UNIVERSITI TEKNOLOGI MARA

OPTIMAL LOAD MANAGEMENT STRATEGY FOR ENHANCED TIME OF USE (ETOU) ELECTRICITY TARIFF IN PENINSULAR MALAYSIA

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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

In Peninsular Malaysia, enhanced time of use tariff (ETOU) has been introduced to encourage commercial and industrial consumers to reduce electricity use through demand side management. However, less numbers of consumers participate in the programme due to lack of know-how to implement efficient load management (LM) strategies. In addition, various consumers' load profiles among different type of electricity consumers have led to the need of a selection method to determine the best load management strategy for a specific consumer. Meanwhile, deciding optimal load management weightage was another challenge faced by consumers, since critical loads should not be disturbed for daily operation. For that reasons, an optimal load management strategy was proposed in this study for Categories C1 (commercial medium voltage) and E1 (industrial medium voltage) consumers. Particle swarm optimization (PSO), evolutionary particle swarm optimization (EPSO), and ant colony optimization (ACO) algorithms were applied to optimize the simultaneous LM strategies of peak clipping, valley filling and load shifting in order to minimize the energy consumption and maximum demand costs, and improve economic indexes such as load factor and building economic efficiency response. Bio-inspired optimization techniques were chosen because of their proven capability in solving non-linear problem. Self-organizing mapping algorithm was integrated with the PSO, EPSO, and ACO algorithms to classify and select the best load management (LM) strategies. A novel method was developed by integrating a modified energy audit procedure with decision tree technique to determine the percentage of controlled loads available for LM, and the optimal LM weightage. The 31 and 11 numbers of load profiles for universities and electronic related manufacturing were conducted as the cases of study for the load management strategy formulation and selection investigation. Meanwhile, for the optimal load management weightage, case studies were conducted for a specific university campus and an electronics manufacturing facility in Peninsular Malaysia, where the tariff price under the current flat tariff were transformed to those under the ETOU tariff. For Category C1 consumers, simultaneous strategy of peak clipping, valley filling, and load shifting were best at a LM weightage of 10 and 50%. For Category E1 consumers, these strategies were best at a LM weightage of 10, 20, and 50%. The results of the specific case study for a university campus and electronic manufacturing has shown that; the integration of energy audit procedure with decision tree technique is able to define the percentage of the controlled load in the buildings that available for LM. Based on the output of the controlled load assessment, the optimal weightage of LM was identified. By which, simultaneous strategies of the peak clipping, valley filling and load shifting worked well to reduce energy consumption and maximum demand costs for the industrial case study. As overall, the optimal LM strategies under ETOU tariff scheme will benefit both commercial and industrial consumers in reducing approximately 5–11% of their monthly total electricity bills.

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