

Impact of Integrating Photovoltaic-Shading Systems in Hotel Hospitality Design in Oniru Beach Lagos

Oshikoya Aderayo. Z¹; Isaac Emmanuella. C²; Onamade Akintunde O³; Jayeoba .Steve⁴
Department of Architecture, Caleb University, Imota, Lagos State, Nigeria.

Abstract:- Globally, energy efficiency has been a threat to building sustainability, therefore alternative energy sources tend to overtake the consumption of power usage in buildings. This study delves into comparing the effects of incorporating photovoltaic shading systems (PVSS) into luxury hospitality design, with a particular emphasis on sustainability, energy efficiency, and customer satisfaction. Through a thorough examination of case studies and literature surrounding PVSS integration, reviewing journals on this subject this article elucidates the advantages, challenges, and ramifications for luxury hotel properties. By conducting a comprehensive analysis, it underscores the pivotal role that PVSS play in shaping the future landscape of sustainable hospitality architecture. This essay delivers valuable insights into the current energy usage and the integration of PVSS in buildings. The findings of this investigation underscore the potential of PVSS to enhance environmental performance, operational efficiency, and guest satisfaction within luxury hotel properties and drive overall business performance. It is recommended to encourage collaboration between architects, developers, and energy professionals to optimize PVSS integration in luxury hospitality design, Educate stakeholders about the benefits of PVSS integration and provide incentives or subsidies to promote sustainable design practices in luxury resort development.

Keywords:- Customer Experience, Energy Efficiency, Environmental Impact, Luxury Hospitality Design, Photovoltaic Shading Systems (pvss), Sustainability.

I. INTRODUCTION

Luxury hospitality design is progressively integrating sustainable practices to align with environmental objectives and cater to discerning guests. In today's competitive hospitality management, the focus on cost saving, customer satisfaction, and environmental impact within the hotel hospitality industry is very important. Photovoltaic shading systems (PVSS) present a viable solution by seamlessly incorporating renewable energy generation into architectural elements. This study probes into the multifaceted impact of PVSS integration within luxury hospitality design, emphasizing its potential to enhance sustainability, energy efficiency, and Customer satisfaction.

The evolution of luxury hospitality design emphasizes sustainability and energy efficiency in response to escalating environmental concerns and changing consumer preferences. The integration of photovoltaic shading systems (PV) emerges as an innovative approach to tackle these challenges while elevating the visual appeal and functionality of luxury hotel properties. This article seeks to explore the diverse impacts of BIPV shading systems in luxury hospitality design, concentrating on their contributions to sustainability, customer experience enhancement, and operational optimization.

Luxury hospitality establishments are increasingly embracing sustainable design principles to fulfill environmental goals and cater to eco-conscious clientele. Photovoltaic shading systems (PVSS) offer an attractive avenue for seamlessly integrating renewable energy generation with the architectural aesthetics of luxury hotels. This study aims to investigate the implications of PVSS integration on sustainability, energy efficiency, and customer experience within the realm of luxury hospitality design.

The primary aim of this study is to provide empirical evidence on the effectiveness of PVSS integration in luxury hospitality design with a view to enhancing sustainability. By analyzing case studies, conducting stakeholder interviews, and literature review, the study seeks to inform architects, developers, and hospitality operators about the potential advantages, challenges, and best practices associated with PVSS implementation.

➤ Objectives

The main objective of this research is to examine the relationship between generating photovoltaic shading system and luxury hospitality buildings. Specifically, the research aims to achieve the following objectives:

- To evaluate the environmental and economic benefits of integrating PVSS in luxury hospitality design.
- To assess the impact of PVSS on energy consumption, carbon footprint, and operational costs of luxury hotels.
- To examine the influence of PVSS integration on customer satisfaction, comfort, and perception of sustainable practices in luxury hospitality properties.
- To achieve the stated objectives, this research will employ Qualitative and quantitative analysis. The data collected for the study will be collected through a literature review, case studies, surveys, and stakeholder interviews to identify key findings and trends.

II. CONCEPTUAL FRAMEWORK

A. Preambles

In today's competitive hospitality management, the focus on cost saving, customer satisfaction, and environmental impact within the hotel hospitality industry is very important. This essay aims to evaluate the existing research on the impact of integrating photovoltaic-shading systems in luxury hotel hospitality design with a focus on Oniru Beach Lagos. By understanding the importance of the above factors, industries can safely introduce PVSS within the industry.

Energy Sustainability is a crucial aspect of SDG's Agenda and therefore that of sustainable development in any megacity including Lagos. (Adewunmi et al. 2023)

Photovoltaic shading systems seamlessly blend solar energy generation with shading capabilities, offering dual advantages of renewable energy production and enhanced thermal comfort. These systems are seamlessly incorporated into the architecture, including building facades, canopies, and other structures, effectively utilizing sunlight to produce electricity while minimizing solar heat accumulation. Through the integration of PVSS, luxury resorts can optimize their energy consumption, diminish their carbon footprint, and distinguish themselves through sustainable design practices. Of all the previously available renewable energy resources, solar energy is considered an inexhaustible resource, the cleanest, and the most abundant one. (Peng.c et al 2011)

Photovoltaic shading systems efficiently utilize solar energy for electricity generation while simultaneously providing shade and shielding from solar glare. Unlike traditional solar panels, Building Integrated Photovoltaic systems (BIPV) seamlessly merge with the architectural elements of buildings, encompassing facades, canopies, and windows. By harnessing renewable energy sources, BIPV systems decrease reliance on conventional power grids, mitigate carbon emissions, and contribute to fostering a more sustainable built environment. The power of the sun that reaches the earth is estimated to be approximately 1.8×10^{11} MW, which is so much larger than the world's energy demand. (Parida, B et al 2011). To make effective use of solar energy, various technologies have been developed, for example, solar lighting technology, solar thermal technology, solar thermal power technology, solar photovoltaic (PV) technology, solar hydrogen production technology, etc.

B. Definition of Terms

➤ Sustainability

PVSS integration aligns luxury resorts with sustainable development goals, promoting environmental stewardship and resource conservation. By generating clean energy on-site, resorts can reduce reliance on fossil fuels, mitigate greenhouse gas emissions, and contribute to global climate action efforts.

➤ Energy Efficiency

PVSS optimize energy efficiency by offsetting electricity consumption from the grid and reducing dependence on conventional power sources. By leveraging renewable energy resources, resorts can achieve significant cost savings, increase energy independence, and achieve a favorable return on investment over the long term while minimizing environmental impact.

➤ Guest Experience Enhancement

PVSS integration enhances guest experience by creating comfortable, visually appealing environments that prioritize natural light and panoramic views. Customers appreciate the eco-friendly features of luxury resorts, fostering brand loyalty and positive word-of-mouth recommendations.

➤ Architectural Versatility

PVSS offers architectural versatility, allowing designers to seamlessly incorporate solar panels into various building elements without compromising aesthetics or functionality. From sleek glass facades to innovative canopy structures, PVSS enables creative design solutions that enhance the visual appeal of luxury hospitality properties. Architects have the flexibility to incorporate BIPV elements into various structural components without compromising aesthetic appeal or design integrity.

C. Energy Use in Hotels

The hotel industry stands out as one of the most energy- and resource-intensive sectors within tourism. Considerable amounts of energy are utilized to provide comfort and services to guests, many of whom seek and are willing to pay for luxurious amenities, services, and entertainment. However, the energy efficiency of various end-users within hotel establishments is often subpar, resulting in greater environmental impacts compared to buildings of similar size in other sectors. These impacts stem from excessive consumption of local and imported resources such as water, food, electricity, and fuels, as well as emissions released into the air, water, and soil. Moreover, the significant volumes of waste generated by hotels further exacerbate environmental concerns. (Lee, S., Kim, J., & Park, H. 2020).

Energy consumption varies significantly among different types of hotels and is influenced by factors such as hotel size, class, number of rooms, guest demographics, location, climate, and range of services and amenities offered. Conceptually, a hotel can be viewed as comprising three distinct zones, each serving different functions:

➤ Guest Room Area

(Bedrooms, bathrooms/showers, toilets) – individual spaces, often with extensive glazing, asynchronous utilization and varying energy loads.

➤ *Public Area*

(Reception hall, lobby, bars, restaurants, meeting rooms, swimming pool, sauna, etc.) – spaces with a high rate of heat exchange with the outdoor environment (high thermal losses) and high internal loads (occupants, appliances/equipment, and lighting).

➤ *Service Area*

(Kitchens, offices, store rooms, laundry, staff facilities, machine rooms and other technical sections) – energy-intensive areas typically requiring advanced air handling (ventilation, cooling, heating)

These areas exhibit distinct energy usage patterns that require tailored management approaches.

Historical studies of energy usage in hotels have highlighted electricity as the primary energy source, with gas and oil accounting for smaller shares. Consequently, electricity consumption serves as a reliable indicator of overall energy expenditure in the sector. While energy costs typically represent a modest fraction of total operational expenses and turnover, they constitute a significant portion of controllable costs, often ranking second only to labor costs. Instances where energy costs surpass half of total operational expenses have been documented.

Energy consumption within the hotel sector is diverse and challenging to comprehensively understand. Currently, most hotels monitor their overall energy consumption without detailed scrutiny of specific end-uses. Although detailed monitoring and documentation of energy flows are technically feasible, they are often perceived as excessively intricate and costly. (Lee, S., Kim, J., & Park, H. 2020).

Several investigations have been conducted to gain a deeper understanding of energy flows in hotels, providing valuable insights for estimating energy consumption profiles across similar facilities.

D. Customer Satisfaction and Experience In Business Growth

Yeh, Chen, and Chen (2019) conducted a case study of tourism factories in Taiwan to explore the relationships among experiential marketing, service innovation, and customer satisfaction. Their findings highlight a strong positive correlation between service quality and perceived value. Improved service quality is associated with higher perceived value, thereby enhancing customer satisfaction.

Business process innovation demonstrates a weak positive correlation with customer satisfaction, indicating that higher levels of customer satisfaction may be associated with increased business process innovation (Hongqi & Ruoyu, 2012).

E. Environmental and Economic Benefits of PVSS in Hospitality Industry

➤ *Environmental Benefits:*

• *Reduction of Carbon Footprint*

PVSS generates electricity from sunlight, a renewable resource, thereby reducing reliance on fossil fuels. This reduces greenhouse gas emissions, mitigating climate change and contributing to a more sustainable environment. Crawford, R. H et al (2012)

• *Decreased Air Pollution*

By using photovoltaic energy instead of traditional energy sources like coal or natural gas, PVSS contributes to cleaner air and improved air quality, as they produce no harmful emissions during operation.

• *Conservation of Natural Resources*

Photovoltaic energy is abundant and inexhaustible, unlike finite fossil fuels. By harnessing solar power, luxury hospitality establishments can contribute to the conservation of natural resources for future generations.

➤ *Economic Benefits:*

• *Cost Savings*

While the initial investment in PVSS installation may be significant, luxury hotels can realize long-term cost savings on electricity bills. PVSS generates electricity on-site, reducing reliance on grid electricity and providing a hedge against rising energy costs. Aranda-Mena et al (2012)

• *Revenue Generation*

In addition to cost savings, luxury hotels can generate revenue by selling excess electricity back to the grid through net metering programs. This can provide an additional income stream and enhance the hotel's overall financial performance.

• *Enhanced Brand Reputation*

Luxury hotels that integrate PVSS demonstrate a commitment to sustainability and environmental stewardship. This can enhance their brand reputation and appeal to environmentally conscious consumers who are increasingly seeking eco-friendly accommodation options.

• *Marketing Opportunities*

Luxury hotels can leverage their use of PVSS as a unique selling point in their marketing efforts. Highlighting their commitment to sustainability and renewable energy can attract environmentally conscious guests and differentiate them from competitors.

Overall, integrating PVSS in luxury hospitality design offers a compelling combination of environmental benefits, cost savings, revenue generation, and branding opportunities, making it a sustainable and economically viable investment for luxury hotels. (Aranda-Mena, G., Crawford, R. H., & Cheung, H. F. 2012).

F. Challenges and Considerations

While the integration of PVSS shading systems offers numerous benefits, it also presents certain challenges and considerations for architects, developers, and hospitality operators. These include initial upfront costs, technical complexity, regulatory compliance, and maintenance requirements. Addressing these challenges requires careful planning, and collaboration between Architects, developers, and energy professionals to ensure seamless integration and optimal performance, a holistic approach to sustainable design and construction. Despite the numerous benefits, PVSS integration in luxury hospitality design presents challenges and considerations that must be addressed for successful implementation. (Smith, J., & Johnson, L. 2019).

III. METHODOLOGY

This research aims to analyze the integration of photovoltaic shading systems in luxury hotel hospitality design with a focus on Oniru Beach Lagos as a case study. This research will employ Qualitative analysis the data collected for the study will be collected through a literature review, case studies, and stakeholder interviews to identify

key findings and trends. Literature Review, which will be a comprehensive review of scholarly articles, industry reports, and case studies, related to PVSS integration, luxury hospitality design, and sustainable architecture has been conducted. Stakeholder Interviews will consist of Semi-structured interviews with architects, developers, and hospitality professionals to gather insights into the challenges, opportunities, and lessons learned from PVSS implementation, and case Studies such as Analysis of real-world examples of luxury hotel and the energy use intensity in their facilities.

IV. RESULTS

Energy usage in the hotel industry is widely varied and frequently challenging to fully comprehend. Presently, many hotel establishments primarily track their total energy usage without delving into specific end-use categories. Although it is technically feasible to conduct thorough monitoring and documentation of various energy flows, this is often considered excessively intricate and costly. Several studies have been conducted with the aim of achieving a deeper comprehension of energy flows in hotels, offering valuable insights for estimating energy consumption patterns among similar facilities.

Table 1 provides an energy efficiency rating for different types of hotels, while the energy use intensity (EUI) in hotel facilities in different parts of the world is shown see also **Figure 1**. (Paulina Bohdanowicz, 2014).

Table 1: Energy Efficiency Rating for Different Types of Hotels

	Efficiency Rating	Good	Fair	Poor	Very poor
A) Large hotels (more than 150 rooms) with air conditioning, laundry and indoor swimming pool					
	Electricity (kWh/m2 year)	< 165	165-200	200-250	> 250
	Fuel (kWh/m2 year)	< 200	200-240	240-300	> 300
	Total (kWh/m2 year)	< 365	365-440	440-550	> 550
	Hot water (kWh/m2 year)	< 220	230-280	280-320	> 320
B) Medium-sized hotels (50-150 rooms) without laundry, with heating and air conditioning in some areas					
	Electricity (kWh/m2 year)	< 70	70-90	90-120	> 120
	Fuel (kWh/m2 year)	< 190	190-230	230-260	> 260
	Total (kWh/m2 year)	< 260	260-320	320-380	> 380
	Hot water (kWh/m2 year)	< 160	160-185	185-220	> 220
C) Small hotels (4-50 rooms) without laundry, with heating and air conditioning in some areas					
	Electricity (kWh/m2 year)	< 60	60-80	80-100	>100
	Fuel (kWh/m2 year)	< 180	180-210	210-240	> 240
	Total (kWh/m2 year)	< 240	240-290	290-340	> 340
	Hot water (kWh/m2 /year)	< 120	120-140	140-160	> 160

Source: (Paulina Bohdanowicz, 2014) Energy-Efficiency and Conservation in hotels–Towards Sustainable Tourism.

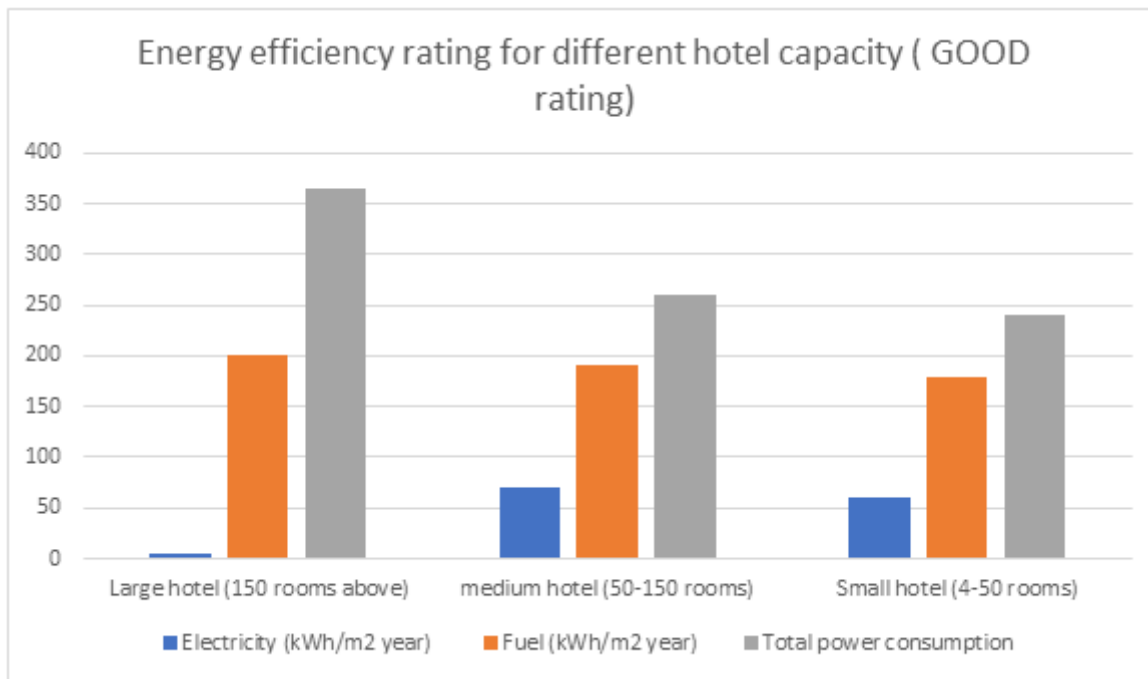


Fig 1 Energy Efficiency Rating for Different Hotel Capacity (Good Rating)

Source: Author with reference from table 1

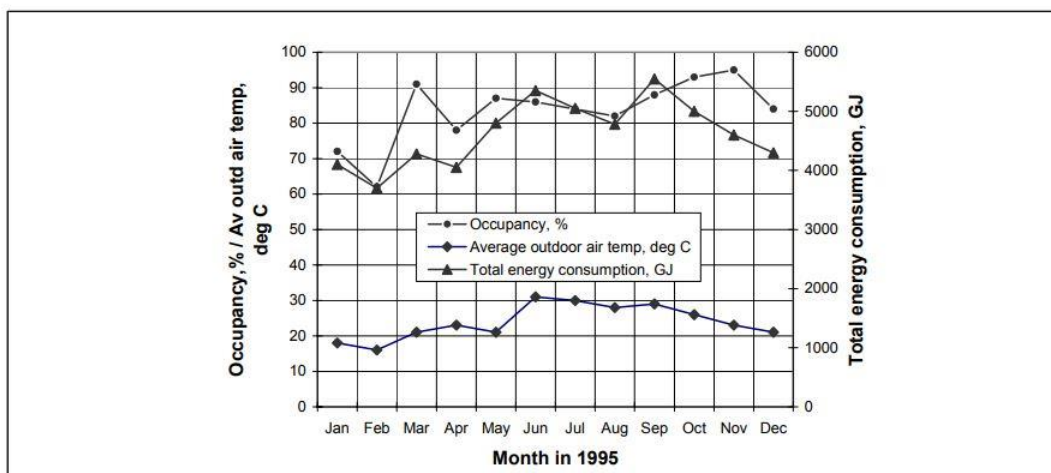


Fig 2: Monthly Total Energy Consumption, Average Monthly Outdoor Air Temperature, and Average Monthly Occupancy Profile for a Hotel Facility in 1995

V. SUMMARY OF FINDINGS

The findings from this research can help provide valuable insight for the proposed Oniru beach hotel and the hospitality industry as a whole.

A. Environmental Impact

PVSS integration in luxury hospitality design leads to significant reductions in carbon emissions, energy consumption, and reliance on non-renewable energy sources.

B. Economic Benefits

Despite initial investment costs, PVSS offer long-term financial benefits through energy savings, operational efficiency, and potential revenue generation from excess electricity production.

C. Guest Experience

PVSS enhance guest satisfaction by creating comfortable, visually appealing environments that prioritize natural light, scenic views, and sustainable design features.

VI. CONCLUSION

The integration of photovoltaic shading systems presents a transformative opportunity for hotel hospitality design, offering a balance between environmental responsibility, economic viability, and customer experience enhancement. By harnessing the power of solar energy and embracing sustainable design principles, hotels can reduce their environmental impact, enhance guest experience, and achieve long-term operational efficiency. As the hospitality industry continues to prioritize sustainability and innovation, PV shading systems are poised to play a central role in shaping the future of luxury resort development by leveraging renewable energy resources and innovative design solutions, luxury resorts can differentiate themselves in the competitive hospitality market while contributing to global sustainability goals.

RECOMMENDATIONS

Encourage collaboration between architects, developers, and energy professionals to optimize PVSS integration in luxury hospitality design.

Invest in research and development to enhance PVSS technology, performance, and affordability for wider adoption in the hospitality sector.

Educate stakeholders about the benefits of PVSS integration and provide incentives or subsidies to promote sustainable design practices in luxury resort development.

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