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Editorial

A further step in decision support models for energy markets

The energy industry has been undergoing deregulation in many countries over the past two decades. This has resulted in a focus, both in industry and in academia, on developing, analyzing, and testing models and decision support tools that address the problems and opportunities resulting from deregulation. While this effort has resulted in significant advances in our understanding of the implications of deregulation, there are still many challenges and opportunities to advance the state-of-the-art of our knowledge in related areas, and some of them are addressed in this special issue: long term expansion planning, energy market design, modelling oligopoly behaviour, reserve market design, hydroelectric dispatch in electricity markets, thermal unit commitment, cross-border trade and distribution efficiency. The papers in this special issue employ a diverse set of tools from a variety of different disciplines, ranging from microeconomics and game theory to optimization and simulation, to address these questions in new and illuminating ways.

Adela Pagès and Narcìs Nabona propose a heuristic method to address the long-term generation expansion problem in "A Heuristic for the Long-Term Electricity Generation Planning Problem Using the Bloom and Gallant Formulation." In this paper, the profit maximization version of this problem is formulated as a nonlinear quadratic programming problem with exponential number of load-matching linear inequality constraints. A heuristic to handle the large number of constraints is proposed and shown to be more efficient than the commonly used strategy of column generating.

In "An Agent-Based Analysis of Technological Diversification and Specialisation in Electricity Markets", Derek W. Bunn and Fernando S. Oliveira develop a power plant trading game that, via computational learning, simulates how players coordinate their behaviour in buying and selling power generation assets. In particular, they look at the question of how market performance depends upon the technologies in the generators power plant portfolios, and whether there is a tendency for the market to evolve into concentrations of specialised or diversified companies.

In "Two-Settlement Electricity Markets with Price Caps and Cournot Generation Firms", Jian Yao, Shmuel S. Oren, and Ilan Adler compare two alternative mechanisms for capping prices in two-settlement electricity markets. With sufficient lead time, forward market prices are implicitly capped by competitive pressure of potential entry. Also, spot prices can be capped through direct regulatory intervention. In this paper the authors explore the implications of these two alternative mechanisms in a two-settlement Cournot equilibrium framework. They formulate the market equilibrium as a stochastic equilibrium problem with equilibrium constraints capturing congestion effects, probabilistic contingencies and horizontal market power.

Derk J. Swider and Christoph Weber propose, in "Bidding under Price Uncertainty in Multi-Unit Pay-as-Bid Procurement Auctions for Power Systems Reserve," a model in which one bidder is assumed to behave strategically while the behaviour of the remaining can be summarized with a probability distribution on the market price together with a reaction function to price dumping by the strategic bidder. The paper discusses several problems that can arise in such a model, as well as how to resolve

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these problems. The applicability of the model is demonstrated using data from markets in Germany.

In "Oligopoly Models for Market Price of Electricity under Demand Uncertainty and Unit Reliability", Lizhi Wang and Mainak Mazumdar consider both load and supply side uncertainties (resulting from generator availability) and obtain Nash equilibrium solutions for Cournot and Supply Function Equilibrium models, in which asymmetric firms (whose generating units have different costs and capacities) submit their bids so that each firm's expected profit is maximized.

"Estimating Conjectural Variations for Electricity Market Models" by S. López de Haro, P. Sánchez Martín, J. E. de la Hoz Ardiz, and J. Fernández Caro proposes a two stage inference procedure for estimating conjectural variations. The first stage infers historical values of the parameters by fitting the models' results to historical market data. The second stage is based on a statistical time-series model designed to forecast parameter values in future scenarios.

In "Clustering Algorithms for Scenario Tree Generation Application to Natural Hydro Inflows", Jesús M. Latorre, Santiago Cerisola, and Andrés Ramos deal with uncertainty in stochastic optimization problems that is normally represented using a scenario tree. A key issue in this type of analysis is to identify an accurate representation of this uncertainty when dealing with historical data. This article uses an innovative two phase procedure to create the scenario tree.

In "Risk-averse Profit-based Optimal Scheduling of a Hydro Chain in the Day-ahead Electricity Market", Javier García-González, Ernesto Parrilla, and Alicia Mateo present a profit-based model for short-term hydro scheduling adapted to pool-based electricity markets. The objective is to determine a realistic operating plan for a set of coupled hydro units belonging to a small or medium-size hydroelectric company, in order to build generation bids for the next 24 hours. The company is assumed to be a price-taker, so market prices are considered exogenous variables and modelled via scenarios generated by an Input/Output Hidden Markov Model.

Chuangyin Dang and Minqiang Li introduce "A Floating-Point Genetic Algorithm for Solving the Unit Commitment Problem". Based on the characteristics of typical load demand, a floating-point chromosome representation and an encoding–decoding scheme are designed to reduce the complexities of handling the minimum up/down time limits. Strategic parameters of the FPGA are characterized in detail.

In "The EU Regulation on Cross-Border Trade of Electricity: a Two-Stage Equilibrium Model" O. Daxhelet and Y. Smeers present a stylized computational model of the European power systems that embeds two important features of the EU Cross Border regulation: congestion of interconnection capacities and access to interconnected networks. The authors develop a two-stage equilibrium model that allows various domestic regulations for the less competitive segments of the market. The paper concludes with a discussion of the applicability of the proposed model to policy analysis.

In "Integrating the Regulatory and Utility Firm Perspectives, when Measuring the Efficiency of Electricity Distribution", Marcos Pereira Estellita Lins, Maria Karla Vervloet Sollero, Guilherme Marques Calôba, and Angela Cristina Moreira da Silva propose a Data Envelopment Analysis (DEA) based method that consistently handles the (possibly opposing) preferences of the regulatory agency and the utility companies. In particular, they formulate a model to obtain a preferred target DEA index utilizing dual-based DEA graphical analysis. In addition, the authors propose and implement a two-phase weight restricted DEA model that, together with the first proposed model, helps to close the gap between real-world issues of local energy market deregulation.

Taken together, these papers help to close the gap between the real-world issues that many localities undergoing energy market deregulation need to address, and the existing theory and tools that are available to them.

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