Portuguese Demo: VPP

Virtual Power Plant, maximizing the flexibility from the aggregation of different renewable generation technologies

A virtual power plant is a concept of joint operational control of multiple power production units. By virtually combining/pooling different generation assets, the flexibility of energy production can be increased.

A virtual power plant uses flexibility from centralised resources: provided by large-scale storage and RES power at the transmission level to test the optimised operation of a variable speed pumped storage power plant, with the capacity to provide dynamic FRR combined with wind farms, as well as demonstrating the ability of the aggregated portfolio to participate in energy markets, and provide flexibility to the system, via frequency regulation and balancing reserves.

Key Features

- Decision support tool for improved real-time management of a storage and generation portfolio, based on mathematical models, including short-term balancing operations
- Tool that integrates forecasting modules for market prices and energy supply;
- Should be used as a market bidding suite for different markets, respecting medium-term strategies for storage management;
- Expected to challenge regulatory constraints, and support emerging balancing area concepts with technology hybridisation;

Implementation approach

The VPP tool developed includes two main elements: The VPP Core and the VPP Controller. The VPP Core is a cloud-deployed software module responsible for performing the stochastic optimisation of VPP control. Operation is orchestrated by a workflow engine that allows the periodic execution of necessary tasks, such as the creation of market bids (capacities and prices), calculation of power dispatch schedules, and transfer of data between inner and outer data sources.

The main algorithmic modules of the VPP Core are:

- Forecasting Module, gathers the forecasts of natural resources, unit availability, system's situation, and market prices.
- Dispatch Optimization module, performs the dispatch of each unit with bids sent to the different markets

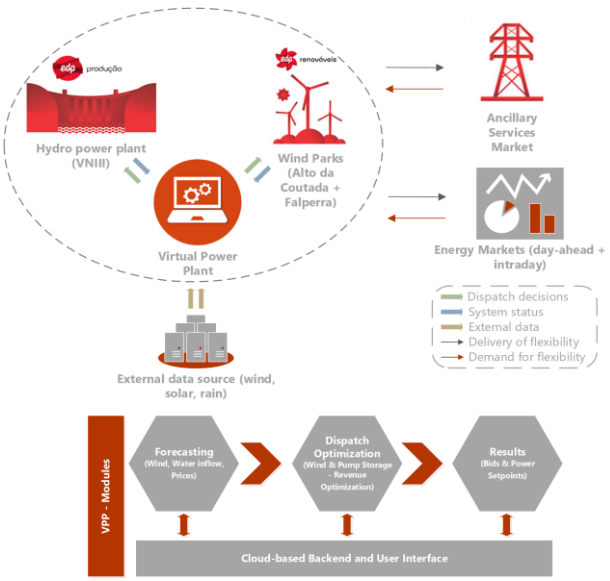
The VPP Controller implements the calculated schedules, handles deviations, and provides feedback from the generating units to the VPP Core.

The demo case studied included three EDP assets: a Variable Speed Hydro Power Plant 756 MW (Venda Nova III) and two Wind Farms: Alto da Coutada (115 MW from 57 turbines) and Falperra (50 MW, 25 turbines).

Testing included an offline testing phase, dedicated to preparing the online demo, and ensuring the validity of procedures, as well as testing wider scenarios and evaluating their economic benefits.

The online demonstration was carried out to prove the technical feasibility of the approach by autonomously controlling the pumped hydro storage in VNIII for deviation handling of wind farm power output.

VPP Overview



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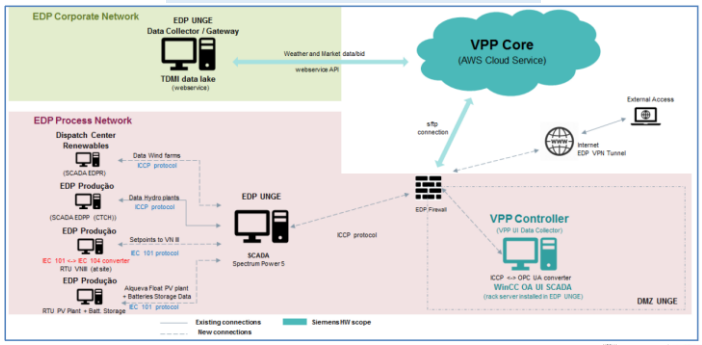
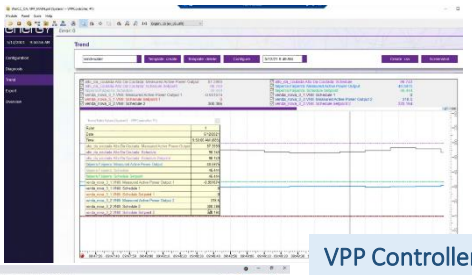
https://eu-sysflex.com/documents/

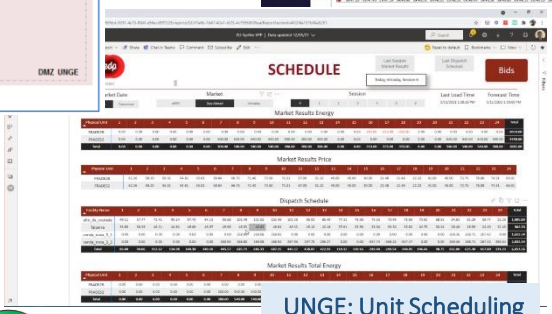
VPP final architecture



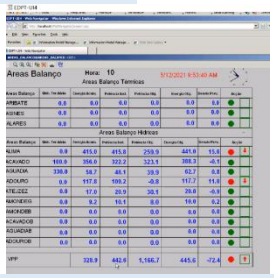
Online testing screens



VPP Controller



UNGE: Unit Scheduling



EDPP: VPP as a balancing area

Key Achievements

- New tool for optimised management of unit portfolios;
- Alternative way to integrate renewables in the power system as feed-in tariffs fade out;
- Leading to a reduction in deviations and imbalances (as compared to the case with units participating individually in the market);
- Showing the benefits of hybridising different generation/storage technologies.

Findings

The VPP was proven as an effective tool to manage a pool of resources, i.e. executing portfolio management of different types of RES units. Pooling different RES units helps to reduce forecasting errors, thus lowering imbalances, which may result in a more stable overall system.

As increasingly more variable renewables join the energy system, aggregating them into VPPs with controllable units/storage (such as hydro) for joint operation and market participation emerges as a viable option for integration into the system. This is expected to also foster the addition of RES, with easier and smoother integration, from both the standpoint of the unit owner/operator, and the system operator, to jointly aim for a secure and stable decarbonised energy system.

Recommendations and Lessons

- Pooling of variable producers (as renewable resources) reduces relative forecasting errors, which leads to a reduction in generation imbalances, as well as an increase in overall producer revenue, and showcases the benefits of joint market participation enabled by the VPP concept.
- Pooling of producers and consumers reduces the effects of market price forecast uncertainty. Local balancing of power generation and consumption reduces the overall capacities to be traded on energy/reserve markets.
- Energy storage can shift power production and consumption, perform price arbitrage on markets and handle forecast deviations.
- Main lever for improving overall performance of the VPP Core is more accurate forecasting of market prices, as well as further enhancement of algorithmic features for market bidding strategies and handling forecast uncertainty.
- National regulatory frameworks must still evolve to allow the VPP concept, i.e. joint dispatch and operation of different types of generation units, to be implemented.

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