UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ASSESSMENT ON THE IMPACT OF DISTRIBUTED GENERATION (RENEWABLE ENERGY) PENETRATION TO THE NATIONAL GRID PROTECTION SYSTEM PERFORMANCE USING ERACS SOFTWARE

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

by

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **ASSESMENT ON THE IMPACT OF DISTRIBUTED GENERATION (RENEWABLE ENERGY) PENETRATION TO THE NATIONAL GRID PROTECTION SYSTEM PERFORMANCE USING ERACS SOFTWARE**

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

……

(MR ADLAN BIN ALI)

ABSTRAK

Industri kuasa telah menunjukkan pertumbuhan yang besar sejak beberapa dekad yang lalu. Permintaan untuk sumber tenaga yang lebih baru dan mesra alam semakain meningkat bagi mengurangkan pelepasan karbon dioksida. Pengenalan tenaga boleh diperbaharui yang dibekalkan melalui penjanaan yang diedarkan (DG) ke dalam sistem kuasa telah mengubah kerumitan aliran kuasa. DG kebanyakannya dipasang pada titik pengedaran dan perubahan ini mempengaruhi keupayaan sistem perlindungan sekarang. Makalah ini memberi tumpuan kepada kesan menyambung generasi diedarkan kepada sistem perlindungan pada tahap pengedaran. Impak yang diselidiki adalah perlindungan yang membutakan dan keadaan itu ditunjukkan dengan menggunakan Relay Time Definite Inverse (IDMT). Model ini disimulasikan menggunakan perisian ERACS dengan nilai-nilai DG yang disuntik untuk melihat kesannya pada sistem perlindungan edaran. Kajian ini bertujuan untuk membuktikan bahawa DG menyebabkan masalah sistem perlindungan yang mungkin membawa kepada peristiwa yang lebih berbahaya

ABSTRACT

Power industry has shown great growth in the past decades. The demand for newer and environmental friendly power sources are in large demand in order to decrease the emission of carbon dioxide. The introduction of renewable energy which supplied through distributed generation (DG) into the power system has changed the power flow complexity. DG mostly installed in the point of distribution and these changeso effects the reliability of the present protection system. This paper focusing on the impact of connecting distributed generation to the protection system at the level of distribution. The impact investigated is protection blinding and the condition is demonstrate by using Inverse Definite Time Relay (IDMT). The model are simulate using ERACS software with different values of DG injected to see the effect on distribution protection system. This study aimed to prove that DG is causing protection system problems which may lead to more dangerous events.

DEDICATION

My mother, Darmawati Binti Tanru.

My sister, Nur Azwa Binti Rusli

My brother, Muhammad Azli Bin Rusli

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RE	- Renewable Energy
DG	- Distributed Generation
CO_2	- Carbon Dioxide
TNB	- Tenaga Nasional Berhad
SESB	- Sabah Electricity Sdn. Bhd.
SEB	- Sarawak Energy Berhad
kV/kA	- kilo volt/kilo amp
IPP	- Independent Power Provider
ST/EC	- Suruhanjaya Tenaga/Energy Commission
FiT	- feed-in tariff
CHP	- Combine Heat Power
SEDA	- Sustainable Energy Development Authority
IDMT	- Inverse Definite Minimum Time
IEC	- International Electrotechnical Commission

CHAPTER 1
INTRODUCTION

1.0 Introduction

This chapter will discuss about background study of Malaysia distribution network as well as distributed generation. The problem statement will be identified and objective will be determined to make sure the project finished within the scheduled time. The scope will be stated as it works as boundaries for this project.

1.1 Background Study

The power system scenario in Malaysia as well as the world have evolved and changed greatly in the past decades. The increasing demand for energy from consumers and the decreasing of non-renewable source lead to widely usage of renewable energy (RE). Apart from decreasing amount of non-renewable resources, the world also facing environmental challenge as the production of vast amount of carbon dioxide (CO_2), greenhouse gases that lead to pollution and extreme climate change.

The world are moving from traditional coal fuelled generation into a more environmental friendly and sustainable generation, sometimes co-generation. RE is a form of energy that will never finished, which means it always available to use. Main example of RE is sun, wind, water and geothermal. RE technology such as solar panel are used widely to accommodate the demand of energy and more known as distributed generation (DG).

Distributed Generation or DG is the type of power generation that exist at the point of consumer. DG usually does not connected directly to the main generation or bulk power transmission. It usually connected near the consumer, which is on the level of distribution. Traditionally, the distribution network is a radial network, which means the power distribution travel form the higher power level to lower power level. The addition of DG to the present distribution network changed the way of power flow for the whole distribution network system. Hence, distribution network consist of centralized generation and distributed generation.

The new distribution network which consist of centralized generation and distributed generation makes the energy distribution more convenient as the consumer can get the power supply from the centralized distribution system as well as from distribution generation. However the merge of this two network have increased the complexity of the overall power system protection of the distribution network.

Although undeniably distributed generation have benefits in energy distribution, it have its own drawbacks. The drawbacks considered in this project are more towards the protection system as the addition of distributed generation changed the distribution network from radial to mesh network.

1.2 Problem Statement

The evolving world and invention technology have made our life as easy. This also apply to how the electrical energy sector have development for the past years. Electrical distribution network and system are not spared in the advancement towards better living, driven by the growing demand. Electrical distribution network have changed greatly in past decades along with the technology advancement.

Traditionally, distribution system have been designed to operate radially without considering the injection of renewable energy. The system radial network works one way,

which it flows from higher terminal to lower terminal. Hence, the protection system is also straightforward as the fault current can only flow in one direction. The connection of DG into distribution network may and can cause problem to the present protection system. This is because the present protection system do not cater the problem cause by the penetration of DG.

The application of DG technology have attract attention in order to improve he power quality, reliability and stability of the power grid. DG technology is often a concern where application of DG can dismiss the reliability of building new transmission grid, especially in rural areas. Furthermore, DG technology application on RE source have been contributing to the low amount of carbon emission and other air pollution problems. However, DG installation may cause huge changes in the traditional design as well the operation of power grids. In addition to that, the increasing of DG in power system require new control techniques for the operation and management of power network. This new control technique is vitally needed in order to maintain and or improve the power supply reliability and quality in the future. (Pouresmaeil, Catalão, & Indices, 2015)

The instalment of DG into the distribution network has changed the traditional power system nature which is radial. Radial power distribution means that the power flow in one direction and in electricity energy flow, it flow from higher voltage to lower voltage level. However, the penetration of DG has changed the nature to bidirectional and thus imposes challenged to the conventional protection scheme that were design to cater radial distribution system. (Jain, Gupta, & Singh, n.d.)

1.3 Objective

In order to complete this project successfully, a few objectives are required as a guide line. The objectives of this project are:

i. To design and develop a theoretical model of Malaysia distribution network without distributed generation and with distribution generation.

ii. To simulate the theoretical model in Electrical ERACS to get fault current data for impact assessment.

iii. To assess the impact of the penetration of distributed generation to the national grid protection performance system focusing on protection blinding.

iv. To find suitable mitigation approach to minimize the protection blinding impact.

1.4 Scope

The scope of this project are

i. The distribution network used are modelled based on Malaysia distribution network as this project is to assess the impact of DG penetration to the national grid.

ii. The level of distribution network used is on the distribution level, hence all the modelled simulation network used 33kV as the generator voltage source.

iii. The simulation are done entirely using ERACS software.

iv. The protection system problem focused in this project is protection blinding caused by penetration of DG in distribution network

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

Ideas and research from past papers and researches are used as the baseline and guideline in completing this project. Literature review is the first step done to begin the project in order to gain more in depth understanding about the concept of the distribution network and the impact of the injection of the distributed generation. In this chapter, details about the project will be elaborated and discussed based on past research, published articles and books.

2.1 Distribution Network

Electricity is transported from one point to another until it reach consumer. It is delivered by using wires and cables along with control system. Power system can be divided into three (3) major parts namely generation, transmission and distribution. The power that are produced from generation will be delivered to consumer through transmission line and then step down to desirable voltage in distribution. The step down voltage are then distribute to each consumer depending to their load demand.(Iman & Mat, 2009)

Distribution of electricity is a big system that combine small system together to send out electricity from the generation point to the customer. The distribution of electric power is one part of the power delivery structure that send electricity from the highly complex meshed, high voltage transmission circuits and send it to the consumers. Medium voltage circuits are the primary distribution lines, usually 600v to 35kV. Transformer that exist at substation will takes the incoming transmission level voltage, range from 300kV to 33kV and step it down to other distribution main circuits. This process happen at distribution substation. As the distribution substation are close to the consumer, the distribution transformer will takes the incoming transmission level voltage and steps it down to a low voltage level such as 415/240 V.

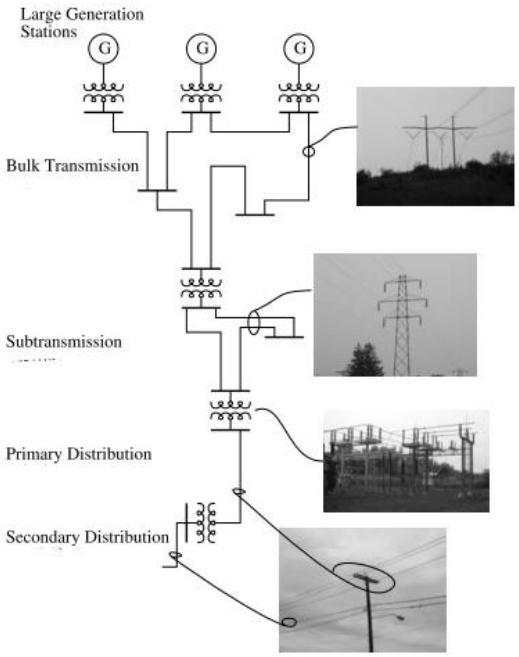

Figure 2.1a: Overview of Electricity Infrastructure (Source:(Short, 2003)

2.1.1 Distribution System Configuration

Distribution of power system have their own configuration, to transfer the medium voltage level section to the low voltage section. Distribution system configuration can be divided into several standard system:

I. Radial system – the load is supplied one radial feeder. Supply flow from higher level voltage to the lower level which makes it a series circuit.
II. Open ring system – load is supplied through one or two available feeders.
III. Closed ring system – load is supplied through the two side of the ring simultaneously.
IV. Dual ring system – the load connected with two rings at the same time, it has four incoming feeder.
V. Multi-radial system – load supplied by more than one radial feeder.

According to (Kim, Cho, & Shin, 2013), the most common configuration of power system is radial system. Radial configuration main advantage is its ease of control. In addition to that, in terms of protection, radial configurations network are equipped with sectionalizing points which enabled the section with fault to be disconnected immediately. However, loop distribution or ring configurations have the advantages in term of voltage regulation and reliability.