

## Soiling Ratio, Rate & Cleaning Efficiency

### Technical Note

#### Soiling and revenue losses

A report by the International Energy Agency's Photovoltaic Power Systems Programme (IEA-PVPS)<sup>1</sup> estimated that the lost revenue from PV module soiling amounted at approximately US \$7.5 billion globally in 2023. This amount is set to increase due to several factors, such as:

- more PV modules being installed in remote regions with greater impacts from soiling.
- lower electricity prices making cleaning less economic due to reduced return per recovered kWh.
- more efficient modules presenting greater relative losses under the same amount of soiling.



The report also showed that soiling is a highly site-specific issue, and that even different sections within a single site can present different soiling levels. This leads the authors to place emphasis on accurate monitoring of these losses as critical.

“An ideal solution should be installable with as little maintenance as possible and be able to detect heterogeneous soiling at both module and site level with high accuracy,” the scientists said.

#### The MetCube – Soiling measurement with high accuracy

The MetCube integrates a Soiling Station to provide valuable data about the soiling ratio impacting a solar farm and the cleaning efficiency of varying methods or systems used by the solar farm to clean its solar PV modules.



The MetCube Soiling Station integrates an automated cleaning system of the 'clean' panel using pressurised demineralised water and a soft brush to clean the reference panel daily. This method guarantees 100% cleanliness of the MetCube reference panel, which can then be taken used to measure soiling impacts and the performance of alternative cleaning methods used onsite.

This solution is optimised to minimise water usage. The water used in each cleaning cycle is recaptured (>95%), stored and filtered within the MetCube for use in future cleaning cycles.



<sup>1</sup><https://iea-pvps.org/wp-content/uploads/2023/01/IEA-PVPS-T13-21-2022-REPORT-Soiling-Losses-PV-Plants.pdf>

## Benchmarking Cleaning Efficiency

The MetCube provides an independent benchmark to measure the cleaning efficiency of methods or systems used by utility scale PV plants, both fixed tilt and tracking.

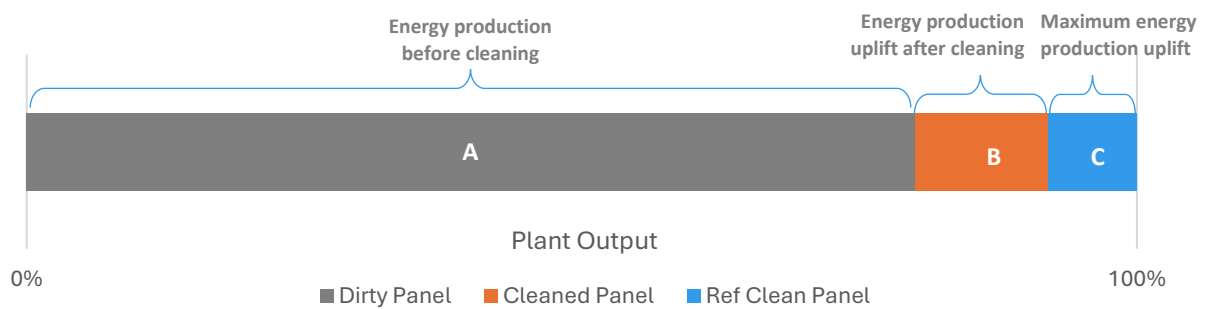
Per IEC 61724-1:2021 standard:

- **Soiling Ratio (%)** is calculated by dividing the electrical output of a PV module under soiling conditions, with the expected output of the clean PV array

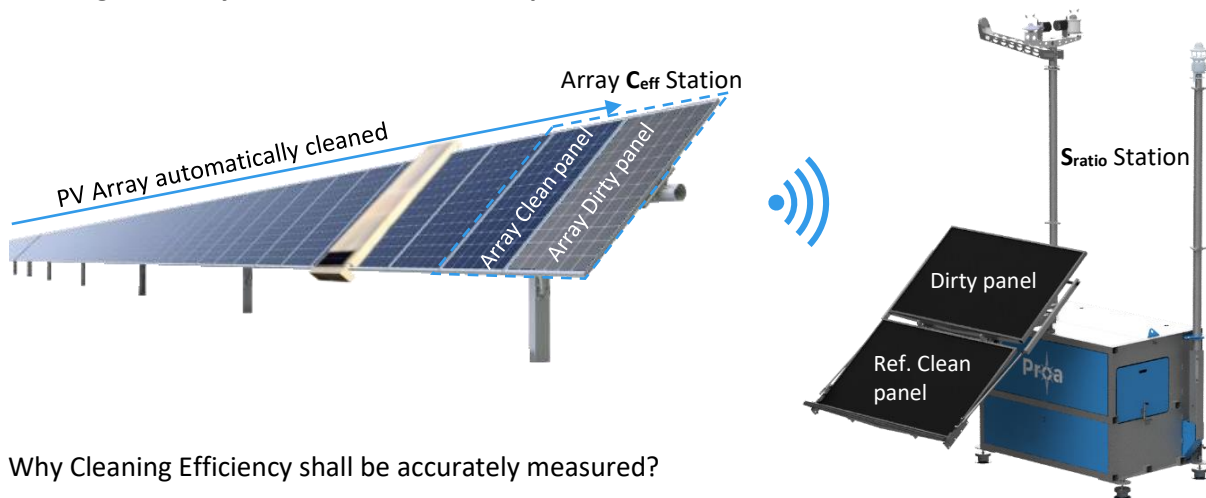
$$S_{ratio} = \frac{A}{A+B}$$

- **Soiling Rate (%/day)** is the daily rate at which the soiling ratio decreases while soiling deposits on the PV surfaces. It is a measure of the slope of the soiling ratio profile for a specific period.
- **Cleaning Efficiency (%)** is calculated by dividing the electrical output of a PV array immediately after cleaning, with a 100% clean PV array.

$$C_{eff} = \frac{A+B}{A+B+C}$$



The MetCube is set to define a new market reference, not only to calculate Soiling ratio and rate, but also to measure the cleaning efficiency of utility scale PV projects by its ability to **guarantee 100% cleaning efficiency on the Reference Clean panel**.



Why Cleaning Efficiency shall be accurately measured?

- Calculate revenue losses due to inefficient cleaning systems or processes.
- Monitor cleaning efficiency drifts overtime (e.g. loss of performance of cleaning robots).
- Benchmark cleaning performance of different methods and/or systems.

- Monitor potential warranty claims of automatic cleaning systems or manual cleaning contractors.
- Optimise schedules and frequency of cleaning events.