

Thermal Variability due to Dusting of Solar Arrays

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PROBLEM

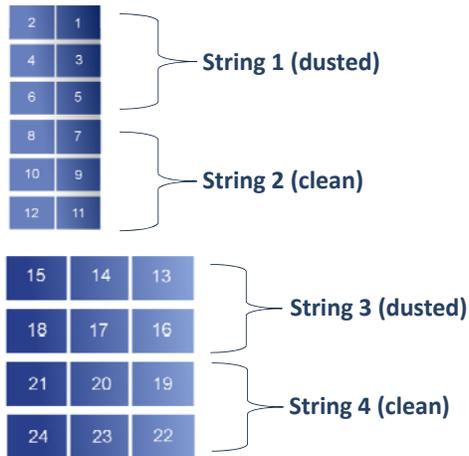
The literature documents the negative effects of dust accumulation on Photovoltaic (PV) modules, typically with an emphasis exclusively on power efficiency. This work examines the variability in temperatures reached by the panels after inducing an artificial dust layer on the surfaces of several panels.

BACKGROUND

- Partial shading is one type of degradation that can lead to permanent damage of the panels and prevent proper operation
 - Shading may be caused by dust, bird droppings and shading from trees
- Shaded cells in series result in mismatch and generate "hot spots," which are localized areas of extremely high temperatures
- Electrical characteristics of hot spots: large negative voltage results in significant Ohmic heat dissipation

METHODOLOGY

- 4 strings of PV panels were observed and dusted with the following set-up:



- Water was sprayed to help prevent the wind from blowing measured quantities of dust off the panels
- Artificial dust was sieved evenly over the bottom cells of tilted panels
- A post-rainfall effect was then simulated through controlled drops of water to create dust formations akin to the real dusting conditions below:

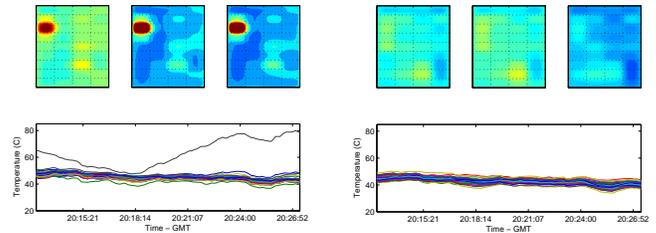


Observed Natural Dust Formation



Controlled Dust Application

RESULTS



Dusted Module with Hot Spot Clean Module

Table 1: Variance and Standard Deviation per String at Solar Noon

	VARIANCE (°C)	STANDARD DEVIATION (°C)
String 1 (Dusted)	26.1330	5.1120
String 2 (Clean)	11.6849	3.4183
String 3 (Dusted)	26.8042	5.1773
String 4 (Clean)	15.5814	3.9473

- Dusted panels were less uniformly heated than they would in normal conditions
- Dusted panels also varied in temperature by about twice as much

CONCLUSION

- Hot spots were generated in a short period of time
- Statistics revealed that there was significant thermal variability between dusted strings and clean strings (as seen in some of the data tables)
- Hot spot cells were higher in temperature compared to neighboring cells usually by over 30 °C
- At night, hot spots were not created; cell temperatures were low and varied little (about 2 °C)
- Conclusive effects of dusting were observed only during the day