Faculty of Electrical and Electronic Engineering Technology

INVESTIGATION OF NEM SOLAR PV POWER INTERGRATION ONTO CENTRAL GRID IN MALAYSIA

HASIF BIN MOHAMAD

Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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A project report submitted
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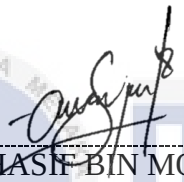
Signature : 

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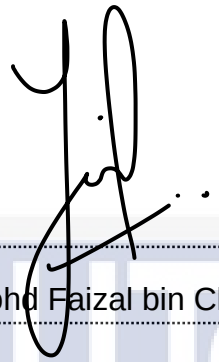
I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

Signature : 

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DEDICATION

Dedicated to

My parents:
Mohamad bin Kandar (Deceased). May Allah forgive his soul.
Marldia binti Hassan. May all your remaining years bless with health and happiness.

My wife :
Rozita Mohd. Shahri. May Allah bless our little family.

My kids :
Daie, Dini, Daud and Dira, May all the success in the world and the after be with you.

Myself :
A journeys ended. It's not the end. Let's embark on another,
Thanks for the support.
Cheers…

ABSTRACT

Installation of solar PV system in Malaysia is at all-time high due to exponential cost reduction and government backing of solar PV generation through scheme as FiT, NEM, and SELCO which drive solar PV growth in generation mix. This research was aimed to investigate and analyze the effects of grid connected solar PV generation on frequency fluctuations, voltage fluctuation, THD_V and voltage flickers, in parallels with studying protections applied in ensuring negatives impacts from grid connected solar PV is negated. Mix methods methodology which encompass site visits, field interviews, parameters measurement on sites using PQA, data analysis using statistical methods consisting Pearson correlation analysis, process capability analysis and descriptive analysis, simulations of solar PV systems using PVSYT, and comparing results through standards of ESAH, MGC and NEM Guidelines was done in order to accomplish the objective of the research. The results found out that solar PV system installed was in compliance with protections standards outline by authorities and utilities providers such as ST, SEDA and TNB. The impact of grid connected solar PV to the grid power quality and stability was minimal. From the analysis, the correlation between power generated by solar PV to PQ could be determine. However, loads dynamics had more directs impacts to the grid stability compared to solar PV systems In conclusion, a solar PV system with all the protection and mitigation requirement was in placed in accordance to the standards outlined, the solar PV output PQ was controlled in precise, accurate and within specification manner. Hence, providing minimum impact to the system frequency fluctuations, voltage fluctuation, THD_V and voltage flickers compared to loads demand dynamics.

ABSTRAK

Pemasangan sistem PV solar di Malaysia mencatatkan pertumbuhan tertinggi disebabkan pengurangan kos dan sokongan kerajaan bagi penjanaan solar PV melalui skim FiT, NEM dan SELCO yang memacu pertumbuhan PV solar. Penyelidikan ini bertujuan untuk menyiasat dan menganalisis kesan penjanaan PV solar yang bersambung ke grid kepada perubahan frekuensi, perubahan voltan, THD_V dan kelipan voltan, selari dengan mengkaji sistem perlindungan yang digunakan dalam memastikan tiada kesan negatif daripada penjanaan PV solar kepada grid. Kaedah metodologi campuran yang merangkumi lawatan tapak, temu bual lapangan, pengukuran parameter menggunakan PQA, analisis data menggunakan kaedah statistik yang terdiri daripada analisis korelasi Pearson, analisis keupayaan proses dan analisis deskriptif, simulasi sistem PV solar menggunakan PVSYT, dan membandingkan keputusan melalui piawaian ESAH, MGC dan Garis Panduan NEM telah dilakukan bagi mencapai objektif penyelidikan. Didapati sistem PV solar yang dipasang di ANM adalah mematuhi piawaian perlindungan yang digariskan oleh pihak berkuasa dan pembekal utiliti seperti ST, SEDA dan TNB. Kesan PV solar kepada kualiti dan kestabilan kuasa grid adalah minimum. Daripada analisis yang dilakukan, korelasi antara kuasa yang dijana oleh PV solar dengan PQ dapat ditentukan. Kesimpulannya, sistem PV solar yang dilengkapi perlindungan dan mitigasi mengikut piawaian yang digariskan, dapat mengawal PQ keluaran PV solar dengan tepat dan mengikut spesifikasi. Serta, memberikan impak minimum kepada turun naik frekuensi sistem, turun naik voltan, THDV dan kelipan voltan berbanding dengan kesan akibat dinamik bekalan dan permintaan kepada beban.

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LIST OF SYMBOLS

$H1$	-	Individual harmonics
f	-	Frequency
Hz	-	Hertz
P_{lt}	-	Absolute long term flicker
P_{st}	-	Absolute short term flicker
kV	-	kilovolt
W	-	Watt
P	-	Number of poles
N	-	Rotor speed
T	-	Transformer
Z	-	Impedence
S	-	Reactive power
PF	-	Power factor
V	-	Voltage
A	-	Ampere

LIST OF ABBREVIATIONS

NEM	-	Net energy metering
$SELCO$	-	Self-consumption
PV	-	Photovoltaic
LSS	-	Large scale solar
AC	-	Alternating current
DC	-	Direct current
THD	-	Total harmonic distortion
PCC	-	Point of common coupling
MSB	-	Main switch board
$SEDA$	-	Sustainable Energy Development Authority
RE	-	Renewable energy
ST	-	Suruhanjaya Tenaga
TNB	-	Tenaga Nasional Berhad
MGC	-	Malaysian Grid Code
LV	-	Low voltage
MV	-	Medium voltage
HV	-	High voltage
$FACTs$	-	Flexible AC transmission system
PQ	-	Power quality
PQA	-	Power Quality Analyzer
GHG	-	Green house gasses
$ESAH$	-	Electricity Supply Application Handbook
LFRT	-	Low Frequency Ride Through
HFRT	-	HighFrequency Ride Through
LVRT	-	Low Voltage Ride Through
HVRT	-	High Voltage Ride Through

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CHAPTER 1

INTRODUCTION

1.1 Background

Solar photovoltaic (PV) system is a method in which green energy could be harvest from the sun. Through solar PV system, sunlight will excite PV panel in which the excitation will produce direct current (DC) voltage. A single cell of solar PV has the ability to generate about 1 Watt (W) to 2 W electricity. Hence, an array of solar PV panel needed to generate adequate electricity for generation class. Produced DC voltages from solar PV panel then converted to alternate current (AC) voltages through inverters. As the amount of voltages generated are typically low, step up transformer needed to increase the AC voltages to match it with grid requirement. However, in recent years smart inverters with transformerless technologies utilizing the advancement of power electronics had been very popular and adopted by many.

Solar PV systems comprise of a number of components that are integral to its function. In grid connected operation, PV panels produced electricty will be directed to an inverter, which then convert the DC voltage to AC voltage. Next, the output will be increased further by step up transformer before feeding the voltages to the grid through the point of common coupling (PCC). Solar PV systems are made up of a number of arrays that produce reasonably high amounts of power during day time periods. Figure 1.1 shows the basic architechture of solar PV[17].