

## Dust and Soiling of Solar Devices: History, Status, and Expectations (Is there a “Holy Grail” Solution?)

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Soiling, the sedimentation of particulate matter (on the size scale of 1/10 the diameter of a human hair) on the exposed surfaces of solar collectors, is a growing area of concern for solar-system performance, reliability, maintenance, and cost. In the case of photovoltaics (PV), the condition of this first-surface of interaction of the incident photons is critical for ensuring that the maximum-possible light reaches the conversion devices. This paper begins with a more than seven-decade historical look at the research invested into this problem, highlighting the motivation and milestones; the researchers and the progress. The current growing terrestrial markets for solar have brought a new focus on soiling and dust issues. That is because many of these new markets in the *solar-rich* geographic regions of our world are ironically also in the most *dust-rich* and soiling-prone ones as well. This paper continues to provide an overview of the status of current research efforts toward understanding the basic soiling mechanisms, the relationships to the PV technology approaches, the geographical differences in the severity of the problem, the dust physics and chemistry—all relating to the current and future mitigation approaches. Included are some fundamental *microscale through nanoscale* examinations at how individual dust particles adhere to module glass surfaces—as well as how the particles might stick to each other under certain environmental conditions. These observations are used to show how fundamental science may lead to the *macroscale* engineering solutions of these soiling problems. This presentation is designed to overview the soiling area and highlight some of the research directions, speculate on short-term approaches preventing solar showstoppers, and speculate on some “holy-grail” schemes that might lead to the final solutions.