



SolarPACES

Concentrating Solar Power, Thermal,
and Chemical Energy Systems

SolarPACES Task III
Solar Technologies and Advanced Applications

Update of guideline: Recommendations for reflectance measurements on soiled solar mirrors

Report WP1

Report on stakeholder interviews

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Dissemination level		
PU	Public	X
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CO	Confidential, only for members of the consortium (including the Commission Services)	

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Executive Summary

This document presents a summary of the interviews conducted with the available shareholders during the project “Update of guideline: Recommendations for reflectance measurements on soiled solar mirrors”. The main objective is to gain feedback on the methods used nowadays and the future needs of commercial users respect to in-field soiling measurements.

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1. Background

The main goal of work package 1 (WP1) within this project is to obtain feedback on the methods of soiling measurements employed currently, and to determine whether those performing the measurements follow the existing SolarPACES guidelines. Additionally, we attempted to gain feedback on the existing guidelines. The goal of this information gathering was to determine whether any revision to the existing guidelines was warranted to help benefit those in the industry who conduct the measurements.

2. Methodology

The team members of WP1 developed a survey composed of approximately 20 questions intended to span approximately a 30-minute-long interview and contacted industry companies including O&M service providers and operators of CSP plants. While we have masked the identity of specific organizations we interviewed, those we interviewed included solar field operators at existing plants who conduct measurements, plant managers who have had experience taking measurements in the past and know the protocol at their respective facility, and service providers who use measurements to either (i) inform their own cleaning services or (ii) validate alternative, drone-based measurements. In total, 14 people were interviewed across seven different organizations.

The questions in the interview had three primary objectives:

- Understanding awareness of the existing SolarPACES guidelines in industry and whether these guidelines influence current measurement procedures;
- Understanding how measurement campaigns are conducted, and how the data obtained from these efforts is used; and,
- Learning whether there were any specific questions or difficulties with existing measurement techniques to see if there is an opportunity for improvement.

3. Results

This section describes key insight obtained by the interviews we conducted in WP1. Because the questions were almost exclusively open-ended in nature, we do not show verbatim responses but instead offer summaries arranged by two themes: the protocols used to collect data, and how much data was collected and used.

Awareness of SolarPACES guidelines and protocols used

Except for one individual who co-authored an earlier version of the SolarPACES guidelines, none of those interviewed were aware of either the general SolarPACES reflectance measurement guidelines or the more focused document “Recommendations for reflectance measurements on soiled solar mirrors” (v. 0.1, 2022). Rather, measurement campaigns follow protocols determined by either the device provider or the solar field technology developers. Devices used in the field include D&S-15R, Solar Optics SOC410, Condor, Konica Minolta CM700d, and ZGM1130. The first three are commonly used in plants and meet the requirements for portable handheld reflectometers listed in Section 4.1 of the soiled mirror guidelines.

There are several attributes of the measurement protocol that follow the SolarPACES guidelines. Nearly all measurement protocols take multiple measurements per facet measured (with a minimum of three), which is in line with Section 5 of the soiled mirror guidelines according to the literature sources referenced within. Additionally, the devices are calibrated at least daily using a reference mirror, calibration coupon or internal standard, and all the instruments used are sent to the manufacturer for service annually; these comply with Section 6.2 of the soiled mirror guidelines. The calibration is always followed by a test measurement on a device-manufacturer-provided coupon or other reference mirror with known reflectance to confirm a successful calibration. Additional calibrations may take place within a daily measurement campaign in cases of high temperature variation (e.g., transporting the device in a warm car and taking measurements on a cold night).

Measurement Number, Frequency, and Usage

Each measurement campaign tends to take measurements of between 40 and 60 facets, depending on the concentrating solar technology; the final number at each facility was determined by analysis of the number of reflectors required to get approximate convergence to a field-weighted reflectance as well as information on the relative reflectance of different sections of the field. The same specific reflectors are measured in each campaign to maintain consistency in location and to minimize variance when estimating relative changes in reflectance over time. Measurement frequency varied from daily to weekly depending on the rate of soiling at the facility.

The primary use of the data was to determine mirror-washing schedules, i.e., prioritizing which parts of the solar field to clean in the next day or week. There was limited interest in obtaining a “ground truth” estimate of reflectance; instead, the operators use a data-driven approach in which they track the productivity of the solar field and the available solar resource (i.e., DNI) to map the reflectance to an expected performance.

Then, they use the relative reflectance measurements to determine which field sections offer the greatest upside in field production if cleaned and send mirror-washing crews to those areas. In some cases, the measurements may yield other decisions, such as adding or removing crews to the schedules after a dust storm or precipitation that naturally cleans the collectors, respectively. Because relative reflectance is sufficient for the plants' needs, these mappings to performance are employed, and device-based measurements are labor-intensive, plants generally rely on collection and analysis of specular, monochromatic or solar-weighted reflectance as a lone measure for decision making and do not utilize the other measures of data recommended in Section 8 of the general guidelines.

4. Conclusions

This work package conducted interviews of concentrating solar thermal service providers and plant operators to gain insight on existing protocols for reflectance measurement in the industry and compare these metrics to the SolarPACES reflectance guidelines. While there is a general lack of awareness of these guidelines amongst those who conduct the measurement campaigns, many of the existing protocols are compliant with the guidelines under the premise that the instruments themselves are compliant (validation of the instruments against SolarPACES guidelines was outside the scope of WP1). One notable difference between the guidelines and industry usage of data was the tendency to use a single measurement of monochromatic specular reflectance to inform decision making rather than the use of many individual components and different apertures; this is largely due to the primary use of the data collected, which is to inform short-term cleaning operations rather than validate the clean-mirror reflectance to a high degree of certainty. To that end, three potential actions from this information could improve the impact of the reflectance measurement:

- A clarification paragraph in Section 6.3 that it may be feasible to develop a plant-specific correlation that relates weather data (i.e., DNI) and reflectance measurements to the productivity of the plant, allowing for the reflectance data to provide value without the requirement to obtain ground truth measurements, but that these transfer functions are useful to determine causes when the correlations do not perform as expected;
- Additional clarification on Section 5 that the number of facets and measurement locations per facet will vary according to the needs of the site and the specific soiling, which may determine how heterogeneous the reflectance is; and;
- An awareness campaign in which device manufacturers and CSP services providers become aware of the SolarPACES guidelines, so that they can, in turn, validate their existing protocols.

It has been decided that the conclusions of the work carried out in this work package will not be incorporated to the current SolarPACES Guideline "PARAMETERS AND METHOD TO EVALUATE THE REFLECTANCE PROPERTIES OF REFLECTOR MATERIALS FOR CONCENTRATING SOLAR POWER

TECHNOLOGY UNDER LABORATORY CONDITIONS” (version 3.1, April 2020) because this guideline has been moved to the international standard IEC, 62862-3-5 (under final revision and due for publication in spring 2026). On the contrary, our conclusions will be included in a specific section in the new edition of the Guideline “Recommendations for reflectance measurements on soiled solar mirrors” (version 0.1, July 2022) containing a series of recommendations for the measurement of soiling in the field. It is also recommended that this new soiling measurement guide be disseminated as widely as possible to CSP plant operators and cleaning companies around the world.