COST EFFECTIVE ENERGY MANAGEMENT STRATEGY OF STAND-ALONE HYBRID. SYSTEM

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DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.I dedicate my project report to the family, especially to the beloved mother, Zubaidah Binti Awang Mat, and my wife, Rosniza Binti Zahari and my kids, who gave many words of encouragement and encouragement for perseverance. I also dedicate this project report to several of my friend and teammates who have help and supported me during this process. I will always be grateful and appreciate for what we have done. I adore you all and may Allah SWT bless and grant you Jannah, Amen.

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ABSTRACT

Renewable energy sources such as solar and wind system are the most affordable energy sources compared to conventional sources. Both energy sources can be connected to support and supply the demand and act as a backup energy sources for locations that are not fitted with any electricity distribution system. Furthermore, these clean energy sources have minimum operational cost and can reduce the dependency on conventional sources due to decrease the release of harmful greenhouse gases polluting the environment. The main problem and challenges that hinder the sustainability of renewable energy sources is voltage fluctuations that may lead to violation solar system and wind generation. Weather event is strongly affecting the solar system and wind generation. This fluctuation will be influencing the energy and stability of the power generation system. Therefore, the purpose of this project is to manage the combination of PV, wind, microturbine and the battery in the stand-alone system in order to ensure the continuity of supply and the optimal Non-Renewable energy utilization can be achieved. Besides, the cost of Microturbine energy generation is targeted to be reduced. Actual data from power supply by Solar (PV) is utilized in this project. The energy management in the hybrid PV-wind and microturbine stand-alone system are able to increase the operation efficiency thus maximizing the battery lifespan by keeping the State of Charge (SoC) at 90% or higher than that. State of charge level control is critical for extending battery life, minimizing power fade, and preventing over draining of battery energy.

ABSTRAK

Sumber tenaga yang boleh diperbaharui seperti sistem solar dan angin adalah sumber tenaga paling berpatutan berbanding dengan sumber tenaga konvensional. Kedua-dua sumber tenaga ini dapat bergabung untuk menyokong dan memenuhi permintaan dan dapat bertindak sebagai sumber tenaga sandaran bagi lokasi yang tidak dilengkapi dengan sistem grid bekalan elektrik. Tambahan pula, sumber tenaga yang boleh diperbaharui ini mempunyai kos operasi yang minimum dan dapat mengurangkan kebergantungan pada sumber konvensional. Peningkatan penggunaan sumber konvensional yang melepaskan gas rumah hijau berbahaya dan boleh mencemarkan alam sekitar dapat dielakkan. Masalah dan cabaran utama yang menghalang kelestarian sumber tenaga boleh diperbaharui adalah dengan turun naiknya voltan yang boleh menyebabkan sistem solar dan penjanaan angin tidak dapat membekalkan bekalan kuasa. Keadaan cuaca juga sangat mempengaruhi sistem solar dan penjanaan angin. Dengan keadaan cuaca yang tidak menentu ia akan mempengaruhi tenaga dan kestabilan sistem penjanaan tenaga. Oleh itu, tujuan projek ini adalah untuk menguruskan gabungan sumber bekalan seperti solar, angin, mikroturbin dan bateri dalam sistem yang boleh berdiri sendiri untuk memastikan kesinambungan bekalan dan penggunaan tenaga yang optimum dapat dicapai. Selain daripada itu, pengurangan kos penjanaan tenaga juga dapat disasarkan. Data sebenar dari bekalan kuasa solar (PV) digunakan dalam projek ini. Pengurusan tenaga dalam Sistem Hibrid Photo Voltic-Wind dan Microturbine yang berdiri sendiri dapat meningkatkan kecekapan operasi. Ia juga dapat memaksimumkan jangka hayat bateri dengan menjaga keadaan pengisian (SoC) pada 90% atau lebih tinggi daripada itu. Manakala keadaan kawalan tahap cas adalah sangat penting untuk memanjangkan jangka hayat bateri, meminimumkan daya pudar, dan mencegah penggunaan tenaga bateri secara berlebihan.

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LIST OF ABBREVIATIONS

RE	-	Renewable Energy
Non-RE	-	Non-renewable Energy
EMS	-	Energy Management System
PV	-	Photo Voltaic
GA	-	Genetic Algorithm
FA	-	Firefly Algorithm
WT	-	Wind Turbine
SOC	-	State of Charge
FC	-	Fuel Cell
MT	-	Microturbine
SQP	-	Sequential Quadratic Programming
SM	-	Sliding Mode

LIST OF SYMBOLS

%	-	Percentage
$	-	US Dolar
ηe	-	Electrical Efficiency

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CHAPTER 1

INTRODUCTION

1.1 Project Background

In developing countries with remote areas, the major issues of access to electricity are the generation of grids far from the region and the high cost of delivering this infrastructure in low populated areas. Typically, the use of the diesel generator is used to resolve the issue of the lack of electricity supply. However, the biggest issue for consumers of diesel generation are high maintenance costs and disruption to the ecological environment [1]. Furthermore, the extension of the grid to rural areas is not always an effective decision option and involves high costs.

The only way to deal with this issue is the use of Renewable Energy (RE). RE appears to be the most promising and successful option, particularly for rural areas that are luckily abundant in RE resources such as solar, wind etc [2]. The renewable energy sources as a standalone system can be a solar and wind generation that considered the alternative and better option for reducing energy poverty in rural areas. Solar and wind energy are better options because they are relatively cheap and clean cost. They do not require combustion process like other generation. These energy systems are versatile, economical, and environmentally sustainable compared to other energy sources such as fossil fuels and gas. Combustion of resources such as coal and gas can cause environmental pollution and natural instability to occurs. There will be many job opportunities from a social point of view, particularly for locals, due to construction, implementation, and maintenance. As a consequence of increased in job opportunities, sustainable economic growth would positively improve the success of the local economy [3].

However, one of the challenges and disadvantages of RE is the reliability of supply and voltage fluctuation. Therefore, certain hybrid RE sources with batteries and Non-Renewable (Non-RE) sources are used to ensure that the load is constantly supplied. In order to ensure optimum energy usage and energy sustainability to the maximum extent, an effective and efficient energy management plan is required.

1.2 Problem Statement

The stand-alone hybrid system ensures continuous supply of power but does not guarantee the maximum use of RE. This will cause the unnecessary use of power from non-RE sources. Therefore, this project proposed effective Energy Management System (EMS) strategy that is capable of utilizing non-RE sources (Microturbine) at minimum.

1.3 Objective

The objectives of the project are as follows:

i. To design EMS strategy for stand-alone hybrid system in order to minimize the cost of microturbine operation.
ii. To determine the output of photovoltaic (PV), Wind Turbine energy system (WT) and micro turbine (MT) at minimum microturbine operation cost.
iii. To analyze the stand-alone hybrid system performance cooperating with proposed EMS strategy.

1.4 Scope of Work

The standalone hybrid renewable energy system consisting of PV, WT, MT, and battery is suggested. PV and WT are the primary sources, and the scope of work are:

i. Energy management solution for standalone hybrid PV, WT energy system, MT, and batteries to supply the 35kW load requirement to residential area.
ii. Size of PV system 40 kW, WT system 50 kW, MT 55 kW and are optimized.
iii. Historical solar irradiance data at KKTM Sri Gading are used in the analysis. Two irradiances during sunny days and cloudy days were selected for analysis every month for a year.
iv. Load data and wind speed data were taken from the previous paper.

1.5 Report Organization

This report proposes an EMS strategy for standalone hybrid PV, WT and MT. The introduction consists of project background, problem statement, Objective and scope of work is discussed in Chapter 1. Chapter 2 tells the review of available methodologies and related jobs that have been discussed by other studies. Chapter 3 briefly discusses proposed methodology, PV and WT input data and Cost function, as well as energy management system strategies. Results and discussion are given in Chapter 4 and a conclusion and future work is shown in Chapter 5.

1.6 Significant of contribution

This project provides some contributions in the methodology used as compared to in the literature review especially energy management systems for stand-alone hybrid systems. The EMS strategy proposed in this report is able to utilize the usage of RE optimally hence reduce the cost of MT.

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