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A SİMULATİON MODEL FOR THE ANALYSİS OF PRİCİNG, INVESTMENT AND REGULATORY PROCESSES İN A DECENTRALİZED ELECTRİCİTY MARKET

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Overview

In this study, a simulation model based on system dynamic philosophy is developed, to better understand and analyze the decentralized and competitive electricity market dynamics in the long run. The developed simulation model oversees a 20 year planning horizon; it includes a demand module, a capacity expansion module, a power generation module, an accounting and financial module, various competitors, a regulatory body and a bidding mechanism. Many features of decentralized markets, such as, capacity withholding, enforced divestment, price elastic demands, investment incentives/disincentives, long term contracts are incorporated into the model. By means of such a decision tool, companies and regulators have a opportunity to better understand possible consequences of different decisions that they may make under different policies and market conditions. The paper is devoted to a detailed presentation of the model. Results and findings obtained through a two phase scenario analysis are also discussed.

Methodology

In a decentralized electricity market, capacity expansion decisions are made by multiple self-oriented power companies, where decision-making of market participants is guided by price signal feedbacks and by an imperfect foresight of the future market conditions. In such an environment, decision makers need to better understand the long-term dynamics of the supply and demand sides of the electricity market and a simulation model is a most fitting tool for this purpose.

In order to better understand and analyze the competitive and decentralized electricity market dynamics, a simulation model based on system dynamic philosophy is developed in this study. The developed simulation model oversees a 20 year planning horizon, incremented into 240 monthly periods, and up to 5 groups of investors can be accommodated. The model includes a demand module, a capacity expansion module, a power generation module, an accounting and financial module, a regulatory body and a bidding mechanism (power pooling system). Many features, singularities and tools of decentralized markets, such as, capacity withholding, enforced divestment, long term contracts, price elastic demands, investment incentives/disincentives, are also incorporated into the model, in the form of user selectable options.

The simulation model has a flexible structure for parametric studies, such that values of the parameters affecting the market can be altered and the results of selected strategies/policies can be analyzed. Total number of possible scenarios that can be simulated is in the millions, while evaluating all these scenarios would require vast amount of computation and analysis time. So, a limited scenario set, consisting of 128 scenarios, has been configured, run and analyzed through a two-phase approach, to pursue the effects of different regulatory and financial policies and primary energy resources' availability on medium-term and long-term performance of the electricity market (the default parameters have been obtained from the Turkish Electricity Market nevertheless, the model can easily be generalized by changing the relevant parameters through a friendly user-interface).

The paper contains a detailed presentation of the model and the considered scenarios.

Results

The results and findings obtained from the two-phase scenario analysis are discussed in the paper. They reveal that the model is able to capture most of the long-term and medium-term dynamics which occur both on the supply and on the demand sides of the power market. Some of the findings are presented below as examples:

In case of inelastic demand, the increasing demand is preferably met by power plant types having lower marginal and investment costs. As the reserve of these plant types are used up in time, other, more expensive investment options are undertaken and the pool price displays sharper increases in the face of rapidly increasing demand.

If the demand is price-elastic, the increase in demand is much slower and reserves for all plant types remain available throughout the planning horizon. Consequently, there is no need in the market to invest heavily in in hardcoal and diesel plants and pool price increases are softer.

In most of the scenarios considered, no wind power plants are undertaken (because of their high marginal and investment costs). Even with 20% governmental support, investing in wind power plants does not become desirable.

The major effect of State support for renewable plants is changes in the market composition in favor of large hydropower and geothermal plants, which lead to a decrease in the system marginal price.

Conclusions

This model is an excellent tool to be used in understanding, investigating and experimenting on a decentralized electricity market, especially in regard to investor behaviour; supply, demand and price fluctuations, short and long term effects of various decisions and primary energy resource limitations. It can also be deployed as an effective training/teaching tool. By means of such a decision tool, companies and regulators have a opportunity to better understand possible consequences of different decisions that they may make under different policies and market conditions.

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Keywords

Electricity Market, System Dynamics, Simulation.