SAND2020-2212C

PROJECT NAME: PV Performance Modeling and Stakeholder Engagement

Last 5 digits of project number: 34366
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PHOTOVOLTAICS TRACK (Reliability and Standards Development)

Collaborative development of new **advanced PV performance models** increases **prediction accuracy**, reduces **uncertainties**, and **lowers LCOE**.

Scan for list of project-related hyperlinks

BACKGROUND / INDUSTRY IMPACT

- PV performance models are used in support of project financing and operations and maintenance.
- Modeling practices have changed little in the last 10 years.
- There are numerous opportunities for improving accuracy.

PROJECT OVERVIEW / OBJECTIVES

- Improve PV module temperature modeling
- Develop tools around IEC 61853 standard
- Develop and validate soiling loss model
- Engage with PV modeling stakeholders (e.g., PVPMC, IEA PVPS Task 13, pvlib-python & Matlab)
- Add to pvlib and PVPMC website

METHODS

- Reduced order modeling of FEA simulations for the development of a transient module temp model.
- Demonstration of new models derived from IEC 61853
- Compare soiling loss measurement methods.

KEY OUTCOMES / MILESTONES

- Prilliman,, et al., (2020), "Transient Weighted Moving Average Model of Photovoltaic Module Back-Surface Temperature", JPV (in review)
- Hosted two workshops per year (two in the US and two in China)
- Leadership role in IEA PVPS Task 13 – Lead author on two reports
- Pvlib-python is making a significant impact on the industry.

FUTURE WORK / REMAINING RISK

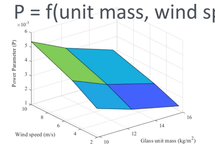
- Publish soiling model work (in the works)
- Develop tutorials and more examples of pvlib-python.
- Develop documented datasets for PV performance model validation.

energy.gov/solar-office

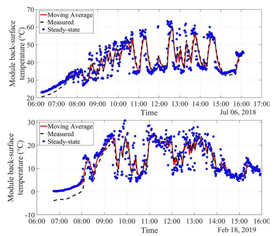
New transient module temperature model – parameters come from spec sheet. FEA thermal analyses found that unit mass (kg/m^2) and wind speed were main factors in controlling the cooling and heating rate due to fast changes in irradiance.

$$T_{MA} = \frac{\sum_{t_i=1}^{1200} e^{-P*t_i} T_{SS,i}}{\sum_{t_i=1}^{1200} e^{-P*t_i}}$$

P = f(unit mass, wind speed)

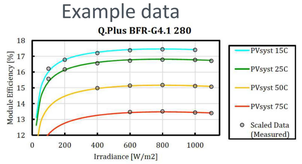


Model validation examples

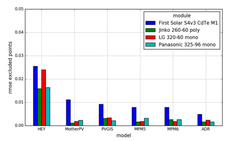


How robust are different performance models?
We tested six models that fit efficiency = f(G,T) data.

Example data

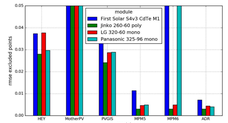


High irradiance data excluded

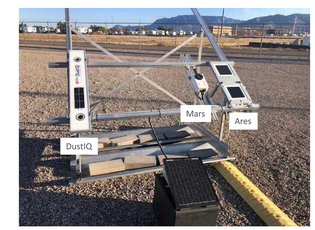


Fitting errors on all data

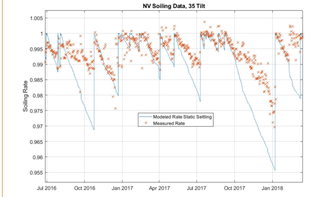
Low irradiance data excluded



Certain models are robust regardless of the range of irradiance



Soiling sensor comparison at Sandia

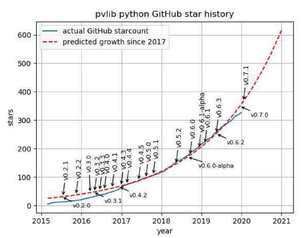


Soiling is an important loss factor. New model based on PM2.5 and PM10 particulate data can predict soiling rates.

pvlib

Open-source modeling function library –

- Forked 334 times
- Used by 80 projects
- 333 stars
- Over 200k downloads



International Energy Agency (IEA) PVPS Task 13

- Subtask 1 lead
  - Activity lead for 1.1: Advanced PV Materials
  - Activity lead for ½ Bifacial PV
- Meetings in Germany, Netherlands, Chile, Sweden, Korea
- Organized workshops in Netherlands and France

PVPerformance MODELING COLLABORATIVE

Workshops (US, China)
Website, documents, data

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