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# Assessing the Impact of Integrated Building Management Systems on Energy Reduction and Sustainability Initiatives in a Selected Sydney Hotel

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## Abstract

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This study analyses the effectiveness of Integrated Building Management Systems (iBMS) as an option to reduce Greenhouse Gas (GHG), such as carbon emissions and improving energy consumption in a hotel building within the busy urban areas of Sydney, Australia. In this research, a case study approach using quantitative data was employed to provide a comprehensive assessment. By time series analysis, 12-months worth of energy consumption data during pre- and post-implementation of iBMS in the selected hotel has been calculated and analysed using percentage reduction formula to identify whether there is a significant impact of implementing iBMS in reducing energy consumption. Although the system may require a considerable upfront costs, the overall benefits in a longer term fulfill its intended objectives. Since commissioning iBMS, the findings indicate a significant reduction in electricity and gas consumption, as well as carbon (GHG) emissions one year's time, by around 16, 18 and 21 percent respectively, which is on track in comparison with similar studies in other regions.

**Keywords:** iBMS; energy consumption; sustainability; hotel; Sydney.

## 1. Introduction

Seventy percent of greenhouse gas emissions (GHG) globally is mainly caused by urbanisation and human activities (UNEP, n.d.) and is now an alarming issue, while 80% of GHG emissions in Sydney, Australia come from buildings, according to the Environmental Strategy 2021-2025 (City of Sydney, 2021). Reduction of GHG emissions up to 70% by 2030 and being net zero by 2050 is the target set by the City of Sydney. For existing buildings, particularly those 25 years and older, stronger requirements were implemented by the City. They mandated these buildings to disclose environmental performance ratings from the National Australian Built Environment Rating System (NABERS) as a baseline. Immense pressure was put on the hospitality establishments to adopt sustainable practices, food waste reduction, and energy saving initiatives while still providing a luxury experience to guests.

Integrated Building Management System (iBMS) is one initiative that provides a solution to enhance sustainability ratings by commissioning centralised control and monitoring to reduce and conserve energy. Some earlier studies show that post implementation of iBMS improved energy saving consumption in commercial buildings, with the precise control and monitoring of iBMS being attributed with the reduction (Salami et al. 2024). Their findings revealed that integrating iBMS into the hotel buildings leads to substantial operational cost reductions and significantly improves its environmental performance and green ratings despite the high upfront investment.

While iBMS provides significant benefits for hotels and commercial buildings, there are some factors to consider when integrating the system. The system requires practitioners who are knowledgeable on utilising iBMS and can provide proactive maintenance in order to reach the system's full potential and achieve the best results (Kumara, Waidyasekara and Weerasinghe, 2016). The system also comes with a high upfront cost; while it can provide benefits and improvements overtime. Additionally, there are also risks of data privacy and cyber-attacks that come with iBMS.

As iBMS is a promising solution in taking a step to help achieve reduction of energy consumption and GHG emissions targets set by the City of Sydney in its Environmental Strategy 2021-2025, this research assesses the impact of iBMS on energy reduction and sustainability initiatives in a selected hotel in Sydney. This aims to provide

valuable insights to Sydney hotel managers, facilities managers, and engineering managers the extent to which commissioning iBMS is a sustainable and cost-saving capital expenditure. With improving energy efficiency in hotel buildings being the main goal, implementation of iBMS provides the direction in achieving this while also providing other benefits such as reducing operational costs and improving the overall guest experience.

Although there are existing and valuable studies relating to the impact of iBMS on energy reduction and sustainability, there may be a knowledge gap in understanding how iBMS impacts Australia's hospitality sector, particularly for heritage buildings aged 30 years and above. Moreover, an intensive cost-benefit analysis of commissioning iBMS in the hospitality sector and assessing the financial implications of pursuing this project, in terms of energy-cost savings versus capital expenditure, is needed, as existing studies often overlook the occupancy rate and marketability factors in Sydney, Australia. The aim of this study is to determine how does the implementation of iBMS impact energy and gas consumption as well as carbon emissions in a selected hotel in Sydney and if the hotel's sustainability performance has been improved by comparing the pre- and post-implementation of iBMS in the hotel building.

## 2. Material and Methods

### 2.1 Research Approach

This research employs a quantitative case study design focused on a single selected Sydney hotel. The hotel has been selected for easy accessibility as the first author of this article could directly collect the relevant primary data from this particular hotel management as a part of their Masters study program. The full name of the hotel has not been disclosed for discretion purposes, and will be referred to the pseudonym 'SYDMC' in this paper. The particular hotel was selected as they have been implementing iBMS since November 2022. Further, it was convenient for the first author to collect data as they know someone who works for the hotel and have agreed to share their data on the condition of anonymity. The case study approach was selected as it allows for an in-depth examination of iBMS implementation in a real-world context, providing valuable insights into the practical effects of this technology within the hospitality sector.

### 2.2 Research Design

The study utilises a pre-post comparative analysis methodology, examining quantitative energy consumption data from two distinct 12-month periods: before iBMS implementation (2021-22) and after iBMS implementation (2023-24). This comparative approach allows for direct assessment of the impact of the intervention (iBMS implementation) on key metrics including electricity consumption, gas consumption, and carbon emissions. The 12-months worth of energy consumption data from the pre-implementation and post-implementation of iBMS versus actual energy bills were verified through threshold variance of less than 5% to ensure data accuracy and to remove incomplete data within a data set.

### 2.3 Statistical Techniques for Data Analysis

The validated 12-months' worth of data on energy consumption and carbon emissions of the selected hotel during pre- and post-implementation of iBMS was examined using time series analysis to determine which factors affect demand. The Australian Bureau of Statistics (2023) defines time series analysis as a collection of observations of well-defined data items obtained through repeated measurements over time. The significant value of energy reduction, electricity and gas, was calculated based on the following equation:

$$\text{Percentage Reduction} = \left( \frac{\sum E_{\text{Pre}} - \sum E_{\text{Post}}}{\sum E_{\text{Pre}}} \right) \times 100\%$$

Where,  $\sum E_{\text{Pre}}$  is the summation of the 12-months total energy pre-implementation and  $\sum E_{\text{Post}}$  is the summation of the 12-months total energy post-implementation of iBMS. Based on the above equation, the percentage reduction was derived. If the results showed more than 15% reduction in terms of energy reduction and carbon emissions reduction, then it indicated there was a significant impact of iBMS integration on energy reduction and sustainability initiatives in the selected Sydney hotel, which aligns with similar studies in other regions.

## 3. Results and Discussion

### 3.1 Energy end-use breakdown

The energy end-use breakdown is an estimation or average of the consumption of each end-use, which is compiled from a list of equipment with kW (Kilo Watt) ratings and estimations of run time and loading factors. The energy end-use breakdown for electricity is summarised in Figure 1. The largest end use is fans (22%). The chillers (17%) and pumps (16%) also consume a significant portion of the energy. Consumption by lighting (11%), electric heating (5%), lifts (9%) and guest room appliances (7%) make up most of the remaining consumption. Since the implementation of the iBMS, SYDMC projects have primarily focused on the assets that contribute to the 80% energy end-use equipment. The iBMS also allows the facility management staff to have direct and centralised control of the building systems. The BMS homepage displays fans, boilers, chillers and cooling tower operation and allows control over schedules, lighting, power, alarms and air quality (Kamali & Hajiabadi, 2014).

### 3.2 Electricity Consumption

The SYDMC hotel electricity consumption for 12 months in 2021-22 was 5,029,527 kWh. During this period, consumption was lowest in November 2021 at 324,412 kWh and was highest in July 2022 at 488,616 kWh, and the

monthly average consumption was 419,127 kWh. In 2023-24, the SYDMC hotel electricity consumption for 12 months was 4,195,739 kWh. During this period, consumption was lowest in November 2023 at 268,109 kWh and highest in January 2024 at 404,653 kWh, and the monthly average consumption was 349,645 kWh. The higher consumption of electricity occurred during the summer time (December to February) in Sydney due to large cooling loads. The electricity consumption data on pre- and post-implementation of iBMS is shown in Table 1 and Figure 2. It is to be noted that the pre-implementation data was collected from September 2021 to August 2022, and the post-implementation data was collected from February 2023 to January 2024. For ease of comparison, the months within these time frames have been compared. Given the percentage reduction formula, where  $\sum E_{Pre}$  is 5,029,527 kWh and  $\sum E_{Post}$  is 4,195,739 kWh, the percentage reduction in electricity consumption is 16.58%. This indicates that the commissioning of iBMS in SYDMC has successfully reduced its electricity consumption in 2023-24.

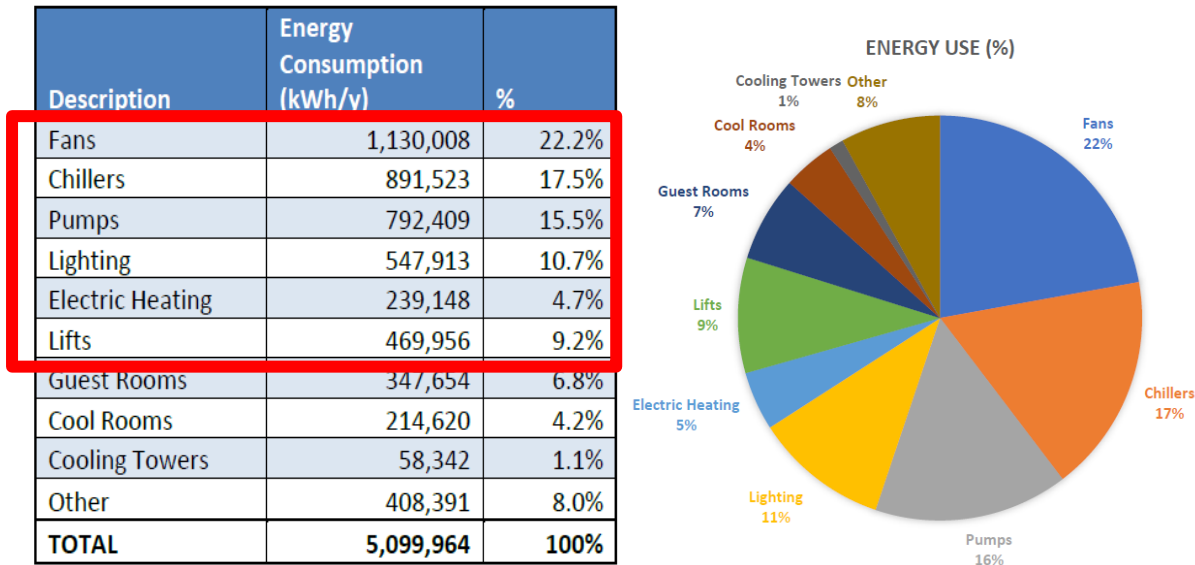


Figure 1. SYDMC Energy End Use Breakdown.

Table 1. Electricity Consumption for SYDMC pre- and post-implementation of iBMS.

Month	Total Energy (kWh) Pre-implementation (2021 & 2022)	Total Energy (kWh) Post-implementation (2023 & 2024)	Difference (kWh)	Percentage Difference
January	453,211	404,653	48,558	10.71%
February	400,227	357,346	42,881	10.71%
March	456,134	380,112	76,022	16.67%
April	427,610	342,088	85,522	20.00%
May	445,596	362,273	83,323	18.70%
June	461,035	384,196	76,839	16.67%
July	488,616	381,731	106,885	21.88%
August	469,620	375,696	93,924	20.00%
September	342,602	280,821	61,781	18.03%
October	341,352	294,269	47,083	13.79%
November	324,412	268,109	56,303	17.36%
December	419,112	364,445	54,667	13.04%
<b>TOTAL</b>	<b>5,029,527</b>	<b>4,195,739</b>	<b>833,788</b>	<b>16.58%</b>

3.2 Gas Consumption

The SYDMC hotel gas consumption for 12 months in 2021-22 was 12,695 GJ (Giga Joules). For this period, consumption was lowest in January 2022 at 524 GJ and was highest in July 2022 at 1,914 GJ, and the monthly average consumption was 1,058 GJ. In 2023-24, the hotel gas consumption for the 12 months was 10,389 GJ. For this period, consumption was lowest in January 2024 at 452 GJ and was highest in July 2023 at 1,622 GJ with a maximum consumption was 1,622 GJ and minimum consumption was 452 GJ, and the monthly average consumption was 866 GJ. Given the percentage reduction formula, where  $\sum E_{Pre}$  is 12,695 GJ and  $\sum E_{Post}$  is 10,389GJ, the percentage reduction in gas consumption was 18.16%. Hence, the commissioning of iBMS in SYDMC has reduced its gas consumption in 2023-24. It is notable that the higher gas consumption occurred during the winter season due to heating load demand. The gas consumption data on pre- and post-implementation of iBMS is shown in Table 2 and Figure 3.

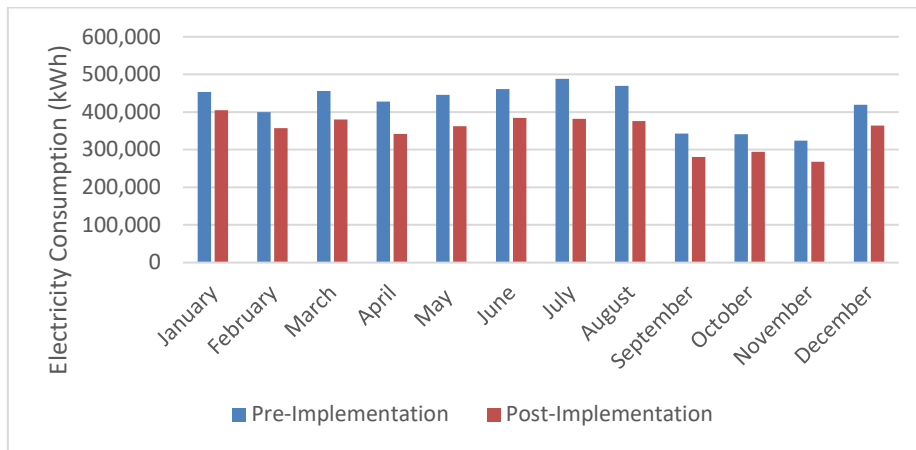


Figure 2. Electricity Consumption for SYDMC pre- and post-implementation of iBMS.

Table 2. Gas Consumption for SYDMC pre- and post-implementation of iBMS.

Month	Total Gas (GJ) Pre-implementation (2021 & 2022)	Total Gas (GJ) Post-implementation (2023 & 2024)	Difference (kWh)	Percentage Difference
January	524	452	72	13.74%
February	589	503	86	14.60%
March	651	543	108	16.59%
April	755	604	151	20.00%
May	851	630	221	25.97%
June	1,151	921	230	19.98%
July	1,914	1,622	292	15.26%
August	1,891	1,513	378	19.99%
September	1,470	1,205	265	18.03%
October	1,254	1,045	209	16.67%
November	1,047	865	182	17.38%
December	598	486	112	18.73%
<b>TOTAL</b>	<b>12,695</b>	<b>10,389</b>	<b>2,306</b>	<b>18.16%</b>

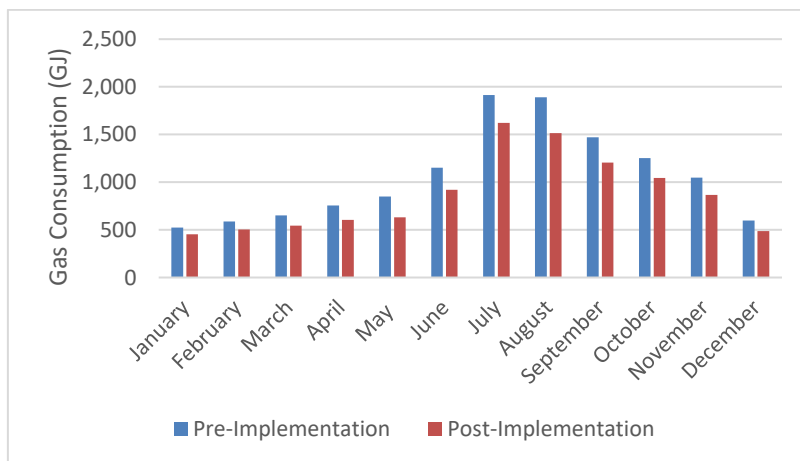
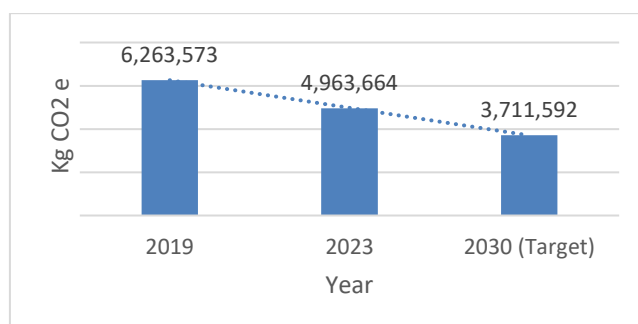


Figure 3. Gas Consumption for SYDMC pre- and post-implementation of iBMS.

The findings of the energy conservation rates for SYDMC was compared with some other similar studies. Digitemie and Ekemezie (2024) reports a 15% reduction in energy consumption in Microsoft's campus in Redmond, Washington and a 20% reduction in energy consumption in the University of California, Berkeley's, campus buildings, which implemented a Building Energy Management System, similar to iBMS. Further, in Salami et al. (2024) research results show that Eko Hotels & Suites achieved a 20% reduction in overall energy consumption by integrating a high-performance building envelope, Variable Speed Drives for Heating, Ventilation and Air Conditioning (HVAC) systems, and by implementing a BMS. Therefore, the energy reduction rate of the selected hotel in this particular study resembles with the findings of some previous studies on the impact of implementing iBMS. Thus from the results on electricity and gas consumption reduction rate, it can be considered that SYDMC is on track in achieving the benefits from iBMS.

### 3.3 Carbon emissions

Between the years 2019 and 2023, in SYDMC there has been a reduction of carbon (GHG) emissions of 1,252,072 kgCO<sub>2</sub>e, which is a drop of by approximately 21%. It is apparent that the commissioning of iBMS in SYDMC has contributed to achieving this reduction of carbon emissions, which is illustrated in Figure 3 along with their target emission of carbon by 2030. This gradual reduction of carbon emissions is comparative to the hotel's electricity and gas consumption reduction pattern.



**Figure 6.** SYDMC Carbon (GHG) emissions reduction rate.

### 4. Conclusions

Overall, this study has assessed a positive impact of iBMS application on energy reduction and thus the sustainability initiatives in a selected hotel located in the City of Sydney. By calculating the percentage reduction of electricity and gas consumption, and carbon emissions, it evidently showed that the iBMS implementation has a significant impact in energy reduction and sustainability initiatives. The selected hotel has reduced its electricity consumption by 16.58%, gas consumption by 18.16%, and carbon emissions by 21 % in one year's time after commissioning the iBMS in November 2022. The findings reveal that the sustainability initiative of integrating the iBMS to the hotel buildings not only leads to the reduction of operational costs, but also significantly improves environmental performance. Furthermore, the findings of the study would support the building facilities managers for the maintenance and equipment optimisation and project initiatives such as securing green building grants, supporting the City of Sydney's Environmental Strategy 2021-2025, and improving hotel marketability and appeal by attracting guests who prioritise environmental sustainability. However, it is recommended that the future research considers the occupancy rates, degree days, and financial costs as variables in its data analysis as the peak heating and cooling demands can affect the energy load requirements. This may show a relationship between temperatures and maximum daily demand that could affect the energy consumption.

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### Conflict of Interests

The authors declare that there is no conflict of interest.

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