U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY
SOLAR ENERGY TECHNOLOGIES OFFICE

PROJECT NAME: Deciphering Degradation: Machine Learning on Real-World Performance Data

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kWh analytics

Reduce the cost of capital and improve reliability of solar by leveraging industry data and advanced analytics to quantify and predict system performance degradation.

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BACKGROUND

- Data-driven analysis on Solar PV system performance and degradation is limited.
- Training a machine learning model on industry data can drive insights into impacts on degradation & system performance.

PROJECT OVERVIEW / OBJECTIVES

- By identifying drivers of system performance degradation, we enable the industry to improve the reliability of solar and attract capital to high performing systems from the finance community.

METHODS

1. Aggregate the largest dataset on real-world solar performance.
2. Analyze system degradation rates using RdTools.
3. Train a machine learning model to identify the key features that determine system performance.
4. Disseminate findings and educate the finance community on where to deploy capital.

KEY OUTCOMES / MILESTONES

- We have analyzed the degradation rates from over 10,000 solar systems using the open source RdTools methodology.
- We have begun developing a machine learning model to identify predictor variables of system degradation.

NEXT STEPS

- Need to analyze additional systems to improve the accuracy of the machine learning model.
- We will disseminate the results and educate the finance community in order to move capital to developing high-performing systems and improve the overall reliability of systems in the solar industry.

PROJECT WORKFLOW AND IMPACT

Support Funding of Reliable Solar Systems

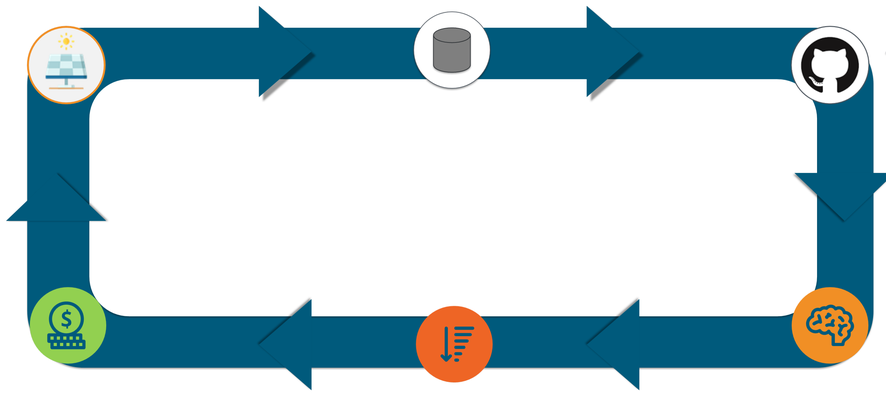
- The market will naturally fund and allocate capital to develop solar systems that perform better (e.g. lower performance losses from degradation

Aggregate Solar Performance Data

- Collect sub-daily interval data on energy generation & weather
- Collect system design and system metadata

Measure Degradation Rates

- Open Source methodology for calculating YoY system performance degradation
- Can be measured at revenue grade meter, inverter, or sub-inverter



Educate Finance Community on Investing in High-Performing Solar Systems

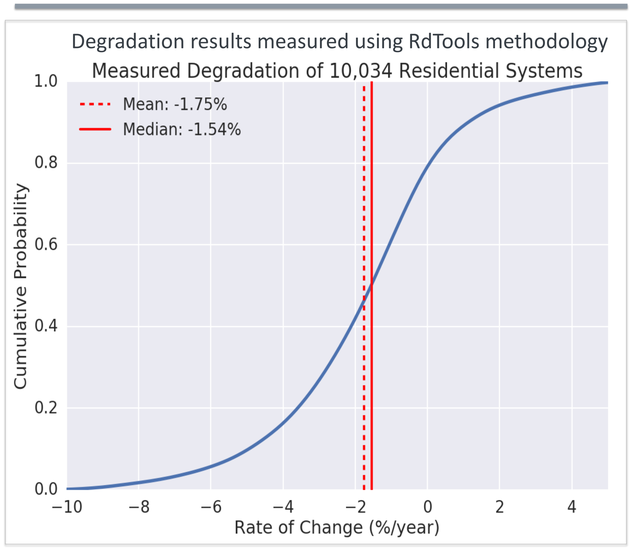
- Data-driven insights on causes of degradation and performance loss will inform intelligent investments into high performing solar systems

Identify Predictor Variables for Degradation

- The machine learning model will identify key features that drive degradation and performance loss

Develop Machine Learning Model on Degradation

Initial Residential Results:



Initial Model Development Approach & Success Metrics

Model Approach:
- Gradient Boosted Trees, Ensemble

Potential Success Metrics:
- R-Squared: How much variance is explained by features?
- Mean Bias Difference: Is there systematic bias in model predictions?
- Mean Absolute Difference: How far off is the prediction?

Model Features:
- Module Metadata: Make/Model, Technology, Vintage, CEC Fields
- Environmental Factors: Module Temp, Temp Cycling, Humidity, etc.
- System Design: Inverter type, Mount Type, Shading, etc.

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