UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Electrical Engineering

GRID CONNECTED WITH MICRO SOLAR GENERATOR

Mohamad Findyrul bin Shariff

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GRID CONNECTED WITH MICRO SOLAR GENERATOR

MOHAMAD FINDYRUL BIN SHARIFF

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2015

DECLARATION

I declare that this dissertation entitled “Grid Connected with Micro Solar Generator” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……..

Name : Mohamad Findyrul Bin Shariff

Date : …….

APPROVAL

I hereby declare that I have read this dissertation/report and in my opinion this dissertation/report is sufficient in terms of scope and quality as a partial fulfilment of Master of Electrical Engineering (Industrial Power).

Signature : …….

Supervisor Name : …….

Date : …….

DEDICATION

To my beloved mother and late father

ABSTRACT

Nowadays, the need of renewable energy sources in on the rise because of the acute energy crisis in electricity generation due to increasing consumption demand and populations. Thus, energy from the sun is the best option for the generation of electricity as it is available everywhere, pollution-free as well as is free to harness. Therefore, objective of this dissertation is to generate simulation framework of the grid connected micro solar generator and analyse its efficiency and performance which can benefits to both educational institutions and industrial field. A framework system has been done to extract maximum obtainable solar power from the photovoltaic array and converted it into alternating current before deliver to the utility grid through controlling and synchronization mechanisms. The system includes photovoltaic array, maximum power point tracker (MPPT), DC-DC boost converter, three-phase inverter, modulation techniques, voltage source controller (VSC) controller and utility grid. Overall findings indicate the implementation of the developed framework can be useful for the further investigation and improvement of the grid connected photovoltaic (GCPV) system. In addition, result also indicate that framework system have a lower total harmonic distortion of 1.17%. The simulation studies are carried out in Simulink MATLAB environment.

ABSTRAK

Pada masa kini, keperluan sumber tenaga boleh diperbaharui adalah meningkat kerana krisis tenaga yang teruk dalam penjanaan elektrik berikutan peningkatan permintaan penggunaan dan populasi. Oleh itu, tenaga daripada matahari adalah pilihan terbaik bagi penjanaan elektrik kerana ia boleh didapati di mana-mana, bebas pencemaran serta bebas untuk dimanfaatkan. Oleh itu, objektif disertasi ini adalah untuk menghasilkan rangka kerja penjana solar mikro secara simulasi grid disambungkan dan menganalisis kecekapan dan prestasi yang boleh dimanfaatkan kepada kedua-dua institusi pendidikan dan bidang perindustrian. Satu sistem rangka kerja yang telah dilakukan untuk mengeluarkan tenaga solar maksimum yang diperolehi dari jajaran fotovoltaik dan ditukar ke dalam arus ulang-alik sebelum disambungkan kepada grid utiliti melalui kawalan dan mekanisma penyelarasan. Sistem ini merangkumi jajaran fotovoltaik, pengesanan titik kuasa maksimum (MPPT), penukar rangsangan DC-DC, penyongsang tiga fasa, teknik pemodulatan, pengawal sumber voltan (VSC) dan grid utiliti. Dapatan kajian ini menunjukkan pelaksanaan rangka kerja yang dibangunkan adalah berguna untuk siasatan lanjut dan peningkatan kepada sistem grid fotovoltaik yang disambungkan (GCPV). Di samping itu, hasil kajian juga menunjukkan sistem rangka kerja yang mempunyai jumlah herotan harmonik yang rendah iaitu sebanyak 1.17%. Kajian simulasi dijalankan dalam persekitaran Simulink MATLAB.

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LIST OF ABBREVIATIONS

AC	-	Alternate Current
CCM	-	Continuous Conduction Mode
CSI	-	Current Source Inverter
DC	-	Direct Current
DCM	-	Discontinuous Conduction Mode
FFT	-	Fast Fourier Transform
GUI	-	Graphic User Interface
IBC	-	Interleaved Boost Converter
IGBT	-	Insulated Gate Bipolar Transistor
InCond	-	Increment Conductance
MOSFET	-	Metal Oxide Semiconductor Field Effect Transistor
MPPT	-	Maximum Power Point Tracker
PI	-	Proportional Integral
PLL	-	Phase Lock Loop
PV	-	Photovoltaic
PVA	-	Photovoltaic Array
P&O	-	Perturb and Observe
SSDM	-	Simplified Single Diode Model
SPWM	-	Sinusoidal Pulse Width Modulation
STC	-	Standard Temperature Conditions
SVPWM	-	Space Vector Pulse Width Modulation
THD	-	Total Harmonic Distortion
TNB	-	Tenaga Nasional Berhad
VSI	-	Voltage Source Inverter
VSC	-	Voltage Source Controller

LIST OF SYMBOLS

V_{mp}	-	Voltage at Maximum Power Point (V)
I_{mp}	-	Current at Maximum Power Point (A)
P_{mp}	-	Power at Maximum Power Point (W)
V_{oc}	-	Open Circuit Voltage (V)
I_{sc}	-	Short Circuit Current (A)
q	-	Electron Charge $(1.60217646 \times 10^{-19}\, C)$
k	-	Boltzmann Constant $(1.3806503 \times 10^{-23}\, J/K)$
G_a	-	Sunlight Irradiation (W/m^2)
K_i	-	Coefficient of Current Temperature.
Δ_T	-	Variation of Temperature.
M_a	-	Amplitude Modulation Index
M_f	-	Frequency Modulation Ratio

CHAPTER 1

INTRODUCTION

1.1 Background

This research project discusses about simulation framework of generating electrical energy from the renewable energy radiated from the sun. The sun‟s energy was cropped using solar photovoltaic (PV), and transferred it into alternating current then finally delivered into grid. The structure of energy conversion mainly consists of photovoltaic panels, maximum power point tracker, converter, inverter and other related power electronic devices. In general, process of generating electricity begins at the PV panels when it absorbs the sunlight‟s ray and converted it to Direct Current (DC) voltage. With presence of maximum power point tracker (MPPT), output from the PV panels can be varied with electrical operating point so that system is able to deliver maximum available power. The operation continues to DC-DC converter where output is stepped-up to range of voltage 650V. In order to be connected to the grid, an inverter plays a crucial role in converting the DC output voltage of 650V to AC voltage of 430V. At the same time, an inverter also plays an important role of control strategy to synchronization to distribution network or utility grid.

1.2 Problem Statements

In the recent years, power demand is increasing regularly and it can be fulfilled by utilization of conventional or non-conventional energy source. As greenhouse effects and environmental issues are becoming a prime concern of all over the world, which led to escalate interest in renewable energy, which is one of options in reducing pollution. Furthermore, natural resources used in the production of power are dwindling and becoming more expensive when they are increasingly dried up in a very near future especially traditional fossil energy. There are few types of renewable energies; one of them is photovoltaic (PV) system or also known as solar energy system.

Photovoltaic (PV) system has high initial investment but in recent years, its‟ price has been slowly drop and payback period also reduces, as it‟s becomes increasingly economical with advancement of power electronics and semiconductor technologies. The favourable incentives in a few number of countries also had profound impact on the commercial acceptance of grid-connected PV systems. With the rapid development of photovoltaic system installations and increased number of grid connected power systems, it has become imperative to develop an efficient grid interfacing instrumentation suitable for photovoltaic systems ensuring maximum power transfer. From information and arguments that have carried out during literature survey, it is clearly stated that there is no doubt of PV system has a good stand in the near future.

1.3 Objectives

Simulation framework of grid connected photovoltaic micro solar power station network systems which have following characteristics:

a) To develop a simulation model for an optimal grid connected with micro solar generator system.

b) To analyse an overall efficiency and utilization performance of system proposed.

1.4 Scope

The project focused on study of development modelling and designing of photovoltaic solar array, controlling maximum power point tracker (MPPT), amplification voltage by boost converter, conversion direct current to alternating current by an inverter and synchronization control strategy to be safely connected to utility grid. The output voltage from boost converter is targeted to achieve at level of 650Vdc before its being supplied for conversion to AC voltage at 430V by the usage of DC-AC inverter. In addition, it also includes the current versus voltage (I-V) characteristic and power versus voltage (P-V) characteristic of the PV module as well as the PV arrays as it is important to validate the performance of the solar module. In terms of synchronization with utility, a proper control strategy is proposed to give the best performance of the proposed photovoltaic framework study. The results illustrate the energy flow of frame system which has capability of 7kW of the power at varied irradiation level from optimum 1000 $W/m^2$to lower irradiation level of 250 $W/m^2$for the entire studied period of time.

1.5 Research Methodology Overview

In this dissertation, mathematical model method is implemented throughout the modelling of overall framework of grid connected with micro solar generator. The research methodology flowchart overview of grid connected with micro solar generator is shown in Figure 1.1 .

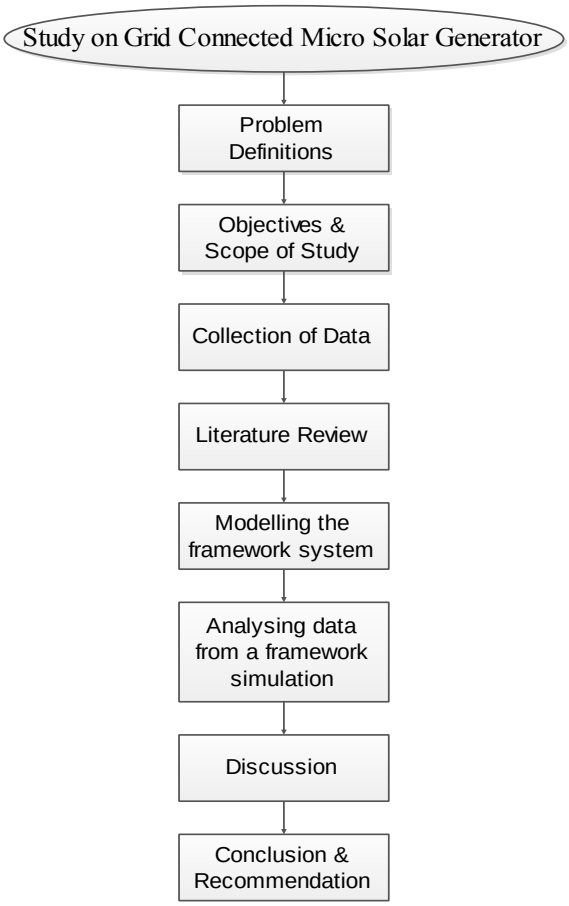

Figure 1.1: Overview Flowchart of Research Methodology

The research methodology starts with problem definitions in order to know and focus an area of the study to be concentrated and come out with a few optional idea to solve the problem. Next, an objective and scope of study is clearly explained in section 1.3 and section 1.4.