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Analyzing Performance Data of Fielded PV Systems

34553 Applied Photovoltaics

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Abstract: In this exercise you will analyze field data that has been collected at the DTU Risø PV test field. The dataset will include 6 months of electrical data from monofacial c-Si PV arrays mounted on fixed tilt structures and on single axis trackers. The field data are sampled every minute, but in this assignment they are resampled to 15 minute averages.

References and links

- Slides from class (Block 6)
- Data file (.csv) containing 6 months of Risø field data at 15 minute resolution.

1. Introduction

As we discussed in class, the monitoring data gives insight to the actual performance of a PV asset. Therefore, the data can be used to verify an investor's (ROI), or assess the accuracy of energy prediction models using a metric like the performance index (PI). From a research perspective such data allows us to compare the performance of various technologies (e.g. trackers vs. fixed tilt), evaluate degradation rates, and even understand how the grid might respond under various PV penetration scenarios.

2. Methods

You will analyze PV performance data from DTU Risø using some of the metrics that we discussed in class. You will be provided data from two 53.68 kWp PV systems (STC rating). One is mounted at a static 25° tilt and the other is mounted on a horizontal single axis tracker (HSAT). The dataset includes:

- G_{POA} measured on the 25° tilted surface and the HSAT.
- Module temperature (T_{MOD}) measured on one cell within the HSAT system (Note: T_{MOD} is **not** available for fixed tilt).
- DC Max power voltage ($V_{MP,DC}$), max power current ($I_{MP,DC}$), and AC power measured on both systems.
- Global horizontal irradiance (GHI), diffuse horizontal irradiance (DfHI), direct normal irradiance (DNI), ambient temperature (T_{AMB}) and wind speed (WS).

The minimum performance metrics you need to calculate are:

- The total sun hours ($kWh \cdot m^{-2}$) received on both surfaces on a monthly basis.
- DC and AC performance ratios (PR) of both systems.
- Temperature corrected PR for AC data of both systems. Use a temperature coefficient of -0.39 %/°C.
  - For the HSAT system use the measured T_{MOD} for the correction.
  - For the fixed tilt system calculate T_{MOD} using G_{POA}, T_{AMB}, and WS. Assume a radiation heat transfer coefficient (U_0) of 29 $W \cdot m^{-2} \cdot K$, and a convective heat transfer coefficient (U_1) of 6.8 $W \cdot m^{-3} \cdot K \cdot s$.
- DC and AC efficiency of both systems.
  - The fixed tilt and HSAT systems contain 176 panels each. The area of 1 panel is 1.6 m^2.

Optional metrics to look at

- GHI transposed to the 25° tilted surface and the HSAT. Pick a transposition model to use.
  - Compare your results to the *measured* GPOA on both arrays.
- Annual degradation rate (Rd) using DKA Solar Centre data and RdTools.[1, 2]

[1] Historical data from DKA Solar Centre: http://dkasolarcentre.com.au/download?location=alice-springs

[2] Open source Python code for degradation rate (Rd) calculations: https://github.com/NREL/rdtools

3. Presentation (6-7 slides)

Your presentation should summarize:

- The PV systems you analyzed and the methods you used to analyze them. (e.g. corrections and/or filters you applied to the data set).
- Your main findings from the analysis you did in this exercise.

Consider different approaches to presenting the performance metrics listed above (e.g. histograms, daily/monthly trends, as a function of diffuse fraction, as a function of G_{POA} irradiance etc.).