An overview for network future development in a rapid expansion city

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Abstract— The optimized methods for a forecasting demand have been discussed among researchers to overview the most sufficient need in a rapid expansion city. The methods developed test and compare between all interrelated issues. Many variables are involved in the calculation of energy future demand, the prediction makes aggressive result to achieved requirements. After discussing proposed research methods a suitable and accurate approach is elected to be applied for any city to satisfy the public demand. The objectives of this research are to overview all the methods of forecasting of the electrical demand using different approaches , and come out with the most optimum suitable procedure in the field of electrical network for long and short terms. The result indicates a brilliant analysis with high contribution in the electrical industry, will find its application in a global rapid expansion city. The methods show a tradeoff between cost, reliability and complexity of operations regardless of energy generated.

Keywords— optimum approach ; load forecasting ; electrical netwrok design ; rapid expansion city ; future demand.

I. INTRODUCTION

Different approaches have been established to analyzing state of the art of forecasting need of the electrical network to face the developing and emerging world economic in rapid expansion cities. Since long-term electricity demand forecasting is a crucial part for a good planning and expansion of electrical power systems [1]. In all planning studies, this forecasting plays an essential and major role in designing and planning for the contribution of network electrical generation facilities.

The forecasting of the electrical demand for the long-term will certainly provide support to establish the amount of investment needed on power generation and network distribution to improve forecasting techniques. However, to make good and consistent electricity demand forecasts, it is important to get an overview of all forecasting techniques available, to sum all the knowledge about the state of art, and have evaluation of long-term demand forecasting [2].

This paper starts with a survey of all published specialists analysis reported so far as a comprehensive technical study. Following the introduction in Section I, the subject addressed in Section II describes the methodology used for the systematic review, comprising the analysis and qualifying the results to optimizing the appropriate technique. In Section III the research analysis will be presented and analyzed. Finally this paper will introduce results and conclusion.

II. METHODOLOGY OF RESEARCH

The methodology used in this paper is a comprehensive review of articles published in the topic of the forecasting electricity demand. The systematic review analyzed and discussed the mathematical calculation and strategy planning expanded to develop the future electrical network.

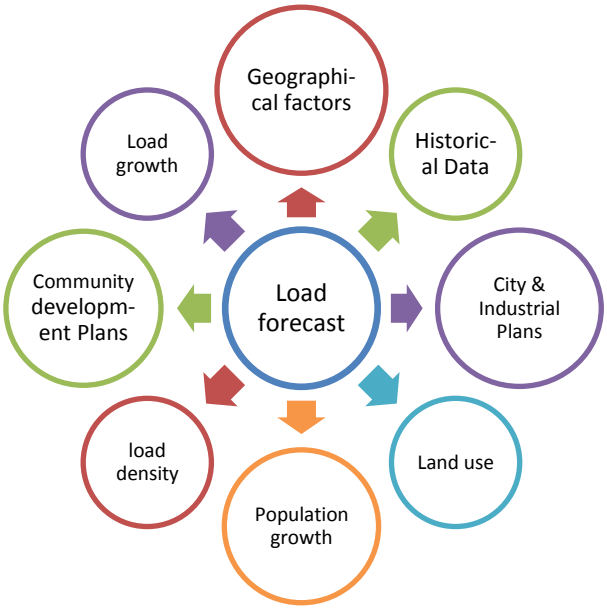


Fig (1) Variable affecting forecasting design

The analysis reported here in this article was predicted under the assumption of many variables involved. The load growth of the geographical area is the most important factor in the electrical technology plan influencing the expansion of a distribution system, therefore the forecasting of load increase

and system reaction is essential in the planning process. Many procedures use, two time scales for load forecasting, long range of the order of 15 or 20 years away, and short range with time up to 5 years distant, taking into account the resolution and accuracy. Figure (1) indicates some of the factors which influence the load forecast as one would expect load and network growth is very much dependent on rapid expansion cities [3].

III. RESEARCH ANALYSIS

The analysis and calculation of the articles will describe the main objectives of the methodologies and techniques developed. Gheisa R. et al. [4] started evaluating a number of research papers on different important points of view. Figure (2) shows a classification of forecasting models, the methodology used in this paper to retrieve information from literature. The article applied a systematic review following a six steps process which can be applied to select papers in specific Journals [5-8], depending on the results from the full review and details analysis [8].

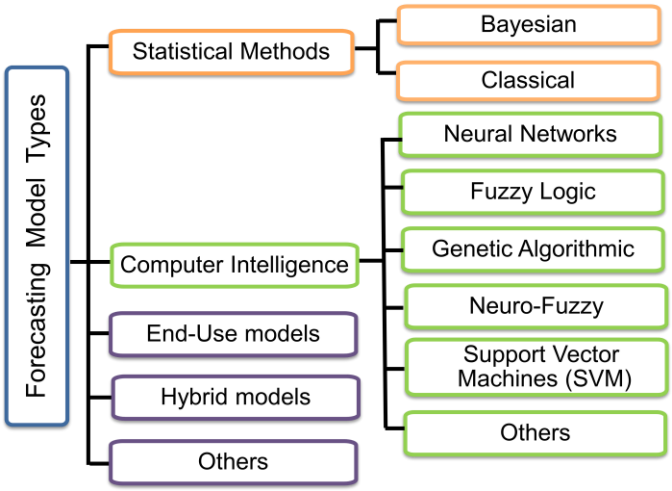


Fig (2) classification of forecasting models

Despite the fact that we have the high number of related articles [4-9], only a number of forecasting techniques were used in the literature for the long and short-terms electricity forecasting using traditional statistical methods up to end uses methods [10-13].

Statistical methods and computer intelligence models are responsible for more than 70% of the used forecasting models. Figure (3) shows the types of models used. In the last 10 years, computer intelligence has been playing a major role in long-term forecasting applications as well as the combined techniques [14].

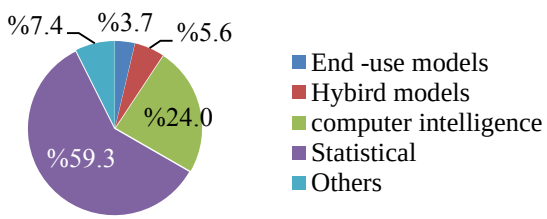


Fig (3) Models by type retrieved from article selection

The most cited articles followed by both statistical models and computer intelligence models are responsible for more than 90% of the all citations. The hybrid models, which combine two or more statistical or computer intelligence models are taking part in academic interest as well. It was found that the numbers of the long-term electricity demand forecasting articles has increased in the last decades. Figure (4) shows the number of articles published in the last four decades [4].

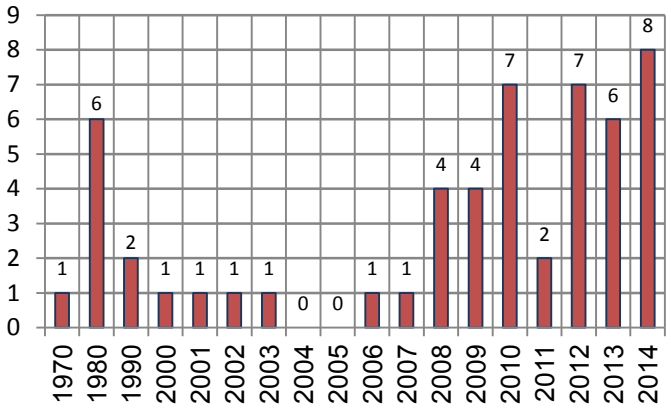


Fig (4) Articles published per year

Salah H. E. Saleh et al. [15] applied the stochastic time series forecasting based on data, by a statistical and mathematical analysis in time series, an Auto-Regressive Integrated Moving Average (ARIMA) model was used, the results indicated a continuous growth of demand for electricity depending on the development of the social system, most of all efficient functioning of a social safety net requires that the target consumer groups be determined on well-defined criteria. This will help in designing programs that aim at improving both resource allocation and income distribution. The country community should reduce unnecessary power usage. People can use energy efficient technologies to improve national energy security. Energy saving at every household is also beneficial. Long load forecasting has come from the single forecasting method to the combined forecasting method. It mostly obtained the weight of the single forecasting, which is used for the combined methods based on some single error index [16-18].

Dongxiao Niu et al. [19], used the combined methods with some error index, which are the mean absolute error (MAE), the mean absolute percentage error (MAPE) and the Relative Degree (RD) to evaluate the forecasting method, then the entropy method is used to calculate the weight of the three indices to form a comprehensive evaluation index about single forecasting method, the Particle Swarm Optimization (PSO) is used to calculate the weights of the single forecasting methods.

The forecasting foundation approach used, the Method of Proportional (MP) equation (1) simplified the calculation method to obtain an accurate results, this equation is used together with the Regression Calculation model (RC), the Grey forecasting Model (GM) and Back Propagation (BP) neural network based on the simple mathematical formula.

$$K = \sqrt[m-n]{\frac{A_m}{A_n}} - 1\,,\; A_l = A_n\,(1+K)^{l-n} \qquad (1)$$

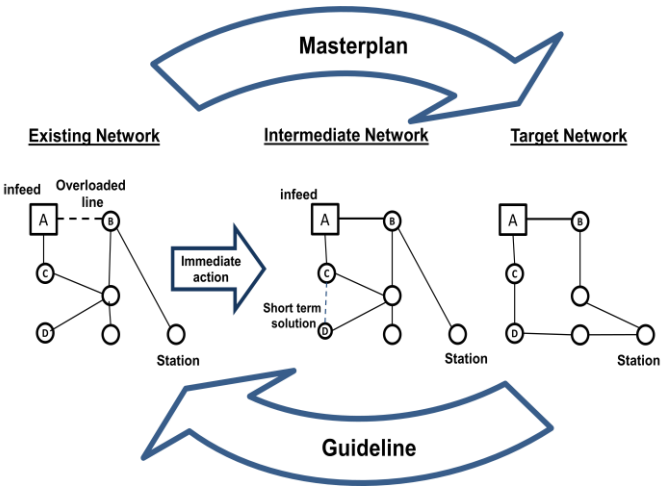
A_m is the load of the m^{th} year. A_n is the load of the n^{th} year.

Mean absolute error (MAE) was introduced and calculated by others to evaluate the approach outcome, which can be guided to get the optimum results [20-22].

Several methods are used to forecast the load electricity demand, and to form a comprehensive forecasting approach, the results were varied, depends on the accuracy, time consumed and cost of reliability. The combined forecasting method based on Particle Swarm Optimization offset the shortage of the single forecasting model and the overall results were evaluated and tested using a single error index to improve the forecasting stability and reliability [23-25].

Amar F. and Hable Matthias [26], describe the planning process, to develop a masterplan for a dynamically developing network. This target in future will be as a guideline for the existing network to predict the intermediate one. The intermediate network shows a transitional state from the existing network to the long-term future network.

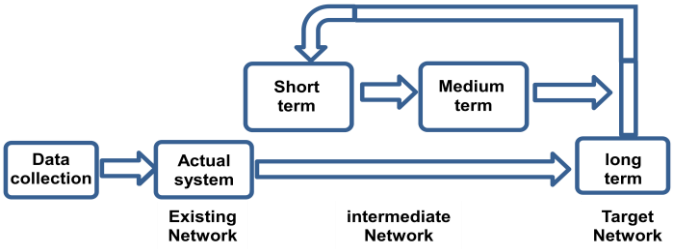
Figure (5) shows the masterplan and the guideline from existing network followed by the intermediate and target network [26].



Fig(5) Materplan of network expansion

The final results do not show the exact target network, it looks similar to the one in the masterplan. The new dynamic developing network should be adjusted and revised at a very short period to keep the masterplan close to reality. The intermediate network acts as a guideline to mitigate actual weak points in the existing network. To rap up a strategy, it is important to know where the developed network should end. This will act as an essential change in the network implemented during short and medium term action [27].

The general planning procedure shown in figure (6) explained the steps to maintain long term future network, starting from data collection, followed to the end. Applying and evaluating the load growth factors, the results will be finally evaluated for accuracy and reliability. The weak points will be detected and solved in short and medium terms and take it back to the target stage to come up with the optimum future network analysis [27].



Fig(6) General planning procedure

IV. Result and Conclusion

A tremendous number of approaches and scientific results have been accomplished in the past to come up with accurate forecasting for network future development in a rapid expansion city. A great effort has been involved to put a great number of factors involved to change the prediction of the phenomena, while we enjoyed the change and aggressive increase in populations, we suffered from cost and increase of power generation, thus power is not the limiting factor for new technology.

In this systematic review discussed, many articles used the mathematical calculation, either with single forecasting methods or combined forecasting methods. Many variables were involved in the calculations of the network. The predicted results show a trade off taking place between cost, reliability, complicity and accuracy. It was found that the optimum approach for future network development for electrical rapid expansion cities in the combined forecasting method can be obtained by use the most rolled variable to get the most appropriate approach, to improve the future electrical load required, this approach appropriate for a city and inappropriate for other cities have different rolled variable affected in the prediction of the load demand. The forecasting calculation need a strategic plan to handle future load prediction with developing network and redesign the existing network to achieve the best requirement needed system in the structure of the future network, this approach will give strong reliability with economic cost for achieving the high performance and

integral in size without any increase in cost or loss in power consumption. The royal road in this paper is the forecasting trend of the expansion cities with aggressive power distribution systems.

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