Strategic Forecasting of Electricity Demand Using System Dynamics Approach

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***Abstract*—Electricity has become an important source of energy in human society. The enormous use of electricity necessitates a mechanism to predict the future demand. Forecasting models provide that mechanism. They facilitate decision makers in keeping a balance between supply and demand, thus strategically managing the supply system A simulation based on system dynamics methodology is developed for demand forecasting. The variables used are population and per capita consumption of electricity to forecast electricity demand. The forecasting horizon of the model is 11 years from 2011 to 2022. Malaysia is used as a case study. The simulation model estimates that at the current rate of consumption and population growth there will be a need of 151.05 terawatt-hour of electric energy in year 2022. It is found that that by using simulation, a fairly accurate forecast can be obtained.**

***Index terms*—Electricity, long-term forecasting, system dynamics, artificial neural networks.**

I. Introduction

Electricity is considered the newest and the most efficient form of secondary energy. It plays an important role in the economic and social development of a country and consequently in the standard of living of people [1].

The issue of present and future supply of electricity is of equal interest to public, politicians and scientific community [2] In this regard electricity demand predictions are essential. These predictions are employed for studies of capacity expansion, development of a supply strategy, particularly related to fuel diversification, and for revenue analysis and market research. The former studies relate to strategic management level, while the latter, at an operational level. Operational forecasting is more optimization approach [3]. Irrespective of the application level, forecasting proves to an important tool for policy and decision makers in energy sector[4].

Electricity forecast are broadly divided in two categories: short term and long term. Short term forecast are useful in daily operations of a utility companies whereas long term forecast are needed for strategic planning. Planning in electricity sector is very challenging due to following reasons: electricity generation capacity is capital intensive, it takes long period of time in construction, and the commodity cannot be stored in large amounts. Along with this, there is high level of uncertainty involved in planning; change in demand (due to any externality) and liberalization of electricity are among the top causes [5]. Due to this peculiarity of the sector, it is not an exaggeration to say that demand forecasting plays a critical role in of integrated electricity planning process. Reliable forecasts alleviate any shortcoming of electricity supply and demand balance that can jeopardize social and economic well being of the people [6].Our goal, in this paper, is to develop a dynamic simulation model that can be used to forecast total annual electricity demand. We are also aiming to show to prospective researchers that simulations have the capability to make sound forecasts.

At present more than 67% of electricity is generated by fossil fuels [7]. According to World Energy Council, coal reserves are going to last for 128 years, natural gas 54 and oil 41 years, at current production and consumption ratio [8]. Another estimate shows that coal, natural gas, and oil will only last for 107, 37, and 35 years, respectively [9]. The inconsistency in these two estimations highlights the uncertainty in availability of fossil fuels for electricity generation. This premise suggests that electricity generation is going to face major challenges in long-run. Along with fuel availability, the choice of technology and its capacity also very significant role in planning process. Failing to invest in right technology and capacity may cause generating firm lose its competitiveness [10]. In this context, strategic forecasting becomes inevitable while considering sustainability of power generation.

There are myriad of studies done on electricity forecasting using various tools and techniques. Using consumption growth factor, Bodger and Tay [11] used logistic and energy substitution to forecast the electricity demand in New Zealand. Kumar and Jain [12] used three times series models to forecast the energy requirement for India including electricity. A Grey-Markov forecasting model to forecast the electricity supply and demand in China was developed Huang et al., [13]. Electricity consumption and economic growth for Malaysia was studied using econometric approach by [14], also Aman et al., [15] used econometric approach for electricity forecasting steal industry of Malaysia. In artificial intelligence category of forecasting methods Ekonomou [16] used artificial neural network (ANN) for long term electricity forecasting in Greece. In the same artificial intelligence category, a hybrid models for long term electricity forecast were developed by Padmakumari et al.,[17], and Azadeh et al.,[18]. A comparison of different forecasting techniques was presented by Tso et al., [19].

The objective of using simulation models in electricity forecasting is that simulations are mathematically flexible. They have the ability to accommodate any pattern of

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