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Modern power plant control offers auxiliary services beyond the grid

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Introduction: Solar power systems have moved from a mere curiosity to professional and substantial element in the electrical power supply chain, participating in grid regulation and energy trade. The emerging of monitoring systems initiated the customer's awareness and progressed the knowhow of PV systems as well as the quality of PV module and inverter manufactures.

As PV systems matured and their acceptance grew, additional services as voltage support, power factor correction and self-consumption were offered. Again, monitoring systems watched over quality and contract fulfilment. It offered the operator tools to analyze, report and maintain the power plant and preserve optimal operation, securing the investor's assets.

Recently, due to a rapidly evolving price degradation, battery solutions are becoming an attractive investment on a private investor, a utility as well as an independent system operator (ISO) or transmission system operator (TSO) level. A battery solution can be in conjunction with a PV power plant or not. The addition of this component to the system, in terms of its unknown future behavior, maturity of the different technologies, the complexity, the difficulty to design battery systems with an approximate (dis-)charge profile, the unpredictability of weather profiles and the implications of future legislation on the high upfront investment, leaves investors insecure. This announces a new era for controlling of modern power plants.

Modern power plant control: Modern power plant controls (PPC) entail a symbiose between the classical controller and the monitoring system. With the incorporation of the upcoming batteries, the PPC will additionally have to support frequency regulation (FR), non-/spinning reserve, voltage support, self-consumption, power backup or black start. Some of these services require a faster control rate (100ms) as is necessary for the PV plant. The battery system itself comprises multiple battery systems, sometimes with different characteristics due to time shifted investments. The system is bounded to internal constraints, to provide maximum power and/or energy. This leads to the necessity of individual control of and communication with each battery system separately. The overlaying of multiple objectives increases the complexity of the controller, as the controller software consists of one solution to solve all cases.

A battery project is designed to fulfil one or more objectives. These are contractually fixed; therefore, the design comprises enough battery power and capacity over the plant's lifespan. Both large scale battery applications and hybrid power plant design tools are in the beginning of their learning curve, inevitably leading to inaccurate battery capacity and system fault tolerance planning. This is where the monitoring system supports the asset owner and indirectly contributes to the maturing process of battery systems in general.

The monitoring system offers posteriori, real time and priori analyses of the power plant including battery systems and it forms a legal foundation to prove compliance with the operating terms and conditions. A posteriori analysis comprises PV, battery and plant specific characteristics. Some characteristics for the battery part are: number of cycle per day diagram, DC voltage and current window maps, round trip efficiency tracking, capacity tracking, state of charge operation diagram, heat profiles of the battery system, number and cause of outages and duration, state of health diagram, number, date and type of battery checks that are performed. Additionally, multiple equivalent systems are compared with one another to identify extraordinary behavior. Important plant characteristics are how efficient is the battery

capacity used, business case specific targets. These key performance indices are reported automatically to the asset owner.

The real-time analysis keeps track of instantaneous health of the system, failure notification and identification and service partner notification. Additionally, direct control of the complete power system enables the operator to (de-)activate parts or the complete system.

A priori analysis empowers the asset owner to optimize current and future investments with respect to real or changing use cases. The analysis incorporates historic plant data, e.g., weather data, conversion efficiencies of inverters, degradation of PV modules, capacity degradation of battery, battery module and inverter outages, and plant prediction models. The asset owner gets reported whether the plant is on target and/or can deliver extra services to increase revenue.

The monitoring system in battery plants is indispensable, as it largely reduces the asset owner's insecurities.

Just like monitoring systems have changed PV systems in their early age, so will they, yet again, drive modern power plant control to an indispensable element in this new battery era.

Conclusion: Designing hybrid plants for a specific business case, is a challenging job and deemed to be prone to inaccurate design, leading to suboptimal use of resources. Monitoring systems empowers the operator/owner to analyze performance, to check investments and to forecast investment opportunities with respect to plant upgrade, plant maintenance and changing business cases.