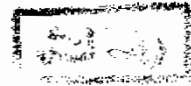


بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ  
وَقَالَ الْخَبِيرُ

فِي سِيرَةِ الْإِمَامِ مُحَمَّدٍ وَآلِهِ  
وَالْمُؤْمِنِينَ

AIN SHAMS UNIVERSITY  
FACULTY OF ENGINEERING  
ELECTRICAL POWER AND MACHINES DEPARTMENT

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



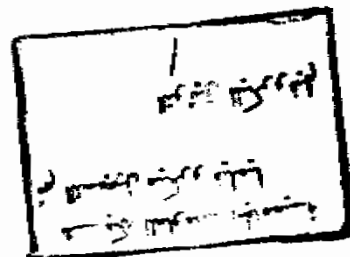
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## ***STATEMENT***

**This dissertation is submitted to Ain Shams University for the degree of Master in Electrical 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**

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# LIST OF SYMBOLS

SYMBOL	DEFINITION	DIMENSION
m/s	Wind Speed	meter per second
m <sup>3</sup>	Cubic meter	-----
MPE	Motor - Pump Efficiency	%
AHED	Average hydraulic energy demand	kwh
V	Volume of water	m <sup>3</sup>
H	Head	meter
AED	Average energy demand	kwh
m <sub>a</sub>	Air mass. Flow rate	kg
m <sub>f</sub>	Fuel mass. flow rate	kg or ton
A/F	Air per fuel ratio	" "
F/A	Fuel per air ratio	" "
A <sub>n</sub>	Annual revenue requirements	\$
A <sub>v</sub>	Annual Variable costs	\$
A <sub>f</sub>	Annual Fixed costs	\$
MARR( or i )	Minimum attractive rate of return or Interest rate	%
D	Depreciation	%
n	Lifetime of years	"
IT	Income Tax	%
F.C.R <sub>T</sub>	Total Fixed Charge Rate	%
P <sub>oreq</sub>	Disel required capacity power	kw
F.C <sub>T</sub>	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 <sub>t1</sub>	the overall capital cost of the diesel system at interest rate = 6 %	\$
C <sub>t2</sub>	the overall capital cost of the diesel system at interest rate i = 8 %	\$
C <sub>R</sub>	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	
$\rho$	Air density	kg/m <sup>3</sup>
m	Mass of air	kg
$u_o$	Unperturbed wind speed	m / s
$A_1$	Gross - sectional area of the turbine disc	m <sup>2</sup>
$A_o$	Area of the oncoming wind speed	m <sup>2</sup>
$A_2$	Area of the air stream at minimum	m <sup>2</sup>
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 interference 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
$\omega_m$	Mechanical angular velocity	
$P_m$	Mechanical power at the output of the turbine	Hp
$P_e$	output electric power	kw
$\eta_m$	transmission efficiency	%
$\eta_g$	Generator efficiency	%

$\eta$	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	----
$C_1$	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
$\xi_h$	Heliostat efficiency	%
$\xi_r$	Receiver efficiency	%
$\xi_{et}$	Energy transport efficiency	%
$\xi_{st}$	Storage system efficiency	%
$\xi_t$	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.

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