Optimization of real power loss and voltage stability index of distribution systems with distributed generation

By

Mahmoud Elsaid Mohamed Dawod

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:

Optimization of real power loss and voltage stability index of distribution systems with distributed generation

Key Words:
Distributed Generation (DG) ; Multi objective optimization ; Voltage stability index ; Distribution system losses

Summary:

The main goal of this thesis is determination of the best location and size of distributed generation unit that improves voltage stability index and reduces the distribution system losses. A methodology has been developed to realize this goal. The multi objective optimization subjected to a set of constraints and using genetic algorithm has been utilized. For verification of this methodology, it has been applied on standard test systems, namely IEEE 33-bus system and IEEE 69-bus system. The deduced results are compared with that given in the literature.

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Dedication

I dedicate this thesis to my parents , my sister , my brother and my best friends.
.

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Nomenclature

AL	Analytical method
DG	Distributed generation
e_C	Vector with all zero entries except for a C in the C-th raw
FC	Fuel cells
FVSI	Novel fast voltage stability index
GA	Genetic algorithm
i	Second order index
i_0	The value of $\delta_{max}/\frac{d\delta_{max}}{dC_{total\,0}}$ in the base case
C_{total}	The system load variation
J	Jacobian of load flow equation
J_{CC}	Matrix obtained from J substituting the C-th row by e_C^T
L_j	L index
L_{mn}	Line stability Index
LQP	Line Stability Index
MT	Micro turbines
PV	Photovoltaics
t_{cc}	Test function
TVI_i	Tangent vector
VSI	Voltage stability index
VCPI	Voltage collapse proximity indicators
V^t	The transpose of voltage
$\frac{dV_i}{d\lambda}$	The entry in the tangent vector $\frac{dx}{d\lambda}$ corresponding to the bus voltage magnitude V_i
λ	Parameter vector represents real and reactive power demands at each load bus.
WTs	Wind turbines
δ_{max}	The maximum singular value of J^{-1}

Abstract

The increasing of energy demand causes more stresses on the transmission and generation systems. The operation of the conventional power system causes massive amount of transmission loss. In addition, the problem of exhaustion of fossil fuel and global warming have reinforced the use of the less environmentally-polluting distributed generation units (DG). The conjunction of DG units into the distribution systems will change the traditional power flow from a unidirectional flow to a bidirectional flow. However, siting of these units has to be studied for realizing economical and technical advantages for distribution systems. The installation of DG at random location with non optimized size will cause increasing of system losses and low voltage profile and this would increase the cost. The energy of DG units will compensate some of the energy demand of the consumers. Therefore, the sizing and position of DG units have to be carefully studied. The problem is formulated as multi objective functions having a number of constraints also genetic algorithm is utilized to solve this problem. A methodology is applied to achieve this purpose. For verification of this methodology, it has been tested by applying it on standard test systems, namely IEEE 33-bus system and IEEE 69-bus system. Further, the deduced results are compared with that given in the literature.

Chapter 1 : Introduction

1.1. Back ground

Increasing of power demand causes more stress on transmission and generation systems that may lead to power outage. Different methods are developed to upgrade security and the reliability of the electrical power systems. When the distribution system is overloaded then the power outages will occur . This will costs millions of L.E. per year. There are new technologies authorise the production of electrical energy in reliable and secure method and will cause a fewer damage to the surrounding environment.One of these solutions is building generation close to the power consumption places. This generation called distributed generation (DG) .The distribution sector had given a large scope for using the distributed generation resources which will improve the system performance. Always the large concentration of generation stations is near to the biggest demand of power or loads. If the loads were far away from the generation station the consumer will face drop in voltage and the outage problem . The advantages of (DG) units can be only obtained by selecting the suitable size of the DG and putting it at suitable location in the power system. Distributed generation units have effects on the voltage profile and consequently losses and voltage stability of the system which contains them.DG penetration can be defined as the total amount of DG within a distribution network divided by the total network capacity.

1.2. Advantages of distributed generation

Alarge number of countries used DG units to supply some of their electrical energy needs. Some of Utilities used DGs unit to get the distribution system efficiency better.Also some of consumers have used DGs to minimize their demand costs, and some consumers have used DGs to minimize the polluted emissions from their power supply.

1.2.1. Reliability

Storm has alarg risk on the grid and when it occurs, it usually causes power outage for alarge number of customers without power for long time. When Hurricane Sandy strick the east coast, a few people who have solar panels were supplying emergency power to their neighbors.

1.2.2. Power Quality

It is found that the power quality of the power system can be determined by many aspects as examples the voltage profile and the system losses compare to the system