

Agent-based Simulation of Retail Electricity Markets: Bilateral Trading Players

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Abstract—The electricity industry throughout the world, which has long been dominated by vertically integrated utilities, has experienced major changes. Deregulation, unbundling, wholesale and retail wheeling, and real-time pricing were abstract concepts a few years ago. Today market forces drive the price of electricity and reduce the net cost through increased competition. As power markets continue to evolve, there is a growing need for advanced modeling approaches. Accordingly, this article looks at using software agents to help manage the complexity of electricity markets, particularly retail markets. The article focuses on bilateral trading and describes some important features of an agent-based system for bilateral contracting. Special attention is devoted to the characteristics and negotiation behaviour of Buyer and Seller agents.

Keywords—Bilateral contracting; deregulated electricity markets; software agents; two-party negotiation; trading strategies.

I. INTRODUCTION

Traditional vertically integrated power utilities around the world have evolved from monopoly structures to open markets. Electric utility systems were unbundled and replaced with a number of separate business entities dealing with the generation, transmission, and distribution of electric power. The deregulation process has led to the establishment of a wholesale market for electricity generation, where competing generators offer their electricity output to retailers, and a retail market for electricity retailing, where end-use customers choose their supplier from competing electricity retailers.

Two major market models have been considered [2]: electricity pools and bilateral transactions. A pool, or market exchange, involves basically a specific form of auction, where participants send bids to sell and buy electricity, for a certain period of time, to a market operator, who in turn analyzes the bids and calculates a market price.

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Bilateral contracts are negotiable agreements on delivery and receipt of power between two traders. These contracts usually involve the sale of large amounts of power (hundreds or thousands of megawatts) over long periods of time (several months to years). Their terms and conditions are set independent of a market operator—although this operator should verify that sufficient transmission capacity exists to complete the transactions and maintain transmission security. Market participants often enter into bilateral contracts to hedge against pool price volatility.

As power markets continue to evolve, there is a growing need for advanced modeling approaches that simulate how market participants may act and react to the changing financial and regulatory environments in which they operate. An agent-based modeling and simulation approach presents itself as a promising approach to model deregulated electricity markets (EMs). Software agents can be designed to act in open and distributed environments, with incomplete and uncertain information, and may efficiently manage cooperative and competitive interactions with other agents.

This work looks at using software agents to help manage the complexity of EMs, notably retail markets. This paper focuses on bilateral trading and describes some important features of an agent-based system for bilateral contracting. In particular, special attention is devoted to the characteristics and negotiation behaviour of Buyer and Seller agents. They are equipped with a generic model of individual behavior and a negotiation framework that handles two-party and multi-issue negotiation. Also, they interact according to the rules of an alternating offers protocol and can pursue strategies motivated by rules-of-thumb distilled from good behavioral practice in real-life negotiations.

The remainder of the paper is structured as follows. Section II describes two prominent agent-based tools for electricity markets: SEPIA [1] and EMCAS [3]. Section III presents some key features of an agent-based system for bilateral contracting in retail electricity markets, focusing on Buyer and Seller agents. Finally, section IV presents concluding remarks and indicates future avenues of research.