

# Spectral and Angular Losses of Soiled PV Modules in India and the USA (PV-6)



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## Scientific Achievement:

Extensive spectral and angular loss characterizations and modeling have been done for the soiled photovoltaic (PV) modules using naturally and artificially deposited field soil samples collected from various locations in India and the USA.

## Significance and Impact:

Almost all the time, all PV modules operate at some level of soiled condition at all locations around the world. The impact of this investigation is an improved energy prediction for the soiled modules once the soiling level is known.

## Research Details:

- Soil Samples: Collected from surface of naturally soiled PV modules in various locations in India (Pondicherry, Agra, Hanle, Jodhpur, and Gurgaon) and the United States (Mesa, Arizona).
- Deposition: Both natural and artificial deposition techniques were used. Naturally deposited test samples were evaluated at ASU in Mesa, AZ, USA. Artificially deposited test samples were evaluated at IIT, Bombay, India.
- Characterizations: Current-voltage; quantum efficiency; spectral transmittance and reflectance; angle of incidence, per IEC 61853-2 standard.

**Publications:** 1) J.J. John, V. Rajasekar, S. Boppana, S. Chattopadhyay, A. Kottantharayil, and G. TamizhMani, Quantification and modeling of spectral and angular losses of naturally soiled PV modules, *IEEE J. PV* 5, 1727-1734 (2015). DOI: [10.1109/JPHOTOV.2015.2463745](https://doi.org/10.1109/JPHOTOV.2015.2463745);  
2) J.J. John, S. Warade, G. Tamizhmani, and A. Kottantharayil, Study of soiling loss on photovoltaic modules with artificially deposited dust of different gravimetric densities and compositions collected from different locations in India, *IEEE J. PV*, accepted (Oct 2015).

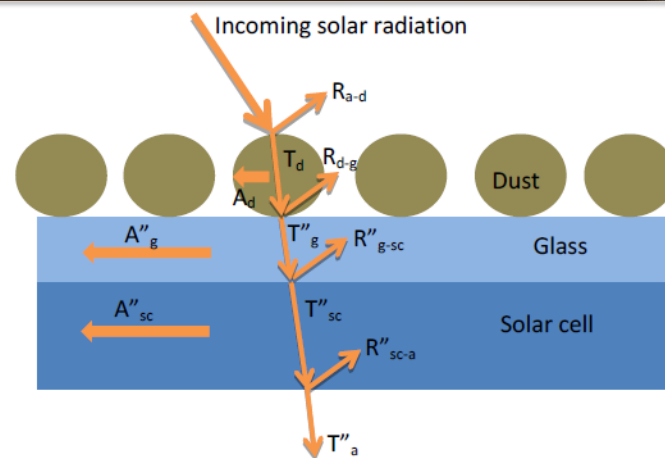
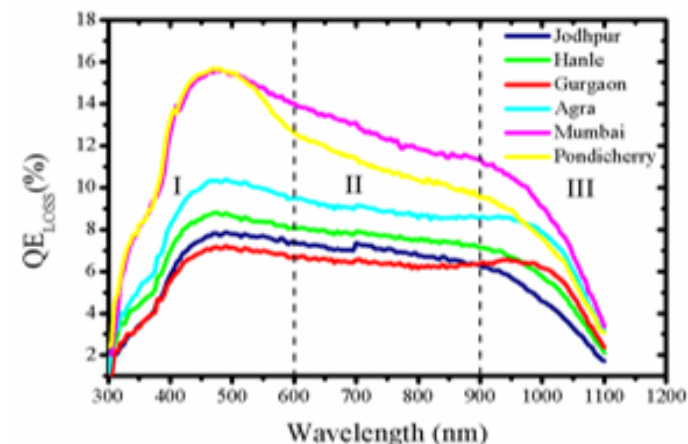


Illustration of optical losses on a soiled PV module.



Influence of location-specific soil properties on the quantum efficiency (QE) of a c-Si solar cell.

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