Micro auctions for distributed generation with flexible zones

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Abstract

The drivers that are likely to shape the 2050 electricity network are numerous: restrictions on fossil fuel use; increased customer participation; increased variability in the availability of generation; and new energy sources, including a more diverse range of energy sources (McArthur et al., 2012).

We need energy auction designs that can handle these challenges. The energy auction designs used today have four main problems. First, they can't handle residential and commercial demand response being more widely integrated in power markets. For example, the consumers want their TV to start working when needed, but the washing machine can start when the price is lower. We need to make sure that the supply has the tools to respond to this increased variability of demand. Second, current designs are not ready to deal with small-scale renewables (rooftop PV, small wind turbines, energy storage etc., hereafter SSS). We need to make sure that a SSS can submit optimal bids. Third, the current uniform-price auction designs used are not efficient. Fourth, given the uniform-price auction, we have potential large gap between submitted bids and the clearing price. Therefore, we have a certain amount of cost inefficiency. It is therefore necessary to consider a new and efficient auction to sell electricity.

In order to cater for these challenges, we propose two tools – Quality of Service subscriptions and proxy agents, and a new auction design. We use Quality of Service subscriptions as a way to respond to the unpredictable nature of demand and supply. In particular, consumers might pay different tariffs for high quality (instant supply on demand, Gold), medium quality (supply within specified short horizon limits, Silver) or limited quality (supply when available, Bronze) offers. Quality of Service can be combined with proxy agents that secure that bidders (SSS) submit optimal bids subject the demand. Quality of Service and proxy agents (which can be seen as Virtual Power Plants) allow for bid complementarities and therefore cost synergies. Our auction design can handle this complex bidding structure. We propose a sealed-bid auction for package bidding where bidders submit quantities (Gold, Silver, Bronze) and vectors of prices. The auction is built up around two stages. The first stage evaluates the submitted bids. The stage (as Stage 2) uses the VCG-idea in order to determine the winners, the quantities and the prices. The auction yields efficiency, it tests the market for cost-inefficiency when using Stage 2 and it can handle the demand and the SSS. The auction is designed to work for multiple small scale generators and loads in a geographically small area under the assumption on unlimited computing power.

References

McArthur, S.D.J. et al. (2012). “The Autonomic Power System – Network Operation and Control Beyond Smart Grids”, 3rd IEEE PES ISGT Europe, IEEE.