ALLOCATION AND SIZING OF RENEWABLE ENERGY DISTRIBUTED GENERATION UNITS IN DISTRIBUTION NETWORKS USING ADVANCED DIFFERENTIAL EVOLUTION ALGORITHM

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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)

Faculty of Electrical Engineering

Universiti Teknologi Malaysia

JUNE 2018

Specially dedicated

to my supervisor and family who encouraged

me throughout my journey of

education.

ACKNOWLEDGEMENT

All praise to ALLAH the Most Merciful who gave me the opportunity and knowledge to reach this stage of my life journey and with His Blessings made me on the road of completing my studies. All thanks to my brothers and sisters and most importantly my father Engineer Hussein Mohamed Abdullah and my lovely mother Zahra Mohamed Yusuf for giving me the inspiration, the full support and dua during every step of my study journey.

All thanks to my friends who were supporting me through my study journey. All thanks to my beloved and precious lecturers who taught me and guided me through and a special thanks to my supervisor Dr. Madihah Binti Rasid who I appreciate for her precious time she spent to share her knowledge and experiences in guiding me to be a better person.

ABSTRACT

Renewable Energy Distributed Generation unit (REDG) can be strategically placed in power systems for grid reinforcement, for reduction in on-peak operating costs, power losses. Often improvement of voltage profiles, load factors, system reliability, integrity and efficiency are resulted from properly designing in the distribution network. The design of the REDGs means the design of the position and capacity in the network. The change of position and capacity could both change the voltage and current distribution in the distribution network, thus influences the voltage and power loss. As the power output of the photovoltaic fluctuates depending on weather conditions which results in back flow of power and voltage fluctuation on the bus which causes instability of the distribution network. In this project advanced differential evolution algorithm is used to allocate and size of REDGs which contains mixed continuous and discrete parameters with limitations in order to improve the voltage profile of the distribution network. The optimal location and range of sizes of the REDGs which results in normal flow of power in the distribution network in different time of the day with power output fluctuation of photovoltaic is examined with limitation on the voltage fluctuation on the bus using MATLAB/Simulink software. Proper design of the Renewable Energy distributed generation could bring positive influence to the distribution networks.

ABSTRAK

Penjanaan Tenaga yang boleh diperbaharui boleh ditempatkan secara strategik dalam sistem kuasa, untuk mengurangkan kos operasi dan kehilangan kuasa. Peningkatan profil voltan, faktor beban, kemampuan sistem, integriti dan kecekapan bergantung pada reka bentuk yang dihasilkan dalam rangkaian pengedaran. Reka bentuk unit penjanaan tenaga yang boleh diperbaharu ialah reka bentuk kedudukan dan kapasiti dalam rangkaian. Perubahan dari segi kedudukan dan kapasiti boleh mengubah voltan dan arus dalam rangkaian pengedaran, sehingga boleh menyebabkan kehilangan kuasa dan voltan. Oleh kerana keluaran kuasa dari sistem photovoltaic tidak sekata atau stabil bergantung pada cuaca yang akan mengakibatkan aliran balik kuasa dan naik turun voltan pada bas yang menyebabkan ketidakstabilan rangkaian pengedaran. Dalam projek ini, algoritma pembezaan lanjutan digunakan untuk meletakkan saiz REDGs yang mengandungi campuran parameter dengan batasan untuk meningkatkan voltan profil rangkaian pengedaran. Lokasi yang optimum dan pelbagai saiz REDG yang digunakan untuk menghasilkan aliran kuasa normal dalam rangkaian pengedaran yang dijalankan pada masa yang berbeza. Dalam pada masa yang sama, keluaran kuasa yang mempunyai nilai yang tidak stabil dalam sistem photovoltaic diperiksa dan dianalisa dengan batasan ketidakstabilan voltage pada bus dengan menggunakan perisian MATLAB / Simulink. Reka bentuk yang betul bagi penjanaan tenaga yang boleh diperbaharui boleh membawa pengaruh positif kepada rangkaian pengedaran.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

DG	-	Distributed Generation
REDG	-	Renewable energy Distributed Generation
PSI	-	Power Stability Index
VSI	-	Voltage Stability Index
PSO	-	Particle Swarm Optimization
DE	-	Differential Evolution
ODE	-	Ordinary Differential Evolution
ADE	-	Advanced Differential Evolution
IEEE	-	Institute of Electrical and Electronics Engineers
PV	-	Photovoltaic
OPF	-	Optimal Power Flow
GA	-	Genetic Algorithm
SA	-	Simulated Annealing

CHAPTER 1

INTRODUCTION

1.1 Background Study

Distributed Generation (DG) have been a field vast in future energy supply systems which will play important role including regenerative energy sources. It simply means it's a system which is not centrally planned, it is usually connected to the distribution network. The ever-increasing power demand bring DG to existence with steady progress in the power deregulation and tight constraints over the construction of new transmission lines for long distance power transmission have created increased interest in distributed electricity generation. DG devices can be strategically placed in power systems for grid reinforcement [1], for reduction in on-peak operating costs and power losses, improvement of voltage profiles and load factors, system reliability, integrity and efficiency. The influences of the DG system to distributed grid include the design of distributed resources of different types, the improvement of power quality and the monitoring and protection while the voltage sags and swells happens. The design of the DG means the design of the position and capacity of the distributed resources in the grid .The change of position and capacity could both change the voltage and current distribution in the distributed grid, thus influences the voltage and power loss of the whole distributed grid [2]. Proper design of the DG could bring positive influence to the distributed grid. The stable voltage could be maintained and the power loss could be reduced.

Voltage profile and reverse power flow being one of the most important issues to solve in a distribution network with DG units. The DG has the following obvious advantages [3]:

1) Reduction of power loss

2) Improved power quality

3) Improved system reliability

4) Improved voltage profile

DG can be based on non-renewable and renewable energy. This study focused on the allocation and sizing of the Renewable Energy Distributed Generation (REDG) and analyze the improvement in voltage profile of the distribution network.

1.2 Problem statement

REDG installation in the distribution network can give several benefits. However, improper design of location and size of REDG will cause reverse power flow in the network thus resulting in instability in the distribution network. Thus, metaheuristic methods is the most suitable method to solve this problem. Differential Evolution (DE) Algorithm [12] is the best among the methods. However, DE algorithm suffer from premature convergence and consume long computation time when the problem becomes complicated.

1.3 Objectives

This study aims to achieve the following objectives:

1. To determine the appropriate location of the REDG units in order to improve the voltage profile of the distribution network.
2. To determine the appropriate sizes of the REDG units in order to improve the voltage profile of the distribution network.
3. To enhance the DE Algorithm by improving the mutation process to reduce the computation time.

1.4 Scope

This study investigates the distribution network with the availability of three units of photovoltaic REDG units. The Photovoltaic (PV) is considered integrated with a battery storage thus the PV power output is constant all the time. The load is studied at constant value with no change. The proposed advanced differential evolution algorithm is used to allocate and size the REDG in the distribution network. All this process are done through simulation no practical work is involved.

1.5 Significance of Study

The appropriate allocation and sizing of the REDG in the distribution network using the enhancement of the mutation process of the differential algorithm shows the reduction in the computational time, improvement in voltage profile and solve the reverse power flow issue thus resulting in stable distribution network.

1.6 Thesis Organization

This report consists of five chapters. The first chapter discusses about the background study of REDG units, problem statement, objective, scope and significance of this project. In Chapter 2, presents the theory and literature reviews on concept of renewable distributed generation systems, methods to allocate and size renewable energy distributed generation units and reverse power flow. Chapter 3 discusses the proposed methodology which will be used in this project. The result and discussion is presented in Chapter 4. Last but not least, Chapter 5 presents the conclusion of this research and some recommendations for future work.

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