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DECENTRALISED MARKET OPERATOR (DMO) – DEVELOPING A NEW MARKET ROLE IN DISTRIBUTED ELECTRICITY SYSTEMS

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Introduction

Germany's transition goals for the electricity system not only require an extensive research on technical solutions but will demand new economic concepts to ensure the transition's success. Currently, the debate concentrates on support for renewable energies, necessary infrastructure in the transmission grid and conventional power plants, especially flexible gas power plants, becoming unprofitable. The main characteristic of the energy transition is supposed to be of a decentralised nature as many renewable energy plants such as photovoltaic (PV) or wind energy converters (WEC) are connected to the distribution grid. The existing energy market structure however represents a centralistic approach and does not offer incentives for a certain distribution grid operation. Furthermore, distribution grid operators do not participate at central markets and even many local utilities perceive themselves as too small to trade independently, for example at the EEX. In contrast to this, an extensive amount of research is dedicated to technology development and smart grid infrastructure, all located in the distribution grid.
One large research programme was the German e-energy platform that comprised several long-term research projects dedicated at different aspects of Smart Grid infrastructure. Additionally, accompanying research took a closer look at regional markets, how they could work and what would be the effect (e-energy 2014). Another German research project further examined regional markets, their coupling with the central market and effects on local prices. A main outcome was that the price advantage of regional markets in the electricity sector is negligible and thus this concept cannot be the solution for the challenges faced within the energy transition (Weber 2013). So far, it is evident that on the one hand, a higher need for flexibility and changing requirements to grid operators will arise through an energy system transformation. On the other hand, it becomes clear that new economic concepts and paradigms will be necessary to ensure its success and public acceptance. Hence, there is a need to for a new market role located at distribution grid level. The concept of a Decentralised Market Operator (DMO) is presented in this paper.

Concept

This paper presents a concept for a new market role "Decentralised market operator" (DMO) who targets a cost optimal distribution grid expansion and operation. The new market role "DMO" is developed to optimize the use of different local, small-scale flexibilities, such as storage and demand side management options but also decentralized electricity generation technologies. Additionally, an actor in the energy system being the DMO can contribute to an economically optimized decentralized grid extension and implementation of efficiency measures. The DMO needs to have the ability to buy, operate and/or contract different technologies. To account for the "unbundling" directive of the EU, the DMO is not able to own the whole decentralized energy system including the grid. Therefore, the main tool of a DMO is to give financial incentives to the owners of the elements in his system. Another possibility for action of the DMO is trading at the wholesale and retail markets. This system optimizer "DMO" can therefore achieve an extension and operation of a cost effective decentralized system, according to the directive of a liberalized market. Furthermore, different grid service assignments, such as the securement of system stability, can be delegated to the DMO.

Method

For the first concept of the DMO, new trading options are developed by a qualitative analysis of current framework conditions, alternative framework concepts and opportunities and barriers for existing stakeholders. A technical potential analysis is conducted for different technologies that are able to provide flexibility to the distribution grid. Furthermore, the costs of those technologies are evaluated. From this, a selection of technologies is chosen based on techno-economic criteria. The selected technologies are analysed concerning the possibility of a DMO to use the flexibilities in an economic optimal way. Hereby, a variety of opportunities for action of the DMO will be analysed, e.g. developing a concept for a contractual agreement with end consumers so that investment into new capacities of a variety of technologies is secured. The DMO uses these options to achieve a cost optimal distribution grid operation. Hereby, distribution grid operation refers not only to grid operation, but also to generation dispatch, demand side management and considering expansion planning.
To evaluate the developed concept and trading options, an optimisation model is being developed. This model optimises the complete distribution grid operation by economic means, i.e. the distribution grid operation shall work at minimal cost. The operation includes all generation, demand and flexibility aspects as well as system security. The trading options will be integrated into the model to reflect the new market role and its actions. By examining different scenarios, the effect of changing regulatory frameworks, varying installation rates of renewable energies as well as

different limitations to the courses of actions the DMO can take will be reflected and analysed. This way it will also be possible to evaluate which effect different concepts for such a market operator would have on future system operation.

Decentralized Market Operator - DMO

With an established smart grid infrastructure more detailed data on distribution grid operation, demand and generation will be available. Furthermore, a faster direct access to operate generation or storage plants will be possible. This gives room to a variety of new operational and trading opportunities within a decentralized grid that might be used by the DMO. The analysis conducted so far has led to the DMO concept shown in Figure 1.
The DMO operates in one distribution grid and aims at an economically optimized distribution grid operation. The DMO can participate at the large, central markets for electricity and regulative power as well as develop own contractual options for the consumer in "his" system or own and operate own power plants, or storage. Therefore, the system operation and expansion will be optimised locally while considering price signals from the central market. Figure 1 illustrates the possible interaction between the DMO and other market participants as well as the restrictions and obligations he as to obey. The most important obligation might be that the DMO has to consider maintaining system stability when planning his operating modes and expansion possibilities. This distinguishes the new market role from already existing operators of virtual power plants or energy utilities.
The DMO can incentivize demand side management as well as the use and installation of new storage options or renewable power plants. Furthermore, he can install, own and operate own storage facilities. Those options shall cover the broadest possible range of generation, trading, flexibility and grid expansion options. The DMO can then use those options to achieve an optimal system operation.

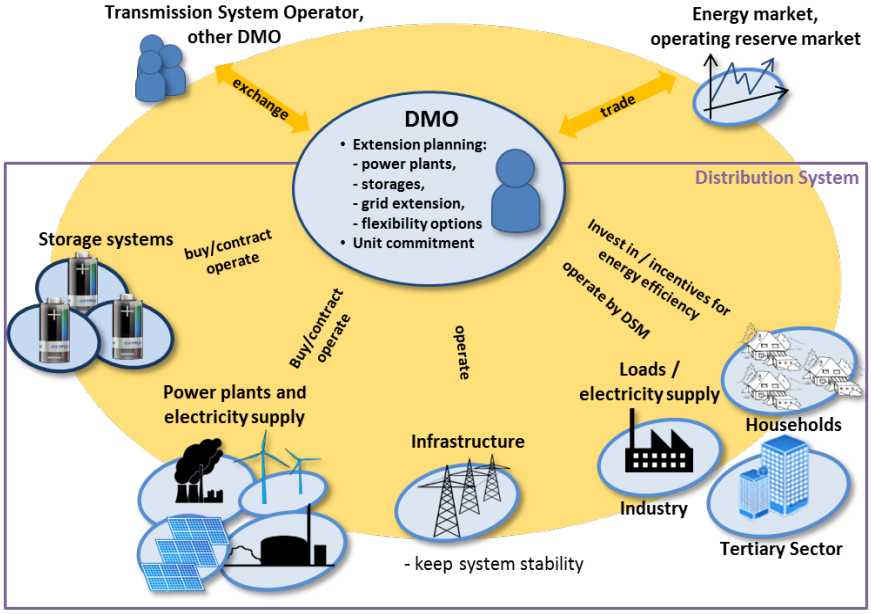

Figure 1: Options for actions, trading and interaction of the Decentralised Market Operator

However, as current legislation requires an unbundling of generation and grid operation and this legislation has to be obeyed by the DMO, a scenario analysis will be used to evaluate different concepts for the DMO. This allows examining how selecting certain trading options affects the system operation and extension. On this basis, a conclusion can be drawn which would be the most appropriate actual DMO concept considering the political objective and framework.

Conclusion

To ensure a stable and cost effective operation of the German energy system with high shares of renewable energy generation it will be necessary to develop new concepts and mechanisms. These have to ensure that the technologies necessary to transform electricity generation to a renewable energies based system are not only technically available, but that required investments also pay off. The presented new market role "Decentralised Market Operator" is a first step into this direction. Further evaluation will show how the DMO will affect different system configurations and which technological potentials can be tapped in contrast to which technologies have to be addressed by different mechanisms or stakeholders.

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