



Cairo University

Study to Transform Egyptian Seasonal Homes into Energy Producing Green Buildings

By

Amr Adel Mohamed Hussein

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
in
MECHANICAL POWER ENGINEERING

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Title of Thesis: **Study to Transform Egyptian Seasonal Homes into Energy Producing Green Buildings**

Key Words:

Zero Energy Home, Homer, Egypt North Coast, Renewable resources, Green Energy Building.

Summary :

The present investigation deals with changing seasonal home at the Egyptian North Coast to a green and zero energy building. Through using a hybrid unit of PV and HAWT. The study Not only aims to changing summer home to a ZEH it also aims to make profits (profits from selling back electricity to the grid) to the home owner , to reduce emissions and to support the national grid with electricity the rest of the year. The course of work investigates the idea theoretically as well as experimentally.

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Dedication

I dedicate this humble work to who words are competing to come out to express its innermost. To who taught me and suffered difficulties to be what I'm. Who doesn't spare anything from me. Who though me patience and success. To whom I miss very much in facing difficulties.

TO MY DEAR FATHER SPIRIT

Table of Contents

Acknowledgements.....	i
<i>Dedication</i>	ii
List of Figures	vi
List of Tables	viii
Nomenclature.....	ix
List of Abbreviations	x
Abstract.....	xii
1 Chapter 1: INTRODUCTION.....	- 1 -
1.1 Renewable Energy Resources in Egypt	- 1 -
1.1.1 Wind energy resource	- 1 -
1.1.2 Solar energy resource.....	- 2 -
1.2 Types of Wind Turbine.....	- 2 -
1.2.1 Horizontal axis wind turbine.....	- 2 -
1.2.2 Vertical axis wind turbine	- 3 -
1.3 Solar Energy Technologies	- 4 -
1.3.1 Solar thermoelectricity	- 4 -
1.3.2 Concentrated photovoltaic (CPV).....	- 4 -
1.3.3 Photovoltaic solar panels (PV).....	- 5 -
1.3.4 Concentrated solar power (CSP).....	- 6 -
1.4 Research Methodology	- 6 -
1.5 Thesis Outlines:	- 6 -
2 Chapter 2: LITERATURE SURVEY	- 7 -
2.1 Introduction.....	- 7 -
2.2 Practical Work Literature Survey	- 7 -
2.3 Theoretical Work Literature Survey	- 8 -
2.4 Conclusion Remarks on Literature Survey	- 10 -
2.5 Objective of Thesis	- 10 -
3 CHAPTER 3: HOMER DATA INPUT	- 11 -
3.1 Introduction.....	- 11 -
3.2 Introduction to homer	- 11 -
3.3 Software Validation	- 11 -

3.3.1	Homer program validation:	- 11 -
3.4	Simulation of the Egyptian Summer Home Model	- 12 -
3.4.1	System description	- 12 -
3.4.2	Simulation model	- 18 -
3.5	Economical Study for Generalizing the idea to 129 Resort in North Coast.	- 21 -
4	Chapter 4: EXPERIMENTAL SETUP.	- 23 -
4.1	Introduction.....	- 23 -
4.2	Experimental Setup	- 23 -
4.3	Measuring Instruments:.....	- 31 -
4.3.1	Introduction.....	- 31 -
4.3.2	Weather station “Davis vantage pro2”	- 31 -
4.3.3	Power and PV Cell temperature Devices	- 34 -
5	Chapter 5: RESULTS AND DISCUSSION	- 35 -
5.1	Introduction:.....	- 35 -
5.2	Theoretical Results and Discussion	- 35 -
5.2.1	For single summer home model (low load consumption).....	- 35 -
5.2.2	For single summer home model (high load case)	- 43 -
5.2.3	Average results for Egyptian north coast summer homes (low load case)	- 49 -
5.2.4	Average results for Egyptian north coast summer homes (high load case)	- 51 -
5.2.5	Economical study summer	- 54 -
5.3	Experimental Results and Discussion	- 54 -
5.3.1	Temperature results:.....	- 54 -
5.3.2	Global solar radiation results:	- 56 -
5.3.3	Comparing power results of Chinese made PV panel and local made PV panel.....	- 57 -
5.3.4	Comparing power results with and without solar tracking system	- 58 -
5.3.5	Comparison between the actual solar power and theoretical	- 60 -
5.3.6	Wind results	- 61 -
6	Chapter 6: CONCLUSIONS AND FUTURE WORK.....	- 63 -
6.1	Conclusions:.....	- 63 -
6.2	Future Work	- 64 -
7	References:.....	- 65 -
8	Appendix.....	- 67 -
8.1	Appendix (A): Egyptian North Coast Summer Village Governmental Data.....	- 67 -

8.2	Appendix (B): Local Made Solar PV Specifications	- 68 -
8.3	Appendix (C): Chinese Made Solar PV Specifications	- 69 -
8.4	Appendix (D): Governmental Global Solar Radiation Data.	- 70 -
8.5	Appendix (E) : Governmental Annual Electricity Report.....	- 77 -
8.6	Appendix (F): Governmental KWh Price for Commercial Electrical Usage (28/5/2018).....	- 78 -
8.7	Appendix (G): EMA Hourly Temperature For The Day Of Practical Test	- 79 -
8.8	Appendix (H): Calibration Certifications.....	- 80 -
8.8.1	Temperature sensor calibration	- 80 -
8.8.2	Solar sensor calibration:	- 81 -
8.9	Appendix (I): Measuring Devices	- 82 -
8.9.1	Multimeter (UT203)	- 82 -
8.9.2	Multimeter DT9205a	- 83 -
8.9.3	Infrared thermometer (DT8380)	- 83 -
8.10	Appendix (J): Paper Certificate of Publication.	- 85 -

List of Figures

Figure 1-1 Wind Atlas [1].....	- 1 -
Figure 1-2 Global Solar Radiation Atlas in Egypt [1]	- 2 -
Figure 1-3 HAWT Aerodynamic Lift [2]	- 2 -
Figure 1-4 Principle of VAWT Aerodynamic Lift [3].....	- 3 -
Figure 1-5 Turbine performance coefficient vs. tip speed ratio of different types of wind turbines [4]...-	3 -
Figure 1-6 Solar Thermoelectricity Device [5].....	- 4 -
Figure 1-7 Example of Concentrated Photovoltaic System [5]	- 4 -
Figure 1-8 Schematic Representation of PV Board under Daylight [7].	- 5 -
Figure 1-9 Concentrate Solar Power: Parabolic Trough system and Solar Tower System [9]	- 6 -
Figure 3-1 Paper Schematic[22]	- 12 -
Figure 3-2 Investigator Schematic	- 12 -
Figure 3-3 Researcher Measured Summer Home Annual Low Load profile	- 14 -
Figure 3-4 Researcher Measured Summer Home Daily Low Load Profile	- 14 -
Figure 3-5 Researcher Measured Summer Home Annual High Load profile.....	- 15 -
Figure 3-6 Researcher Measured Summer Home Daily High Load Profile	- 16 -
Figure 3-7 Daily Global Solar Radiation from EMA [see Appendix D]	- 16 -
Figure 3-8 Monthly Average Wind Speed from EMA [see Appendix D].....	- 17 -
Figure 3-9 Hybrid Power System Design	- 18 -
Figure 3-10 Wind Turbine selection and data input.....	- 19 -
Figure 3-11 PV Solar data input [Homer Software]	- 19 -
Figure 3-12 Converter Data Input [Homer Software].....	- 20 -
Figure 4-1 PV Panels Base	- 23 -
Figure 4-2 Base Angle Adjustment Using Compass.....	- 24 -
Figure 4-3 PV Holder.....	- 24 -
Figure 4-4 DC Motor	- 25 -
Figure 4-5 PV Panels (Local made and Chinese made).....	- 25 -
Figure 4-6 a-Local Made PV Specification Summary b-Chinese PV Specification Summary	- 26 -
Figure 4-7 Fully Assembled Test Rig 45° Facing The East.....	- 27 -
Figure 4-8 Fully Assembled Test Rig.....	- 27 -
Figure 4-9 Tracking system on	- 28 -
Figure 4-10 Various Modes of Tracking.....	- 28 -
Figure 4-11 Variation of solar flux for N-S tracking mode [30].....	- 29 -
Figure 4-12 Variation of solar flux for E-W tracking System [30].....	- 29 -
Figure 4-13 Dc 230 Watt Load	- 30 -
Figure 4-14 Assembled 3kW HAWT	- 31 -
Figure 4-15 Davis Vantage Pro 2 Weather Unit [31]	- 32 -
Figure 4-16 Davis Vantage Pro 2 Receiver Hand Held [31]	- 32 -
Figure 4-17 reserve handheld display definition [31].....	- 33 -
Figure 4-18 Solar Radiation Sensor[31]	- 33 -
Figure 5-1 Annual Single Egyptian Summer Home Low Load Case Production	- 36 -
Figure 5-2 Annual Single Egyptian Summer Home Low Load Consumption	- 36 -

Figure 5-3 Monthly Average Electric Low Load Case Production	37 -
Figure 5-4 Single Egyptian Summer home production in summer time (Low Load case).....	37 -
Figure 5-5 Single Egyptian Summer Home Production In Winter Time (Low Load Case).....	38 -
Figure 5-6 Monthly Average Grid Purchase and Grid Contribution Low Load Case	40 -
Figure 5-7 Daily Results for Single Home in winter (Low Load Case).	41 -
Figure 5-8 Daily PV, Wind and Grid Purchases Results for Single Home in Summer Season (Low Load Case).	42 -
Figure 5-9 Daily Consumed Load and Grid Contribution Results for Single Home In Summer Season (Low Load Case).....	42 -
Figure 5-10 Annual Single Egyptian Summer Home High Load Case Production.....	43 -
Figure 5-11 Annual Single Egyptian Summer Home High Load Consumption.....	44 -
Figure 5-12 Single Egyptian Summer home High Load Case Production in Summer Time	44 -
Figure 5-13 Single Egyptian Summer Home High Load Case Production In Winter Time.....	45 -
Figure 5-14 Monthly Average Electric High Load case Production.....	45 -
Figure 5-15 Monthly Average Grid Purchase and Grid Contribution (High Load Case).....	46 -
Figure 5-16 Daily Results For Single Home in Winter .(High Load Case).....	47 -
Figure 5-17 Daily PV, Wind and Grid Purchases Results for Single Home In Summer Season (High Load case)	48 -
Figure 5-18 Daily Consumed Load and Grid Contribution Results for Single Home In Summer Season (High Load case).....	48 -
Figure 5-19 Annual Egyptian Summer Homes Production (Low Load Case)	49 -
Figure 5-20 Annual Egyptian Summer Homes Consumption and Contribution (Low Load Case)	50 -
Figure 5-21 Monthly Average Grid Purchases and Grid Contributions at Low Load Case	51 -
Figure 5-22 Annual Egyptian Summer Homes High Load Case Production	52 -
Figure 5-23 Annual Egyptian Summer Homes Consumption and Contribution High Load Case	52 -
Figure 5-24 Monthly Average Grid Purchases and Grid Contributions At High Load Case	53 -
Figure 5-25 Comparison between Measured and EMA Ambient Temperature	55 -
Figure 5-26 PV Temperature Effect Over Efficiency [32]	55 -
Figure 5-27 Comparison PV Cell Temperature in case of with and Without Solar Tracking System ..	56 -
Figure 5-28 Comparison between Hourly Measured Global Solar Radiation and Hourly Global Solar Radiation from EMA	56 -
Figure 5-29 Chinese Made & Local Made Power Results Without Tracking System.....	57 -
Figure 5-30 Chinese Made and Local Made with Tracking System Power Results.....	58 -
Figure 5-31 Comparing Power Results For Chinese Made In case Of With Tracking System And In Case Of Without Tracking System	59 -
Figure 5-32 Comparing Power Results for Local Made In Case of with Tracking System and In Case of without Tracking System	60 -
Figure 5-33 Comparison between Solar PV Power Actual and Theoretical.....	60 -
Figure 5-34 Relation between Wind Speed and Wind Power.....	61 -
Figure 5-35 Measured Wind Power In Single Summer Day	62 -
Figure 5-36 Comparison between Measured Wind Power And Homers Wind Power.....	62 -

List of Tables

Table 1-1 Efficiency Comparison for Different Types of PV solar panels [8].	- 5 -
Table 3-1 Validation Results	- 12 -
Table 3-2 Researcher Measured Summer Home instruments Daily Low load	- 13 -
Table 3-3 Researcher Measured Summer Home instruments Daily High load Measurements	- 15 -
Table 3-4 Daily Global Solar Radiation Conversion	- 17 -
Table 3-5 Summer Resorts sample [Appendix A]	- 21 -
Table 3-6 Average Number of Homes Per Shore Length	- 22 -
Table 4-1 Energy Production for South, West, and East side PV Modules for Each Month in 2014 given per Module[30]	- 26 -
Table 4-2 Comparison of Energy Received for Various Modes of Tracking[30]	- 30 -
Table 4-3 Technical data for the solar radiation sensor [31]	- 34 -
Table 5-1 Total Yearly Production And Consumption For Low Load Case	- 35 -
Table 5-2 Monthly Average and Sellback Raw Data Sample	- 39 -
Table 5-3 Monthly Average Grid Purchases and Grid Contributed Analyzed Data	- 39 -
Table 5-4 Daily Model Results in Winter Season (Low Load Case)	- 40 -
Table 5-5 Daily Results in Summer Season	- 41 -
Table 5-6 Reduced Emissions Low Load Case	- 42 -
Table 5-7 Total Yearly Production and Consumption for High Load Case	- 43 -
Table 5-8 Monthly Average Grid Purchases And Grid Contributed Analyzed Data	- 46 -
Table 5-9 Daily Model Results in Winter Season (High Load Case)	- 47 -
Table 5-10 Daily Model Results in Summer Season.(High Load Case)	- 47 -
Table 5-11 Reduced Emissions High Load Case	- 48 -
Table 5-12 Total Yearly production for Egyptian North Coast (low load case)	- 49 -
Table 5-13 Total Annual load Consumption For Egyptian North Coast (Low Load Case)	- 50 -
Table 5-14 Monthly average Purchases and Contributions Analyzed Data Low Load Case	- 50 -
Table 5-15 Total Yearly production for Egyptian North Coast (High Load Case)	- 51 -
Table 5-16 Total Annual load Consumption For Egyptian North Coast High Load Case	- 52 -
Table 5-17 Monthly average Purchases and Contributions analyzed data High Load Case	- 53 -

Nomenclature

A	Turbine swept area	m^2
CO_2	Carbon Dioxide	
C_p	Turbine performance coefficient	
D	Drag force	N
f_{PV}	PV derating factor	$\%$
G_I	Solar radiation incident on the PV array in the current time step	kW/m^2
$G_{I,STC}$	Incident radiation at standard test conditions	$[kW/m^2]$
L	Aerodynamic lift	N
P_m	Turbine mechanical output power	W
T_a	Ambient Temperature	C°
T_c	Photovoltaic Cell Temperature	C°
V_w	Wind Speed	m/s
Y_{PV}	the rated capacity of the PV array, meaning its power output under standard test conditions	kW
β	Blade pitch angle	degree
λ	Tip speed ratio	
ρ	Air density	Kg/m^3
Ω	Electric Resistance	Ohm

List of Abbreviations

AC	Alternative Current
BA	Building America
BEOpt	Building Optimization Software
BPS	Building Performance Simulation
COE	Cost of Energy
CPV	Concentrated Photovoltaic
CSP	Concentrated Solar Power
CTEG	Concentrator Thermoelectric Generator
DC	Direct Current
DOE2	USA Department of Energy (software)
E	Equinoxes
EMA	Egyptian Meteorological Authority
GTS	Green Tech Solutions
HAVC	Heating, Ventilation and Air-conditioning
HAWT	Horizontal Axis Wind Turbine
HOMER	Hybrid Optimization Model for Electric Renewable
INhome	Team Purdue's submission to the United States Department of Energy Solar Decathlon 2011
ISS	Integrated Sensor Suite
LCC	Life Cycle Cost
NPC	Net Present Cost
NREL	National Renewable Energy Laboratory
NZEB	Net-Zero Energy Building
NZEB:A	A Footprint Renewable NZEB
NZEB:D	A Off-site Purchased Renewable NZEB
NZEH	Net-Zero Energy Home
O&M	Operation and maintenance Cost
Pro	Professional
PV	Photovoltaic
REF.	Refrigerator
RISO	National Laboratory of Sustainable Energy at Technical University of Denmark

SIM	Sensor Interface Module
SS	Summer Solstices
TV	Television
USA	United States of America
VAWT	Vertical Axis Wind Turbine
WS	Winter Solstice
ZEH	Zero Energy Home