PVPMC

PVPMC 2026,
Albuquerque,
NM, USA

Why Nominal is not P50

Quantifying systematic bias in solar performance modeling

May 13, 2026

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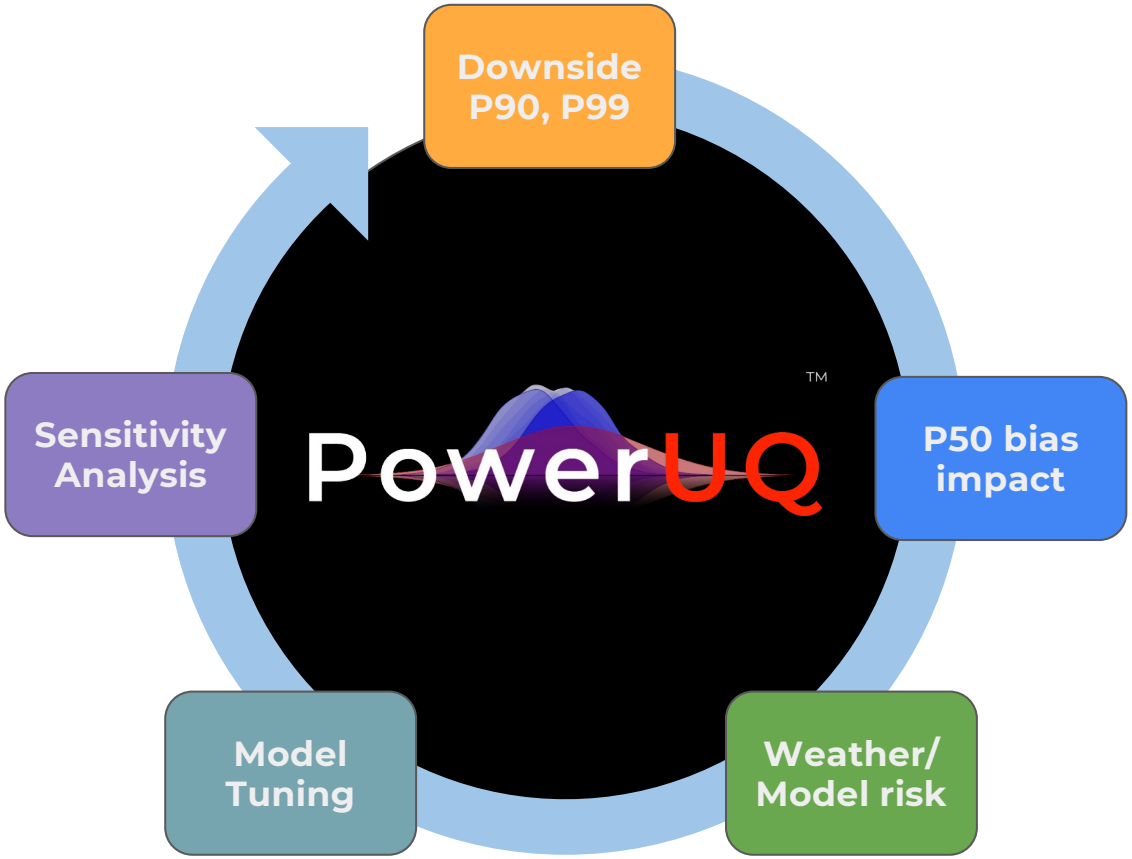
PowerUQ™



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Terabase
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Statistician drowns while crossing a river. River was 3 feet deep on average.

By Staff Reporter

May 23, 2025 — In a tragic irony, a well-known statistician drowned yesterday while attempting to cross the Greenfield River, where the average depth is reported to be just 3 feet.

The victim, Dr. Arvind Menon, 42, was a professor of statistics at the State University and widely respected for his work in probability theory and data analysis.

According to police, Dr. Menon was hiking along a popular trail and decided to cross the river to save time. He reportedly noted to a companion, "It's just 3 feet on average. Perfectly safe."

Moments later, he slipped into a deep section and was swept away by the current. His body was recovered downstream nearly an hour later.

The Greenfield River near Maple Trail crossing. Photo: R. Sharma

Friends and colleagues remember Dr. Menon as brilliant, humble, and deeply passionate about teaching. "He loved reminding us that statistics is useful in life," said a former student. "I guess life reminded him too."

This incident has sparked conversations online about the misleading nature of averages.

The river's average depth of 3 feet is calculated across a long stretch that includes many shallow areas. However, it also has deep pockets and sudden drop-offs—some exceeding 10 feet.

"Averages hide variability," said Dr. Leena Kapoor, a colleague. "They summarize data, but they don't capture risk."

Experts say this is a powerful real-world reminder that relying solely on averages can be dangerous—whether you're crossing a river, making decisions, or interpreting data.

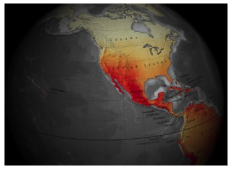
As one viral post put it:

"The average says the river is 3 feet deep. The reality says: know where you step."

MORE INSIDE

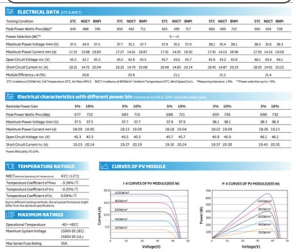
Inspired from the work of S. Savage; The flaw of averages

What is Nominal?



TMY 8760/
P50 8760

Awesome Solar



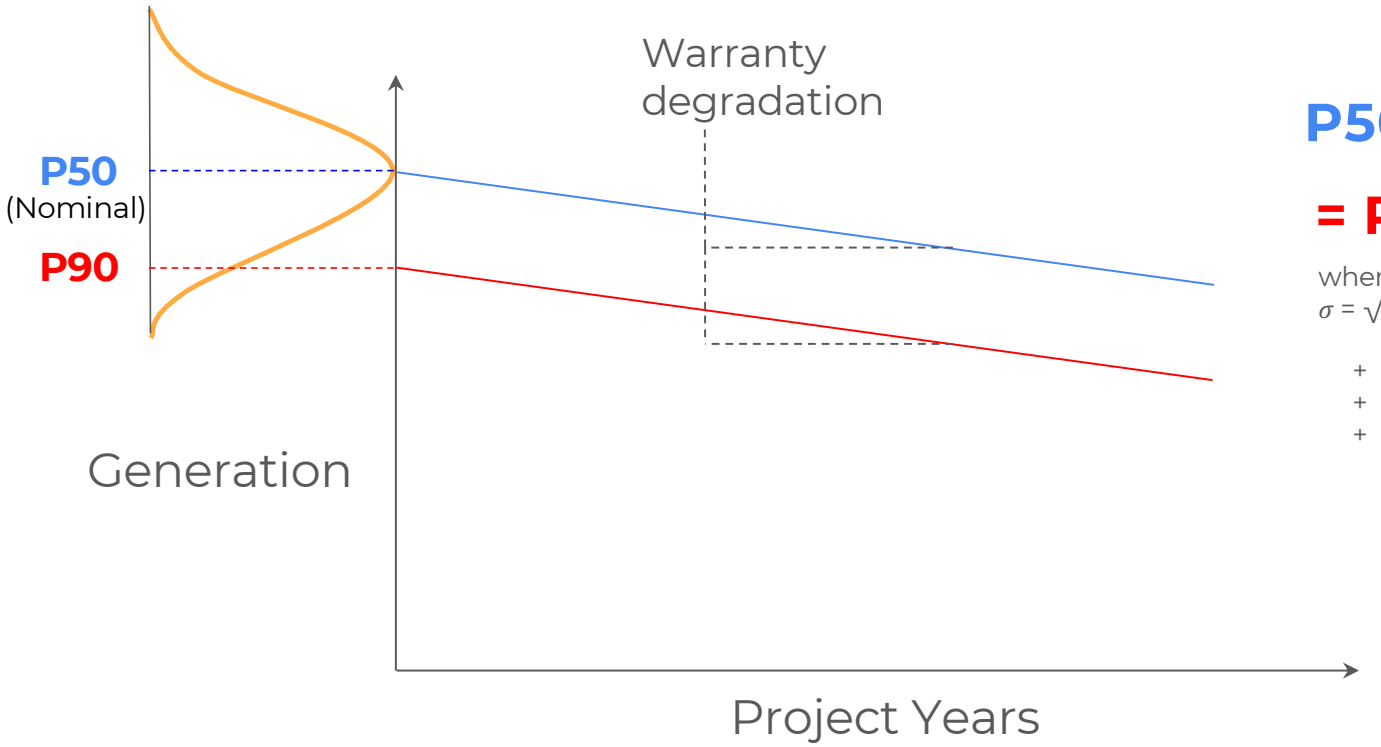
Equipment Datasheets

Deterministic Performance Model

Nominal Energy

Nominal Energy ~ **P50**

Spreadsheet math behind billions $$$ pro-formas



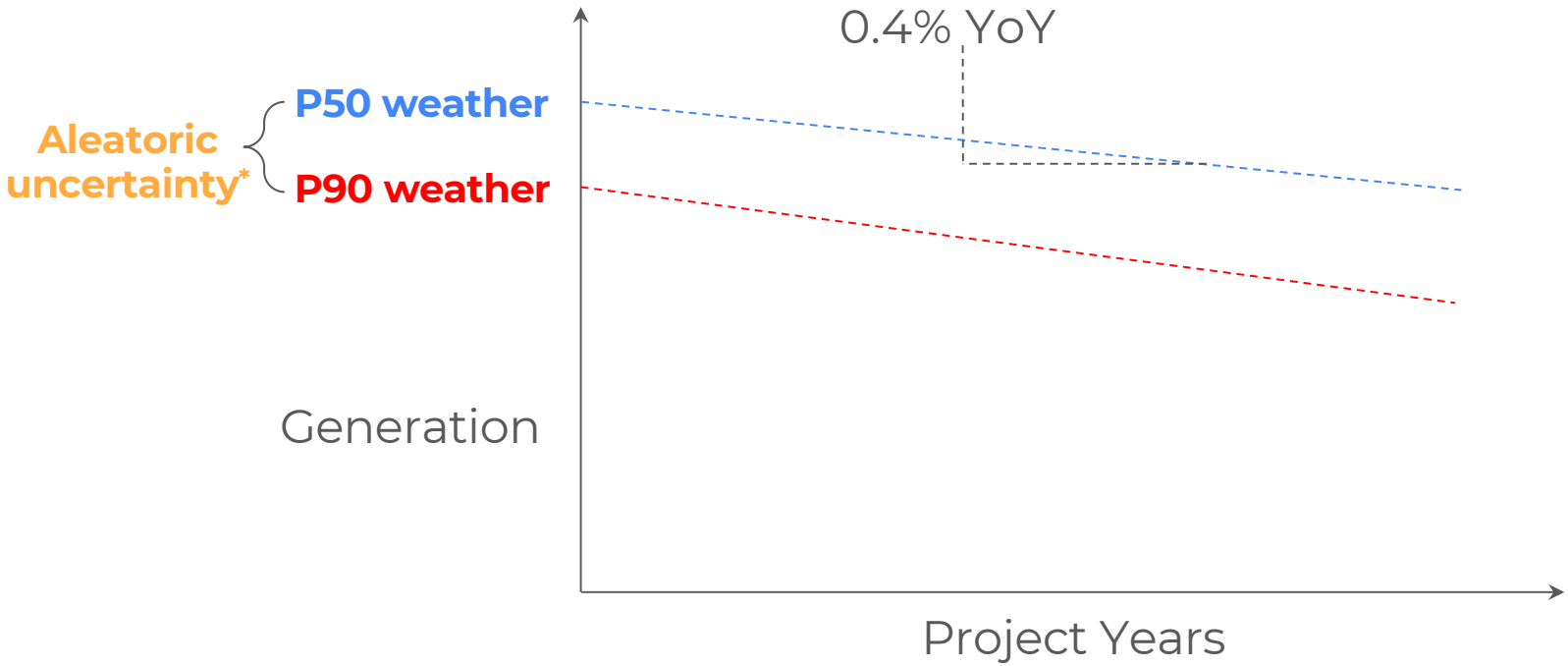
Haircut

P50 x (1 - 1.282 x σ)

= P90

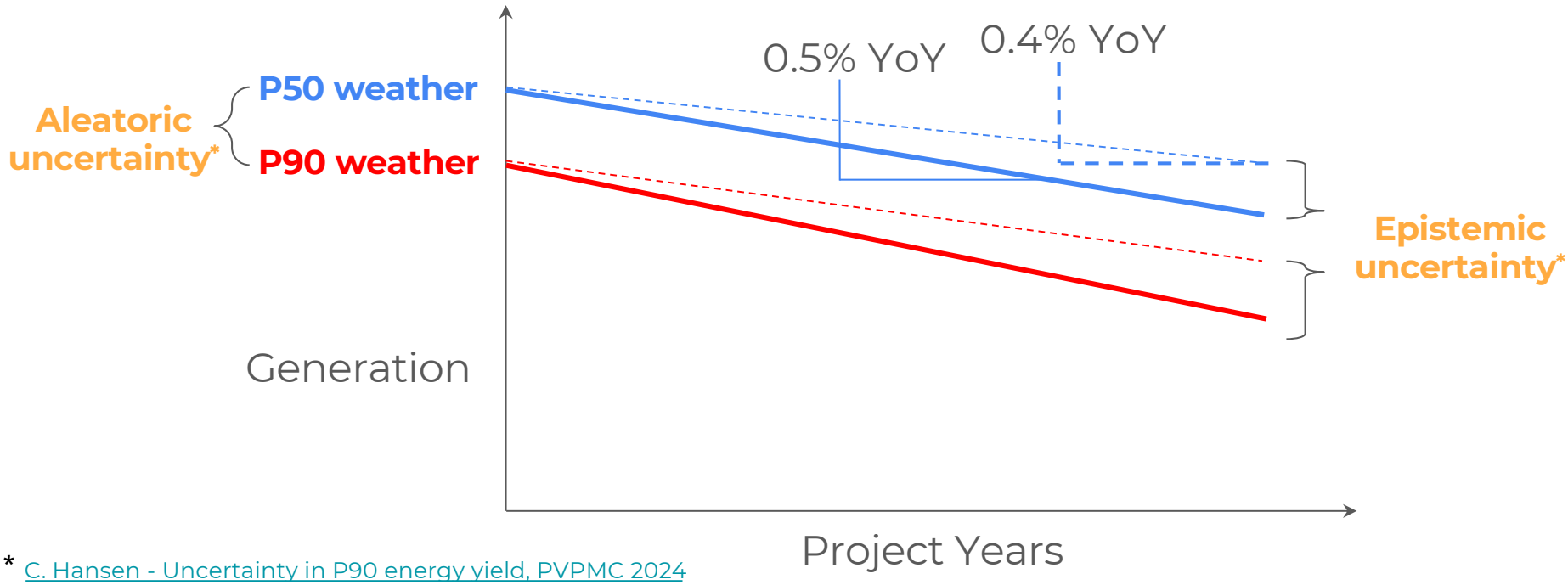
where
σ = √(
IAV^2/√N
\+ Model accuracy^2
\+ Irradiance error^2
\+ … (bring your own std. dev.; as many as you want)^2
)

Example: One module degrading YoY



P90 **AND** P50 - both are uncertain

If model parameters are uncertain; model output is also uncertain

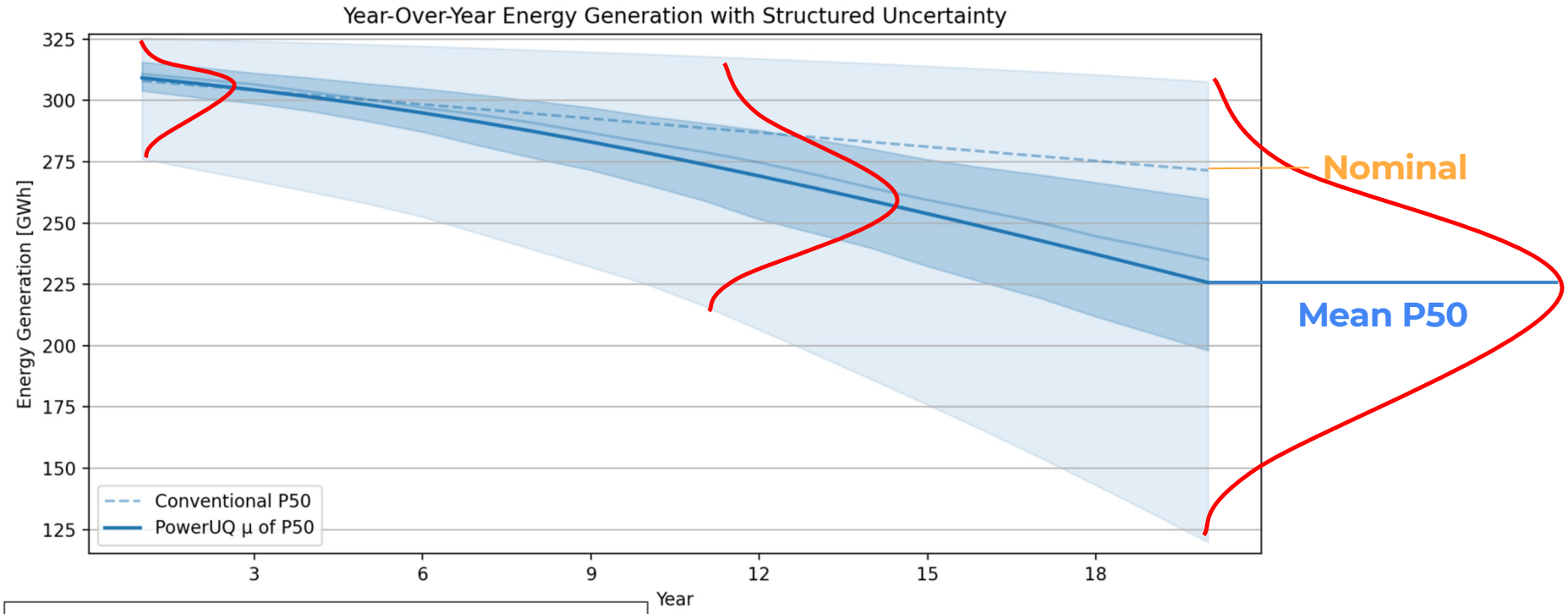


* C. Hansen - Uncertainty in P90 energy yield, PVPMC 2024

No shortcut to P50

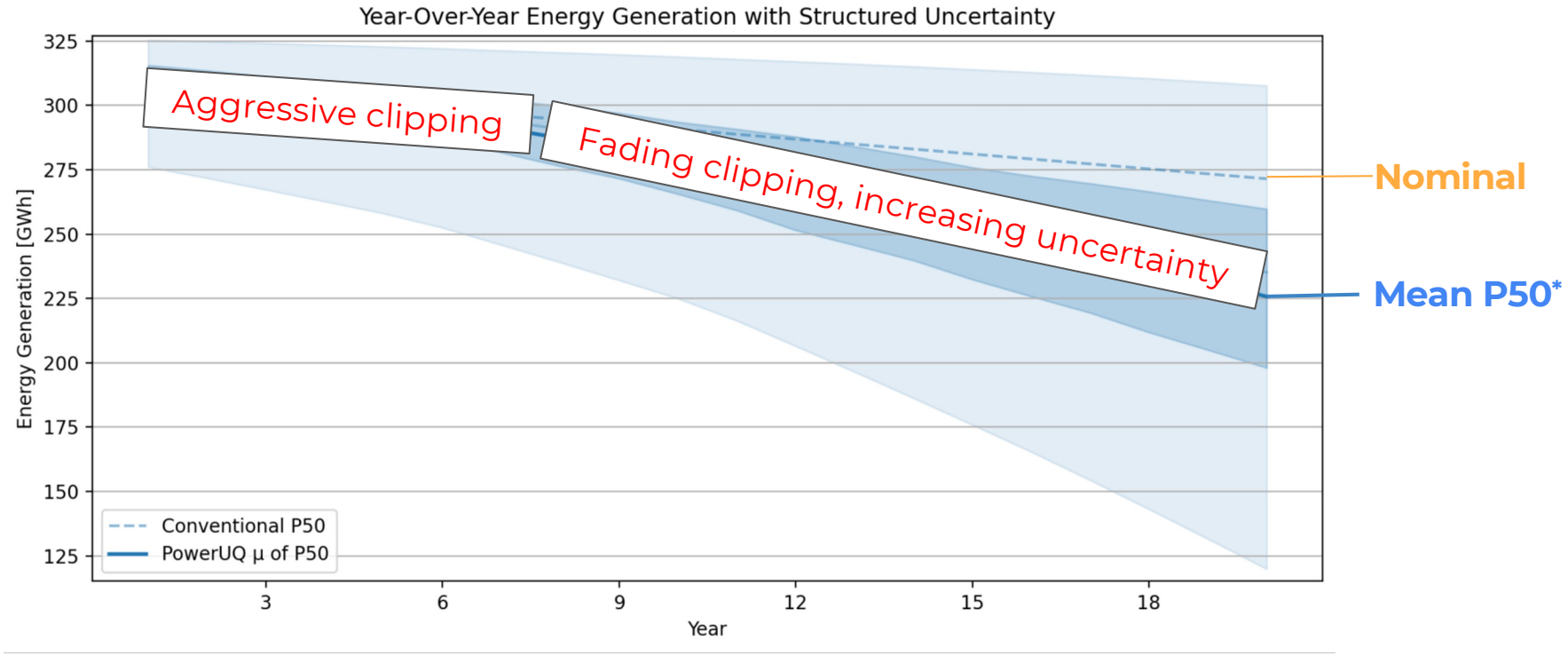
PowerUQ™

Structured UQ reveals **“P50 cone of uncertainty”**

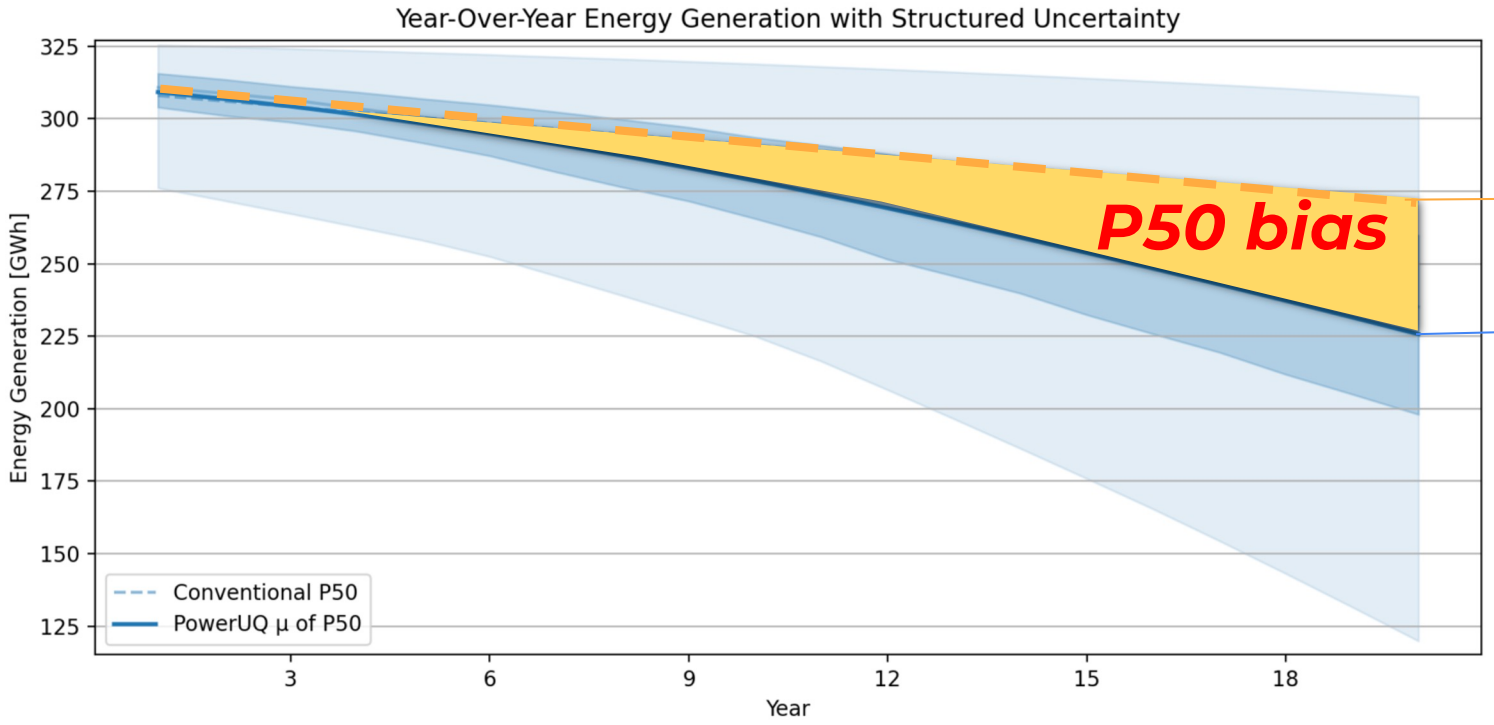


Typical 100 MW solar PV project in Barstow, CA

Clipping, curtailment can shape the “structure”



P50 bias of 5% leads to 1-2% project IRR at risk



Nominal

-

Mean P50*

=

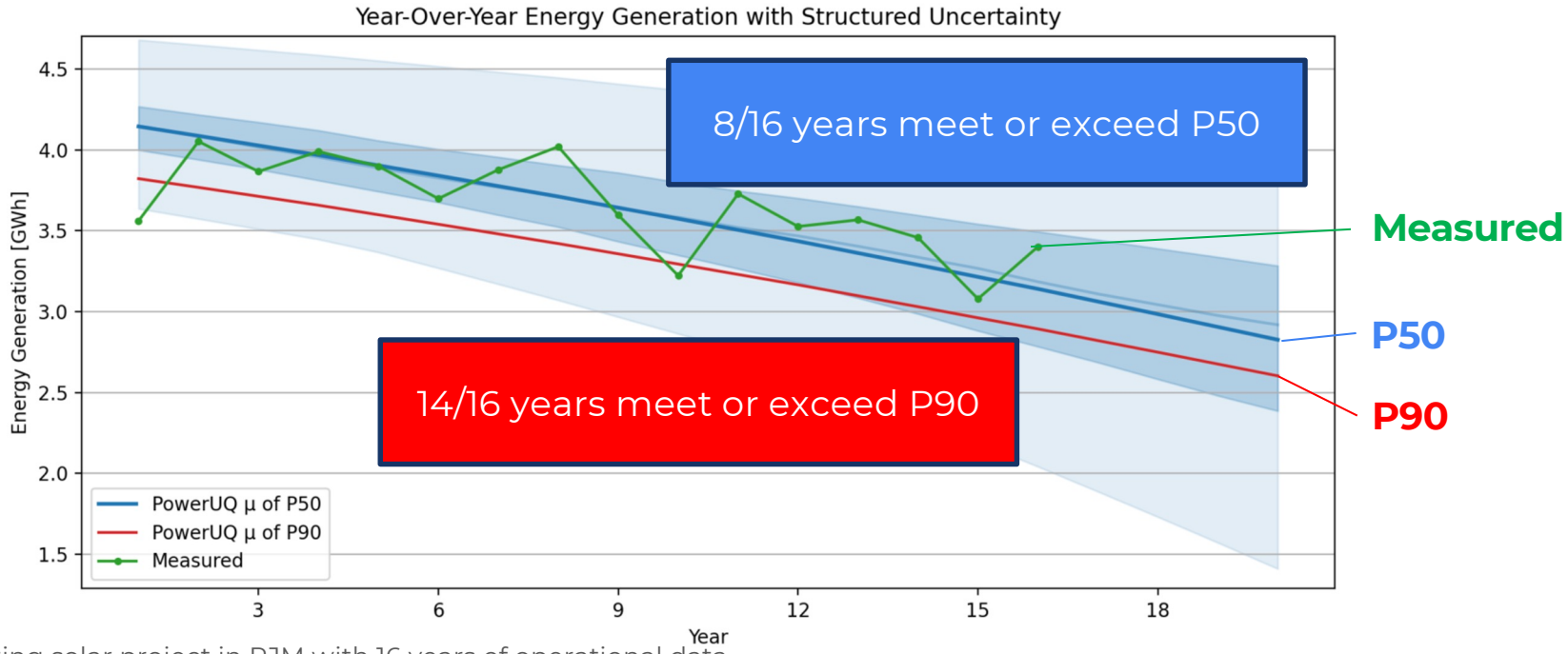
P50 bias

* GUM: Guide to the Expression of Uncertainty in Measurement

Applications

1. Performance model validation & tuning

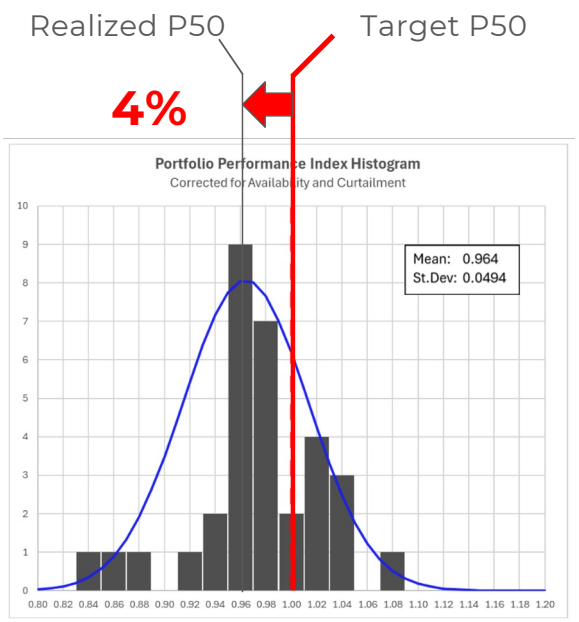
Structured UQ enables validation & tuning w.r.t. the frequentist definitions of P50 & P90.

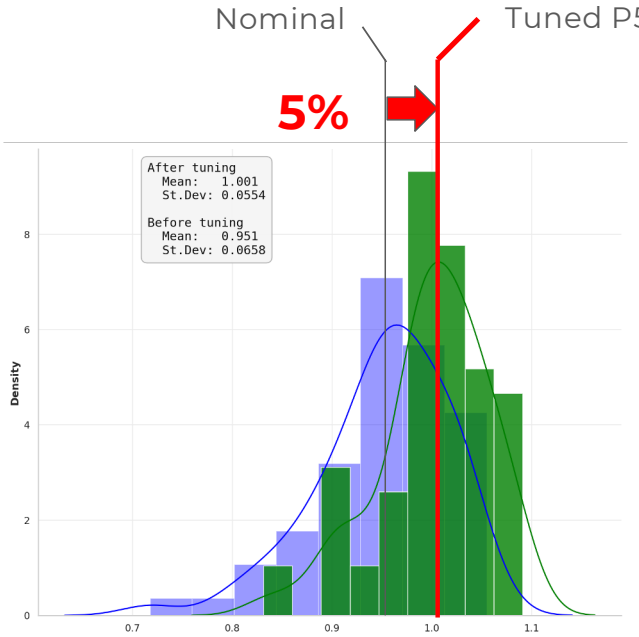


Operating solar project in PJM with 16 years of operational data

2. Detecting and tuning the portfolio P.I. bias

Systematic bias in pre-build performance models can lead to portfolio bias shortfalls





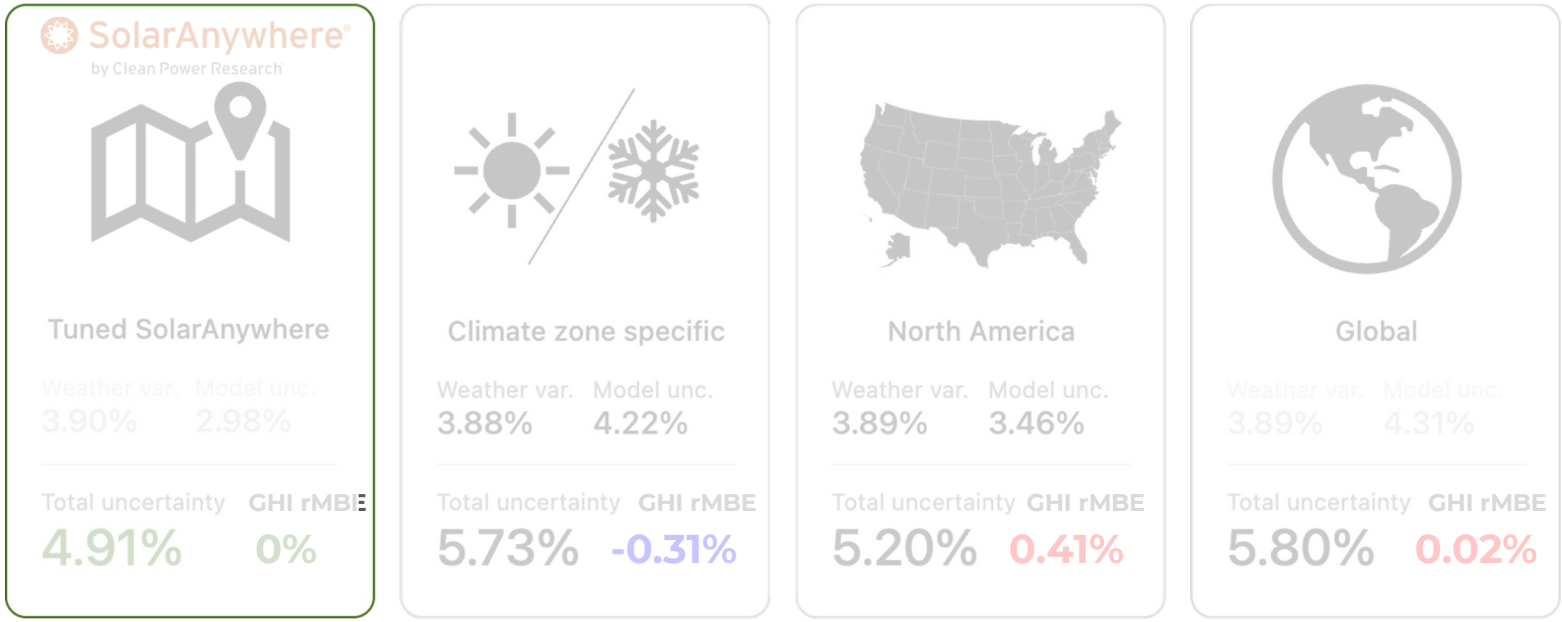
Non-weather adjusted Performance Index (P.I.)

K. Elser, "Financier's View on Solar Uncertainty Analysis", PVPMC 2024

67 project-years from EIA.org

3. Site-adaptation studies reduce bias **AND** uncertainty

From naïve global to site-tuning; bias goes to 0 and generation uncertainty reduces by approx. 1%



Upcoming Webinar
PowerUQ x SolarAnywhere

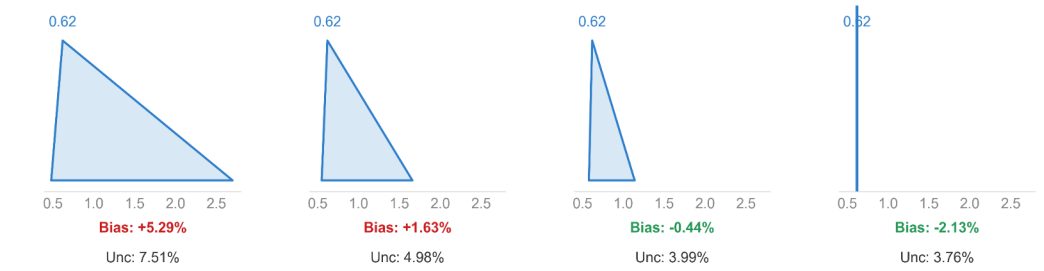
Tuned

Naïve

4. Sensitivity analysis: degradation rate uncertainty

Degradation rate P50 bias impact is sensitive to asymmetry in input distributions

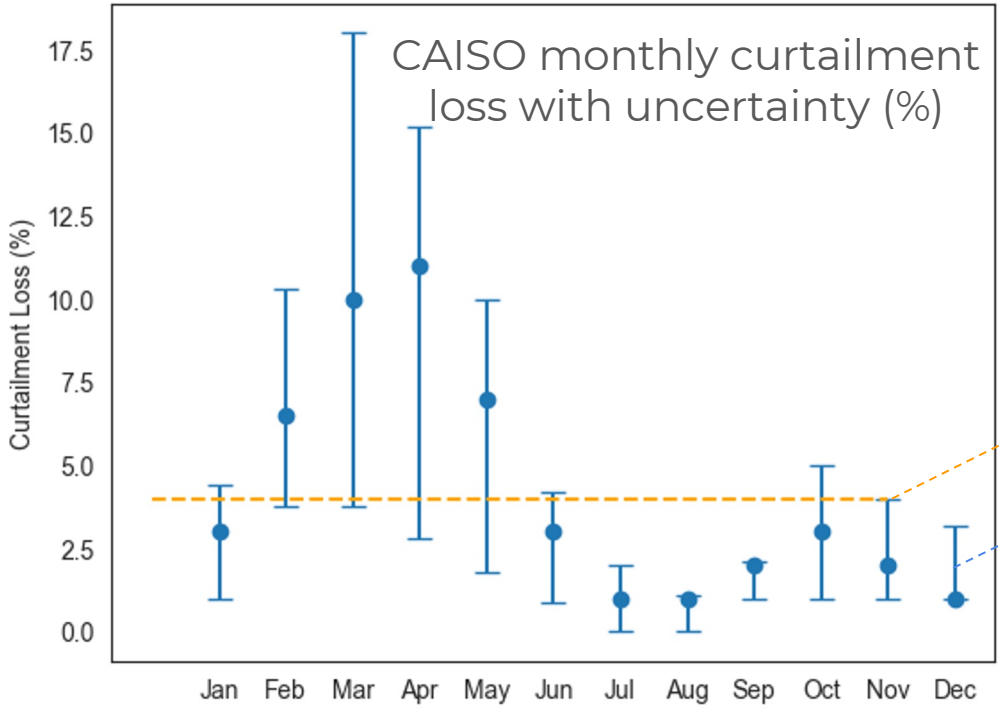
Input distributions
(identical most-likely value)



Degradation rate

5. Curtailment uncertainty impact

Accounting for Curtailment uncertainty increased the P50 bias impact by 1.2% over 5% baseline.



Nominal (4% haircut)

−

Mean P50

= 6.2%

Lifetime P50 bias

Conclusion

Nominal is not P50 and there is no shortcut to calculating P50.

But which P50?

Which P50 should be the target for highest value creation?*

- Resource P50?
- Generation P50?
- Revenue P50?
- Project IRR P50?
- Portfolio IRR P50?

** Just as P50 resource may not result in P50 generation due to inputs asymmetry and non-linear models; P50 generation may not result in P50 revenue due to curtailment; P50 revenue doesn't result in P50 levered IRR due to financial structuring (leverage amplified returns and bias losses); Because projects on their own met P50 targets, doesn't mean the portfolio will return P50 hurdle rate.*

Thank You!

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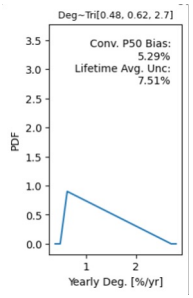
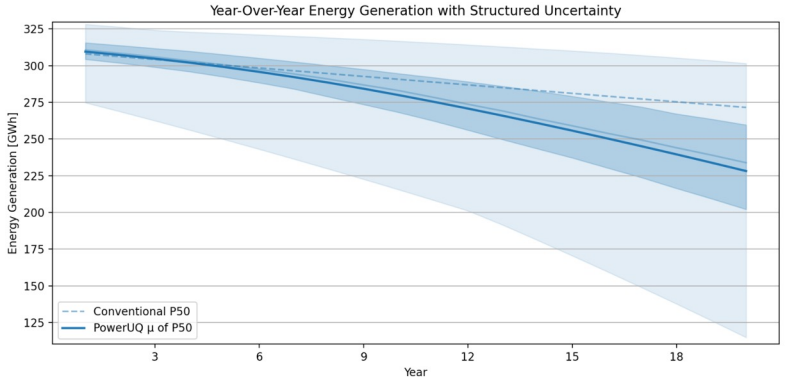
Degradation uncertainty sensitivity to asymmetry

Asymmetric uncertainty





No Uncertainty