Optimal Investment in Competitive Energy-only Markets

Hamid Aghaie, PhD Student, Vienna University of Technology,
Gusshausstrasse 25-29, 1040, Vienna, Austria
Phone: +43 6889062542, E-mail: aghaie.hamid.fl@ait.ac.at

Overview

Electricity is an undifferentiated commodity with limited storage capability, low demand elasticity and wide seasonal variations. All producers with wide range of generation technologies have to bid based on their short term marginal cost in the electricity market and it makes difficulties for most expensive producers i.e. gas plants, to recover their capital costs. This issue causes less incentive for investment in new capacity which leads to resource adequacy problem. In this study, the main question is that how competitive energy-only markets can mitigate the resource adequacy problem by imposing efficient pricing and investment planning. In other words, how an energy-only market can make incentives for new investment by adjusting regulator-imposed price caps and capacity obligations in presence of both price sensitive and price insensitive consumers.

The paper is organized as follows: Section II gives a brief overview about the energy only markets and capacity markets. The section III identifies the uncertainties in the generation and demand side of the market and calculates the reliability criteria. In section IV, we describe the energy market model using system dynamics approach and the results are given in section V. The conclusion of the paper is in section VI.

Methods

In the proposed approach, the contribution of generation and demand to the resource adequacy is identified using probabilistic modeling of the components and Monte Carlo sampling. Then, system dynamics approach is utilized to comprehend the dynamics of the interactions between the energy market components such as supply, demand, market price, profitability and investment decisions. System dynamics is an approach to study the casual effects of the interactions within the components of a system during time. The contribution of this paper is to model the impact of demand response and optimal scarcity price on the incentives for new investment.

Results

The main case study is the German energy-only market with a perfect competition. It is assumed that the investors or entrepreneurs have complete information about all players in the market and they decide to invest if and only if it is profitable. We analyze the interrelationships between scarcity prices and capacity obligations and load rationing. The optimal level of investment is when the expected gap between the market price and the marginal cost of generation is equal to the expected cost of adding generation capacity of that type. The preliminary results show that the optimal load shedding period has a negative correlation with the frequency of scarcity prices and the level of price cap. Also, it is shown that the higher price cap results the lower average utilization of the price-sensitive loads in a fixed demand response capacity. The reason is that the higher price cap leads to higher revenue for new capacity and higher new installed capacity compared to the lower price cap scenarios.

Conclusions

In this study, the optimal and efficient price and investment for an energy-only market structure is derived in which price insensitive consumers may have to be rationed under some contingencies. Then, it is proved that the resource adequacy problem could be mitigated under the achieved optimal price and investment planning. The case study is the German electricity market and the optimal prices and investment patterns for a long term period are discussed. The preliminary results show the correlation between the scarcity prices and frequency of scarcity situations and the volume of price-sensitive loads.

Reference

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