Cairo University

SIMULATION AND OPTIMAL SIZING OF THE HYBRID SOLAR-DIESEL POWER GENERATING SYSTEM

By

Eng. Ahmed Maged Al-Halaby

A thesis submitted to the

Faculty of Engineering at Cairo University

In Partial Fulfillment of the

Requirements for the Degree of

MASTER OF SCIENCE

In

Electrical Power and Machines Engineering

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Under supervision of

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Title of Thesis: **Simulation and Optimal Sizing of the Hybrid Solar-Diesel Power Generating System**

Key Words: hybrid systems, optimization techniques, PSO, diesel emissions, life cycle cost

Summary:

This research purposes to choose the optimal sizing for hybrid PV/batteries/diesel power system. It focuses on I–V and P–V specifications of the modules and arrays, taking into account the physical and electrical specifications of the batteries. It also focuses on the study of the best control technique to get the maximum economic power from the diesel generator, and checks the results practically using sizing software programs: HOMER, PVSYST, MATLAP SIMULINK models for system components, and PSO optimization model.

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Dedication

This thesis is dedicated to my great **mother** who has been a great source of motivation, love, and inspiration; to my brothers, **Mostafa** and **Mahmoud;** my beloved uncle **Abd Elkader Hashem;** my beloved **aunts**, for their love; and my dear **friends** for their encouragement and support over the study years.

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List of Symbols and Abbreviations

A_D	Number of cloud days
AEP	Actual emission penalties (US$/tones)
AVR	Automatic voltage regular
C	Total sky cover
Ca	The operation and maintenance cost for one year
C_{cap}	The component initial capital cost
C_i	Weighting factor
CO	Carbon monoxide
CO&M	The component life cycle operation and maintenance cost
CO_2	Carbon dioxide
COE	Cost of Energy
Crep	The component life cycle replacement cost
CRF	Capital recovery factor
Cslv	The component life cycle salvage cost
CSP	Concentrated solar power
d	Discount rate
D	Diffuse solar radiation
DOD	Depth of discharge
EF	Emission factor (grams/litter)
E_f	Excitation voltage
EP	Emission penalties (US$/tones)
EPA	Environmental protection agency
E_v	Daily evaporation in millimeter
F	Fuel consumption rate (L/hr)
f	Inflation rate
F_s	Fuel curve slope for generator (L/hr/ kw)
F_1	Solar energy density on south facing tilted by latitude angle
F_2	Solar energy density on full tracking system
F_3	Solar energy density on East-West tracking system

F_4	Solar energy density on north-south tracking system
FLFC	Full load fuel consumption (L/ kw)
F_o	Generator fuel intercept coefficient (L/hr/kw)
f_{pv}	De-rating accumulation factor
G	Global solar radiation
GA	Genetic algorithm
Gbest	Best global
$gbest_i$	Best global of the group
H	Constant of Inertia
HC	Hydrocarbons
i	Interest rate
I	Direct incidence solar radiation
I_0	Reverse bias current
IK	Short circuit current
Iter	Current iteration number
$Iter_{Max}$	Maximum iteration number
Kd	Damping factor
K_D	Diffuse fraction
K_t	Relative global solar radiation
LCC	Life cycle cost
LOLP	Loss of Load Probability
LPSP	Loss of Power Supply Probability
n	The system life time in years
ŋ_inv	The inverter efficiency
n_{comp}	The component life time (years)
NLFC	No load fuel consumption (L/ kw)
NOCT	Normal operating cell temperature
NO_x	Nitrogen oxides
NPC	Net present cost
NPCBT	The battery system net present cost (US$)
NPCconv	The converter net present cost (US$)
NPCdiesel	The diesel generator net present cost (US$)
NPCpv	The PV modules net present cost (US$)