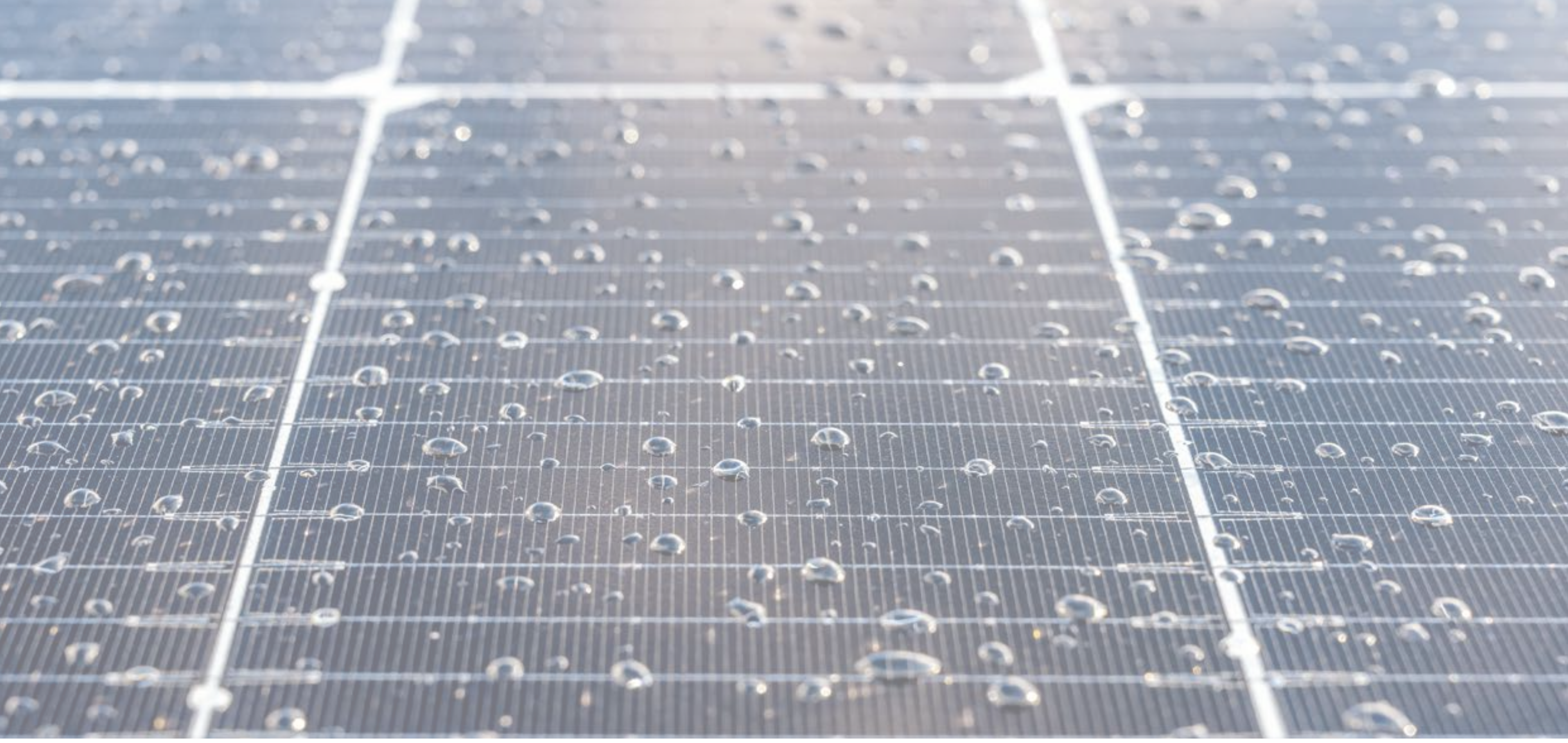
Environmental monitoring solutions for PV Systems

MAXIMIZE THE PERFORMANCE OF YOUR PV SYSTEM WITH INTELLIGENT MONITORING

senseca



Why measuring solar efficency

Did you know that weather conditions have a considerable influence on photovoltaic generation?
Even a simple cloudy day can drastically affect incident solar energy.
Besides solar irradiance, also temperature, humidity, atmospheric pressure, precipitation, and wind speed and direction can affect solar cell efficiency. For this reason, monitoring weather parameters through a weather station is essential to accurately assess the PR of PV systems.

Maximize Financial Return

A monitored photovoltaic system not only produces more energy but can also generate significant savings on operational and maintenance costs. This translates into better overall financial returns for investors and system owners.

Remote Monitoring

The ability to monitor photovoltaic systems remotely allows for constant control and efficient management, even for systems located in remote or inaccessible areas. This feature is particularly important for optimizing the management of large portfolios of systems distributed over vast territories.

Maintenance Optimization

Thanks to monitoring, it's possible to proactively plan maintenance interventions based on collected data on system efficiency and performance. This reduces downtime and the costs associated with reactive maintenance.

Different components of radiation

DHI

DHI - Diffused Irradiance measured through pyranometer with a shadow ring (LPS13).

GTI or POA and GHI

Global tilted irradiance GTI or POA: total irradiance incident on the tilted plane, i.e. a PV panel. GTI irradiance can be measured by a pyranometer installed at the same angle as the PV panels.
Global horizontal irradiance GHI: total of direct and diffuse solar radiation falling onto a horizontal surface.
GTI and GHI are measured through pyranometers. (LPS10)

DNI

DNI - Direct Irradiance
Solar radiation falling directly onto a surface normal to the direction of the sun, with the diffuse radiation excluded.
Direct irradiance DNI: Pyrheliometer mounted on a solar tracker (LPPYHRE16).

IEC 61724-1

How to apply the standard in your photovoltaic system

IEC 61724-1 is an international standard that specifies the terminology, quantities, symbols, and basic concepts for photovoltaic (PV) system performance monitoring and analysis. It provides guidelines for the monitoring of parameters relevant to the performance of PV systems, including meteorological and system parameters. This standard helps in assessing the performance of PV systems, ensuring their reliability, and facilitating comparisons between different systems.

Application scale	Method
Residential systems	Measuring the generated power of solar panels in W and kWh
Rooftop or small to medium-sized commercial systems (IEC 61724-1, Class B)	POA irradiance measurement in W/m^2 from a pyranometer
Utility-scale and large commercial systems (IEC61724-1, Class A)	POA and GHI irradiance measurements in W/m^2 from two pyranometers

System size	Multiplier
<40	2
≥ 40 to < 100	3
≥ 100 to < 300	4
≥ 300 to < 500	5
≥ 500 to < 700	6
≥ 700	7, plus 1 for each additional 200 MW

The standard delineates two classifications of monitoring systems, namely Class A and Class B.

- **Class A** is designed for extensive PV systems, such as utility-scale or large commercial installations.
- **Class B** is tailored for smaller-scale systems, such as rooftop or small to medium-sized commercial installations.

Regardless of the size of the PV system, users of this document can select the classification that best suits their specific application.

Parameter	Monitoring purpose	Class A system*	Minimum N° of sensors
In-plane irradiance (POA)	Solar resource	√	1 * multiplier
Global horizontal irradiance	Solar resource, connection to historical and satellite data	√	1 * multiplier
PV module temperature	Determining temperature-related losses	√	3 * multiplier
Ambient air temperature	Estimation of PV temperature, connection to prediction models	√	1 * multiplier
Wind speed		√	1 * multiplier
Wind direction		√	1 * multiplier
Rainfall	Estimation of soiling losses	√	1 * multiplier
Soiling ratio	Estimation of soiling-related losses	√ if typical annual soiling losses without cleaning expected to be > 2 %	1 * multiplier
Snow	Estimation of snow-related losses	√ if typical annual snow losses without cleaning expected to be > 2 % and soiling measurement does not measure snow loss	1 * multiplier

Further requirements for solar radiation measurement in the IEC 61724-1 monitoring

Cleaning	Alignement	Recalibration
1 x / week (unless it can be proven that this is not needed)	tilt ± 1° azimuth ± 2°	1 x / 2 yr

*This extract from the IEC 61724-1 considers, as an example, the measurements required for a Class A PV systems with monofacial solar panels. Further optional monitoring parameters might be required for other type of systems such as Class B systems, CPV or bifacial. E.g. for bifacial PV, parameters such as horizontal albedo, in-plane rear side irradiance, diffuse radiation are also required. We always suggest referring to the standard to check what parameters are required for your system.

Class A PV Systems

Meteorological conditions play a major influence on PV generation. There is no doubt that the solar radiation data are by far the most important ones. However, even a simple cloudy day can affect incident solar energy drastically as well as temperature, humidity, atmospheric pressure, precipitation or wind speed and direction may affect the efficiency of solar cells.

PYRANOMETER (for POA and GHI)
PYRAsense

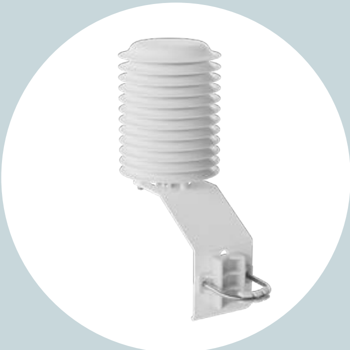
A complete series of Spectrally Flat Class A, Class B and Class C pyranometers all compliant to ISO 9060:2018 and WMO recommendations.
All available with a wide variety of standard outputs for easy integration in any installation.
Digital models with internal diagnostic sensors to keep operating conditions always under control. Built-in days-of-operation counter.

VENTILATION AND HEATING UNIT
VUP12

To increase the accuracy of solar radiation measurements maintaining the operating temperature of the sensor uniform. The ventilation functionality minimizes the well-known "Type A" offset ; the heating function allows avoiding snow and ice accumulation on the sensor's dome.

2-AXIS ANEMOMETER
HD52.3D...

Measure key meteorological parameters with ease: wind speed and direction, U-V Cartesian components of wind speed and wind gust.
Optional features like global solar radiation, temperature, relative humidity, barometric pressure, take your measurements to the next level, ensuring you have all the data you need at your disposal.



TEMPERATURE & RELATIVE HUMIDITY TRANSMITTERS
ETS80... / HD9007A...

Environmental temperature, relative humidity and, optionally, barometric pressure transmitter series with standard RS485 Modbus-RTU output.
All available with UV-resistant shield to protect the sensors from solar radiations, rain and wind.

TEMPERATURE TRANSMITTERS
HD48...TFP

A series of transmitters complete with Pt100 contact temperature probe to keep the panels temperature under control.
Versions available with active 4...20 mA or 0...10 V analogue output, with only RS485 MODBUS-RTU output, or with passive (2-wire) 4..20 mA output.

RAIN GAUGES
HD2015... / HD2013...

Tipping bucket rain gauges with 400 cm^2 and 200 cm^2 collecting area.
Crafted with unbeatable durability, our rain gauges are meticulously constructed from corrosion-resistant materials, ensuring they withstand the test of time.
For extreme conditions, the option of integrated heating provides reliable performance even in freezing temperatures.

RAIN DETECTOR
HD2013.3

Simple and effective way to detect precipitations.
Quick and simple to integrate in any outdoor installation or configuration thanks to the enhanced connection possibilities: we supply this version in Modbus-RTU or 4-20 mA or 0-10 V or contact output.

DATA LOGGER
HD33LMT.4

Data logger for weather station. Possibility of connecting many sensor types thanks to the 4 analog inputs, the 2 contact inputs and the RS485 MODBSU-RTU and SDI-12 digital inputs.
4G/3G/GPRS/ETHERNET module for remote monitoring.
Sending of data via e-mail, FTP and to an HTTP server.

ALL-IN-ONE METEO COMPACT STATION
HDMCS-100 / HDMCS-200

An indipendent and self-supporting solution with solar panel and back up battery, easy to install and ready to use.
Measuring at the same time:
Wind speed - Wind direction - Temperature - Relative Humidity - Barometric Pressure - Rainfall or Solar Radiation

Environmental parameters to monitor on PV

Measuring the amount of **solar radiation** reaching the PV panels is crucial to assess the available sunlight and determine the energy potential of the PV plant.
This is usually expressed in terms of a performance ratio (PR): the actual yield of the plant (how much energy it produces in a given time period) expressed as a percentage of its theoretical yield (how much energy it could produce in that time period assuming the panels convert the incident light into energy at their nominal efficiency).
The performance ratio is a key indicator for PV system owners, but it is not the only parameter of interest.

Photovoltaic efficiency is highly dependent on **temperature**. As a general rule, for every degree centigrade increase in temperature above 25 °C, the efficiency of a typical PV module decreases by about 0.5 percent. By measuring the **temperature of the ambient air and of the modules** themselves, a temperature-adjusted efficiency ratio can be calculated, giving PV system operators a more accurate overview of system performance.

Wind can also affect the temperature of PV modules dramatically. Because the surface temperatures of PV modules are warmer than those of the ambient air, wind cools them, increasing their efficiency and yield in warmer environments. Wind also has a significant effect on dirt, so knowing wind conditions can play an important role in soil monitoring.
Because high wind speeds can damage PV systems, monitoring wind speed and direction is often important in determining the safe location of the equipment.

Different types of rainfall can have a variety of effects, both positive and negative, on PV systems. For example, while heavy rains can drastically reduce soiling by washing away dirt, light rains can actually increase panel soiling. Hailstorms, on the other hand, can cause severe damage to panels and equipment.

Air pressure and humidity influence the formation of snow, frost, and condensation on the panels, which, in addition to decreasing energy yield, can have an effect on dirt.
Air humidity, in particular, can also produce spectral changes that affect PV module productivity.

Dew and frost mitigation - For Class A systems, the effects of dew and frost accumulation on irradiance sensors shall be mitigated for locations where dew or frost is expected during more than 2 % of annual GHI hours. Determination of whether an installation site requires mitigation may be performed by examining typical meteorological year data for the site, paying attention to ambient temperature and dew point. For the purposes of this assessment, dew or frost is considered expected when ambient temperature is within 1.5 °C of dew point.

Our Service

SENSORS CALIBRATION

To ensure continuous monitoring without interruptions, sensor recalibration must be performed with minimal downtime and sensor interruptions. This can be achieved by various methods, one of which is the replacement of installed sensors with new or recalibrated units.
For Class A systems, recalibration of sensors should take place at least once every two years, or more frequently as recommended by the manufacturer.
For Class B systems, follow the manufacturer's recommended recalibration schedule.
Our **ISO 17025 accreditated Photo-radiometry laboratory** is part of our facilities and guarantees an uncertainty of 1.7 % on the calibration of pyranometers. Fully compliant with the requirements of the IEC standard!

Senseca ISO 17025 Calibration Center is accredited for:

- Photo-radiometry
- Temperature
- Humidity
- Pressure
- Air speed
- Acoustic

- The first in Italy to be accredited for photo-radiometric quantities and still the only one for some of them
- First laboratory in the world to be accredited according to ISO 17025 standard for the calibration of pyranometers
- Extended solar irradiance sensitivity uncertainty 1.7%

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