EVOLUTION OF SELF CONSUMPTION WITH DIFFERENT NETWORK CHARGING SCHEMES

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Overview

The objective of the paper is to simulate decentralized investment in self-supply over time and identify conditions for long-term stabilization of self-supply shares in distribution networks. For a number of energy systems with rising shares of distributed generation (eg. USA, Australia and Germany) the risk of a self-enforcing growth of self-supply, also referred to as the ‚utility death spiral' has been discussed [Costello et al. 2014, Hittinger & Siddiqui 2017, Simshauser 2016]. Network charges exhibit a link between rising infrastructure cost and declining user withdrawal. Hence, they have been discussed as a means to adjust incentives for decentralized self-supply [Simshauser 2016; Picciariello et al. 2015, Prata & Carvalho 2017, Procter 2013]. The research question of this paper is: What network charges lead to stabilization of self-supply shares on a sustainable level?

Methods

The paper presents a formal model of a distribution grid with growing self-supply. The model is calibrated with data assumptions based on German distribution grid data. It simulates investment into additional self-supply over several periods based on network charges and other incentives. The network is populated with two types of users; regular households and prosumer households with a photovoltaiv (PV) system. Prosumer households withdraw less energy but requir the same peak capacity as regular households.

In the model network charges that recover the cost of the network are assigned based on energy withdrawal and / or user peak load. The cost of the network is assumed as constant. Cost shares assigned via energy and respectively load vary in four different charging schemes:

- volumetric charges,
- peak load pricing,
- mixed (50-50) and
- variable load split, pegged to prosumer share.

As energy withdrawal decreases with more prosumers in the network, most of these charges (except load only) increase with prosumer shares. Also other incentives vary with prosumer share, such as the energy yields which decrease as the most suitable loactaions are occupied. As a consequence there is a feedback between investments into self-supply and prosumer shares of the previous period. All incentives from factors other than network charges are subsummated as remaining incentives.

Results

The simulations consider two scenarios of remaining incentives: moderate decrease and exponential decrease with rising prosumer shares. These are analysed in combination with the incentives from different network charging schemes.

For moderate decrease in combination with volumetric charges, the increase in prosumer shares reinforces itself over time. The system does not stabilize until eventually all network users have become prosumers. Contrarily, with exponentially decreasing remaining incentives the increase in prosumer shares is contained. The system stabilizes at a higher prosumer share.

With charges based on a 50-50-mix of energy and peak load the system still does not stabilize with moderately decreasing remaining incentives. Yet, the increase in prosumer shares is slightly slower. For exponential decrease and mixed network charges, the system stabilizes. The resulting stable prosumer share is lower than with energy based charges.

Varying the load share with increasing prosumer share stabilizes the system even in a scenario with moderately decreasing remaining incentives. Interestingly, the correlation factor between load share and prosumer share affects the magnitude of the new stable prosumer share.

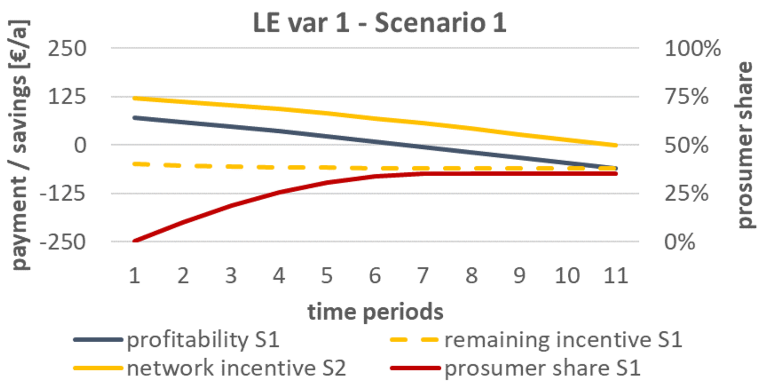

Figure: stabilization of prosumer share over time with varying load share by a correlation factor of 1 (LE var 1) in a scenario with moderately decreasing remaining incentives (scenario 1)

Conclusions

The simulations in the paper confirm that incentives for investments into self supply rise with prosumer shares for energy based network charges. As a consequence the network stabilizes at a new prosumer share or becomes obsolete with 100% prosumers. The outcome depends largely on the remaining incentives other than network charges. For only moderately decreasing remaining incentives the system does not stabilize with energy based charges. However, linking load and energy share in charges to the prosumer share stabilizes the system. The analysis finds that in this case the correlation factor between load or energy share and porsumer influences the new equlibrium prosumer share.

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