

ENERGY MANAGEMENT OF MULTIPLE ALTERNATIVE ENERGY
RESOURCES

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Special dedicated
to my supervisor and family who encouraged
me throughout my journey of
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ABSTRACT

Alternative energy resources have gain popularity as replacement to the conventional power generation as one of the effort to reduce green gasses emission to the atmosphere. The problem with alternative energy resources is the characteristic which is non-linear and single source of renewable energy cannot meet demand from end user. Multiple energies required to compensate the non-linearity to ensure steady energies to meet demand. In this project, simulation is done using MATLAB/Simulink. Each block set of alternative energy has been model and modify based on previous research and journal. Energy Management of Multiple Alternative energy has been modelled into two types of microgrid which is DC microgrid and AC microgrid. For AC microgrid, power converters that consists of inverter are designed. DC energy inputs from photovoltaics, fuel cell and battery converted to the required value of AC microgrid voltage. This multiple input then integrated into single microgrid which is connected to local grid. For DC microgrid more complex power converters are required, DC -DC Converter are required to regulate the voltage from DC energy resources. AC energy input from wind turbine converted into DC Voltage and the voltage regulated using DC-DC Converter. Similar to AC microgrid, multiple energy resources then integrated into single DC microgrid which connected to the local grid. Simulation for both system has been done via various input of the alternative energy resources system while load set to maximum demand. System also simulated in grid connected mode and standalone mode. Result for both microgrid simulation show that energy management in multiple alternative energies shall delivered steady power flow to the load. Each configuration has its own analysis from simulation output.

ABSTRAK

Sumber tenaga yang boleh diperbaharui telah meraih populariti bagi menggantikan penjanaan kuasa secara konvensional sebagai satu usaha untuk mengurangkan pelepasan gas hijau ke atmosfera. Masalah tenaga sumber tenaga alternatif adalah sifatnya yang tidak linear dan satu sumber tidak dapat menampung permintaan tenaga daripada pengguna. Sumber tenaga pelbagai adalah diperlukan untuk menampung ketidak linearan dan memenuhi keperluan tenaga. Dalam projek ini, simulasi adalah menggunakan perisian MATLAB/Simulink. Setiap blok tenaga alternatif dimodelkan dan diubahsuai berdasarkan kajian dan jurnal yang lepas. Sistem pengurusan tenaga telah dimodelkan kepada dua jenis mikrogrid iaitu mikrogrid DC dan mikrogrid AC. Untuk mikrogrid AC, penukar kuasa yang melibatkan *inverter* telah direka bentuk. Input tenaga DC daripada *photovoltaics*, sel kuasa dan bateri telah ditukarkan kepada nilai voltan grid AC yang diperlukan. Tenaga pelbagai ini telah disatukan dalam satu mikrogrid yang dihubungkan dengan grid tempatan. Untuk mikrogrid DC, sistem yang lebih kompleks diperlukan iaitu penukar kuasa DC – DC diperlukan untuk mengawal aliran kuasa daripada setiap input tenaga DC. Untuk input tenaga AC daripada turbin angin akan ditukarkan kepada voltan DC dan penukar kuasa DC –DC mengawal aliran kuasa daripada sumber tersebut. Sama seperti mikrogrid AC, tenaga pelbagai akan disatukan dalam satu mikrogrid DC yang dihubungkan dengan grid tempatan. Sistem akan disimulasi dalam keadaan pelbagai input daripada sumber tenaga alternatif dan beban adalah ditetapkan kepada keperluan maksima. Sistem akan diuji dalam dua kondisi iaitu dihubungkan dengan grid tempatan dan secara bersendirian. Keputusan simulasi kepada kedua-dua mikrogrid menunjukkan bahawa pengurusan tenaga pada tenaga pelbagai dapat membekal kuasa yang stabil kepada beban. Setiap konfigurasi mempunyai analisis tersendiri berdasarkan keluaran simulasi.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENTS	vii
	LIST OF TABLES	x
	LIST OF FIGURES	xi
	LIST OF ABBREVIATIONS	xiv
	LIST OF SYMBOLS	xv
1	INTRODUCTION	1
	1.1 Background of Study	1
	1.2 Problem Statement	3
	1.3 Objectives of Project	4
	1.4 Scope of Project	5
	1.5 Project Report Outline	5
2	LITERATURE REVIEW	7
	2.1 Alternative Energy Resources	8
	2.1.1 Photovoltaic System	9
	2.1.2 Wind Energy System	10
	2.1.3 Fuel Cell System	13

2.1.4	Storage Element/Battery	14
2.2	Selection of Bus Voltage System	16
2.2.1	DC Bus System	17
2.2.2	AC Bus System	18
2.3	Power Electronic Converter	18
2.3.1	Buck Converter	19
2.3.2	Boost Converter	20
2.3.3	Buck Boost Converter	20
2.3.4	AC-DC Rectifier	21
2.3.2	DC-AC Inverter	22
2.4	Energy Management System	23
2.4.1	Maximum Power Point Tracking	24
2.4.2	Supervisory Control and Data Acquisition	25
2.4.3	Fuzzy Logic Reasoning	26
2.5	Controller Method	26
2.5.1	PID Control Controller	26
2.5.2	Fuzzy Logic Controller	27
2.5.3	Artificial Neural Network	28
2.5.4	Phase Locked Loop	29
2.6	Simulation and Optimization Software	30
2.7	Previous Work	30
3	METHODOLOGY	33
3.1	Multiple Energy Resources Modelling	35
3.1.1	Photovoltaic System	35
3.1.2	Wind Turbine System	38
3.1.3	Proton Exchange Membrane Fuel Cell	40
3.1.4	Battery	41
3.2	Power Electronic Converter Design	42
3.2.1	DC-AC Inverter	42
3.2.2	AC-DC Rectifier	44
3.2.3	DC-DC Converter	44
3.2.4	Phase Locked Loop	40

3.3	Converter Controller	46
3.4	Simulation AC Microgrid System	48
3.5	Simulation DC Microgrid System	49
4	RESULTS AND DISCUSSIONS	50
4.1	AC Microgrid Simulation Result	50
4.1.1	Individual Energy Resources Power Outputs	51
4.1.2	Multiple Energy Resources Power Outputs	54
4.2	AC Microgrid Voltage Output Analysis	54
4.3	DC Microgrid Simulation Result	56
4.3.1	Individual Energy Resources Power Outputs	57
4.3.2	Multiple Energy Resources Power Outputs	58
4.4	DC Microgrid Voltage Output Analysis	59
5	CONCLUSIONS AND RECOMMENDATIONS	60
5.1	Conclusions	60
5.2	Recommendations	62
	REFERENCES	63

LIST OF TABLES

TABLE NO.	TITLE	PAGES
1.1	List of Main Alternative Energy and Energy Storage	3
3.1	Photovoltaic SPR-305-WHT-U (305W)	36
3.2	Proton Exchange Membrane Fuel Cell: Ned Stack PS50 PEM FC	41
4.1	Power from Wind Turbine	52
4.2	Power from Photovoltaic	52

LIST OF FIGURES

FIGURE NO.	TITLE	PAGES
1.1	Concept of DC Grid Multiple Energy System	2
1.2	Concept of AC Grid Multiple Energy System	2
2.1	Major Area in Multiple Alternative Energy Resources	7
2.2	DC Bus Multiple Alternative Energy Resources	8
2.3	DC Bus Multiple Alternative Energy Resources	9
2.4	Power Vs Voltage Curve Throughout Day	10
2.5	Relationship Between Wind Power Output And Wind	11
2.6	Permanent Magnet Synchronous Generator (PSMG)	12
2.7	Asynchronous (Induction) Generator Wind Turbine	13
2.8	Hydrogen-oxygen PEM Fuel Cell process	14
2.9	Standalone DC Grid System	17
2.10	Standalone AC Grid System	18
2.11	Buck Converter	19
2.12	Boost Converter.	20
2.13	Buck-Boost DC-DC Converter	21
2.14	Three Phase AC DC Rectifier	21
2.15	Three phase PWM inverter circuit	22
2.16	Energy Management System Scope	23
2.17	Combination of Power from Multiple Alternative Energy Resources to Cater Power of Load	24
2.18	MPPT Concept In Wind Turbine For Maximum Power Harvesting.	25
2.19	Energy Management in Microgrid	25

2.20	PID Controller Referring To The Equation 2.13 And Equation 2.14	27
2.21	FLC Used To Control Battery Charging And Discharging	28
2.21	Architecture of ANN Function	28
2.22	Phase Locked Loop	29
2.23	Energy Management System of Multiple Alternative Energy by Emad Maher Natsheh	31
2.24	Decouple DC Bus and AC Bus in Power Flow Management Configuration.	32
2.25	Flowchart Of Double-Layer Coordination Discussed For Energy Management System	32
3.1	Overall Project Flow Chart	34
3.2	Equivalent Circuit Present The PV Block	36
3.3	Dialog Box of The PV Model	37
3.4	Subsystem of PV in AC Bus System	37
3.5	Different Irradiance Simulated in PV System	38
3.6	Subsystem of Wind Turbine in AC Microgrid System	39
3.7	Subsystem of Wind Turbine in DC Microgrid System	39
3.8	Different Wind Speed Simulated	39
3.9	Circuit For Fuel Cell Stack Model In MATLAB/Simulink	40
3.10	Subsystem for PEMFC in AC Grid System	40
3.11	Battery Model Equivalent Circuit In MATLAB/Simulink	41
3.12	Subsystem for Battery In AC Grid Simulation	42
3.13	IGBT Inverter for DC to AC in Photovoltaic System	43
3.14	Rectifier for AC to DC in Wind Turbine System	44
3.15	Buck Converter with PID Controller	45
3.16	PLL Design to Synchronise Voltage from Input Source and Bus Voltage for AC Grid	45
3.17	Voltage Measurement to Set Each Voltage According to The Required Grid Voltage.	46

3.18	Voltage Regulator Block	47
3.19	PID Controller Toolbox for AC Grid System	47
3.20	Multiple Energy in AC Microgrid System	48
3.21	Multiple Energy in DC Microgrid System.	49
4.1	Power from The Grid	51
4.2(a)	Power Generated By Wind Turbine	52
4.2(b)	Power generated by Photovoltaic	53
4.2(c)	Power generated by PEMFC	53
4.2(d)	Power generated by Battery	53
4.3	Power Generated by All Multiple Alternative Energy.	54
4.4	Voltage Output at AC Microgrid	55
4.5	Voltage Output at AC Microgrid at 0.1 Second to 0.3 Second	55
4.6	Voltage Output at AC Microgrid at 0.1 Second to 0.3 Second	56
4.7(a)	Power Generated by Wind Turbine	57
4.7(b)	Power Generated by Photovoltaic	57
4.7(c)	Power Generated by PEMFC	58
4.7(d)	Power Generated by Batteries	58
4.8	Power Generated by All Multiple Alternative Energy	59
4.9	Voltage Output at AC Load	60

LIST OF ABBREVIATIONS

SOC	-	State of charge
EMS	-	Energy Management System
PEMFC	-	Proton Exchange Membrane Fuel Cell
PID	-	Proportional Integral Derivative
PV	-	Photovoltaic
AC	-	Alternating Current
DC	-	Direct current
FLC	-	Fuzzy Logic Controller
PWM	-	Pulse Width Modulation
ANN	-	Artificial Neural Network
IGBT	-	Insulated Gate Bipolar Transistor

LIST OF SYMBOLS

E	-	Energy
N	-	Number of parameter
P	-	Power
L	-	Load
I	-	Current
V	-	Voltage
T	-	Period
t	-	Time
K	-	Boltzman constant
%	-	Percentages
V _o	-	Output voltage
V _s	-	Voltage supply
D	-	Duty cycle

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Alternative energy has gain popularity due to fossil fuel depletion and the effect of green gas emissions from conventional power plant. These green gases lead to the global warming that effect climate and increase sea level that will see major city will be submerged in the future. Alternative energies that include renewable energy sources need to be utilised to reduce green gas release to the atmosphere. The main problem with renewable resources is the dependency on weather condition [1]. For example, wind speed and solar irradiance can change according to season and daily profile.

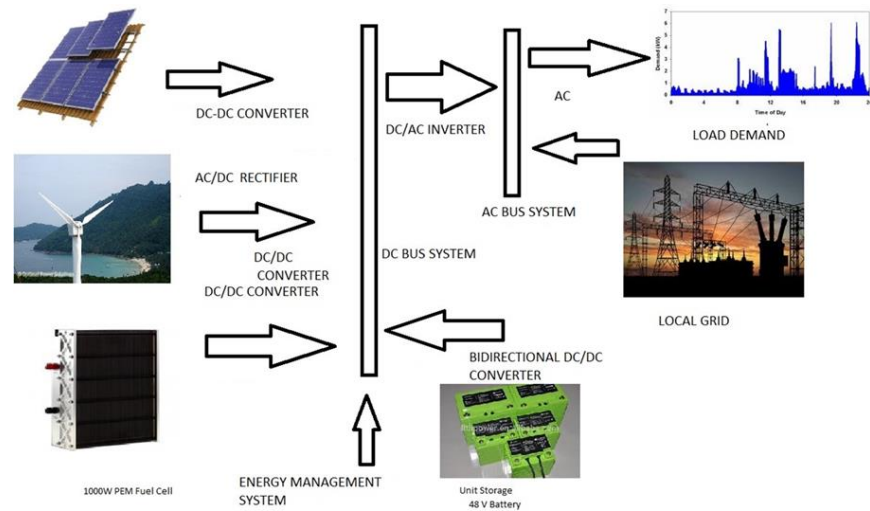


Figure 1.1: Concept of DC Grid Multiple Energy System

Multiple energies system are combinations of two or more of the relevant generation along with energy storage can tremendously improve the performance. In Table 1.1, list of main alternative energy and energy storage that can be utilized in multiple energy system. However, this multiple energies system required a management system for each alternative energies and unit storage to increase the lifespan of each renewable energy and batteries.

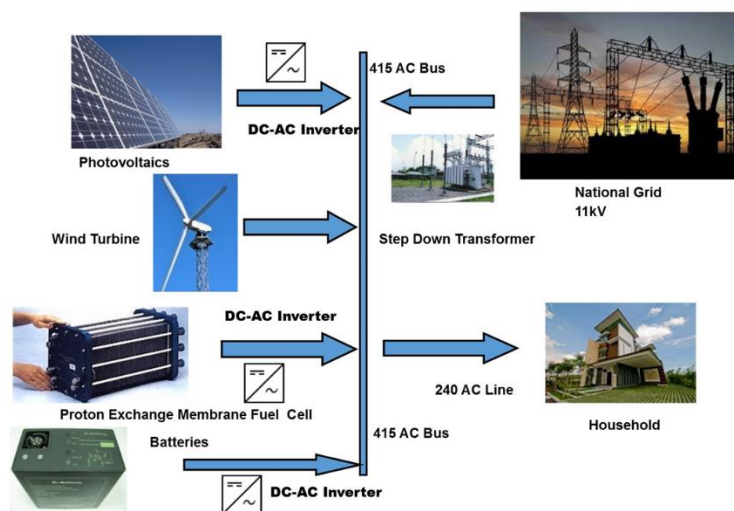


Figure 1.2: Concept of AC Grid Multiple Energy System

Main Alternative Energy	Energy Storage Types
Photovoltaic	Battery
Wind	Compressed air
Hydro/ Micro hydro	Flywheel
Geothermal	Hydrogen
Fuel Cell	Super capacitor

Table 1.1: List of Main Alternative Energy and Energy Storage

1.2 Problem Statement

Conventional power generation is the result of fossil fuel combustion. This fuel combustion lead to greenhouse gas emission that lead to the global warming. Power Generation is identified as major contributor to the green houses. Most of developing nations especially in European Union produce more that 25% of their generation via renewable energy resources [2].

Alternative energy from photovoltaic (PV) and wind turbine generator are capable of producing clean and unlimited sources but depend heavily dependent on weather. Fuel cell is also identified as alternative energy that capable of replacing conventional unit storage. With the advancement of hydrogen production, fuel cell seems to have bright future in power generation.

However, alternative energy is non-linear and only single source renewable energy typically cannot meet demand from end user. Multiple energies required to compensate the non-linearity to ensure steady energy to meet demand.

Multiple Energy Resources with different characteristic requires energy management system to properly control the power flow to ensure steady energy to the demand.

Energy management system will ensure the efficiency, power and lifetime of each component in multiple energy resources system. Each management systems have its own advantages and disadvantages.

1.3 Objectives of Project

In this project, targets and objective need to be achieved. The main energy source used in this research is fuel cell (FC) and photovoltaic (PV) module. DC energy source from batteries, FC, and PV will compensate each other to regulate the grid

voltage in order to supply a stable power output system. The objectives of this project are:

- a) To investigate the power flow in multiple alternative energy resources of Photovoltaic, Wind Turbine, Proton Exchange Membrane Fuel Cell and Batteries
- b) To simulate the proposed multiple alternative energies using MATLAB/Simulink.
- c) To analyse the simulation results.

1.4 Scope of Project

This project is to develop a system in MATLAB/Simulink that consists of three alternative energies system which is Photovoltaic, Wind and Fuel Cell together with batteries connected to the grid and load.

Power electronic converters that will act as energy conversion of each alternative energy resources studied and designed. Then controller for each converter designed for steady power flow from individual alternative energy.

These four alternative energies shall be integrated into AC microgrid and DC microgrid together with suitable energy management system to control the power flow. Various situations introduce to the system and the outcome of the power flow of the system studied and analysed. The final goal is this project is that the energy management of multiple alternative energy can deliver steady power supply to load demand.

1.5 Project Report Outline

Chapter 1 generally describe on the multiple alternative energy system. This chapter also provides information on the objectives of the study, problem statement and the scope of the study.

Chapter 2 focused on the previous work done for energy management system of hybrid and multiple energy system. This chapter also include the modelling of alternative energies that will be used in the MATLAB/Simulink software.

Chapter 3 discussed on the modelling of the Multiple Alternative Energy System using MATLAB/Simulink software.

Chapter 4 explained on the analysis and discussion from the result obtained from the system simulation on MATLAB/Simulink software.

Chapter 5 explained the conclusion of the Multiple Alternative Energy System and the suggestion for future works.

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