

# PV Soiling Frequently Asked Questions

- ARES Soiling Station
- Solar Soiling
- PV Soiling Monitors

01

## What is soiling of solar panels?

Soiling of solar panels refers to the accumulation of dust, dirt, and other debris on the surface of the panels. This can include things like pollen, bird droppings, and even particulate matter from the air. The soiling can occur naturally over time, but can also be exacerbated by factors such as location (e.g. near a construction site), weather conditions (e.g. high winds), and the type of surface on which the solar panels are installed. The soiling can reduce the efficiency of the solar panels by blocking sunlight from reaching the cells and preventing them from generating electricity to their full capacity.

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## What is soiling monitoring?

Soiling monitoring is the process of measuring and analyzing the amount of dust, dirt, and other debris that accumulates on the surface of solar panels. This information can be used to determine the need for cleaning and to schedule cleaning at the optimal time to minimize the impact of soiling on the performance of the solar panels.

Soiling monitoring is important because even a small amount of dust on solar panels can significantly reduce their efficiency. By regularly monitoring the soiling level of the panels, operators can ensure that the panels are kept clean and performing at their best.

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## Should you clean your solar panels?

Yes, here are 3 reasons why cleaning your solar panels is important:

1. Increased Efficiency: Dust, dirt, and debris can accumulate on solar panels, reducing their ability to absorb sunlight and generate electricity. Regular cleaning can increase their efficiency by up to 25%.

2. Extended Life Span: Solar panels are exposed to the elements, and regular cleaning can help protect them from damage caused by dust, dirt, and other debris. A longer lifespan means a better return on investment for the solar panel owner.

3. Cost Savings: Cleaning solar panels can lead to cost savings in the long run by increasing their efficiency, extending their life span, and reducing the need for repairs or replacements.

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### **How often should you clean solar panels?**

The frequency at which solar panels should be cleaned depends on several factors, including the location of the panels, the type of environment they are in, and the level of soiling. In order to maximize projects, solar panels shouldn't be washed too often or not often enough. It's important to understand exactly when to wash. This is no easy task and is what Fracsun specializes in.

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### **What happens if you don't clean your solar panels?**

If you do not clean your solar panels, the accumulation of dust, dirt, and other debris on the surface of the panels can significantly reduce their efficiency. Over time, this can lead to a decrease in the amount of electricity that the panels can produce.

Dirt, dust, and other debris can also cause a buildup of static electricity on the surface of the panels, which can attract even more dust and debris. This can lead to a cycle of decreasing efficiency as the panels become increasingly dirty.

In addition to reducing the efficiency of the panels, a buildup of dust and debris can also cause physical damage to the panels over time. For example, dust and debris can scratch the surface of the panels, reducing their ability to produce electricity.

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## **What is a PV soiling monitor?**

A PV (photovoltaic) soiling monitor is a device that is specifically designed to measure the amount of dust, dirt, and other debris that accumulates on the surface of solar panels. Soiling refers to the buildup of this debris on the surface of the solar panels, which can reduce the amount of sunlight that is absorbed and converted into electricity.

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## **What are the benefits of using a PV soiling monitor?**

There are several benefits to using a PV soiling monitor, including:

1. **Improved energy efficiency:** When solar panels become dirty, their energy output decreases. By using a PV soiling monitor, you can track the amount of soiling on your panels and schedule cleaning or maintenance when necessary, thereby maximizing the efficiency and energy output of your system.
2. **Reduced maintenance costs:** Regular cleaning of solar panels is essential for maintaining their performance, but cleaning too frequently can be costly and time-consuming. By using a PV soiling monitor, you can determine when cleaning is needed, avoiding unnecessary maintenance and reducing costs.
3. **Longer lifespan for solar panels:** Dirt, dust, and debris can damage the surface of solar panels over time, reducing their lifespan. By monitoring and cleaning your solar panels regularly, you can help extend their lifespan and protect your investment.

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## **How often do soiling sensors need to be calibrated?**

Calibration of soiling sensors depends on many different factors. ARES is calibrated during assembly and shouldn't require any calibration upon installation. We recommend our customers normalize the data coming from the device if they ever notice drift, but this rarely happens. To learn more about this process please refer to our user manual.

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## **How do PV soiling monitors differ from other types of solar monitoring equipment?**

PV soiling monitors are specifically designed to measure the amount soiling that accumulates on the surface of a solar panel, whereas other types of solar monitoring equipment measure different aspects of solar panel performance.

For example, a solar irradiance sensor measures the amount of solar radiation that reaches the surface of a solar panel, while an inverter monitoring system tracks the energy output of the entire solar panel system. A performance monitoring system may also monitor individual panels to detect faults or issues with the system's performance.

In contrast, a PV soiling monitor is focused on measuring the level of soiling on the surface of the solar panels, which can significantly impact the system's performance.

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## **Can PV soiling monitors be used in all weather conditions?**

PV soiling monitors are typically designed to operate in all weather conditions as they are meant to monitor array performance year-round. In general, most PV soiling monitors are designed to operate in a range of temperatures and humidity levels, and may be equipped with features such as weather-resistant enclosures or protective coatings to help protect against environmental factors. The ARES device has been designed to withstand harsh conditions that are regularly experienced at most solar locations. For specifics on the ARES device please refer to our documentation in the resources tab.

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### **What soiling type is ARES capable of measuring?**

The ARES device can accurately measure all types of soiling. It has been designed to measure the same soiling type that is affecting the monitored plant and therefore covers all soiling types.

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## **How does ARES measure soiling?**

ARES accurately measures the instantaneous and daily soiling loss by comparing the irradiance difference between two identical large-area reference cells. One cell is washed daily, while the other is left to soil naturally. The Wash Extension hardware automatically cleans one reference cell on a daily basis, eliminating the need for manual cleaning.

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## **What method is used to measure irradiance?**

Irradiance values are derived from the short-circuit current (temperature compensated) of the reference cell.

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## **At what frequency does ARES output data to the Fracsun cloud?**

By default, ARES outputs data every 5 minutes. This frequency can be adjusted remotely. If you prefer even more resolution, you can connect the ARES device to the Wash Extension battery (12V) via the M12 cable. Higher resolution data draws more power than the default frequency.

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## **Is a 5 minute resolution good enough to measure soiling?**

Yes. Soiling buildup is often a very slow and gradual process that takes days or even months to show an obvious trend.

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## **How long can the internal battery run ARES without sun before it's depleted?**

The internal battery draws very little power during the night because it goes into a deep-sleep state. The battery remains well-charged, even in the dark winter months. ARES cannot detect soiling at night, so it does not output data and consume battery power then.

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## **How does ARES push data to the Fracsun cloud and portal?**

All ARES devices have an integrated cellular modem that communicates with the nearest cellular tower. A secure connection is made to the Fracsun cloud and a message that contains the data is published.

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## **Does ARES need a SIM card to operate?**

ARES utilizes an internal E-SIM, which is a chip-based SIM card. There is no slot for an external SIM card.

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## **Which cellular carrier(s) does ARES connect to?**

In the United States, ARES connects to the AT&T LTE M1 network. Globally, ARES is powered by over 350 carriers across the world and automatically connects to the best networks across 2G/3G/LTE.

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## **What if the preferred installation location has weak or no cellular access?**

For poor cellular reception, you can install a higher gain external antenna. For sites with no reception at all, you can directly connect to an onsite data logger using Modbus RS-485. In this case, you cannot view the data in the portal.

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## **Does ARES store data in internal storage in case of cellular network failure?**

No it does not. That being said, we have found that most network failures only last a couple hours and that ARES is still able to generate an accurate daily soiling loss value during these events, even with the missing irradiance data from that downtime.

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## **Does ARES support Modbus TCP/IP?**

No, but it can communicate over Modbus RS-485. You also may be able to use a Modbus TCP/IP to Modbus RS-485 converter if only TCP/IP is available.

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**How effective is the cleaning of the reference cells?**

We apply a nano-scale hydrophobic coating to the clean reference cell only. The coating, combined with a daily high pressure water spray, greatly reduces the need for mechanical cleaning on that sticky / hard soiling. That being said, we would recommend visual inspections during site visits to verify the efficacy of the cleaning.

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**How does the system clean sticky (tough to remove) soiling matter like pollen, soot, and ash?**

The combination of the hydrophobic coating and daily high pressure spray are often enough to remove sticky soiling.

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**What type of solar reference cells are used in the ARES soiling monitoring station?**

ARES uses polycrystalline large-area reference cells. The cells are standard size 156 x 156mm and the glass is 200 x 200mm.

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**How does the ARES soiling measurement, which utilizes polycrystalline cells, compare to that of thin film PV technologies?**

The accuracy of our soiling measurement with a thin-film plant greatly depends on the thin-film technology used. CIGS, popular in First Solar modules, correlates well with our soiling station due to a similar spectral response seen in polycrystalline. CdTe and a-Si technologies don't correlate as well due to their different spectral responses, but we can still make decent correlations.

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**How does ARES manage degradation of the the reference cell over time?**

Because the polycrystalline reference cells may degrade at different rates over time, a simple calibration must be performed to match the cells as close together as possible using software-based scaling.

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### **How often is a calibration needed?**

Preferably a calibration should occur once a year.

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### **What is the calibration process like for the ARES reference cells?**

Fracsun uses a very simple automatic calibration process, which can be activated remotely in the portal or writing to Modbus registers. It should occur when both reference cells are completely cleaned.

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### **How does shading affect the soiling measurement?**

When a shadow is cast over the ARES unit, vastly different clean and soiled irradiance values can result in erroneous soiling values. These soiling values are just instantaneous ones and should be ignored.

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### **Is there a slope / inclination range that works best for ARES?**

Any slope / inclination of 5 degrees or more is best. For tracking systems, the automated spray must occur when the nozzles are pointed towards the ground (not the sky).

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### **Does ARES work when installed flat rooftops?**

ARES can work on flat rooftops, but the angle must be slightly adjusted to at least 5 degrees so that the water from the daily spray flows away from the cell.



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### **Can I move an ARES soiling station from one location to another?**

Yes, a soiling station can be moved from one location to another. Don't forget change the device coordinates in the Portal.

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### **Does ARES require the Wash Extension to measure soiling?**

No. ARES does not need the Wash Extension to measure soiling. The Wash Extension's purpose is to automatically rinse ARES's clean reference cell on a daily basis. This process can also be scheduled manually by a local site resource.

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### **What is the Wash Extension?**

The Wash Extension is an accessory for the ARES soiling monitoring station. The Wash Extension stores and automatically pumps water up to the high-pressure spray nozzles on the ARES device. While it's not required, almost all of our customers use it.

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### **How much water does the Wash Extension reservoir hold?**

16 gallons (60 liters) of water when fully filled.

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### **How often does the Wash Extension need to be refilled?**

The Wash Extension reservoir needs to be refilled once a year in its default configuration (1 wash per day).

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### **What type of fluid should be filled in the Wash Extension reservoir?**

Distilled water or filtered water (RO + DI preferred) with a TDS value of less than 20 ppm. Under no circumstances should tap water be used. Tap water contains minerals that will build up on the solar glass after each wash, affecting the irradiance measurement and soiling accuracy.

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### **What is the default frequency of cleanings?**

1 wash per day. The Wash Extension can be configured to wash up to 3 times per day.

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### **What type of maintenance is expected in the Wash Extension?**

Typical maintenance includes annual water tank filling, pump replacement after 5yrs, battery replacement after 7yrs, and incidental damage from vegetation mitigation (mowers, sheep, etc).

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### **What is the default time the Wash Extension cleans?**

9am local time. The Wash Extension can be configured to wash at any hour of the day.

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### **Does the Wash Extension work in freezing conditions?**

Yes, it can work in freezing conditions. Please read our Winterization instructions.

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### **Are there any chemicals used within the reservoir?**

In non-winter operation, there are no chemicals used within the reservoir.

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### **Does the Wash Extension support Modbus communication?**

Yes. The Wash Extension supports Modbus RS-485 communication. Please read the Modbus documentation for more information.

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### **How many ARES soiling monitoring stations would you recommend for 1 MW, 5 MW, and 20 MW plants?**

This greatly varies on the PV plant, dust type, and source of the soiling. We can perform a virtual site evaluation if you can share some details about your plant. The general recommendation would be 1 to 2 devices per 5MW.

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### **Should ARES be installed on the ends of a tracker row?**

The ends of a tracker row are often the best location to install ARES for accessibility reasons. For northern-hemisphere projects, installing on the south end of a row is recommended because the Wash Extension has less shading. For south-hemisphere projects, installing on the north end of a row is recommended.

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### **Can ARES measure soiling for bifacial modules?**

Yes, you can use ARES to monitor soiling on ground-facing bifacial modules. However, when lower albedo is present, the soiling accuracy may not be as good. Generally speaking, if we are able to measure irradiance values of at least  $200 \text{ W/m}^2$  on the ground-facing ARES, the data should be good enough to get a soiling loss value. Irradiance measurements under  $100 \text{ W/m}^2$  will start to have an error, so values below that threshold will likely be trimmed when calculating the daily soiling loss/ratio. Fracsun is continually researching the newest solar technologies, and results for measuring bifacial soiling look promising.

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### **Does the portal indicate a daily loss soiling value?**

Yes. The daily soiling loss value is calculated using modified clean and dirty insolation values. Fracsun's calculation algorithm combs through the day's irradiance data to clean up the insolation data by weight irradiance values (higher irradiance carries more weight than lower irradiance), removing

irradiance values under a specific threshold, and removing irradiance values that are very far apart from each other (mostly due to shading).