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Reusing Operations & Maintenance Records: Moving from Reactive to Proactive Management of Solar Photovoltaic Sites

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Motivation

- Photovoltaic (PV) plants are complex systems due to interactions between physical and social components. Thus multiple stakeholders (including data generators, data users, and researchers) are interested in different aspects of similar data streams (Figure 1).
- As systems age, new and unknown set of challenges regarding how we maintain productivity and performance PV systems are becoming apparent

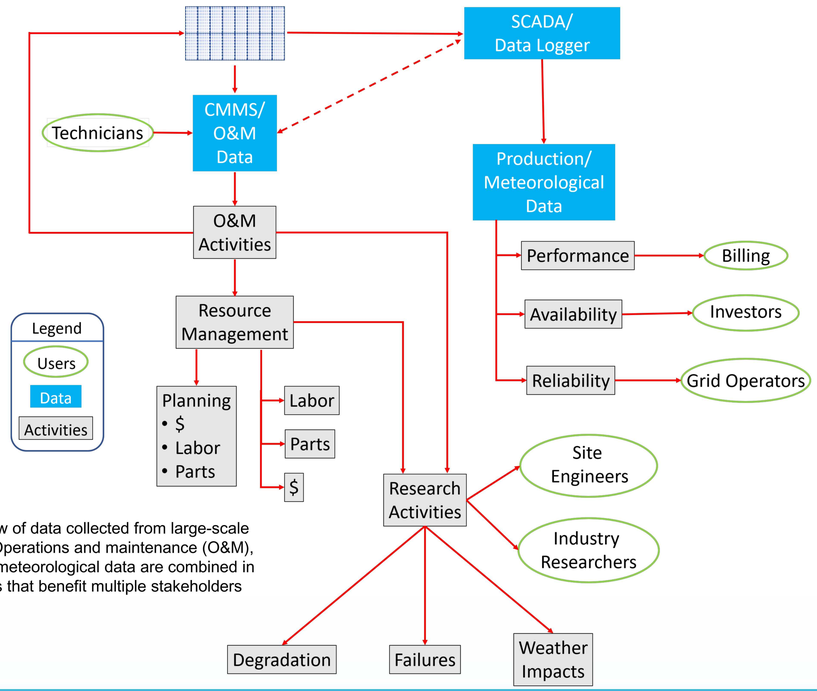


Figure 1. Overview of data collected from large-scale PV power plants. Operations and maintenance (O&M), performance, and meteorological data are combined in support of activities that benefit multiple stakeholders and users alike.

Challenges

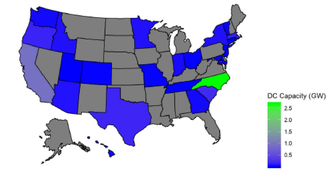
- Properly categorizing faults and underlying causes becomes challenging due to diverse data capture practices for operations & maintenance (O&M) and performance records
- Improving PV performance requires data but there are competing interests and limited resources

→ **Study Focus: Given different data collection practices, how do we *reuse existing data* to tackle problems such as degradation, failures, weather, etc.?**

Standardizing metadata for reusability

- Combine data from multiple PV plants into a single database (Figure 2)
- PVROM database contains O&M records for 800+ sites across 24 U.S. states.

	PVROM
# of Sites (Utility Sites)	819 (529)
Total Sites DC/AC Size (GW)	4.6/3.6
Oldest, Newest Site	01/2008, 05/2019
# of O&M Tickets	44,212



- Leverage machine learning (ML) and natural language processing (NLP) to:
  - Impose consistent database structure across partners
  - Enable characterization and analysis of failure modes (Figure 3)

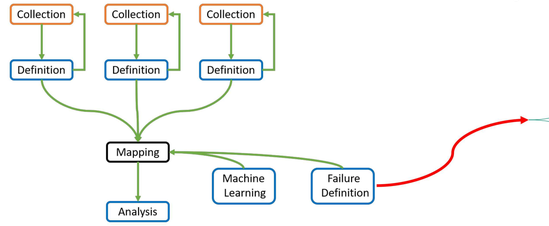


Figure 2. Overview of approach to combine O&M records from multiple PV plants into a single mapping informed by machine learning to facilitate records analysis.

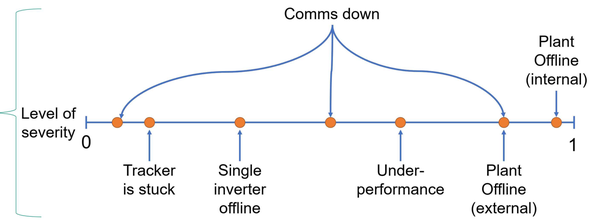


Figure 3. Continuum of types of failure according to severity of failure affecting PV operations with '0' being least severe to '1' being most severe.

- O&M records are parsed into different categories to capture the underlying context and specific details for events (Figure 4). This improves reusability of this information for different analyses.

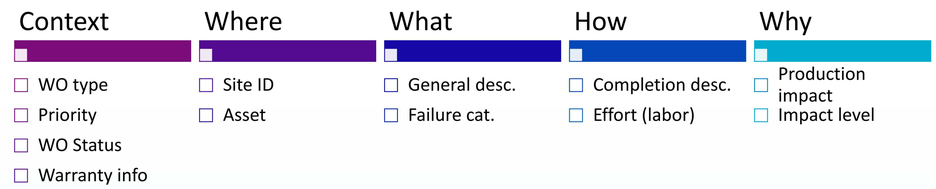


Figure 4 (right). Categories O&M data were parsed into for ML and NLP processing.

Synergistic Activities

- Improved understanding of data collection practices is informing the development of a consistent taxonomy for capturing O&M events.
- Increased database coverage is improving distribution analyses of failures and related efforts for cost models (Figure 5).

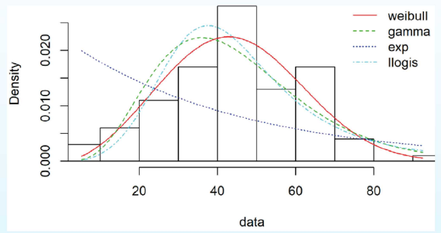


Figure 5. Sample development of distribution parameters for characterizing and identifying systemic failures. These parameters are used as an input for O&M cost model calculations.

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