

Chair of Information Systems for Sustainable Society

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Master Thesis

Designing Information Systems to Analyze Competitive Behavior Within a Simulation Environment for Sustainable Electricity Markets

Wicked problems like sustainable energy and financial market stability are societal challenges that arise from complex sociotechnical systems in which numerous social, economic, political, and technical factors interact. Understanding and mitigating these problems requires research methods that scale beyond the traditional areas of inquiry of information systems (IS) individuals, organizations, and markets and that deliver solutions in addition to insights. In [1], the authors address these challenges through competitive benchmarking (CB), a novel research method that helps interdisciplinary research communities tackle complex challenges of societal scale by using different types of data from a variety of sources such as usage data from customers, production patterns from producers, public policy and regulatory constraints, etc. for a given instantiation.

Against this backdrop, the Power Trading Agent Competition (Power TAC) is a competitive simulation platform for the power sector which was built on the basis of competitive benchmarking principles. Power TAC allows to test and assess business models and strategies in a risk-free manner. Furthermore, based on experiments and sensitivity analyses, one may derive policy implications, for example with respect to market design. Within Power TAC, dozen research groups from around the world jointly devise, benchmark, and improve IS-based solutions. Power TAC models a “liberalized” retail electrical energy market, where competing business entities or “brokers” offer energy services to customers through tariff contracts, and must then serve those customers by trading in a wholesale market. The retail market is a tariff market, in which customers are able to choose among tariff contract offerings from the competing brokers. Customers are models of household, business, and institutional users of electric power, as well as small-scale producers of power that own solar arrays or small wind turbines [2] [3].

Once a year a Power TAC competition is launched in which loose groups and institutions from all over the world are granted the option to implement a broker and test their strategies within a competitive simulation framework. More precisely, brokers are challenged to maximize their profits by buying and selling energy in the wholesale and retail markets, subject to fixed costs and constraints; the winner of an individual “game” is the broker with the highest bank balance at the end of a simulation run. Costs include fees for publication

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and withdrawal of tariffs, and distribution fees for transporting energy to their contracted customers. Costs are also incurred whenever there is an imbalance between a broker's total contracted energy supply and demand within a given time slot.

However, the awards ceremony after the finals of each competition is only a starting point for the participating parties to gain insights into the underlying drivers of their performance. Therefore, detailed log files are provided afterwards. Thereby, participants can reproduce single rounds and trace individual target figures and actions such as tariff transactions during the course of competitions.

The crux of this thesis is to design suitable information systems to analyze competitive behavior within past Power TAC tournaments. These systems shall be based on the field of data analytics and machine learning techniques. Special focus shall be placed on the interaction of different strategy choices, the development of the broker design and the respective strategies over time, and the identification of competitive advantages and strengths in individual years. This target requires the implementation of meaningful and comparable key performance indicators, the development of insightful visualization techniques, and the contextualization of your data analyses' results. The results of this thesis are supposed to provide insights into competitive behavior in newly emerging markets and the development of market behavior towards mature structures.

Literature References:

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