Virtual Power Plant for optimization of Microgrid Operation

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ABSTRACT: *In this contribution we describe technical and business case for demand side based virtual power plant for optimization of Microgrid operation. The legal aspect of European harmonized electrical market is described in the introduction section. We describe key players and roles on electrical market.*

Keywords: Electrical Market, Virtual Power Plant, Microgrid

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1. Introduction / Uvod

The increasing share of renewable energy sources and dispersed energy production are placing new challenges for maintaining the stability of the electrical grid. In pursuing this goal, demand side management (DSM), combined with energy storage, is progressively gaining in importance as one of the measures that acts both locally and on the system level. In order to benefit optimally from DSM, both market and technology drivers have to take full effect; - structuring of the vertically integrated electrical power system has to be carried out in practice, and the concept of electricity trading has to be introduced on the prosumer level to generate strong incentive for demand response.

In such a system, the DSM can be used both to reduce the energy disbalance in the Balance Group by the Balance responsible party (BRP) and as part of the ancillary services such as system reserves of the System operator (SO) to maintain the stability of the grid, with the reserves being “negative”, i.e. on the demand side; similar approach can be used also for other ancillary services for SO, in particular congestion management of local Distribution network. These two objectives largely define the target business cases: supply tertiary reserves to SO; optimize operation of the Balance group or its part for its BRP or scaled down equivalent. One subset of the latter is a micro-grid based on DSM.

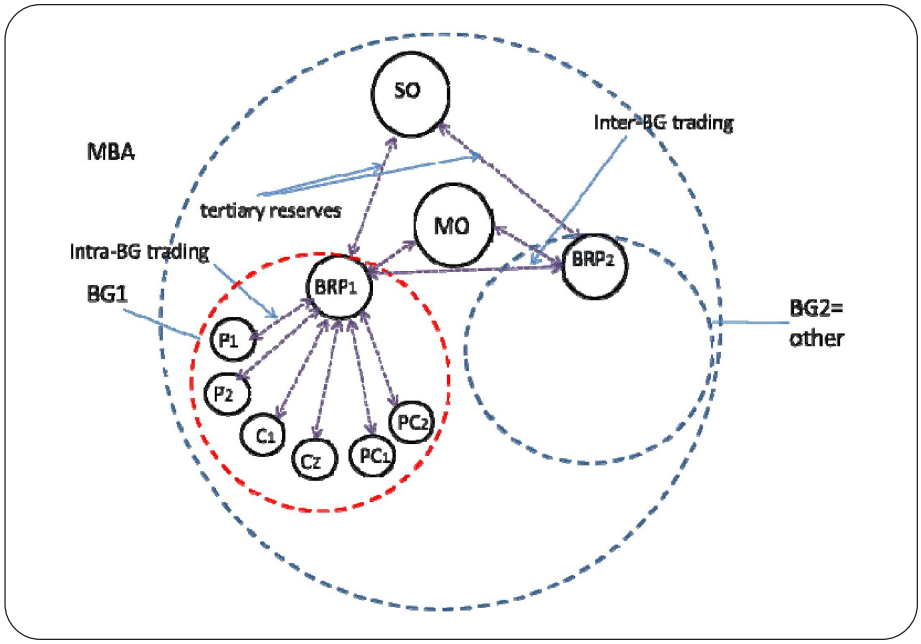
The structuring of the system and the roles of the players are in accordance with the structure of the system, roles and processes in harmonized electricity market model in Europe, joint model by ENTSO-E, EFET and EbIX, which is the common basis and lighthouse for all the evolving national models in Europe. [1],[4]

With inclusion of intra-BG automatic trading, the different trading processes and the roles (players) involved in the bottom two levels of the decomposed electricity market in the Harmonized Electricity Market model in Europe are sketched in Figure 1.

2. DSM Enabling Technologies

2.1 Automatic Trading with Prosumers in the Balance Group

Because of the large number of prosumers in the Balance group, the energy trading with them has to be carried out automatically using appropriate algorithms.



Legend:

P,i ... Producer

C,i ... Consumer

PC,i ... Prosumer

MO ...Market Operator

Figure 1. Intra-BG trading of BRP with parties connected to the grid as part of the MBA trading

This concept places the prosumer into an active role and stimulates its proactive behavior – with stimulating the internal measures for augmenting its demand response.

The prerequisite of the concept of trading is introduction of WINWIN business model into relationships of involved players, in particular between the BRP and the party connected to the grid. Such a model has already been developed in implemented in 2010 by a Slovenian SME, and successfully demonstrated in 2011 in a pilot demonstration project [2].

The evolution of this model and solution involves a radical novel approach for active demand (and supply) side management in which electricity consumers and producers issue explicit so-called flex-offers indicating their available flexibilities in time and electricity amount. The concept puts the prosumer into an active position and enables its pro-active behavior – stimulating internal measures to augment the demand response [3].

2.2 Augmented Demand Response of Prosumers

Based on price incentive, the size of demand response in prosumers can be augmented using advanced Demand Response Management (DRM) in prosumers, a set of technologies and methodologies which influence the demand response based on cost-benefit algorithms. To enable net economic benefit, the consumption scheduling at prosumer is based on concept of energy reservoirs in ambient and production processes coupled with internal energy production. Such technology adapts the size of DR to the cost-effect consideration taking into account collateral cost incurred by prosumer for peak demand reduction. The external variable is cost of energy (purchased or sold).

3. Microgrid

3.1 General Description

Project will be carried out in the frame of suitable locations with variable available prosumers and producers of EE, including with RES systems, business and industrial prosumers, public and residential buildings and including a network system of electrical vehicle charging stations.

Two sub-cases are planned: micro-grid system is connected to the electrical grid (basic case), and isolated operation of the microgrid system (auxiliary scenario).

The project location will be on the geographical territory of the DSO distribution company where the selected local community is situated. The Micro-grid responsible (MGR) will be the designated leading BC carrier.

3.2 Business Case

The business case is defined by the following boundary conditions:

- DSM vs open contracts
- DSM vs RES losses
- SO penalties (scale down of BRP use case)

Business case will grow with RES share.

Identified non-industrial or end-user partners: DSO, MGR (Microgrid Responsible)

3.3 Players - roles, Processes and Relations

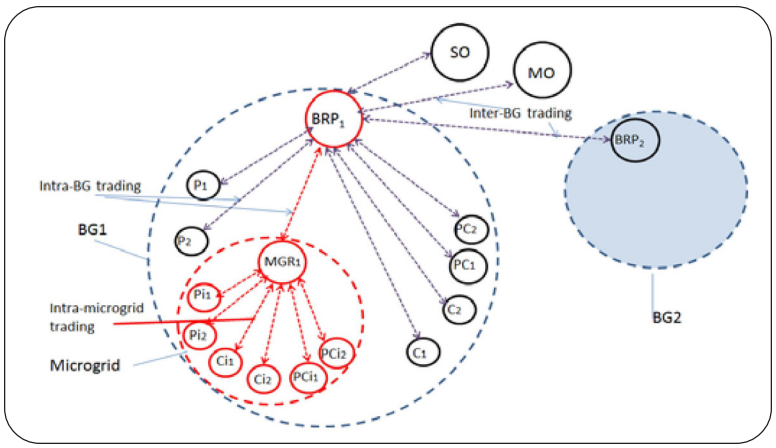


Figure 2. Players - roles, processes and relations

4. Intelligent Trading Interface

Intelligent trading interface (ITI) represents a structured interfacing system for exchange of data for communication in automatic

energy trading between prosumer‘s DRM system and the aggregating subsystem of a BRP, MGR or aggregating service. It is connected with Smart meter with both open and closed contract metering functionality for RES and other energy sources. On the trading side, it will be implemented for KIBERnet FLEX automatic trading technology and on the DRM side for KIBERnet DRM and for Smart Grid DRM systems, but its structured concept will allow to use it as a kernel system for other methodologies of dynamic pricing by automatic energy trading with standardized exchange of data between stakeholders in the process of production, transfer, consumption and trading of energy.

Virtual Power Plant consists of several elements, as depicted in Figure 3. Main building blocks are: Control Centre, Intelligent Trading Interface and Energy Management System. Intelligent Trading Interface (ITI) is a core solution that enables existing prosumers to become a part of Demand Side Management program and take advantage of his/hers flexibility in electrical energy consumption and production. ITI is an IoT device installed on top of existing EMS at prosumer and acts as an interface between VPP and prosumer.

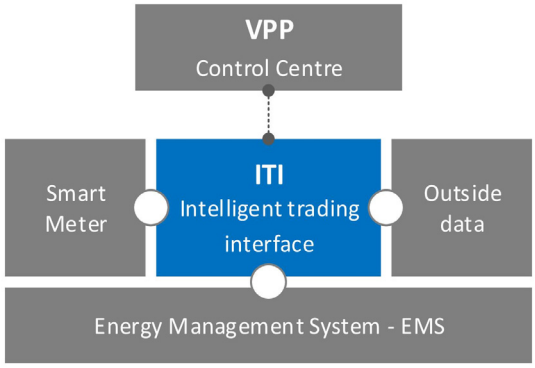


Figure 3. Virtual Power Plant architecture

5. Prosumer – The Driving Force for Dsm in Smart Grids

The interdependence and relations between DSM and EMS in the Comprehensive Smart Community can be described by the following statements:

• The case of DSM is built on DR of prosumers.

• In the concept of vertically nested systems, prosumer is the lowest level – and potentially the most complex one.

• The business case of EMS depends largely on DSM.

• The use case of DSM depends largely on EMS.

• The DSM cases are all also EMS cases.

The function of internal EMS of the prosumer is to manage the processes of consumption, production and storing of energy, with two main objectives:

• Provide reliable and secure operation of these processes, especially energy supply.

• Optimize operation of these processes, to increase their economic effectiveness by reducing the costs and increasing the revenue.

The controlling concomitant and driver is increasing share of energy production at the prosumer by inflexible renewable energy sources.

Micro-grid case is »local community or city centric«, implying an active strategy and role played by local authority directly or through ESCO models; the intent is to deploy the system to a dominant part or to a large part of community prosumers. Thus,

it is the basic case for increasing local energy supply and balancing, the backbone of the second pillar of growth of RES - dispersed energy production.

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