Energy Losses due to Temporally or Spatially Significant Tracker Faults

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Background

Wood's analysis of SCADA data from operational solar PV plants using single-axis trackers indicates they are often not operating optimally, resulting in potentially significant energy losses if issues occur repeatedly (either temporally or spatially). Wood presents results from two case studies representing different tracker failure mechanisms:

- **Case Study 1: Back-tracking anomalies.**
- **Case Study 2: Tracker data availability issues and stalled trackers.**

For reference, an expected daily tracker angle profile for a site with back-tracking activated is shown in Figure 1 below.

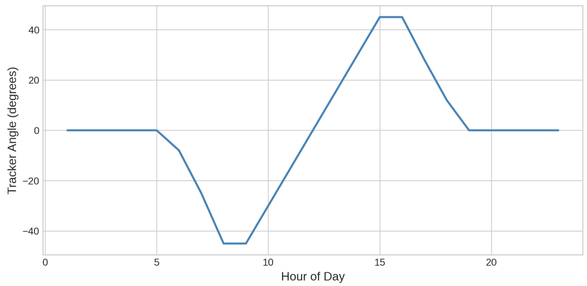

Figure 1: Expected Daily Tracker Angle Profile (with back-tracking)

Methodology

Input Data (SCADA at 5, 10 or 15-minute resolution)

Wood used meteorological data (GHI, POAI, ambient temperature, module temperature), meter data (energy production and setpoint), inverter AC and DC power, and tracker angles (actual and target) for the following two case studies.

Data Screening and Flagging

To ensure accurate and representative input meteorological data, Wood screened meteorological data to remove erroneous values and then temperature-corrected the POAI data.

To explain underperformance and accurately assign losses, Wood flagged inverter unavailability using the inverter power data and flagged grid curtailment and grid outages using the energy meter data.

Operational Power Curves

Using the screened meteorological data and flagged power data, Wood developed operational power curves for each inverter but unflagged underperformance was still prevalent in the power curves (see Figure 2).

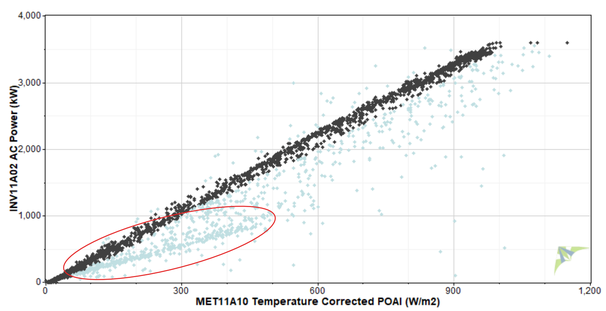

Figure 2: Under-performance in Inverter Power Curve (after flagging)

Case Study 1 Results

Wood looked for trends in the observed under-performance (e.g., at certain times of day or at certain inverters). As highlighted in the red circle in Figure 2, there was a distinct dual trend noted at lower irradiance levels. This was also prevalent when we plotted unclassified energy losses by hour of day and month (Figure 3) where, perhaps contrary to what would be expected, most of the unclassified energy losses occur in the early morning and late afternoon rather than in the peak sunlight hours.

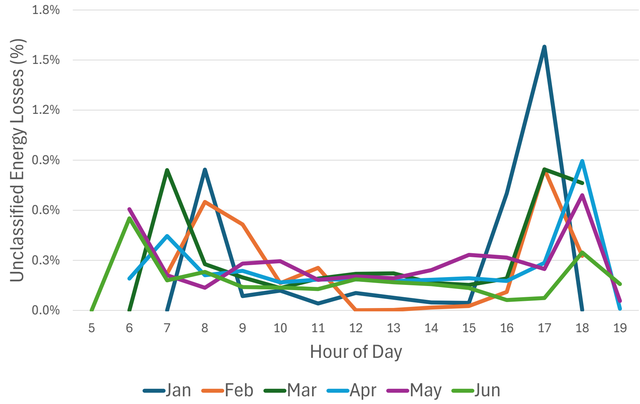

Figure 3: Unclassified Energy Losses by Hour of Day and Month

Given that this corresponds to when back-tracking is occurring, Wood examined the tracker angles during these times and noted anomalies in the tracker angle data.

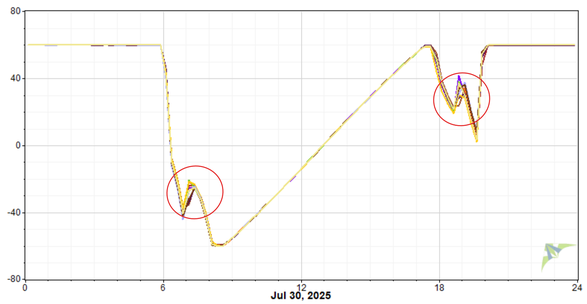

Figure 4: Tracker Angles Indicating Inaccurate Back-tracking

Despite these energy losses occurring at low irradiance levels, the temporally repetitive nature of them (occurring every day) means they equate to 2.0% of possible production.

Case Study 2 Results

Under-performance (after flagging of other issues) was also observed in the power curves resulting in unclassified energy losses at the case study 2 project. Wood examined the tracker angle data to assess whether tracker issues were contributing to this, but the data availability of the tracker data was only 82.1%, with the remaining 17.9% exhibiting flatlines (see Figure 5).

When examining the tracker angle data (Figure 6) in conjunction with the inverter power data, it was clear that some tracker angle flatlines corresponded to stalled trackers, but in other cases the flatline data was only a communications issue.

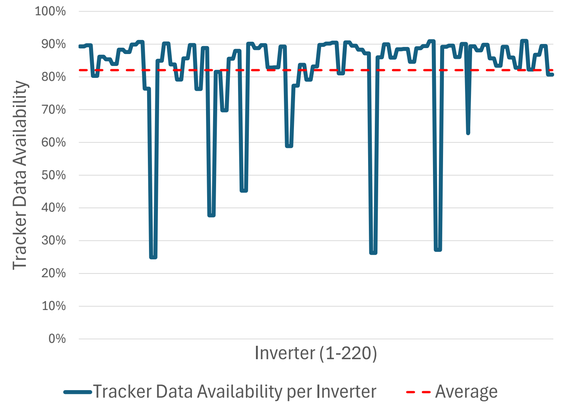

Figure 5: Tracker Data Availability per Inverter

Examples of the tracker data issues are shown in Figure 6 below.

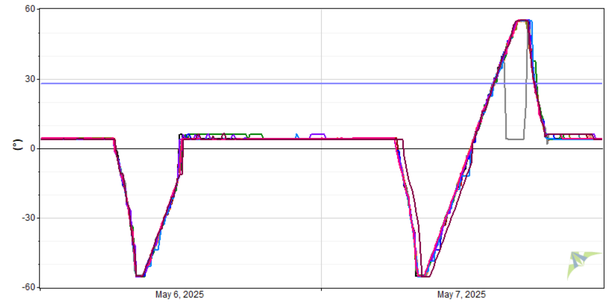

Figure 6: Tracker Angles Indicating Various Issues

To assess the true extent of stalled trackers on performance and separate out communications issues, Wood:

- Calculated the average inverter power in each timestamp for the inverters with trackers performing as expected.
- Compared this to the inverter power for those inverters whose trackers were exhibiting flatlines.

In the case of communications issues, the difference between these values was negligible, however, if it was truly a stalled tracker, the difference between these values provided an estimate of the energy losses resulting from stalled trackers. In this case, Wood calculated a potential uplift of 0.9% if all trackers were functional all the time.

Conclusions

Wood draws the following conclusions from these two case studies and other experience:

- Always request tracker angle data when performing performance analysis of operational projects using SCADA data.
- Analyze tracker angles in conjunction with irradiance and power data (i.e., not independently) due to potential data/communications issues.
- Tracker issues may explain energy deficits compared to budget production.
- Pre-construction availability predictions and O&M availability warranties often fail to account for such issues.
- It is essential to think in terms of energy, not time.