UNIVERSITI TEKNOLOGI MARA

ENERGY EFFICIENCY OF AN UNBALANCED DISTRIBUTION SYSTEM BASED ON THE CONSERVATIVE VOLTAGE REDUCTION WITH OPTIMAL PLACEMENT AND SIZING OF CAPACITOR USING ANT COLONY OPTIMIZATION TECHNIQUE

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ABSTRACT

Energy efficiency can be achieved through reducing the loss of the power by using an adequate amount of power in an electrical distribution system. In this thesis, the energy efficiency is analysed based on an electrical distribution system along with the implementation of the Conservative Voltage Reduction (CVR), and the Optimal Capacitor Placement and Sizing (OCPS). In order to determine optimal location and sizing of the capacitors, Ant Colony Optimization (ACO) is implemented. The capacitors will ameliorate the energy efficiency through energy consumption and power loss minimization. Prior the ACO is implemented to solve OCPS, specific number of busbars is allocated. The Power-Loss-Index (PLI) is performed to achieve the pre-selection of busbar. Three variables will represent the objectives and fitness of the proposed optimization technique, which are, the total cost of power losses, energy consumption and capacitor installation. The parameters that are considered as the proposed optimization technique constraints are; the voltage magnitude limit, Total Harmonic Distortion (*THD*) limit, power factor limit and capacitor size limit. Conservative Voltage Reduction (CVR) is used to gain further enhancement of the energy efficiency. This is achieved through changing the transformer tap setting in order to lower and then retain the voltage magnitude at a specific level whilst ensuring the stability of the electrical distribution system. In this study, MATLAB® is used as a platform to implement the proposed methods. These techniques will firstly transfer the information, execute the three-phase unbalanced load flow solution and retrieve. Then it will collect the results or data from the three-phase unbalanced electrical distribution systems which are modeled in the SIMULINK® toolbox. The evaluation and the effectiveness of the conducted methods, in order to improve the energy efficiency, are verified through several case studies. The findings are collected from two test systems, IEEE 13-bus unbalanced electrical distribution system and the pragmatic electrical distribution system model of Sultan Salahuddin Abdul Aziz Shah (SSAAS) building in Shah Alam, Selangor. Finally, our proposed methodology has shown ability to reduce the cost utility bills of SSAAS building. Particularly, our methodology managed to reduce the cost of maximum demand in utility bills.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND AND SIGNIFICANCE OF RESEARCH

The definition of 'energy efficiency' is the usage of energy-frugal, prudent and wise. The main aims of using energy efficiency are to reduce the expenses, cost of living and avoid wastage thus will establish a beneficial service to the nature. The reduction of energy consumption, and the cost power generation will leads to reduce the use of fossil fuels and as well as the impact of harmful gas emissions to the environment. However, due to the instability of the fossil fuel in the world market, the companies based power generation intends to increase the utilities bill and this will hinder the initiative which intensity on the agenda of energy efficiency.

With the concern on the environmental effects, the Malaysian Prime Minister, Dato' Sri Najib Tun Razak had announced a pledge during the 2009 United Nations summit on climate change in Copenhagen. The pledge stated that Malaysia has a commitment to a 40% reduction in terms of greenhouse gas emission intensity of Gross Domestic Product (GDP) by the year 2020 comparing to another information published in 2005 [1]. Apart from that, the 10th Malaysian Plan (2011-2015) under Energy Policies has emphasized on the energy efficiency as one of the most important agenda [2]. This corroborated by several number of organized programmes, such as the SAVE programed (rebate for selected energy efficient electrical appliances), formulation of Energy Efficiency Master Plan, Energy Labeling and Minimum Energy Performance Standards (MEPS), and Green Building Index (GBI).

There are several issues or problems which incite to an inefficient consumption of energy in the distribution systems, such as the harmonic. Harmonics in power systems may lead to the increase of heating in the equipment and conductors. The installation of shunt capacitors, without considering the existence of harmonic source in the distribution system, may cause an increasing in the harmonic distortion levels due to the resonance between capacitors and inductive element in the system [3]. The production of the harmonic in a distribution system is hard to be controlled. It is