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DESIGNING BUSINESS MODELS FOR DIFFERENT MARKET PARTICIPANTS IN A HYBRID RETAIL ENERGY MARKET

Tariff-Design Options for Residential Customers

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Motivation

The increasing global energy demand and the further development of European energy markets will raise new challenges and business opportunities for different market participants in the energy supply chain across the different energy domains electricity, heat and gas. In general, different energy services (e.g. heating, cooling, lighting, etc.) demanded by customers can be met by different energy domains. Thus, electricity, heat and gas supply companies are competing for customers' load profiles. Considering certain coupling technologies (e.g. CHP, heat pumps, etc.), the different distribution grids can be interpreted as one hybrid energy network.

The work presented in this paper is part of the European FP7 project "OPtimising Hybrid Energy grids for smart citieS (OrPHEuS)". This project aims to develop hybrid energy network control strategies and corresponding business models to achieve better efficiency and smarter operation enabling a cooperative coexistence of different energy domains. For the economic validation a formal framework is set up describing the objectives, practices and interdependencies of the various market players, namely distribution system operators (DSO), supply companies and consumers.

In detail, the analytical contribution of this paper is the development of mutually consistent optimization models for each market participant from a hybrid energy networks' point-of-view considering the existing market rules but also anticipating possible future structural changes in the energy market design.

Methods

The models are formulated as linear programs (LP) and mixed integer programs (MIP). They are implemented in MATLAB using the YALMIP toolbox and solved by the Gurobi Optimizer. Some interesting aspects of the objectives of the various market participants are indicated in the following:

i. To describe the consumers' objectives, several LPs are presented. Starting from a cost function for standard customers (without self-generation) several models are developed by gradually adding new terms and constraints according to additionally installed technologies (e.g. PV systems, heat pumps, energy storages, etc.) in order to describe the characteristics of "prosumers" (with self-generation).

ii. The supply company models are also formulated as LPs or MIPs if long-term investments are considered. Special focus is laid on the difference between single- and multi-domain operation.

iii. The model describing the DSOs' objectives focuses on the asset management of the existing grid and possible further network extension. It is formulated as a MIP and aims to optimize (re-)investment timing in the grid from an economic point of view subject to the constraints set in a grid regulation process.

Results

At present, the models are still being developed. Therefore, final results on the evaluation of different business models are not available yet. However, preliminary results are presented, showing the functioning of customer models and the influence of different tariff types on the (residual) loads of residential customers/"prosumers". These findings suggest that tariff design can have a significant impact on the residual loads of "prosumers" with self-generation and energy storages if their devices are controlled automatically in a cost-minimizing way.

Curriculum vitae

Daniel Schwabeneder[1] is a research associate and PhD candidate at the Energy Economics Group at the Technical University of Vienna. He received a M.Sc. degree in Mathematics from the University of Vienna. He joined the Energy Economics Group in October 2013 as a junior researcher where he participates in international and national research projects.

His research interests in Energy Economics include modelling and optimization in terms of sustainable energy systems under consideration of hybrid grid structures and security of supply aspects.

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