ABSTRACT

Importance of energy as an entity for improving the quality of life of people has been recognized the world over. During the early fifties, the major contributor to the energy requirements of India had been the non-commercial sources of energy. In the past decade, the trend has changed with heavy reliance on commercial sources. For both developed and developing countries, a glimpse of the future commercial energy requirement is vital to plan a proper energy strategy. In the present work, viable energy forecasting models have been developed to assist planners and policy makers.

In building future energy scenarios, two approaches commonly used are the time series trend approach and the econometric approach. Since time series trend approach has been found to be inaccurate, econometric models are being used to improve the accuracy of the predictions. However, so far technological and environmental factors have not been included in combination in the development of such energy econometric models.

In the present work to start with, time series model is developed using seven regression equations and the best fit is selected from among them. Next an econometric model has been developed with consumption, price and gross national product. Then evolved the development of a Modified model which takes into consideration, the variables such as consumption, price, gross national product (GNP), technological efficiency and carbon dioxide emission.
The Modified model links environmental quality and technological efficiency with energy-economic factors. A comparison is made between the results obtained from the Modified model with a time series and an econometric model using squared error, square of correlation coefficient and Durbin Watson statistic.

A short term model using short range data - 19 years and a long term model using long range data - 36 years are developed and compared. It is found that in all cases Modified model yields better results. Within short and long term models, long term model is the better model with lesser error. A prediction of the demand of commercial energy sources such as coal, oil and electricity upto 2010-11 is made using the Modified model.

The predicted demand of coal, oil and electricity obtained from Modified model is used as input in Mathematical Programming Energy Economy Environment (MPEEE) model. The MPEEE model maximizes the GNP - energy ratio which is found to be conceptually related to energy efficiency. The constraints limit the emission of CO₂, SO₂, NO₂, TSP, CO and VOC. The MPEEE model is analysed for different percentage reductions of emission. The difference between the predicted requirement from the Modified model and the optimum from the MPEEE model will have to be supplied by non-conventional energy sources. This difference also indicates indirectly the amount of conservation to be aimed at.

Among the emissions, CO₂ emission has been found to be maximum because of the exponential growth of electricity generation. A critical electricity generation capacity is determined for every percentage reduction of CO₂. Different
scenarios evolved for different levels of plan of electricity generation capacity. An optimum electricity generation capacity has been obtained for maximization of GNP-energy ratio. India has a declining GNP-energy ratio. When optimum distribution pattern is followed, it is found that the ratio starts increasing beyond 2005-'06 and helps in the stabilization of the ratio.

The impact of price and population has been studied on the results of the long term model. The confidence limits have been established to remove uncertainty. Error analysis has been conducted to validate the model.

Sectorwise models - Modified and MPEEE models, have been developed and the future scenario has been studied and the percentage utilization of coal, oil and electricity in different sectors has been determined for optimum GNP-energy ratio.

A Delphi study is conducted to determine the possible percentage utilization of the non-conventional sources of energy keeping in view, technology, emission and availability. The social acceptance has also been depicted from the study. Statistical tests for consensus and stability gave positive results.

Scenarios have been developed for various conditions, for example, the extent of renewables that can be exploited, feasible amount of energy conservation, impact of foreign policies and growth rate of GNP. Policies necessary for effective implementation have been indicated.