Chapter XIII
Electric Load Demand and Electricity Prices Forecasting Using Higher Order Neural Networks Trained by Kalman Filtering

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ABSTRACT

In this chapter, we propose the use of Higher Order Neural Networks (HONNs) trained with an extended Kalman filter based algorithm to predict the electric load demand as well as the electricity prices, with beyond a horizon of 24 hours. Due to the chaotic behavior of the electrical markets, it is not advisable to apply the traditional forecasting techniques used for time series; the results presented here confirm that HONNs can very well capture the complexity underlying electric load demand and electricity prices. The proposed neural network model produces very accurate next day predictions and also, prognosticates with very good accuracy, a week-ahead demand and price forecasts.

INTRODUCTION

For most of the twentieth century, when consumers wanted to buy electrical energy, they had no choice. They had to buy it from the utility that held the monopoly for the supply of electricity in the area where these consumers were located. Some of these utilities were vertically integrated, which means that they generated the electrical energy, transmitted it from the power plants to the load centers and distributed it to individual consumers. In other cases, the utility from which consumers purchased electricity was responsible only for its sale and distribution in a local area. This distribution utility in turn had to purchase electrical energy from a generation and transmission utility that had a monopoly over a wider geographical area. In some parts of the world, these utilities were regulated private companies, while in others they were public companies or government agencies. Irrespective of ownership and the level of vertical integration, geographical monopolies were the norm. Thus, for many years, economists thought the electricity industry was a "natural monopoly," because of the great expense of creating transmission networks (Joskow, 1998).

However, during the last two decades, the electric power industry around the world has been undergoing an extensive restructuring process. The critical changes began in 1982, when Chile formalized an electric power reorganization (Rudnick, 1996) followed, several years later, by the United Kingdom (Green & Newbery, 1992), New Zealand, Sweden (Anderson & Bregman, 1995) Norway (Amundsen, Bjorndalen & Rasmussen, 1994), Australia (Brennan & Melanie, 1998) and some important United States jurisdictions such as New York (NYSO) and California (CISO). Before these changes, it was noticed that the industry could be reconstituted into a more competitive framework (Stoft, 2002) because of technological changes in generation. New technologies allowed that small size plants were as efficient as larger plants. Thus, many economists and engineers thought that the distribution and transmission of electrical power may be a natural monopoly because of scale economies but its generation was not.

In this new engineering world, the basic economic characteristics of the electricity chain have been reconceptualized, with differing implications for generation, transmission, and distribution. Some of these activities have been restructured to give rise to new participants such as retailers, system operators and market operators, all with new functions and motivations. To optimize benefits derived from the new markets, the participants must have tools to take the best decisions. One of these tools is no doubt a technique to forecast electricity demand and pricing. Electricity demand forecasting is a task that power systems operators have used for many years since it provides critical information for the operation and planning of the system. In fact, the ability to forecast the long-term demand for electricity is a fundamental prerequisite for the development of a secure and economic power system. Also, demand forecast is used as a basis for system development, and for determining electricity tariffs. More and more, accurate forecasting models of electricity demand are a prerequisite in modern power systems operating in competitive markets. Over estimation of demand may lead to unnecessary investment in transmission and generation assets. In an open and competitive market excess generation will tend to force electricity prices down. However unnecessary infrastructure will impose additional costs on all customers. Under estimation of demand may lead to shortages of supply and infrastructure. In open markets, energy prices would most likely rise in this scenario, while system security would be below standard. Both extremes are undesirable for the electricity industry and the economy of any country as a whole. Thus, it is essential to select an appropriate model which will produce as accurate, robust and understandable a forecast as possible. The method proposed in this chapter

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