Life-cycle automation and services

A holistic approach to photovoltaic plant automation, operation and maintenance

ADRIAN TIMBUS, MARC ANTOINE, LUIS DOMINGUEZ – The photovoltaic power industry is rapidly growing, with worldwide installations expected to grow by 60 to 66 GW in 2017 [1]. ABB is deeply involved in this growth, applying a holistic approach to photovoltaic generation projects that encompass the entire plant life cycle as well as the two stages of photovoltaic generation projects. The first stage is to design the solution, select the equipment and build the plant. The second is to ensure that the plant produces the maximum amount of power, and that its equipment is managed efficiently to minimize operation and maintenance costs. This holistic approach is a culmination of ABB's expertise in providing technologies for solar power applications and the company's vast service and maintenance resources.

1 ABB's photovoltaic power plant offering

As a leading provider of photovoltaic (PV) power plant technologies, ABB partners with and guides owners and investors. ABB performs feasibility studies and analyzes the project's profitability; designs, engineers and optimizes plants; provides project management; and supplies electrical and automation systems. Through its comprehensive operation and maintenance (O&M) offering, which includes an advanced remote monitoring and service concept, ABB ensures that each plant maximizes production while protecting its assets.

ABB's scalable power and automation solutions for PV power plants are designed for rapid deployment. They are pre-assembled, factory-tested and containerized to enable short lead times and easy installation. With the exception of the solar panels, which ABB does not manufacture, the solutions consist entirely of ABB products, designed specifically for PV applications. These are seamlessly integrated to deliver the highest levels of reliability and efficiency and the lowest levels of plant energy consumption. ABB has delivered more than 100 integrated electrical and automation solutions for PV power plants, with a combined generating capacity of around 1,000 MW.

ABB's technologies for photovoltaic (PV) power plants are designed to maximize plant performance and provide owners with a rapid return on investment and long plant operating life. From electrical balance of plant (EBoP), to control systems and power management, to production forecasting and remote monitoring and services, ABB's PV power generation technologies seek to ensure maximum power production at minimal cost → 1.

World-leading plant automation system

Symphony® Plus for Solar, ABB's automation system for PV power plants, is a versatile and scalable monitoring and control system. As its name suggests, it is part of ABB's Symphony Plus platform, the total plant automation solution for the power and water industries. Symphony Plus is the latest generation of the Symphony family of distributed control systems which, with more than 6,500 operating installations, is one of the most widely used plant automation platforms in the world.

Symphony Plus for Solar monitors and collects data from the critical components of the plant. These include the panel strings, transformation centers (each of which contains inverters, transformers, medium-voltage switchgear and low-voltage switchboards), the grid connection and the meteorological stations. The system supports a broad range of communication protocols, enabling it to connect and exchange data with all of the components. Equipped with a real-time database and historian, it acquires and stores all relevant plant data, either on-site or at an ABB remote service center.

Using the IEC 61850 communication protocol, Symphony Plus for Solar monitors and controls substation equipment and integrates generation and electrical components into a single information system.

One of the main differentiators of the Symphony Plus platform is that it is designed to last the operating life of the plant. Through ABB's "evolution without obsolescence" life-cycle policy, each generation of the Symphony Plus family builds on and enhances its predecessor, adding new technologies and new functionalities to meet the evolving performance objectives of its users. An investment in Symphony Plus hardware and software is thus protected throughout the life cycle of the plant.

> Symphony Plus for Solar improves the return on investment with comprehensive O&M services.

Power management

Power management functionality is key to faciliting the grid connection of PV plants. Symphony Plus' high-performance controller connects to all relevant actuators (inverters, tracking systems and – if applicable – capacitor banks, STATCOMs[1] or energy storage), and performs real-time calculations to regulate the plant's power production in accordance with the specifications. Accessing all relevant plant information, it dispatches set points to the inverters. It also ensures that plant management and control is in accordance with the local grid code requirements, controls the production ramp rate, and provides power factor and voltage control at the point of connection to the grid.

Production forecasting

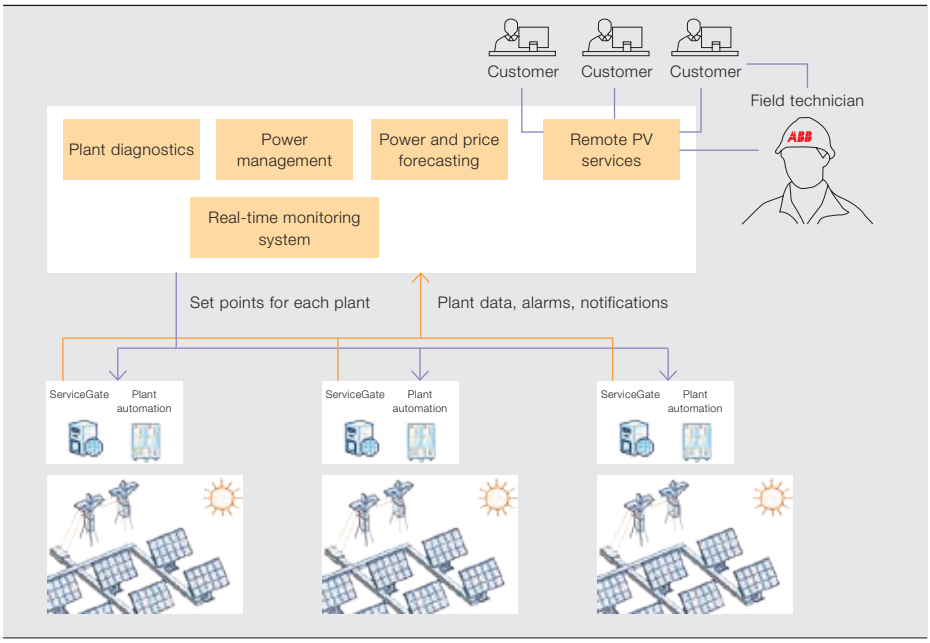
As PV plants grow larger, the ability to forecast power production has become an increasingly important factor in plant profitability. ABB provides a flexible production forecasting solution that uses data from the panels, strings and invert-

Title picture
Operation and maintenance services are one of the key components of ABB's photovoltaic offering, allowing plant operators to minimize operation and maintenance costs.

Footnote
1 Static synchronous compensators

ABB provides a flexible production forecasting solution to predict plant output.

2 Architecture of Symphony Plus for Solar



3 Alarms and notifications in the remote portal

ers, as well as historical production and meteorological information, to predict plant output. The forecasting horizon spans from hours ahead (typically 6 h ahead, with a time resolution of 15 min) to days ahead (typically one week, with hourly resolution).

ABB has also developed algorithms that track the movement of clouds in the vicinity of the PV plant. Using advanced image processing and computer vision techniques as well as optical and physical models, the algorithms predict the time of arrival and duration of cloud cover over the plant, and calculate the expected drop in output power. If the plant is equipped with an energy storage system, optimization of power balancing is achieved by using the accurate short-term prediction of power fluctuations caused by cloud coverage.

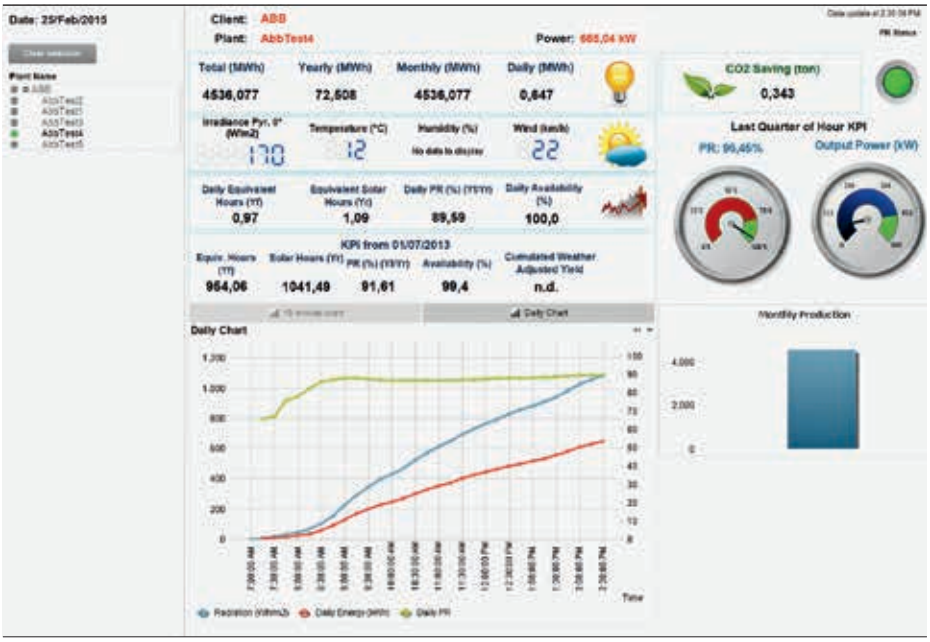
Remote monitoring and control

Plant owners need to minimize operation and maintenance (O&M) costs by being able to quickly identify underperforming components. They require predictive maintenance to reduce downtime, extend equipment life cycles and evaluate the impact of equipment failure. They also expect quick access to service engineers and product experts.

ABB's remote monitoring, operations and service platform for PV power plants delivers on all these fronts. Symphony Plus for Solar comprises three main components: a remote-enabled interface called Symphony Plus ServiceGate,

4 Overview display using maps

5 KPI dashboard



ABB's remote service center, and a dedicated Web portal → 2. The platform can be used for a single plant or a fleet of PV or other renewable energy plants.

ServiceGate provides a high-speed and secure data transmission connection between the plant automation systems and an ABB remote service center. It supports system configuration, health checks and system diagnostics, as well as remote operations of plant equipment.

The data from ServiceGate is received by, and stored at, ABB's remote service center, which is equipped with a dedicated hardware platform and configurable software. It runs the processing and monitoring software and advanced applications, and stores the results displayed in the dedicated Web portal. Unlike other monitoring systems on the market, ABB's system enables real-time plant operations through an ergonomic human-machine interface (HMI). Moreover, an optimized power management function is also available at the fleet level to control the production of the entire fleet at the best economic running point. The service center is manned 24 hours a day by accredited engineers, ready to react at all times to any field problems.

The Web portal has a dedicated interface through which the PV plant communicates with the external world. All plants in the fleet can be managed through the same Web portal, which can be accessed by authorized users anytime, anywhere using a PC or mobile device. The log-in provides different levels of authorization based on roles defined in IEC 62351.

Key features of the Web portal include alarms and notifications, dynamic presentation of collected data, predictive maintenance, production forecasting, production and performance cockpits, a reporting and ticketing system, and health checks.

Alarms and notifications

Besides receiving standard alarms from the plant such as faulty inverters and plant equipment, users can generate their own alarms for situations like "low KPI value." When an alarm is activated the platform conducts a preliminary diagnosis of possible operating failures and immediately notifies the responsible personnel by SMS or email → 3.

Symphony Plus for Solar comprises three main components: a remote-enabled interface, a remote service center and a dedicated Web portal.

6 Plant performance report

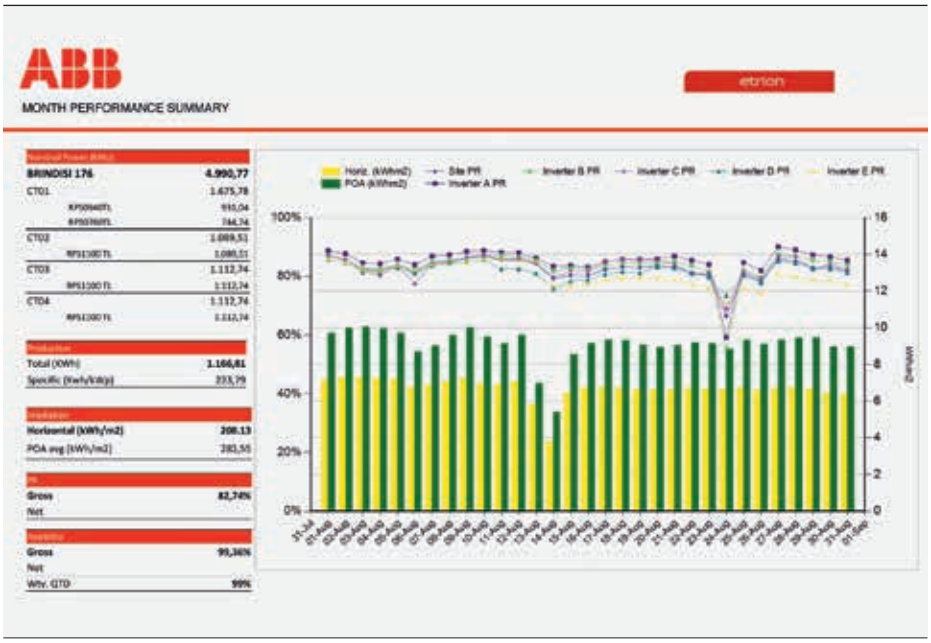


ABB is currently using the remote service platform to monitor and control more than 50 PV power plants worldwide.

Maps with dynamic data

Maps show the geographical location of the fleet plants with icons. An adjoining frame contains a list of the plants in the fleet and uses dynamic traffic lights and icons to show the status of contractual KPIs, the presence of open maintenance tickets and the status of the plant's connection to ServiceGate → 4.

Predictive maintenance

The remote service platform contains a set of tools to detect and correct the most common reasons for underperforming assets. The tools analyze the plant in small sections (typically individual strings) to pinpoint local problems at an early stage before they develop into larger production problems. They detect soiling (dust accumulation on the modules); total and partial shading of strings; and aging, which analyzes the efficiency of the PV modules over time to determine the loss in performance caused by degradation.

Production and performance cockpits

Other applications that monitor and analyze plant production include performance ratio monitoring, which is a real-time cockpit for monitoring plant production and KPIs (based on QlikView technology) → 5; equipment condition trending that monitors the performance of critical plant equipment in real time; and fleet analysis, which provides a historical data dashboard for comparing and analyzing fleet performance.

Reporting and ticketing system

The remote service platform stores data from the PV plants, and the Web portal uses the data to, for example, automatically generate: reports on production, interventions and actions by operators; an O&M log book that collects tickets relating to O&M activities and tracks operators' actions; and executive-level reports with information necessary to manage the plants → 6.

Health checks

The remote service platform also performs equipment health checks. These consist of fingerprint diagnostics, which monitor and assess equipment performance and identify reliability issues. They are available for plant assets, including the automation system (hardware and software), cyber security settings, and electrical process equipment. The fingerprints are used to start a continuous optimization process by identifying necessary improvements and a schedule for their implementation.

ABB is currently using the remote service platform to monitor and control more than 50 PV power plants worldwide. These plants range in size from less than 1 MW to more than 100 MW, and include single plants and entire fleets. High customer satisfaction and a large number of renewal contracts indicate that ABB's holistic approach to PV power production is producing real benefits and measurable value for customers.

Adrian Timbus
Marc Antoine
ABB Power Systems, Power Generation
Baden, Switzerland
adrian.timbus@ch.abb.com
marc.antoine@ch.abb.com

Luis Dominguez
ABB Corporate Research
Baden-Dättwil, Switzerland
luis.dominguez@ch.abb.com

Reference

[1] Bloomberg New Energy Finance