UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTY OF ELECTRICAL ENGINEERING

SESSION 2011/2012
SEMESTER 2

FINAL YEAR PROJECT REPORT
(FYP 2)
BEKU 4983

DISTRIBUTION GENERATION INSTALLATION OF KUCHING INTERNATIONAL AIRPORT

KIMBERLY ANDING

B010810187

BACHELOR OF ELECTRICAL ENGINEERING
(INDUSTRIAL POWER)
JUNE 2012

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTY OF ELECTRICAL ENGINEERING

BACHELOR OF ELECTRICAL ENGINEERING
(INDUSTRIAL POWER)

SESSION 2011/2012
SEMESTER 2

FINAL YEAR PROJECT REPORT
(FYP 2)
BEKU 4983

DISTRIBUTION GENERATION INSTALLATION OF KUCHING INTERNATIONAL AIRPORT

KIMBERLY ANDING **B010810187**

SUPERVISOR
MR. AIMIE NAZMIN BIN AZMI

DATE SUBMITTED
08 JUNE 2012

" I hereby declare that I have read through this report entitle "*Distribution Generation Installation of Kuching International Airport* " and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

Signature : .....

Supervisor's Name : En. Aimie Nazmin Bin Azmi

Date : 8th June 2012

DISTRIBUTION GENERATION INSTALLATION OF KUCHING INTERNATIONAL AIRPORT

KIMBERLY ANDING

This Report Is Submitted In Partial Fulfilment of Requirement for the Degree Of

Bachelor in Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2012

I declare that this report entitle "*Distribution Generation Installation of Kuching International Airport*" 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.

Signature : .....

Name : Kimberly Anding

Date : 8th June 2012

Dedicated to:

Eric Anding,

Goden Suwim,

Grace Anding

and the late David Rudolp Anding.

ACKNOWLEDGEMENT

My heartfelt gratitude goes out to the people involved in this project. Supervisor Mr. Aimie Nazmin bin Azmi, lecturers, panels, fellow friends and beloved family thank you from the bottom of my heart for making this experience a memorable one.

Not forgetting to the Engineering Department of Malaysia Airports Berhad for their kindness.

Your selflessness is remembered for a long time.

ABSTRACT

In power system, there is always a need to achieve an improved system in the development and operation stage. The improved technology has been heavily emphasized to utilize Renewable Energy (RE) as the source of fossil fuel is depleting. This project accounts for the heuristic process of introducing a system called the Distribution Generation (DG) empowered by solar energy at Kuching International Airport (KIA). DG is one technology that applies the generation of power at the distribution level for better performance with an added advantage of being operated by RE sources. The main purpose of this project is to perform a heuristic study of the DG installation by considering the solar energy system sizing, technical impact and the economic influence. The DG is sourced by means of renewable energy to distribute to a greener country as an effort to conserve earth's indigenous resources. Thus, the solar energy is chosen to incorporate in this project of DG installation in KIA. The installation of DG in the KIA system may improve the system performance in term of the technical area and at the same time provide a channel for renewable energy development for the advancement of modern engineering and the betterment of the environment.

ABSTRAK

Dalam bidang sistem kuasa, usaha untuk memperbaiki sistem sedia ada sentiasa berterusan dalam peringkat perkembangan dan pengendalian. Penambahbaikkan dalam bidang teknologi sentiasa menegaskan kepentingan memanfaatkan tenaga yang boleh diperbaharui dengan realibiliti terhadap bahan api fossil yang semakin terurai. Projek ini membincangkan proces perlaksanaan sistem pengagihan penjanaan yang diperkuasakan oleh tenaga solar di Lapangan Terbang Antarabangsa Kuching (KIA). Teknologi pengagihan penjanaan adalah suatu teknologi yang mengaplikasikan penjanaan kuasa pada peringkat pengagihan untuk meningkatkan prestasi dan pada masa yang sama dijanakan oleh sumber yang boleh diperbaharui. Tujuan utama projek ini dijalankan adalah untuk menganalisis pemasangan pengagihan penjanaan dan membuat perbandingan sebelum pemasangan dan selepas pemasangan. Teknologi pengagihan penjanaan ini disumberkan oleh tenaga yang boleh diperbaharui dalam usaha memelihara sumber asli bumi. Oleh itu, tenaga solar dipilih untuk dimasukkan sebagai tenaga sumber untuk projek pemasangan pengagihan penjanaan di KIA. Pemasangan ini dapat meningkatkan prestasi sistem dari segi teknikal dan pada masa yang sama menjadi satu saluran untuk perkembangan tenaga hijau dan kemajuan kejuruteraan moden.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CHP	-	Combined Heat and Power
CIRED	-	Congress International des Reseaux Electtriques de Distribution
CL	-	Connected Loads
DG	-	Distribution Generation
GHG	-	Green House Gases
GEN SET	-	Generator Set
IEEE	-	Institute of Electrical and Electronics Engineers
KIA	-	Kuching International Airport
KW	-	Kilowatt
MD	-	Maximum Demand
MBIPV	-	Malaysia Building Integrated Photovoltaic
MW	-	Megawatt
PSCAD	-	Power System Computer Aided Design
PV	-	Photovoltaic
RE	-	Renewable Energy
RE Bill	-	Renewable Energy
SEDA Bill	-	Bill for Sustainable Energy Development Authority
SEB	-	Sarawak Energy Berhad

APPENDICES

CHAPTER 1

INTRODUCTION

Electricity supply has been very much dependent on fossil fuels. This is among the apparent reasons why the promotion of energy efficiency and RE are introduced as the fifth form of fuel for the country. These indigenous sources are depleting and are in a dire state for conservation thus an immediate step must be taken to reduce the depletion of Earth's natural sources. This includes developing modern engineering technology that integrates the greening concept into modern engineering.

In an effort to encourage more investors to invest in the RE sector, the Malaysian Government has introduced the Feed-in Tariff (FiT) for RE. On 28th April 2011, the Renewable Energy Bill (RE Bill) and the Bill for Sustainable Energy Development Authority (SEDA Bill) has been passed by the Dewan Negara (House of Senate) [1]. It will act as the mechanism for FiT. The new tariff will enable users to generate and sell the generated power to the power grid of the utility company at a standardized price. The passing of these bills act as a stepping stone towards greening the country by providing the standard FiT that makes RE advancement comprehensible to the RE developers. The technology behind the implementation of the RE development is called the Distribution Generation.

Besides selling power to the utility as set by FiT, DG by RE can reduce the meter reading by SEB if the power supplied to the load exceed the required capacity using a special meter called the net meter. This is one way to reduce the electricity bill by SEB and help reduce dependency on fossil fuels.

The idea of DG is related with the use of small generating units installed at strategic points of the electric power system or locations of load centres [2]. The development of DG has been discussed over the years as the technology can run on RE resources. It is in par with most country that emphasise highly on green technology.

It is known that DG that runs on RE and will ultimately contribute to the greening of the environment besides contributing to the technical benefits and economic benefits. This project discusses much of the installation of DG that includes the RE system sizing for the generating capacity, the technical impact it has on the electrical system and proceed with reviewing the economic management.

1.1 Motivation and Scenario

Recent emphasis given by the government to produce technology with green concept has induced the idea for DG to be implemented in buildings. It has over the years embarked on a list of initiatives in reducing green house gases (GHG) with the signatory of 1972 Montreal Protocol and proceeded with Kyoto Protocol. The current Malaysia Building Integrated Photovoltaic (BIPV) Technology Application Project is aimed at a long-term cost reduction of non-emitting GHG technology through incorporation of PV technology within building designs. It is expected that the project can avoid 65 100 tons of carbon dioxide emissions from the country's power sector in 2010 [3].

In a parallel context, technological innovations have brought engineering development at a high pace that mankind has yet to see. Utility company are considering the employment of DG technologies that is beneficial for consumers and operators alike. Some

of the issues highlighted of the implementation of DG are in term of the technical specifications where it is envisage to improve the design and performance of the network [2].

1.2 Objectives

The objectives of this project are:

i. To determine the required solar system sizing of DG installation in the distribution network.

ii. To determine the technical impact of DG installation in KIA distribution network.

iii. To review the economic management system of the installation.

1.3 Scope

The projects take into account the essential loading of KIA level 2 during office hours (8am – 5pm). The generation of DG is empowered by solar energy where it is placed to the distribution system of KIA MSB 1. The system sizing is determined to accommodate the allocated loading of KIA level 2 which consist mostly of administrative offices.

The two situations of technical impact covered in this report that is determined are when the SEB is made a primary DG a secondary supply and SEB made a secondary DG a primary supply. It is done as a paradigm study of the effects of the technical specification when DG is installed. Despite the definition of DG differs from other countries such as the rating of the plant or the voltage level connected to the DG system, this project solely focuses on the fundamental behaviour of the generation injected right before the loads of

KIA level 2. Simulation by a computer-aided design PSCAD is carried out in order to observe the performance of the probable outcomes of the DG technology.

Thereafter, the economic impact is studied to review the project status. The economic aspect will cover the simple payback period that help investors evaluate the project

1.4 Problem Statement

At norm, electricity is supplied to buildings by utility company from the generated power plant that is transmitted to the distribution level. The electrical network of KIA receives an incoming supply of 11kV that is stepped down to 415V and further down to 240V. Most buildings are designed to be equipped with backup power system due to sensitive machines that requires full and reliable operation without interruption. The current backup system incorporated in KIA is the generator set (Gen Set) in which it is fueled by diesel.

With grid connected PV system DG, buildings are able to generate electricity independently and thus reduce the dependency on the electric company or the current gen set that is fueled by fossil fuel. It is noted that fossil fuels are non-renewable energies that are scarce and need urgent conservation. DG implementation has benefits in terms of economical and the technical performance and of utmost importance; the source of the DG is of indigenous RE which is critical to conserve the environment.

Also, when the network is heavily loaded during peak periods, load current drawn from a supply increases and consequently causes the voltage drop and losses. KIA operates on a 24hour basis with characteristics of peaks hours during operation from morning until evening and a lower demand for the remaining hours. The study of this project will focus on the performance of the system upon DG installation; the system sizing, technical impact and economic review.

KIA as a commercial consumer is challenged for a design and operation that is cost-effective for loading and reliability. The purpose of this project accounts for the installation of the DG upon placement in the system and to determine the selected system sizing for the operation. It is a heuristic process of performing a load flow analysis to determine the technical benefits of DG installation.

CHAPTER 2

LITERATURE REVIEW

2.1 Renewable Sources of Energy

Over the years, technologies have been developed to accommodate the depletion of Earth's natural resources. Meanwhile, interest on RE has began a widespread attention as a replacement. It is the combination of DG and RE that is important to ensure livelihood of mankind on Earth sustain while fossil fuel is diminishing.

RE represents the inexhaustible energy which occurs naturally and repeatedly that is assured to resurface without depleting. This source of energy does not emit GHG and is therefore an ideal choice to go parallel with DG.

Common forms of RE used are such as photovoltaic power stations, wind power plants, micro turbines, fuel cells, biogas and biomass. With the advantage of the support from RE, DG can save investment, reduce energy consumption of fossil fuels and enhance reliability. Also, the Malaysian government aims for 2080MW of power to be produced via RE by year 2020 [4]. As of December 2004, the total number of RE projects approved by the government is generating at a capacity of 212.4MW [5].

Malaysia is situated along the equatorial line with sunshine throughout the year and coupled with a high irradiance level is well suited for PV generation of about 1400-1900kWh/m^2 [6]. The conventional solar power plants use concentrating devices to obtain maximum sunlight to achieve the high temperatures required to produce steam for power. The mechanism of solar system is initiated by the flat-plate collectors that transfer the heat of the Sun to water either directly or through the use of another fluid and a heat exchanger [7].

2.1.1 PV System Sizing

Solar energy refers to the energy obtained from the sun. It is abundant and free and is widely recognized as one of the many source of RE. It has near zero environmental impacts and is known as a clean energy. Malaysia known as a tropical country is blessed with solar energy potential from the constant sunlight received regularly. Thus, the method for utilizing solar is greatly emphasized in studies of determining the correct solar system sizing for optimum utilization.

Some problems have been identified in utilizing solar system sizing. Main concerns of solar system sizing are in the accuracy of data used. It is noted that the solar energy is dependent on the presence of the solar in a specific zone and by using the correct information of the sun only can the evaluation process be proceed[8]. This paper proposed a design procedure that is suitable in determining the system sizing. The basic understanding of solar energy is that more power will be produced on a brighter day compared to cloudy days. The rated average peak sun hours per day based on yearly sun data is determined by the geographical area based.

The connection of solar panels can be done in series and parallel in order to increase voltage and current respectively. One of the major characteristics of a solar system component is the selection of battery ampere-hour where the batteries are used to store the energy produced by the solar panels. It is the load that will draw energy from the batteries

directly or through inverters which act as converting the battery DC voltage to the required AC voltage of loads.

2.2 Distribution Generation

Generally, a large central generator is fed to the electrical power system through a generator transformer to a high voltage interconnected transmission network that will further distribute to the loads. The transmitted power is then extracted to be distributed to the loads for consumers. A conventional power system is typically designed as shown in Figure 2.1.

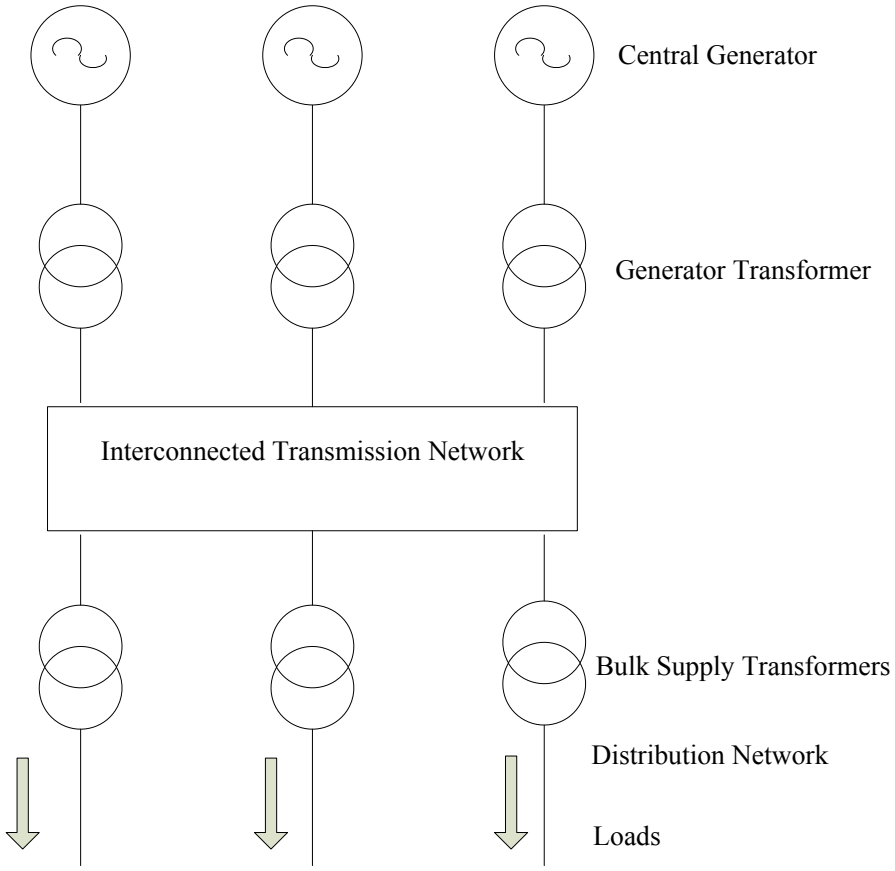

Figure 2.1: Conventional Power System

Recent studies have revolutionized the power system by introducing distribution generation or what is known as embedded or dispersed generation on the distribution

system that has networks connection between consumers of 230/415V to 145kV [2]. Some of the attributes of the embedded generation recognised and reported by the *Congress International des Reseaux Electtriques de Distribution* (CIRED) WG04 [9] are:

i. Not centrally planned by the utility

ii. Not centrally despatched

iii. Normally smaller than 50-100MW

iv. Usually connected to the distribution system.

Not centrally planned and despatched mean that the reactive power generation are out of control of the system operator. DG is also associated with the use of small generating units installed at a strategic points where it has been discussed in paper [10] that it depends on the ratings and locations of the DG units. It must be noted that the ratings and locations will consequently determine the reduction of line losses.

The equipment ranges of DG ranges in size from less than a kilowatt (kW) to tens of megawatts (MW) [7]. It also can meet all or the partial needs of consumer demands. Also, if it is connected to the utility company it can be sold at a standardized price under the FiT scheme.

DG can also be used in an isolated way connected to the distribution system primarily in the sub transmission level in which the generated power is supplied to the consumer's local demand or integrated into the grid supplying energy to the remainder of the electric power system [7]. For the project of DG installation in KIA, the application of DG is used as to supply to consumer's local demand on a stand alone system. The supplying unit may be run by RE resources, fossil fuels or combine heat and power (CHP). This form of energy is highly promoted as it enhances the utilization of energy in an efficient manner.