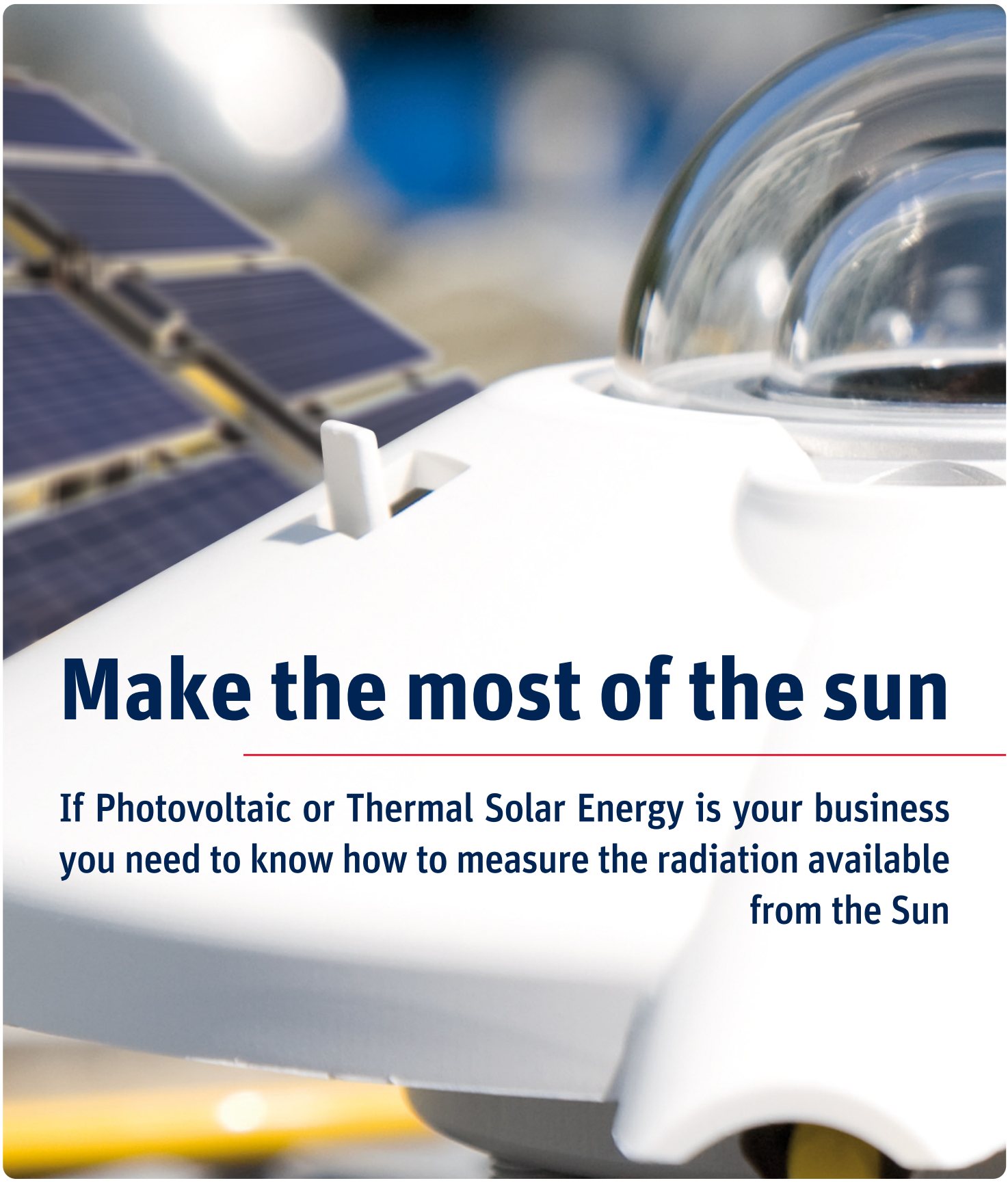
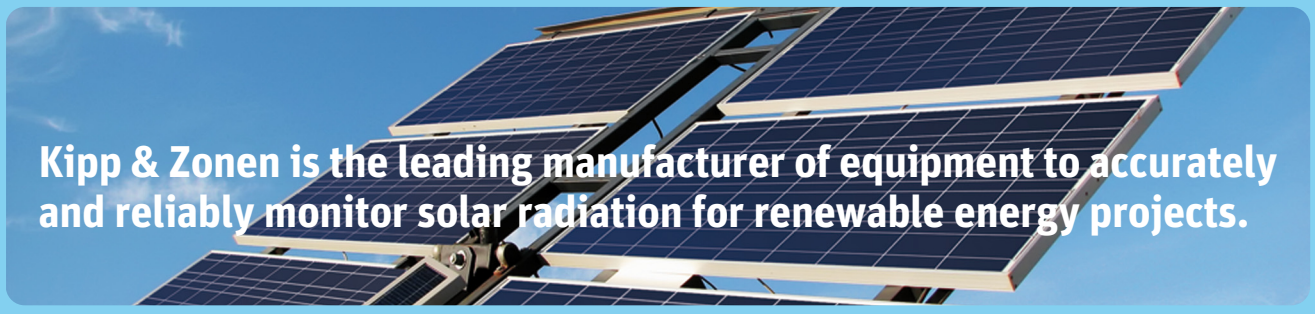


Make the most of the sun

If Photovoltaic or Thermal Solar Energy is your business you need to know how to measure the radiation available from the Sun

Improve Technology
Find optimal locations
Help investment decisions
Select the appropriate system type
Maximise operating efficiency
Schedule maintenance
Monitor performance

KIPP & ZONEN
SINCE 1830



Kipp & Zonen is the leading manufacturer of equipment to accurately and reliably monitor solar radiation for renewable energy projects.

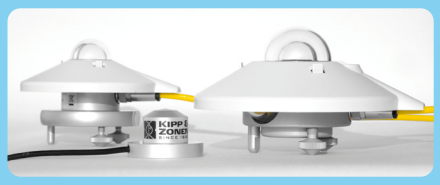
What is solar radiation?

Solar radiation reaches the outside of our atmosphere with an irradiance of about 1400 Watts per square metre (W/m²). It is partially reflected, scattered and absorbed in the atmosphere by its constituent gasses, water vapour and clouds. Some of the absorbed energy is re-radiated in the far infrared.

Radiation reaching the Earth's surface from the sun and sky is split into short-wave radiation, at a number of bands in the wavelength range from 300 to 4000 nm (4 µm), and long-wave radiation from 4.5 to more than 40 µm (far infrared). The amount of radiation reaching the ground is mainly influenced by clouds, particles, pollution and aircraft contrails in the atmosphere.

Why should I measure it?

Good quality, reliable solar radiation data is becoming increasingly important in the field of renewable energy with regard to both photovoltaic (PV) and thermal systems. It is a key input to decision making on activities such as research and development, production quality control, determination of optimum locations, monitoring the efficiency of installed systems and predicting the system output under various sky conditions. Errors of a few percent can significantly impact upon the return on investment.

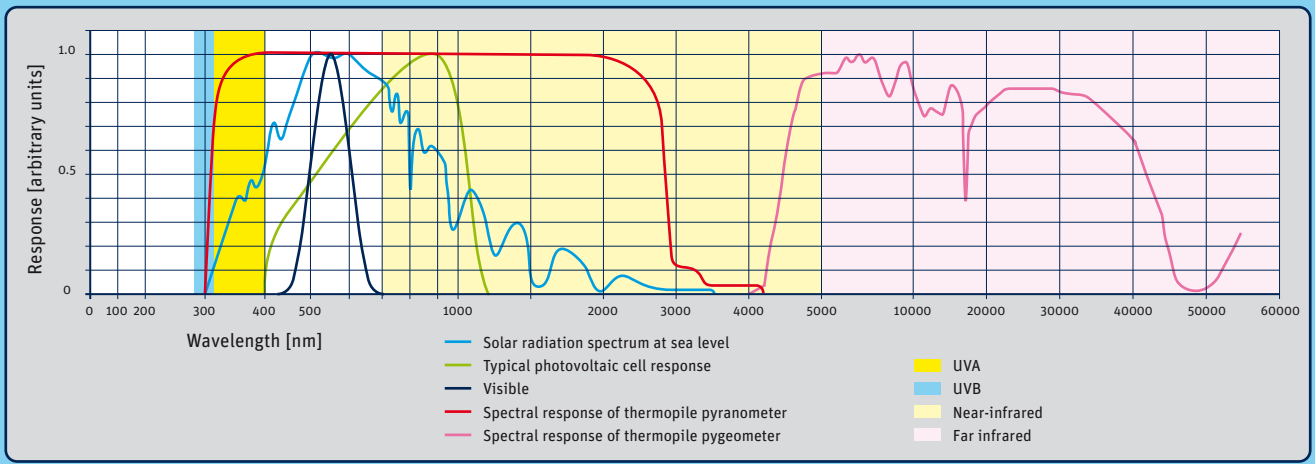


What do I measure it with?

Photovoltaic materials have most of their sensitivity in the visible and near-infared parts of the spectrum, from approximately 400 to 1100 nm, with a peak just beyond the visible range. There is little response to ultraviolet, and none to long-wave radiation. Commercial-scale thermal energy systems typically use reflective solar collectors that focus both short-wave and long-wave energy onto the medium that is to be heated for the energy transfer process.

Measurements of solar radiation are usually made using thermopile type radiometers with a flat spectral response. The types of instruments, performance specifications, and calibration methods are defined by the World Meteorological Organisation (WMO) and International Standards Organisation (ISO). They provide accurate measurements of the total solar energy available under all sky conditions. The data can be compared with measurements from meteorological networks and satellites, across various locations, and for different types of solar energy systems.

The 'global' short-wave radiation is measured by a horizontally mounted Kipp & Zonen CMP Pyranometer and the long-wave radiation by a Kipp & Zonen CGR Pyrgeometer.



Solar spectrum at sea level, photovoltaic response, visible, pyranometer response, pyrgeometer response, UVA, UVB, near-infrared and far infrared

What instruments do I need for my installed system?

PV panels have a wide field of view and are positioned to receive the maximum amount of solar radiation. Therefore, in addition to the horizontally mounted pyranometer it is recommended to have another fixed to the panel or array to measure the energy available from the hemisphere that the panel can see. This allows the system efficiency to be monitored and maintenance, such as cleaning, to be scheduled.

Where relative measurements of trends are sufficient, a lower specification and lower cost sensor can be used. Our SP Lite2 Silicon Pyranometer uses a photo-diode detector with a spectral response similar to most types of solar cells and is widely used for field testing and monitoring applications.

To focus the sun's radiation onto a target some PV systems use solar concentrators with lenses. And thermal solar energy systems usually have some form of reflector. Both have a relatively small angle of view and it is important to know the amount of radiation available directly from the sun. This 'direct' short-wave radiation is measured by the CHP 1 Pyrheliometer, that has a 5 ° view and is mounted on our SOLYS 2 Automatic Sun Tracker.

What do I need for research or solar prospecting?

As previously described, measurements using WMO / ISO type pyranometers and pyrgeometers can be compared directly across sites anywhere in the world, with data from meteorological networks, with satellite information, and with solar radiation prediction algorithms. They are independent and can be used for any type of solar energy system. Therefore it is the ideal solution for solar energy research and site prospecting.

The next step is the extension to a complete Solar Monitoring Station. It comprises a sun tracker fitted with a pyranometer for global radiation, a pyrheliometer for direct radiation, and a pyranometer shaded from the direct sun to measure the 'diffuse' sky radiation. There may also be a tilted pyranometer measuring the total radiation available to a PV system that has 2-axis tracking arrays. For thermal energy systems a pyrgeometer is added. Normally, the outputs from all the radiometers are connected to a dedicated data logger and stored for retrieval by remote access.

At www.kippzonen.com you can find the different configurations and possibilities for your solar energy system.

Why Kipp & Zonen?

Kipp & Zonen has been designing and manufacturing solar radiation measurement equipment for over 75 years and supplies leading meteorology and climatology organisations, research institutes and energy companies around the globe. Our radiometers can help you to optimize the performance of your system. We have a world-wide reputation for quality, reliability, expertise and support.

In addition to our radiometers and sun trackers, we have a wide range of accessories, data loggers and interfacing solutions. All our products have a 2-year warranty.

1. Project PEGASE of CNRS-PROMES in the Pyrenees of France. 2. Solar thermal collector testing site of the University of Jyväskylä Renewable Energy Research and Education Program. Photo by Jussi Maunuksela (2009). 3. and 4. Solar farms in Palma de Mallorca. Owner: AFFIRMA. Engineered and installed by ELECNOR

Passion for Precision

Kipp & Zonen is the leading company in measuring solar radiation and atmospheric properties. Our passion for precision has led to the development of a large range of high quality instruments: from all weather radiometers to complete measurement systems.

We promise our customers guaranteed performance and quality in various markets: Meteorology, Climatology, Hydrology, Industry, Renewable Energy, Agriculture and Public Health. We hope you will join our passion for precision.

System configurations

Basic Solar Monitoring
For fixed (tilted) panels
1 horizontal pyranometer for global radiation
1 tilted pyranometer for tilted global radiation

Recommended instruments
SP Lite2 / CMP 3 / CMP 6

Advanced Solar Monitoring
For concentrating and / or tracking systems
1 horizontal pyranometer for global radiation
1 pyrheliometer with sun tracker for direct radiation
1 tilted pyranometer fitted to sun tracker

Recommended instruments
CMP 11, CHP 1, SOLYS 2

Complete Solar Monitoring System
Includes global, direct, diffuse and global tilted measurement
1 horizontal pyranometer for global radiation
1 pyrheliometer with sun tracker for direct radiation
1 tilted pyranometer fitted to sun tracker
1 shaded pyranometer for diffuse radiation (shading assembly on sun tracker)

Recommended instruments
CMP 11 / CMP 21, CHP 1, SOLYS 2

Relevant IEC standards for PV panel testing

IEC 60904 (part1/10) Photovoltaic devices, measurements and requirements

IEC 61215 Design qualification and type approval, crystalline silicon

IEC 61646 Design qualification and type approval, thin film

IEC 61853 Module performance testing

Relevant ISO standards for pyranometers

ISO 9060 Specifications and classifications of instruments

ISO 9847 Calibration of field pyranometers

Traceability

All Kipp & Zonen solar radiation instruments are fully traceable to the World Radiometric Reference (WRR) in Davos, Switzerland, where Kipp & Zonen instruments form part of the World Standard Groups

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