EVALUATION OF CHARGING-DISCHARGING PERFORMANCE OF ULTRACAPACITOR-BATTERY ENERGY STORAGE SYSTEM IN SOLAR PHOTOVOLTAIC SYSTEM

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Electrical Power)

School of Electrical Engineering
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Universiti Teknologi Malaysia

FEBRUARY 2022

DEDICATION

This project report dedicated to my beloved parents
Sutekno bin Abdul Ghani & Norasiah Binti Sulaiman and all my friends in MKE programme for their support and encouragement.

ACKNOWLEDGEMENT

First and foremost, I am very grateful to ALLAH S.W.T for giving me life and chances to finish this project without much difficulty. Special thank goes to my supervisor and supportive Dr Zulkarnain. The supervision and support that he gave truly helps the progression into completing this project. This cooperation is much indeed appreciated.

My grateful thanks goes to my familyfor their endless support and encouragement. My deepest gratitude also extend to all lectures of University Teknologi Malaysia (UTM), for their guidance, ideas and support to complete this master project. This project had opened my eyes on solving real problems and I was able to relate them with what I have been studied in UTM during the 2 years.

Last but not least, I would like to thanks to all my friends for the wise idea and tips the project works I'm very much enjoy working with all of you and thank you very much for all of the contribution and care.

ABSTRACT

Global energy demand is particularly met with fossil fuels, these resources is too many environmental of drawback was not viable. The most mature renewable energy source is solar energy. Solar energy conversion systems would have been become the nimble growing industry technologies in many countries. Besides, solar energy cannot contribute power steadily after all power production rates changes with seasons. Meanwhile the applications of Photovoltaic systems without any supporting power supply in storage system like batteries and ultracapacitor there are limited in the sizing short-term or long-term energy storage for self-governing PV system on both for overnight longer time storage. However, limited studies have been carried out where PV system most of the energy is wasted during power conversion process inside PV system converter also total energy loss in capacitor charging loop. Besides in grid integration of PV system cumbersome, solar energy is naturally intermittent with stochastic fluctuations, by virtue of which, stability and power quality of grid operation are affected. The project presents the simulation of a PV system with an ultracapacitor, to observe its charging-discharging performance of an and compare the performance of PV systems with only battery and battery-supercapacitor integration.

ABSTRAK

Permintaan tenaga global sentiasa dipenuhi dengan bahan api fosil, sumber ini terlalu banyak kelemahan pada alam sekitar yang tidak berdaya saing. Sumber tenaga boleh diperbaharui ialah tenaga solar. Sistem penukaran tenaga solar akan menjadi teknologi industry yang berkembang secara pesat di kebanyakkan negara. Selain itu, tenaga solar juga tidak dapat menyumbang kuasa secara berterusan apbila kadar pengeluaran kuasa berubah mengikut keadaan semasa. Sementara itu, sistem PV tanpa sebarang bekalan kuasa sokongan dalam sistem simpanan seperti bateri dan ultrakapasitor adalah terhad dalam saiz simpanan tenaga jangka pendek atau jangka panjang untuk sistem PV diurus pada kedua-duanya untuk penyimpanan dalam masa semalaman. Walau baigaimanapun, kajian terhad telah dijalankan pada sistem PV kebanyakan tenaga terbuang semasa proses penukaran kuasa dalam sistem PV dan mengakibatkan sejumlah kehilangan tenaga dalam gelung pengecasan kapasitor. Selain itu, penyepaduan grid menyebabkan tenaga solar semulajadi jadi terputus-putus dan turun naik stokastik, dimana kestabilan dan kualiti di grid akan terjejas. Projek ini mewakili simulasi of system PV dengan ultracapacitor, untuk memerhatikan prestasi mengecas dan menyahcas dan membandingkan sistem prestasi bateri dan supercapacitor bateri.

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LIST OF SYMBOLS

C	-	Capacitance
D	-	Duty cycle
f_s	-	Switching Frequency
I_D	-	Diode current
I_L	-	Inductor current
i_L	-	Ripple inductor current
$I_{L, max}$	-	Maximum inductor current
$I_{L, min}$	-	Minimum inductor current
L	-	Inductance
L_{Min}	-	Minimum inductance
P_{max}	-	Maximum power
Vo	-	Ripple output Voltage
V_L	-	Inductor voltage
V_S	-	Input voltage

LIST OF ABBREVIATIONS

DC	-	Direct current
EDLC	-	Electrochemical double layer capacitor
KVL	-	Kirchhoff’s voltage law
MATLAB	-	Matrix laboratory
PWM	-	Pulse width modulation
SC	-	Supercapacitor
SOC	-	State of charge
DoD	-	Depth of Discharge

CHAPTER 1

INTRODUCTION

1.1 Introduction Background

Presently the changing global landscape, the energy has become a main focus of the leading scientific community and world power. There has been incredibly intrigued in developing also refining more effective energy storage. There are one device ultracapacitor, has developed altogether over the final decade and developed with the potential to speedy major progresses in energy storage.

The storage devices must meet all the requirements in particular application of energy storage. In these applications, the evolution of high energy density capacitors (ultracapacitor or electrochemical capacitors) has been launched by various groups around the world. Furthermore, ultracapacitor also known as supercapacitor or electro double layer capacitor (ELDC) which is energy store at double-layer capacitor as charge separation within the double-layer shaped at the interface between the solid electrode material surface also the liquid electrolyte in the micropores of the electrodes [1]

As rapid growth in technologies, there a many research has been done to produce an electric double layer capacitor to utilize high surface area electrode materials and thin electrolytic dielectric to gain capacitances a few orders of magnitude larger than conventional capacitors. Therefore, ultracapacitors are able to gain more greater energy densities as long as still maintain the characteristic high-power density of conventional capacitors.

Ultracapacitor have much higher power and longer shelf while the cycle life also high efficiency, that can stand at higher current and temperature. The high efficiency power in the range of 1000 to 5000 W/kg and this device has the specific

energy at the range of 1 to 10Wh/kg. Thus, charging-discharging of efficiency of ultracapacitor is very high around from 85% to 98% also the rate of discharge can be quick, ranging from 0.3 to 30s [2].

1.2 Problem Statement

A typical standalone PV system is used a battery being the main electrical energy storage element while the system as an insolation dependent sources where it has high degree of output power fluctuations. There is major problem in PV system with battery storage is to have a long operating life, and yet have a high charge-discharge cycle rate in order to recover as much solar energy as possible and supply high peak energy on demand. Nevertheless, the specific regard to the battery's state of charge (SOC) also battery reserve time along of discharge profile for the various loading conditions. During the peak demands the battery alone would have to deliver and received at the high peak currents. When low SOC it would tend to overheat and not be able to handle current peaks if the battery has a higher internal resistance.

1.3 Research Objective

The objectives of the research are:

(a) To simulate a PV system with ultracapacitor.

(b) To observe the charging-discharging performance of ultracapacitor battery energy storage system in solar PV system.

(c) To compare performance of system only with battery and battery supercapacitor PV system.

1.4 Scope of Study

This project investigates a PV system with the battery and ultracapacitor in terms of their charging-discharging performances. This work was covered the design of a grid connected PV system using MATLAB/ Simulink software.

1.5 Expected of Contribution

The work is expected to give contribution on below matters better understanding on the charging and discharging of ultracapacitor in PV system.

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