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Forecasting future energy demand: Electrical energy in Mexico as an example case

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Abstract

Knowledge of the future energy demand in the world, in a region, or even in a single country, is an important tool for planning and establishing an energy policy either by international agencies or by the respective government. This energy demand will have to be satisfied by an optimum mix of the available energy sources, taking into account the restrictions imposed by future economic and social changes towards a sustainable world. However, forecasting energy demand is a complex task because it is affected by many variables at the micro level. Therefore, a macro model with only a few variables that can be predicted in a global way is needed; i. e. without a detailed analysis for each of these variables. In this work, for predicting the energy demand, the global variables affecting it have been defined first. It has been established that social, economic and technological development aspects can be taken into account by means of three important variables: population growth rate, gross domestic product per capita and energy intensity. Based on the simple model presented here, energy demand can be forecasted in accordance with different scenarios for the variables´ future evolution. As an example case, this model has been applied to estimating possible scenarios of the electrical energy demand in Mexico, for the next 40 years. At the end, based on these results, some recommendations are made for electrical energy planners and policy-makers.

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Energy; Demand; Forecasting

1. Introduction

Demand forecasting is an essential prerequisite of an energy system study, not only for planning the investment in the capacity expansion, but also because it plays an important role for setting tariffs and

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relevant plans for the demand side management. As a result, energy demand forecasting studies constitute a vital part of the energy policy of any country, especially for those countries, like Mexico, whose energy demand is growing relatively fast. Due to its developing economic structure, Mexico´s energy demand, especially for electricity, has been increasing quickly as a result of its economic growth in recent years. Gross electricity consumption was around 150 TWh in 2000. It increased to around 181.5 TWh in 2009, and according to the government projections, it will be 370 TWh in 2025 [1]. This situation shows that the electricity sector in Mexico is dynamically changing as occurs in many other developing countries in a similar situation.

In literature, considerable efforts have been made for energy demand forecasting. Box–Jenkins models, regression models, econometric models, neural networks are the most commonly used techniques for energy forecasting studies [2]. For example, the use and limitations of economic models in the corporate environment were described by Baker and Finizza. They have reviewed the alternative model types and their applications for business environment analysis, investment alternatives and strategic decisions [3]. A study on model credibility was conducted by Yoichi Kaya in Japan. More than 10 economy wide models were selected and compared [4]. David B. Reister (1990) discussed the various engineering economic approaches for developing energy demand models [5]. The main theoretical and empirical issues encountered in the construction of a short/medium-term energy–economy linked system of models were presented by Capros et al. [6].

The effect of the unexpected economic fluctuations, the perceived shortages in the natural gas supplies and the high dependency of the power generation system on this resource, results in an electrical energy cost increase and demand fluctuation in the short term. However, long term forecasting does not require observing the short term fluctuations of the many variables that affects energy demand, including those associated to political changes. Therefore, for the long term, instead of complex models, a more practical approach is needed in order to estimate the energy demand of any country. Hence, in this work we propose a simple model that requires the use of only a few macro variables for determining the long term variation of the energy demand. This model is applied to the electrical energy sector in the Mexican case, as an example, so that some policy recommendations are made at the end.

2. The Macro variables and the Simple Model

It is clear that the energy demand in a given country will increase at a rate that depends upon the population and economic growth of the people living in the country. On the other side, as the energy efficiency use is increased, as a consequence of the technological development, the energy demand will tend to be reduced. In other words, energy demand is driven by three important variables: Total population (P), Gross domestic product per capita (GDPC) and energy intensity (I).

The first variable is related to social development and has to do with the way in which a given society changes culturally. While in India the population grows in an explosive manner, in several European countries the population is already decreasing. Therefore, we can expect a more slow energy demand increase in these countries as compared to the high energy demand increase expected in India.

Gross domestic product per capita is directly related to the degree of economic development of a country or region. It is also related to the productivity of the people and therefore, the larger this variable, the more energy will be demanded. Asia countries like China and India itself are having an economic growth which is much higher than that of developed countries, like USA or Germany. Therefore, the energy demand increase rate in these countries will be incomparable smaller than for developing countries.

The energy intensity is a variable that has to do with the efficiency and the productive use of energy by a particular society. We expect this variable to be related with many aspects of the everyday life of the