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ENERGY - EFFICIENT DESIGN FOR G+1 STOREY INSTITUTIONAL CANTEEN LITERATURE REVIEW

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ABSTRACT

This project outlines the design of a G+1 institutional canteen focused on energy efficiency, sustainability, and functionality. Emphasizing a climate-responsive approach, the design utilizes passive architectural strategies such as natural ventilation, optimized daylighting, thermal insulation, and strategic building orientation to reduce reliance on artificial heating, cooling, and lighting systems.

Active energy-saving technologies further enhance the canteen's performance, including the use of LED lighting, smart sensors, and infrastructure ready for renewable energy sources like solar panels. The building materials are carefully selected to minimize environmental impact, incorporating sustainable options like AAC blocks, reflective roofing, and low-VOC finishes that contribute to a reduced carbon footprint.

Efficient space planning and zoning ensure functionality while adhering to national standards such as the Energy Conservation Building Code (ECBC) and the National Building Code (NBC). These efforts not only cut operational costs but also promote comfort, hygiene, and user well-being.

The project serves as a scalable and replicable model for sustainable institutional buildings, demonstrating how thoughtful design can align with long-term environmental goals while maintaining high standards of functionality and user experience.

Keywords: Natural ventilation, G+1 Canteen design, Low-VOC finishes, National Building Code (NBC), AAC blocks.

1. INTRODUCTION

As global energy demands continue to rise, sustainable design in the construction sector has become a necessity rather than a choice. Educational campuses, often composed of high- occupancy spaces like canteens, present an ideal opportunity to implement energy- efficient architecture. These buildings run throughout the day and require efficient ventilation, cooling, lighting, and cooking arrangements, which are typically energy-intensive.

This report explores the architectural and technical approach to designing an energy- efficient G+1 institutional canteen, which balances environmental responsibility with functional efficiency. The G+1 structure is selected for its space-optimizing potential in campus settings. The ground floor typically houses the main kitchen and dining area, while the upper floor accommodates additional dining space, storage, or office areas.

Using a combination of passive solar design, smart zoning, climate-responsive materials, and green technology, the design reduces energy consumption while enhancing occupant comfort. It promotes environmental stewardship and showcases a sustainable design model aligned with ECBC, IGBC, and NBC guidelines.

2. LITERATURE REVIEW

Zhang et al. (2025) this study focuses on optimizing energy-saving and decarbonization designs for school canteen buildings in Nanjing. By employing EnergyPlus simulations and the Strengthened Elitist Genetic Algorithm (SEGA), the research identifies optimal retrofit schemes that achieve zero net energy consumption and zero lifecycle carbon emissions, providing valuable insights for sustainable retrofitting of educational buildings.

ENERGY STAR® Guide for Cafés, Restaurants, and Institutional Kitchens (2014) this guide offers practical strategies for improving energy efficiency in foodservice establishments. It emphasizes the importance of maintaining and adjusting equipment, reducing idle time, and considering energy-efficient alternatives like induction ranges to enhance overall energy performance.

Strategies for Reducing Energy Consumption in a Student Cafeteria in a Hot-Humid Climate: A Case Study This case study assesses energy performance in a student cafeteria at King Fahd University, Saudi Arabia. Implementing various energy conservation measures, including HVAC system optimization and lighting improvements, resulted in a combined design saving of 27.4%, demonstrating the effectiveness of targeted energy-saving strategies in hot-humid climates.

Energy Efficiency in Commercial Kitchens (YorkSpace) This research highlights the integration of energy efficiency into culinary education, aiming to connect culinary planning with energy waste mitigation. It underscores the need for chefs to understand their role in improving energy efficiency within commercial kitchen operations.

Campus Cafeteria Serves As Sustainable Model for Energy (NREL) The National Renewable Energy Laboratory's campus cafeteria exemplifies energy-efficient design by incorporating ENERGY STAR-rated appliances, demand-controlled ventilation systems, and daylighting strategies. These features collectively contribute to reduced energy consumption and serve as a model for sustainable foodservice facilities.

Energy Efficiency in the Food Industry: A Systematic Literature Review This systematic review identifies energy efficiency indicators within the food industry, serving as inputs for sectoral evaluations based on multicriteria techniques. It provides a comprehensive overview of effective actions for improving energy efficiency in manufacturing processes related to food production.

Decarbonizing the Commercial Kitchen | Better Buildings Initiative This guide identifies methods to save energy and water in commercial or institutional kitchens. It provides kitchen operators with information on implementing energy-efficient practices and technologies to reduce environmental impact.

Energy Efficiency Foodservice Kitchen - Strata GPO This article discusses how energy-efficient kitchens can reduce energy use and costs while boosting productivity. It highlights the latest developments in electrified kitchens and the benefits of adopting energy-efficient equipment.

ENERGY STAR® Guide for Cafés, Restaurants, and Institutional Kitchens (2015) An updated version of the ENERGY STAR guide, this document continues to provide strategies for enhancing energy efficiency in foodservice establishments, emphasizing equipment maintenance and operational best practices.

Energy-Saving and Decarbonization Design Optimization for School Canteen Buildings: A Case Study in Nanjing This study explores energy-saving and decarbonization design optimization for educational buildings, focusing on a high school canteen in Nanjing. It compares optimal energy-saving and lifecycle decarbonization retrofit schemes to identify performance differences and provide practical guidance for retrofitting educational buildings.

Energy Efficiency in the Food Industry: A Systematic Literature Review This research involves developing a systematic literature review to identify energy efficiency indicators in the food industry, aiming to improve decision-making processes by increasing the quality of information related to energy indicators.

Decarbonizing the Commercial Kitchen | Better Buildings Initiative This guide identifies ways to save energy and water in a restaurant or other commercial or institutional kitchen, providing kitchen operators with information on implementing energy- efficient practices.

Energy Efficiency Foodservice Kitchen - Strata GPO An energy-efficient kitchen can reduce energy use and costs, and boost productivity. This article looks at the latest happenings in electrified kitchens and the benefits of adopting energy-efficient equipment.

ENERGY STAR® Guide for Cafés, Restaurants, and Institutional Kitchens (2015) This guide provides practical strategies for improving energy efficiency in foodservice establishments, emphasizing the importance of maintaining and adjusting equipment, reducing idle time, and considering energy-efficient alternatives.

Campus Cafeteria Serves As Sustainable Model for Energy – NREL This case study highlights how a campus cafeteria integrates energy efficiency technologies, sustainable operations, and solid business practices to serve as a model for high-performing food service facilities.

3. METHODOLOGY

3.1 Collection of Data:

3.1.1 Salient Features:

Utility of structure

No. of stories: G+1

Type of construction: R.C.C. framed structure

Type of walls: Brick wall

3.1.2 Geometric Details:

Floor to floor height: 13ft

3.1.3 Materials:

Grade of concrete: M25

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Grades of steel: Fe500 for main steel, Fe500 for shear reinforcement

3.2 **Preliminary Data and Proposed Design:**

Sr.No.	Information	Description
1	Type of building	G+1 storey RCC frame structure
2	Function	Institutional
3	Floor to floor height	3.6576m
4	Riser, tread, and width of stairs	150, 300, 1200mm
5	Masonry wall thickness	230mm
6	Type of floor finish	Ceramic tile
7	Grade of concrete	M25
8	Grade of steel	Fe500

4. MODELING AND ANALYSIS

The site chosen lies within a well-established institutional campus. Selection and analysis focus on optimizing environmental and functional conditions:

• Climatic Considerations : local temperature, humidity, wind direction, and solar angles

• Topography : flat terrain for ease of foundation and drainage

• Orientation : maximizing day lighting and cross ventilation

• Accessibility : easy access to utilities, roads, and campus pathways

• Noise and Odor Control : keeping service and waste areas away from sensitive zones

The goal is to create a climate-responsive structure that takes advantage of the natural environment to reduce dependence on mechanical systems.

5. RESULTS AND DISCUSSION

The analysis for the G+1 institutional canteen design was conducted using a combination of building information modeling (BIM), sustainable design principles, and material selection criteria to optimize both energy performance and user comfort.

Components	Conventional Canteen	Energy-Efficient Canteen	Savings
Electricity Bills	Rs. 3.5-4 lakhs	Rs. 2-2.5 lakhs	35-45% reduction
Maintenance	Rs. 80,000	Rs. 60,000	Reduced due to efficient systems
HVAC Usage	High	Low	Lower recurring cost

Table 1: Operational Cost Comparison

The cost of integrating energy-efficient features is estimated to be 10-12% higher than a conventional design.

Based on energy savings from efficient appliances and lighting, the return on investment (ROI) is expected within 5-6 years.

6. CONCLUSION

The design of an energy-efficient G+1 institutional canteen exemplifies the growing need for sustainable and climate responsive infrastructure in educational institutions. Through this project, a conscious effort has been made to reduce energy consumption, promote the use of renewable resources, and create a thermally comfortable, well-ventilated environment that supports the health and productivity of users.

The project successfully integrates both passive and active design strategies, including optimal orientation, natural lighting and ventilation, use of high-performance building materials, and energy-efficient systems. These strategies collectively contribute to lower operational costs, reduced environmental impact, and enhanced user satisfaction.

Beyond functionality, the design emphasizes inclusivity, hygiene, ease of access, and future adaptability. The use of green materials, energy-saving appliances, and water-efficient systems positions the building as a model for eco-conscious institutional development.

This canteen can serve as a replicable prototype for other campuses, encouraging the broader adoption of sustainable construction practices. It aligns well with national energy codes (ECBC, NBC) and supports India's goals toward a greener built environment. With continued innovations in material technology and energy systems, such designs can become the new norm, significantly contributing to long-term environmental preservation and economic efficiency.

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