Customized automatic weather station

Measuring the sun

With solar measurement forming an important part of the data landscape, and particularly so as power plants increase in size and output, PES was keen to learn from Roman Affolter, Technical Head of Meteorological Services, CSP Services about the latest bankable solar resource assessments for high-quality regional irradiance mapping.

PES: It's lovely to welcome you to PES Roman and to learn more about your involvement in the solar industry. I see that you offer meteorological services in the form of ground measurement of solar irradiance. What does that mean?

Roman Affolter: Thank you. Yes, CSP Services is a full-service provider offering solar ground measurement campaigns. In contrast to many other service providers, we have developed our own automatic weather stations. Those stations are designed to optimally integrate with our services, ensuring smooth campaigns and the highest data quality. The hardware can then be adapted according to the client's needs.

As a spin-off of the DLR we have a strong

scientific background. This gives us the motivation and skill to constantly improve our methods, by participating in research activities. For example, we have been involved in large solar resource mapping activities around the globe, such as the World Bank's ESMAP program and the DLR enerMENA network.

PES: How has your service been developed over time?

RA: We have our roots in the Concentrating Solar Power (CSP) industry, where accurate information about solar irradiance is required. Investments need to be backed by bankable solar resource data. The huge size of current PV power plant requires the same practice in the photovoltaics sector.

PES: You mentioned that you offer a full-service, what does that mean?

RA: It is not enough to just deploy measurement equipment to receive the demanded high-quality data. Permanent attention and monitoring by experts are necessary. Procurement of measurement equipment, shipping, site selection and site preparation, installation, operation and maintenance, data quality control and reporting are important factors.

Due to more than a decade of successful projects around the globe, we not only have the experience, but also have created a strong and reliable network of regional partners. That enables us to deliver and commission our systems quickly, even at remote and difficult to access places. Simply put, we are a one-stop shop when it comes to solar measurements.

PES: At what stage of a solar project should ground measurements be taken and how long does the process usually take?

RA: There are three phases where solar measurements matter. The first is during project development, usually in the feasibility study phase. Just like an oil company will not just drill anywhere without profound analysis of the available resource, the solar resource must be quantified and uncertainty reduced to a minimum. During this phase, it is best practice to measure for a complete 12-month period to cover all seasons.

Accurate measurements are important during the commissioning phase, too. For the final acceptance of the plant, the owner requires proof whether the plant performs according to the contractual targets. It is of obvious advantage, if this is proven by an independent third-party.

Thirdly, during plant operation. The plant´s performance should be monitored to detect or prevent premature degradation or faults. The information helps to maintain the performance at a high level and can also be used as a solid basis for warranty claims. Again, high-quality measurements prove how much solar irradiance has actually been received. A comparison with the modeled efficiency of the plant reveals whether the system is working as it is supposed to or not.

PES: It's useful that stations can be customized, but which are the main questions and aspects that you address with your measurements?

RA: We quantify the exact solar irradiance, with its temporal variation which is diurnal and seasonal. Additionally, we can quantify other important effects relevant for utility-scale solar. Such as soiling of PV modules, atmospheric corrosivity, and with increasing significance, the ground albedo and its diurnal and seasonal variation.

The measurements can be combined with our Q4cast nowcasting system. Q4cast provides information on the solar irradiance throughout the next 15 minutes, including its spatial distribution.

PES: It all sounds very thorough. What type of hardware do you use to record the measurements?

Roman Affolter

RA: We always use the most appropriate hardware for the project, since we are not bound to one provider. For solar irradiance sensors, we exclusively use ISO9060 Class A equipment, except when requirements explicitly differ. In any case, quality, robustness, and proven reliability in the field are decisive factors for selecting our hardware.

This is complemented by our own equipment, like the Rotating Shadowband Irradiometer or custom-built PV module soiling measurement systems.

PES: What is the benefit of your service for solar project developers?

RA: There are several benefits. Foremost, we deliver gap-free bankable data with low uncertainty and detailed documentation. This includes hardware specifications and calibration certificates, installation and maintenance reports with a sensor cleaning log. We achieve this with customized high-quality equipment, short delivery times, installation and maintenance services, and continuous data quality control.

We provide turn-key ground measurement campaigns worldwide, relying on our strong network of regional partners. This allows the developer to focus on other urgent tasks and studies.

PES: You already mentioned that the measurements can be a great help during plant commissioning but what are the benefits during plant operation?

RA: The quality of the data is suitable for performance analysis. Operators can save time and rely on accurate solar irradiance data. They are relieved of the measurement documentation, worrying about sensor calibration schedules and other cumbersome tasks, which are not their key activities.

Additionally, depending on the market the power plant operates in, our Q4cast system can help to optimize intraday market participation or avoid penalties

Automatic weather station with integrated cloud camera for nowcasting

imposed for incorrect production schedules, e.g., by detecting production ramps caused by incoming clouds as soon as they become visible.

PES: And for power plant owners, are the advantages of this measured data similar?

RA: Basically, the same aspects apply. For owners, it is an advantage that we can act as an independent third-party data provider. This can be of massive value during plant commissioning. Differences between owner and EPC over the power plant performance are solved much easier if the reference data comes from a neutral side.

For example, soiled sensors measure a lower solar irradiance and thus indicate a better plant performance than there actually is. The EPC might therefore be rather motivated to reduce the cleaning intensity of the sensors.

PES: Why not just use cheaper and quicker methods and perhaps just acquire satellite data?

RA: It's not one or the other. The magic is in the right mix. Satellite data is used to calculate long-term average values due to its long-time availability; ground data is much more precise and has a much higher time resolution.

In project development, ground measurement data serves as calibration for satellite data and reduces the model uncertainties. This is called site adaptation. It reduces the site-specific satellite model bias and improves the fit of the frequency distribution of values. In large-scale projects, even one percent uncertainty reduction can result in millions of dollars of reduced financing cost. The investment in a solar resource ground measurement campaign is more than justified in large-scale solar power projects.

PES: When is a good moment to start with ground measurements? How long does a campaign usually take?

RA: For feasibility studies, our clear recommendation is to start as early as possible. Best practice is to measure for 12 months continuously, hence there is no way to recover from a late start. Any other problems may be solved with the allocation of more resources or manpower, but the passing of time cannot be recalled.

For plant monitoring, this is more or less self-answering. When the plant is operative, solar measurement should be in place.

PES: Can you help retrospectively, if better data is needed but hasn't been measured according to best practice standards?

RA: To a certain extent, yes. Our experts can do an in-depth data review and partial reconstruction. We determine which parts of the data are usable and which aren't, and employ gap-filling techniques. There is the possibility of synthesizing time series from the useable parts of ground data and satellite data.

However, it must be said that continuous high-quality data can only be obtained by applying best practices and quality control from the very beginning. Sadly, we have seen enough cases where it has been neglected. Usually, either as a result of underestimating the importance and complexity of solar irradiance measurement or of insufficient budget allocation.

For me, this is hard to understand. Solar radiation is the resource of solar power plants, just as coal is the resource of a coal-fired power plant. No one would build a coal mine without exploring the available resource in detail, monitoring its extraction, and examining the cost and efficiency of the process.

If we want to make a successful transition to renewable energies, we need to optimize all aspects of solar energy projects. In my opinion, it is necessary to have exact knowledge of the solar resource and the performance of the solar power plants.

PES: Does it always make sense to conduct ground measurements though. Are there times when it's not necessary?

RA: It depends on project size, project type, already available ground data from a reliable service provider, market environment, and other factors. For example, if there are existing solar plants just around the corner, sufficient data may be available already. Small scale projects like the typical rooftop installation on private homes will not require such detailed information and can rely on satellite data and simulations only.

PES: What is the maximum distance the measurement system should be from the project site? Can ground measurement data be used even if the solar plant will not be built on the same site?

RA: This depends on several factors, such as the topography, nearby water bodies, geography, and more. The answer will be individual for each project, but in flat areas

without significant topographic features, a few kilometers to a few tens of kilometers can be acceptable. As a general rule I would say: the closer the measurement site is to the project site, the lower the uncertainty and the better fitting other parameters such as albedo, soiling, corrosion or wind.

In practice, the measurement site selection often is a compromise between local site conditions such as site security, local infrastructure, availability of local maintenance staff, and representativeness of the measurement site for the future project site.

PES: Are there any projects you are currently working on you can tell me about?

RA: CSP Services is currently finalizing the implementation of a network of 33 automatic weather stations over continental ECOWAS states for the West African Power Pool (WAPP). This activity, financed by the World Bank, will improve the knowledge on solar resources in the region.

We are measuring solar resources in numerous large-scale PV projects in Asian, European, and Middle Eastern countries. Currently, we have around 50 automatic weather stations operative. By active participation in IEA PVPS Task 16 we try to improve industry best practice.

PES: It sounds like you have a lot going on, what do you think the future will bring?

RA: We hope that more solar project developers, plant operators, and owners appreciate the potential of having high-quality data from the start and at all times during operation, to maximize yield and avoid efficiency losses.

There will be more technological developments to facilitate solar irradiance measurement and standardization will be improved. For example, in 2023 the IEA Best Practices Handbook will be updated, addressing current pressing needs of the industry, such as general recommendations on how to measure and consider ground albedo.

We believe that future solar power plants will have to operate in the market like conventional power plants. This means that they will have to know their power generation as precisely as possible in advance. The markets will act more flexibly and with shorter time horizons. In this environment, our Q4cast nowcasting system will be of great value to power plant operators and owners.

www.cspservices.de

Operation and maintenance of automatic weather stations