Smart SCADA and the use of digital twins in renewable energy plants

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As the installation of renewable energy projects continues to grow worldwide, so too does the need for smart SCADA tools to manage their day-to-day operations and optimize performance. SCADA solutions are responsible for ensuring this is performed to meet the needs of all key stakeholders. SCADA solutions intended for renewable energy control centers need to have a comprehensive approach, adopting best-in-class digital tools to create a complete suite, accompanying the data from real-time acquisition to supporting O&M and strategic management decisions. Successful integration of state-of-the-art solutions into one single product is key to solving the most complex operational challenges.

Each renewable energy project has its own unique characteristics linked to the environmental features and topography of their specific location. No two projects are identical, each asset owner faces different challenges, depending on the mix of assets and systems it has. That is why there is no one-size-fits-all solution, and customization is a key success factor when deploying such a system.

One of the most important tools to be integrated in SCADA solutions for renewable energies are digital twins. These advanced analytical models are increasingly used to solve problems arising from the management of renewable assets such as wind farms and photovoltaic plants to improve performance and extend their useful life.

The key goal of digital twins and advanced analytics is the use of data to gain important insights into the health and performance of renewable assets to support the decision-making processes for the operation and maintenance of those assets throughout their useful life. Understanding the performance, identifying underperformance, and taking corrective maintenance actions can deliver true value creation and extend the lifetime of the assets.

The following case study is focused on data-driven digital twin based on real-time SCADA data using Ingeteam's INGESYS™ Smart SCADA product. Asset owners can easily analyze this SCADA data using the company's analytics tool suite.

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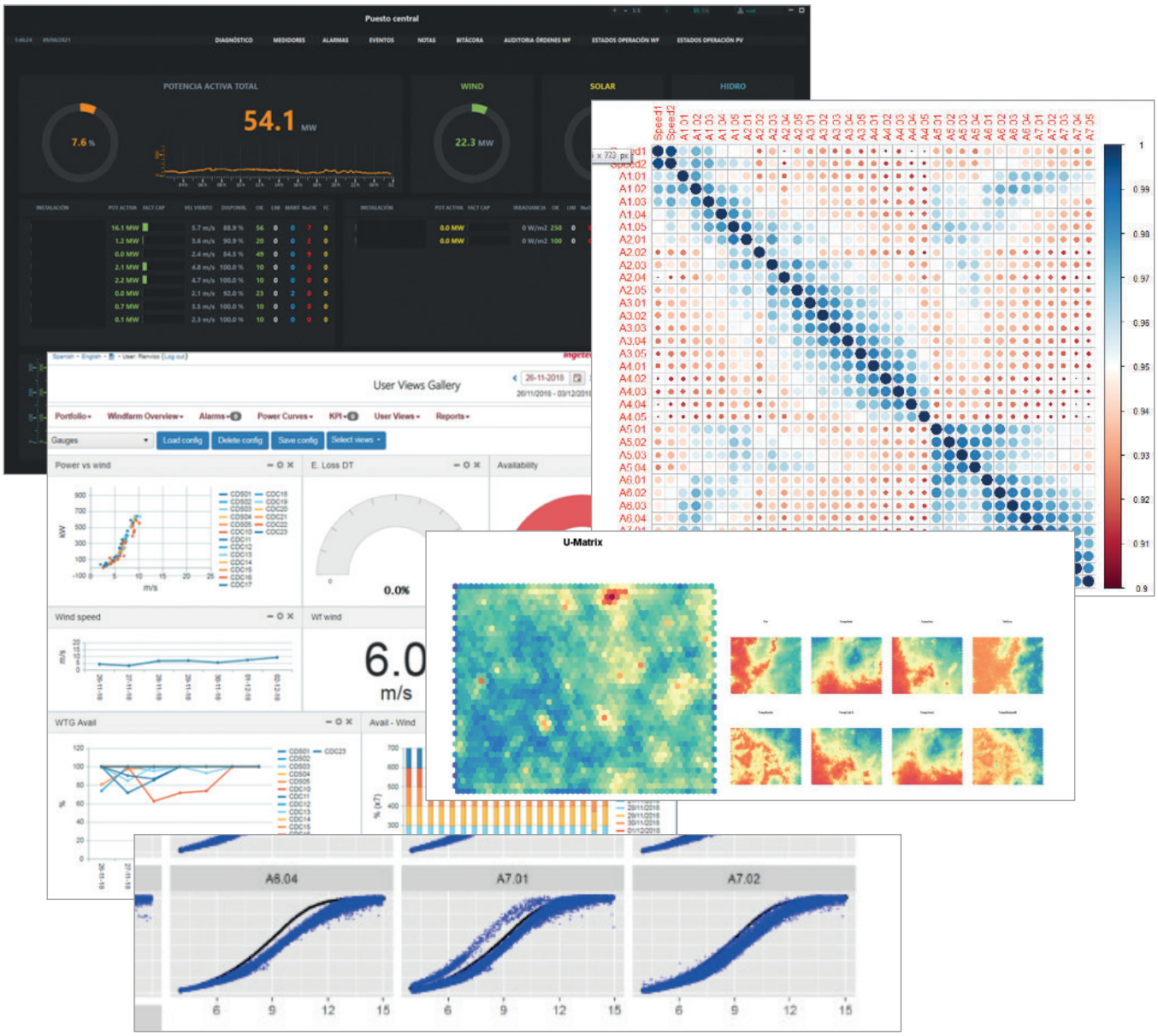

Analytics Tools of INGESYS™ Smart SCADA

Deploying a data-driven digital twin to monitor multi-technology asset portfolios

The use of data-driven digital twins and advanced analytics to support the decision-making processes on the operation and management of renewable energy assets throughout their useful life provides multiple benefits. Ingeteam's INGESYS™ Smart SCADA product, integrates these functions within its Renewable Energy Control Center solutions.

An asset owner in Latin America, with a portfolio spanning 4 countries, including wind farms and photovoltaics plants, needed to unify the data generated by its wind and solar assets to create value. The real challenge was to build a central SCADA platform to so that it could optimize its O&M strategy decision across different technologies and countries.

All the data available was integrated into the INGESYS™ Smart SCADA to build the Digital Twin of its fleet, through the creation of data-driven models for the assets. This was performed by:

- **Detecting key component behavior changes and trends.** The operational performance of each plant in the portfolio is monitored using Key Performance Indicators (KPIs) providing an overview of the health and performance of each unit. KPIs are automatically created and can be easily used across the asset owner organization to measure and direct the O&M efforts.
- **Integrating machine learning algorithms to detect anomalies.** Machine learning models for each key component in the wind farms and solar plants are created and deployed within the INGESYSTM INGESYS™ Smart SCADA analytics modules. These models learn the normal behavior of the components and continuously track performance, raising alerts to any deviations from their normal patterns. These alerts allow the technicians to focus their resources onto the right units.
- **Applying visual analytics.** Time is a scarce resource for field technicians. Visual analytic tools (see examples above) allow technicians to easily explore the huge amount of data generated by the assets and identify performance issues without needing the skills of data scientists.
- **Analysis of performance and power curves.** Asset performance is a key factor that must be closely watched. Machine learning models and KPIs detect early deviations from the underlying trends.

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Dashboard Machine Learning Models

Routine reports can be generated automatically, freeing up time for client technicians to focus on O&M tasks and apply the insights gained through data analytics. This is achieved by means of easily customizable dashboards.

Below are three examples of issues identified thanks to the digital twin and data analysis:

Identifying underperformance

Using the digital twin created for the specific assets of the client, a comprehensive performance analysis was carried out. This analysis detected that one of the wind farms in the portfolio was not performing as expected.

Together with the client, the root causes of this underperformance were analyzed and identified, and corrective actions implemented at the affected wind farm. This is just one example of how the insights gained through data analytics can be applied to correct specific problems. When the client detected a problem, they were able to concentrate their O&M efforts only on the affected wind turbines.

Enhancing security

Applied data science not only provides performance improvements. Security enhancements for aging assets is also a key value driver in asset management. For instance, the client was able to spot abnormal thermal behavior in a subset of the transformers. This insight allowed the client to launch an O&M campaign to correct the issue before it escalated further.

Curtailment losses

In another example, the curtailment losses associated to a specific solar plant were calculated in fine detail and economic savings were achieved by means of joints work with the transmission system operator (TSO).

Conclusion

Overall, the deployment of the Central SCADA improved the internal processes and decision making for managing all the client’s assets. As a result, in the first year following the implementation of improvements, the client generated estimated savings of over $500,000.

The use of digital twins and advanced analytics enables all users, from operators and O&M technicians to performance and reliability analysts and managers, to have the right tools and the necessary information to meet their specific needs within one central platform. Information is available for each user type without division into difficult to access silos. Within our Smart SCADA platform, a suite of specific tools can be optimized for each specific stakeholder. Moreover, the overall decision-making process was improved across the full organization, beginning with real-time operators, field technicians and ending with skilled O&M analysts and managers.

In the case study presented, we focused on the data-driven predictive tools inside our INGESYS™ Smart SCADA platform. We have demonstrated how one customer with a portfolio of wind and solar assets in several Latin American countries has achieved significant cost savings and improvements both in asset performance and security. Therefore, we can conclude that INGESYS™ Smart SCADA was a key factor in the digital transformation of our customer asset management.

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