بسم الله الرحمن الرحيم

وَقُلِ اعْمَلُوا

فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ

١٤٠٧

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
ELECTRICAL POWER AND MACHINES DEPARTMENT

Economy of Using Renewable Energy Resources in a Rural Area in Egypt

A Thesis
Submitted in partial Fulfillment of the Requirements
of the degree of Master of Science in Electrical
Engineering « POWER AND MACHINES »

By
HASSAN SELIM ALI
B.SC. Elec. Eng., Asuit University, 1974

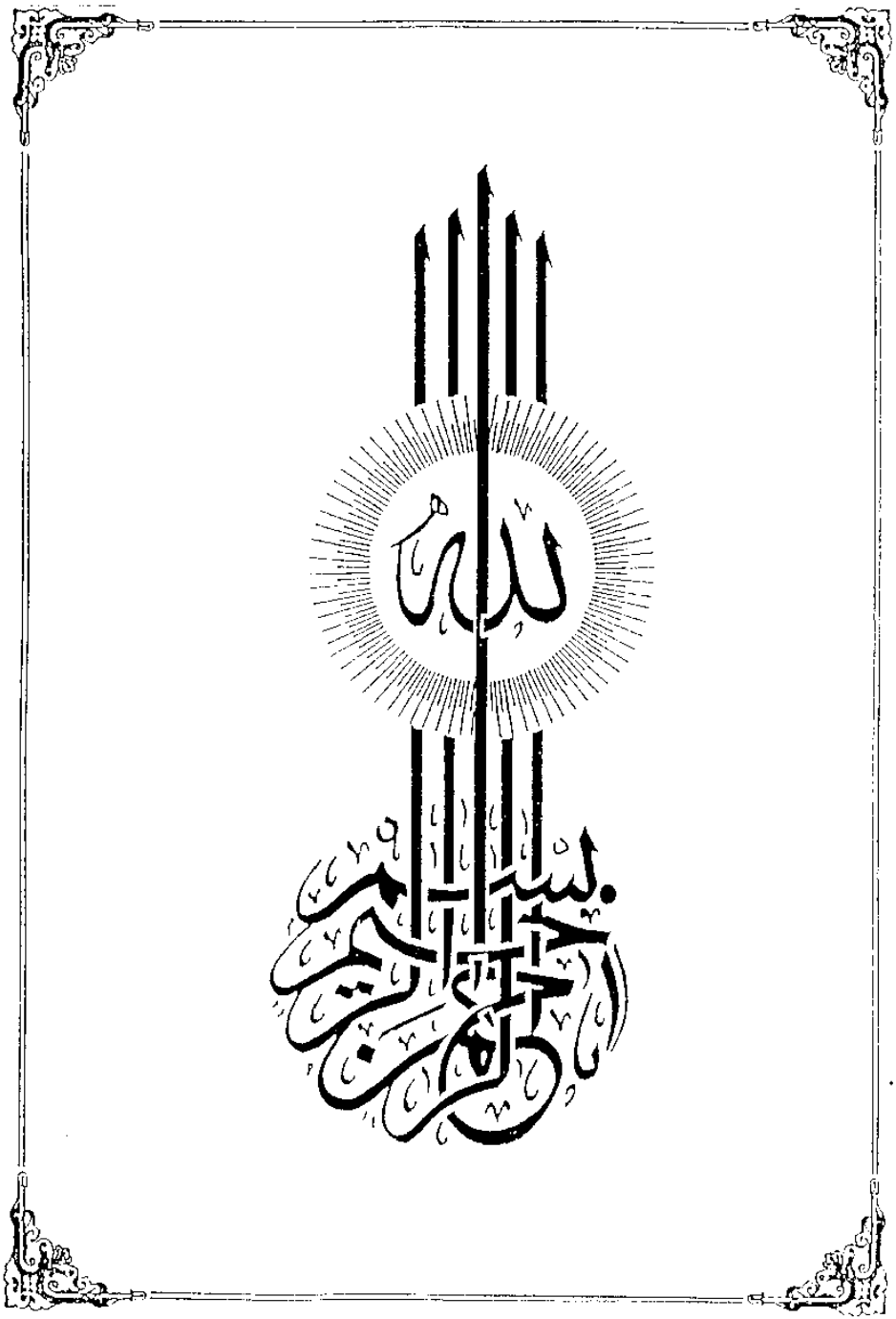
621.042
H.S

Supervised by

Dr. Soheir Sakr
Elec. Power and Mach. Dept.,
Faculty of Engineering.
Ain Shams University

Dr. A.M. Atallah
Elec. Power and Mach. Dept.,
Faculty of Engineering.
Ain Shams University

CAIRO 1993



Central Library - Ain Shams University

STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master in Elctrical Engineering.

The work included in this thesis was carried out by the author. No part of this thesis has been submitted for a degree or a qualification at other University or Institution

Date : 19/9/1993
Signature : Hassan Selim Ali
Name : **Hassan Selim Ali**

ACKNOWLEDGEMENT

The author would like to thank Dr. Soheir Sakr and Dr. A.M. Atallah for all that they have done . Their encouragement and fruitful remarks will always be a guiding lights throughout the author's life.

The author has the honour to dedicate this modest thesis to Dr. S. Sakr and Dr. A. M. Atallah thanking them for all the efforts they have exterted so that it could be finished.

The author can hardly find the words to express his thankfulness, appreciation and gratitude for all the help and useful guidance of Dr. S. Sakr and Dr. A. M. Atallah offered during their supervision. He will be always indebted to them and will never forget their care.

LIST OF SYMBOLS

SYMBOL	DEFINITION	DIMENSION
m/s	Wind Speed	meter per scond
m^3	Cubic meter	----------
MPE	Motor - Pump . Efficiency	%
AHED	Average hydraulic energy demand	kwh
V	Volume of water	m^3
H	Head	meter
AED	Average energy demand	kwh
m_a	Air mass. Flow rate	kg
m_f	Fuel mass. flow rate	kg or ton
A/F	Air per fuel ratio	" "
F/A	Fuel per air ratio	" "
A_n	Annual revenue requirements	$
A_v	Annual Variable costs	$
A_f	Annual Fixed costs	$
MARR(or i)	Minimum attractive rate of return or Interest rate	%
D	Depreciation	%
n	Lifetime of years	"
I T	Income Tax	%
$F.C.R_T$	Total Fixed Charge Rate	%
P_{oreq}	Disel required capacity power	kw
$F.C_T$	Total Fuel Consumption	cubic meters
S	The price after n period	L.E or $
n	Number of years	
P	the present value	L.E or $
C_{t1}	the overall capital cost of the diesel system at interest rate = 6 %	$
C_{t2}	the overall capital cost of the diesel system at interest rate i = 8 %	$
C_R	The total running cost	$ / year

A_{n1}	Annual cost at i = 6 %	$ / year
A_{n2}	Annual cost at i = 8 %	$ / year
C_u	The cost of electricity	c / kwh
C_T	Total capital cost	$
I.G	Induction generator	---
D.C	Direct current	---
A.C	Alternating current	---
HAWT's	Horizontal axis wind Turbine's	---
VAWT's	Vertical axis wind Turbine's	---
R.P.M	Revolution per minute	
ρ	Air denisty	kg/m^3
m	Mass of air	kg
u_o	Unpertubed wind speed	m / s
A_1	Gross - sectional area of the turbine disc	m^2
A_o	Area of the oncoming wind speed	m^2
A_2	Area of the air stream at mimimn	m^2
F	Force of air on the turbine	
u_2	Wind speed leaves the turbine	m / s
u_1	Wind speed of the turbine disc	m / s
P_t	The power extracted by the turbine	kw
P_w	The power extracted from the wind	kw
a	The interferance factor	%
P_o	The power in the unperturbed wind	kw
C_p	Power coefficient	%
C_{pmax}	Maximum power coefficient	%
u_c	Cut - in wind speed	m / s
u_r	Rated wind speed	m/s
u_f	Furling wind speed (cut - out)	m/s
w_m	Mechanical angular velocity	
P_m	Mechanical power at the output of the turbine	Hp
P_e	output electric power	kw
m	transmission efficiency	%
g	Generator efficiency	%

o	Overall efficiency	%
P_{mr}	Rated output power of the turbine	kw
C_{pr}	Coefficient of performance at rated wind speed	
W_t	Transmission angular velocity	
W_e	Generator angular velocity	
q	Number of stages for gear box	
X & Y	Parameters	
P_{tr}	Rated mechanical power	kw
P_{er}	Rated output power	kw
u_{11}	Wind speed at Z_1 hub height	m/s
u_{22}	Wind speed at Z_2 hub height	m/s
Z_1	Hub height at wind speed u_1	meters
Z_2	Hub height at Wind speed u_2	meters
E	the energy per year per kilowatt of rating	kwh
C.F	Capacity Factor	%
C&k	The weibull parameters	
u_m	mean wind speed	m/s
E_{av}	the average energy required	kwh
Y_1	The cost of initial few machines	$
Y_2	the cost of units after n doublings	$
S	The slop of the cost curve	----
X_1	The first volume of production	___
X_2	The secound volume of production	___
C_t	The capital cost of wind generating units	$
P_D	Diesel generating power required	kw
C_{tw}	Total capital cost of all wind units	$
C_{td}	Total capital cost of diesel units	$
C_r	Running cost	$
P_1	The power output of the wind turbine at average wind speed u_{m1}	kw
P_2	The power output of the wind turbine at	kw

	average wind speed u_{m2}	
T_d	The average operating time of the disel back - up of wind system	hours
O & M	Operation and Maintenance	
N	Number of wind units	
d	Rotor diameter	metes
Cos	Power factor	
P_c	The power capacity required for solar thermal central receiver power plant	MW
η_h	Heliostat efficiency	%
η_r	Receiver efficiency	%
η_{et}	Energy transport efficiency	%
η_{st}	Storage system efficiency	%
η_t	Steam turbine efficiency	%
A_h	Required area of heliostats	m^2
P_{th}	Thermal power	kw_{th}
C_h	Heliostat cost	$
C_r	Receiver cost	$
SI	silicon material	$
B	Boron	
Ph	Phosphorous	
Wp	Watt peak	
PV	Photovolatic	
S.O.C	State of change	
AH	Battery capacity in amper hours	
D.O.D	Depth of discharge	
K V A	Kilo volt amper	
E O	East Oweinat	

ABSTRACT

Posing the choice of using renewable energy for cultivating an area outside the Nile basin is the main objective of this study. Renewable energy is very clean and has no environmental effects. It is easy for construction and there is no need for transporting any fuel to the proposed site. For this purpose 10,000 feddans of both summer and winter crops can be used as a demonstration scheme and a new city at the proposed site consequently will be constructed.

The water requirements for both centre pivot and drip systems will be estimated for the proposed crops (citrus, vegetables, alfalfa, sunflower, sorghum and wheat/barley). Then, the daily average energy required for both systems of irrigation will be calculated during each month of the year. The non irrigation loads (distilled water, residential load, hospitals, officers, ... etc) also be estimated.

For supplying the energy required to the calculated load, four options are presented, these are: stand-alone diesel generator system, wind-diesel hybrid system, solar thermal generator-auxiliary boiler hybrid system, and photovoltaic with a back-up of batteries or diesel system. Each one of these four options was studied where we presented an introduction, system description, how the energy is produced, survey of the capital cost, operation and maintenance cost from different sources of different countries. A cost estimation for each item of each option including annual cost has been done. Then we have compared between the four options to select the minimum overall cost and to supply the energy required for irrigation and non irrigation.

TABLE OF CONTENTS