Electricity Demand Forecasting: An Essential Tool for Power System Planning, Operation and Control

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ABSTRACT

Forecasting is the backbone of any planning process in all fields of interest. It has a great impact on future decisions. It is also of great importance to the operation and control of business, which is reflected as profits or losses to the entity. This paper aims to provide the planner with sufficient knowledge and background of the different scopes of forecasting methods, in general, and when applied to power system field, in particular. Various load and energy forecasting models, and theoretical techniques are discussed from different perspectives, time frames, and levels. The paper presents the attributes and importance of forecasting through several cases of research conducted by the author for the Jordanian power system. In all cases the methodologies selected cover short, medium and long term forecasting periods and the results are accurate.

Keywords: short, medium and long term forecasting timeframes, electric power system, electrical energy, peak load, forecasting algorithms and techniques

1. INTRODUCTION

One of the crucial tools of planning is to attempt to foretell or foresee the future. The term forecast stands for predictions of future events and conditions. The process of making such predictions is called forecasting. The process of attempting to predict the future encompasses several business activities such as following up technological evolutions, estimating sales, knowing cost trends and competition, plans for power exchange, maintenance requirements, replacement of major plant or equipment, and expansion and enhancement of the power system. Forecasting has evolved over the years into an exact science and many models and tools are presently available commercially. The main purpose of forecasting is to meet future requirements, reduce unexpected cost and provide a potential input to decision making (Montgomery, Johnson & Gardiner, 1990; IAEA, 1988).

Energy has always received great attention from countries and individuals since it represents a commodity essential for comfortable life. With the advent of increased civilization and economic development energy has become a life-sustaining commodity. No one can dare to
Imagine what would be the status of life without energy. Therefore, it is of paramount importance that people look for new energy resources. It is also essential that exact methodologies for predicting the future load for energy be developed to meet future supply.

In many societies electricity, which is termed clean energy, constitutes a major share of the total energy requirements (Gellings, 1991). However, in certain cases electricity production has been charged with polluting the environment. Nevertheless, electricity has the least pollution record compared to all other energy sources if one considers the transportation of energy from source to final destinations.

The electrical energy requirements to be supplied by generating units and/or load imports/exports comprise the sales to consumers, and the associated generation, transmission, and distribution losses.

Since a major objective of any power company is to accurately predict future loads (Srivastava, & Veankataraman, 1997; Soliman, et al., 2004), then forecasting can be broadly classified, in the sense of time frames, as: a) long-term forecasting (2-20 years), b) medium-term (1-12 months), and c) short-term (1-4 weeks ahead), and d) very short term (1-7 days ahead).

Long-term demand forecasting is intended for applications in capacity expansion, and long-term capital investment return studies. Medium-term forecasting is utilized in preparing maintenance scheduling, and to plan for outages and major works in the power system. Short-term forecasting is used in operation planning, unit commitment, and economic dispatching. The very-short term forecasting is devoted for load exchange and contracting with neighboring networks, and to maintain a secure power system (Amjady, 2001).

Electricity demand forecasting has reached an advanced level because of the attention devoted to it by all electricity companies (Alfares, & Nazeeruddin, 2002). Meanwhile, researchers in universities, research institutes, electricity regulatory bodies, and electricity companies have contributed greatly to the development of this “science”. Further collaboration between the academic and industrial fields shall imminently lead to better implementation of this science and result in more prosperity to the societies in terms of better utilization of the scarce energy resources of our planet.

In any power system, there is vital need for an overall generation plan. This requires a system level forecast of total generation requirements and peak load. Information about total system energy sold is readily available through utility bills. However, the main problem for such a plan is the determination of demand in the future. This is achieved through calculating future load from forecasted energy and load factors (using the relationship Peak load = energy/ load factor*hours). This is applied to each consumer category and then the total peak load is calculated through summing the individual loads using certain pertinent coincidence factors. Because electrical energy cannot be stored appropriately, correct demand forecasting is very important for the correct investments (Gellings, 1991; Feinberg, Hajagos, & Genethliou, 2003).

Figure 1 shows the steps involved in the general forecasting steps applied to various applications. The process will answer three major questions: Why forecasting? How to forecast?, and what are the results of forecasting? This, of course, involves data gathering, analysis and modeling in addition to the feedback. This in turn will serve in validating the proposed models and implemented analysis techniques (Elkarmi, & AbuShikha, 2012).

2. CLASSIFICATION OF ELECTRICAL DEMAND FORECASTING

2.1. General

Electricity demand forecasting is usually divided into three or four time frame categories. 1) Long-term for a period of one year up to 20 years. This is used for system expansion planning, long-term financial planning, and tariff studies. 2) Medium-term for a period of one to
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