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Toward A Sustainable Build: A Case Study Of The College Of Engineering, Al-Qasim Green University

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ABSTRACT

This paper projects a practical vision for developing and converting the College of Engineering building at the Al-Qasim Green University into a sustainable green building in response to environmental and climate challenges, and to promote sustainable and long-term progress and improvement. The vision focuses on increasing energy and water efficiency, reducing waste, and enhancing the quality of the educational environment. The plan is based on design principles that involve trimming down of energy consumption, steadily migrating toward solar energy, installing photovoltaic cells, LED lighting units, and motion sensors. A smart, sensible, and practical building management system (BMS) is also proposed for monitoring energy and water consumption efficiently. In the water management sector, measures include rainwater harvesting, the use of treated graywater, and water-saving valves, along with smart irrigation systems that can reduce consumption by up to 40%. In waste management, the plan focuses on waste sorting, recycling, composting, and promoting a recycling culture among students and staff. The feasibility study shows that this transformation will achieve energy and water savings, improve air quality, and reduce toxic emissions, drawing on the past and continuing experiences of Arab and international universities to endorse and confirm local applicability.

Key words: *Innovation, Sustainability, Ecology, Retrofitting.*

1. INTRODUCTION

Taking the present scenario into account, as well as the accelerating climate change and environmental challenges facing the world today, it has become imperative to review and reconsider traditional construction methods, which rely heavily on energy consumption and natural resources without sparing a thought for the environmental dimension and long-term sustainability. These challenges have become more pressing in developing countries, including Iraq, where buildings suffer from multiple problems such as low energy efficiency, weak natural ventilation systems and thermal insulation, and high summer temperatures. This leads to an avoidable increase in our reliance on artificial cooling systems, which in turn increases electricity consumption and harmful greenhouse gas emissions [1, 2].

These problems cause an unnecessary increase in economic and environmental burdens, in addition to their negative impact on the comfort and health of building users. Furthermore, the prevailing urban style in Iraq typically does not adhere to sustainable design principles or the use of environmentally friendly materials, exacerbating the environmental impact caused by buildings, and reducing their operational efficiency. In this context, the concept of "green buildings" emerges a likely lifesaver as a global trend aimed at balancing modern construction requirements with environmental conservation. This is achieved through the design and implementation of buildings that use energy and water efficiently, reduce waste and emissions, and provide a healthy indoor environment, with a focus on the use of plentiful and sustainable local resources[3, 4].

This study aims to highlight the possibility of converting the College of Engineering structure at the Al-Qasim Green University from a traditional building to a green building. This study analyzes the building's current status in terms of energy efficiency, ventilation systems, water utilizatiion, construction materials, and lighting and cooling systems, in addition to assessing its compliance with internationally recognized green building standards such as LEED or the Global Sustainable Building Rating System. The study also aims to identify environmental and technical shortcomings in the current building and proposes a set of practical, applicable solutions,

consistent with local technical and material capabilities, taking into account the climatic and economic conditions in Iraq.

2. STATEMENT OF PROBLEM

Most traditional buildings in Iraq, such as the College of Engineering building at Al-Qasim Green University, suffer from poor and scanty adherence to environmental and sustainability standards, leading to excessive energy and water consumption, high operating costs, and poor indoor environmental quality. These problems are exacerbated by harsh climatic conditions, poor construction materials, and a lack of awareness of the importance of green buildings. The role of universities as educational centers highlights the need to adopt these concepts. Hence, we bring to light the importance of research into the feasibility of converting senseless traditional buildings into sensible green buildings, focusing on the College of Engineering as a model application.

3. GREEN AND SUSTAINABLE BUILDINGS

Traditional buildings: These are buildings constructed using traditional construction methods and materials without regard for environmental standards or resource efficiency[3].

Green buildings: These are buildings designed and controlled to reduce environmental impact, maximize efficiency in consumption of energy and water, and improve indoor environmental quality[4].

Sustainable buildings: These are buildings that balance environmental, economic, and social needs over the duration of their lifespan. This is the broader concept under which green buildings fall. Table (1) presents a detailed comparison between conventional buildings and green buildings. We keep in mind the terms of several key aspects related to environmental and operational performance efficiency, such as energy and water consumption, quality of building materials, quality of indoor environment, costs, and environmental impact[5, 6]. This comparison highlights the fundamental differences between the two models, highlighting the advantages of green buildings as a more sustainable and efficient option in the modern urban environment. Table (2) also briefly and comparatively illustrates the key differences between conventional buildings and green buildings[7, 8].

Table (1): Comparison between traditional buildings and green buildings

Item	Traditional Buildings	Green Buildings
Energy Consumption	High, due to poor insulation and inefficient appliances, which consume large amounts of energy for heating and cooling.	Low, thanks to intelligent designing that takes into account good insulation and smart systems such as solar or wind-powered air conditioning.
Water Consumption	High, due to the lack of reuse or rainwater harvesting technologies, thus wasting large amounts of water.	Low, thanks to rainwater harvesting techniques and the reuse of graywater for garden irrigation or other purposes.
Building Materials	Traditional and unsustainable, such as uninsulated concrete and brick, which contributes to a building's environmental footprint.	Sustainable and recyclable, such as recycled or natural materials with a low carbon footprint.
Indoor Environmental Quality	Weak, due to the lack of proper ventilation and natural lighting, which impacts the comfort and safety of occupants.	Good, thanks to adequate natural ventilation and natural lighting that enhance the comfort and health of residents.
Operating Costs	High, due to the excessive energy and water consumption, as well as the maintenance of traditional systems.	Low in the long term, due to the efficiency of the systems used to save energy and water.
Environmental Impact	Negative, due to the increased carbon emissions and excessive consumption of natural resources.	Positive, reducing the carbon footprint and promoting sustainability through environmentally friendly technologies.
Climate-Smart Design	Ignorance of local climatic conditions, such as wind or sun directions, which	Sensitive to the local climate, through a design that adjusts to wind and sun directions, which improves thermal comfort

	leads to thermal discomfort inside the building.	and reduces the need for heating and cooling.
Renewable Energy Systems	Lack of renewable energy systems and reliance primarily on non-renewable energy sources.	Relies on renewable energy such as solar or wind power to meet the building's energy needs.
Flexibility for Expansion and Renovation	Limited, as any renovation or modification requires significant reconstruction and additional costs.	Flexible and adaptable to future changes, as new systems can be added, or old systems be easily renovated.
Contributing to Improving Quality of Life	It does not offer any significant environmental or health improvements for occupants and may lead to health deterioration due to indoor pollution.	Provides a healthy environment that helps improve quality of life, while reducing indoor pollution and enhancing the well-being of residents.

Table (2): The difference between green and sustainable buildings

Standard	Green Buildings	Green Buildings
Primary Focus	Environment and Resource Efficiency	Environment and Resource Efficiency
Scope	Focuses on the building itself	Focuses on the building itself
Life Cycle	Often the operational phase	Often the operational phase
Health and Comfort	Part of the evaluation	Part of the evaluation

4. LEED (LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN)

The LEED system was developed by the U.S. Green Building Council (USGBC) in 1998. It is the world's most recognized green building rating system, aiming to improve energy and water efficiency, reduce the environmental impact of buildings, and enhance the indoor environment. LEED consists of several categories (Fig. 1)[9].

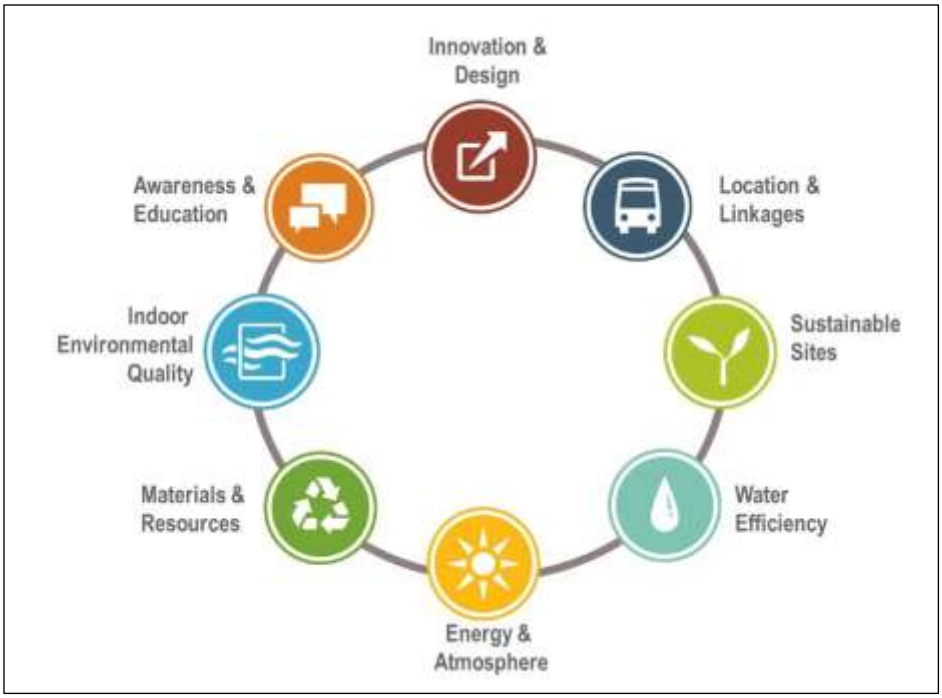


Fig. 1: LEED Standard Categories

5. STUDY AREA - AN ANALYTICAL STUDY OF SITE CHARACTERISTICS AND GREEN TRANSFORMATION POTENTIAL

5.1 Geographical Location

The College of Engineering at Al-Qasim Green University is located in Babylon Governorate, specifically in the city of Al-Qasim, outside the University's central campus. The college is located at the following geographic

coordinates: latitude 32.5100° N, longitude 44.3500° E. The total area is 8,460 m^2, the building area is 2,315 m^2, and the green spaces are 4,000 m^2, (Fig. 2). The College of Engineering campus contains several facilities, including the Deanship Building, which includes the administrative wing, and the classroom building. The college also houses engineering workshops for practical training, and the Student Club Building, which provides a social environment for students. There is also the Engineering Consulting Office Hall, which is used for providing space for engineering consultations and projects.

Fig. 2: Location of the College of Engineering

5.2 Climate

The climate of the College of Engineering at Al-Qasim University is characterized by a semi-arid desert climate. During the summer, the region experiences high temperatures, sometimes exceeding 50 degrees Celsius. This poses significant challenges to thermal comfort for students and faculty, and impacts the growth of plants and crops. In contrast, temperatures drop to below 10 degrees Celsius during the winter, potentially causing climate fluctuations that affect the sustainability of vegetation. Rainfall in the region is low and limited to short periods during the winter, particularly between November and March. Rainfall is irregular and in small quantities. This makes it difficult to rely on rainfall to provide adequate water needed for agriculture or environmental activities.

5.3: Analyzing Wind Trends

Studying wind directions and speeds is an important factor in assessing the potential for green building transitions, particularly with regard to renewable energy. The College of Engineering at Al-Qasim Green University is located in a relatively open area, making it vulnerable to the effects of monsoon winds, particularly during the spring and fall seasons. Wind speeds typically range between 10 and 25 km/h, and winds often originate from the northwest and southeast.

5.4: Topographic and Geological Characteristics

The region is characterized by flat terrain, with some slight slopes at its edges. The soil is a mixed clayey type, relatively infertile, and is prone to rising groundwater levels during the winter, along with high salinity levels, which negatively impact both construction and agriculture.

5.5: Current Land Use

The college's land uses include educational and administrative buildings, open spaces that are either unused or planted with various trees and grasses.

5.6: Waste Generated

The College of Engineering at Al-Qasim Green University generates several types of waste as a result of various activities on campus. The most prominent of these wastes are:

1. Paper Waste: This includes torn papers, unused documents, and study materials. This waste can be recycled to produce new paper or converted into raw materials for use in other projects.
2. Food Waste (from the Student Club): This includes food scraps produced by the Student Club serving college students. This waste can be converted into organic fertilizer using composting techniques, which helps improve soil fertility in gardens or green spaces on campus.

3. Tree Litter: This includes fallen leaves and small branches produced by trees in the garden or around buildings. This waste can be collected and converted into organic fertilizer or used to improve soil fertility in green agricultural projects.

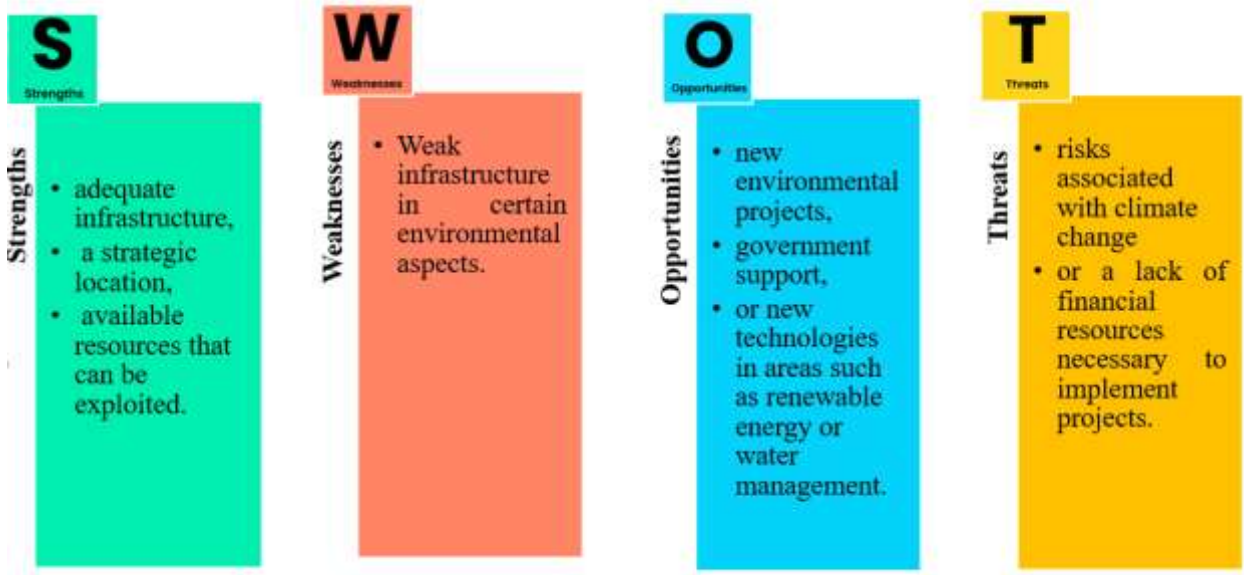
5.7: People in the College

The College of Engineering includes a diverse group of individuals who form part of the daily life within the college. These individuals are distributed among teaching professors, administrative staff, and students. The numbers can be roughly summarized as follows:

1. Teaching Professors: The college has approximately 70 male and female professors specialized in various engineering fields, who teach theoretical and practical subjects to students. These professors contribute to the development of the academic pursuit and research environment within the college.
2. Administrative Staff: The college employs approximately 55 administrative staff, including technical and administrative staff responsible for organizing daily operations at the college, such as hall management, administrative follow-up, and maintenance.
3. Students: The college has approximately 600 male and female students in various engineering disciplines. These students constitute the largest portion of the university community and are the ones who use the educational and research facilities on a daily basis. By knowing the approximate numbers of individuals in the college, it is possible to better plan for providing environmental needs and green facilities that support sustainable education and contribute to raising environmental awareness among all college members.

5.8: SWOT Analysis for the Study Area

SWOT analysis is a strategic tool used to assess the strengths, weaknesses, opportunities, and threats facing a given area. In this context, SWOT analysis is used to assess the environmental and urban situation at the College of Engineering at Al-Qasim Green University with the goal of developing sustainable environmental projects and achieving a shift toward green buildings[10].



6. PROPOSED VISION FOR TRANSITIONING INTO A GREEN BUILDING

In light of the environmental and climatic challenges facing the study area, and the growing need to adopt sustainable development concepts, there is an urgent need to transform the College of Engineering building into a green building. This transformation is based on an analysis of the environmental and urban characteristics of

the site, as mentioned above, particularly the SWOT analysis, which revealed significant opportunities for improvement despite the challenges.

6.1: Energy

Solar energy is the most suitable option for generating electricity in Al Qasim City, given the abundant solar radiation (more than 300 sunny days per year). The project aims to exploit this resource to achieve energy efficiency through the following measures:

- Installing solar PV panels on building roofs to cover 30–50% of electricity consumption, especially in the spring and summer.
- Replacing lighting with LEDs to reduce energy consumption by 60–80%, and thus reduce maintenance costs.
- Installing motion sensors in underutilized areas to provide an additional savings of up to 20%.
- Integrating an BMS to monitor and analyze consumption and improve operational efficiency.
- Studying the use of wind energy: Using small turbines on rooftops, despite the limited wind in the area. These measures contribute to reducing carbon emissions, lowering costs, and enhancing the college's image as a self-sustainable institution.

6.2: Water Management

Al Qasim City faces increasing water challenges due to climate change and scarcity of rainfall, necessitating the adoption of smart solutions within educational buildings. The College of Engineering has developed an integrated plan to achieve efficient water management, including the following measures:

- Water conservation: Using water-saving valves and smart mixers reduces waste by 30–50% in sanitary facilities.
- Rainwater harvesting: By collecting water from building rooftops and storing it in ground tanks, this saves approximately 10–15% of total water consumption during the rainy season.
- Greywater reuse: Resulting from laundries and laboratories after preliminary treatment, this water is used to irrigate plants, reducing reliance on fresh water by 30–40% for irrigation.
- Smart irrigation network: Relying on drip irrigation and humidity sensors, it reduces water loss in irrigation by up to 25–35% compared with traditional systems.
- Environmental Awareness: This includes awareness campaigns and workshops to instill a culture of water conservation, which contributes to promoting responsible behavior and reducing waste in everyday uses[11].

6.3: Waste and Recycling – Towards a Zero-Waste College

The accumulation of solid waste poses a major environmental challenge at the College of Engineering, due to the lack of an effective management system, especially given the high volume of paper and plastic waste. To transition to a green building, the plan proposes implementing the following measures:

- 100% waste sorting within the college through the distribution of color-coded containers (organic, plastic, paper, and electronic).
- Partnership with local recycling companies to collect and process reusable waste according to environmental standards.
- Recycling paper and plastic waste to reduce the total volume of waste by an estimated 40–60%.
- Environmental awareness campaigns: including workshops, posters, and student competitions to promote a recycling culture among students and staff.
- Establishing a central collection point for recycled waste, which will later serve as an environmental education center.
- Utilizing organic waste to produce compost for irrigation of green spaces, reducing organic waste by 20–30%.

6.4: Smart Systems – Digitization in the Service of Sustainability

Smart systems are a vital component of the transition to a modern green building, contributing to improved operational efficiency, reducing waste, and enhancing user awareness by integrating technology with environmental management.

- Building Management System: A centralized system that connects lighting, ventilation, water, and energy systems to monitor performance in real-time, helping to:

- Immediately detect faults and leaks.
- Automatically turn off lights during off-duty hours.
- Reducing operating costs and increasing efficiency by an estimated 20–25%.
- College Mobile Application: Displays electricity and water consumption for each department or laboratory, promoting transparency and positive competition between departments, and engaging students in continuous monitoring.
- Internet of Things (IoT) Sensors: Placed at critical points (water tanks, air conditioning units, etc.) to monitor performance indicators and trigger alerts when consumption exceeds normal limits.
- Lighting and Air Conditioning Automation: Using motion and natural light sensors, air conditioning and lighting are only turned on when needed, reducing energy waste by up to 30%.
- Interactive Environmental Displays: Display live environmental performance indicators (electricity, water, recycling, etc.) to raise awareness and promote sustainable behavior on campus.

6.5: Economic Feasibility

The economic feasibility assessment is based on a comprehensive analysis of the costs of the proposed environmental measures in the College of Engineering's green building project, compared with the expected returns in terms of savings in energy, water, and waste. The total initial investment is estimated at approximately 35,000,000 Iraqi dinars, distributed among the following packages (Table 3):

Table (3): Economic feasibility

Item	Expected Outputs	Estimated Cost (Dinars)
Thermal insulation and exterior cladding	Reduce the building's heat load by 20%	9,000,000
Solar energy systems (PV panels)	Generate 30–50% of annual electricity consumption	15,000,000
LED lighting + motion sensors	Reduce lighting consumption by 60–80%	4,000,000
Water harvesting and treatment system	Saves 30–40% of irrigation water	5,000,000
Waste sorting and recycling	Recycles 50% of the college's waste	1,000,000
BMS system + mobile	Application monitors and optimizes the building's smart operation	1,500,000

6.6: Environmental Feasibility

The project to convert the College of Engineering at Al-Qasim Green University into a green building contributes to a set of tangible environmental benefits on four main levels:

- Reducing Carbon Emissions: Reducing reliance on electricity from the fossil fuel-based national grid through the use of solar energy leads to a reduction of CO_2 emissions by 25–35 tons annually. The application of thermal insulation and LED lighting reduces the need for air conditioning, reducing energy consumption, and associated emissions by an additional 15–20%.
- Improving Indoor and Outdoor Air Quality: Increasing green spaces planted with native plants enhances the absorption of dust and pollutants and increases oxygen levels in the university environment. Relying on natural ventilation (such as wind turbines) reduces the accumulation of indoor pollutants by an estimated 30–40% and improves comfort and overall health in classrooms.
- Increasing the Efficiency of Natural Resource Use: Technologies such as rainwater harvesting, graywater use, and water-saving valves contribute to reducing pressure on groundwater, achieving savings of up to 40% in water consumption. Smart systems (BMS, IoT) reduce waste through real-time control and operation as needed, enhancing resource sustainability.

- Enhancing Local Biodiversity: Establishing educational gardens and green spaces with local species supports the natural environment and restores some forms of wildlife (such as birds and beneficial insects).

7. COMPARATIVE STUDIES

This section aims to review some successful experiences in universities and educational institutions that have adopted sustainability practices, as part of this research's efforts to transform the College of Engineering's building into a green building (Table 4). By studying these similar cases, these models can be leveraged to achieve the environmental transformation goals at Al-Qasim Green University[12, 13].

Table (4): Some University Experiences

Key outcomes	Sustainable management implemented	Educational institution
Cairo University	Installing solar cells on college buildings	Reduce electricity bills by 35%
Jordan University of Science and Technology	A smart rain harvesting system	Save 40% of irrigation water
European Universities (Selected Models)	Using recycled building materials	Reduce buildings' carbon footprint by 20%

8. CONCLUSION

The proposed transformation of the College of Engineering at Al-Qasim Green University into a green building demonstrates both environmental and economic determination and viability. Through the integration of renewable energy systems, smart technologies, and sustainable water and waste management strategies, the project is expected to achieve measurable improvements across multiple performance areas.

1. By installing solar PV panels, the building can generate **30–50%** of its electricity needs, reducing reliance on fossil fuels and cutting carbon emissions by **25–35 tons annually**. LED lighting and motion sensors will reduce lighting energy consumption by **60–80%**, while thermal insulation is expected to reduce the building's heat load by **20%**, contributing to further savings.
2. In the water sector, measures such as rainwater harvesting, graywater reuse, and smart irrigation systems will save up to **40%** of water consumption. Waste management interventions—including sorting, recycling, and composting—will divert an estimated **50%** of solid waste from landfills, while reducing organic waste by **20–30%**.
3. Smart systems such as the BMS and IoT sensors are projected to improve resource efficiency by **20–25%**, while also enabling real-time performance monitoring. The total estimated investment of **35,000,000 IQD** is justified by long-term savings and operational efficiency, with an expected return period of **4–6 years**.
4. Ultimately, this project not only enhances environmental performance and reduces costs, but also sets a precedent for sustainable building practices in Iraqi universities, offering a replicable model that balances innovation with local feasibility.

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