EFFICIENCY ANALYSIS OF PV INVERTER – ADJUSTABLE SPEED DRIVE SYSTEM

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To my beloved wife, father, mother, brothers and sister

For their love, supports and blessings

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ABSTRACT

This project entails efficiency analysis of a distributed generation system consisting of Photovoltaic (PV) – Inverter system as the renewable source connected to a network of Adjustable Speed Drives (ASDSs) as the load. A small-scale laboratory of the Photovoltaic, Inverter, ASDSs and Loads system were used in this research. Two power supplies from PV and grid were connected to three ASDSs which powered three separate induction motors. Experiments were carried out. Measurements were recorded from which the interaction between the source and the load in this system may further be analyzed. Analysis of the result was carried out in which results of both experiments were compared. At the end of the research project, the worst and best case operating scenarios were indentified from which base-line information for optimum operating conditions is achieved.

ABSTRAK

Projek ini merangkumi analisa kecekapan sistem penjana pengagih yang mana mengandungi sistem solar-inverter sebagai sumber tenaga baru yang bersambung dengan sistem Adjustable Speed Drives (ASDs) sebagai beban. Satu makmal ujikaji yang berskala kecil yang mengandungi solar, inverter, ASDs dan sistem beban telah dibina. Dua sumber tenaga yang diperolehi dari sumber PV dan grid disambung dengan tiga ASDs yang bersambung dengan tiga motor aruhan yang berasingan. Ujikaji telah dijalankan. Ukuran dan bacaan telah dicatat dari yang mengenai antara sumber dan beban dalam sistem ini boleh ditambah dalam analisa. Analisa dan bandingan telah dibuat daripada hasil keputusan yang diperolehi daripada ujikaji. Di akhir projek, buruk dan bagus operasi sistem akan di perolehi yang membawa kepada operasi sistem yang terbaik.

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LIST OF SYMBOLS

M1 = Motor 1

M2 = Motor 2

M3 = Motor 3

PV = Photovoltaic

ASD = Adjustable Speed Drives

*k*W = Kilo Watt

Hz = Hertz

V = Voltage

I = Current

n = rpm = Rounds per Minute

ω = Rotor Speed

t = Torque

π = Pi

η_{Total} = Efficiency Total

P_o = Power Output

$P_{i,Total}$ = Power Input Total

$P_{o,Total}$ = Power Output Total

W/m2 = Watts per Square Meter

HVAC = High Voltage Alternate Current

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CHAPTER 1

INTRODUCTION

Renewable energy is no longer just an option nowadays. The renewable energy plays an important role in our live due to rise demand for electrical power. Photovoltaic is one of the renewable energy that has been used for about decade ago. The word "photovoltaic," first used in about 1890, is a combination of the Greek word for light and the name of the physicist and electricity pioneer Allesandro Volta. So, "photovoltaic" can be translated literally as "light-electricity." Photovoltaic or known as solar energy is a renewable resource that is vast and is locally available. It is a clean energy source that allows for local energy independence. The sun's energy flow reaching the earth is typically about 1,000 Watts per square meter (W/m2), although ease of use varies with location and time of year. Simple PV systems provide power for many small consumer items, such as calculators and wristwatches. More complicated systems provide power for communications satellites, water pumps, and the lights, appliances, and machines in some people's homes and workplaces. Many road and traffic signs along highways are now powered by PV. In many cases, PV power is the least expensive form of electricity for performing these tasks [1].

Photovoltaic produce DC voltage to the load. The voltage can be converting to AC by using DC-AC converter which is commonly known as inverter. The inverter conversion process with power electronics is generally known as the switched-mode inversion. One major application of switched-mode is Adjustable Speed Drive (ASD). Adjustable Speed Drives (ASDs) are power electronic circuits

used to control the speed of motors. In practice, many ASDs are connected together to form a network of adjustable speed drives to control the speed of motors in manufacturing lines, buildings (for HVACs), agricultural sectors (for irrigation pumps), and house-hold applications (such as those found in energy-saving washers and dryers). Today, 55% of the total electrical power in the US is consumed by the motor drives industry. Due to the advent in power electronics, adjustable speed drives employing solid-state switches have become popular in motor applications due to the significant energy saving that they offer. It has been estimated that the widespread use of adjustable speed drives causes as much as 20% reduction in energy consumption. This is equivalent to the total electric energy produced by about 162 power plants.

In this project, PV system and ASD will be used and connected each other to see how it can save the energy usage and although to see their efficiency. Further, the results of this project, henceforth, will be useful in developing a smart or innovative load management PV-inverter-ASD system that ensures maximum system efficiency at any given time. This, in turn, will result in significant energy savings, suppression of operating cost, and provision of efficient planning tool for future expansion of PV system as the alternate source of energy.

1.1 Objective

To determine and identify optimum operating condition based on the worst and best case operating scenarios.

1.2 Scope

1. This project consists of small scale laboratory of grid-connected PV inverter with Adjustable Speed Drive (ASD) system as load.
2. Measurement at source and load will be conducted to identify efficiency of the system.

1.3 Project Background

1. There have certain problem such as power quality at grid connection when grid system connected to PV-inverter system.
2. Impact of ASD in grid connected PV-inverter system.

1.4 Methodology

1. This project will be started by collecting and studying the written source such as book, paper, thesis and website which related to the project.
2. After that, a small-scale laboratory of the Photovoltaic, Inverter, ASDs and Loads system will be setup.
3. From the experiment, measurements were conducted at the source and the load.
4. Data obtained from measurement will be used in calculation that will lead to the result.
5. After that, analysis of the result will be done.
6. At the end of the project, the worst and best case operating scenarios will be indentified from which base-line information for optimum operating conditions may be achieved