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Technological Advancement of Energy Management Facility of Institutional Buildings: A Case Study

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Abstract

An efficient energy management system in commercial/institutional buildings can reduce energy consumption and operational cost and provide a comfortable and healthy indoor environment. However, without incorporating energy-efficient technologies and analysing the resulting performance the building energy management system may not provide effective control over energy consumption and the indoor environmental conditions. To verify system performance, it is necessary to study the building energy efficiency, examine building indoor environment and investigate existing operational strategies. This can eventually give the actual energy scenario of the building exploring problems existing within the system and opportunities for further upgrade paths that are both technologically and economically sustainable. To get the actual scenario of building energy management facilities, an institutional building of Murdoch University, Australia that incorporated state of the art technologies in the last two decades will be studied in this paper. Through this case study analysis salient information is revealed that will bring benefits to the energy management personnel as well as researchers in this area.

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Keywords: Energy Management System (EMS); Energy Consumption; Indoor environment; Institutional Building.

1. Introduction

Efficient energy management strategies can play an important role in controlling and monitoring energy usage as well as improving building indoor environment in commercial and institutional buildings. Research shows that implementing efficient energy management strategies can lead to 5-15% energy savings in existing buildings [1]. This significant percentage of energy saving opportunity has heightened attention among policymakers and researchers with a view toward increasing energy efficiency and reducing GHG emissions in buildings [2, 3].

The technology of building energy management system (BEMS) is getting sophisticated with time enabling better control over energy consumption, healthy and comfortable indoor environments and reducing operational cost [4].

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Heating, ventilation and air-conditioning (HVAC) system controlled by BEMS is a major contributor to energy consumption in commercial and institutional buildings. Historically HVAC systems were used to maintain the satisfactory thermal comfort level inside the building, lately the need for providing visual comfort to the occupants and preserving indoor air quality has increased especially with the revolution of technology [5]. This competing requirement of HVAC system demands effective and efficient operation to improve the energy efficiency, thermal and visual comfort level and indoor air quality.

In fact, a potential for energy savings resides in the use, control and interaction of appliances and domestic devices, in order to get their maximum efficiency during normal operation [6]. And the contribution of energy management system (EMS) in this regard is unescapable. However, BEMS are often incorrectly regarded as a fit and forget system. An efficient BEMS can turn into an inefficient one without a routine basis maintenance and upgrade [7]. Therefore, it is the demand of efficient EMS to upgrade after reasonable time interval to maintain consistent performance [1]. This technological advancement of BEMS must comply with Energy Management Control (EMC) legislation and more importantly, keep pace with any modifications to the building structure. To evaluate the effectiveness of any EMS and its existing strategies, it is very important to study the performance of energy consumption, examine building indoor environment and investigate existing operation strategies. However, building energy performance and indoor environmental condition depends on building specific information such as geographic location, building type, size, age, occupancy schedule, operation and maintenance, energy sources, utility rate structure, building fabric, service systems, etc [7]. Therefore, this information can guide in future for optimal retrofit solutions or upgradation opportunities. One of the good ways of collecting this information is performing preliminary case study. Through case study analysis it is possible to evaluate if the operation results are satisfying design expectations and to identify opportunities to improve the energy efficiency that will lead to sustainable building energy consumption [8, 9].

Murdoch University Energy Management system established in 1974 has been upgraded on need basis with efficient equipment and advanced control system to ensure efficient performance and to maintain economically viable operational cost. This research will study the EMS of this University to understand the chronological development of building energy management technology and its application to energy management facilities in institutional buildings. The aim of this study is to identify if there is any scope for improving the performance of the existing HVAC system and the energy efficiency of the study building that is technologically and economically sustainable. To achieve the goal this study will collect the building specific information, investigate the operational strategy of AHU of the study building, gather information about operation, maintenance and upgradation history of the energy management facility of University, examine the strategy of existing HVAC control system and identify problems existing within the system. Based on preliminary case study analysis some possible upgradation opportunities will be revealed in this study that are apparently technologically and economically sustainable. These opportunities will be assessed in further studies to quantify the economic and indoor environmental benefits. The benefits achieved through resulting upgradation of the EMS of Murdoch University will be also quantified in further studies through data analysis to determine the economic and environmental outcome of applied technology.

2. Methodology of investigation

The methodology of investigation has been selected and developed based on the aim of this case study. This study performed a survey of the energy management system of an institutional building facility through a process of studying necessary documents, reviewing the Building Management system via the Graphical User Interface (GUI) and performing walk through audit of the energy management facility. The flow chart as shown in Figure 1 depicts the consecutive approaches to achieve the goals.