Chapter 1

Overview

The business structure of the power industry is very simple in a traditionally regulated environment. Vertically integrated electric utilities oversee the entire chain of power delivery, while state commissions set customer rates. After the successful deregulation of airlines and telecommunications industries there has been a movement toward deregulating the electric power industry. The market model that is still evolving is considerably more complex than the traditionally regulated environment. There is a vision that the market should segment the responsibilities of the vertically integrated utilities along logical cross sections and different market participants would assume responsibility for a particular aspect of the power delivery chain. Central to this book is the premise that if one wishes to design and operate a market for the electric power industry that segments the delivery chain, one must first understand the planning and operations of vertically integrated utilities, with an emphasis on how the different elements of the delivery chain interact with one another.

This chapter begins with an overview of the roles and responsibilities of the utility within a traditionally regulated environment. Then the chapter looks at the market segmentation of the power delivery chain along with the different market participants that assume the various responsibilities. The chapter provides a first glimpse at topics that are discussed more fully in the remainder of the book and identifies chapters that provide further discussion of the topics. Respecting the premise noted at the end of the preceding paragraph, before addressing a market environment we first address the aspects of power delivery in a vertically integrated utility in both this chapter and the remainder of the book.

1.1 THE POWER DELIVERY CHAIN IN A VERTICALLY INTEGRATED UTILITY

This section describes the power delivery chain that a vertically integrated utility oversees. A brief description of the chain elements is provided, along with references

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to chapters in which a fuller discussion is present. There are three major elements in the chain associated with different planning horizons: long term, short term, and midterm.

1.1.1 Infrastructure Additions: Long-Term Planning

Electric power delivery requires an expensive infrastructure of generation and transmission equipment. The infrastructure must be expanded to meet growing demand for electric energy. In a regulated environment, utilities propose infrastructure development projects to state utility commissions. Project proposals should provide convincing evidence that the project economically addresses a community need. State commissions approve projects along with a customer rate structure that provides funding for the approved projects (funding includes a profit margin for the utility). Utilities then oversee the construction of new facilities.

An important aspect of infrastructure development is the interdependence of requirements between transmission-related equipment and generation equipment. The network of generation plants and transmission equipment is called the grid. Generation additions must be coordinated with other accompanying upgrades to the grid by an integrated approach. An integrated approach is necessary to address two objectives of infrastructure additions: cost minimization and reliability.

Chapter 2 characterizes load and load growth and additionally presents generation technologies that are available for growing the infrastructure. Chapter 3 addresses the configuration and operations of the grid that must be considered when expanding infrastructure. Chapter 5 describes the long-term planning and development process.

1.1.2 Day-Ahead Scheduling and Real-Time Grid Management: Short-Term Planning

Utilities must demonstrate effective use of generation units. This entails dispatching units that most economically serve customer load while also addressing security and reliability constraints imposed by the transmission system. Utilities set a day-ahead dispatch schedule against a forecasted load, verify that the transmission system can manage the forecasted power flows, and test the proposed dispatch against possible equipment failure to ensure security and reliability in the event of a contingency. Finally, utilities monitor the grid and operate grid equipment to ensure the balancing of load with generation supply in real time.

The starting point for the process is a load forecast for the customer base. Load must be matched with a set of units that economically satisfies the load. There are inherent limitations on grid capabilities that must be taken into account when setting a dispatch schedule. Similar to the planning of infrastructure additions, an integrated approach that considers generation resources as well as grid limitations must be applied to unit dispatch scheduling and operations. This integrated approach must address two key objectives: cost minimization and reliability.

Chapter 2 characterizes load requirements and presents the generation technologies that utilities own and dispatch. Chapter 3 presents the configuration, limitations, and operations of the grid that must be taken into account when setting a dispatch schedule. Chapter 4 discusses the day-ahead dispatch scheduling process.

1.1.3 Load and Supply Management: Midterm Planning

Midterm planning is a set of decisions that affects short-term dispatch scheduling but is distinct from short-term planning because the issues are addressed before the setting of the day-ahead dispatch. This set of decisions is also distinct from long-term planning because it involves management of existing supply resources as opposed to the addition of new resources. Midterm planning decisions include setting maintenance schedules for generation and transmission equipment, determining the best use of resources with limited availability (i.e., generation with limited use due to environmental regulations), and the pooling of resources with neighboring utilities. The objectives of midterm planning decisions are identical to those of long-term and short-term planning decisions: cost minimization and reliability.

As with short-term and long-term planning, an understanding of these issues requires knowledge of generation and transmission equipment, the subjects of Chapters 2 and 3. Midterm planning as its own topic is presented in Chapter 6.

Remark

- An additional activity that this text does not address is a utility's fuel procurement. This is an activity that is certainly within the power delivery chain; however, the text focuses on planning activities related to generation and grid infrastructure. Fuel delivery infrastructure and procurement is a separate topic that requires its own text.

1.2 THE POWER DELIVERY CHAIN IN A MARKET ENVIRONMENT

A market environment is one in which end customers choose their electric service provider from among several competing companies. This contrasts with a traditionally regulated environment in which a regulated utility is assigned a territory and services all customers within the territory. The market environment is referred to as a power market.

The power delivery chain in a market environment must address the three elements of the chain identified in Section 1.1. Within a market environment there is not a single agent that performs these tasks. Instead, many different market participants each perform specific functions. In this section, we identify the various market participants along with their market functions.

There are several functioning power markets throughout the world. Several markets exist in the eastern United States: PJM (Pennsylvania, New Jersey, and

Maryland), New England, and New York. A market exists in Texas, and California is moving toward the development of a market. Australia and New Zealand also operate power markets, and there are several European markets that are in various stages of development. Scandinavia has perhaps the world's most mature market. Every functioning power market in the world assigns a single regulated public agent to manage the grid because the transmission network must be managed and operated by a single agent that is indifferent to market outcomes. This agent is called the independent system operator (ISO). As such, there are no fully deregulated power markets. Instead, there is a degree of deregulation confined to some aspects of the electric power delivery chain.

As noted above, interdependence between grid and generation operations requires close coordination between these activities. Because there are no natural divisions between these activities, a distinguishing factor of different power markets is the role of the ISO in generation-related decisions. The ISO's role in the power delivery chain is presented below along with other market participants' roles.

The chapters corresponding to these activities are Chapters 7 through 10. Chapter 7 presents a market structure that accounts for operational requirements of the power delivery chain. Subsequent chapters describe the practice of market participants within the market structure.

1.2.1 Infrastructure Additions: Long-Term Planning and Investment Analysis

Long-term planning within a utility environment devolves into investment analysis in a market environment. Independent power producers (IPPs) are for-profit companies that construct, own, and operate power plants. The decision to construct a new facility is based on the economic analysis of an IPP along with its ability to obtain financing for the project.

Because of the interdependence between generation and the grid, a power plant cannot be constructed without consideration of its impact on the grid. Indeed, for the grid to accommodate a new power plant, additions to the transmission system must be considered. The ISO assumes the role of determining grid upgrades associated with a power plant addition. Financing, construction, and recovery of grid upgrades differ among the different markets.

Transmission equipment in a market environment is constructed and owned by transmission companies (TRANSCOs). Addressing infrastructure additions solely for reliability and grid security is an issue of paramount concern. Projects typically require combined regulatory and market-based mechanisms. The regulatory aspect tasks the ISO with proposing projects to a commission, as is the case with utilities. TRANSCOs should bid for construction and ownership rights and then lease the equipment to the ISO at agreed-upon terms.

Chapter 7 provides an overview of market structure that addresses investments, and Chapter 9 focuses on investment analysis.

1.2.2 Day-Ahead Scheduling and Real-Time Grid Management: Short-Term Planning and Asset Management

Short-term planning and real-time operations activities of utilities fall within the heading of asset management in a market environment. This is so because market participants refer to power plants and grid equipment as assets and it is in the short-term phase that assets are scheduled and dispatched.

Day-ahead scheduling proceeds through a market that the ISO operates. There are four market participants associated with these activities: the ISO, IPPs, retailers, and integrated energy companies. Retailers are companies that sign up end customers, procure electricity on their customers' behalf, and bill the customers. Retailers do not own and operate power plants; as noted above, IPPs perform this role. Integrated energy companies are those that provide the combined services of IPPs and retailers. Below, we do not refer to integrated energy companies as they assume the role of both IPP and retailer. Note that both retailers and IPPs require access to the grid; IPPs must be able to place their power on the grid, and retailers must be able to deliver power to their customers through the grid. It is the ISO's responsibility to ensure fair access to the grid.

Every day the ISO receives demand bids for electricity from retailers as well as supply bids of individual power plants from IPPs for the following day's scheduling. Using these bids, the ISO sets a dispatch schedule that awards the selected generation units a market clearing price that is commensurate with the bids of retailers. The ISO ensures that the transmission system is able to manage anticipated power flows as well as contingencies associated with the day-ahead schedule.

Real-time grid management, ensuring that power demand is equilibrated with supply while maintaining reliability and security standards in real time, is the responsibility of the ISO. The ISO has the authority to dispatch units in line with market awards, even though IPPs operate the power plants. The ISO also directs the use of grid equipment.

The contents of Chapters 2, 3, and 4 are critical to understanding asset management in a market setting; these chapters provide universal planning and operational principles that apply to power delivery. The structure of a market that accounts for operational issues identified in Chapters 2, 3, and 4 is presented in Chapter 7. Chapter 8 provides details of market participants' behavior in the short-term markets.

1.2.3 Load and Supply Management: Midterm Planning, and Risk Management

Midterm planning falls under the realm of risk management in a market environment. Risk management is the use of market instruments to align the financial positions inherent in a portfolio of end customers and assets with the company's risk

preference. Adjustments to the market participant's portfolio are made through market sales and purchases that set the price of electric power well in advance of the delivery date for that power. Whereas the objective of a utility is to minimize the cost of service while maintaining reliability, the objective of a market participant is to capture profits while managing earnings risks. The market instruments available to IPPs and retailers are presented in Chapter 7. Limitations and use of the market instruments are presented in Chapter 10.

Remarks

- There is a natural relation between chapters devoted to utility planning and those devoted to the practice of market participants in a market structure. Chapter 8, *Asset Management in Short-Term Markets*, is the counterpart to Chapter 4, *Short-Term Utility Planning*. Chapter 9, *Investment Analysis: Long-Term Planning in a Market Environment*, is the counterpart to Chapter 5, *Long-Term Utility Planning*. Finally, Chapter 10, *Risk Management in the Midterm Markets*, is the counterpart to Chapter 6, *Midterm Utility Planning*.
- Stand-alone transmission projects in a market environment and the corresponding activities of TRANCOs are not addressed.