SANTERNO
ENERTRONICA GROUP

7.5 MW / 5.2 MWh Energy Storage System, installation completed

A SMART ENERGY STORAGE SYSTEM PROJECT

Santerno installed and commissioned a 7.5 MW, 5.2 MWh storage system to serve as a grid stabilizer in an off-grid petrochemical plant.

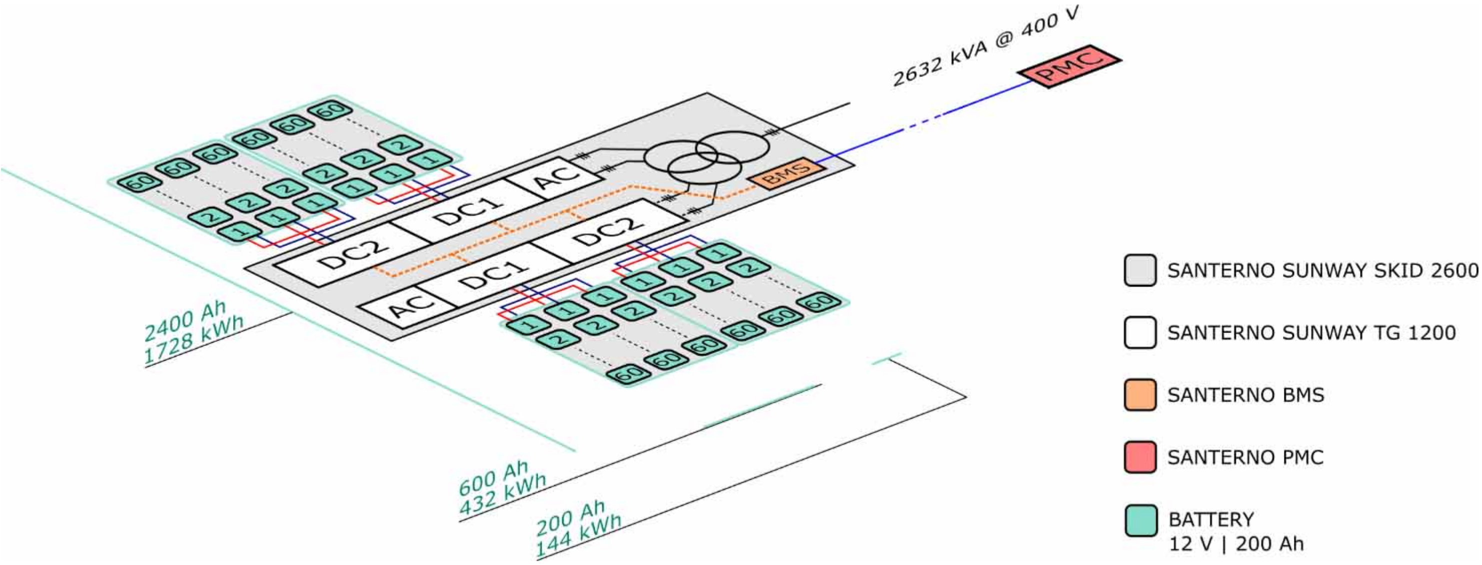
The system comprises three functional units, each featuring one Santerno Skid controlled by a Santerno power management controller (PMC). The units serve three sections of the plant which may be either connected to each other -de facto paralleling the units- or not. Santerno Skids are modular, plug and play solutions integrating one or more inverters, an LV/MV transformer, an MV switchgear and auxiliary equipment, such as remote monitoring devices, mounted on a concrete base. The Skids shipped to the petrochemical plant include two Sunway TG1200 1000V TE inverters each, connected to VLRM batteries working at a nominal voltage of 720 V and controlled by a Santerno battery management system (BMS). The inverters can discharge the batteries up to 2C rate.

The petrochemical plant works off-grid, lacking a connection to the national electric grid. Loads, ranging from MW-rated water pumps to ICT devices, are powered by steam turbines. Santerno was asked to deliver a solution addressing some critical grid stability issues affecting the plant, leading to frequent shutdowns of machinery. Santerno Skids jointly with Santerno PMCs are now preventing interruptions in the functioning of all equipment thanks to fast and accurate voltage-feedback and frequency-feedback control algorithms.
Voltage-feedback regulation is autonomously carried out by the inverters, which absorb reactive power when grid voltage exceeds a certain threshold and generate reactive power when grid voltage gets too low. Such voltage-feedback regulation leverages the fast response of the inverters, which vary their output according to variations in the grid voltage within milliseconds, typically.

Frequency-feedback regulation is performed by the PMCs. Frequency-feedback regulation consists in supporting the grid by injecting active power when the grid frequency falls below a preset level and by absorbing active power when the grid frequency overshoots. Both production and consumption of active power hinge on batteries, which get discharged or charged. Hence, frequency-feedback control relies on real-time communication between the PMCs and BMSs. Both Santerno PMC and Santerno BMS feature Ethernet connectivity. This allows them to communicate via the local LAN and PMCs, through which the user monitor and controls the system, to be installed in a convenient location.

Architecture

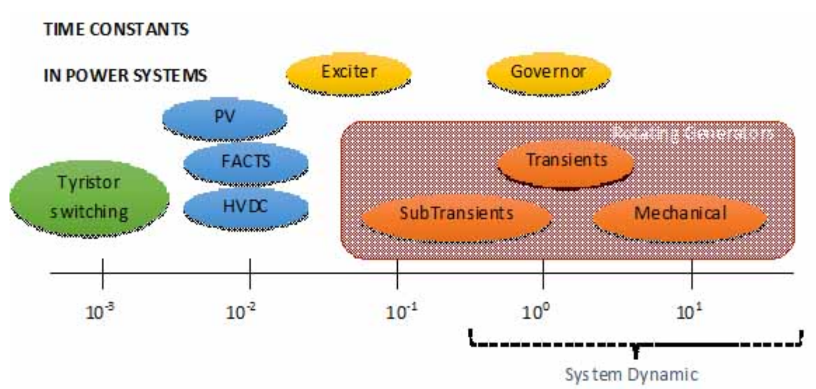
Santerno solution was designed as per the following hierarchical architecture:



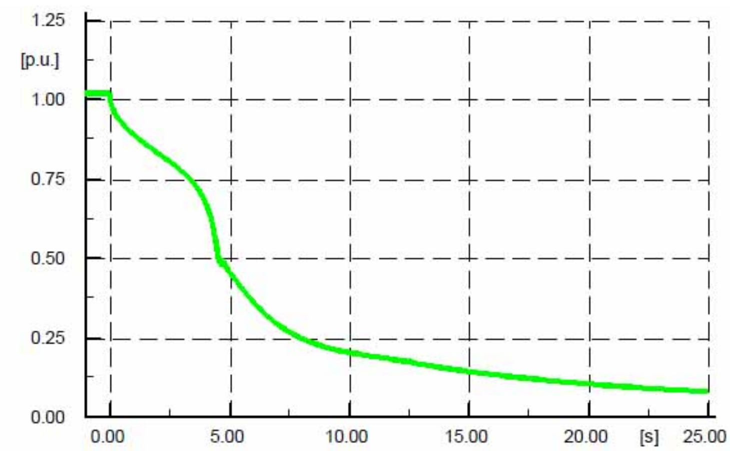
High level power management control is implemented at the PMC level. Santerno PMC features include voltage regulation, P/Q setpoint, power shift, frequency feedback control. Medium level battery management is implemented at Skid level, thanks to Santerno BMS. BMS features include battery supervision, charge/discharge, periodic equalization. Low level power conversion control is embedded into the inverters and includes grid interface functions, power regulation, voltage feedback control.

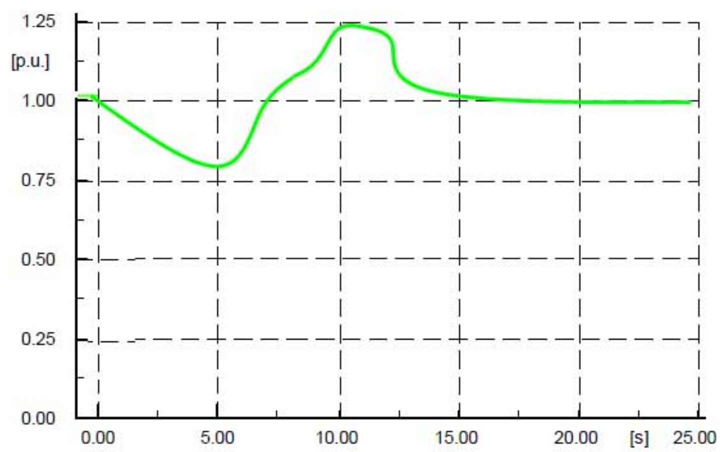
Dynamic simulation and assessment

During the feasibility study of complex power management projects, involving disparate loads and generators, correctly analyzing the system dynamics is key to a successful deployment. The task is complicated by the contributions from both loads and generators varying over time along with their operating conditions. It should also be noted that time constants characterizing the devices connected to a typical industrial power plant range from milliseconds to seconds.



Dynamic simulation is an industry practice that Santerno routinely adopts in the development and deployment of its solutions from the photovoltaics portfolio. Leveraging the experience built up in solar applications, a dynamic simulation of the plant was therefore run to get the power management solution design off the ground. The petrochemical plant is powered by large synchronous generators, serving distributed loads (e.g. pumps, compressors, motors) among which a few 1 MW+ motors stand out for the impact of their discontinuous operation on local grid stability. A simplified representation of the plant, featuring all generators and most critical loads, was used for the simulation. Since transients associated with motors connection and disconnection typically last for some 20 seconds, simulation was run with a timestep of 1 ms. The plant behavior was simulated both without and with Santerno power management solution at play.





Simulations showed Santerno power management solution to be extremely effective at stabilizing the local grid even during the most demanding transients thanks to the combined effect of fast active power and reactive power modulation.

Flexible and powerful technology

Santerno inverters are native four-quadrant operating devices. This enables independent management of active and reactive power. In this specific project, inverters are marshalled by Santerno BMS. The result is a flexible, powerful and safe active front-end to the grid. Control algorithms implemented in all Santerno inverters are developed adhering to a proven and quality-oriented workflow hinging on synthesized software code, verified by hardware in the loop tests before release. This automotive-derived method has shown inherent robustness over time and makes fast development and deployment of enhanced functionalities possible whenever needed.

Commissioning and start-up

Santerno supported the commissioning and start-up of the whole system, including verification of system integration works performed by the customer on-site.
The key steps towards project completion were

- System Integration validation
- Local and Remote Monitoring commissioning
- Inverter commissioning and start-up
- PMC and BMS commissioning and start-up

Remote operation and monitoring

Santerno devices feature native Internet connectivity. Among other benefits, this allows our commissioning engineers to be fully supported remotely by Santerno headquarter personnel in real time. PMC and BMS configuration was carried out remotely at a dedicated Research and Development team's hand, for instance. Even commissioning procedure was executed under the direct control of staff working in the . newly operated Control Room, capable of both actively controlling and collecting data from Santerno devices installed all over the world
Native Internet connectivity also allows Santerno inverters and monitoring solutions to leverage extensive cloud services: data collected by . embedded dataloggers are uploaded daily to Santerno cloud and fed to advanced diagnostics and performance analysis algorithms
In this project, a dedicated dashboard was developed for the customer to monitor system performance with an eye on both daily grid .stabilization activity and long-term battery performance