IMPACT OF WEATHER ON SHORT TERM LOAD FORECASTING

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June 2012

" I hereby declare that I have read through this report entitle "Impact of Weather on Short term Load Forecasting" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

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This Report Is Submitted In Partial Fulfillment of Requirement for the Degree Of Bachelor in Electrical Engineering (Industrial Power)

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2012

I declare that this report entitle "*Impact of Weather on Short term Load Forecasting*" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Specially dedicate to

To my beloved mother and father

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ABSTRACT

In Peninsular Malaysia, forecasting of electricity supply or load supply is essential at Tenaga Nasional Berhad (TNB) for effective and reliable operation and planning of power system. The load forecasting can be done by three types of forecasting which are Short Term Load Forecasting, Medium Term Load Forecasting and Long Term Load Forecasting depends on the interval of time. However, effective forecasting is difficult in view of the complicated effects on load by a weather factor and customer classes. The load pattern are influenced by the condition of weather, namely heavily rain, cloudy, thunderstorm, etc as each of these weather condition has different load behavior. This project proposes a Feed Forward Neural Network method to forecast future's load in Peninsular Malaysia with the inclusion of weather data. The idea is to select the half hourly load data of the 7 weeks as input data and use the load data of week eighth as the target data to find the best output of the forecasting process. This project also includes the load forecasting without inclusion of weather data so that the result can be compared with the result of load forecasting with inclusion of weather data.

ABSTRAK

Di Semenanjung Malaysia , ramalan bekalan elektrik atau bekalan beban adalah aspek yang sangat penting di syarikat pembekal kuasa iaitu Tenaga Nasional Berhad (TNB) untuk tujuan menghasilkan perkhidmatan yang berkesan dan boleh dipercayai serta ia juga penting dalam perancangan sistem kuasa. Terdapat tiga jenis ramalan beban iaitu ramalan beban jangka pendek, ramalan beban jangka sederhana dan juga ramalan beban jangka panjang. Ketiga-tiga jenis ramalan beban ini adalah bergantung kepada tempoh masa. Walau bagaimanapun, ramalan beban yang berkesan adalah sukar dicapai kerana terdapat faktor-faktor yang boleh mempengaruhi ramalan beban seperti faktor cuaca dan jenis pelanggan. Corak beban dipengaruhi oleh keadaan cuaca seperti hujan, mendung, ribut petir dan lain-lain kerana setiap keadaan cuaca ini mempunyai corak beban yang berbeza. Projek ini mencadangkan kaedah rangkaian saraf kehadapan (Feed Forward Neural Network) untuk meramal beban di Semenanjung Malaysia untuk hari esok dengan memasukkan suatu data cuaca. Idea projek ini adalah untuk membuat ramalan dengan memilih data beban dalam tempoh setiap 30 minit selama 7 minggu sebagai data masukan dan menggunakan data beban minggu ke-lapan sebagai data sasaran untuk mencari keluaran yang terbaik bagi proses ramalan ini. Projek ini juga termasuk ramalan beban tanpa memasukkan data cuaca supaya hasil nya boleh dibandingkan dengan hasil ramalan beban dengan kemasukan data cuaca.

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LIST OF ABBREVIATIONS

TNB	-	Tenaga Nasional Berhad
MAPE	-	Mean Absolute Percentage Error
SESB	-	Sabah Electricity Sendirian Berhad
SESCO	-	Sarawak Electricity Supply Corporation
STLF	-	Short Term Load Forecasting
FLR	-	Fuzzy Linear Regression

CHAPTER 1

INTRODUCTION

1.1 Project Background

Electricity is essential for human life. The electricity is supplied by the power utility companies for the each state in Peninsular Malaysia followed the customer requirements. The supply should be enough to distribute to the customers so that any problem such as high penalty payment, system failure and energy wasting can be avoided.

This project is about the forecasting of load in Peninsular Malaysia for short term period such as for a week ahead load based on demand for 7 weeks previous data. Because of the power supply company in the Peninsular Malaysia is Tenaga Nasional Berhad (TNB), thus the historical load data from this company is applied as inputs data for this project. The method that applied in this project is a Feed Forward Neural Network method which will be simulated by using the Matlab software.

This short term load forecasting (STLF) project also considers the condition of weather in order to achieve the accurate forecasting result. The result of this forecasting will be compared to the result of load forecasting without weather condition consideration. The accuracy will be achieved if the Mean Absolute Percentage Error (MAPE) is below than 1.5% [1]. The more small value of MAPE, thus it is more accurate.

1.2 Problem Statement

In Malaysia, Tenaga Nasional Berhad (TNB), Sarawak Electricity Supply Corporation (SESCO), Sabah Electricity Sendirian Berhad (SESB) are the power utility companies that responsible to generate and distribute electricity to the consumers at Peninsular Malaysia, Sarawak and Sabah respectively. The power electricity that generated by these three companies are also known as load supply. This load supply should be sufficient to each consumer so that these companies can avoid paying the high penalty for the insufficient load supply. So, the future load should be forecasted so that the load supply is more accurate and reliable. There are three types of load forecasting which are Short Term Load Forecasting (STLF), Medium Term Load Forecasting (MTLF) and Long Term Load Forecasting (LTLF). This project is focuses on the Short Term Load Forecasting [1].

Short Term Load Forecasting is a method that forecasts the load supply for a small time interval such as a few minutes, hours and days ahead profiles. During the forecast process, there are some factors that should be considered such as weather and customer's classes such as industrial consumers, domestic or residential consumers and commercial consumers. Weather of each state in Peninsular Malaysia is fluctuating and usually not same for every month. For example, in Terengganu, Kelantan and Pahang, they will face the heavy rain on December. But, for other states, the weather is different with the weather of the three previous states. Thus, the electricity supplied from TNB should be forecasted accurately so that the problem such as energy wasting and system failure can be avoided.

For STLF, there are some methods that can be applied in order to forecast the load such as Linear Regression Method, Data Mining, Fuzzy Logic and Neural Network.

1.3 Objectives

The main objectives of this project are:

1) To study and understand the concept of Short Term Load Forecasting (STLF) using Feed Forward Neural Network method in Matlab software.
2) To study the effect of weather on the Short Term Load Forecasting.
3) To compare result of load forecasting with inclusion weather data and result of load forecasting without inclusion of weather data.

1.4 Project Scope

This project focuses on load forecasting for weekday in Peninsular Malaysia while considering the impact of weather on forecasting. This project also includes the analysis of load pattern in Peninsular Malaysia for each period. The method that used in this forecasting is the Feed Forward Neural Network method. The forecasting is for a week ahead by using historical load and previous weather data with the error is less than 1.5% (<1.5%). This project also includes the load forecasting without inclusion of weather data.

1.5 Project Layout

This report was divided into 5 chapters where it consists of:

Chapter 1: Introduction

Chapter 2: Literature Review

Chapter 3: Methodology

Chapter 4: Result

Chapter 5: Analysis and Discussion

Chapter 6: Conclusion and Future Recommendation

Chapter 1 is about the background of the project that has been conducted, problem statement, objectives and scope of the project.

Chapter 2 is about the overview of this project based on literature review.

Chapter 3 is explained about the methodology and shows the flow of the project. Besides, there are also focused on the method that will be implemented and the software used to finish the project.

Chapter 4 is the list of results obtained from the forecasting process.

Chapter 5 is about the discussion with the analysis from the graphs that obtained from the simulation that has been done.

Chapter 6 is about the conclusion of overall this project and the recommendation to improve this project on the next research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The important terms such as load forecasting, short term load forecasting, fuzzy linear regression method and load demand need to be study so that this project can flows smoothly, clearly and systematically. Several load forecasting studies have been mentioned that there were two more types of load forecasting besides the short term load forecasting, which were medium term load forecasting and long term load forecasting [1]. There are many methods that can be used to the short term load forecasting purpose such as regressions, similar day methods, neural networks and fuzzy linear regression method [1-5]. The accurate result of load forecasting can affect by a few factors such as weather, holidays, seasonal effect and economic.

2.2 Load Forecasting

Power system load forecasting is an important part for Energy Management System (EMS) in power utility companies because accurate load forecasting results will reduces the generation costs, reliable, protects power system operation and planning [1]. In fact, the load forecasting is directly have relationship with the power operation such as a scheduling of dispatch, a preventive of generators maintenance plan and also a reliability evaluation of the systems [2]. The accurate result that obtains from the forecasting also important for the electric power price forecasting on the electric power markets [2].

The load forecasting can be classified into three types including short-term forecasting, medium-term forecasting and long-term forecasting [1]. The power electric load can be forecasted by using many methods such as fuzzy logic, neural network, regression and data mining.

2.3 Short-term Load Forecasting (STLF)

Short term load forecasting is includes load forecast of the next few hours, a day and several days where it will give a great impact on the economic load dispatching and optimal power flow [2]. The STLF is very important for systems to produce the reliable power system operation, for market operators to determine tomorrow market prices and also essential for market participants to prepare bids. There are many negative effects will be occurred if the load is forecasted inaccurately such as the increasing cost of operation system, the utility companies should pay for a high penalty because of the insufficient power supply, energy wasted and also system failure will be occurred.

However, in order to ensure the accurate load forecasting, there are some factors that has complicated effects on the load. They are season, day type, weather and also the electricity prices [3]. This study is only focused on the impact of weather on the short term load forecasting.

There are many methods to do the short term load forecasting such as regressions, similar day methods, neural networks and fuzzy logic approach.

2.3.1 Regressions Methods

The regression is a method that used to describe the relationships between load and the affecting factors such as weather and weekday index [4]. It is a method that widely used statistical techniques for finding the best straight line of a set of data. Besides, there are a pre-

specified functional forms where it functional coefficients are analyzed by using regression analysis of historical data. The most value of MAPE that can be achieved by using this method is 3.57% [2].

2.3.2 Similar Day Methods

At the first stage of this method, it uses a historical days that have variable factors such a weekday index and weather that same to the forecasted day's variable factors. This is a simple method but this method is not sufficient to capture any difficult and complicated load features if it used alone. In order to achieve the accurate result, it should be combined with other suitable method to do the load forecasting [4]. The most value of MAPE that can be achieved by using this method is in range 1.20-2.22% [4].

2.3.3 Fuzzy Logic Approach

This method has been used and applied in multiple fields such as the forecasting area. This fuzzy logic is related to the Boolean logic that usually used for digital circuit design. The Boolean logic is represented by the value of "0" and "1". By using fuzzy logic approach, the outputs are be able to deduce from the fuzzy inputs via the techniques of mapping input to outputs or called as curve fitting [3].

A number of studies showed that fuzzy approach has a better performance compared to the other methods [1]. There are some advantages by using fuzzy logic approach such as:

1) Not necessary to have a mathematical model for mapping inputs to outputs
2) Not necessary to have a precise inputs which shows a noise graph and fast changing (high frequency load features).