



Ain Shams University
Faculty of Engineering
Electrical Power and Machines Department

Multiple Distributed Generators for Enhancement of Voltage Stability in Distribution Systems

A thesis Submitted to the Faculty of Engineering, Ain Shams University
in partial fulfillment of the requirements for the Degree of Master of
Science in Electrical Engineering

Prepared by:

Eng. Bahaa Saad Mahmoud Bassuonie

B.Sc. in Electrical Power Engineering
Department of Electrical Power and Machines
El-Shorouk Academy

Under Supervision of:

Prof. Dr. Ahmed Rizk Abul'Wafa

Faculty of Engineering –Ain Shams University

Assoc. Prof. Dr. Aboul'Fotouh A. Mohamed

High Institute for Engineering, El-Shorouk Academy

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Examination Committee

Title, Name and Affiliation

Signature

Prof. Dr. Adel Ali Mohamed Abou El-Ela

Electrical Engineering Dept.
Faculty of Engineering - Shebin El-Kom
Menoufiya University

ABOU EL-ELA

Prof. Dr. Elsayed A. Mohamed

Electrical Power & Machines Engineering Dept.
Faculty of Engineering - Abbasya,
Ain Shams University

EA Mohamed

Prof. Dr. Ahmed Rizk Abul'Wafa

Electrical Power & Machines Engineering Dept.
Faculty of Engineering - Abbasya,
Ain Shams University

Ahmed Rizk Abul'Wafa

Date: 11/11/2015



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Title, Name and Affiliation

Signature

Prof. Dr. Ahmed Rizk Abul'Wafa (Principal)
Electrical Power & Machines Engineering Dept.
Faculty of Engineering - Abbasya,
Ain Shams University

Assoc. Prof. Dr. Aboul'Fotouh A. Mohamed
Electrical Power & Machines Engineering Dept.
High Institute for Engineering - El-Shorouk city
El-Shorouk Academy

Date: 11/11/ 2015

STATEMENT

This thesis is submitted to Ain Shams University in partial fulfillment of the requirement for the M.Sc. degree in Electrical Engineering. The included work in this thesis has been carried out by the author at the Electrical Power and machine department, Ain-Shams University. No Part of this thesis has been submitted for a degree or a qualification at other university or institute.

Name: Bahaa Saad Mahmoud Bassuonie

Signature: *Bahaa Saad*

Date: 11 / 11 / 2015

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Thanks must go to Allah the creator of this universe who ordered us to study and explore his creations in order to know him better. However, as I come to understand more, I find that there is so much more knowledge to absorb and to get to grips.

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ABSTRACT

Nowadays, power systems obliged to operate near to their stability limits due to the continually increasing in power demand.

Power system operation close to its stability limits may lead to system instability and spread of the partial blackout. The integration of Distributed Generators (DGs) into the distribution power system is a promising option to improve the overall system performance by enhancing the system voltage stability and reduces the system power loss to mitigate the challenge of the system instability problem. However, DG units have to be optimally placed and sized, to achieve a positive impacts on the power system.

In this thesis, two algorithms are proposed for finding the optimal location and size of multiple DG units in the Radial Distribution Networks (RDNs) to improve the overall system performance. The first algorithm is an extended improved analytical method (**EX.IA**). And the second method is based on the new binary particle swarm optimization (**NBPSO**) as an intelligent method.

The proposed strategy implies the following main tasks: Voltage stability analysis to evaluate the voltage stability index (L_j) for each node, and the maximum value between (L_j) values will indicate the stability index of the system. Load flow analysis for computing node voltage requires for computing the (L_j) at the node j , and voltage stability enhancement to mitigate the voltage stability problem by applying the proposed solutions.

Voltage stability index calculation depends on the feasibility of power flow equations for each node. The indicator L is a quantitative measure for estimating the voltage stability margin for the current operating point. The value of indicator L is between **0** (no load) and **1** (voltage

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collapse). The lower value of indicator L means a larger voltage stability margin. Newton Raphson load flow algorithm is chosen to transact with the power flow analysis in RDNs.

The objective function of optimal allocation DGs in RDNs is to improve the system voltage stability and minimize system losses at minimum cost. Based on obtained results, it can assure that the proposed methods allocated the DG units to improve the system performance, and it is observed that the improvement of system voltage stability index is directly proportional to the maximizing of system loss reduction till reaching a specific point then the relation becomes inversely proportional; this specific point is depending on the DG unit size.

The proposed strategies are evaluated by being implemented on 33-node and 85-node IEEE test systems. The obtained results are presented and discussed. All the required software is developed using MATLAB m-files as a platform.

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