Chapter 23
An Intelligent Hybrid Model for Bus Load Forecasting in Electrical Short-Term Operation Tasks

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ABSTRACT

The main objective of this chapter is to present a hybrid model for bus load forecasting. This approach represents an essential tool for the operation of the electrical power system and the hybrid model combines a bus clustering process and a load forecasting model. As a case study, the model was applied to the real Brazilian electrical system, and the results revealed a performance similar to that of conventional models for bus load forecasting, but about 14 times faster. The results are compatible with the safe operating load levels for the Brazilian electrical power system and have proved to be adequate for use in real operation tasks.

INTRODUCTION

To facilitate sustainable economic growth, it is necessary to undertake the planning of the use of energy resources by avoiding wasteful, especially when it comes to non-renewable supplies. The optimization problem of energy resources is present in several areas and is based on a sustainability policy that seeks a balance between economic development and environmental preservation (Lund, 2007) and (Ilić et al., 2011). In the Brazilian electricity sector, there is a constant concern in the operation of the electrical energy system efficiently. In this sense, there is a need to develop

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action plans aimed at producing electricity safely, minimizing losses and avoiding risks (Saadat, 2002) and (Guille et al., 1997).

To ensure the safety and efficiency in the management of an electrical system must be taken several decisions in the short, medium and long term. The accuracy in each of these actions will define the quality and cost of electricity delivered to consumers. The ideal is that there is an inverse relationship between quality and cost, which is expected to be high quality and low cost (Stoft, 2002). The availability of information at the right time, is an essential factor to enable optimal management of an electrical system, and helps to maintain the relationship between quality and cost of energy (Wu et al., 2005).

In general, information and knowledge have become a competitive advantage in business organizations, and its use is of vital importance for survival and maintenance of the company. The decision making process needs access to market information, economics, behavioral, and other aspects which can contribute to change and adapt the product or service to market. As the decision process is based on the quantity and quality of information collected and verified, this information can be considered as strategic resources essential to the success of a company, being defined as one of the largest and most valuable company assets (O'Brien et al., 2010).

In Brazilian electrical sector, in terms of management and technical decisions, we can say that the availability of strategic information provides significant gains (Sullivan, 1997). For example, to undertake the planning and operation of the system, information on hydrology, demand and load level are essential to define the number of generating units in each plant and to choose the transmission line that will be used to deliver energy to the consumer. The availability of accurate information enables the optimal operation of the system, maintaining the relationship between quality and cost of energy (Sullivan, 1977).

One way to obtain information and knowledge is through artificial intelligence (AI) tools. AI based models emphasize the development of systems capable of reproducing specific features of human intelligent behavior and generate information. Typically, intelligent systems are capable of learning from experience and to apply the acquired knowledge; treat complex situations, solve problems when information is missing, and other possibilities. Currently, there are several IA based techniques on to obtain information, such as: expert systems, artificial neural networks, fuzzy inference systems, evolutionary computation, and others.

Many authors have applied AI techniques to solve problems of decision making in power systems. AI techniques have been used successfully to solve problems in many the areas, such as: voltage control, loss reduction in distribution networks, load forecasting, dispatching generating units, transmission planning, and others. Specifically, this chapter explores some of the tools of AI for solving a particular problem of short-term operation in electrical sector: "*the bus load forecasting problem*".

The short-term operational planning of an electric power system determines an operational schedule that establishes the hourly generation at each power plant for next day to next week. The goal of this scheduling is to assure the real time operation of the system. This planning is usually performed daily and must be executed in a few hours. One important aspect in this process is the impact of generation dispatch on transmission system for each time interval. To evaluate this impact, load distribution in the electrical network must be know, because the performance of transmission lines and transformers depends on the load of each bus (Sullivan, 1997). Moreover, knowledge of bus load is important for other applications, such as reliability analysis (Billiton et al., 1996), congestion analysis, system operation, commercial strategies, tariff definition (Sinha et