UNIVERSITI TEKNOLOGI MARA

ENHANCED VOLT-VAR OPTIMIZATION FOR ENERGY EFFICIENCY OF ELECTRICAL SYSTEM IN A LARGE BUILDING BY CONSIDERING THE PARTICLE SWARM OPTIMIZATION TECHNIQUE

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Customarily, shunt capacitors are often installed in electrical distribution networks for reactive power compensation which in turn will reduce power losses, voltage profile improvement and feeder capacity releases. This spurs into an idea of energy efficiency and energy saving improvement for an unbalanced electrical system in a large-scale commercial type building acquired via the power losses minimization under the concept of Volt-VAR optimization utilizing the capacitors for reactive power compensation and voltage regulators for the voltage magnitude control. However, finding optimal placement and sizing of voltage regulators and capacitors in a large-scale commercial type building having unbalanced electrical system involving an intricate and complex combinatorial optimization problem. In this thesis, a detail analysis of energy efficiency of unbalanced electrical system for large scale commercial type building has been performed with the integration of optimal placement and sizing of voltage regulators subsequent to capacitors (OPS-VRC). Particle Swarm Optimization (PSO) and Stochastic Optimization (SO) techniques have been used to determine the optimal location and sizing for voltage regulators and capacitors yielding to an improvement in terms of energy saving, power losses minimization and total cost investment for the installed equipment. Furthermore, the total cost of energy consumption, total cost of power losses, and voltage regulator as well as capacitor installation costs are the components considered in the objective function of the proposed optimization techniques indispensable to maximize the total energy saving for the unbalanced electrical power system in a large-scale commercial type building. Other than that, voltage magnitude limit, total harmonic distortion of voltage magnitude (THD_v), power factor, voltage regulator size and capacitor size are the parameters considered as the constraints for the proposed optimization techniques. In this study, the proposed technique of PSO and SO developed in the MATLAB® has successfully transferred the optimal sizing and placement of voltage regulators and capacitors to the SIMULINK® software. Simultaneously, the SIMULINK® software had performed the load flow solution for the unbalanced electrical system of a large-scale commercial type building and transferred the obtained results back to the MATLAB® software for further and detailed analyses. The results have shown that the proposed method of OPS-VRC based PSO provides a propitious amount of energy saving as well as power loss minimization with minimal investment cost whilst maintaining the power factor, voltage magnitude as well as total harmonic distortion without violating the limit specified by the utility according to Electricity Regulations 1994 and the standard MS IEC 60038:2006. Further comparison in the performance of OPS-VRC based PSO is performed with the newly designed of Stochastic Optimization and PSO for the optimal placement and sizing of capacitors (OPS-C), voltage regulators (OPS-VR), capacitors subsequent to voltage regulators (OPS-CVR), voltage regulators subsequent to capacitors (OPS-VRC) in order to verify effectiveness of the proposed methodology in providing energy efficiency improvement for a large-scale commercial type building.

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