Monitoring, control, and analytics of a 650 MW PV power plant

Germany will be home to the largest unsubsidised photovoltaic (PV) power plant in Europe, situated in Witznitz in a former open-cast lignite mine. The 650 MW DC facility, with an investment volume in the mid to high hundreds of millions of euros, is currently under construction by MOVE ON Energy and covers an area equivalent to 850 football pitches. It is the perfect site to demonstrate the capabilities of an advanced monitoring, control, and analytics system.

The PV plant is located near the coal-fired power plant Lippendorf and will be the first photovoltaic park in Germany to be connected to a 380 kV network. The plant will feature two 380 kV transformers to facilitate the efficient transmission of electricity. Power is generated by 1.1 million bifacial PV modules in East-West orientation.

When building the substation for the PV utility-scale plant, several challenges had to be overcome. The construction site was located on the spoil heap of the Witznitz brown coal open-pit mine, where the soil had limited load-bearing capacity, particularly in the loose upper soil layers.

To address this, various technologies were used, including vibration compaction. A 60cm diameter lance was pressed about 12 metres into the ground to improve load-bearing capacity. This resulted in a reduced settlement of the two-hectare construction site by approximately one metre. Despite the difficulties, the improved load-bearing capacity achieved through these measures enabled the construction of the substation for the PV utility-scale plant to proceed.

German solution provider Gantner has, in collaboration with MOVE ON Energy, developed a cutting-edge monitoring and control concept. This sophisticated system is not only designed to meet the strict security and robustness requirements of critical infrastructure, but it also complies with the stringent guidelines set by Germany's Federal Office for Information Security, known as 'BSI'. As of January 2022, power generation plants with a net nominal capacity of more than 104 MW are considered critical infrastructure in Germany, according to the newly revised Critical Infrastructure Ordinance.

Gantner supplies a complete solution, consisting of both hardware and software components to the power plant, which complies with the new international standard IEC 61724 Ed.2 'Photovoltaic System Performance Monitoring Guidelines for Measurement, Data Exchange and Analysis'.

CEO, Jörg Scholz says: 'Advanced monitoring, control, and analytics solutions for PV power plants are crucial to ensuring optimal performance and profitability. With our state-of-the-art technology, we can provide real-time insights into the performance of solar assets, enabling operators to identify and resolve issues quickly and efficiently.

'Our solutions also help to reduce maintenance costs and extend the lifetime of PV power plants, while ensuring compliance with industry standards. Ultimately, our goal is to help our customers maximize their return on investment and contribute to the transition towards a more sustainable energy future.'

Gantner's PPC: a comprehensive solution for PV power plant monitoring and control

The Q.reader Power Plant Controller (PPC) is the key component of Gantner's comprehensive solution for PV power plant monitoring and control.

With its highest voltage 380kV grid connection the Witznitz' project also sets new standards for grid integration. This required a dedicated development effort to ensure compliance with the strict requirements and standards for grid connections which exceed the common requirements for the certificates VDE AR N 4110/4120. To achieve certification according to VDE AR N 4130, Gantner further enhanced the functionality of the Q.reader and developed certified PPC simulation models such as PSS/E and Power Factory.

One of the PPC key features is the ability to monitor and control multiple grid connection points, which allows for more efficient monitoring and control of the power plant. In the case of the Witznitz' 650 MW power plant, the plant is connected to two transformer stations, each with its own PPC. This high level of precision and accuracy in monitoring and control helps ensure that the power plant is operating at optimal performance and is compliant with industry standards for grid connection.

The functions of the PPC, along with accurate models, offer possibilities in the planning of PV plants to conduct grid studies and simulate operational concepts even before the start of construction.

High-tech hardware for PV power plant monitoring and autonomous operation

The hardware supplied to the power plant includes 22 10ft Monitoring Containers with specific characteristics. These containers are air conditioned to withstand extreme temperature ranges and are equipped with a powerful battery system to provide three to four days' autonomous operation in case of power supply loss. Each of the 22 containers provides 44 pcs. RS485 communication bus lines available for control of totally 3600 inverters from Delta each with 125 kW power output.

Furthermore, the external transformer temperature will be monitored, and the ventilators will be dynamically controlled to reduce noise. The facility is equipped with an industrial fibre optic network infrastructure. Therefore, each container includes three managed switches to connect all network devices.

Additionally, Gantner has provided an advanced reference meteorological station

that supplies data for local communities and serves as a validation source for weather forecast data. For PV-specific plant analysis an additional meteorological station is used. To monitor the irradiation conditions for bifacial modules, albedo meters will be applied.

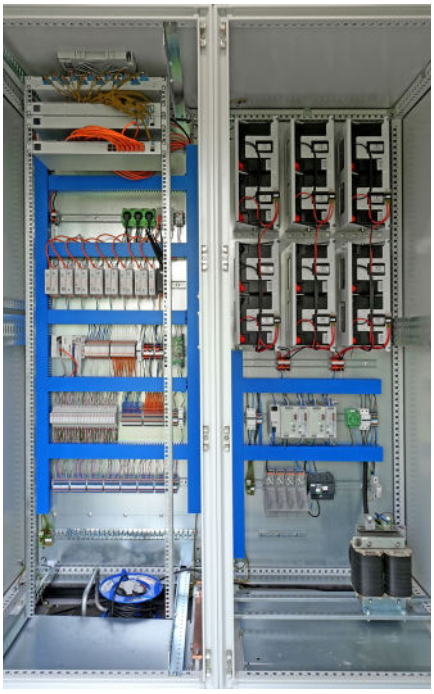
The extensive monitoring of weather conditions such as irradiation, module and ambient temperature, wind, humidity, and others enables the application of a mechanistic power model for performance calculations. Combining the benefits of different PV models, has created a new mechanistic power model. This model calculates the expected PV power depending on the weather sensor data.

Setting a new standard for accuracy and precision in PV modelling

Gantner's mechanistic power model (MPM) is an innovative methodology that calculates expected PV power based on weather sensor data. It considers the physical behaviour of PV modules and weather conditions, enabling precise and accurate predictions of power output. The MPM accounts for temperature's significant impact on PV efficiency, and it incorporates data from on-site sensors and satellite data for a comprehensive view of weather conditions.

The MPM represents a major advance in PV modelling technology, enabling plant operators to optimize the performance of their PV systems by accurately predicting power output.

Through collaboration with Delta, which integrates IV scan functions into their inverters, the resulting data can be analyzed using a loss factor model. This enables the early detection of degradation and the identification of potential future issues within the PV plant and to prioritize O&M tasks.



Advanced data management and analytics tools for utility-scale PV power plants

Utility-scale PV power plants generate large amounts of data on PV module performance, weather conditions, and grid integration. Managing and analysing this data requires advanced data management and analytics tools. The Gantner.webportal is a cloud-based SaaS solution used for big data analytics that processes millions of measured and calculated values per minute. It can handle the massive data volume generated by the Witznitz' plant of two million data points stored per minute, summing up to 17 GB per day and 180 TB over the plants' lifetime of 30 years.

Gantner is certified to the information security management system standard ISO 27001, ensuring robust cybersecurity measures to protect the plant's data, control systems, and critical infrastructure. The Digital Twin feature of the webportal allows users to create a virtual replica of the power plant with the mechanistic power model (MPM) mentioned earlier. Third-party applications can access the power plant data via an API, integrating it into their data warehouses for unified storage and further applications.

This includes advanced analytics tools allowing for deeper analysis and unlocking the full potential of the power plant. For instance, predictive maintenance can be performed by analyzing historical data on equipment performance and environmental conditions by state-of-the-art AI techniques. Such algorithms can be trained to predict when components are likely to fail or require maintenance.

This allows plant operators to schedule maintenance proactively, avoiding costly unplanned downtime and maximizing equipment lifespan. In addition to its built-in features, it enables the integration of customer-specific models and analysis, allowing for valuable insights to be gained for future planning of PV plants.

Utility-scale PV power plants require regular maintenance and repair to ensure optimal performance. Managing maintenance schedules, identifying faulty components, and scheduling repairs efficiently can be complex due to the large scale of the plant and the need for coordination among multiple stakeholders. Features such as O&M planning, ticketing and an inventory directory assist its users in efficient workflows for above mentioned tasks.

In addition to its state-of-the-art hardware and software platform, Gantner offers a range of advanced services to power plants, including inverter configuration and firmware updates, remotely via the the system. This level of support ensures that plant operators can always rely on the company to provide the latest technology and expertise to keep their plants running smoothly.

A global leader in PV power plant analytics and optimization

With a proven track record of supplying complete solutions to large scale projects in over 44 countries on five continents, including some of the largest PV power plants in Denmark, Poland, Angola, Spain, and the Netherlands, Gantner is at the forefront of the industry. Their system is constantly evolving to meet the specific challenges of new areas, making it one of the most powerful and versatile solutions available.

Overall, the company's commitment to innovation and excellence has solidified their position as a leader in the PV industry. With a global reach and a proven track record of success, it is the go-to solution for power plant operators looking to maximize the performance and profitability of their PV systems.

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