

IEA PVPS Task 13: best practices for KPIs

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Introduction

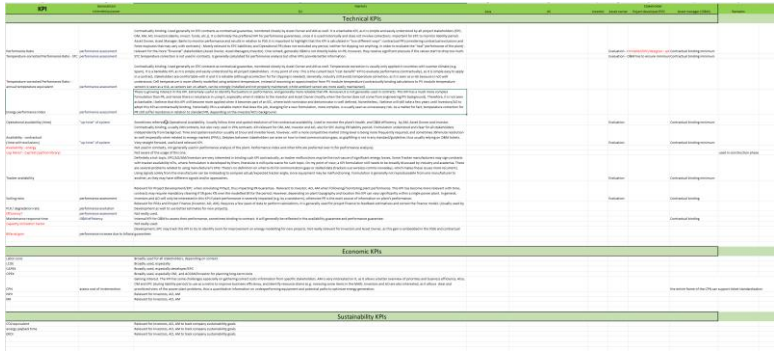
- IEA PVPS Task 13: “"provides a **common platform to summarize and report** on technical aspects affecting the **reliability, quality, and performance of PV systems** in a wide variety of environments and applications. Combine and integrate knowledge into valuable **summaries of best practices** and methods for ensuring PV systems perform at their optimum.“
- Subtask 3.4, report 1: “Best practice guidelines for the use of economic and reliability KPIs “

Outline

- Overview of KPIs
- Best practices to calculate KPIs
- Challenges
- Conclusions & outlook

Methodology to gather input

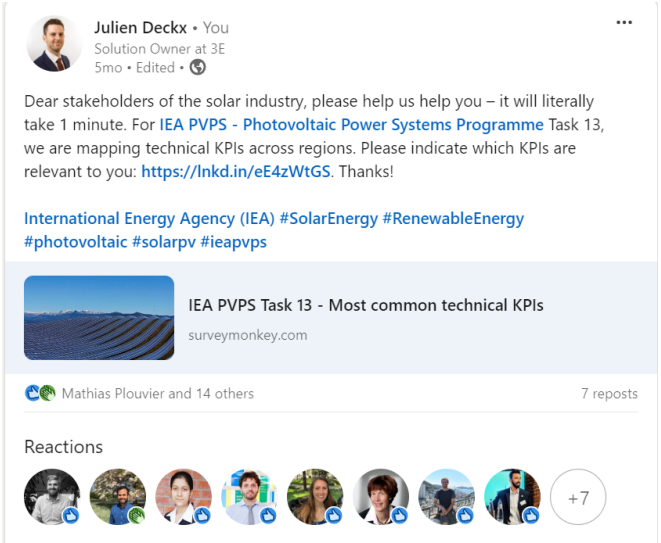
Direct input through bilateral contacts



Workshop at Solar Quality Summit Europe 2024



LinkedIn survey



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High-level conclusions from input

- Regional variations: while there are trends per region, a globalized world and market means that there are no strict differences to be seen.
- Contractual KPIs: no consistency in which KPI variations are mostly used contractually. E.g. PR vs temperature-corrected PR, time-based vs energy-based Availability, etc.

Detailed description - examples

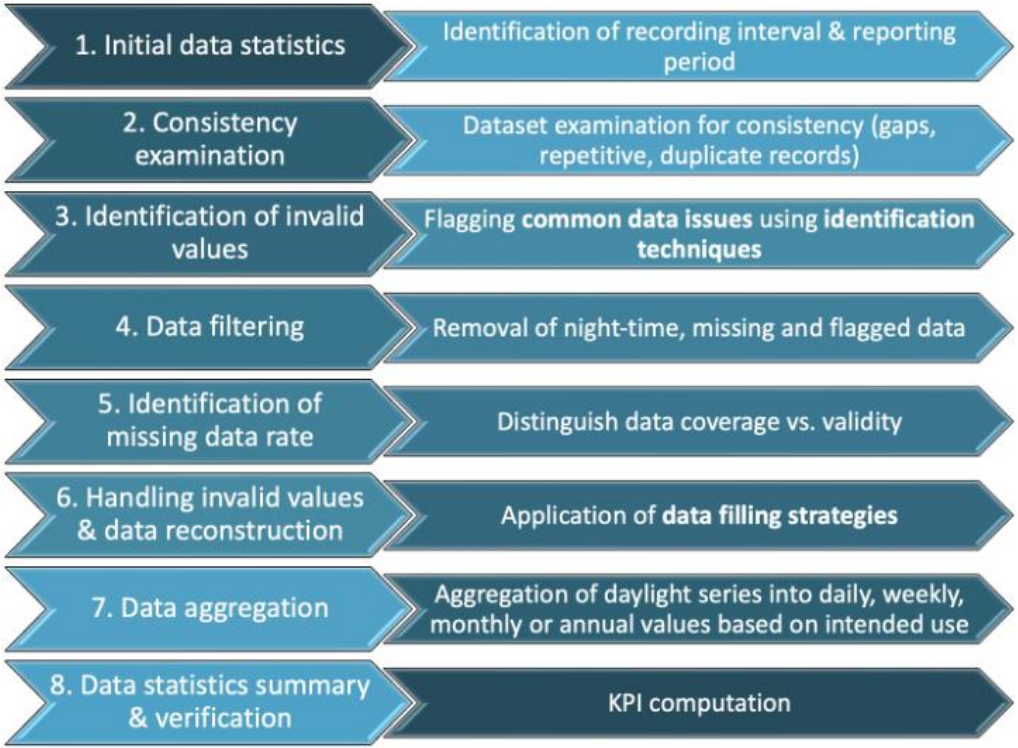
	Energy Performance Index (EPI) IEC TS 61724-3:2016	ASTM Capacity Test ASTM-E2848-13
Description	Calculated as: $$EPI = \frac{Y_{meas}}{Y_{exp}}$$ with measured yield Y_{meas} and expected yield Y_{exp}, calculated based on a pre-agreed performance model.	Power at "reporting conditions" (RC): $$P_{RC} = G_{RC}(a_1 + a_2 \cdot G_{RC} + a_3 \cdot T_{RC} + a_4 \cdot v_{RC})$$ with reference irradiance G_{RC}; temperature T_{RC}; wind speed v_{RC}; regression coefficients a_i, based on measured data.
Application	(Mostly) EU: replacement or complement to performance ratio (PR).	US: (mostly) acceptance testing of PV plant
Advantages	Less affected by system and weather conditions than PR	More accessible calculation method than EPI
Challenges	Complex and hard-to-reproduce calculation method	Still more complicated and less transparent than PR. Linearity assumption and exclusion of all non-linear evetns

Best practices in data handling



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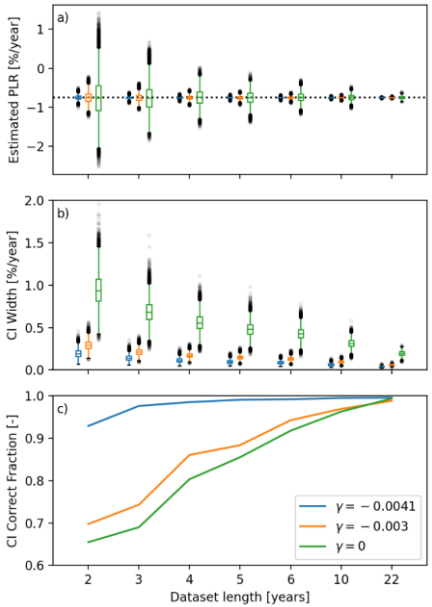
Unified data quality routine (PR, PLR)



Adapted from: A. Livera, M. Theristis, E. Koumpli, S. Theocharides, G. Makrides, J. Sutterlueti, J. S. Stein and G. E. Georghiou, "Data processing and quality verification for improved photovoltaic performance and reliability analytics," Prog. Photovolt: Res. Appl., vol. 29, no. 2, pp. 143-158, 2021.

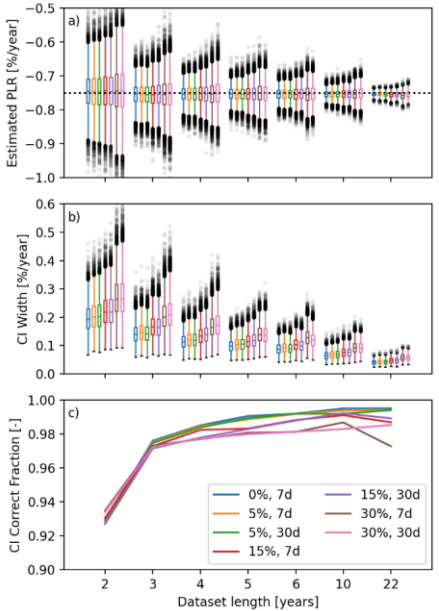
Impact of data quality

Incorrect data



Impact on confidence interval (CI) of no temperature correction (γ = 0%/°C), temperature correction with incorrect temperature coefficient (γ = -0.30%/°C), 3) temperature correction with correct temperature coefficient (γ = -0.41%/°C)

Missing data

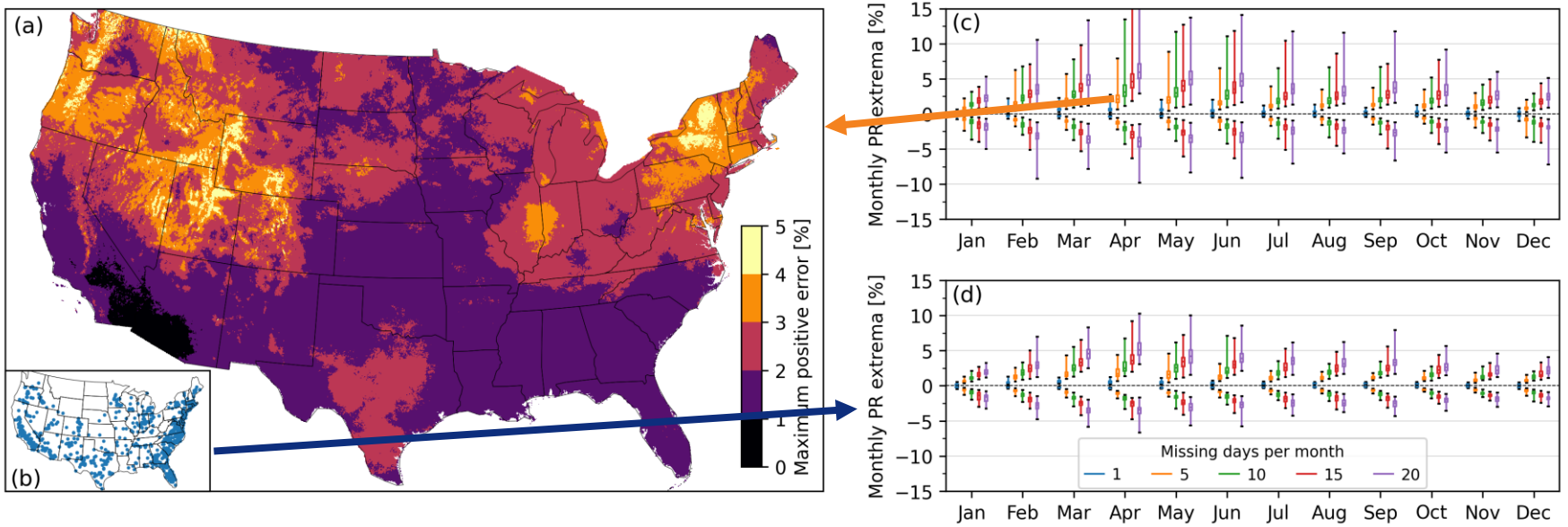


Impact on confidence interval (CI) of varying percentages of missing data, in chunks of 7 or 30 days

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M. Theristis, K. Anderson, J. Ascencio-Vasquez and J. S. Stein, "How Climate and Data Quality Impact Photovoltaic Performance Loss Rate Estimations," Solar RRL, vol. 8, no. 2, 2023.

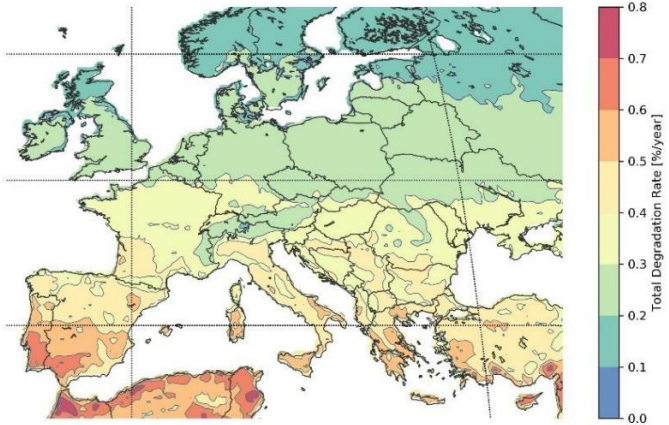
Climatic variability on uncertainty



S. Lindig et al., "Assessing Photovoltaic System Performance: A Comprehensive Review of Technical Key Performance Indicators and the Role of Data Integrity", In Preparation

Conclusions & outlook

- High variability in KPIs, not clearly segmented by region or contract type
- Some clear regional differences nevertheless, e.g. EPI & capacity test
- All KPIs have pros and cons, but further harmonization is feasible and required
- Subtask 3.4., Report 2: "*Global maps of performance, reliability and economic KPIs in PV modules and PV systems".* Map the most relevant KPIs by region. Similar to the example on the right, but with measured instead of modelled data.



Total Degradation Rates [%/year] modelled using reanalysis data and physical models for the European Continent

J. Ascencio-Vásquez, I. Kaaya, K. Brecl, K.-A. Weiss and M. Topič, "Global Climate Data Processing and Mapping of Degradation Mechanisms and Degradation Rates of PV Modules," Energies, vol. 12, no. 4749, 2019.

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