Quick Read Whitepaper
8 Minutes

Pyranometer Dome Heating

Active Dew & Frost Resistance
Improved Measurement Accuracy

QRW_PDH 07-2022

Why worry about Dew & Frost?

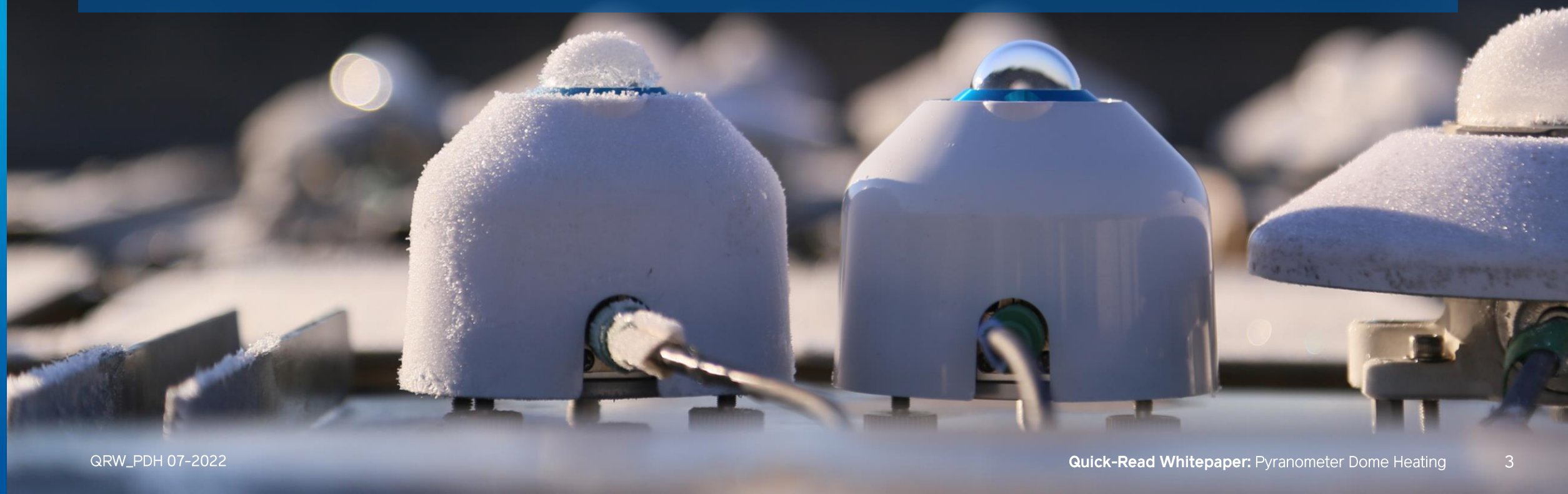
Similar to the effects of ‘soiling’; the accumulation of material on PV panels, usually dust, leaves, or bird droppings; dew and frost, can have a negative impact on energy production and optical measurements performed at PV sites and the measured irradiance values of pyranometers by reflecting, blocking or absorbing solar irradiance.

Dew and frost can become a daily problem in certain climates or at certain times of the year. Unlike dust or grime, however, dew and frost dissipate naturally over time, sometimes quite quickly. When the sensors and monitoring systems used to manage solar parks are affected too, it can become difficult to make an accurate assessment, gauge the impact on potential yields or make decisions about cleaning and maintenance.

Pyranometers are affected by Dew & Frost

Dew & Frost forms on the dome of a pyranometer owing to radiative cooling at night and can lead to measurement errors, particularly in the early morning. In addition to the direct impact on measurement accuracy, dew and frost can support soiling, helping sand and dust adhere to the sensor dome.

Due to the impact that dew and frost can have on PV systems, Class A monitoring solutions compliant with IEC 61724-1:2021 are required to mitigate against them to ensure accuracy.



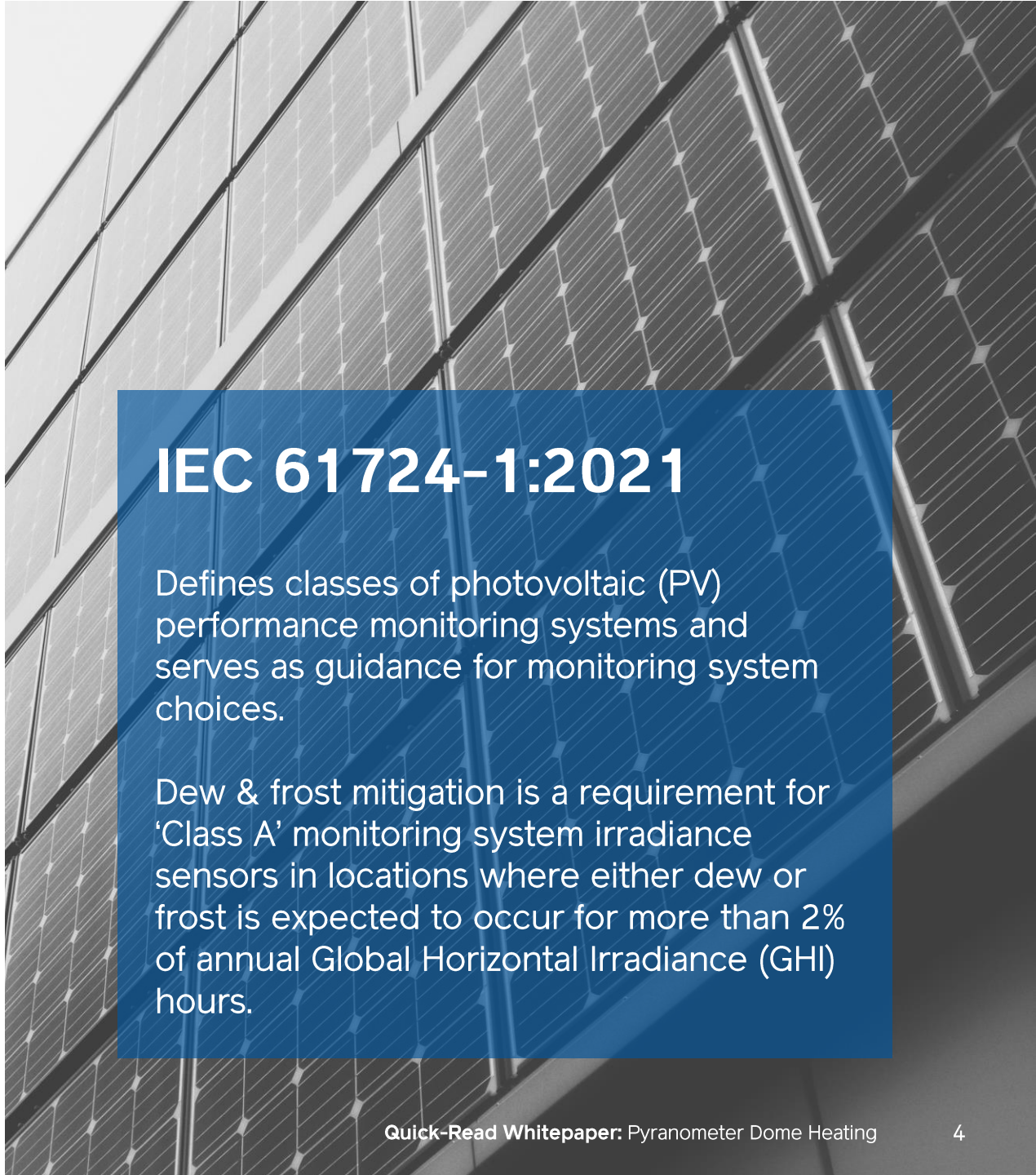
Dealing with Dew & Frost

The conventional solution for dew and frost on a pyranometer has been to attach an external ventilation and heating unit, usually designed not just for dew and frost, but heavy snow too.

However, many pyranometer heating systems are designed to stay on, drawing power whether they are needed or not.

And while EKO's own MV-01 external ventilator and heater option, and the heating system in the MS-80SH, have been carefully designed to avoid affecting the thermopile sensor in our pyranometers, the heaters used in other brand pyranometers can lead to offsets in measured values, and lower accuracy.

As PV sites have grown in size and complexity, the need for an alternative, in-built, high-accuracy, low-power heating solution for pyranometers has grown too, especially in cases where the solar radiation monitoring system is battery-powered or in a remote location. This is why we developed the **MS-80SH**.



IEC 61724-1:2021

Defines classes of photovoltaic (PV) performance monitoring systems and serves as guidance for monitoring system choices.

Dew & frost mitigation is a requirement for 'Class A' monitoring system irradiance sensors in locations where either dew or frost is expected to occur for more than 2% of annual Global Horizontal Irradiance (GHI) hours.

PATENT PENDING

MS-80SH Pyranometer

Features

- <1.4W Integrated High-Efficiency User Controlled Dome Heating for active dew & frost resistance
- ISO 9060:2018 Class A, Spectrally Flat & Fast Response
- <0.5s Super-Fast response for always accurate measurements
- <1W/m² Record Lowest Zero Offset A, and <0.5% Lowest Non-Stability over 5-Years
- Level A EMI/EMC Electronics Surge Filter & Protection
- Internal Diagnostics for temperature, tilt, roll, and relative humidity
- 5 Year Warranty & Recommended Recalibration Interval
- ISO 17025 accredited calibration

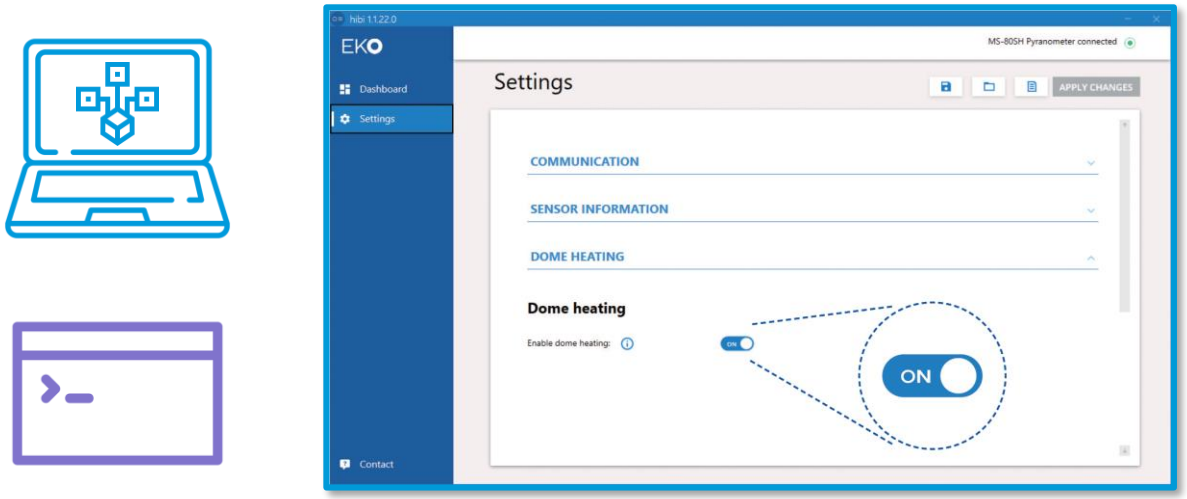
MS-80SH Overview

With an on/off, user-controlled, integrated high-efficiency dome heating system, the MS-80SH is the new standout choice for value, accuracy, speed, reliability and IEC 61724-1:2021 Class A monitoring.

Featuring EKO's state-of-the-art thermopile detector and quartz diffusor technology, S-Series internal diagnostics, superior low zero-offset behaviour, surge protection and digital Modbus 485 RTU and SDI-12 interfaces; the MS-80SH is ideal for any application.

These features, along with EKO's unique 5-year recalibration interval and new high-efficiency, low power consumption, integrated solid-state dome heating, make the MS-80SH one of the best value Class A sensors available; great for complex networks, hard-to-reach locations, monitoring networks with restricted access or areas prone to dew, frost and variable weather conditions.

Dome Heating Control



hibi

With ‘Hibi’, a custom, free-to-download, programme developed by EKO, users can connect their pyranometers with a standard laptop for real-time access to the internal diagnostics, heating system control, custom settings, and irradiance data.

Hibi helps to make the MS-80SH our most accessible Class A sensor available. Easy to use, deploy, and maintain.

Most pyranometers with in-built heating systems keep the heating system on at all times, whatever the conditions, whether it is needed or not.

Not the MS-80SH. The simple ON/OFF toggle in the Hibi app, gives users complete control over the dome heating function. The heating system can also be controlled via Modbus command.

Ensure accuracy with the heating system on, or save power when it isn’t needed.

PATENT PENDING

MS-80SH Specifications

ISO 9060:2018 Parameters	Class A	MS-80SH
Response Time	< 10 s	< 0.5 s
Zero Offset a	±7 W/m²	±1 W/m²
Zero Offset b	±2 W/m²	±1 W/m²
Non-Stability	±0.8 %	±0.5 % (5-Years)
Non-Linearity	±0.5 %	±0.2 %
Directional Response	±10 W/m²	±10 W/m²
Spectral Error	±0.5 %	±0.2 %
Temperature Response	±1 %	±0.5 %
Tilt Response	±0.5 %	±0.2 %
Additional Signal Processing Errors	±2 W/m²	±1 W/m²
ISO 9060:2018 Sub-Categories		
Fast Response (< 0.5 s)		☑
Spectrally Flat		☑
MS-80SH Technical Features		
Power Consumption (Heater On)		MAX 1.4W
Output		Modbus, SDI-12
Spectral Range		285 to 3000 nm
Operating Temperature Range		-40 to 80°C

Validating Performance

MS-80SH w. Integrated dome heating

MS-80S

MS-80S w. MV-01

Experiment location:
EKO Ami Solar Park,
Ibaraki Prefecture, Japan

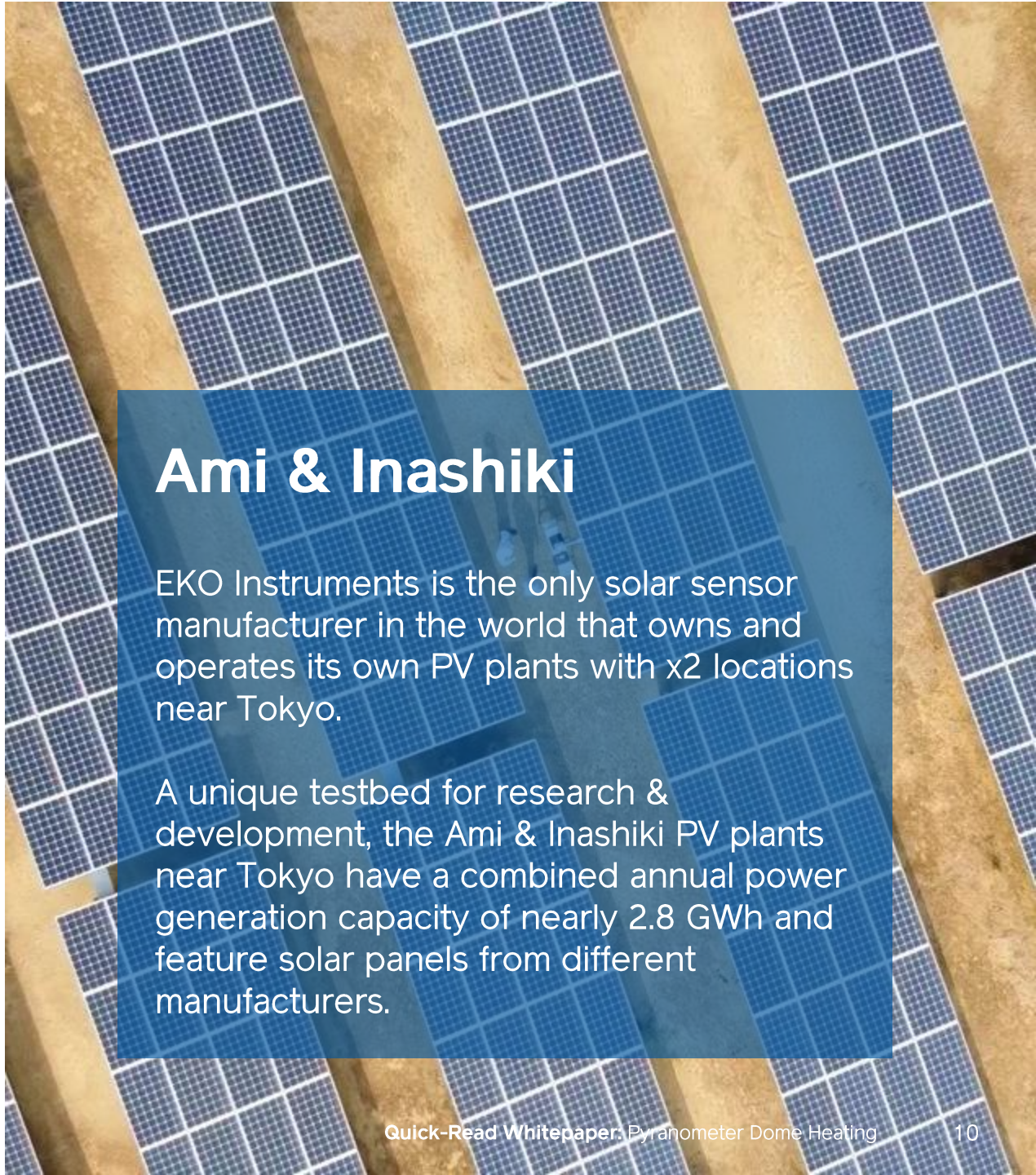
Validating Performance

We validated the active dew & frost resistance of the MS-80SH by comparing it against the MS-80S with an external MV-01 Ventilator & Heater and a standard MS-80S with no dome heating.

Over the course of several months, as we trialled various configurations head-to-head, and in different conditions at our Ami Solar Park near Tokyo.

On site and remote tests proved that that the MS-80SH consistently achieved similar levels of dew & frost mitigation as the MS-80S with an external MV-01 Ventilation & Heating unit, with significantly lower-power usage.

The reliability of the MS-80SH combined with its efficient, low-power consumption of <1.4W versus other pyranometers, make it a stand out choice for applications that require IEC 61724-1:2021 Class A monitoring.

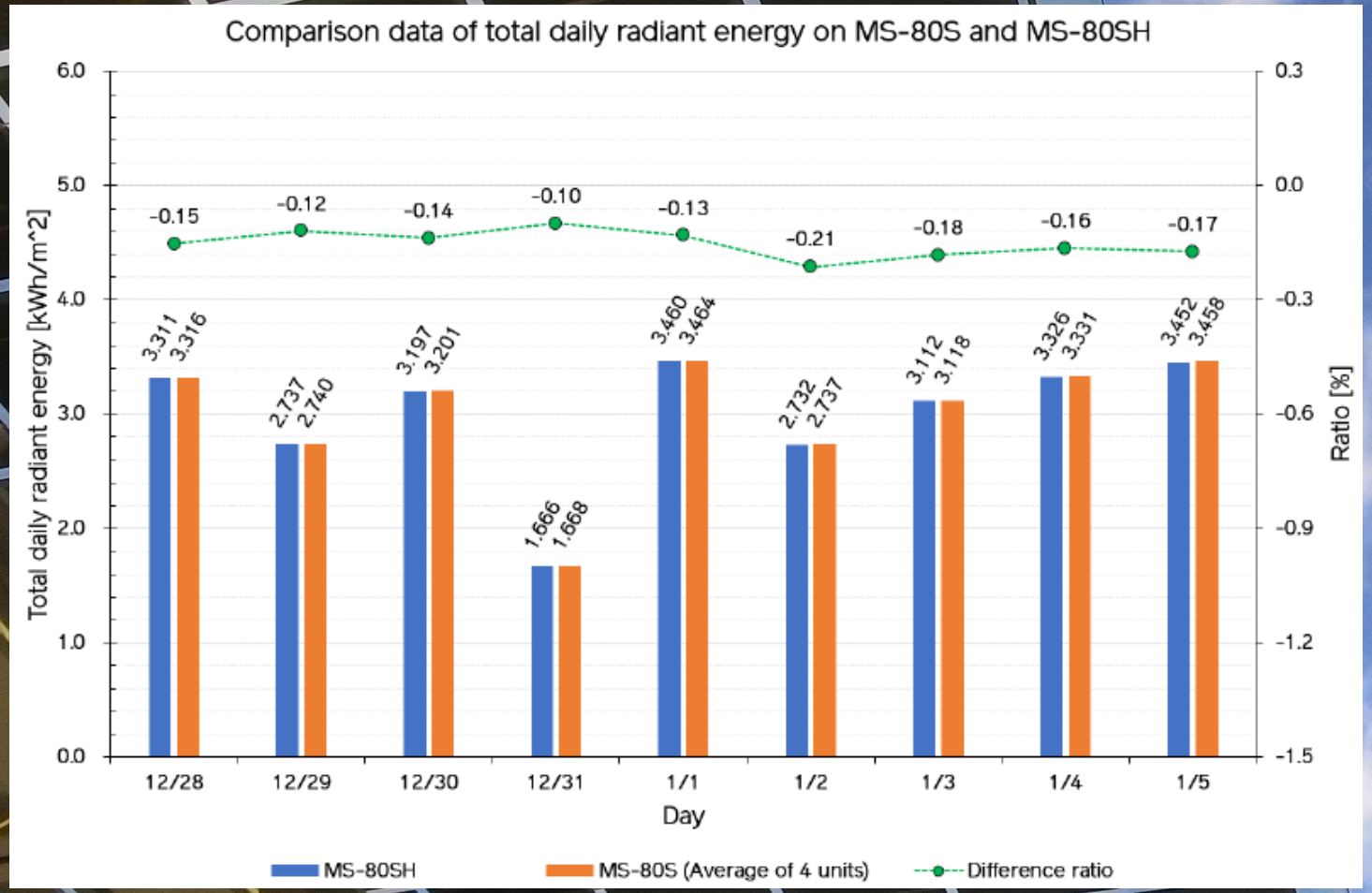


Ami & Inashiki

EKO Instruments is the only solar sensor manufacturer in the world that owns and operates its own PV plants with x2 locations near Tokyo.

A unique testbed for research & development, the Ami & Inashiki PV plants near Tokyo have a combined annual power generation capacity of nearly 2.8 GWh and feature solar panels from different manufacturers.

PATENT PENDING



Heating without compromise

Heating systems can affect the thermopile sensors used in Class A pyranometers, leading to offsets in measured values, and lower accuracy.

The MS-80SH was designed with this challenge in mind and built to suppress the occurrence of offsets.

Our studies found that the MS-80SH achieved similar levels of class-leading performance and solar radiation measurement accuracy as the MS-80S, even when the heater is on.

PATENT PENDING

Validating Vs Dew

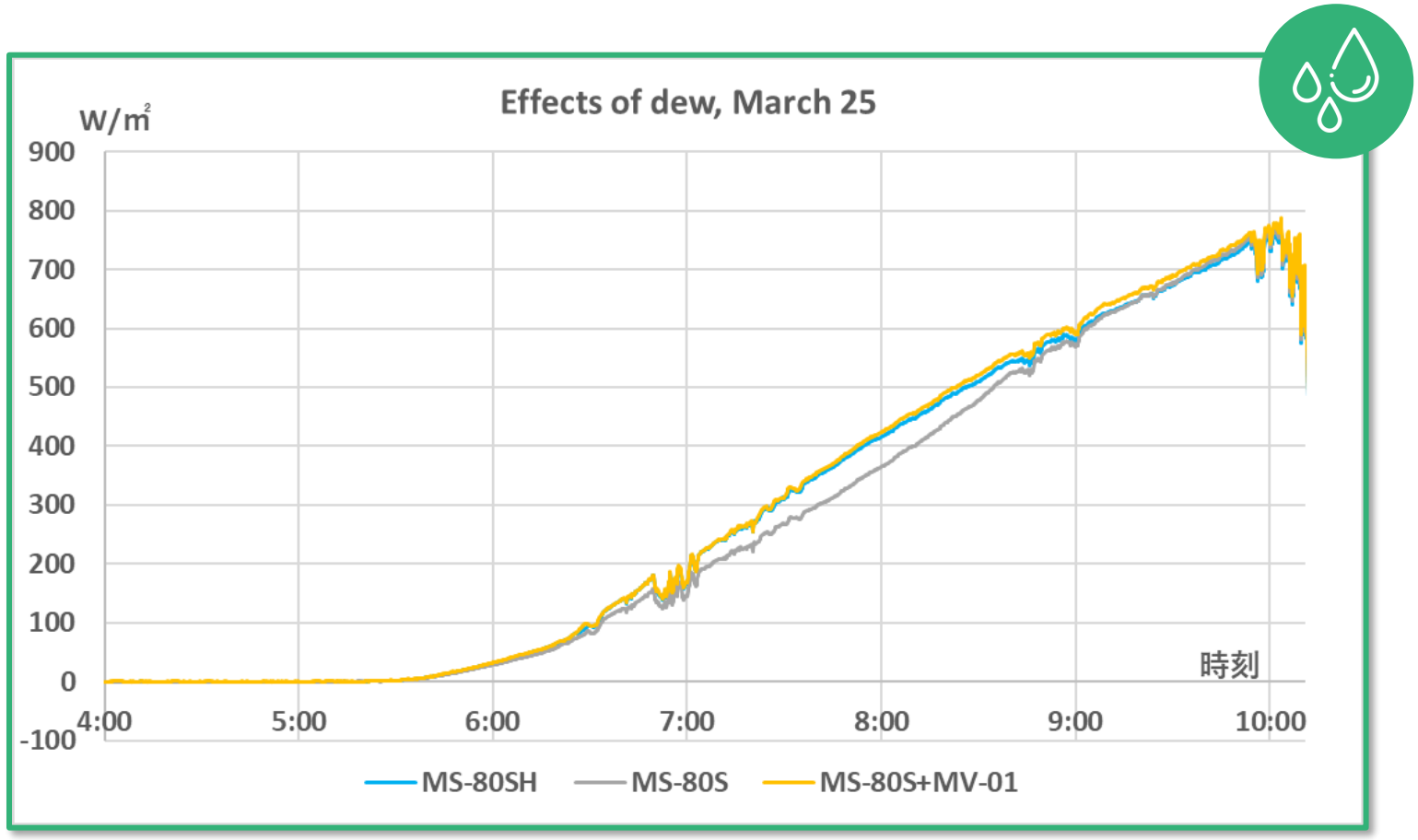


FIGURE 1:
Example of solar radiation measurement data when overnight dew occurs

In the example shown in FIG. 1, the MS-80S, with no dew or frost mitigation experienced an error due to the adhesion of dew to the dome overnight.

The maximum value of the observed error, over a 2-hour period in the morning was 14%.

The MS-80SH and MS-80S with MV-01 Ventilator & Heater meanwhile protected the sensor dome from the build-up of dew.

PATENT PENDING

Validating Vs Frost

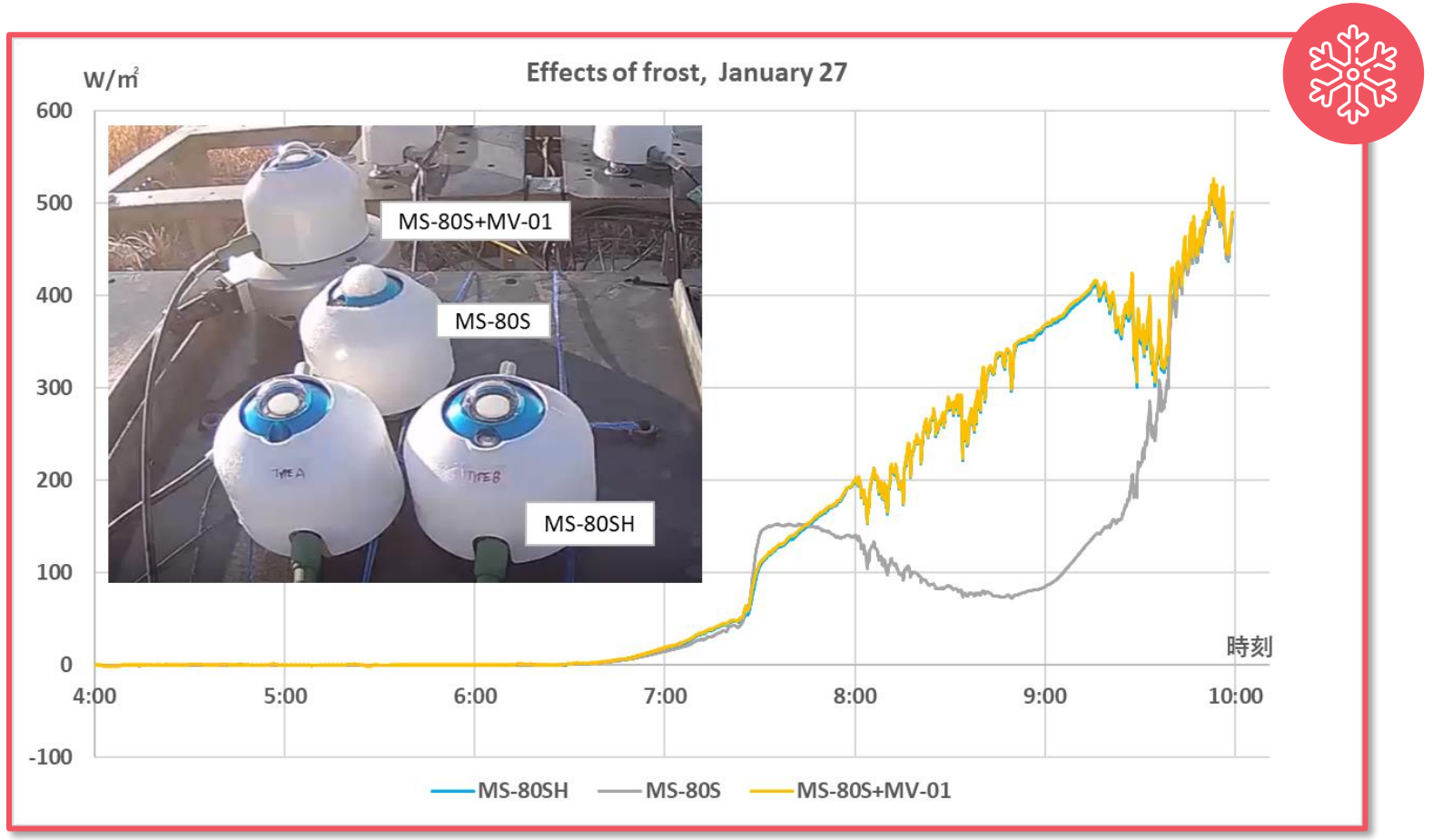


FIGURE 2:
Example of solar radiation measurement data when frost occurs

Similarly, in FIG. 2, frost adhesion to the dome of the MS-80S overnight led to a large error lasting over 1 hour in the morning.

The maximum value of the observed error was 78%.

Again, the MS-80SH and MS-80S with MV-01 protected the sensor dome from frost adhesion overnight.

PATENT PENDING

Validating in Albedo

EKO MS and S-Series Pyranometers, including the MS-80SH, can be set up in pairs using the MS-Albedo kit to measure direct solar irradiance from above and reflected or albedo irradiance from below. We tested the MS-80SH against the MS-80S in this albedo configuration.

In this case, though there was no seasonal frost during our test window, we could establish that the amount of dew forming on the downward facing MS-80SH was significantly less than the MS-80S and dissipated rapidly.

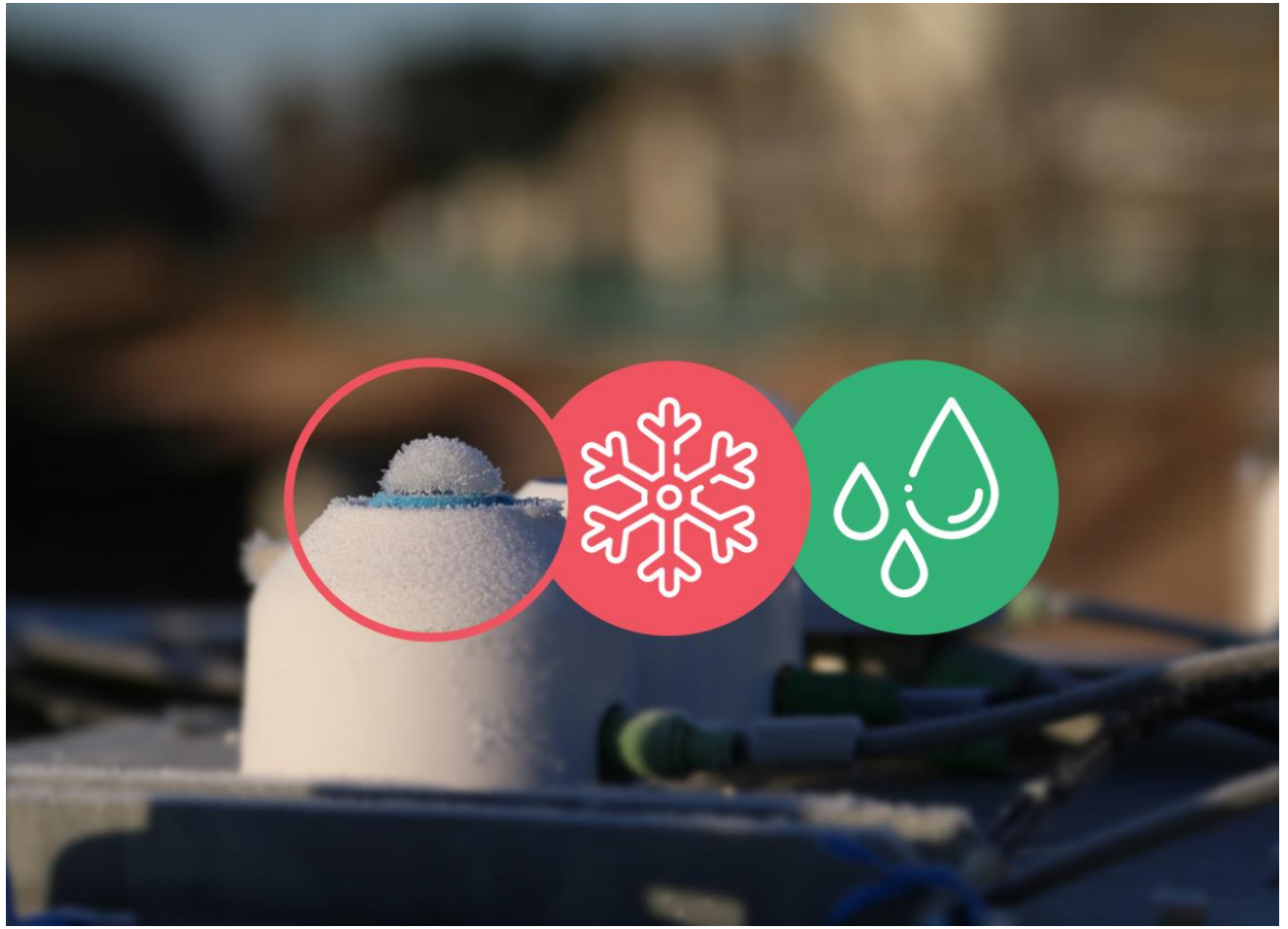
Date	Sunrise	Condition	Wind Direction, Wind Speed (m/s)		Lowest Temp (°C)	Dew	Frost	Top-side Albedo	Bottom-side Albedo	Top-side Albedo	Bottom-side Albedo
			Avg	Wind Direction				MS-80SH	MS-80SH	MS-80S	MS-80S
2022/05/19	4:29	Foggy	0	N/A	12.5	○	×	OK	OK	NG	NG
2022/05/20	4:28	Cloudy	1	N-NE	14.5	○	×	OK	OK	NG	OK
2022/05/21	4:28	Cloudy	1.4	SE	15.7	×	×				
2022/05/22	4:27	Rainy	1.9	N-NE	14.6	×	×	OK	OK	NG	OK
2022/05/23	4:26	Rainy	1.9	NE	14	×	×				
2022/05/24	4:26	Cloudy	0.6	NW	13.5	○	×	OK	OK	NG	OK
2022/05/25	4:25	Sunny	1	S	16.5	○	×	OK	OK	NG	OK
2022/05/26	4:25	Sunny	1	SW	16.5	○	×	OK	OK	NG	NG
2022/05/27	4:24	Rainy	3.3	S-SW	17	×	×				
2022/05/28	4:24	Foggy (After rain)	1.1	W-SW	15.7	○	×	OK	OK	NG	NG
2022/05/29	4:29	Cloudy	1.3	S-SW	15.8	○	×	OK	OK	NG	OK
2022/05/30	4:29	Cloudy	1.3	NE	16.1	○	×	OK	OK	NG	NG
2022/05/31	4:29	Rainy	4.2	N-NE	14.7	×	×				
2022/06/1	4:29	Foggy	0.6	N	16.9	○	×	OK	OK	NG	OK
2022/06/2	4:29	Sunny	1.6	N-NE	15.8	○	×	OK	OK	NG	NG
2022/06/3	4:29	Cloudy	2.5	N-NE	15.3	○	×	OK	OK	NG	OK
2022/06/4	4:29	Sunny	0.9	N-NE	14.2	○	×	OK	OK	NG	NG

Low Power, High Performance

EKO's elite series of Class A pyranometers have, since the launch of the original MS-80 in 2016, all featured a single, compact dome. This key feature is one reason why the MS-80SH needs much less power than other pyranometers with dome heating systems.

Frost and dew form when the temperature of the dome drops below the ambient air temperature. Heating the dome can help to prevent this. However, as the size of the glass dome increases, its surface area also increases, requiring more power to mitigate falling ambient temperatures.

A smaller dome means lower thermal resistance, more effortless heat transfer, and less power.

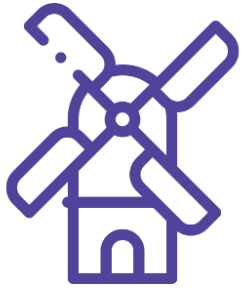


Find out more

Visit eko-instruments.com to find your nearest EKO office and supplier.

EKO Instruments Co., Ltd.
1-21-8 Hatagaya, Shibuya-ku
151-0072
Tokyo, Japan
P: +81-3-3469-6713
https://eko.co.jp

EKO Instruments USA Inc.
111 North Market Str. Suite 300
CA 95113
San José, United States
P: +1 408 977 7751



EKO Instruments Europe B.V.
Lulofsstraat 55, Unit 28
2521 AL
Den Haag, Netherlands
P: +31 (0)703050117

EKO Instruments Sales China
Hong Kong

EKO Instruments Sales India
Mumbai

EKO

Over 90 years of Japanese design, reliability & precision in solar energy sensors, environmental science, and material analysis. EKO Instruments are today deployed around the world, supporting environmental research and renewable energy projects through continuous innovation, industry leading turn-key solutions, and an uncompromising commitment to quality.

Find out more at **eko-instruments.com**