Energy Efficient Technology and Sustainability of Hotel Businesses in Cross River State

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Abstract
The purpose of the study was to examine the effect of energy-efficient technology on the sustainability of hotel businesses in Cross River State. The specific objectives were to: determine the effect of energy-efficient lighting systems on the sustainability of hotel businesses; examine the effect of smart energy management systems on the sustainability of hotel businesses; assess the effect of renewable energy adoption on the sustainability of hotel businesses. This study adopted conceptual review. Information was gathered using textbooks, journals, published and unpublished journals, libraries and internet applications. Based on conceptual review, it was found thus: Energy-efficient lighting systems have a positive effect on the sustainability of hotel businesses in Cross River State. Smart energy management systems have a positive effect on the sustainability of hotel businesses in Cross River State. Renewable energy adoption has a positive effect on the sustainability of hotel businesses in Cross River State. The study recommended that hotel operators should invest in energy-efficient lighting systems such as LED bulbs and motion-sensor lighting to reduce electricity consumption, lower operating costs, and improve the sustainability of their businesses. Also, hotel management should adopt smart energy management systems that enable real-time monitoring and control of energy usage. This will enhance operational efficiency, minimize energy wastage, and support long-term sustainability goals.

Keywords: *Energy-efficient technology, energy-efficient lighting systems, smart energy management systems, sustainability*

Introduction

Energy-efficient technology has become an essential component of sustainable business operations in the hospitality industry due to increasing energy costs, environmental concerns, and growing stakeholder expectations for responsible business practices. Hotels are among the highest energy-consuming establishments within the service sector because of their continuous dependence on lighting systems, air-conditioning, heating, refrigeration, laundry facilities, and other guest-support services. As a result, hotel operators are increasingly adopting energy-efficient technologies such as smart energy management systems, LED lighting, automated building

controls, occupancy sensors, and renewable energy solutions to reduce energy consumption and improve operational efficiency. Studies have shown that these technologies contribute significantly to cost reduction, environmental conservation, and long-term business sustainability (Khatter, 2025; Parvez *et al.,* 2026). The concept of sustainability in hotel businesses encompasses the ability of organizations to achieve economic viability while maintaining environmental responsibility and social well-being. In recent years, the hospitality industry has witnessed a significant shift toward green and sustainable practices as governments, customers, and investors increasingly demand environmentally responsible operations. Research indicates that energy conservation has become one of the most important sustainability strategies in hotels because energy consumption accounts for a substantial proportion of hotel operating expenses and carbon emissions (Sahu & Haider, 2026). The adoption of green technologies enables hotels to minimize waste, reduce greenhouse gas emissions, optimize resource utilization, and enhance their corporate image, thereby strengthening their competitive advantage and long-term survival. Furthermore, technological innovations have transformed sustainability practices in the hospitality sector by integrating digital solutions with environmental management objectives. Advanced technologies such as artificial intelligence-based energy monitoring systems, smart HVAC controls, automated lighting systems, and Internet of Things (IoT) applications enable hotels to monitor and regulate energy usage more effectively. These innovations not only reduce energy waste but also improve service quality and guest satisfaction. According to Israni and Hanrahan (2026), energy reduction technologies serve as catalysts for sustainable hotel operations by supporting digital transformation and improving overall organizational efficiency. Similarly, Parvez et al. (2026) found that green technology adoption positively influences environmental sustainability and operational performance within hotel establishments. In Cross River State (CRS), hospitality and tourism remain important contributors to economic development, employment generation, and revenue creation. The state is home to several tourist destinations, including Obudu Mountain Resort and Tinapa Business and Leisure Resort, which attract visitors from within and outside Nigeria. However, many hotel businesses in the state continue to face challenges such as high energy costs, unreliable electricity supply, and increasing operational expenses. These challenges threaten the sustainability and profitability of hotel operations. Consequently, the adoption of energy-efficient technologies has become a strategic necessity for hotels seeking to reduce operating costs, improve environmental performance, and ensure long-term sustainability. Evidence from recent hospitality studies suggests that energy-efficient systems, smart building technologies, and net-zero energy initiatives can significantly improve hotel sustainability outcomes and business resilience. Therefore, investigating the relationship between energy-efficient technology and the sustainability of hotel businesses in Cross River State is timely and important. Such a study will provide valuable insights into how technological innovations can enhance operational efficiency, reduce environmental impacts, strengthen competitiveness, and support the long-term sustainability of hotels within the state's growing hospitality industry. The sustainability of hotel businesses has become a major concern in recent years due to rising energy costs, increasing environmental regulations, and growing customer demand for environmentally responsible services. Hotels are highly dependent on energy for lighting, air conditioning, heating, refrigeration, and other operational activities, making energy consumption one of the largest components of their operating expenses. In Cross River State, many hotel businesses continue to experience challenges associated with high energy costs, unreliable power supply, and excessive dependence on fossil-fuel-powered generators, which increase operational costs and negatively affect profitability and environmental sustainability. Despite the growing awareness of energy-

efficient technologies such as smart energy management systems, LED lighting, energy-efficient appliances, and renewable energy solutions, the extent to which these technologies contribute to the sustainability of hotel businesses in Cross River State remains unclear. Many hotels have been slow in adopting energy-efficient technologies due to financial constraints, inadequate technical expertise, and limited awareness of their long-term benefits. This situation may undermine efforts to achieve operational efficiency, environmental conservation, and long-term business survival. Therefore, there is a need to examine the relationship between energy-efficient technology and the sustainability of hotel businesses in Cross River State. Specifically, the study seeks to determine how the adoption of energy-efficient technologies influences the economic, environmental, and operational sustainability of hotel businesses in the state.

Theoretical framework

This study is anchored on the Ecological Modernization Theory (EMT) and the Resource-Based View (RBV) Theory. These theories provide a suitable foundation for explaining how the adoption of energy-efficient technologies can enhance the sustainability of hotel businesses in Cross River State.

Ecological Modernization Theory (EMT)

Ecological Modernization Theory was developed by Joseph Huber (1985) and further advanced by Mol and Spaargaren (2000). The theory posits that environmental protection and economic development are not mutually exclusive but can be achieved simultaneously through technological innovation, institutional reforms, and sustainable production practices. Ecological Modernization Theory emphasizes the role of modern technologies in addressing environmental challenges while promoting organizational growth and competitiveness. The theory argues that organizations can improve their environmental performance through the adoption of cleaner and more efficient technologies. In the hospitality industry, energy-efficient lighting systems, smart energy management systems, and renewable energy technologies represent environmentally friendly innovations capable of reducing energy consumption, minimizing carbon emissions, and enhancing resource efficiency. Through the implementation of these technologies, hotels can achieve sustainability objectives while maintaining profitability and operational effectiveness.

The relevance of Ecological Modernization Theory to this study lies in its assertion that technological innovation serves as a catalyst for sustainable development. The theory provides a framework for understanding how energy-efficient technologies can contribute to the environmental, economic, and operational sustainability of hotel businesses in Cross River State. Since the study focuses on the relationship between energy-efficient technology and sustainability, Ecological Modernization Theory offers a direct explanation of how technological advancement can improve sustainability outcomes within the hospitality sector.

Resource-Based View (RBV) Theory

The Resource-Based View Theory was propounded by Wernerfelt (1984) and further developed by Barney (1991). The theory maintains that an organization's ability to achieve sustainable competitive advantage depends on its possession and effective utilization of valuable, rare, inimitable, and non-substitutable resources. According to the theory, internal resources and capabilities are the primary drivers of organizational performance and long-term success. From the perspective of the hospitality industry, energy-efficient technologies constitute strategic organizational resources that can improve operational performance and sustainability. Investments

in energy-efficient lighting systems, smart energy management systems, and renewable energy technologies provide hotels with capabilities that reduce energy costs, improve operational efficiency, and enhance environmental performance. These benefits enable hotel businesses to strengthen their competitiveness and achieve long-term sustainability.

The Resource-Based View Theory is relevant to this study because it explains how energy-efficient technologies function as valuable organizational resources that contribute to sustainable business performance. The theory supports the argument that hotels that effectively adopt and manage energy-efficient technologies are more likely to achieve superior sustainability outcomes than those relying on conventional energy systems. Therefore, RBV provides a useful lens for examining the contribution of energy-efficient technology to the sustainability of hotel businesses in Cross River State. Among the two theories, Ecological Modernization Theory (EMT) is adopted as the principal theory for this study because it directly explains the relationship between technological innovation and sustainability. The theory specifically emphasizes how environmentally friendly technologies can simultaneously promote environmental protection, economic efficiency, and organizational sustainability, making it highly suitable for examining the effect of energy-efficient technology on the sustainability of hotel businesses in Cross River State.

Literature Review

Energy-efficient lighting systems refer to modern lighting technologies designed to provide adequate illumination while consuming less electricity than conventional lighting systems. Examples include Light Emitting Diodes (LEDs), compact fluorescent lamps (CFLs), and motion-sensor lighting systems. In the hospitality industry, lighting constitutes a significant portion of total energy consumption due to the continuous operation of guest rooms, lobbies, restaurants, conference halls, and outdoor facilities. Consequently, the adoption of energy-efficient lighting systems has become an important strategy for promoting sustainability in hotel businesses. According to Singh, Mishra, and Yadav (2024), energy-efficient lighting technologies significantly reduce electricity consumption and operational costs while improving environmental performance. Similarly, Khatter (2025) observed that hotels adopting LED lighting systems experience substantial reductions in energy expenditure and carbon emissions, thereby enhancing their long-term sustainability. Energy-efficient lighting also contributes to environmental sustainability by reducing greenhouse gas emissions associated with electricity generation. Furthermore, modern lighting technologies offer longer lifespans and lower maintenance costs, enabling hotels to achieve operational efficiency and economic sustainability. Therefore, energy-efficient lighting systems are increasingly recognized as a critical component of sustainable hotel operations. Smart Energy Management Systems (SEMS) are technology-based solutions that monitor, control, and optimize energy consumption within an organization. These systems utilize digital technologies, sensors, automated controls, and real-time data analytics to improve energy efficiency. In hotel businesses, smart energy management systems regulate energy use in lighting, heating, ventilation, air conditioning, and other operational areas. The growing adoption of SEMS in the hospitality sector is driven by the need to reduce energy wastage and improve operational efficiency. According to Parvez et al. (2026), smart energy management technologies enable hotel operators to monitor energy consumption patterns and make informed decisions that enhance sustainability performance. Likewise, Israni and Hanrahan (2026) argued that digital energy management systems improve resource utilization and support sustainable business operations by reducing unnecessary energy consumption. Through automated controls and predictive analytics, hotels can optimize energy use without compromising guest comfort. The implementation of smart

energy management systems therefore contributes to economic sustainability through cost savings, environmental sustainability through reduced emissions, and operational sustainability through improved efficiency and resource management.

Renewable energy adoption refers to the utilization of energy sources that are naturally replenished, such as solar, wind, hydro, and biomass energy. Among these, solar energy is the most widely adopted renewable energy source in the hotel industry due to its accessibility and cost-effectiveness. The increasing concern over climate change and energy security has encouraged hotels to integrate renewable energy technologies into their operations. Renewable energy systems reduce dependence on fossil fuels and conventional electricity sources, thereby lowering energy costs and environmental impacts. According to Silva et al. (2026), hotels that adopt renewable energy technologies demonstrate higher levels of environmental sustainability and resilience compared to those relying solely on conventional energy sources. Similarly, Sahu and Haider (2026) found that renewable energy investments contribute significantly to energy conservation, cost reduction, and sustainable business performance in hospitality organizations. In addition, renewable energy adoption enhances the corporate image of hotels by demonstrating commitment to environmental responsibility, which can positively influence customer satisfaction and loyalty. Consequently, renewable energy adoption has become a strategic approach for achieving long-term sustainability in hotel businesses.

Empirical Literature

Singh, Mishra, and Yadav (2024) examined the implementation of energy-efficient systems in hotel buildings with the aim of understanding how sustainable energy solutions contribute to hotel performance. The study adopted a qualitative research approach through a review of existing energy management practices in hospitality facilities. The findings revealed that energy-efficient technologies such as efficient lighting systems, improved HVAC systems, and renewable energy solutions significantly reduce energy consumption, operational costs, and environmental impacts. The study concluded that hotels that integrate energy-efficient technologies are more likely to achieve sustainability objectives through improved resource utilization and reduced carbon emissions. However, the study was mainly conceptual and did not empirically test the relationship between specific energy-efficient technologies and hotel sustainability outcomes, creating a gap for further investigation in contexts such as Cross River State. Similarly, Luo, Joybari, Ma, Liu, and Lai (2024) investigated the effect of renewable power generation on energy consumption and cost performance in homestay hotels. Using real operational data from three hotels in Sanya, China, the study employed a cost-benefit assessment model to evaluate the impact of photovoltaic-battery renewable energy systems on hotel sustainability. The findings showed that renewable energy adoption significantly reduced electricity purchases and improved hotel profitability, with renewable energy penetration exceeding 57% in different operational scenarios. The study concluded that renewable energy technologies provide both environmental and economic benefits for hotel businesses. However, the study focused mainly on solar photovoltaic systems, leaving limited evidence on other dimensions of energy-efficient technology such as smart energy management systems and lighting technologies.

Adeel, Sabir, Shahnawaz, and Zafran (2024) examined the adoption of environmental technologies in the hotel industry and their influence on sustainable intelligence and pro-environmental behaviour. Using survey data from hotel employees and managers, the study assessed how environmental technology adoption contributes to sustainable practices within hospitality organizations. The findings indicated that hotels adopting green technologies demonstrate stronger

sustainability orientation, improved environmental awareness, and better resource management practices. The study emphasized that technological adoption is essential for reducing environmental challenges in the hospitality sector. Nevertheless, the study focused broadly on environmental technologies rather than specifically examining energy-efficient technologies and their direct influence on hotel sustainability performance. In another study, Arıkan Kargı and Cesur (2024) conducted a study on renewable energy technology selection for hotel buildings using a multi-criteria decision-making approach. The study applied Analytical Hierarchy Process (AHP) and VIKOR methods to determine the most suitable renewable energy alternatives for hotel facilities. The findings showed that renewable energy technologies, particularly solar-based solutions, are effective strategies for reducing conventional energy dependence and supporting sustainable hotel development. The researchers concluded that selecting appropriate renewable energy technologies is crucial for improving energy efficiency and achieving sustainability goals in hotel operations. However, the study concentrated on technology selection rather than examining how technology adoption influences overall business sustainability. Luo et al. (2024) further examined the role of photovoltaic systems and LED lighting in promoting clean energy transition within hotel operations. The study analyzed the environmental and economic implications of combining renewable energy systems with energy-efficient lighting solutions. Findings revealed that integrating photovoltaic systems and LED bulbs enhanced energy decarbonization, reduced operational energy demand, and improved the competitiveness of hotel businesses through green practices. The study highlighted that sustainable energy technologies can support environmental, economic, and social dimensions of hotel sustainability. However, the research was conducted outside Nigeria, making it necessary to examine the applicability of these findings within the Nigerian hospitality environment, particularly Cross River State where hotels face unique energy challenges.

Methodology

This study adopted conceptual review. Information was gathered using textbooks, journals, published and unpublished journals, libraries and internet applications

Findings

Based on conceptual review, it was found thus:

1. Energy-efficient lighting systems have a positive effect on the sustainability of hotel businesses in Cross River State.
2. Smart energy management systems have a positive effect on the sustainability of hotel businesses in Cross River State.
3. Renewable energy adoption has a positive effect on the sustainability of hotel businesses in Cross River State.

Conclusion

The study x-rays the effect of energy-efficient technology on the sustainability of hotel businesses. The study revealed that energy-efficient lighting systems have a positive effect on the sustainability of hotel businesses. Smart energy management systems have a positive effect on the sustainability of hotel businesses. Renewable energy adoption has a positive effect on the sustainability of hotel businesses. Energy-efficient technology has become an essential component of sustainable business operations in the hospitality industry due to increasing energy costs, environmental concerns, and growing stakeholder expectations for responsible business practices.

Energy conservation has become one of the most important sustainability strategies in hotels because energy consumption accounts for a substantial proportion of hotel operating expenses and carbon emissions.

Recommendations

Based on the findings, the following recommendations are proposed:

1. Hotel operators should invest in energy-efficient lighting systems such as LED bulbs and motion-sensor lighting to reduce electricity consumption, lower operating costs, and improve the sustainability of their businesses.
2. Hotel management should adopt smart energy management systems that enable real-time monitoring and control of energy usage. This will enhance operational efficiency, minimize energy wastage, and support long-term sustainability goals.
3. Hotel businesses should increase the adoption of renewable energy technologies, particularly solar energy systems, to reduce dependence on conventional electricity and fuel-powered generators, thereby improving environmental sustainability and reducing energy costs

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