# DustVue™

SOLAR-MODULE SOILING SENSOR

## IEC 61724-1 Compliant PV Soiling Sensor

Providing on-board data filtering and real-time soiling loss


## Overview

Soiling, the loss of photovoltaic (PV) module power output due to the accumulation of dirt and/or snow on the panel surface, is an important operational issue of solar energy power plant performance. The DustVue Solar-Module Soiling Sensor provides solar energy professionals who are responsible for managing the performance of a PV power plant with the information needed to evaluate and manage the impact of soiling. Soiling loss is calculated using industry-standard methodologies. Raw data is stored and available for additional post-processing.

## Benefits and Features

- Complies with IEC 61724 methodology
- Monitors soiling loss in real time
- Assures data quality by real-time filtering
- Calculates average daily soiling loss
- Supports Modbus, DNP3, PakBus, data encryption, and internet protocols
- Does not require programming
- Includes quick-deploy guide to simplify installation

## Technical Description

The DustVue Solar-Module Soiling Sensor can be the heart of an independent soiling measurement station or added to any new or existing MET station. It supports many communications protocols including DNP3, Modbus, PakBus encryption, and several internet protocols.

The DustVue is delivered field ready and requires no programming, simplifying deployment/configuration. It calculates the soiling loss from short-circuit current corrected for module temperature from a clean reference PV module and a test PV module that is allowed to soil naturally. Two rugged, high-quality sensors are included with the DustVue for measuring back-of-PV-module temperature. The reference and test PV modules can be user supplied (full-sized production modules supported) or ordered with the DustVue as an option (two 20-W modules).

Measurements are included in the daily average only when a threshold of global solar irradiance is met, avoiding differences in soiling due to environmental instability, module-current dependence or irradiance level, and to an extent, spectral effects. The DustVue calculates a quality factor to give the user some feedback on the number of qualified measurements.

Effective irradiance is calculated from the measured short-circuit current and module temperature in accordance with IEC 60904-10. A daily average soiling-loss is calculated, which is made available for a supervisory control and data-acquisition (SCADA) system and stored in on-board memory. For immediate feedback, a real-time soiling loss and quality factor are available. Raw measured data are stored and available for analysis or for researchers looking to perform independent post-processing.

The procedure is straightforward and easily implemented with manual washing of the reference module, usually cleaned at the same time as the on-site pyranometer(s).

Figure 1 shows the effective irradiance calculated from the short-circuit current from the two panels. The figure also shows the calculated soiling-loss index (SLI) as a percentage. The asymmetry in SLI during morning and afternoon hours can be attributed to two reasons: (1) a misalignment in the installation of the panels, and (2) effects due to a large angle of incidence of solar irradiance during morning and afternoon hours. In order to avoid these, a daily average of SLI is calculated from measurements around two hours before and two hours after the solar noon at the location.

Figure 2 shows the same measurement taken on a cloudy day. In order to avoid spurious soiling losses due to rapid cloud movement, elaborate data processing is performed and only stable measurements are considered in the daily average SLI calculation.

Figure 3 shows a time history of SLI. The SLI starts at zero and then keeps building up. It drops down due to rain or cleaning events. The figure also shows precipitation on the same graph.

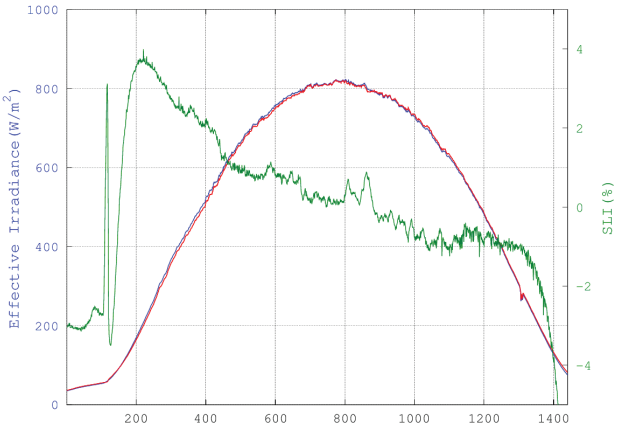


**Figure 1:** Effective irradiance as calculated from the short-circuit current of the PV modules on a clear-sky day. The green curve shows daily soiling loss.

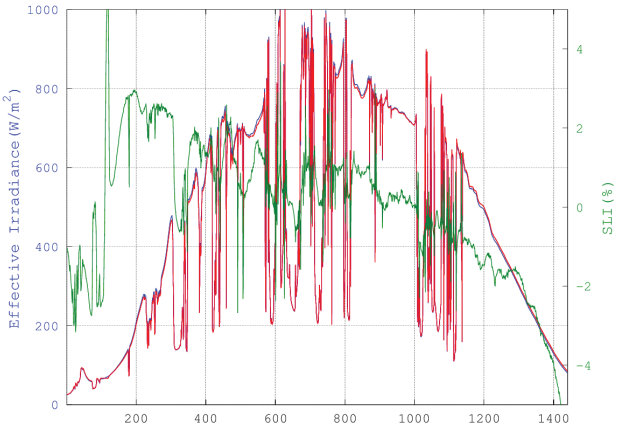


**Figure 2:** Effective irradiance as calculated from the short-circuit current of the PV modules on a cloudy day. The green curve shows daily soiling loss.

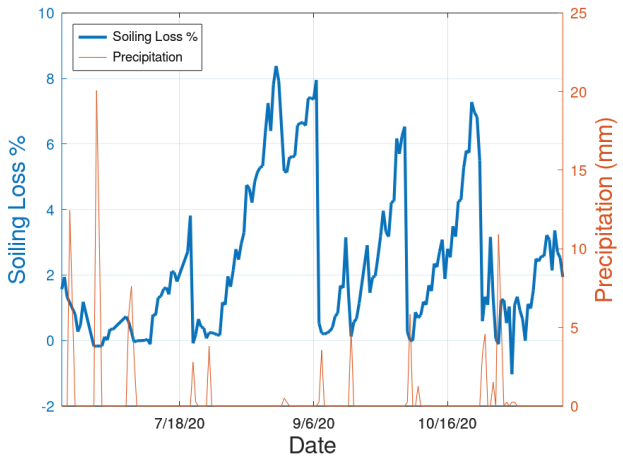


**Figure 3:** Daily average of daily soiling-loss rate over a period of eight months along with precipitation data

## Application Overview

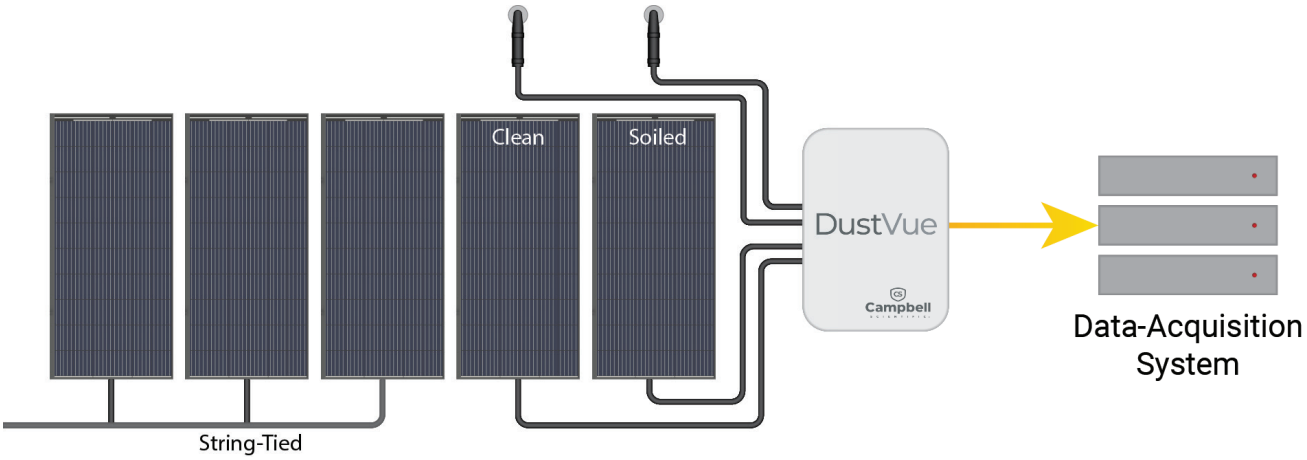


**Figure 4**

Figure 4: The DustVue can feed data directly to a SCADA system using MODBUS over TCP/IP.

## Short-Circuit Current Methodology

Numerous studies and documents have been published over several years outlining and testing various methods to calculate losses due to soiling, along with their advantages and disadvantages. These studies show that the short-circuit current of a solar module is directly proportional to the light intensity and can be used as a reliable method to measure changes in light intensity from reaching the solar cells.

While other methods have been studied, such as I-V curve tracers or maximum power point trackers, these systems can provide minimal accuracy gain only under certain conditions that may not be practical in a field setting. The disadvantage of these systems is their cost and scalability, as they are typically a much more expensive and complicated endeavor.

The DustVue uses the short-circuit current measurement method to provide end users with a simple, lower-cost solution that is more readily scalable and deployable in larger numbers on utility-scale solar projects using proven methods.