

Operational performance of large fleet of PV systems

Seminar WG2

Jonathan Leloux (UPM)

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Data available for Pearl PV: 20,000+ PV systems

BDPV

- № 15,000 PV systems
- France + Belgium
- Monthly energy data
- Period: 2007 2018
- Detailed metadata
- Rtone Rbee Solar
 - ♦ 6,000 PV systems
 - Selgium + France
 - № 10-min energy data

 - Period: 2011 2018
 - 💊 Basic Metadata





In the (raw) metadata you will not trust!

Azimuth angle of PV generators as reported by data providers - Europe



Tilt angle [degrees]



Tilt angle of PV generators as reported by data providers - Europe

Overview of orientation losses for one country



Net Annual Energy Losses respect to optimum orientation (%)

P 🕘 A R L P V

Monitoring data filtering and Quality Control (QC) – ETL

Team

Sonathan Leloux, Penka Georgieva, Zlatica Marinkovic, Sascha Lindig, Jesús Robledo

- Details
 - ♦ Quality Control on metadata: azimuth, tilt and peak power of PV systems,...
 - Different approaches: physical modelling, cost function, pattern recognition, ANN.



Mapping annual and seasonal soiling in Western Europe

Team

Leonardo Micheli, Joao Gabriel Bessa, Jonathan Leloux, Florencia Almonacid, Eduardo F. Fernandez

Details

Application of NREL's and Kimber's soiling estimation methodologies to several thousands of PV systems in Europe.

PV degradation vs stress factors (temp, RH%, UV, etc)

Team

Sascha Lindig, David Moser, Jonathan Leloux

Details

Degradation assessment using PVlib. Switch in paradigm from assessing a limited amount of data of high quality (typically lab data) to assessing a very large amount of data of lower quality (monitoring data).

Performance Ratio in Europe: 60%-90%

Yearly integrated Performance Ratio - Europe



Source: Leloux 2015

The data follow a Weibull distribution for 0.6 < PR < 0.9</p>

Probability plot of Yearly integrated Performance Ratio vs Weibull distribution - Europe



Difference in PR between inverters: 1-5 %





Difference in PR between modules (no thin-film): 1-6%





PV modules technology greatly affects performance





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PV systems performance has improved over time

Yearly integrated Performance Ratio in 2013 vs year of installation of PV system - Europe



Some PV systems are clearly subject to faults

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Monthly integrated Performance Ratio - All 12 months of the year - Europe



The monthly PR is influenced by several parameters

Monthly integrated Performance Ratio - Europe

PV is still dependent on local regulation

Peak power PV systems - Belgium

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The small PV systems have a lower PR

Faut detection: not so simple with PR

Fault detection in a "perfect" world

Belgium: a wonderful play-field for PV fleets

Looking for the best peers in neighborhood

Coordinates focus PV system 316 and peers

Constructing Performance to Peers (P2P)

P 🗊 A R L P V

P2P vs PR: more stable better signal/noise

Fault detection from P2P: "static" approach

Fault detection with P2P: dynamically

CUF, P2P, confidence intervals and fault detection threshold (PV installation 211412355)

Fault detection with P2P on daily data

Fault detection with P2P on 10-min data

Fault detection with P2P under clear-sky

Shading detection from P2P vs sun position

Stability: P2P vs PR vs season of year

P = A R L P V

P2P stability vs number of good peers

Thank you for your attention!

Neighbors like you are precious and few.

