PV Performance and Energy Harvest over Time for Utility and Rooftop Systems
Obadiah Bartholomy, TJ Vargas, Megan Simone, Sacramento Municipal Utility District

Rancho Seco Utility PV Performance Measurements over 25 Years

Rancho Seco PV was installed in 1984 with a nameplate capacity of 1.18MW DC. The system operated consistently for 27 years, with regular maintenance primarily associated with tracker operation and periodic replacement of PV modules and other inverter and array components.

Rancho Seco PV System Attributes

<table>
<thead>
<tr>
<th>Age</th>
<th>Years of operation: 1984-2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Sacramento, CA</td>
</tr>
<tr>
<td>System Type</td>
<td>1.18 MW DC Nameplate, Single Axis Tracker</td>
</tr>
<tr>
<td>Number of Modules</td>
<td>28,672</td>
</tr>
<tr>
<td>Module Type</td>
<td>Arco M52N</td>
</tr>
</tbody>
</table>

Measuring Performance of Groups of Residential PV Systems

SMUD’s residential PV programs began in the early 1990s with a utility-owned approach to minimize risk to customers of the relatively new technology. Transitioning to customer-owned, utility aggregated programs and then strictly utility incentivized programs occurred between 2000 and 2007.

One unique aspect of these programs is that SMUD required separate meters for monitoring production of the systems. With the switch to smart-metering, there are now opportunities to understand a variety of system performance issues remotely and more completely.

Module Quality and Related Issues

DuPont Testing on Module Backsheet Tedlar® for Arco MS2N Modules
Images and Descriptions provided by DuPont based on tests performed on removed and spare modules from Rancho Seco PV System.

DuPont Testing on Module Backsheet Tedlar® for Arco MS2N Modules

Visual inspection shows essentially no appearance difference between Tedlar®-backsheet exposed and unexposed modules.

Material analysis and characterization of Tedlar®-material components favors Tedlar®-backsheet over EVA encapsulant. EVA encapsulant was used in the original module design of the residential systems, along with Tedlar®-backsheet, and were the type and brand of quality assurance inspected.

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Using Satellite based irradiance measurement and individual PV system modeling provided by Clean Power Research, and comparing to actual metered monthly values, these charts demonstrate observed drops in performance index for residential systems over time. Commercial systems showed less degradation, but also had fewer systems in some of the year-bins, limiting ability to make robust conclusions. However, it is also intuitive that the commercial systems would have lower degradation in system energy harvest rates due to there being less shading and a higher likelihood of system monitoring. The most significant performance factor impacting residential PV systems is most likely shading, followed by component level failure. Further analysis of hourly metered data should provide more robust shade impact assessment.

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