Addressing Solar Underperformance

Introduction

THIS POSTER REVIEWS:

1. **The status of solar performance modeling.**
2. **The disconnect between current performance modeling and actual generation.**
3. **Steps the industry can take to mitigate solar underperformance.**

1 The Underperformance Challenge

As the solar industry matures, the tools to measure solar performance modeling against real results have sharpened. Analytical tools and comparative studies now give us a clearer lens on asset performance. The data reveal a widespread gap between expectations and actuality. According to recent data, solar projects are more than thirteen times more likely to chronically underperform their downside production scenarios ("P99's") over a multi-year period than expected.

2 Solar Performance Modeling Vs. Actual

DATA POINT 1

On Average, Systems Underperform by 5-13% Annually

The 2021 analysis of >30% of non-residential systems in the U.S. compared actual production against financed P50 estimates (target production) from 2011 – 2020 and found that systems on average underperformed by 5-13% in any given year, even after adjusting for weather.

kWh analytics – 2021 Solar Generation Index

Weather-Adj. Performance Index: 111% — 100% — 82%

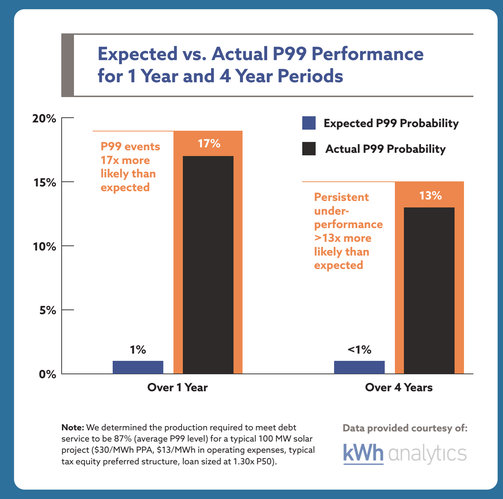
Region	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	% YOY [19-20]
Southwest											2%
Southeast											0%
West											-13%
Northeast											-4%
Mid-West											-2%
Mid-Atlantic											-12%
Northwest											1%
National Average	87%	95%	93%	93%	94%	93%	92%	92%	91%	92%	-4%

Data provided courtesy of: kWh analytics

DATA POINT 2

1-in-8 Solar Assets Chronically Underperform P99 Estimates, Exposing Newer Loans to Default Risk

The 2021 kWh analytics Solar Risk Assessment revealed solar projects are more than thirteen times more likely to chronically underperform their initial production forecasts over a multi-year period than expected.



Note: We determined the production required to meet debt service to be 87% (average P99 level) for a typical 100 MW solar project ($30/MWh PPA, $13/MWh in operating expenses, typical tax equity preferred structure, loan sized at 1.30x P50).

Data provided courtesy of: kWh analytics

3 Steps to Mitigate Underperformance

SOLUTION 1

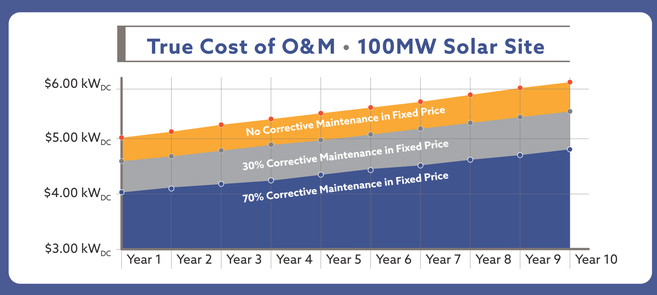
Avoid Compounding Underperformance - Identify & Fix Issues Before Hand off to O&M Team

First-year generation degradation may be small. Amortized over the 25+ years of a solar plant, what starts out small is compounded to consequential underperformance. In the early infant stages of a project, there are typically many issues to resolve. Issues that could be addressed are often sidetracked in the rush to complete the project. In this case study, the Origis Services team conducted a root cause analysis of all the systems in the place, concentrating on the inverter efficiencies, to amend year one shortfalls.

SOLUTION 2

Staff and Budget to Reduce Downtime, Underperformance and Lifetime Project Expense

Analyzing data from more than two gigawatts of utility scale solar, Origis Services discovered the most effective way for asset owners to reduce overall O&M costs is to include roughly 70% of corrective maintenance into the annual service fee contract. Including optimal levels of corrective maintenance in service contracts, combined with onsite project management, mitigates production down time. Instead of paying high-priced, dispatched services, O&M that includes the corrective maintenance "sweet spot" of 70% can cost effectively respond to inevitable equipment failure.



SOLUTION 3

Tie Performance Engineering Closely with Field Operations

There are many options for solar project monitoring. Then there is the human expertise factor, performance engineering. As much as we want to call the software smart, it is still "human made." Software has difficulties recognizing all the problems originating during the input stages. Performance engineering is in part quality control because it verifies what is going on in the field against what has been installed and assumptions the software is making. Performance engineering is a highly skilled human expertise to provide an additional analytical layer. Along with skilled performance engineers, combining trained field operations closely with the expertise in the ROC results in a tight system to identify and amend performance issues.