Ain Shams University
Faculty of Engineering
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OPTIMIZATION OF HYBRID RENEWABLE ENERGY SYSTEM USING NEW TECHNIQUES

A Thesis Submitted to the Faculty of Engineering, Ain Shams University in partial fulfillment of the requirements for the Degree of Master of Science in Electrical Engineering

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For the thesis

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Statement

This thesis is submitted to Ain Shams University in partial fulfillment of the requirements for the degree of Master of Science in Electrical Power Engineering.

The work included in this thesis was carried out by the author in the department of Electrical Power and Machines Department, Ain Shams University.

No part of this thesis has been submitted for a degree or a qualification at any other university or institute.

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Acknowledgement

First, I should state the greatest thanks for our God, that it is only by his willing I have succeeded to finalize this work.

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I would like to thank my supervisor **Assoc. Professor Dr. Adel Taha Mohamed** for his encouragement and helpful advice. Great thanks also to his fruitful support in the review and correspondences of the publications of this work.

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ABSTRACT

The significant increase in demand for energy has driven the global energy consumption to unprecedented levels. As a result, the cost of energy has reached new levels and is expected to continue to rise. The consequences of this large increase in energy cost will pose serious challenges to the economies of most developing nations. In addition, harmful emissions from fossil fuel are causing serious environmental and health problems and are believed to be the main cause of the global warming phenomenon, all this has necessitated an urgent search for alternative energy sources presented in renewable energy sources.

The first phase of the thesis starts with a review of the previously published literatures on several aspects regarding renewable energy. Some literatures are about various types of renewable energy, some talk about various hybrid renewable energy resources, some discuss how to choose right type of hybrid renewable energy and some illustrate how to perform economical optimization of renewable hybrid energy using various techniques, but all of them have the same conclusion that it became an essential need to use renewable energy as a substitute to traditional energy resources.

Also this phase of thesis presents a survey on various types of renewable energy concerning their availability and how to optimally utilize these resources to get best benefit of them along with illustrating the benefits and draw backs of connecting hybrid renewable energy to grid.

The second phase of thesis presents two case studies. The two case studies are about studying the performance of the two standard IEEE 9 bus and IEEE14 bus power system under normal conditions and also under unexpected scenarios such as line or generator outage and studying the effect of insertion of renewable energy to the system under both conditions.

At last optimization for allocation of renewable energy in the standard IEEE 14 bus power system is carried out along with conclusions and recommendations for future work.

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LIST OF ABBREVIATIONS

AC:	Alternating Current
DC:	Direct Current
RES	Renewable Energy System
HRES	Hybrid Renewable Energy System
PV	Photo Voltaic
ETAP:	Electrical Transient Analyzer Program
P.U	Per Unit
GIS:	Gas Insulated System
WTG:	Wind Turbine Generator
LF:	Load Flow
TB:	Turbine
T:	Transformer
V:	Voltage
MW:	Mega Watt
MVAR:	Mega Volt Ampere Reactive
R:	Resistance
X:	Reactance
B:	Susceptance
DG:	Distributed Generation
DE:	Differential Evolution
PSO:	Particle Swarm Optimization

CHAPTER 1

Introduction

1.1 Background

Over the past few years the rapid depletion of fossil-fuel resources on a worldwide basis has necessitated an urgent search for alternative energy sources.

Moreover the fuelled generators have more than one disadvantage such as:

1. They contribute to air and noise pollution.
2. They need regular maintenance and fuel-especially expensive at a remote site.
3. They are less efficient following engine start up, and when operated at other than 80-100 percent of rated capacity.
4. Operating and maintenance costs are high.

On the other hand there are many alternatives for fossil fuel resources such as: photovoltaic ,wind energy, hydro power, biomass and geothermal energy.
Photovoltaic and wind energy have been considered as promising towards meeting the continually increasing demand for energy.
Some of the benefits of renewable energy generators are:

1. They use free resources like the sun or wind.
2. Operating and maintenance requirements are low.
3. They operate reliably, even if unattended.
4. They don't contribute to pollution or waste natural resource.
5. The wind and photovoltaic sources of energy are inexhaustible ,the conversion processes are pollution-free, and their availability is free.

As research began to get deeply involved in renewable energy field many years ago and the concept of how to get the best

benefit from renewable energy resources, the idea of using hybrid renewable energy became the main concern for all the research and development society.

1.2 Outline of the Thesis

In this thesis, optimization of hybrid renewable energy system using new techniques is investigated and analyzed from both technical and economic aspects.

Chapter 2 gives a detailed explanation for different non renewable and renewable energy resources available,the advantages and disadvantages of them and the suitable way to utilize each type to get best benefit from these type of energy resources.

Chapter 3 gives an extensive literature review in the sector of hybrid renewable energy system, various techniques of optimization of hybrid renewable energy resources along with previous case studies done in this field and practical implementation of these case studies in different parts of the world.This chapter is introduced as an awareness guide for the next chapters.

Chapter 4 presents a case study for a standard IEEE 9 and 14 bus systems, studying it's performance and characteristics before and after insertion of hybrid renewable energy source under different scenarios using ETAP program.

Chapter 5 illustrates the different techniques that can be used for deciding the optimum location and size for DG in IEEE standard system.

Chapter 6 discusses the particle swarm optimization technique and how it can be used for IEEE 14 bus system using MATLAB software

Chapter 7 presents a discussion of results obtained and recommendations for future research.

A list of references is given at the end of the thesis.