



Cairo University

IMPACT OF INCLUDING DISTRIBUTED GENERATION UNITS ON THE PERFORMANCE OF ELECTRICAL POWER DISTRIBUTION SYSTEMS

By

MOHAMED IBRAHIM ABDELAZIZ SHEKEEW

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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Title of Thesis:

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THE PERFORMANCE OF ELECTRICAL POWER DISTRIBUTION
SYSTEMS**

Key Words:

Distributed Generation; Electrical Power Distribution Systems

Summary:

Recently, the distributed power generation (DG) plays an important role in the planning of power systems because the demand load increases rapidly and the traditional solutions of utility may be expensive. So that the existing network should be utilized and developed in an optimal manner.

The thesis presents the optimal location, size and number of different types of distributed generation (DG) units that should be added to distribution systems. The single objective is to minimize the total power losses by optimal location and size of two types of DG units considering the voltage limits and the lines' transfer capacities. Also, the effect of increasing number of DG units is presented according to the power factor of the substation and the voltage profile of the system. Moreover, solutions to improve the performance of the system in case of using DG units which supply active power only are suggested. Also, the best results in the case of single optimization are used in the multi-objective problem. The part of multi-objective aims to minimize the total active, reactive and voltage regulation index. This optimization problem can be classified as a mixed-integer nonlinear problem which is difficult to solve by classical optimization techniques. The Genetic Algorithm (GA) is used as an optimization technique and backward / forward sweep (BFS) method is applied as a load flow technique. The IEEE 33-bus and 69-bus radial distribution systems are used to test the effectiveness of the proposed models.

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To my Father, on him God Mercy

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Nomenclature

Abbreviations and Symbols:

<i>DG</i>	<i>Distributed Generation</i>
<i>GA</i>	<i>Genetic Algorithm</i>
<i>BFS</i>	<i>Backward / Forward Sweep</i>
<i>VRI</i>	<i>Voltage Regulation Index</i>
<i>CIGRE</i>	<i>International Council on Large Electricity Systems</i>
<i>MATLAB</i>	<i>Matrix Laboratory</i>
<i>PV</i>	<i>Photovoltaic</i>
<i>WT</i>	<i>Wind Turbines</i>
<i>FC</i>	<i>Fuel Cell</i>
<i>PEMFC</i>	<i>Proton Exchange Membrane or Polymer Electrolyte Membrane Fuel Cell</i>
<i>AFC</i>	<i>Alkaline Fuel Cell</i>
<i>DMFC</i>	<i>Direct Methanol Fuel Cell</i>
<i>PAFC</i>	<i>Phosphoric Acid Fuel Cell</i>
<i>MCFC</i>	<i>Molten Carbonate Fuel Cell</i>
<i>SOFC</i>	<i>Solid Oxide Fuel Cell</i>
<i>PL</i>	<i>Total active power losses</i>
<i>HRSG</i>	<i>Heat Recovery Steam Generator</i>
<i>CHP</i>	<i>Combined Heat and Power</i>
<i>PSO</i>	<i>Particle Swarm Optimization</i>
<i>ANSI</i>	<i>American National Standards Institute</i>
<i>QL</i>	<i>Total reactive power losses</i>
<i>j</i>	<i>Branch Number</i>
<i>i</i>	<i>Bus Number</i>
<i>n</i>	<i>Total Number of Buss</i>
<i>n_{br}</i>	<i>Total Number of Branches</i>
<i>R_{br(j)}</i>	<i>Resistance of branch Number j</i>
<i>X_{br(j)}</i>	<i>Reactance of branch Number j</i>
<i>I_{br(j)}</i>	<i>Current of branch Number j</i>

Abstract

Recently, the distributed power generation (DG) plays an important role in the planning of power systems because the demand load increases rapidly and the traditional solutions of utility may be expensive. So that the existing network should be utilized and developed in an optimal manner.

The thesis presents the optimal location, size and number of different types of distributed generation (DG) units that should be added to distribution systems. The single objective is to minimize the total power losses by optimal location and size of two types of DG units considering the voltage limits and the lines' transfer capacities. Also, the effect of increasing number of DG units is presented according to the power factor of the substation and the voltage profile of the system. Moreover, solutions to improve the performance of the system in case of using DG units which supply active power only are suggested. Also, the best results in the case of single optimization are used in the multi-objective problem. The part of multi-objective aims to minimize the total active, reactive and voltage regulation index. This optimization problem can be classified as a mixed-integer nonlinear problem which is difficult to solve by classical optimization techniques. The Genetic Algorithm (GA) is used as an optimization technique and backward / forward sweep (BFS) method is applied as a load flow technique. The IEEE 33-bus and 69-bus radial distribution systems are used to test the effectiveness of the proposed models.