POWER STABILITY OPTIMIZATION ON GRID CONNECTED WITH SOLAR AND WIND ENERGY HARVESTING

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Bachelor of Electrical Engineering (Power Industry)

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“I hereby declare that I have read through this report entitle " Power Stability Optimization On Grid Connected with Solar and Wind Energy Harvesting" and found that it has comply the partial fulfillment for awarding the degree of bachelor of electrical Engineering (Industrial Power).”

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POWER STABILITY OPTIMIZATION ON GRID CONNECTED WITH SOLAR AND WIND ENERGY HARVESTING

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A report submitted in partial fulfillment of the requirements for the degree of Bachelor of Power Industry

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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I declare that this report entitle “Power Stability Optimization on Grid Connected with Solar and Wind Energy Harvesting" 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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To my beloved mother and father

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ABSTRACT

Combination of wind hybrid energy system and solar photovoltaic (PV), are essential in power system stability. Both of this systems can operate and gain more stability rather than each of that system work alone. The main objective of this project is to analyze the performance of combination of both system which is Solar Photovoltaic PV generator and Wind Turbine generator is connected with grid network. Thus, solar Photovoltaic PV and wind turbine generator is designed and connected to grid network that consist of 14- bus and tested in the Power System Analysis Toolbox (PSAT) and simulated by using MATLAB Simulink. Simulation results show that the hybrid generation system with combination of wind and solar PV can keep and optimize the stability of the system at desired level under the condition of wind and solar variation.

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ABSTRAK

Gabungan sistem tenaga solar-Anginhibrid, adalah penting dalam kestabilan sistem kuasa. Kedua-dua sistem ini boleh beroperasi dan mendapat kestabilan sistem yang lebih baik daripada sistem ini beroperasi secara tunggal. Objektif utama projek ini adalah untuk menganalisis prestasi gabungan kedua-dua sistem yang Solar Photovoltaic PV penjana dan angin penjana turbin disambungkan dengan rangkaian grid. Oleh itu, PV Photovoltaic solar dan penjana turbin angin direka dan disambungkan kepada rangkaian grid yang terdiri daripada 14 - bas dan diuji dalam Sistem Kuasa Analisis Toolbox (PSAT) dan simulasi dengan menggunakan MATLAB Simulink. Hasil simulasi menunjukkan bahawa sistem generasi hibrid dengan gabungan angin dan solar PV boleh memastikan dan menambah baik kestabilan sistem pada tahap yang dikehendaki di bawah keadaan angin dan perubahan solar

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LIST OF SYMBOLS

P	-	Power
A	-	Capture Area
V	-	Wind Speed
ρ	-	Air density (1.225 kg/m^3)
MW	-	Mega Watt
V	-	Voltage
s	-	Seconds
t	-	Time
PV	-	Photovoltaic
WT	-	Wind Turbine

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CHAPTER 1

INTRODUCTION

1.1 Background

Stability is the tendency of power system to develop restoring forces equal to or greater than the disturbing forces to keep the state of equilibrium. If the forces tending to hold machines in synchronism with one another are enough to overcome the disturbing forces, the system is said to remain stable. The stability studies is separated into two major parts which is steady state stability and transient stability. Steady state stability is ability of electrical system to recover synchronism after small and slow disturbance, such as changes of gradual power. Transient stability is to remain synchronism when sudden disturbances, such as three-phase fault, the sudden outage of line or the sudden addition or removal of loads. As the usage of electricity increases every year will lead to instability of power system due to increasing of loads. Thus, to overcome the instability of the power system, there are many ways has been applied which can improve the power stability which is applying FACTS controller to AC power, and other electricity generation like oil and coal and etc.

Increasing of usage the unrenewable energy will lead to environment pollution. Thus, to replace the conventional non-renewable sources is develop clean and renewable energy such as solar and wind energy. Study have been conducted to investigate the operation of solar and wind power systems. Therefore, in this paper will designed Solar and wind energy system to optimize the stability of grid connection. The practice and effective method to get better

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performance in developing countries to provide a steady and reliable supply of electricity by combining wind turbine with solar electricity to the grid network.

1.2 Problem Statement

The existing transmission lines are built 20 years ago. Due to ageing and other related factors, it is unreliable in future. Furthermore, fast going technologies and increasing number of population will result in possibility of overload problem. Thus, a new transmission lines with use of renewable energy power sources such as solar and wind energy to it. This to support the usage of renewable energy and is estimated to last for the next 20 years to ensure stability of the system on grid connection.

1.3 Objectives

The objectives of this project are:

1. To investigate the operation of solar and wind power systems.
2. To design hybrid PV and wind system using PSAT software which is using MATLAB Simulink.
3. To verify the optimization power of solar and wind energy harvesting.
4. To analyze the performance of Solar PV and wind energy system.

1.4 Scope

Solar PV and wind energy system is developed based on the proposed system in simulation. The variable speed wind turbine with doubly fed induction generator connected with wind model type Weibull and solar photovoltaic generator (PV) are used in this simulation. The stability of each system in work alone and combination of both systems is compared and analyzed. Thus, in this case, hybrid PV and wind system is designed by using MATLAB software to optimize the power stability of grid connection.

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CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will discussed about the solar and wind energy harvesting. A brief definition of solar and wind energy will be explained and the basic operation of this both system also will be discussed in this topic. In addition, a few theory regarding FACTS for Grid integration of wind power also will be included.

2.2 SOLAR ENERGY SYSTEM

2.2.1 Definition

Solar system in renewable energy which is photovoltaic PV system is divided by two categories which are flat plate system and concentration system [7]. The flat plate system is directly captured the sunlight whereas the concentrator system is collect a large amount sunlight and concentrate it and focus to the PV panels. For the output power, the output PV array at real power is 100kW [1]. Compared to the PV module which the parameter is set up 3.5kW [2].

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2.2.2 Photovoltaic System (PV)

Power generating system which is from a type of renewable energy is known as PV system. This PV module or PV panel is function as convert the direct ray from the sunlight to electricity. This photovoltaic PV module will used semiconductor as converting the solar radiation into direct current (DC) electricity.

2.2.3 Operation

In understanding on how the photovoltaic PV system work when a grid-connected to PV is includes a few component that will work together. Figure 2.1 shows flow of block diagram operation of PV. The amount of sunlight which direct ray that hits the panel will generate electricity. Then, direct current (DC) electricity will produced and the inverter that connected to the grid will convert the DC into AC electricity. Thus, the AC electricity can be used to utility. As we know that the solar cell only can produce power during the day, the main power grid will supply power as usual.

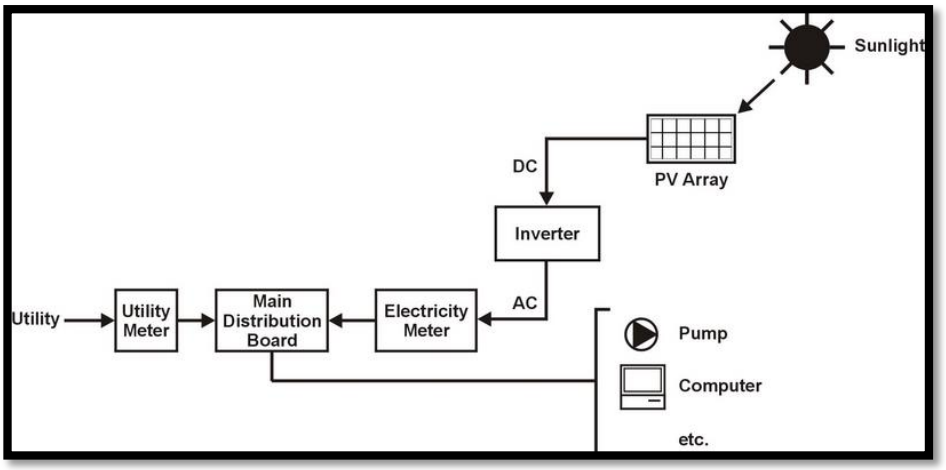

Figure 2.1: The flow of block diagram operation of PV

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2.2.4 Advantage of Solar Energy System

The advantage of using solar energy power system in electricity is this system is renewable energy, and easy to get which means that free source, only receive energy from the sunlight. In addition, solar energy system is long life span (durable).

2.3 WIND ENERGY SYSTEM

2.3.1 Introduction

Wind turbines can be divided into three parts which is small, medium, and large turbine [7]. The output power rating of small turbines is less than 20kW which are used for residential application. For the medium turbines, the output rating provide around 20 to 300kW which installed power that used to supply either remote loads that need more electrical power or commercial building. On the other hand, the power range of the large turbine are MW which in corporate complex system and wind farm. By the way, the parameter wind plant that was set up is 5kW [2]. Compared to the wind turbine that connected to the point of common coupling (PCC) is 1.5kW.

2.3.2 Power from Wind Turbine

The power produce by wind turbine is depend on blades, height, velocity of wind and etc. Thus, the equation below shows how to calculate power that produce from wind turbine. The Figure 2.2 illustrate the power available from the wind and Figure 2.3 shows wind speed, Power, & height.

$$P = \frac{1}{2} A \rho V^3 \tag{2.1}$$

A= capture Area

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V= wind Speed

ρ= air density (1.225 kg/m^3)

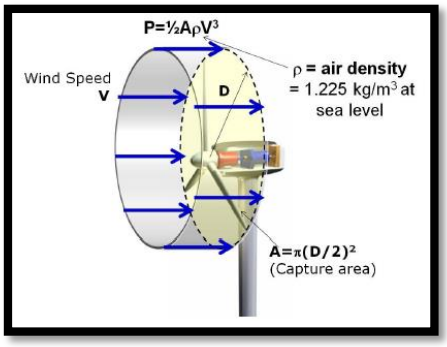

Figure 2.2: The power available from the wind

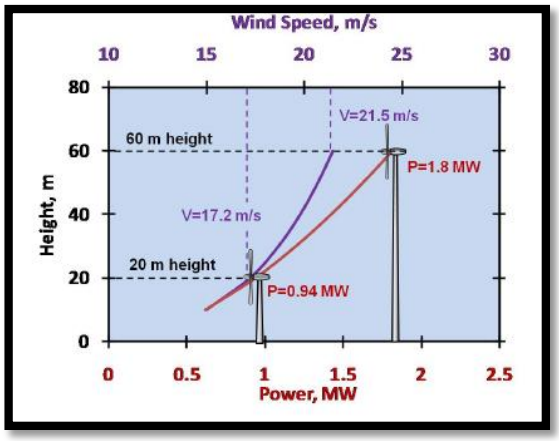

Figure 2.3: Wind speed, Power, & height

2.3.3 Operation

A simple principle will operated by wind turbines which the energy in the wind turns two or three propeller-like blades around a rotor. To create electricity, the main shaft that

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connected with rotor will spins a generator. The most energy which captured by the wind turbine are mounted on a tower. Figure 2.4 shows the operation of wind turbine connected to the grid. Faster and less turbulent wind at 100 feet or more above ground.

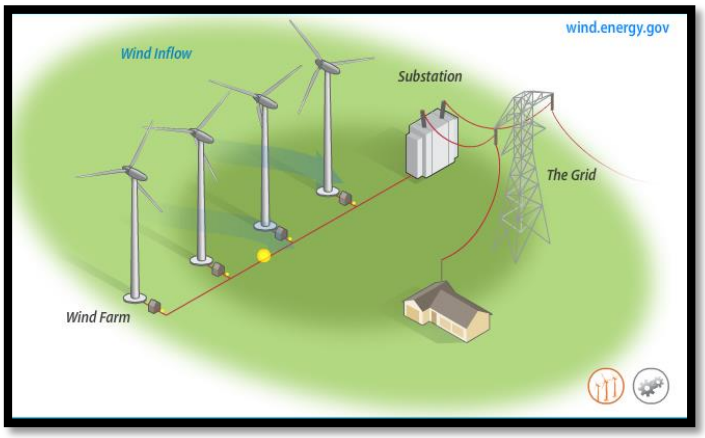

Figure 2.4: The operation of wind turbine connected to the grid

2.3.4 Advantage

The advantages of used wind energy system is free source and ability to capture efficiently. Furthermore, this energy system is friendly to the surrounding environment. In addition, when combined with solar electricity, this energy source is great for developed and developing countries to provide a steady, reliable supply of electricity.

2.4 FACTS controller and Hybrid Renewable Power System

To address new operating challenges that being presented today, the Flexible AC Transmission System (FACTS) provide proven technical solution [6]. The issues on applying FACTS controller to AC power benefit to the power system which can improve the power stability, increased system security, and reliability. However, the hybrid renewable energy system (HRES) can reduce fuel consumption and environmental pollution [1].

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2.5 Summarize of The Literature Review

An investigation on operation of renewable energy which is solar and wind energy system was conducted in the literature review. It was found that method that will used in this project by design solar and wind energy system that will connected to the grid system to keep the system stable.

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CHAPTER 3

METHODOLOGY

3.1 Introduction

In order to make the progress of this project work smoothly, this chapter will explain more detail about the methodology that has been used to complete this project. This may include from the project has been started until this project is complete all relevant experimental and descriptive techniques used in this project will be outlined. This methodology will used and helps as guidelines to get good result. Besides that it can help this project in solving problem and can be completed step by step as scheduled.

3.2 Software Development

3.2.1 MATLAB Simulink

MATLAB Simulink software will be used in this simulation because it can be set up easily, and some module can be modified and added. Thus, this software is a commercial tool for modeling, simulating and analyzing. A graphical editor, customizable block libraries, solver for modeling and simulating dynamic system is provided in this MATLAB Simulink. This will helps for further analysis because it enabling to export simulation results to MATLAB. This project is conducted by using MATLAB software Version R2011a.

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