Ain Shams University

Faculty of Engineering

Electrical Power & Machines Department

Time Varying Load Models Application for Optimal Allocation and Sizing of PV Systems in Distribution Networks

Master Thesis

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Submitted in partial fulfillment of the requirements for the Master degree in Electrical Engineering

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STATEMENT

This Thesis submitted to Ain Shams University in partial fulfillment of the requirements of Master degree in Electrical Engineering.

The included work in this thesis has been carried out by the author at the department of electrical power and machines, Aviation Engineering and Technology Institute. There no part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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ABSTRACT

Distributed Generation (DG) is widely used in distribution systems to enhance the dynamic characteristics of the network such as improving the voltage profile, minimizing active and reactive power losses. A variable voltage load model is assumed in many distribution systems. Therefore, the results are more reliable and accurate.

This thesis presents an optimal method for selection of size and site of DG unit based photovoltaic system to minimize a multi objective function that depends on active and reactive power losses and voltage deviation. This is possible by giving appropriate weight for each one of the above variables towards the design or operational limits of the PV system taking into consideration the variable load model and mixed load between residential, commercial and industrial. Optimization is made by using a new analytical method and also by using a new optimization technique which is called Big Bang-Big Crunch optimization technique which provides an effective approach for computing the sensitivity of power loss and voltage profile for active and reactive power insertion in the radial distribution system. A 33-bus test distribution system and 69-bus test distribution system have been applied to demonstrate the effect of DG on the distribution network. The Forward/Backward Sweep Load Flow technique is used in this thesis.

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List of Abbreviations

PV:	Photovoltaic
MPP:	Maximum Power Point
DG:	Distributed Generation
O&M:	Operation and Maintenance
T&D:	Transmission and Distribution
GA:	Genetic Algorithm
SA:	Simulated Annealing
TRANSCOs:	Transmission Companies
DISCOs:	Distribution Companies
GUI:	Graphical User Interface
ABC:	Artificial Bee Colony
MVA:	Mega Volt Ampere
MINLP:	Mixed Integer Non-Linear Programming
DNO:	Distribution Network Operators
RDN:	Radial Distribution Network
ECI:	Equivalent Current Injections
BIBC:	Node Injection to Branch Current Matrix
BCBV:	Branch Current to Nodule Voltage Matrix
IB:	Branch Current
KCL:	Kirchhoff's Current Low

KVL: Kirchhoff's Voltage Low

IMO: Multi Objective Index

AIMO: Average Multi Objective Index

ILP: Active Power Loss Index

ILQ: Reactive Power Loss Index

IVD: Voltage Deviation Index

VD: Voltage Deviation

BB-BC: Big Bang Big Crunch

List of Symbols

R_P : Shunt resistor

R_s : Series resistance

I_L : Photo generated current

m : Ideality factor for diode

I_o : The diode reverses saturation current

q : The elementary charge

k : Boltzmann's constant

T : absolute temperature

I_s : Drift current

I_D : Diffusion current

P_K : Real power injection at bus k

Q_K : Reactive power injection at bus k

P_{oK} : Active load at bus k at nominal voltage

Q_{oK} : Reactive load at bus k at nominal voltage

V_K : The voltage at bus k

n_P : Active load voltage exponent

n_q : Reactive load voltage exponent

FF : fill factor

V_{MMP} : Voltage at maximum power point

I_{MMP} : Current at maximum power point

$V_{o.c}$: Open circuit voltage (v)