A PROPOSED ECONOMICAL BASED APPROACH FOR OPTIMAL SIZING AND PLACEMENT OF DISTRIBUTED GENERATION

By

Eng. Zenhom Mohamed Zenhom Kotb

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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Key Words:
Distributed generation, Genetic Algorithm, Loss reduction, Radial distribution system, Simple payback period.

Summary:

In this thesis, a new approach for optimal allocation of distributed generation for reducing the Simple Payback Period (SPBP) is presented. Distributed Generation (DG) is a small capacity generating units connected to the distribution network close to the consumers. It can provide a promising future for power generation in electric networks. In recent years, the demand for distributed generation into the electrical networks is rapidly increasing. Connecting DG units into the distribution networks can offer environmental, economic and technical advantages. Those advantages can be optimized if the DG unit site and size is properly determined. The goal of this thesis is to provide a complete study of the impact of connecting DG units in the distribution networks on power loss based on economical point of view. Genetic Algorithm (GA) is presented to solve the optimal DG allocation problem in the distribution system. The Proposed solution methodology has been tested on IEEE 33 standard bus system using MATLAB software.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

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List of Abbreviations

ABC	Artificial Bee Colony
ACS	Ants Colony Search
AGA	Adaptive Genetic Algorithm
ANN	Artificial Neural Network
BSDG	Black Start Diesel Generators
CAES	Compressed Air Energy Storage
DG	Distributed Generation
DGA	Distributed Generation Allocation
EPRI	Electric Power Research Institute
FES	Flywheel Energy Storage
GA	Genetic Algorithm
GAMS	General Algebraic Modeling System
IA	Immune Algorithm
ICA	Imperialist Competitive Algorithm
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronics Engineers
LSF	Loss Sensitivity Factor
MAS	Multi Agent System
MINOS	Modular In-core Nonlinear Optimization System
NEMA	National Electrical Manufacturers Association
OECD	Organization for Economic Co-operation and Development

PHS	Pumped Hydroelectric Storage
PSO	Particle Swarm Optimization
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SMES	Superconducting Magnetic Energy Storage
SPBP	Simple Payback Period
SPSO	Selective Particle Swarm Optimization
TDD	Total Demand Distortion
THD	Total Harmonic Distortion
VSI	Voltage Stability Index

List of Symbols

AES	The annual saving in energy cost ($/year)
ARC	The annual running cost of the DGs ($/year)
B_{ij}	The susceptance of the branch between bus i and bus j
Cp	The coefficient of performance
$c1_i$	The installed cost of the DG unit i per kW of the rated power
$c2_i$	The operation and maintenance cost per kWh for the DG unit i
FC	The fixed, or installed, cost of the DGs ($)
G_{ij}	The conductance of the branch between the two buses i and j
H	The period of operation per year (hrs/year)
Ho	The net head (m)
n	The total number of buses
N	The total number of DG units
nb	The total number of branches
NAS	The net annual saving ($/year)
P_{loss}	The total active power loss
P_{loss}^{base}	The total active power loss for the base case
P_{loss}^{DG}	The total active power loss when DG units are connected
P_{D_i}	The active power demand at bus i
P_{DG_i}	The rated power of the DG unit i
Pw	The total power related with the wind kinetic energy
Q	The volumetric flow rate (m3/s)

Ri	The fuel input for the DG unit i (Mbtu/hr)
r_{ij}	The real part of the ijth element in [Zbus] matrix
V_i	The voltage magnitude at bus i
V_j	The voltage magnitude at bus j
ρ	The air density
ηg	The generator efficiency
ηb	The gearbox efficiency
δ_i	The angle of voltage at bus i
δ_j	The angle of voltage at bus j
ρ_P	The energy market price ($/kWh)
ρ_f	The fuel market price ($/Mbtu)
α_i	The loss sensitivity factor at bus i