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A rule based electrical energy distribution model for energy efficiency in technical institutions: A case study

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ABSTRACT

The effective and efficient utilization of electrical energy is the outcome of smart energy management system. Moreover, appropriate augmentation of renewable energy alternatives through distributed generation can considerably unburden the power utility system. This paper identifies the scope for the rule based approach to develop an energy efficient utilization model for bulk power consumers. The augmentation of distributed power generation using solar PV has also been proposed which considerably reduces the maximum demand (M.D) of power during peak hours. The distributed generation from solar PV for this case-study uses minimum storage battery as the generation schedule and the load schedule often coincides. The portfolio of energy distribution is formulated based on priority of energy demand. The proposed model can be suitably modified for similar type of load centers including industrial loads.

1. Introduction

The gap between electrical energy demand and supply is widening day by day. The growing population and urbanization creates huge burden on limited power and natural resources. Moreover, misuse of electrical power is a global concern in terms of environmental and climate change issues [1]. Efficient usage of available energy is a potential area of study for many researchers in recent past to provide an appropriate and cost effective methodology which can be easily implemented in practical system.

A smart building energy management system (BEMS) has been proposed in [2] based on optimum usage of energy. The scheme can be further improved through the efficient replacement of inefficient devices in a cost effective manner. Moreover, the renewable energy utilization in the building structures through distributed generation can be an added advantage for the BEMS. The reduction of active power demand at load point through electrical energy storage facility has been reported in [3]. However, the maintenance and replacement schedule for the storage systems are not cost effective and environment friendly. Rescheduling of the non-vital loads during the peak hours is another step in this direction to create a positive impact on consumer's electricity bill as well as on the power delivery system [4,5]. Due to unscheduled load management, there is poor utilization of the energy generated from renewable sources through distributed generation schemes [6]. Therefore, proper selection of type and capacity of renewable energy augmentation is highly essential for smart energy management systems [7]. An integrated scheduling of the multiple energy supply sources to meet the building energy demand has been proposed in [8]. However, coordination and control is complex for implementation in case of individual load centers which leads to higher operating cost. Effective research is going on from last few decades to come up with a cost effective solution for integration of non-conventional with conventional energy resources. In this regards the proposed schemes reported in [9–11] can be utilized to reduce huge burden as well as congestion on deregulated power system. However, the proposed schemes are not cost effective due to usage of large storage battery.

The main features of the proposed work can be summarized as follows;

1. Design of a simple and cost effective electrical energy efficient load model through a rule based approach.
2. Improving the technique for reduction of the maximum demand through appropriate renewable distributed generation augmentation with usage of minimum storage battery.

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2. Proposed strategy

2.1. Methodology

There always exist a huge scope for energy savings in technical institutions through optimized operation and effective management without changing the existing civil and electrical infrastructures. A systematic management approach is highly essential to develop an energy efficient load model and implementation of the same in a cost effective manner. However, the execution of such programs must be carried out through multidimensional predefined objectives. For the proposed efficient model, the objective has been outlined and achieved through a rule based approach referred as optimum load allocation chart. The presented work not only highlights the energy efficiency but also describes the methodology for smoothening of the load curve. The unburdening of the utility supply through an appropriate renewable distributed generation can be an added advantage which has been discussed in the proposed work. The organization of optimum load allocation chart has been described in Fig. 1. The objective of the proposed chart is to provide a common platform for efficiency optimization of all types of load. In addition to achieving the said objective, it aims to unburden the utility to enhance the overall performance of the power system. Detailed analysis of the connected load is the first step of energy auditing process. However, such energy audit needs the complete information of energy usage pattern of each individual load. Scope for energy saving can be identified at this stage by comparing the load curve with existing load and that with efficient alternatives.

Though, there may be scope for energy savings in multiple categorized loads, the efficiency program must be implemented on priority basis and in a phase wise manner while taking the cost effectiveness into account. For easy and convenient prioritization process, Pareto analysis has been considered for this proposed rule based model. The break-even points and respective replacement options has to be determined for the implementation of the project. Moreover, leveling of the modified load profile can be an added advantage. The strategy for minimizing the maximum demand can be “shave the peak, and fill the valley” without compromising the comfort level of the end users. Augmentation of renewable distributed generation with the load centre not only improves the reliability and efficiency of the system but also helps to unburden the utility.

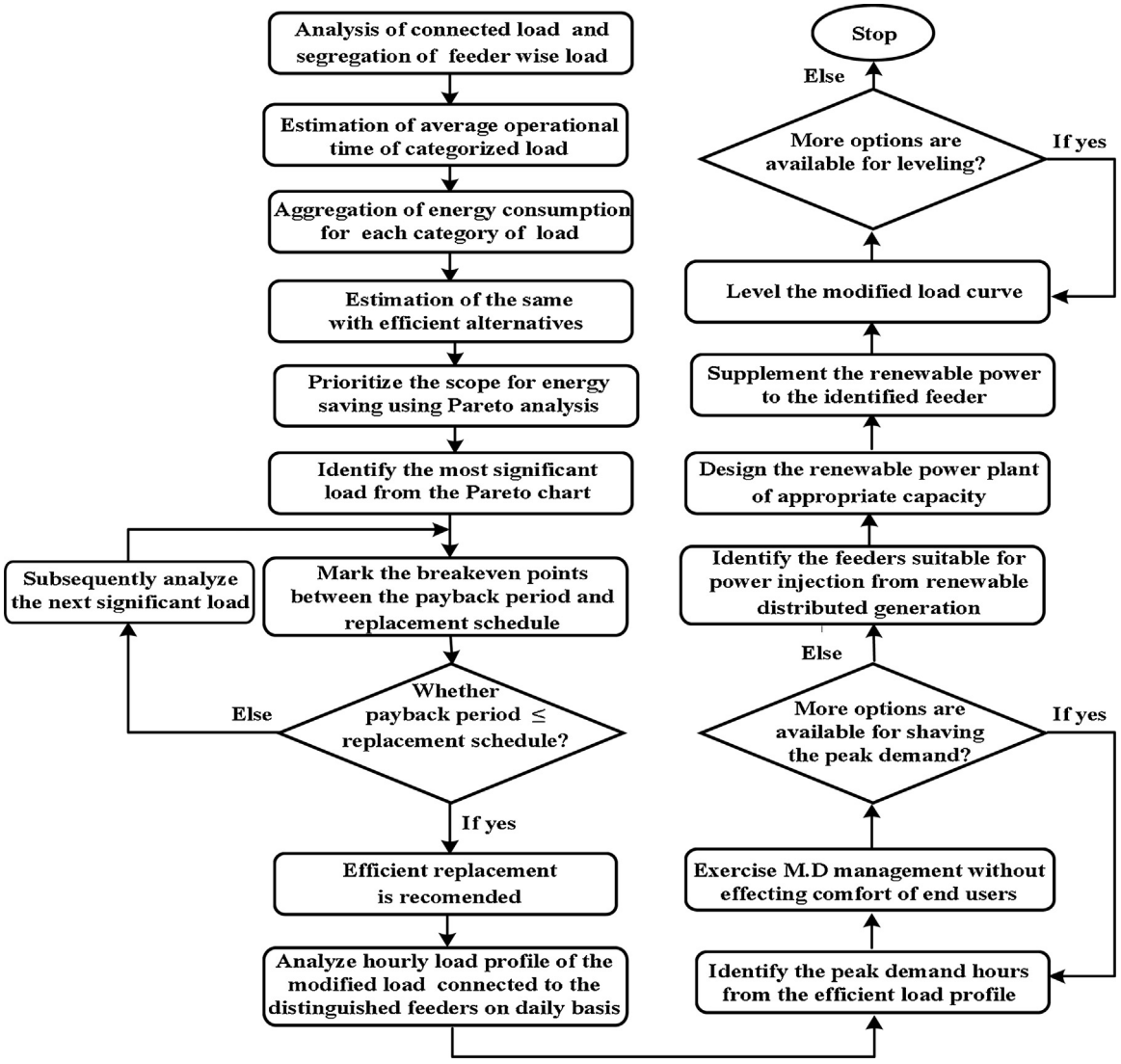

Fig. 1. The proposed optimum load allocation chart.