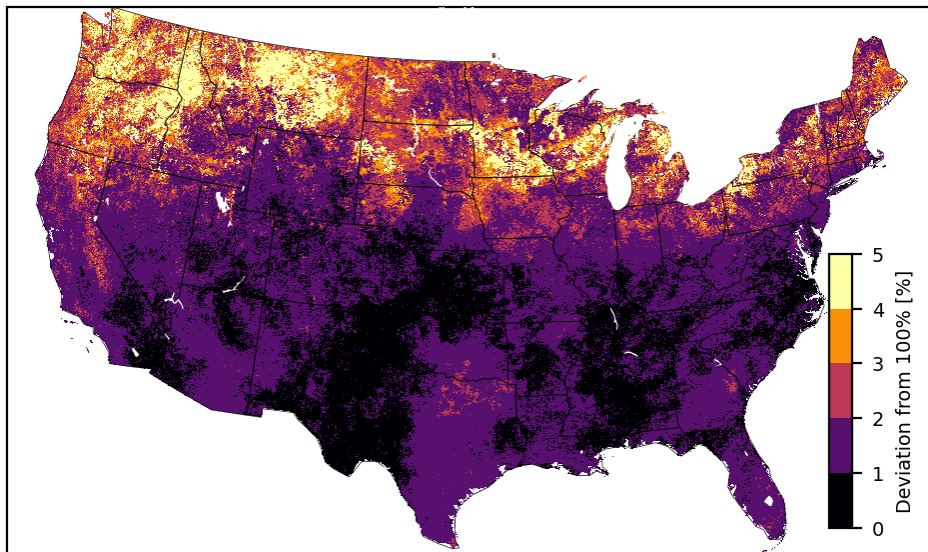


ASTM CAPACITY TEST



$$P = E \cdot (a_1 + a_2 \cdot E + a_3 \cdot T + a_4 \cdot v)$$

ASTM CAPACITY TEST



ENERGY PERFORMANCE INDEX PROPAGANDA



$$\text{EPI} = \frac{E_{\text{actual}}}{E_{\text{expected}}}$$

A vision for a brighter tomorrow: O&M using Energy Performance Index

- Use the same simulator from design through operations
- Consistent modeling throughout system life
- Define “performance” using our most sophisticated tools
- O&M energy accounting links directly to original financial model
- More precise KPIs → better prioritization and decision making



CONCLUSIONS

- Widely-used, standard KPIs have **significant uncertainty** for performance analysis
 - Even when implemented correctly
 - Even when computed with perfect data
- The uncertainty varies with location and season. No one-size-fits-all rules.
- Why do we accept such crude models for O&M? What's stopping us from using modern simulators for performance analysis?
- More details in the paper, coming soon



PV Operations & Maintenance

ANALYTICS COLLABORATIVE

IESO Award Number 52770

Thank you!

Kevin Anderson
ksande@sandia.gov

Hey I'm doing solar now, can you finance my project?

I'm thinking "Fat Stacks Solar, LLC" lol

Send the model and I'll take a look

Ya for sure. The model is tight, it does the irradiance thing

...like, only irradiance? What about other effects?

Oh I'll do temperature too, my bad

Clipping, spectrum, ohmic, shading, soiling???

OMG FINE clipping too jesus



REFERENCES

- Clipping-corrected PR:
 - J Blakesley et al., “Clipping-corrected performance ratio: a new metric for high DC:AC ratio PV systems”, EPJ Photovoltaics 2026. <https://doi.org/10.1051/epjpv/2026002>
 - G. Luchetta, “Oversizing & grid constraints: impacts in PV modelling and KPI guarantees”, 2024 European PVPMC Workshop. <https://pvpmc.sandia.gov/download/8173/>