

Artificial power exchange based on reinforcement learning: market power and collusive behavior

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Since early nineties, worldwide production and distribution of electricity has been characterized by a progressive liberalization. The state-owned monopolistic production of electricity has been substituted by organized power exchanges. Power exchanges are markets which aggregate the effective supply and demand of electricity. Spot-price markets are usually Day Ahead Market and are requested in order to provide an indication for the hourly unit commitment. This first session of the complex daily energy market collects and orders all the offers, determining the market price by matching the cumulative demand and supply curves for every hour of the day after according to a merit order rule. Subsequent market sessions operate in order to guarantee the feasibility and the security of this plan.

The electric market is usually characterized by a reduced number of competitors, thus oligopolistic scenario may arise. Understanding how electricity prices depend on behavior of the suppliers and on production costs has become particularly important. Main goal is to increase the overall market efficiency, trying to study, to develop and to apply different market mechanisms. Auction design is the standard domain for commodity markets and the properties of different auction mechanism must be studied and determined correctly before their appliance.

In this work, the nature of the clearing mechanism is investigated comparing two different methods, i.e., discriminatory and uniform auctions. The theoretical framework used to perform the analysis is the theory of learning in games. The demand is considered inelastic and sellers use learning algorithms to understand proper strategies for increasing their profits. The auction mechanism is modeled in two different duopolistic scenarios, i.e., a low demand situation, where a single seller can clear all the demand, and a high demand condition, where all sellers are requested involved in the clearing. Moreover, heterogeneity in the cost function is considered.