TECHNO-ECONOMIC EVALUATION OF OFF-GRID HYBRID RENEWABLE ENERGY FOR A REMOTE AREA ELECTRIFICATION IN IRAN

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A project report submitted in partial fulfilment of the

requirements for the award of the degree of

Master of Electrical Engineering (Electrical Power)

Faculty of Electrical Engineering

University Teknologi Malaysia

DECEMBER 2015

To my beloved mother and father who are always there for me

And

To my dearest brother who changed my life on earth into heaven

ACKNOWLEDGEMENT

First and foremost, I would like to thank my parents who not only tolerated my absence, but also supported me while I was away from home.

Additionally, I would like to thank my esteemed supervisor, Associate Professor Dr. Mohd Muhridza Yaacob for his help, and feedback. I am greatly indebted to him, because this study could never have been completed without his astute guidance and moral encouragement.

Furthermore, I like to express my heartfelt thanks to my dear brother Soroush for his undying help, and encouragement.

With love and gratitude,

Amir Ahmad Yahyazadeh Bandarrigi

ABSTRACT

In this project, comprehensive information about various types of renewable energy is provided. Also, solar and wind energy is analyzed specifically. For this project a residential area in the town of Astara, Iran has been selected. Based on information provided by TAVANIR Company and electricity distribution companies in the region of Astara, power consumption has been calculated to be kwh / day20. Independent system for providing power in the region is diesel generators, wind power and photovoltaic power. HOMER software has been used in this project which is based on the design of power supply system according to lowest cost. For this purpose the environmental characteristics of the area including the amount of solar energy received on account of annual wind speed in meters per second have been considered. This application is based on optimization. To achieve this objective consumer information, including load profile in terms of time, number, type and price of diesel generators, number, type and price of wind energy turbines, number, type and price of photovoltaic cells are keyed in to the application and the software, based on mathematical optimization models, selectes the best options (such as optimization algorithms and PSO algorithm in MATLAB) as output.

ABSTRAK

Dalam projek ini, maklumat yang komprehensif mengenai pelbagai jenis tenaga boleh diperbaharui disediakan. Juga, tenaga solar dan angin dianalisis secara khusus. Untuk projek ini kawasan perumahan di bandar Astara, Iran telah dipilih. Berdasarkan maklumat yang diberikan oleh TAVANIR Syarikat dan syarikat-syarikat pengedaran elektrik di kawasan Astara, penggunaan kuasa yang telah dikira sebagai kwh / day20. Sistem yang bebas untuk menyediakan kuasa di rantau ini adalah penjana diesel, kuasa angin dan tenaga photovoltaic. Perisian HOMER telah digunakan dalam projek ini yang berasaskan kepada reka bentuk sistem bekalan kuasa mengikut kos terendah. Untuk tujuan ini ciri-ciri alam sekitar di kawasan tersebut termasuk jumlah tenaga suria yang diterima pada akaun kelajuan angin tahunan meter sesaat telah dipertimbangkan. Permohonan ini adalah berdasarkan kepada pengoptimuman. Untuk mencapai maklumat pengguna matlamat ini, termasuk profil beban dari segi masa, bilangan, jenis dan harga penjana diesel, jumlah, jenis dan harga turbin tenaga angin, bilangan, jenis dan harga sel fotovoltaik diberi kekunci masuk untuk permohonan dan perisian, berdasarkan model pengoptimuman, selectes pilihan yang terbaik (seperti algoritma pengoptimuman dan algoritma PSO dalam MATLAB) sebagai output.

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CHAPTER I

INTRODUCTION

1.1 Background

In recent years, renewable energy resources such as wind and solar energy get serious attention from people who concern about the environmental impact around the world. The main purpose exploitation of renewable energy is to avoid the environmental downfall and mitigate energy crisis [1]. Many renewable energy sources sets techno-economic and functional limitations in their application for covering most type of energy needs. Renewable energy sources are available freely wherever the environmental impacts are negligible.

The performance of all power system configurations in term of economic analysis and optimization, are evaluated using a simulation tool called HOMER. HOMER is a computer model that simplifies the task of evaluating design options for both off-grid and grid-connected power systems for remote, stand-alone and distributed generation (DG) application.

The cost and environmental impacts can be evaluate by using HOMER with various technologies like run-of-river hydro power, generator: diesel, solar

photovoltaic (PV), wind turbine, gasoline, biogas, alternative and custom fuels, co fired, electric utility grid micro turbine and fuel cell can be evaluated.

1.2 Problem Statement

As we know, oil and its derivatives are valuable and vital national assets and non-optimal use of them often creates irreparable losses, so scholars and experts are looking for resources that will gradually replace fossil fuels [3]. Fossil fuels will impose enormous environmental pollutions, in other words, on one hand the burning of fossil fuels would unleash toxic gases into the environment and cause human respiratory problems as well as the pollution of the environment and on the other hand concentration of these gases in the atmosphere prevents heat to get out of the Earth and it would lead to an increase in temperature and changes in the Earth's climate, which is called the greenhouse effect [1]. If rising temperature continues with the current trend, it would be almost impossible to restore it to its former condition. Most scientists have suggested that the best solution is to stop the growing trend of these harmful gases.

Therefore it is also essential to our country's officials to look for ways to reduce the use of fossil fuels in order to reduce the mentioned hazardous gases. Designing a power system based on renewable energies is a good solution for this problem. In designing a power system, there are many decisions on the configurations of the system that must be considered. What are the components need to be included in the system design? How many and what is the size of each component should be used? The large number of technology option, the variation in technology cost and availability of energy resources such as wind energy, solar energy, biomass energy, hydro energy and etc. make these decisions more difficult.

Some users develop their own models for their investigations, while others purchase commercially available software or use free software available on the Internet. This study investigates the capabilities of a software package HOMER to analyze system design optimization of renewable energy technologies, which is commercially available.

1.3 Objectives of the Study

This project has several objectives, the objective are:

i. To study the implementation of renewable energy in IRAN
ii. To design a DG System based on renewable energy system for a Remote area in IRAN
iii. To gather data on any aspect of existing renewable or sustainable energy.
iv. To compare the cost of different types of renewable energy to find the affordable combination.

1.4 Scope of Work

i. Types of renewable energy to be studied are solar and wind energy
ii. Data to be collected are effectiveness, cost, effect on environment, etc.
iii. Comparison will be made on the cost of different types of renewable energy to determine the most affordable renewable energy.

1.5 Thesis Outline

This thesis completed with five chapters. Chapter one will gives an introduction about the project. The introduction contains project background, problem statement, objective, and also scope.

Chapter two more focuses on literature review of this project and the various types of renewable energy sources. This chapter also describes the technologies used for generating electricity.

The methodology used to complete this project was described in chapter three. The software used is HOMER. The calculation to determine a proper size of each component in the system is also explained in this chapter. The site meteorological and load data are also discussed in this chapter.

Chapter four shows the steps in simulate the proposed system configurations which have been previously discussed. This chapter also discusses result obtained from the simulation tool HOMER.

The conclusions and recommendations for further design and simulation of this project are stated in chapter five.

5.2 Recommendation

In future, the PV standalone system should be installed in Iran compared to wind standalone and PV-wind hybrid system. In this project, the charge controller is not put in the equipment consideration. To implement the PV system, charge controller should be considering in that system. A battery controller is a device which regulates the charge current and prevents over charging. In photovoltaic systems, such devices can regulate the charge current either by interrupting the array current (series type) or by short-circuiting sections of the array (shunt type). As short-circuiting will aggravate any tendency to hot spot failure, the series type is not always advisable. A more sophisticated type embodies a microprocessor which maintains battery current, voltage and temperature, computes the state of charge and regulates the input and output currents so as to avoid overcharging and excessive discharge [16]. Besides that, Solar Advisor Model Software that specific and more specialists on the PV system can be used to verify the result.

REFERENCES

1. Ghorashi A H, Rahimi A, Renewable and non-renewable energy status in Iran: Art of know-how and technology-gaps, Renewable and Sustainable Energy Reviews 15, pages 729-736, January 2011.
2. Ministry of Energy, Energy in Iran, Annual Report, 2009.
3. Dovi VG, Friedler F, Huisingh D, Klemes JJ, Cleaner energy for sustainable future, Journal of Cleaner Production 17, pages 889-895, July 2009.
4. Brennan T, Palmer K, Martinez S, Alternating Currents. Electricity Markets and Public Policy, Resources for the Future, Washington D.C, 2002.
5. Parliament of Iran, The Fourth and Fifth National Development Plan (2007 to 2011, 2011 to 2015), http://parliran.ir/index.aspx?siteid=1&siteid=1&pageid=3362, [15, March, 2012].
6. Fadai D, Esfandabadi ZSh, Analyzing the Causes of non-Development of Renewable Energy-Related industries in Iran, Renewable and Sustainable Energy Reviews Journal, Vol 15, pages 2690-2695, August 2011.
7. Ghazinoory S, Huisingh D, National program for cleaner production (CP) in Iran: a framework and draft, Journal of Cleaner Production 14, pages 194-200, 2006.
8. Aslani A, Naaranoja M, Zakeri B, The Prime Criteria for Private Sector Participation in Renewable Energy Investment in the Middle East , Renewable and Sustainable Energy Reviews Journal, Volume 16, Issue 4, Pages 1977-1987, May 2012.
9. Aslani A, Naaranoja M, Antila E, Aslani F, Prioritization of Renewable Energy Resources to Participation of Private Sector Investment, IEEE Green Technologies, pages 204-207, April 2012.

10. Iran Renewable Energy Organization (SUNA), Biomass Energy, http://www.suna.org.ir/ationoffice-zisttoodehoffice-zisttoudehenergy-fa.html, [15, March, 2012].
11. Energy Balance Sheet, Department of Electrical and Energy Department of Energy Ministry, 2007.
12. Koroneos C, Dompros A, Renewable energy driven desalination systems modeling, Journal of Cleaner Production 15, pages 449-464, 2007.
13. Supersberger N, Energy Systems in OPEC Countries of the Middle East and North Africa, Wuppertal Institute, 2009, http://personal.lse.ac.uk/kumetat/pdfs/OPEC-Energy-Systems_report.pdf , [15, March, 2012].
14. Iran Renewable Energy Organization (SUNA), Solar Energy, http://www.suna.org.ir/ationoffice-sunenergyoffice-solarenergy-fa.html, [15, March, 2012].
15. Eu Solar Thermal electricity Association, Available from: http://www.estelasolar.eu/index.php?id=18, [15,March, 2012].
16. Energy Balance Sheet, Department of Electrical and Energy Department of Energy Ministry, 2009.
17. Sarmad Z, The Research Method in behavioral Science, Aghah pub, Tehran, Iran, 2009, ch.5.
18. Saaty TLPeniwati K, Group Decision Making: Drawing out and Reconciling Differences. Pittsburgh, Pennsylvania, RWS Publications, USA, 2008.
19. Alamsyah, T.M.I.; Sopian, K.; Shahrir, A. In Technoeconomics Analysis of a Photovoltaic System to Provide Electricity for a Household in Malaysia
20. Sandia National Laboratories," Batteries and Charge Control in Stand-Alone Photovoltaic Systems,Fundamentals and Application"