

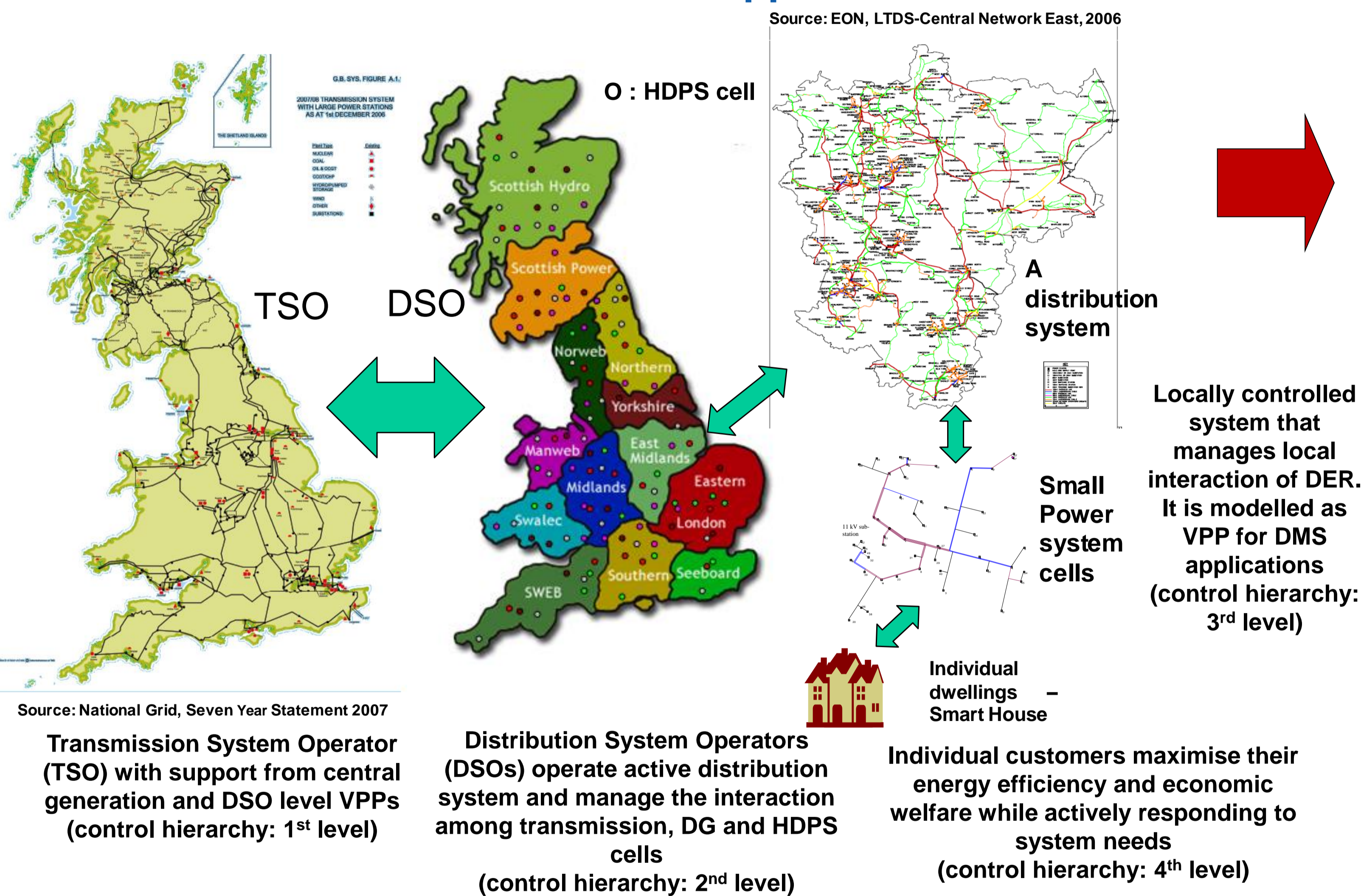
MicroGrids and Virtual Power Plant: Concepts to Support the Integration of Distributed Energy Resources

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Introduction

Highly Distributed Power Systems consist of smart grids with millions of actively controlled Distributed Energy Resources. HDPS need a new system control approach because the current centralised control approach designed for a relatively small number of large central generators is not suitable for HDPS. Decentralised control concepts have been investigated to support HDPS. The system is divided into a number of smaller and manageable autonomous and active distribution system cells (a microgrid concept) to allow local control activities while providing support to larger systems. In order to enable access of DER located in HDPS cell to system management tools and energy trading activities outside the cell, the cell is represented as a Virtual Power Plant to the Energy Management System at transmission or EHV distribution systems.

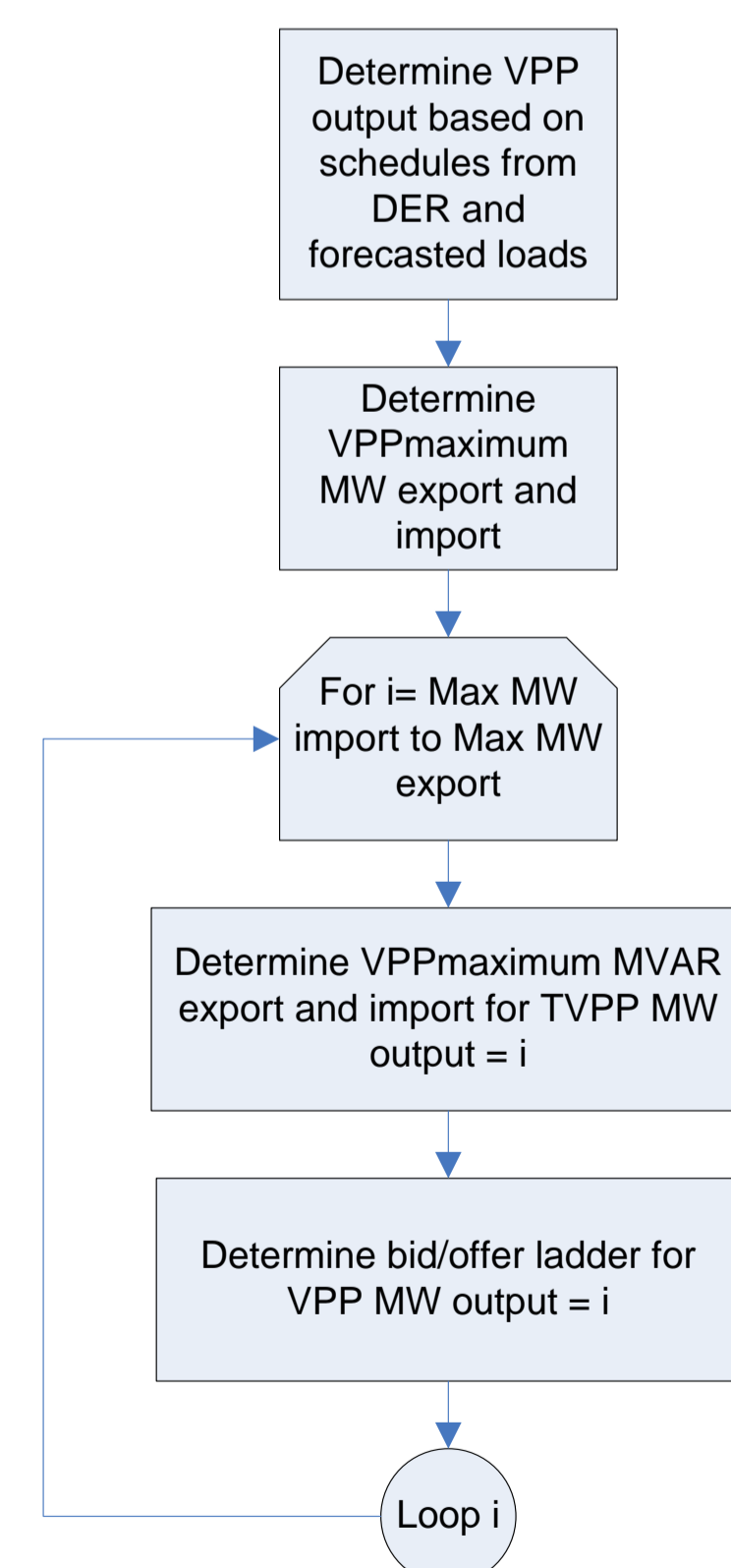
Decentralised Control Approach



VPP Parameters

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

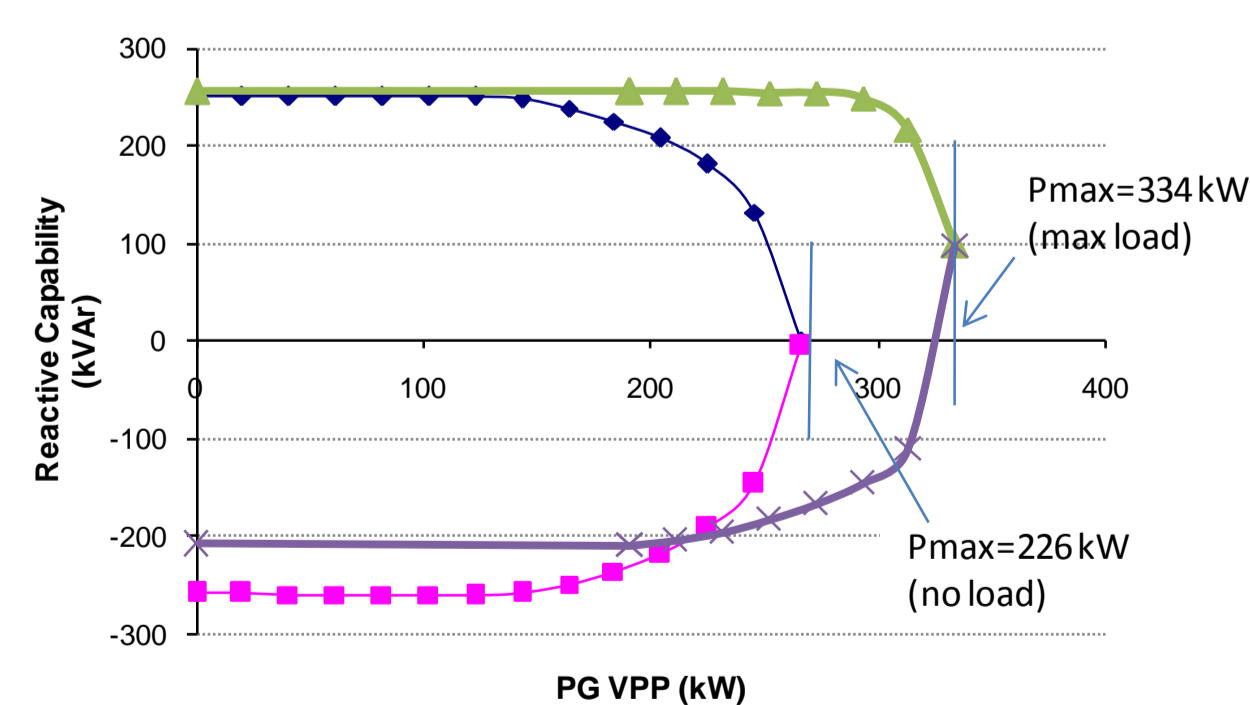
Algorithm for PQ characterisation of VPP



Research Challenges

- Characterisation and modelling of a HDPS cell consisting of a constrained network, a number of DG technologies, and controllable loads (smart appliances) as a Virtual power plant with dynamic parameters
- Synchronisation and efficient integration of autonomous local controller and VPP local system operation into larger Energy Management System
- Analyses on the technical viability and economic benefits of the proposed control concepts

PQ characteristics of VPP



List of published papers

- Aunedi M., Strbac G., Pudjianto D., "Characterisation of Portfolios of Distributed Energy Resources Under Uncertainty", CIRED - 20th Intl. Conf. on Electricity Distribution, Prague 8-11 June 2009
- Pudjianto, D., Ramsay, C., Strbac, G., "MicroGrids and Virtual Power Plant: concepts to support the integration of distributed energy resources", Proc. IMechE, Part A: J. of Power and Energy, 2008, 222(A7), pp. 731-741.
- Pudjianto, D., Ramsay, C., Strbac, G., "Virtual Power Plant and System Integration of Distributed Energy Resources", IET Renewable Power Generation, Vol 1, No 1, March, 2007, pp10-16