

Virtual Power Plant as a vehicle for delivering efficient integration of DER

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VPP Focus of FENIX

- Provide novel solutions for cost-effective integration of Distributed Energy Resources (DER) in the operation and development of electricity networks
- Virtual Power Plant (VPP) as a key delivery mechanism
 - Provide access of DER to energy market (commercial aggregation)
 - Provide access of DER to ancillary and network management services markets (grid aggregation)

What is a Virtual Power Plant?

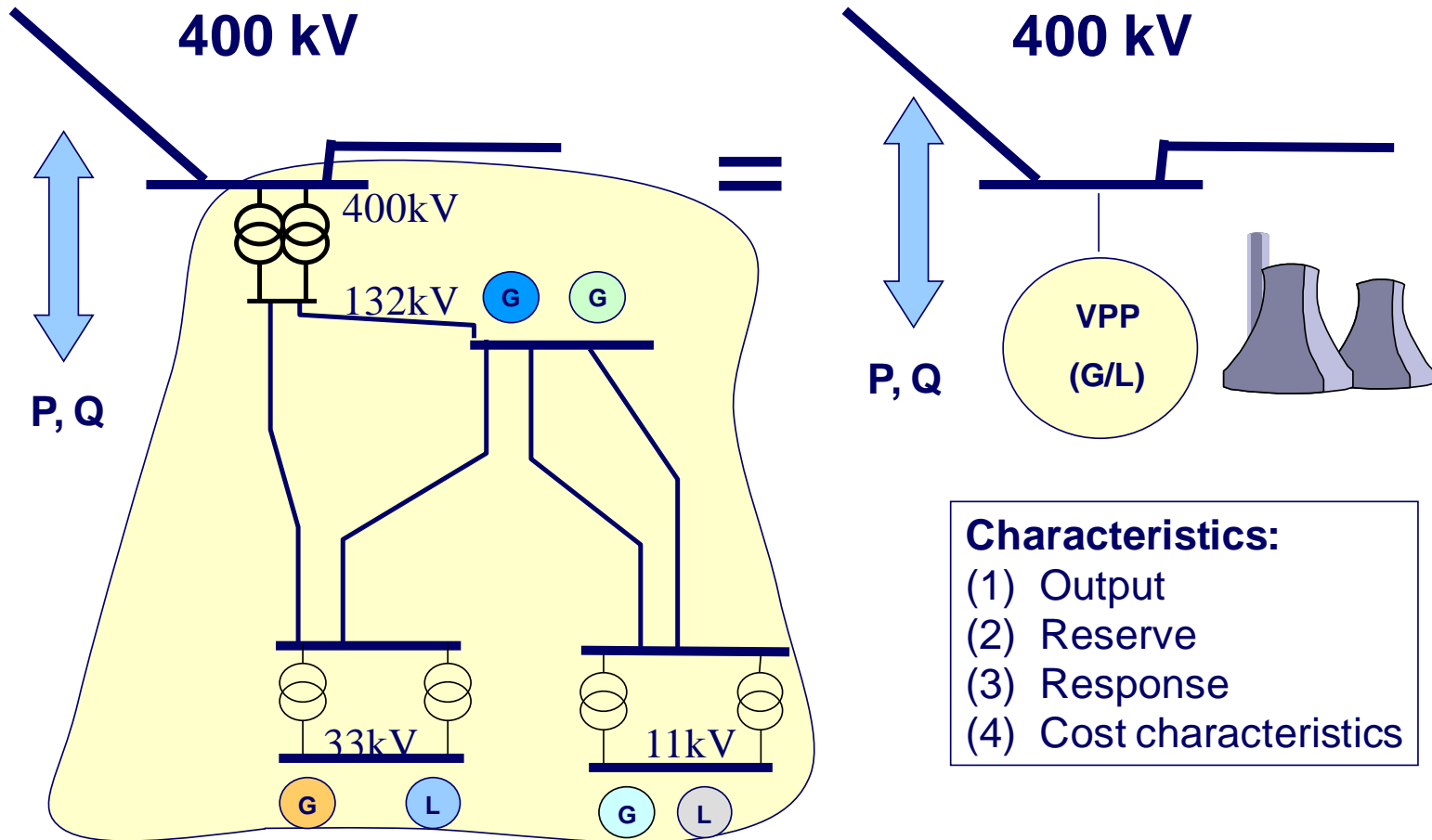
(From FENIX glossary)

- **Virtual Power Plant (VPP)**
 - *A Virtual Power Plant (VPP) aggregates the capacity of many diverse DER, it creates a single operating profile from a composite of the parameters characterising each DER and can incorporate the impact of the network on aggregate DER output.*
 - *A VPP is a flexible representation of a portfolio of DER that can be used to make contracts in the wholesale market and to offer services to the system operator. There are two types of VPP, the Commercial VPP (CVPP) and the Technical VPP (TVPP). DER can simultaneously be part of both a CVPP and a TVPP.*

FENIX definition of DER

- DER encompasses all energy resources in the distribution network including:
 - Generation units
 - Responsive loads
 - Electricity storage systems
- FENIX DER can include resources of various flexibilities:
 - Dispatchable / predictable
 - Inflexible / intermittent

VPP Concept: Analogy With Conventional Generation



Challenges in Characterising VPP (1)

- VPP is a complex generating plant
 - Diversity of technology and locations – electricity-led, heat-led CHP, weather condition driven output
 - Characteristics of demand (process, amount of storage, load recovery patterns)
 - Inter-temporal dependencies
- Uncertainty in:
 - VPP output
 - Reserve capabilities
 - Dynamic response characteristics

Challenges in Characterising VPP (2)

- Wide range of time horizons to be considered
– from seconds, minutes to hours
- Incorporation within DMS & EMS systems
- VPP characteristics may vary significantly in time (load/output patterns etc.)
- The characteristics of the network to which the DER are connected will also impact the overall characterisation of the VPP

Benefits of VPP concept

- DER are currently not integrated into system operation and market participation
- Too small and too numerous to be visible or manageable on an individual basis
- VPP counteracts this problem by aggregating individual characteristics from a portfolio of DER
- The aggregate characteristics can then be used in a manner similar to transmission connected generation

VPP – Source of Control

- VPP as a **source of controllability** of transmission and distribution networks
 - Frequency control
 - Voltage control
 - Flow control
 - Fault level control
 - Stability enhancement
 - Reliability enhancement

Examples of generation and load parameters to characterise a VPP

Generator parameters	Controllable load parameters
<ul style="list-style-type: none">• Schedule or profile of generation• Generation limits• Minimum stable generation output• Firm capacity and maximum capacity• Stand-by capacity• Active and reactive power loading capability• Ramp rate• Frequency response characteristic• Voltage regulating capability• Fault levels• Fault ride through characteristics• Fuel characteristics• Efficiency• Operating cost characteristics	<ul style="list-style-type: none">• Schedule or profile of load• Elasticity of load to energy prices• Minimum and maximum load that can be rescheduled• Load recovery pattern

VPP functionality

- The VPP can be used by system participants to:
 - Facilitate access for DER to a wide range of markets (e.g. forward markets, Power Exchange)
 - Provide services to support system management (e.g. reserve, frequency and voltage regulation)
 - Unlike transmission connected generation, it can contribute to active management of distribution systems
- These two activities give rise to two different types of VPP:
 - Commercial VPP (CVPP)
 - Technical VPP(TVPP)

CVPP and TVPP (1)

- CVPP is a competitive market actor (e.g. supplier)
- Composition of a CVPP portfolio is not necessarily constrained by location
- DER will contract with a CVPP to optimise their revenue potential and market visibility
- A single distribution network area may be occupied by more than one CVPP
- DER free to choose which CVPP offers them the most favourable representation

CVPP and TVPP (2)

- Because of locational requirements, TVPP is a monopoly role of DSO (able to access local system information)
- TVPP will include every DER in a distribution network region
- TVPP will represent the network region at the point of connection with transmission
- DER operating and cost parameters (received from CVPPs) and local network knowledge will be used by TVPP to manage the local system

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