NREL Efforts to Address Soiling on PV Modules
Lin J. Simpson, Matthew Muller, Mike Deceglie, Helio Moutinho, Craig Perkins, Chun-Sheng Jiang, David Miller, Leonardo Micheli, Govindasamy Tamizhmami, Sai Ravi Vasista Tatapudi, Mowafak Al-Jassim

I. Introduction

Natural soiling has reduced the energy output of PV systems since the inception of the technology. Soiling is a complex problem that increases uncertainty and drives up LCOE through lost energy production, increased O&M costs, and higher finance rates. In NREL’s comprehensive review of solar energy soiling,1 the issues have been discussed in the literature for more than 70 years, and yet “the fundamental properties of dust and its effect on energy transfer are still not fully understood, nor is there a clear solution to the problem.” For this project, NREL is performing systematic efforts to understand the processes involved so that the effects of soiling can be predicted for different environmental conditions and to provide the PV industry with the tools/knowledge necessary to devise cost effective mitigation.

II. Methodology and Goals

IV. Conclusions and Future Pursuits

Mechanisms:
• Capillary and van der Waals forces scale with contact area, not particle size
• Developed working definition of cementation and demonstrated method that determines when dust particles become cemented
• Need to quantify additional adhesion mechanisms
• Need to identify appropriate cost effective cleaning/mitigation strategies

Standards:
• Characterizing long term soiling/corrosion processes of fielded PV modules
• Initial glass coupons deployed around the world
• Dust soiling causing some haze
• Need to correlate accelerated test results to observed field observations
• Begin drafting standard(s)

Soiling Rates:
• Initial procedures to determine soiling losses from production data working
• Initial correlation between soiling losses & environmental factors identified
• Need to expand to many more sites to validate initial findings

References

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Outcomes

Accelerated Testing

Accumulated soiling loss rate:

Conduct accelerated tests to validate initial findings.

Contact area of real dust particles does not scale with particle size

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Coating Deployment Guidelines

Quantifying Soiling Mechanisms

Outcomes

Module Coating Standards

Reduce Performance Uncertainty

Predict Soiling Losses

Correlate environmental parameters to soiling,

- 90% correlation to PM2.5 and dry period length for initial 10 sites.

Obtain soiling loss from production data.

Automatically extract soiling loss from PV system data.

- Less than a 1% absolute difference at 8 sites

Soiling stations

Production data

Soiling rate

Uncertainty in soiling station is large because more frequent cleaning is needed.

- Comparison with “soiling station” data at 10 initial sites indicates method is working. Expanding to more data sets.

Soiling rate vs (Site)

95% confidence intervals from outdoor sites

Spread in soiling rate analysis for different sites.

- see Deceglie et al., PVSC Proceedings 2016 and 2017 7

Soiling rate vs Site


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