Restructured Electric Power Systems: Operation, Trading, and Volatility

by Mohammad Shahidehpour and Muwaffaq Alomoush

The electric power industry is in the midst of a major restructuring in which electric energy would be traded as a commodity, electric power markets would foster open access to all suppliers of electric power, discrimination against any user of the transmission system would be reduced or eliminated, a competitive wholesale market at the national level would be fostered to reduce prices, and a competitive retail market at the state level would be encouraged to provide customer choice and competition in service and reliability. Ultimately, small customers will be able to choose their electric supplier much as they currently select their long-distance telephone carrier.

For decades the electric utilities monopolized the way power was generated, transmitted, and distributed to customers in their service territories. Utilities were vertically integrated and provided generation, transmitted power in bulk from generating stations to load centers, and distributed power to customers. Although these three components remained the same, where restructuring brought on by deregulation has occurred, the three services were unbundled. Furthermore, coordination and rules were established to guarantee competition and nondiscriminatory open access to all users in the interconnection. These changes were brought about by a series of FERC Orders that progressively changed the environment in response to how the industry responded and how FERC felt it measured up to its objectives for a competitive, efficient marketplace. The energy shortages and rolling blackouts in California and elsewhere suggest that the evolution from a monopolistic to a competitive marketplace has not always been smooth. *Restructured Electric Power Systems: Operation, Trading, and Volatility* provides the reader with information without taking any position for or against any of these FERC Orders. It provides rational pro and con arguments made as these FERC Orders were discussed prior to implementation and the reasons that FERC gave for issuing the orders in their final form. The authors provide unbiased reporting of background information. Fortunately for the reader, they selected a self-consistent set of topics that could be covered in a book about operation under a restructured electric power system environment.

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The book covers the following developments:

- A competitive marketplace needed new trading-based methods for scheduling which generators and services would be provided for whom and by whom. This was carried out in detail for various restructured systems.
- A second level of concern existed, regarding what level of generation and what level of service each of the scheduled generators and control devices would provide based on the marketplace trading. This was also carried out for several restructured systems.
- The transactions and limitations of the trading marketplace-based operation process must be transparent in order to bolster customer and supplier confidence. Thus, the Open Access Same-Time Information System (OASIS), a reporting process and system, was implemented. A discussion of OASIS, the information it provides, and how it is determined is given
- Energy shortages or congestion in the interconnection that restrict the flow of power are two of the many previously unknown risks that can cause market volatility in a monopolistic environment. Market-based vehicles were needed and created to reduce and manage each of the risks identified. The risks and the various vehicles created to manage each risk are discussed.
- A comparison of the market-based operating structures for various regions of the United States is provided, and a comparison of restructuring in several foreign countries is given in order to provide a perspective of what has been tried and their relative successes.

Each of these subjects is covered by first providing a detailed and clear explanation of a particular topic within that subject. Then, graphical representation and illustrative examples are given to help the reader gain a clear understanding of that specific topic. These examples and graphical representations are absolutely necessary and are chosen at the right level of complexity to help the reader fully understand and yet not get caught up in unnecessary detail. The authors constantly define and explain new terms and acronyms as they are encountered either in the text or footnotes. This subject is developing so rapidly that there is no previous source for obtaining definitions of these terms and acronyms. There is also an appendix that contains a long list of acronyms and their definitions so that if the reader forgets a definition, it can be quickly found. In the first chapter, the authors also provide an overview of

the subject of restructuring that greatly helps the reader who needs to be brought up to speed about this topic.

Restructured Electric Power Systems; Operation, Trading, and Volatility is suitable for electrical and nonelectrical faculty and students interested in the restructuring of the electric power system, electricity traders, power system regulators at the state and federal levels, vendors, manufacturers, consulting company engineers, electric utility operations and operation planning engineers, and researchers in power system analysis and operation. The reader should be familiar with the basics of power system operation and analysis, such as can be obtained in an undergraduate textbook like that by Glover and Sarma [1]. A graduate course using a good textbook such as Wood and Wollenberg's [2] would assist in following all of the differences between monopolistic operation and restructuring-based operation. There is a very recent book [3] that provides a much more theoretical and complete treatment of valuing generation assets, dynamic hedging for load-serving obligations, and pricing transmission contracts and locational spread options. There is no question that other topics in this book will be covered in more detail as time goes on. This book is recommended because it provides an excellent introduction to a reasonably broad and important set of topics.

The following description of chapters is a slightly edited version of the descriptions given in the preface of the book.

Chapter 1 provides an introduction to the electric utility industry and its functions. This chapter is a general review of restructuring for power engineers and includes introductory information for nonelectrical engineering majors with an interest in utility restructuring. The chapter reviews key issues in restructuring and different restructuring models, including stranded costs, market operations, transmission pricing, congestion management, PoolCo model, bilateral contracts, and the hybrid model.

Chapter 2 provides a discussion on major U.S. market models, independent system operators (ISOs) in the U.S. and major ISO functions as related to the FERC Order 888. These models include California, the Pennsylvania–New Jersey–Maryland (PJM) interconnection, New York Power Pool (NYPP), Electric Reliability Council of Texas (ERCOT), New England ISO, and Midwest ISO. The chapter discusses some of the shortcomings and advantages of these models, presents comparisons among models, and reviews topics such as horizontal and vertical market power, stranded costs, tics, market clearing prices, contracts for differences, and transmission pricing.

Chapter 3 introduces OASIS, presents a comprehensive review of OASIS, discusses the FERC Order No. 889 that mandated its development, and elaborates on exploring OASIS as an electronic information system. OASIS allows users to instantly receive data on the current transmission network operating status, the capacity of a transmission provider (transmission availability), and requests of transmission services, available transmission capability, and transmission pricing. This chapter discusses requirements of transmission providers and types of information on OASIS, such as the availability of transmission services, hourly transfer capacities between control areas, hourly firm and nonfirm power scheduled at various points, current outages information, load flow data, current requests for transmission service, and secondary information regarding capacity rights that customers wish to resell. In addition, the chapter discusses how the information is posted on OASIS; the interfaces that are required for this posting; which part of the information is secure and which part is public; how OASIS enables any transmission customer to communicate through requests to buy and responses to sell available transmission capabilities; and how utilities use OASIS to share operating data regarding transmission availability, generation capability, system loads, interchange, area-control error, frequency, and operating reserves. The chapter will also discuss whether or not OASIS has a data link to other systems.

Chapter 4 presents the tagging system and discusses the major contributions of NERC's Policy 3. The chapter illustrates the constrained path method (CPM) and explains the philosophy behind the transition from the old tagging system to the new system and functional requirements of software used by market participants to meet the minimum NERC Policy 3 requirements. In addition, the chapter shows procedures for canceling and curtailing interchange transactions. It explains how tags are created and submitted and types of information contained in the tag. The functional specifications presented explain obligations and duties of all parties to an interchange transaction, required data to represent a transaction, and specific mechanisms for exchanging the data electronically. The chapter helps readers understand the three main services in electronic tagging (Tag Agent Service, Tag Authority Service, and Tag Approval Service) and their interdependency. It explains how tags are initiated, authorized, and approved. The chapter illustrates some tagging concepts using graphical representation and provides examples that help readers grasp the entire picture of interchange transactions. It elaborates on implementation, curtailment, and cancellation of interchange transactions.

Chapter 5 presents various characteristics of electric energy trading and focuses on key issues of trading systems. A description of successful trading tools is presented, and qualifying factors of a successful trading system are addressed. The chapter concentrates on main derivative instruments such as futures, forwards, and options. Different categories of traders, trading hubs, price volatility, and green power trading are discussed. Electricity contract specifications of the New York Mercantile Exchange (NYMEX) and Chicago Board of Trade (CBOT) are presented and the presentations are supported by pertinent examples for energy trading.

Chapter 6 provides more information on possible hedging mechanisms in the restructured electric power industry. It presents the basics of hedging tools in electricity markets, new derivatives that are created especially for electricity markets, types of risks, and motivations that lead to more risks in electricity markets. In addition, the midwest crisis that occurred in June 1998 (the unforgettable mark in the U.S. electric industries) is presented to show why hedging strategies are important in electricity markets. It gives a detailed overview of sources that lead different market players to suffer from financial price risk, gives an overview of how players of energy markets may use electricity financial derivatives to hedge different risks, and highlights shortcomings in the electricity derivatives pricing model. The chapter also discusses major challenges to electricity derivatives, which include implementing reliable forward curves, inadequacy of existing price indices, basis risk, and inadequacy of traditional pricing models. Forward price curves and counterparty risk are presented, followed by a discussion on how California deals with counterparty risk. The chapter also discusses the Greeks to analyze exposures of a portfolio or a position. The chapter presents a discussion on tools for weather-related risks and shows numerous examples for using different hedging tools such as swap transaction, caps, floors, swing contracts, and weather-related derivatives. Many examples are presented regarding these issues.

Chapter 7 discusses electricity pricing and its impact on electricity market operations. The chapter presents electricity price volatility and means of measuring volatility in electricity market prices. Various indexes and price hubs in the U.S. are introduced and a case study for California is presented. The chapter discusses basic risks in electricity pricing and presents different pricing models. The construction of forward curves for long-term pricing is discussed and a detailed discussion for short-term electricity pricing is presented. The chapter compares the characteristics of electricity price forecasting with those of load forecasting in power systems. The application of artificial neural networks in short-term electricity pricing is discussed and practical case studies are presented.

Chapter 8 presents issues related to RTO. In order to promote efficiency in wholesale electricity markets and to guarantee that electricity consumers pay the lowest price possible for reliable service, FERC recently improved its regulations by proposing the formation of RTOs. In addition to improving grid reliability and correcting the nondiscriminatory practices, FERC's objective is to improve market performance and to create light-handed regulations. The chapter will familiarize readers with RTOs and will discuss issues on minimum characteristics and minimum functions of an RTO. The sources of engineering and economic inefficiencies present in the operation, planning, and expansion of regional transmission grids include: difficulty calculating ATC values; parallel path flows; limited scope of available information; and the use of nonmarket approaches to managing transmission congestion, planning, and investing in new transmission facilities, pancaking of transmission access charges, absence of clear transmission rights, absence of secondary markets in transmission service, and possible disincentives created by the level and structure of transmission rates.

Chapter 9 presents a review of certain electric utility markets outside the U.S. Although the number of case studies is limited, it provides an interesting perspective for challenges faced by electricity restructuring around the globe. Among the models discussed in this chapter are the Nordic Power Exchange, Australia National Electricity Market, restructuring of electricity in Canada, and electricity industry models in England and Wales. In each instance, the chapter reviews the specific characteristics of the case and provides a comparison with the restructuring models in the U.S. The chapter provides several numerical examples to help readers examine the model more thoroughly.

References

[1] J.D. Glover and M.S. Sarma, *Power System Analysis and Design*, 3rd ed. Pacific Grove, CA: Brooks/Cole, 2001.

[2] A.J. Wood and B.F. Wollenberg, *Power Generation Operation and Control*, 2nd ed. New York: Wiley Interscience, 1996.

[3] P.L. Skantze and M.D. Illic, *Valuation, Hedging, and Speculation in Competitive Electricity Markets: A Fundamental Approach*. Norwell, MA: Kluwer, 2001.

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