Energy Yield Loss caused by Dust Deposition in Solar Power Plants

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***Abstract*—The deserts could power the world using a variety of solar-power generation technologies including photovoltaic (PV), Concentrated Photovoltaic (CPV), Concentrated Solar Power Systems (CSP), and Wind. In principle, for instance, the Mojave Desert has the potential to meet the entire electrical energy requirements of the United States. The available solar energy in these arid areas offers an enormous potential that greatly exceeds the current market need. In order to maintain high sunlight-transmission or reflection efficiency, solar collectors must be kept dust free. In the worst case, the dust left by a sand storm can completely block sunlight from reaching the collector. A study conducted by the US National Renewable Energy Lab showed that the transmission loss of sunlight through the front glass plates of photovoltaic devices could vary from 5% up to 30% per year depending upon the dust deposition. In this paper, we report (1) Rate and characteristics of dust deposition in some of the semi-arid and desert areas of the world with potential of large-scale solar installations, (2) Loss of transmission and reflection of sunlight in the PV, CPV and CSP systems as a function of particle size and charge distributions, (3) Charging characteristics of the dust particles for their removal by the Electrodynamic Screens (EDS), and (4) Light trapping properties of the particles deposited on the PV modules. Energy yield losses in solar power plants reported from different regions are summarized.**

A test chamber was used for studying light obscuration by dust deposition on solar panels and Fresnel lenses and reflectivity losses in solar mirrors. For each experimental run, a small amount of dust was dispersed using a fluidized bed to deposit a thin layer of particles with a controlled size distribution. Experimental data showed that the normalized power output of the solar cell, plotted as a function of the surface mass density of dust deposited on the glass plate, had an exponential decay. The decay curve agreed with the theoretical predictions. Similarly, reflectivity losses in solar mirrors were determined as a function of dust deposition. The effects of electrostatic charge on the adhesion and packing density of the deposited dust layer were investigated. Experimental data are presented using dust samples from different regions.