Developing Virtual Power Plant for Optimized Distributed Energy Resources Operation and Integration - DTU Orbit (13/12/2018)

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Distributed Energy Resources (DER) are small-scale power generation and storage technologies, typically in the range of a few kW to tens of kW, located close to the customer side. They are right now under heavy development and have a great market potential in the near future. However, these sources are usually deployed in a fit-and-forget way which to a great extent confines their value and presents challenges in relation to:

- Optimized DER operation related to time-varying onsite demand requirements, ambient conditions and electricity prices, etc.
- Coordinated control of many small units in the electric power system
- Efficient electricity market participation to benefit both power system operation and DER owners

To address these issues, an innovative concept Virtual Power Plant (VPP) is investigated in this PhD study. Based on a comprehensive overview of the state of the art of VPP, the Market-Based VPP (MBVPP) concept is proposed. The function-based MBVPP provides a generic and flexible solution for the DER integration by connecting the DER to the bulk power system operation via market participation.

Two schemes for managing the DER generation and trading portfolios, direct control and price signal control, have been discussed and simulated. Due to their prevalence and controllability, the μCHP systems are modeled to represent the general DER technology in the corresponding studies. For the direct controlled VPP, all the μCHP units are optimally controlled by the VPP operator based on forecasted market and demand information. For the proposed price signal scheme, an Artificial Neural Network (ANN) is developed to characterize and estimate the price responsiveness of a μCHP group. It is found that although the prognosis result is relatively good, the price signal controlled scheme is still challenged by many uncertainties which reside in the nature of price signal control such as jumpy response. To demonstrate the feasibility of the VPP, a prototyped VPP with two Dachs μCHP systems is set up in the laboratory as a proof of concept. It has shown that, on the premise of an advanced Information and Communication Technology (ICT) infrastructure, the VPP represents a feasible solution to be implemented.

**General information**

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