Case study
Ensuring Exceptional
PV Performance with insolar
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The operation and maintenance (O&M) of a solar plant constitutes the most important service after plant commissioning. Actual yield and uninterrupted operation are entirely dependent on the prompts and proper detection, assessment, and correction of the various faults that may occur. A complete and reliable monitoring system is a necessary tool in order to maintain comprehensive control of the solar plant and to subsequently detect any minor or major malfunction, failure, or defect. Insolar, the integrated and vendor-independent solution from inaccess, facilitates the centralized management of geographically distributed solar plants. It is also the most analytical platform that can provide detailed information on every element of a plant.

In the present case study, a monitoring procedure was followed using the insolar monitoring platform. This platform is described for use in a grid-connected 2 MWp solar power plant. The plant is located in the prefecture of Argolida, Peloponnes, Greece, and is owned by Elliniki Technodomiki Anemos SA. The owner’s company is one of the largest developers, owners, and operators of renewable energy plants in Greece with a fleet of several wind and solar power plants. Meanwhile, its mother company is ELLAKTOR, a multinational construction group with operations spanning various sectors of public and private development. These include real estate, energy, railway, fuel pipes, and other infrastructure development in as many as ten countries.
The solar plant was commissioned during August of 2009. Having completed several years of full operation, the plant constitutes a very strong example of monitoring features and capabilities and provides a clear and full-term overview of these attributes. The solar plant is built with 186 SMA string inverters, so it is an operation that requires extensive monitoring analysis. It also calls for a detailed “reading” of possible alarms coming from many different kinds of sources. Apart from that issue, this specific solar plant has proven that a well-designed and technically competent combination of solar plant construction and monitoring should lead to an almost hassle-free, high-performance operation.

This monitoring system was designed to include every single aspect of the solar plant. All elements of electro-mechanical equipment from strings, inverters, and electrical switchboards to transformers and substations are included. Also, energy meters positioned at critical points, such as the connection to the grid point and the load-connection point, are other key instruments that contribute to the completion of the PV plant’s performance evaluation. The communication system, the conditions of the substations (such as internal temperature), and security-alarm systems are monitored as well to ensure complete control of the plant. As it will be made evident in the ensuing discourse, there have been benefits of utilizing the unique advantages of the insolar system coupled with the skilled maintenance personnel at the plant. In particular, the plant’s average yearly performance ratio has never dropped below 81.7% with an average monthly value of 83.8%. It has to be noted that the performance ratio is calculated as per the IEC 61724 standard. This includes any module underperformance due to temperature variations from STC along with any production losses due to equipment failures.
Using insolar to Detect Malfunctions

Any issue is immediately visible in three locations within insolar.

- On the **Summary** page is a sortable list of all current problems.
- The **Map** tab provides a basic description above the geographical pinpoint.
- The **Events Viewer** tab lists all current events in an easily sortable format.

![The Summary View](image3.png)
The Plant Browser is also characterized by a practical and variable coloring of any part of the plant where a specific issue or problem may occur. It is this page that has the most detailed analysis concerning all levels of monitoring ranging from the point of a common-coupling meter down to a string-level current.
The Plant Manager

The **Plant Manager** screen provides quick access to all important elements and parameters of the solar plant. Included are values for the energy flow, present revenue, and CO2 reduction results. Also handy are plots of revenue over time, yields and losses, efficiencies, performance ratios, and active energy towards the utility. Key among these elements are yield and losses, efficiencies and performance ratio plots. By crosschecking those values with detailed logs produced from the plant browser components tree, it is possible to detect immediately the type of malfunction or failure that led to a lowered yield or an increased loss.

*Image 4* The Plant Manager View
The Event Handling

The Event Handling page enables the detection of similar issues that take place during a specific period of time. It is therefore easy to link them to the overall performance of the plant or to specific conditions such as soiling issues.
Examples of Real Problem Solving with insolar

Below are some real-life examples of problems that were encountered during the last few years. They have been presented to emphasize the significance of detailed plant-performance monitoring. They are also vital for the accurate and timely notification of maintenance personnel in case of critical failures.

Insolar made all required corrective maintenance visits more efficient by giving the technicians a complete overview of the problem and the proper approach to solve it before arriving at the plant. As a result, all failures are being restored within a few minutes or hours and without the need for any additional visits.

Low Performance Ratio

Performance ratio is one of the most significant indicators of a solar plant’s performance and operation. Special attention is always given to any alarms or messages associated with a decrease in performance ratio. In one specific case, a notable performance ratio drop was followed by a low-performance ratio alarm, which persisted for several days. Specifically, the performance ratio dropped from its normal range of between 82 – 93% to values below 80% without any technical issues or malfunctions being present. The operator’s technical team visited the site and discovered extensive soiling of the PV panels. It turns out that a light rain during very dusty conditions had left heavy deposits on the panels. After cleaning them, the production and performance ratio returned to normal.

Low Current Abnormal Status

At some point in time, an alarm indicating an abnormally low current status periodically appeared. By following the history of events, the low-current abnormal status was isolated to a number of specific strings and was limited to a few hours before sunset. Low current status is a message indicating that one or more strings are underperforming compared to others. This kind of irregularity typically indicates a shadowing issue. Combining the insolar recorded events with images taken from cameras close to this part of the plant provided proof. The vegetation beneath some panels had grown to such an extent that it shadowed some panels during the latter hours of the day. This conclusion was verified by an on-field technician, and the vegetation was removed so as not to cause further problems in that specific group of panels.

Buckholz Relay Status

The insolar system includes monitoring of the Buckholz relay status of the oil-immersed power transformers used at this solar plant. There are three states in the monitoring portal describing this relay’s condition: a) normal, b) alarm, and c) trip. The condition of the Buckholz relay is extremely important since a possible trip will lead to the disconnection of the transformer. Such an event will halt the plant section that is connected to this specific transformer and will lead to a great loss of energy produced. After the alarm was presented, a technician was sent to check on the transformer’s condition. The technician discovered that the transformer windings were overheating and that this activity had caused the alarm. Consequently, the alarming features of the insolar platform recovered a significant part of the money that was invested in monitoring with the detection of this single fault.
Conclusions

The actual events described above confirm the important role and reliability of insolar’s monitoring system. Without a well-designed and competent monitoring platform, a solar-plant operation is always at risk for minor or major malfunctions and failures. These kinds of events could not only affect a plant’s availability but also cause equipment damage with financial consequences. Insolar’s monitoring hardware and software are designed in such a way that any source of abnormality or fault is detected in seconds, verified for persistence, and communicated within minutes to the solar plant’s stakeholders. Such a detailed and immediate detection-and-alarming procedure is what makes the insolar system so valuable and so necessary for solar plants with significant investments at risk.
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