Case Study of Using a Modified “DC/POA” Method in Determining PV System’s Degradation Rate and the Impact of Data Filters

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Abstract

Outdoor degradation rates of a PV system can be assessed remotely using DC power and plane of array (POA) irradiance measurements. In this work, a modified so-called “DC/POA” method is introduced to determine the degradation rates of several PV plants of less than 3 years by analysing the meteorological and inverter hourly and sub-hourly time-series data collected from the data-logging equipment without conducting site inspections. Various filters are applied prior to the linear regression technique to reduce the outliers in the data which is caused by several known issues such as low light behaviours, data irregularities and system outages. The degradation rates and confidence interval are presented; its relationships with various filters are also discussed. It is found out that the degradation rates are sensitive to data filters and further refinements are required to isolate module degradation rates from system degradation characteristics of the DC system.

Introduction

A robust method to determine the degradation rate of PV systems on site to serve as a tool in monitoring the decline in performance of the PV modules installed in the field. Specific filters were applied to DC/POA method, which is recommend as most precise among other methods [1].

Method

Data Acquisition

- Outdoor, Inverter & Meteo. sensor time series
- Hourly, Sub-hourly

Filter Criteria

- Data filters and further refinements are required to isolate module degradation rates from system degradation characteristics
- Irradiance
- Module Temp.
- Hourly, Sub-hourly

Linear Regression

- Module power is adjusted back to 25°C equivalent via
- Performance Indicator (PI):
- Linear regression of data post filtered dataset to determine Degradation Rate, Rd

Impact of Filters

Filter: Performance Ratio and Irradiance vs Degradation Rate, Rd, & Confidence interval

SYSTEM A

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>System Size</th>
<th>Commissioning Date</th>
<th>Analysis Period</th>
<th>Module</th>
<th>Inverter</th>
<th>Irradiance Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Germany</td>
<td>755 kWp</td>
<td>Dec-10</td>
<td>27 Months</td>
<td>REC131PF</td>
<td>Refusal G6X</td>
<td>X&amp;J MPP1</td>
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<tr>
<td>B</td>
<td>Germany</td>
<td>679 kWp</td>
<td>Dec-10</td>
<td>27 Months</td>
<td>REC131PF</td>
<td>Refusal G6X</td>
<td>X&amp;J MPP1</td>
</tr>
<tr>
<td>C</td>
<td>Italy</td>
<td>992 kWp</td>
<td>Aug-11</td>
<td>26 Months</td>
<td>REC131PF</td>
<td>SMA IBOCP</td>
<td>Silicon Sensor</td>
</tr>
<tr>
<td>D</td>
<td>Italy</td>
<td>988 kWp</td>
<td>May-11</td>
<td>32 Months</td>
<td>REC131PF</td>
<td>SMA IBOCP</td>
<td>Silicon Sensor</td>
</tr>
</tbody>
</table>

Results

Degradation Rates (%/year) of the four sites determined using this model below - 0.6%/year; consistent with published data of multi-crystalline PV modules [3]

<table>
<thead>
<tr>
<th>Site</th>
<th>PR Filter</th>
<th>Irradiance Filter</th>
<th>Degradation Rate</th>
<th>Confidence Interval (95%)</th>
<th>P&amp;I Power Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>PR ≥ 90%</td>
<td>G ≥ 200</td>
<td>-0.19%/year</td>
<td>± 0.12%</td>
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<tr>
<td>B</td>
<td>PR ≥ 90%</td>
<td>G ≥ 200</td>
<td>-0.17%/year</td>
<td>± 0.10%</td>
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<tr>
<td>C</td>
<td>PR ≥ 75%</td>
<td>G ≥ 800</td>
<td>-0.60%/year</td>
<td>± 0.35%</td>
<td>1217</td>
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<tr>
<td>D</td>
<td>PR ≥ 80%</td>
<td>G ≥ 800</td>
<td>-0.53%/year</td>
<td>± 0.31%</td>
<td>953</td>
</tr>
</tbody>
</table>

Discussion

- Modified DC/POA method shown to be robust method
- Filters to apply to exclude abnormalities and non-linearity vary from site to site
- The amount of filter also affects the confidence of the reported rate especially for PV plants with low data analysis period
- Degradation rate determined using above method reported degradation rate below published rates
- Mean soiling loss of PV plants reported to be between -2.4 to -8.3 x 10^-3/day [2]; Such soiling loss has not been excluded from reported Rd
- Method needs to be improved to take soiling rate into consideration

References