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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Under the Supervision of

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Doctor of Mechanical Engineering, Cairo University

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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.

Acknowledgements

In the name of great Allah the Most Gracious and the Most Merciful. Alhamdulillah for the strengths and His blessing in completing this thesis. Special appreciation goes to my supervisor, Prof.Dr. Mahmoud Fouad for his invaluable help of positive comments and suggestions throughout the thesis works have contributed to the success of this research. Moreover I want thank Dr. Karim Awny for his supervision.

I would like to appreciate Prof.Dr. Adel Nasser, Prof.Dr. Ali El Naggar and Dr.Taher Halawa for their support. My acknowledgement also goes to all the technicians and office staffs of Cairo University as well as Higher Technological Institute (HTI).

I want to express my thankfulness to Eng. Ossama Mokhtar Gohneim the owner of Green Tech Solutions (GTS) Company for sponsoring my research and my study and for supporting with tools and information.

Sincere thanks to all my friends especially Mr. Taraq Abd El Salam, Eng. Hassan Gassor , Eng. Hany Ibrahim Yahya, Eng. Marwa Mohsen and Eng. Mohamed Salah and others for their kindness and moral support during my study. Thanks for the friendship and memories.

Last but not least, my deepest gratitude goes to my beloved parents, my brother and Maria Budinkevych for their endless love, prayers and encouragement.

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

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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_{Γ}	Solar radiation incident on the PV array in the current time step	kW/m^2
$G_{\Gamma,STC}$	Incident radiation at standard test conditions	$[kW/m^2]$
L	Aerodynamic lift	N
P_m	Turbine mechanical output power	W
Ta	Ambient Temperature	C°
Tc	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