Newsletter 41

RT1: affordably measure solar irradiation and panel temperature for rooftop PV installations

A new way to measure the soiling ratio of PV panels: DustIQ

Measurement of UV radiation added to Antarctic site of the LES solar measurement network

Kipp & Zonen radiometers help Swedish researchers to understand global warming

KIPP & ZONEN
SINCE 1830

Content

July 2017

Contact

If you have a news item for the newsletter or want to share your experiences with Kipp & Zonen applications and contribute to our next issues, please e-mail the editor: kelly.dalu@kippzonen.com

Breakthrough technology launched at Intersolar

In a rapidly growing market, less obvious improvements may lag behind. When suppliers focus on demand fulfilment and matching commodity prices, innovation generally takes place inside the industry's black box. Now, Kipp & Zonen breaks through this black box from the outside, with a fundamental new technology.

DustIQ for PV Soiling Monitoring

A very visible improvement that enables optimisation of the yield of every PV plant is our unique new DustIQ, based on Kipp & Zonen's very smart Optical Soiling Measurement (OSM) technology.

Investors, EPC's and SCADA suppliers participated in the final design stage of the development of the product, turning the new DustIQ into a breakthrough to solve the problems in monitoring PV panel soiling. A product that combines seamlessly with other smart Kipp & Zonen solar irradiation instruments, through robust design and Modbus® digital communication.

Commercial rooftop sites and PV power plants will benefit from the moment of installation, based on real-time insights into light transmission loss caused by soiling. The worlds' most renowned solar plant monitoring software suppliers have integrated the data registers, so O&M companies and stakeholders will not be limited in their access to this breakthrough innovation.

To stay informed, subscribe to the DustIQ News Feed at **www.kippzonen.com/DustIQ**.

Global challenges, Dutch solutions!

Erik Valks
CEO Kipp & Zonen

RT1: affordably measure solar irradiation and panel temperature for rooftop PV installations

By Donald van Velsen, Kipp & Zonen Product Manager - Solar energy PV installations on building roofs are really taking off in many parts of the world. On apartment buildings, car parks, sports facilities and smaller industrial sites. No land purchase or leasing is needed and the power is available on-site, where needed, for example powering air conditioners when the solar energy and heat input are greatest. If excess power is available it can be stored in batteries or (if feed-in tariffs are favourable) sold back to the grid operator.

The RT1 Smart Rooftop Monitoring System

Even though a commercial rooftop installation is much smaller than surface-based utility-scale solar energy parks, it is still vital to be able to check if your equipment is performing the way it should. How often do you go up on the roof for cleaning or repair?

Most maintenance decisions are based on the calculation of the actual power generated, for the incoming solar energy, compared to what it should theoretically generate. This is termed the Performance Ratio (PR) of the PV panels and is, in effect, the operating efficiency of the installation. For this calculation the incoming solar irradiation and the PV panel temperature are key parameters.

At Kipp & Zonen we listened to our distributors and customers and had a close look at the currently available instrumentation and decided to develop a new product that would be easy to install, easy to use, be resistant to soiling and still be affordable. Our answer to this problem is a brand-new smart rooftop monitoring system, the RT1.

Easy Mounting and Connection

RT1 has a robust housing that fits snugly to the corner of a PV panel and only takes one clamp screw to install; an adapter enables fitment to the side or top sections of a panel. A 20 m long cable connects power to the RT1 and provides data in the solar industry standard MODBUS® digital protocol via RS-485. MODBUS® is available on many inverters and SCADA systems and assists in making the collected data available in the cloud or on a dedicated server.

A PV panel temperature sensor is a standard part of the RT1 and plugs into the housing, so that it can be easily removed if needed, for example to recalibrate it.

Low Maintenance

The conical diffuser of the RT1 is similar to the well-proven design of the SP Lite2 with its self-cleaning and soiling-resistant properties, aided by wind and rain, that are superior to those of the conventional flat surfaces used in reference cells and other photodiode radiation sensors. RT1 has a 5-year warranty and does not need recalibrating for 5 years.

Keep up-to-date by registering at **www.kippzonen.com/RT1** to receive the latest information available ■

PV panel temperature sensor

A new way to measure the soiling ratio of PV panels: DustIQ

By Donald van Velsen, Kipp & Zonen Product Manager - Solar parks are financial investments, so they need to have the highest Return on Investment (ROI) possible and the most commonly used indicator for this around the World is the Performance Ratio (PR), which is usually expressed as a percentage.

$$\text{Performance Ratio} = \frac{\text{final yield}}{\text{reference yield}} \times 100\%$$

The final yield of AC power generated is easily measured with high accuracy at the grid connection. The reference yield is the theoretical power produced by irradiance on the PV panels; the solar energy received by the panels multiplied by the efficiency of the conversion to electrical energy. 100 % is rarely achievable (even when the plant is new) due to installation, operational and environmental variables; typical PR's are in the 75 % to 90 % range.

An important factor in the PR is the amount of electrical energy production lost because of deposits on the surface of the PV panels that reduce the transmission of light through to the solar cells. This can be due to dust, sand, pollen, soot, ash, sea salt or even bird droppings; generically called 'soiling'.

This effect is expressed as the Soiling Ratio (SR) and runs from 1 (completely clean) to 0 (completely obscured). However, (like PR) this is often given as a percentage of 'cleanliness' from 100 % all the way down to 0 %.

Until now, measuring the loss of light transmission due to soiling has relied on systems where a reference PV panel is kept clean whilst a similar panel is getting dirty. The cleaning regime may be manual or (more expensively) automatic, and rely on water, brushes, machinery, power and regular scheduling.

These systems are expensive and are often only installed at one location in a solar park, whereas the panel soiling varies across the site, due to varying wind directions and the shielding effect of leading panel rows on those further back.

Breakthrough Solution

That is why the Innovation & Technology department at Kipp & Zonen spent a lot of time and effort in researching alternative and novel solutions and came up with our unique Optical Soiling Measurement (OSM) technology. This uses an internal light source to measure the loss of transmission of a transparent material caused by soiling of its surface, it does not rely on sunlight and can operate day and night.

The first product featuring OSM was recently launched at Intersolar Munich, the DustIQ PV Soiling Monitor. DustIQ does not rely on a clean reference surface, it should be cleaned at the same time as the PV arrays that it is monitoring. This reduces the operating costs of the soiling measurement system substantially. DustIQ has two spatially separated sensors to cover a representative area.

Multiple Locations

Because of the compact size, simple installation and cost-effectiveness of DustIQ it is easy to integrate into PV arrays to form a network of monitors at multiple locations and heights, providing the O&M team with a 'soiling map' of the solar park. This allows panel cleaning schedules to be optimised across the site, reducing costs.

These features mean that it is also possible to attach DustIQ to tracking PV panels or CPV systems.

Optimize maintenance schedules, minimize yield losses, know exactly when and where to clean.

We hope you're as excited as we are about this revolutionary new way of monitoring the soiling ratio of PV panels and we recommend that you register at **www.kippzonen.com/dustiq** to receive the latest updates ■

Measurement of UV radiation added to Antarctic site of the LES solar measurement network

By Dr. Gonzalo Abal, Laboratorio de Energía Solar, Centro Universitario Regional Litoral Norte, Salto, Uruguay.

The Solar Energy Laboratory (LES) of Uruguay has recently conducted its first measurement campaign to assess UVA, UVB and UVE (Erythemal) radiation in the Antarctic Summer. The Base Científica Antártica Artigas (BCAA) of the Uruguayan Antarctic Institute is located at latitude 62°11'(S) and longitude 58°52'(W) at Collins Harbour on King George Island (the largest of the South Shetland Islands), about 100 km from the Antarctic peninsula.

UVS radiometers at Collins Harbour in the Antarctic summer of 2016-2017

These measurements are of particular interest, since the base is located within the southern 'Ozone hole' area of influence. The main instruments were a new Kipp & Zonen UVS-B-T radiometer calibrated at the factory in June 2016 and a UVS-AE-T last calibrated at the PMOD laboratory in Switzerland (World Radiation Center, Davos).

These instruments are thermally stable due to their internal heaters, which maintain the electronics and optics at +25 °C. Auxiliary instruments for global horizontal irradiance measurement and ambient temperature were calibrated at our laboratory. Both the UV instruments performed as expected and a preliminary analysis of the data shows rather higher UVB than expected as a fraction of broadband irradiance.

The Solar Energy Laboratory also operates an outdoor calibration facility, the only one available in Uruguay. More than 100 radiometers have been calibrated against our secondary standard Kipp & Zonen CMP22 pyranometer, following standard ISO 9847:1992 'Calibration of field pyranometers by comparison to a reference pyranometer'.

At LES we have also operated and maintained (with support from the local Ministry of Energy) a continuous solar radiation measurement network since 2010. This network currently has eight sites distributed over Uruguayan territory. All the sites have a Kipp & Zonen secondary standard pyranometer (CM11 or CMP10) as the main GHI measurement. A redundant GHI measurement using photodiode radiometers and an ambient

temperature measurement based on a calibrated Pt1000 RTD is also included.

At some sites, diffuse radiation or tilted radiation is also measured. This quality-controlled data has contributed to the development of several large photovoltaic projects in the country. Currently (as of 2016) Uruguay generates 98.6 % of its electricity from renewable sources (solar, wind, biomass and hydropower) and is exporting its surplus electrical energy to its largest neighbours, Argentina and Brazil. To contextualize, the worldwide average for the renewable share of electrical generation is close to 20 %.

LES also maintains a solar radiation monitoring station for DNI, DHI and GHI comprising a SOLYS2 sun tracker with sun sensor and shading ball assembly, pyrheliometer and ventilated pyranometers. The unventilated CMP10 shown is fitted for comparison purposes. The details of the LES solar measurement network can be found at **www.les.edu.uy**

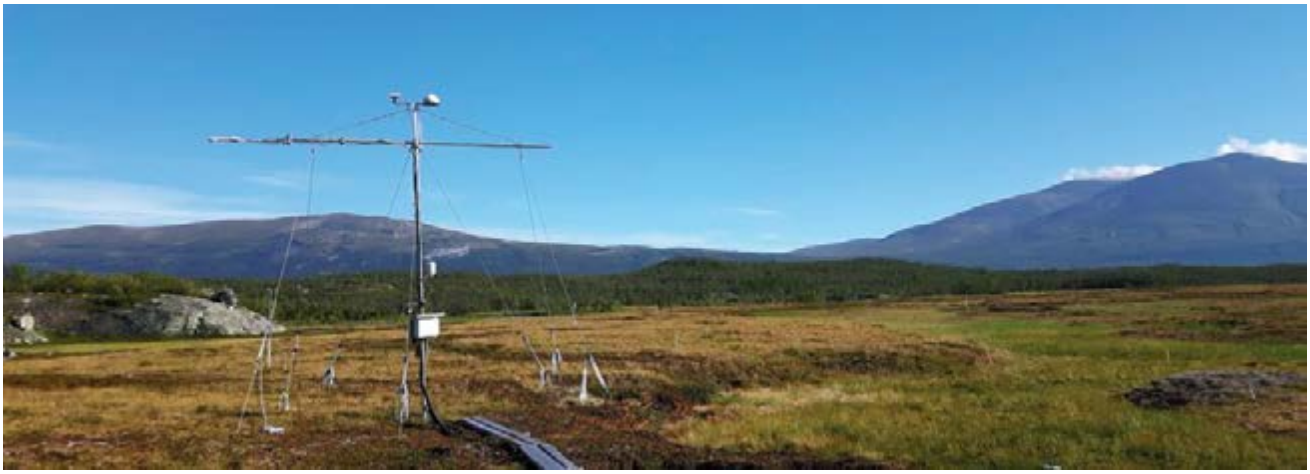
Calibration of pyranometers at LES

Continuous irradiance measurements with radiometers mounted on a SOLYS2 sun tracker at LES

Kipp & Zonen radiometers help Swedish researchers to understand global warming

By Ulf Mäkitalo, Head of Sales, In Situ Instrument

Climate change and global warming are amongst the most discussed topics in the world today, in one way or another it affects every citizen of our planet. There is a broad consensus in the research community that unusually rapid rises in global temperatures are caused by man-made emissions of greenhouse gases.



In order to better understand the forces behind climate change, long-term measurements with high accuracy are of crucial importance. A lot of research has been done in this field but the quality, consistency, and accessibility of the data sets are still insufficient in many cases.

The need to harmonize research methods, measurement data and the analysis of results led to the start of ICOS - the Integrated Carbon Observation System. ICOS is a European research infrastructure that provides harmonized and high precision research data in order to understand the greenhouse gas balance of the European continent and nearby areas. ICOS consists of measuring stations in 17 European countries. All the stations are equipped according to a common protocol of either specified sensors or standardised sensor specifications.

In the Swedish implementation of ICOS, Kipp & Zonen radiometers were selected exclusively. The CNR4 net radiometer with CNF4 ventilation unit is used in all the stations as part of the Eddy Covariance flux system. To achieve high standards of global horizontal irradiance measurement ICOS has chosen a ventilated CMP21 pyranometer.

Kipp & Zonen radiometers were the natural choice because many of the researchers behind ICOS in Sweden are familiar with the instruments and have great confidence in them. It is also practical and cost-effective to use the same equipment on all sites.

The Swedish distributor of Kipp & Zonen, In Situ Instrument AB **(www.insitu.se)**, has been part of the design and development of the ICOS concept and has also installed all of the ICOS systems in Sweden. Here, special emphasis was placed upon durability and performance under harsh climatic conditions, with lightning protection, power back-up, documentation and traceability.

In some cases this was a challenging task in remote locations with no power or communication facilities. However, during the operational years so far the Kipp & Zonen instruments have performed as expected and led to a high degree of satisfaction within ICOS.

Find out more about ICOS at **www.icos-ri.eu**

Welcome to Kipp & Zonen Tim and Perumal!

Kipp & Zonen is happy to introduce you to our new team members; Tim Kessels and Perumal Pillai. Tim is our new Finance Manager and works from the head office in the Netherlands. Perumal, however, will be working from Mumbai as our Sales Manager for India. Welcome to the team!

Tim Kessels

Tim Kessels:
"I'm very pleased to introduce myself as the new Finance Manager within the Kipp & Zonen group. Following last year's changes within the organization, I was recruited to complete the management team.

After starting my career in accountancy, I switched to 'finance management' where I found my passion. In my last assignment I was Manager Finance & Control at Luzac Opleidingen, a company comparable to Kipp & Zonen in size. At this company, it was my goal to bring the finance department to a higher level. When this goal was achieved, I started looking for a similar size company with the same kind of goals, but in a totally different business area.

And then Kipp & Zonen showed up! I love working at this company because of the strong product range, the market leading position and the innovative product-ideas which will undoubtedly further strengthen the company. As part of the team, I aim to once again bring the finance department to a higher level, this time including other company functions under my responsibility, managing the supply chain and ICT. With our strong hands-on mentality, I'm convinced we will be able to manage this successfully as a company."

Perumal Pillai:
"I'm very excited to be part of such a strong global organisation as Kipp & Zonen, being leaders in the industry. As Sales Manager India, I will be supporting the Kipp & Zonen partners and driving the OEM sales performance to strengthen our brand's position, grow the Indian market in commercial solar energy projects and in research institutions at large. I will be working closely with Gene Phay, Sales Director of Kipp & Zonen Asia Pacific.

I bring years of valuable experience in the sales of industrial products and gained a lot of knowledge of the Indian solar panel business. I look forward to working closely with the growing solar EPC industry, key accounts, partners and meteorological institutions aligned with achieving targets of the government's renewable energy mission.

With a command of over 5 diverse Indian languages, I will be undertaking extensive travel within the 29 States and 7 Union Territories that make up India" ■

Perumal Pillai

Fairs & Events

EMS Annual Meeting • Dublin • Ireland	4 - 8 September
Asian/Pacific region Brewer workshop Darwin • Australia	4 - 8 September
Solar Power International • Las Vegas • USA	10 - 13 September
Renewable Energies Cuba • Havana • Cuba	19 - 21 September
Renewable Energy India Expo • New Dehli • India	20 - 22 September
EU PVSEC • Amsterdam • Netherlands	25 - 29 September
Meteorological Technology World Expo Amsterdam • Netherlands	10 - 12 October
Asia Clean Energy Summit • Singapore	24 - 26 October

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; Meteorology, Climatology, Hydrology, Industry, Renewable Energy, Agriculture and Public Health.

We hope you will join our passion for precision.

HEAD OFFICE

Kipp & Zonen B.V.
Delftechpark 36, 2628 XH Delft
P.O. Box 507, 2600 AM Delft
The Netherlands

+31 15 2755 210
info@kippzonen.com
www.kippzonen.com

SALES OFFICES

Kipp & Zonen France S.A.R.L.
88 Avenue de l'Europe
77184 Emerainville
France

T: +33 1 64 02 50 28
F: +33 1 64 02 50 29
kipp.france@kippzonen.com

Kipp & Zonen Asia Pacific Pte. Ltd.
10 Ubi Crescent Lobby E
#02-93 Ubi Techpark
Singapore 408564

T: +65 6748 4700
F: +65 6748 6098
kipp.singapore@kippzonen.com

Kipp & Zonen USA Inc.
125 Wilbur Place
Bohemia
NY 11716
United States of America

T: +1 631 589 2065
F: +1 631 589 2068
kipp.usa@kippzonen.com

Go to www.kippzonen.com for your local distributor or contact your local sales office.

441441-1707

KIPP & ZONEN
SINCE 1830

Newsletter 44

Giant power plants in Morocco equipped with Kipp & Zonen

Lufft weather sensors with Kipp & Zonen on top

Monitoring systems for rooftop photovoltaic installations

CREST investigates the benefits of AirShield® DNI

Outdoor weather stations for indoor climate control

KIPP & ZONEN
SINCE 1830

Content

April 2018

Contact

If you have a news item for the newsletter or want to share your experiences with Kipp & Zonen applications and contribute to our next issues, please e-mail the editor: kelly.dalu@kippzonen.com

Kipp & Zonen solutions for Global Atmospheric Watch

In a world where technology advances at high speed, focus is increasingly important. Being successful in the core activities of your business environment requires combining many relevant technologies that progress independently. Our meteorology end users have explained their difficulties in keeping up, considering the wide range of scientific areas that they work in. From radar, lidar and sodar instruments to system integration and big data. A myriad of technologies that require a meta-analysis approach to ensure that the combination bears fruit.

Based on these insights, Kipp & Zonen decided to help customers by designing solutions; bundling accurate instruments and data integration to respond to concrete demands.

The Global Atmosphere Watch (GAW) programme exemplifies an important initiative of the World Meteorological Organisation, where solutions are required to accelerate progress. The international network of ground measurement stations collects data required for research into the major climate issues affecting our world, such as global warming.

With its solutions, Kipp & Zonen intends to help GAW to understand the increasing influence of human activity on the global atmosphere and, hopefully, to influence political policies through the Intergovernmental Panel on Climate Change (IPCC). Among the grand challenges are:

- More accurate prediction of weather and climate trends and their affects.
- Changes in the weather and climate specifically related to human influence on atmospheric composition; particularly, greenhouse gases, ozone and aerosols.
- Reduction of airborne pollution affecting human health and the biosphere and issues involving long-range transport and deposition of pollutants.
- Stratospheric ozone depletion and the increase of harmful ultraviolet (UV) radiation.

Solution thinking and analysis of the GAW datasets helped us to leverage existing products into packages that meteorological agencies can install to directly contribute to the GAW. Accurate datasets of Ozone, UV and the earth's radiation balance are comparatively limited within the GAW and the Kipp & Zonen Brewer MkIII and BSRN-compliant monitoring stations will help to close this gap.

Erik Valks

DustIQ now has on-site calibration

If you search the internet for 'soiling of PV modules' you find more than half a million webpages and over 6,000 scientific papers on the subject! Countless hours have been spent researching this challenge for solar energy technologies. The locations on our planet that seem perfect for generating energy from the Sun, are often also locations where soiling is the biggest threat to reaching the contracted performance ratio.

The growing awareness of light transmission (and generated power) loss of PV modules due to soiling is stimulating scientific research and innovative developments to deal with the impact, such as anti-soiling glass coatings and more effective cleaning solutions. Kipp & Zonen's recent product developments, RaZON+, AirShield DNI for pyrheliometers and the RT1 rooftop monitoring system, are all designed to be soiling resistant or preventive. But the newest development is of course our DustIQ soiling monitoring system.

The measurement principle

DustIQ uses Kipp & Zonen's Optical Soiling Measurement (OSM) technology. A pulsed blue LED flashes light onto the glass cover from below and some of the light is reflected back inside by the soiling on top of the glass, which is measured by a photodiode. There is a linear relationship between the amount of soiling, LED light reflected and the loss of sunlight transmitted through the glass. From this the soiling ratio (SR) can be calculated.

DustIQ has unique features. No outside light source is needed, so it works day and night. The two sensors are not for a clean-dirty comparison, but to have two independent spot measurements to compare and use. DustIQ does not need to have a clean surface, it gets dirty at the same rate as the PV panels around it and you just clean it when they are cleaned. No additional maintenance is needed.

Where to position DustIQ

Installation is simple, using mounting clips to mount onto standard PV modules or to incorporate into arrays. Also, DustIQ is much lower cost than previous soiling monitoring systems, so it can be affordably installed at multiple locations and heights to provide a soiling map of a solar park.

According to the IEC61724-1:2017 standard for photovoltaic system performance monitoring, a PV plant should have as many soiling monitors as there are pyranometers for irradiance. However, soiling is a rather different phenomenon to radiation, and is also very site-specific. Where you normally expect the same average global horizontal irradiation (GHI) value for all the pyranometers across a solar plant over a day, this is not necessarily true for soiling. If the wind always blows from the East, one would expect more soiling (and thus a different cleaning interval policy) at the Eastern side of that plant. When the wind direction changes over seasons, this pattern could shift during the year.

We would recommend installing several units on a larger plant. For example, with 25 MW one DustIQ in the middle and one near each corner would be a logical choice to understand the soiling distribution. Of course, every additional DustIQ adds up to more detailed measurements to inform decisions on where and when to clean the plant.

Local dust calibration

A major recent enhancement is the addition of a small PV cell that is used for local dust calibration (LDC). The standard factory calibration is for Arizona Test Dust but, using a simple procedure, DustIQ can be site-calibrated for the local dust composition and the effect of it on the sunlight transmission loss.

A clean DustIQ is installed and left to get dirty until it reports at least 10% transmission loss. The 15 minute calibration procedure can then be carried out. It needs to be performed only once and no tools or software are needed, just pressing a button. The only requirement is a clear sky during a 4 hour window around solar noon.

The process is a step-by- step cleaning of the two sensors and the PV cell to create several step changes in measured signals that the DustIQ can interpret and correlate to transmission loss.

Ongoing field tests

A substantial part of the research and development testing was made indoors, in climate and dust chambers, but also outside at our facilities in Delft. However, our local environment in the Netherlands has a lot of rain and not a lot of dust in the air; leaving little to measure for the latest model DustIQ with the integrated PV cell for local calibration. Therefore, DustIQ's have been installed in several locations around the world to give serious exposure to different types of soiling.

One of the locations is the large research, development and test centre PSA (Plataforma Solar de Almeria) in the south of Spain, where CIEMAT and DLR evaluate concentrating solar power technologies. A great location for DustIQ because there are several other soiling measurement technologies installed on site such as the TraCS system that uses two CHP1 pyrheliometers and a dust collection mirror on a SOLYS2 sun tracker.

Morocco is well on its way to capitalising on the energy source of the sun and it is also a geographical area that has a lot of dust. We are happy to have added Green Energy Park as a test location for DustIQ. It is situated in Ben Guerir, about an hours' drive from Marrakech and has an arid environment where there is a lot of dust; especially in spring, summer and early autumn.

Keep an eye out for publications on the measurements, comparisons and conclusions from these and other DustIQ test sites ■


DustIQ

NOOR II and III

Giant power plants in Morocco equipped with Kipp & Zonen solar monitoring

By Eduardo de Ugarte Martínez, Business Development Manager at DILUS Instrumentation y Sistemas of Madrid

DILUS has for many years been the Kipp & Zonen distributor for Spain, working with all the major renewable energy utilities and solar engineering and technology companies. DILUS has supplied and installed over 200 Kipp & Zonen trackers and one of our latest projects is to provide the meteorological and radiometric instrumentation systems for the innovative Noor solar energy complex in Morocco.

Ouarzazate is a town in Morocco at a height of 1160m on a plateau south of the High Atlas Mountains, the name means 'door of the desert' in the Berber language. It is home to Morocco's largest film studios and many 'desert' films have been shot there, including Salmon Fishing In The Yemen. It is also an ideal site for solar energy production.

In 2009, the Moroccan government adopted a new energy strategy to increase the share of renewables in the national power mix from around 30% in 2009 to 42% in 2020. Morocco's 2009 Solar Plan called for the development of 2000 MW of solar energy, starting with the Ouarzazate Solar Power Station (OSPS). This is located 10 km north-east of the town and is also known as the Noor Power Station, noor is Arabic for 'light'.

This is the first in a series of planned developments in the area by the Moroccan Agency for Solar Energy (MASEN) and the Noor project is planned to produce an actual 580 MW at peak and is being built in four phases and is expected to cost $9 billion. If you visit the site you will find an ocean of parabolic reflectors and a large solar power tower. It is the biggest thermal solar energy generating complex with 'molten salt' energy storage in the world.

Noor I, was officially commissioned in February 2016 and involved the construction of a 160 MW concentrated solar power (CSP) plant. It has half a million 'rocking' parabolic trough reflectors covering 450 hectares. The focused sunlight heats up a transfer fluid which is then used as the energy source for conventional steam turbine electricity generators, instead of oil or gas. Excess energy is used to heat molten salt, which is stored in heavily insulated tanks at about 560°C and can be used to produce steam. When fully charged the Noor I storage system can provide up to 3 hours of electricity after sundown.

Noor II is similar in construction to Noor I but covers 680 hectares and has 200 MW of installed capacity with up to 7 hours of molten salt storage. Commissioning started in January 2018 and will be completed at the end of March.

Noor III is rather different and even larger in area, 750 hectares. It has a 160 MW solar power tower and is due to be fully operational by the end of 2018. Flat mirrors on 2-axis trackers (heliostats) are used to reflect the sunlight onto a receiver on top of a tower that heats up the molten salt directly to generate steam, and also provides up to 7 hours of heat storage.

SENER, a Spanish engineering and technology group, designed and built Noor I and II and is also the technology provider for Noor III. EPC duties are shared with SEPCOIII of China. SENER is a partner in the Ouarzazate consortium, led by ACWA Power of Saudi Arabia, together with MASEN, Aries and TSK. ACWA is also responsible for the last phase of the complex, Noor IV, which will have 70 MW of photovoltaic modules over 210 hectares.

SENER awarded a contract to DILUS Instrumentation y Sistemas in 2016 to design, supply, install and commission the meteorological and radiometric instrumentation systems for Noor II and Noor III. Each solar monitoring station measures direct, global and diffuse solar irradiance; based on SOLYS Gear Drive sun trackers with a CHP1 pyrheliometer and two ventilated CMP11 pyranometers. These measurements are used as inputs to the plant solar energy production management systems. Noor II has three stations and the larger Noor III site has four.

Alongside the solar irradiance measurements, it's also important to measure wind speed and direction because both plants use reflector technologies that can be affected by strong winds. Six 2D and seven 3D ultrasonic wind sensors have been mounted by the reflector fields on 20 m high masts that fold down for servicing.

This major project establishes DILUS as a leading company in instrumentation, providing turn-key integrated solutions to the solar energy industry. For more information visit ***www.dilus.es.***

Visit **www.masen.ma/en** to find out more about solar energy in Morocco.

WS500-UMB all-in-one sensor

Lufft weather sensors with Kipp & Zonen on top

When Kipp & Zonen joined the OTT Group in January this year it became a sister company to G. Lufft Mess- und Regeltechnik GmbH of Fellbach, Germany. Actually, we have had a relationship for many years. At sites where solar radiation is measured it is often required to monitor other environmental and meteorological parameters that affect the weather, climate, agriculture, water resources, and the output of solar energy plants.

There are countless situations where you can see one or more Kipp & Zonen pyranometers installed with a Lufft all-in-one weather sensor nearby. Lufft took this to the next level in 2012 by developing versions of their smart UMB series that included a Kipp & Zonen CMP3 ISO 9060:1990 Second Class pyranometer mounted on the top. In 2015, models with the CMP10 Secondary Standard instrument were introduced for higher accuracy measurements.

Easy monitoring with all-in-one weather sensors from Lufft

Lufft was the first manufacturer to combine several meteorological sensors in one convenient housing with simple installation and a single cable for power and data. There are multiple choices of configuration to suit individual customer requirements and several of the models are well-suited for solar energy site assessment and plant monitoring, the most commonly used being the WS500-UMB and WS600-UMB models.

WS500-UMB has measurements of air pressure, ultrasonic wind speed and direction, and fan-ventilated air temperature and relative humidity. WS600-UMB adds a radar precipitation sensor.

Heating is available for the ultrasonic and radar sensors. As with all the UMB series, they operate from 12 or 24 VDC and the data connection is established by RS-485 in several formats, including Modbus® as used with Kipp & Zonen Smart instruments.

WS510-UMB

These models are typically installed along with several Kipp & Zonen SMP series Secondary Standard pyranometers to measure global horizontal, and plane of array, irradiance (GHI and POA). All the outputs are connected into a local digital data logger or networked to a plant Supervisory Control and Data Acquisition (SCADA) system.

With the addition of PV module back-of-panel temperature sensors and DustIQ all the information necessary for high quality solar energy production monitoring is provided. The ideal set up for calculating performance ratios and for operation and maintenance management.

Lufft sensors with Kipp & Zonen on top

Where only a horizontal ISO standard irradiance measurement is required there is a choice of Lufft UMB models with integrated Kipp & Zonen pyranometers.

A CMP3 Second Class pyranometer is fitted to the WS301, WS501 and WS503. These models are typically suited to applications where the higher accuracy of a Secondary Standard pyranometer is not required. This applies in meteorological, agricultural and water resource related applications.

They are also ideal for larger commercial rooftop PV applications in combination with the Kipp & Zonen RT1 smart rooftop monitoring system.

• WS301-UMB measures air temperature and pressure and relative humidity, along with Global Horizontal Irradiance (GHI),
• WS501-UMB adds wind speed and direction to the WS301 measurements,
• WS503-UMB contains the same parameters as WS501, but the CMP3 is in a different mounting that can be angled to measure horizontal or tilted irradiance.

WS310-UMB and WS510-UMB are equivalent to the 301 and 501 models, respectively; but fitted with a CMP10 Secondary Standard pyranometer in place of the CMP3. These are the models for utility-scale solar energy applications, when used with additional SMP10 pyranometers for POA irradiance.

An external rain gauge or surface temperature sensor can be connected to all of the above models. The irradiance measurement performance is similar to the stand-alone CMP3 and CMP10 pyranometers ■

WS301-UMB

WS501-UMB

WS503-UMB

WS600-UMB

G. Lufft Mess- und Regeltechnik GmbH

Since it's founding by Gotthilf Lufft in 1881, the company has been a leader in the production of meteorological instruments, always with the motto 'tradition meets innovation'. Like Kipp & Zonen, Lufft's capacity for innovation and passion for precision has helped its products establish the solid reputation that they enjoy around the world. In November 2012, Lufft was awarded a German Standards Brand Prize and was named a German 'Brand of the Century'.

The company's products can be found in use wherever environmental factors need to be measured. With its headquarters in Fellbach, optical sensors division in Berlin, and offices in Carpinteria, California and Shanghai, the company has approximately 100 employees. For more information please go to **www.lufft.com**

Irradiance monitoring systems for rooftop photovoltaic installations

By Jake Wilkinson, Editor at AZoNetwork

Rooftop Solar Installations are the Future

Rooftop solar is on the rise. While widespread adoption of feed-in tariffs in the early 2000's fuelled early uptake of solar technology by lessening the financial burden to investors, advancements in photovoltaics are yielding increasingly efficient solar cells at ever lower costs. Rate of uptake of solar is increasing faster than for any other energy source: in 2016, new global solar PV capacity increased by over 50% and exceeded 74 GW.The possibility of generating power from a rooftop solar setup is an increasingly attractive prospect for many; offering short-term affordability, long-term profitability, and a much-needed movement away from fossil fuels. The prospect is especially appealing to owners of warehouses, office buildings or blocks or flats with large, unused roof areas.

London's "Walkie Talkie" skyscraper is a recent addition to a long list of skyscrapers making use of their roof space with solar panels, now housing a 50 kWp (kilowatt peak) solar installation; while the average warehouse in the US can expect to house a few hundred kilowatts of solar capacity on its roof.

The opportunity to exploit our existing roof space for solar power is huge: recent estimates from the USA's National Renewable Energy Laboratory suggest that the US could generate 39% of its current annual electricity consumption using only rooftop solar installations, while sunnier states could produce 74% of their annual consumption.

As technology advances and interest increases, the cost of solar PV technology is falling. For example, in the UK, the cost of solar PV technology decreased by 70% between 2011 and 2016, and is predicted to decrease a further 35% by 2020. In 2015, European PV modules sold for less than €0.80 per Watt of capacity, and Chinese modules for less than €0.65 per Watt.

Why PV panel monitoring is important

Although the costs are lower than ever before, installing a rooftop solar PV system remains a sizeable investment; and as with any investment, effective system monitoring is crucial to their performance. Measurement of energy production throughout the day enables users to maximise efficiency of their system – for example, by timing the use of high-load appliances or machinery to coincide with periods of high solar irradiance. Maximising the self-use proportion in this way ensures the best economic outlook as the avoided cost of purchasing electricity from the grid is greater than the potential earnings from feeding energy into the grid.

Monitoring can also inform users when cells are not functioning correctly. For smaller installations, this monitoring is usually based on a comparison of the output of one PV panel relative to another. Whilst this is useful, it doesn't actually give information on the overall level of performance of your solar installation. In order to accurately gauge whether your system is performing optimally, some measurement of incoming solar irradiance is required.

This is where the pyranometer comes in; monitoring solar irradiance (and therefore the solar energy available to a PV installation) provides vital knowledge to make important decisions on future energy yield, efficiency, performance and maintenance. Measurement of the solar energy incident on a PV panel is required to determine the performance ratio, and thus the return on investment of any solar PV project.

Affordable irradiance monitoring for small solar installations

While solar irradiance monitoring is common in larger, utility-scale, PV installations, this generally involves expensive solutions that require careful calibration. The demand for an affordable and easy-to-use irradiance monitor for rooftop installations is increasing as PV gains popularity.

With this in mind, meteorological instrument manufacturer Kipp & Zonen developed the RT1 rooftop monitoring system. Designed to attach easily to the corner of any commercial PV panel without tools or screws, the compact device houses a silicon pyranometer and electronics, with a plug-in temperature sensor that can be affixed to the back of the PV panel.

The RT1 is designed to be as simple to set up and use as possible, but still provides high quality measurements of the plane-of-array (POA) irradiance from the sun and sky in W/m^2. Accurate positioning of the device is simple, because it fits directly onto a panel it is automatically aligned in the same plane and enables rooftop PV users to optimise the position of their array themselves. The temperature sensor is thermally isolated from the air, and couples to the back of the panel using special heat-conducting 3M tape.

The device is rugged enough to suit virtually any rooftop application; it's built to operate at temperatures as low as -40 °C and as high as +80 °C, and the cables and sensors are durable and waterproof. The RT1 comes with ties and self-adhesive mounting pads for the cables and, after setup, recalibration is not needed for 2 years. All this results in an inexpensive and user-friendly system for reliable monitoring of rooftop PV system performance ■

CREST investigates the benefits of AirShield® DNI in a less obvious climate

By Brian Goss, Ian Cole and Patrick Isherwood, Centre for Renewable Energy Systems Technology (CREST), Loughborough University, UK

We, the Centre for Renewable Energy Systems Technology (CREST) of Loughborough University, were one of the first to install the AirShield® DNI for pyrheliometers since Kipp & Zonen redesigned it and started manufacture. The Applied Photovoltaics group at CREST specializes in improving the performance and reliability of PV systems. Having reliable and long term solar irradiance data is invaluable for our work.

The CREST research centre has measured irradiance outdoors at Loughborough in the East Midlands region of the United Kingdom for 15 years. The main focus of the group is to improve the accuracy of solar photovoltaic performance monitoring. There are two aspects to this, one is to characterize the performance of nearby PV panels under test and the second is to improve the way irradiance data is processed for use in system design and performance prediction.

For example, we recently published a paper addressing the bias which is introduced when data is interpolated between geographical locations and when data is averaged into hourly datasets. This work demanded that we have high temporal resolution of direct sun and diffuse sky irradiances to validate our new methodology.

Having our own irradiance monitoring system means that we can measure at very high temporal resolution (up to 4Hz), whereas the fastest publicly available data is at 1 minute (0.16Hz). This high temporal resolution is important for photovoltaic applications since solar cells change their performance instantaneously in response to clouds and shading. Thermal lag of thermopile sensors must obviously be taken into consideration.

Pyheliometer soiling issues

CREST operates two pyrheliometers and two pyranometers on a SOLYS2 precision sun tracker; to measure direct, diffuse and global irradiances. The pyranometers are fitted with ventilation units and our experience is that the outer window on a pyrheliometer tends to become soiled much more quickly than the domes of our pyranometers. The pyranometers are exposed to rain, sleet and snow which have a cleaning effect; whereas the pyrheliometers have a shield that protects the window from the precipitation. In addition, the pyrheliometers are pointed slightly downwards at night by the sun tracker and the windows are not exposed.

Our equipment is located on an exposed rooftop location to minimize shading effects, but this means that daily cleaning

can be challenging to achieve safely at certain times of the year, so CREST is investigating ways to reduce the cleaning requirements for our systems.

How the AirShield DNI helps

We understand that the AirShield was originally designed for dusty climates, but we thought it would be interesting to try it and to measure the difference in dirt accumulation on pyrheliometers with and without the AirShield. We will also be checking whether the AirShield makes any reduction in condensation or frosting of the windows. We may experiment in the future with adding a small heater at the fan intake as is done in the pyranometer ventilation units.

We like the design of the AirShield because standardized field-replaceable components have been used for the air supply unit and hose. The system was easy to install and was performed in two hours by two technicians. The 12 volt blower fan and separate power supply meant that we had the option of supplying the system from a 230 VAC or 12 VDC supply, depending on safety and other design requirements. No modifications to the AirShield were required to achieve a robust installation.

If the trial is successful, then we will consider installing a second AirShield DNI for our other pyrheliometer.

For more information on the group's research go to:
www.lboro.ac.uk/crest

AirShield DNI installed and almost ready to operate

Outdoor *weather stations* *for* **indoor** *climate control*

The Netherlands has a large and successful horticultural economy for flowers, fruit and vegetables that are exported around the globe. One key supplier to this industry is SERCOM Regeltechniek B.V. based in Lisse, home of the famous Keukenhof Gardens. The company designs and manufactures automated climate control systems for plant propagation and growth; including fertiliser dosing. SERCOM has for many decades led the Dutch market in the field of controlling storage rooms for flower bulbs and vegetables.

SERCOM is known for reliable, full solution systems which they supply worldwide. At the entrance to their headquarters building they proudly display a Kipp & Zonen CMP3 pyranometer. As a key feature of their outdoor weather station, the CMP3 supplies accurate measurement of the incoming solar radiation. Due to the 'greenhouse effect' this is an important influencer of the indoor climate.

The algorithms of a climate control system rely heavily upon the outside weather conditions, so SERCOM measures temperature, relative humidity, wind velocity, wind direction and rain intensity along with solar irradiance.

Sunlight not only affects the indoor temperature but is of major importance for the growth and quality of plants inside the greenhouse. If the irradiance is higher than optimal, shades can be activated by the control system; if it is too low, additional lighting can be turned on and regulated.

SERCOM acknowledges that a Kipp & Zonen pyranometer is the most reliable solar irradiance measuring device for the horticulture industry, and that is why a CMP3 is prominently displayed immediately as you enter the SERCOM offices ■

Meet Erik Noort, our Brewer engineer and coordinator

First of all, a short introduction about the Brewer, if you have never heard of it. It is not related to beer, at all! It is a unique spectrophotometer that uses ultraviolet radiation from the sun and sky to measure properties of the atmosphere. UV radiation directly from the sun is the light source for the measurement of Ozone and Sulphur Dioxide concentrations in the stratosphere, plus aerosol and particle properties. Spectral measurements can be made directly from the sun, or from the whole sky, of UVA, UVB and UVE irradiance and for reporting the UV Index for public health information.

My role as the Brewer engineer and coordinator is to make sure that the instruments are manufactured, tested, calibrated, installed, serviced and supported. The Brewer is not a straight-forward and simple product, so my job is not as easy as it sounds. Coordination of it all is the biggest challenge because a lot of our work is executed onsite. Our team travels around the world and so does our reference Brewer and UV calibration equipment, and it all needs quite an amount of documents and logistics to arrange shipping and customs clearances.

Erik Noort (l) and Pavel Babal (r) in Hanoi, Vietnam

One year ago I started my job at Kipp & Zonen, but it wasn't my first experience with the company. In 2012 I was an intern at the R&D department on the subject of infrared radiation; how to measure this with a pyranometer and pyrheliometer. After I graduated as a Bachelor of Applied Physics my first job was at Jacobs in the oil industry, followed by a 5-year career in machinery as a support engineer and machine owner. I was happy to see the job opportunity at Kipp & Zonen that I was waiting for. Now, one year later, it feels like I never left!

I spend my spare time photographing nature and, of course, I take my camera along to every Brewer I visit. Here are a few of the highlights of my first year at Kipp & Zonen.

Vietnam, Hanoi, August 2017

Together with my colleague Brewer engineer Pavel Babal I serviced and calibrated the 3 MkIII Brewers belonging to the Aero-Meteorological Observatory (AMO) at their headquarters in Hanoi. Two Brewers were shipped from Sapa in the North and Ho Chi Minh City in the South to the central office, so that we could calibrate all 3 Brewers at once. None of them were fully operational anymore, but with our services they are now back on their sites and measuring Ozone and UV correctly again.

The Netherlands, Delft

For training purposes I helped with assembling Brewers the first weeks at the job with Kipp & Zonen, so I could get to know the product. This also helped to finalise the latest version of the Brewer with upgraded electronics and new power supplies. I also learnt how to repair old Brewers.

Tenerife, Canary Islands, February 2018

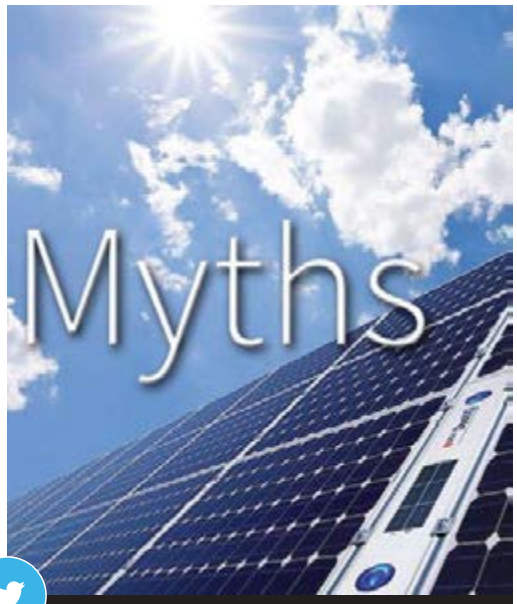
Tenerife is home to the Regional Brewer Calibration Center - Europe (RBCC-E) which is operated by the Izaña Atmospheric Research Center of EAMET and located at the Izaña Observatory on Mount Teide. Pavel and I visited when it was freezing cold to service the triad of reference MkIII Brewers, they are at over 2000 m altitude and there can be snow in winter.

It was good to meet people from the Brewer community and share experiences with each other. The weather did cause some challenges and it was not very comfortable to do the service. Luckily, much of the work can be done indoors and all went smoothly so we spent limited time outside. But that also meant I could only take some pictures with my phone and I brought my camera set up for nothing! ■

Fairs & Events

Green Energy Expo • Daegu • Korea	4 - 6 April
InterMET Asia • Singapore	11 - 12 April
33rd Conference on Agricultural and Forest Meteorology Boise, Idaho • USA	14 - 18 May
ISARS 2018 • Cologne • Germany	22 - 25 May
NEC, PV Power Expo • Shanghai • China	28 - 30 May
ASEAN Sustainable Energy Week Bangkok • Thailand	6 - 9 June
Expo Solar - PV Korea • Seoul • Korea	13 - 15 June
Intersolar Europe • Munich • Germany	20 - 22 June

follow us



6 myths about satellite and pyranometer irradiance measurements for solar power plants #blog #whitepaper

Where to place DustIQ in a PV plant? Our CTO shares his view on this in his latest #blog https://hubs.ly/H09Zz1T0

Our R&D manager returns from the successful DustIQ test installation in Southern Spain #blog #soiling #DustIQ https://hubs.ly/H0b7QkP0

A horizontal pyranometer in India to collect irradiance data #newsletter43 #solarenergy #irradiancemeasurement

How to install a pyranometer on the SOLYS2 sun tracker? This step by step video will demonstrate how easy it is.

HEAD OFFICE

Kipp & Zonen B.V.
Delftechpark 36, 2628 XH Delft
P.O. Box 507, 2600 AM Delft
The Netherlands

+31 15 2755 210
info@kippzonen.com
www.kippzonen.com

4414144-1804