Models of Imperfect Competition in Analysis of Siberian Electricity Market

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ABSTRACT

The paper considers mechanisms for organizing free trade in the electricity market that are based on submitting bids of energy consumers and producers to the market operator. The authors discuss and compare possible strategies of generator behavior that lead to different equilibrium situations and correspond to Cournot model and the models of supply function equilibria, and a perfectly competitive equilibrium. The mechanisms are tested on the basis of the Siberian electric power system.

Keywords: Electricity Market, Liberalization, Models of Imperfect Markets, Models of Supply Function Equilibrium, Oligopoly

INTRODUCTION

Successful operation of electric power industry implies coordinated action of generating companies aimed at optimization of system operation both in technical and economic sense. In 2011 the second stage of the reform of electric power industry came to an end, and as a result we switched to a fully liberalized market based on absolutely different conditions. Now instead of vertically integrated natural monopoly the electric power industry represents four independent stages: electricity production, transport, distribution and supply. Moreover, competition is introduced to all levels, but transport. It is assumed that market competition affects the prices, and that their level should both sufficiently satisfy consumers and effectively develop the industry.

Today the world knows several ways of organizing the operation of the free market in the electric power industry. Here we can single out the mechanisms that involve the creation of organized markets with online and day-ahead trading, i.e. the introduction of capacity markets, system services, etc. It is also possible to introduce a market structure that implies the formation of bilateral contracts between the...
supplier and the consumer which can be either controlled or uncontrolled by the government.

Liberalization processes that take place in the world have a short history. Free markets of the electric power industry are at different stages of their formation and development. Some of them proved to be quite efficient in certain countries; some of them did not. Generally, the results of liberalization cannot be definitely assessed also because of the short period of existence of such markets. Today it is hard to clearly determine an efficient mechanism of organizing the electric power industry. Therefore, it is necessary to conduct a thorough comprehensive analysis of both forms of organization and specific conditions, under which they will be used.

In the course of rapid restructuring of Russian electric power industry the project of new markets has been developed and implemented without detailed testing. This is also explained by some objective reasons, including the necessity to take fast measures to reform the mechanism of functioning due to the crisis in this industry. In fact, when determining and choosing today’s mechanism the government assured people that such a mechanism would provide “correct incentives” for the participants and therefore “effective results” in the market operation. This was supported by references to the foreign experience of successful adoption of this or that mechanism or by the general analysis, which was conducted only for some “perfect” conditions of the market functioning. Per se, there was no comprehensive testing of this mechanism for specific conditions of Russia.

Formerly the electric power industry of Russia was controlled in accordance with the criterion of optimal network loading, level of demand and minimization of electricity production costs. Today under the conditions of liberalization the priorities change. It becomes necessary to introduce other criteria of optimal electricity market functioning. In our opinion the most important are: 1) maximization of social welfare (social welfare function); 2) minimization of energy and capacity costs; 3) stability of market organization (no incentives to change the rules of behavior, stable price level for a long period of time); 4) reliability of power supply to companies and citizens; 5) creation of conditions for effective and advanced development of electric power industry (fulfillment of infrastructural tasks of the industry).

Explicitly it is very difficult to assess possible mechanisms of industry market functioning by the given criteria. Therefore, we need models suitable to analyze specific features of the market architecture and rules of organizing interactions between market participants. What we mean is the mathematical models, which describe the actions of generation companies, on the one hand, and the actions of consumers, on the other hand, under the conditions of a liberalized market.

Each of the models presented below implements its own market architecture. The difference will depend on what factors the suppliers will be guided by when submitting the bids (their supply functions) to the market: by the market price, demand elasticity, supplies by competitors, actions of competitors, if the amount of supplies changes, etc. Each of these models can be referred to some rules of the market operation. If from the point of view of the chosen criteria not only the models will encourage the electricity suppliers to act in the most optimal way, but the chosen strategies of economic agents will be stable as well, this mechanism will be considered as efficient.

In scientific literature one of the most widespread approaches to the analysis and forecasting of electricity market conditions is the use of microeconomic models of Cournot type, SFE-Supply Function Equilibrium (or rather its linear variant) and CSFE-Conjectured Supply Function Equilibrium. All these approaches take into account the capacity constraints, which is very important for the electric power industry.

Cournot model is one of the most widespread models for analyzing the functioning of markets with imperfect competition. It is not difficult to add capacity constraints to Cournot model and adapt it to the spot electricity market. You can find it, for example, in the papers (Vasin & Vasina, 2005). The authors also consider a
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