

# Using VPP for supporting grid operation: The system operator perspective

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# TVPP definition

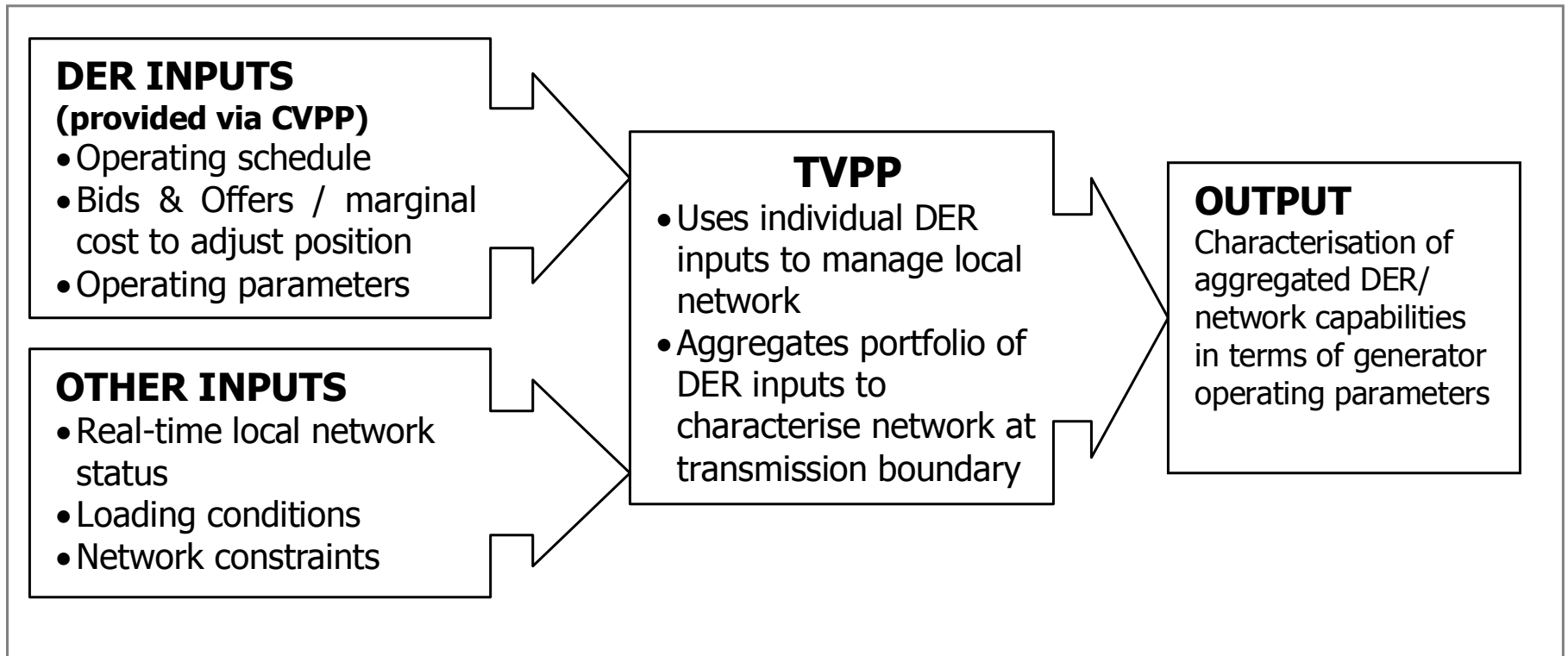
(From FENIX glossary)

- *A **Technical VPP (TVPP)** is a type of VPP. The TVPP consists of DER from the same geographic location. The TVPP has an aggregated profile which represents the cost and operating characteristics of the DER portfolio, it also includes the influence of the local network on DER portfolio output.*
- *Services/functions from a TVPP include local system management for DSO, as well as providing TSO system balancing and ancillary services.*
- *The operator of a TVPP requires detailed information on the local network; typically this will be the DSO.*

# Using DER for system management through TVPP

- Technical VPP provides the following:
  - Visibility of DER to the system operator(s)
  - DER contribution to system management activities
  - Optimal use of DER capacity to provide technically feasible system services incorporating local network constraints
- TVPP aggregates the characteristics of a system containing DER, controllable loads and networks within a single electric-geographical area
- A hierarchy of TVPP aggregation may be created to characterise operation at low, medium and high voltage
- At distribution-transmission interfaces TVPP presents a single profile representing the whole local network, equivalent to transmission connected generation

# Technical VPP activity



# TVPP participation in local system management and grid aggregation

- TVPP requires information on each DER in its network to facilitate active network management and technical characterisation of the network at the transmission level
- TVPP aggregates the operating positions, parameters and cost data from each DER in the network together with network information (topology, constraints etc.)
- TVPP activity requires local network knowledge and control capabilities – typically DSO will be best placed to fulfil this role
- TVPP characterises the local network at its point of connection using the same parameters as transmission connected plant

# System operator perspective on TVPP

- TSO: evaluates the TVPP grid aggregation profile along with other bids/offers
  - Increased competition between service providers may improve market efficiency
- DSO: can evolve to use TVPP for active management of the distribution network
  - DSO will continue to be a local monopoly – active management would need to be a regulated activity

# Potential services for grid operation

- Local services:
  - Voltage support
  - Local congestion management
  - Security services
- System services
  - Balancing
  - Reserve
  - Frequency response
  - Transmission congestion management

# Case study

- Development of an algorithm to quantify TVPP characteristics
  - Factors under consideration:
    - Individual generator characteristics
    - Network constraints
    - Loading conditions
  - Parameters under study
    - Composite re-dispatching cost characteristics
    - PQ characteristics
  - Based on AC OPF



# Composite re-dispatching cost characteristics

## Algorithm

- step 1: Compute TVPP output according to MW output scheduled
- step 2: Perturbation in TVPP output
- step 3: Calculate the cost associated with the perturbation using AC OPF

Min Cost of re-dispatch (acceptance of offer and bids)

Subject to

Network constraints including voltage and flow limits  
Generation constraints

# PQ characteristics

## Algorithm

For each TVPP output under study, compute maximum and minimum reactive power that can be exported and imported to TVPP terminal

## Optimisation problem:

Min/Max Q capability of TVPP

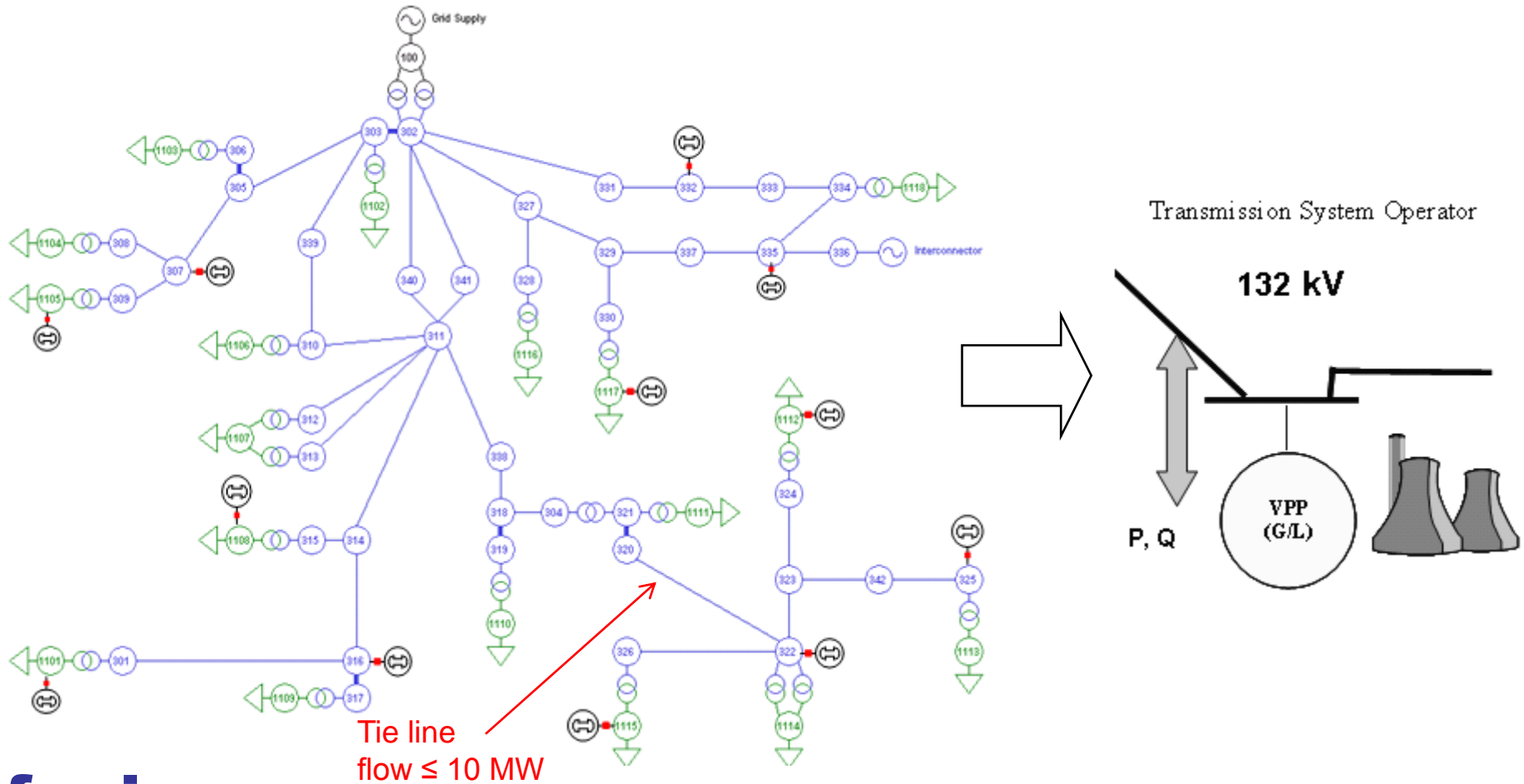
## Subject to

Network constraints including voltage and flow limits  
Generation constraints

# Test system

- TVPP concept is demonstrated for the UK Generic Distribution Network Model (EHV 1)
  - Resembles a rural network in the UK
- Total load in the network: 12.4 MW, 2.5 MVA<sub>r</sub>
- 12 distributed generators operating in the system:
  - Active output: 19.75 (min) to 40.25 (max) MW
  - Reactive output: -22.78 (min) to 22.78 (max) MVA<sub>r</sub>
- Scheduled generation: 30.5 MW (net export)
- Constraint is introduced to restrict the flow on a tie line to 10 MW

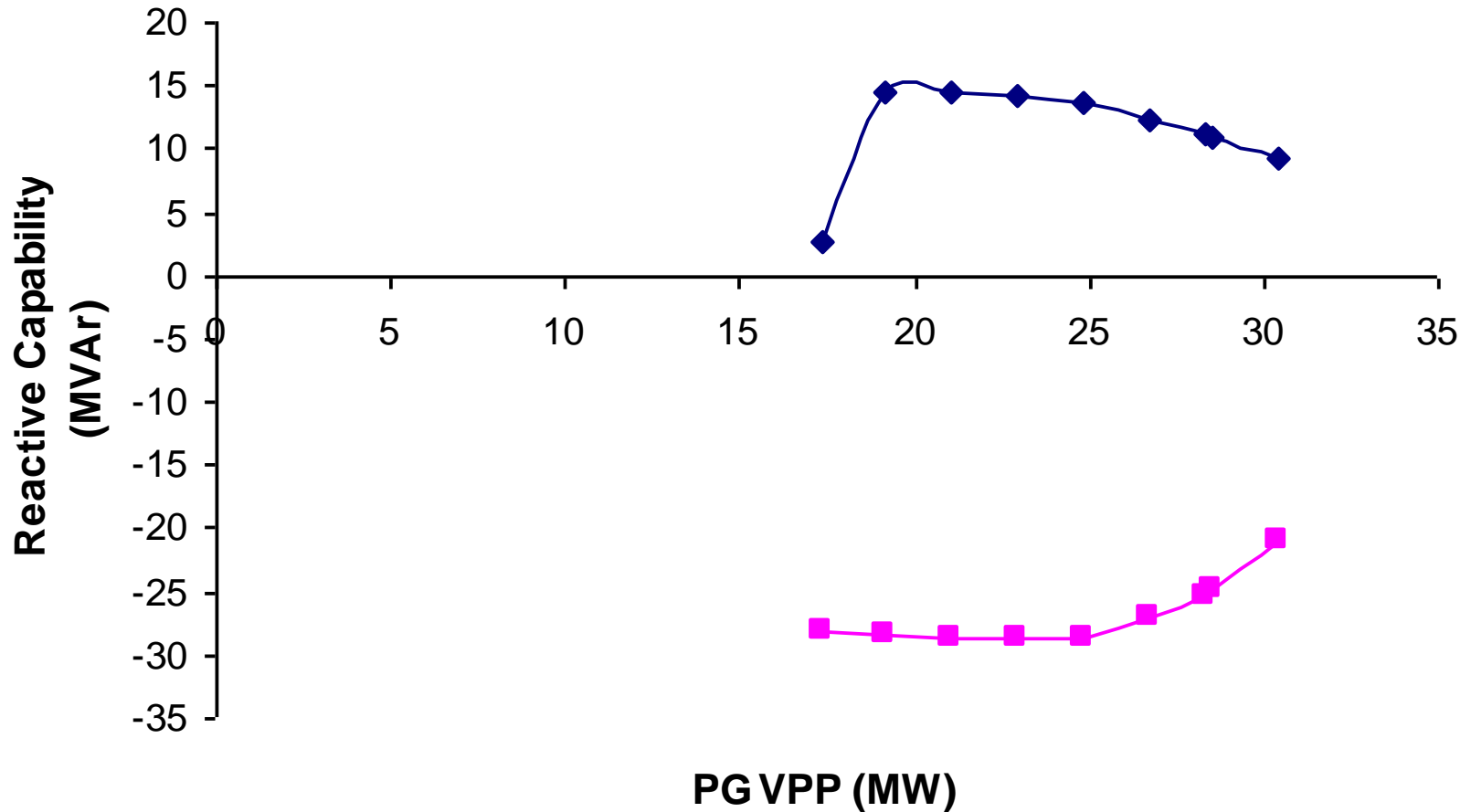
# UK Generic Distribution Network Model EHV 1



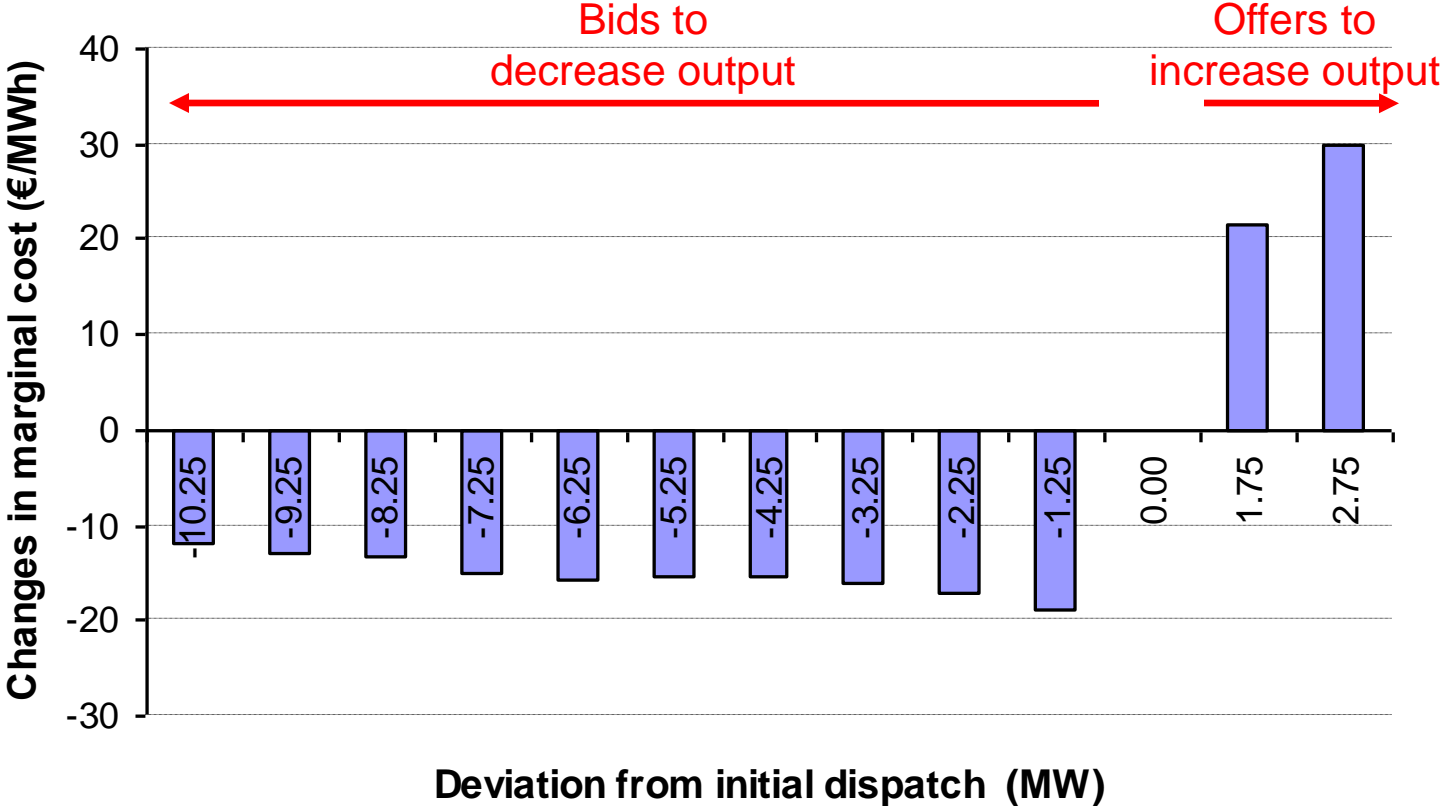
# Test system

- TVPP consists of
  - 12.4 MW and 2.5 MVA<sub>r</sub> aggregated load
  - Aggregated generation:
    - Active power limits: 17.3 to 30.4 MW
    - Reactive power limits: -28.7 to 14.3 MVA<sub>r</sub>
- Maximum limit (30.4 MW) is less than without network constraint (40.25)
  - Highlights the importance of network constraints in TVPP characterisation
- Maximum net injection of this TVPP: 18 MW

# PQ characteristic of the TVPP



# Bid offer ladders for the TVPP



# Concluding remarks

- Steady-state characteristics of TVPP derived from individual components, accounting for all relevant constraints
- Dynamic aggregation methods also elaborated in the project
- TVPP characterisation enables system operators to use DER capabilities for various system services



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