ABB Power Generation explains the benefits that a Virtual Power Pool (VPP) can deliver, the challenges faced by operators and how a central control system will play a central role in optimising participation in electricity markets.

VPPs offer the potential to connect small and medium renewable power plants to the electricity market, and provide grid services such as power balancing. These represent greater penetration of renewables and therefore greater income for plant operators.

VPP is a term to describe a collection of power generation sources, energy storage devices and demand response participants distributed around a distribution grid. Almost any power generating technology can form part of a VPP, including biogas, bio-mass, combined heat and power (CHP), microchip, wind, solar, hydro, power-to-heat, diesel engines and fossil fuel.
Making virtual power pools a reality

Process Automation Power Generation

Optimization system will then assign power capacities from load demand and the VPP's long-term obligations. A market power capacity, renewable production forecast, the foreseen consumption inside the VPP itself.

Broadly speaking, a VPP has three goals: obtaining better energy bills.

Three distinct markets are available for VPPs, these being the balancing market, the spot market and the derivatives market. Although this article refers to the German energy market and the European Energy Exchange, the concepts apply to most international power grids and energy markets.

The first of the markets is the balancing power market. Its role is to ensure stable operation of the power grid, which requires a balance between supply and demand. The market aims to keep the frequency inside tightly defined limits around 50 or 60 Hz, depending on the grid, and also compensate for regional differences in generation and consumption.

It operates by injecting or absorbing ‘balancing power’ into or from the grid. Balancing power is supplied from three sources: primary balancing power, secondary balancing power and minute reserve. The transmission system operator (TSO) purchases these from ancillary service providers through a tendering process.

The key to joining the balancing market is to qualify as an ancillary service provider, which requires gaining approval from the TSO for each generation unit. Whereas conventional power plants were once the only source of balancing energy, VPPs can interconnect multiple smaller generators to reach the minimum threshold for participating in the balancing power market.

To participate, the VPP’s agent will place bids on the market for the VPP’s available balancing power.

Second is the spot market, which in Europe is EPEX (European Power Exchange). It offers VPP operators two options for short-term trading: the Day-Ahead market and the Intraday market. Day-Ahead trading is the term for a daily auction of electricity for the following day. Electricity is packaged into hours or blocks of hours and is auctioned at noon every day of the year without exception.

Intraday trading enables the purchase of blocks of electricity to be consumed on the same day, either in blocks of 15 minutes, one hour or several hours.

The third market is the power derivatives market, for example the European Energy Exchange (EEX). Brokers trade power futures and options on this market and often use it to hedge against price fluctuations on the spot market.

Successful VPP operation calls for a VPP operator who has a clear overview and control of power generation assets, as well as good management of participation in the energy markets.

A central control and optimization system is the foundation for both aspects of operation. On one hand it connects the decentralized assets and on the other it optimizes the operation, planning and commercial decisions. To achieve this, the control system must meet the high availability standards required for grid operations and real-time operating data must be available.

A rapidly growing installed base is a common challenge for VPP operators. For this reason, the central control and optimization system must be highly scalable so that it can accommodate fast growth from a few units to thousands. One operator using an ABB control system grew its base from 20 units to more than 2,800 in less than three years. And because the hardware and software was hot-swappable, the units were added without interrupting operations.

Another central tenet of VPP operation is ensuring the highest standards for cyber security. Generating assets are distributed across a large area and have wireless connections. They can be protected by equipping them with remote terminal units that communicate using private GSM or encrypted Internet connections.

ABB has the expertise, hardware and software that cover all aspects of control and optimization system requirements for the relevant generating units.

In terms of operations, the interfaces are designed to enable the VPP to integrate the control system into its IT landscape, including connections to the markets themselves, systems used by the market traders and grid operators for access to balancing power reserves, as well as accounting, reporting and diagnostic platforms. There are also interfaces required to automate the flow of information and signals from generating assets in the field.

Behind the interface, optimization software uses algorithms to control the generators’ set points in real time. The system takes account of online measurements of plant properties such as power limits, disturbances and schedule deviations. This enables the optimization program to run the VPP in the best possible configuration.

A successful control and optimization system is made up of modules that look after control of generating assets, monitoring, forecasting, trading and invoicing.

As renewable energy grows in popularity, the job of matching power supply and demand is becoming more complex. VPPs have a strong role to play in helping small generators market their energy in a cost-effective way.
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