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Sustainable Integration of IGBC Green Building Guidelines with Building Automation for Residential Buildings

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Abstract: *This study focuses on the sustainable integration of IGBC Green Building guidelines with Building Automation Systems (BAS) for residential buildings. The rapid growth of urban housing in India has increased the demand for energy-efficient, environmentally responsible, and cost-effective construction practices. The research analyses the Indian Green Building Council (IGBC) guidelines and explores how automation technologies such as sensors, smart meters, and control systems can enhance building performance. A comparative analysis between conventional buildings and IGBC-certified green buildings is carried out to evaluate energy consumption, water efficiency, and occupant comfort. The findings indicate that combining green building principles with automation can achieve 30–35% energy savings and 50–60% water savings while improving indoor environmental quality. The study concludes by recommending cost-effective automation solutions suitable for both new and existing residential buildings to achieve sustainability goals.*

Keywords: IGBC, Green Building, Building Automation System (BAS), Energy-Efficient, Residential Buildings, Sustainability, Smart Sensors**.**

I. INTRODUCTION

India's housing sector is witnessing unprecedented growth, driving a need for sustainable, energy-efficient, and environmentally responsible construction practices. Green buildings represent a holistic approach that reduces adverse environmental impacts through efficient use of energy, water, and materials throughout a building's lifecycle.

A. Green Building

A Green Building is designed to reduce the negative impact on the environment. It uses energy, water, and materials efficiently throughout its life cycle. Green buildings provide better indoor air quality and natural light for occupants. They focus on reducing waste, recycling materials, and saving natural resources. Use of renewable energy sources like solar power is encouraged. Green buildings help in reducing pollution and carbon emissions and promote environmental responsibility and sustainable development. Overall, they balance environmental protection, human comfort, and economic benefits.

B. Indian Green Building Council (IGBC)

IGBC stands for Indian Green Building Council. It was formed in 2001 by the Confederation of Indian Industry (CII), with its headquarters at CII – Sohrabji Godrej Green Business Centre, Hyderabad. IGBC is a non-profit organization promoting the Green Building Movement in India. Its main goal is to make India a global leader in sustainable buildings. IGBC develops Green Rating Systems for homes, offices, schools, factories, and hospitals. It works with

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architects, builders, and developers to promote eco-friendly practices. Notably, the Indian Green Building Council (IGBC) launched its 31st chapter in Rajkot on August 30, 2025.

C. Building Automation System (BAS)

Building Automation System (BAS) is a technology used to monitor and control building operations automatically. It integrates various systems such as lighting, HVAC (heating, ventilation, and air-conditioning), security, fire safety, and energy management. The main aim of building automation is to increase energy efficiency, enhance comfort, and reduce operational costs. Automated systems can adjust lighting and temperature based on occupancy or time schedules. BAS provides real-time data and reports that help in maintenance and performance analysis.

D. Objectives

- Study IGBC guidelines and evaluation criteria for residential buildings.
- Analyse the need for automation in building services.
- Compare energy usage of conventional buildings and green buildings.
- Evaluate the integration of green building with building automation.
- Recommend automation systems for existing and new buildings for energy saving.

E. Scope of Work

The study is limited to residential buildings (detached, semi-detached, and row houses). Automation analysis focuses on sensors and specific functions. Energy usage comparison is performed for a residential building and a similar IGBC-certified green building. Recommendations are provided based on IGBC guidelines and appropriate automation tools.

II. LITERATURE REVIEW

A review of recent literature highlights significant advancements in integrating digital technologies, automation, and renewable energy with green building practices.

A. Digital Technologies and Green Buildings

Manzoor et al. (2025) explored the integration of BIM, AI, and IoT with green building practices, demonstrating that BIM improves design accuracy and resource optimization, AI enables predictive analysis and smarter energy management, and IoT supports real-time monitoring of building performance. However, the study identifies challenges including high initial costs and gaps in regulatory frameworks.

B. Energy-Efficient Healthcare and Commercial Buildings

Silva et al. (2024) examined energy efficiency in healthcare buildings by comparing sustainable, green, and smart building approaches. The research emphasizes that green design strategies, including efficient HVAC systems, renewable energy integration, and improved insulation, play a key role in minimizing environmental impact, while smart technologies enable real-time adaptive control.

C. AI-Based Sustainability Evaluation

Xiang et al. (2022) focused on evaluating green building sustainability by integrating AI with energy consumption analysis. AI techniques were used to process energy-related data, identify patterns, and predict building performance. The study concluded that AI-based evaluation methods overcome limitations of traditional assessment approaches by offering dynamic and comprehensive performance measurement.

D. Building Integrated Photovoltaic (BIPV) Systems

Tajik and Jahangir (2025) presented an integrated smart green facade combined with photovoltaic systems. The study demonstrated that the green facade, combined with PV panels, reduces heat gain and increases energy savings while

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providing temperature regulation and improved air quality. Muritala et al. (2023) reviewed BIPV applications, highlighting advancements in photovoltaic materials and their role in net-zero energy goals.

E. Renewable Energy in Smart Buildings

Orikpete et al. (2023) explored the integration of renewable energy technologies within smart building design. The research highlighted how solar PV, wind energy, and energy storage combined with smart automated control systems can optimize energy generation and consumption. Abisuga et al. (2022) reviewed sustainable smart buildings, emphasizing the role of sensors, automation, and data-driven energy management in achieving reduced carbon emissions.

F. Literature Gap

While existing research highlights strong progress in automation and green building technologies, a clear gap exists in IGBC-focused, cost-based automation studies specifically for residential buildings in the Indian context. This research directly addresses these gaps by integrating IGBC guidelines with sensor-based BAS and providing comprehensive cost-benefit analysis for residential applications.

III. IGBC GUIDELINES AND GREEN BUILDING FRAMEWORK

A. IGBC Green Homes Rating System

IGBC Green Homes integrates green design and construction techniques in residential projects, promoting efficient use of energy, water, and materials while minimizing pollution and waste. The tangible benefits include 20–30% reduction in energy consumption and 30–50% reduction in water use. Intangible benefits include improved air quality, better occupant health and comfort, and conservation of national resources.

B. Certification Levels

TABLE I: IGBC CERTIFICATION LEVELS

Level	Points Range	Recognition
Certified	50 – 59	Best Practices
Silver	60 – 69	Outstanding Performance
Gold	70 – 79	National Excellence
Platinum	80 – 100	Global Leadership

C. Rating System

TABLE II: IGBC RATING SYSTEM POINTS

Sr. No.	Category	Maximum Points
1	Sustainable Design	20
2	Water Conservation	23
3	Energy Efficiency	20
4	Materials & Resources	18
5	Resident Health & Well-being	14
6	Innovation & Design	5

Sr. No.	Category	Maximum Points
Total		100

D. Key Rating Criteria

The IGBC rating system evaluates six major categories. Under Sustainable Design (20 points), criteria include soil erosion control, natural topography preservation, heat island mitigation, passive architecture, and green parking facilities. Water Conservation (23 points) covers water-efficient fixtures, rainwater harvesting, landscape design using native plants, wastewater reuse, and water metering. Energy Efficiency (20 points) includes minimum energy performance (ECBC baseline), enhanced energy performance, solar water heating, renewable energy integration, and energy monitoring via smart meters and BMS. Materials & Resources (18 points) covers waste segregation, green procurement, eco-friendly wood, and use of alternative materials such as fly ash bricks and AAC blocks. Resident Health & Well-being (14 points) mandates minimum daylighting (50% daylight in spaces), ventilation design, and no-smoking policies. Innovation & Design (5 points) rewards novel sustainable strategies and exemplary performance.

IV. CASE STUDY: IGBC-CERTIFIED RESIDENTIAL PROJECT

A. Project Overview

The Brick & Concrete House located in Ahmedabad, Gujarat, India, designed by Indigo Architects (Mitali and Tarun Kapoor), was selected as the case study. The project is an individual residential dwelling with a total built-up area of approximately 350 m² on a 550 m² plot. The building is located in a hot and dry climate zone (as per ECBC 2017) and was completed in 2018. It was rated under IGBC Green Homes – Version 3.0 and achieved Platinum Certification.

B. Design Philosophy and Key Highlights

The project used local brick, concrete, and stone for low embodied energy and integrated courtyards, shading, and natural light for passive climate response. Key sustainable features include: orientation to reduce west sun exposure; courtyard for stack-effect ventilation; dual plumbing for greywater reuse; rainwater harvesting with filtration; low-flow fixtures achieving 40% potable water saving; high thermal mass brick walls and insulated roof; solar water heater; and LED lighting achieving 30% energy saving. Additionally, 100% of spaces have daylight and cross ventilation, with non-toxic low-VOC finishes and outdoor connectivity from all living zones.

C. Technical Parameters

- Wall Assembly: 350 mm exposed fly ash brick wall
- Roof: RCC slab with vermiculite insulation and high-SRI finish
- Glazing: Double-glazed 6 mm units with shading devices
- Ventilation: Cross ventilation via aligned openings
- Renewable Energy: Solar water heating system
- Lighting: 100% LED with daylight sensors
- Water System: Dual plumbing with greywater reuse

D. IGBC Rating Achieved (Platinum)

TABLE III: IGBC RATING ACHIEVED

Sr. No.	Category	Maximum Points	Points Achieved
1	Sustainable Design	20	17
2	Water Conservation	23	20

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Sr. No.	Category	Maximum Points	Points Achieved
3	Energy Efficiency	20	18
4	Materials & Resources	18	15
5	Resident Health & Well-being	14	12
6	Innovation & Design	5	5
Total		100	87

The building achieved a score of 87/100, qualifying for Platinum certification. Performance metrics include 30–35% energy savings over ECBC baseline, 50–60% water reduction through reuse systems, more than 90% construction waste recycled, and indoor air quality maintained as per ASHRAE 62.1 standards. Indoor temperatures were recorded at 4–6°C cooler than outdoors during summer months.

V. AUTOMATION SYSTEMS FOR GREEN RESIDENTIAL BUILDINGS

Building Automation Systems (BAS) enhance green building performance through intelligent monitoring and control. The automation tools are categorized by IGBC criteria areas:

A. Sustainable Design Automation

Daylight/LUX Sensors measure natural light levels and automatically adjust artificial lighting, enabling electricity savings by maximizing daylight utilization. PIR (Passive Infrared) Sensors detect occupancy and control lighting and HVAC accordingly, eliminating energy waste in unoccupied spaces. Temperature and Humidity Sensors maintain thermal comfort by feeding data to automated HVAC controls.

B. Water Conservation Automation

Smart Water Meters monitor consumption in real-time, enabling sub-metering per flat/unit as required by IGBC. Leak Detection Sensors provide immediate alerts for pipe leakage, preventing wastage. Soil Moisture Sensors optimize irrigation by activating water supply only when required. Ultrasonic Sensors measure tank levels for automated pump control. Diversion Valve Sensors enable automatic switching between potable, greywater, and rainwater harvesting systems.

C. Energy Efficiency Automation

Smart Energy Meters enable real-time energy monitoring and BMS integration per IGBC Energy Monitoring credits. Smart Switches automate lighting and appliance control. Smart Lighting Dimming Modules optimize energy use based on occupancy and daylight availability. BLDC (Brushless DC) Fans offer 50–60% energy savings over conventional ceiling fans. Solar panel integration with smart inverters enables net metering and generation tracking.

D. Resident Health and Well-being Automation

IAQ (Indoor Air Quality) Sensors monitor CO_2, PM2.5, VOC, and humidity levels, triggering ventilation when required. Temperature and Humidity Sensors maintain comfort conditions automatically. Smoke/Fire Sensors and LPG/Gas Leak Sensors ensure resident safety with automatic alerts and responses. Smart Lighting with circadian rhythm support improves occupant well-being.

E. Network & Power Infrastructure

A Central Automation Hub integrates all subsystems on a unified platform. Wireless Mesh Networks ensure reliable, low-latency communication between sensors and controllers. Power over Ethernet (PoE) enables simultaneous data and power delivery to sensors, reducing cabling complexity. Voice Control Interfaces and mobile applications provide user-friendly access and control. Power Backup systems (UPS + battery) ensure BAS continuity during power outages.

VI. ENERGY AND COST ANALYSIS

A. Conventional vs. Green Building – Residential Case

A residential building of conventional construction was identified and its energy consumption was analysed. The conventional building was then conceptually converted to a green building system to evaluate savings.

TABLE IV: ENERGY CONSUMPTION COMPARISON – RESIDENTIAL BUILDING

Parameter	Conventional Building	Green Building (No Automation)	Green Building + Solar
Daily Energy (kWh/day)	64.14	37.30	17.30 (net)
Monthly Consumption (kWh)	1,924	~1,119	519
Monthly Electricity Cost (₹)	₹13,468	~₹7,833	₹3,633
Energy Reduction	—	~42%	~70–75%

Key upgrades for conversion include: replacement of conventional ACs with inverter ACs (30–40% saving), transition to LED lighting (70–80% saving), installation of BLDC fans (50–60% saving), passive design improvements (natural ventilation reducing cooling load), and installation of a 5 kW solar PV system generating approximately 20 kWh/day.

B. High-Rise Residential Building – Single Unit Analysis

TABLE V: HIGH-RISE UNIT ENERGY ANALYSIS

Parameter	Without Automation	With Automation
Monthly Consumption (kWh)	1,351	1,089
Monthly Cost (₹)	₹9,457	₹7,623
Monthly Saving (₹)	—	₹1,834
Annual Saving (₹)	—	₹22,008

C. High-Rise Common Utilities Analysis

Common utility areas (lobby, corridor, stairwell, lifts, pumping) of a high-rise residential building were analysed with and without automation. With automation integration and solar panel addition for common utilities, substantial reductions in energy costs were achieved, further supported by renewable generation offsetting grid dependence.

D. Cost of Automation Investment

- Basic automation package: ₹76,000 per unit
- Comprehensive automation (full BAS with solar monitoring): ₹1,95,000 per unit
- Estimated payback period: 3–5 years
- Annual monetary saving per unit: approximately ₹22,000

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VII. FRAMEWORK FOR CONVERTING CONVENTIONAL TO AUTOMATION-ENABLED GREEN BUILDINGS

A step-by-step framework was developed for systematic conversion of conventional residential buildings into automation-enabled green buildings aligned with IGBC guidelines:

Step 1 – Assessment of Existing Building:

Conduct an energy audit and building performance assessment. Identify current energy, water, and material consumption patterns.

Step 2 – Mapping with IGBC Green Building Criteria:

Evaluate existing compliance with IGBC mandatory and credit requirements across all six categories. Identify gaps and prioritize interventions.

Step 3 – Passive Design Improvements:

Implement passive cooling strategies including shading devices, courtyard design, reflective roof coatings, and improved glazing to reduce thermal load.

Step 4 – Energy Efficiency Upgradation:

Replace conventional systems with energy-efficient alternatives: inverter ACs, LED lighting, BLDC fans, and high-efficiency water pumps.

Step 5 – Water Efficiency and Management:

Install low-flow fixtures, dual plumbing for greywater reuse, rainwater harvesting systems, and sensor-controlled smart irrigation.

Step 6 – Integration of Building Automation System (BAS):

Deploy central automation hub, sensors (PIR, LUX, IAQ, temperature, leak detection), smart meters, and automated control systems.

Step 7 – Renewable Energy Integration:

Install solar PV systems for common areas and individual units. Integrate net metering and battery storage for self-sufficiency.

Step 8 – Smart Monitoring and Data Analytics:

Implement real-time dashboards for energy and water consumption. Use predictive analytics for maintenance scheduling and performance optimization.

Step 9 – Cost-Benefit Analysis:

Evaluate return on investment, payback period, and lifecycle cost benefits to demonstrate economic viability.

Step 10 – Final Implementation and Optimization:

Commission the complete integrated system, train occupants and facility managers, and establish continuous monitoring protocols.

The transformation flow progresses from: Conventional Building → Passive Design → Efficient Systems → Automation → Renewable Integration → Smart Monitoring → Green Automated Building.

VIII. RESULTS AND DISCUSSION

A. Energy Consumption Results

- Conventional Building: Daily Energy = 64.14 kWh/day; Monthly Cost = ₹13,468
- Green Building (without automation): Daily Energy = 37.3 kWh/day; Reduction ≈ 42%
- Green Building with Solar (5 kW system generating 20 kWh/day): Net daily consumption = 17.3 kWh; Monthly consumption = 519 kWh; Monthly cost = ₹3,633; Total energy saving = 70–75%

B. Automation System Results (High-Rise Unit)

- Without Automation: Monthly consumption = 1,351 kWh; Cost = ₹9,457/month
- With Automation: Monthly consumption = 1,089 kWh; Cost = ₹7,623/month
- Savings: Monthly = ₹1,834; Annual = ₹22,000

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C. Water Consumption Results

- From the case study: 50–60% water reduction achieved
- Achieved through: rainwater harvesting, greywater reuse, smart irrigation, and low-flow fixtures

D. Comparison with IGBC Benchmark Data

TABLE VI: ENERGY COMPARISON WITH IGBC DATA

Parameter	IGBC Data	Project Result
Energy Saving	20–30% (IGBC baseline)	70–75% (with solar + design)
Automation Saving	10–25%	15–20%
Solar Contribution	20–40%	~53% (20/37.3 units)

The project shows higher-than-baseline savings due to the combined strategy of passive design, efficient systems, building automation, and solar energy integration.

E. Discussion

The results clearly demonstrate that integrating IGBC guidelines with building automation significantly improves residential building performance across energy, water, and occupant comfort dimensions. Major energy reduction is attributed to replacement of conventional systems with efficient alternatives (inverter AC: 30–40% saving; LED lighting: 70–80% saving; BLDC fans: 50–60% saving), passive design strategies reducing cooling load, and renewable solar energy integration reducing grid dependency.

Automation plays a supportive yet critical role. Sensors (PIR, daylight, IAQ) reduce unnecessary usage, smart meters enable monitoring and control, and smart thermostats optimize HVAC operation. However, automation alone yields 10–25% savings; maximum savings occur when combined with green design principles and renewable energy.

Water savings of 50–60% are achieved through rainwater harvesting, smart irrigation with soil moisture sensors, and grey-water reuse systems, collectively reducing municipal water dependency, operational costs, and environmental impact.

The initial investment of ₹76,000 to ₹1,95,000 per unit is justified by a payback period of 3–5 years, making the system economically viable. The integration also aligns with national goals of energy conservation and sustainable development by reducing carbon emissions and lowering fossil fuel dependency.

IX. CONCLUSION

A. Key Findings

- Green buildings significantly reduce energy consumption (70–75% with solar) and water consumption (50–60%).
- Integration of automation enhances operational efficiency by an additional 15–20%.
- Solar energy plays a major role in achieving near self-sufficiency in energy.
- IGBC guidelines provide a strong, structured framework for sustainable residential development.

B. Performance Summary

- Energy saving: 70–75% (combined green design, automation, and solar)
- Water saving: 50–60%
- Cost saving: approximately ₹10,000/month difference
- Payback period: 3–5 years

C. Practical Implications

The proposed framework is suitable for both new and existing residential buildings and is scalable from individual houses to high-rise apartments. It directly supports India's sustainability goals including energy conservation targets and green building movement expansion. IGBC guidelines and BAS integration together provide a replicable model for sustainable residential development across Indian cities.

D. Final Statement

The integration of IGBC green building guidelines with building automation systems provides a highly efficient, economically viable, and environmentally sustainable solution for modern residential buildings. It not only reduces operational costs but also improves occupant comfort and contributes to long-term ecological balance. This research demonstrates that sustainable building development is not a luxury but a viable and necessary approach for India's growing residential sector.

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REFERENCES

[1] B. Manzoor, M. F. Antwi-Afari, and K. S. Alotaibi, "Green buildings and digital technologies: A pathway to sustainable development," Green Technologies and Sustainability, 2025.

[2] B. V. F. Silva, J. B. Holm-Nielsen, S. Sadrizadeh, M. P. R. Teles, M. Kiani-Moghaddam, and A. Arabkoohsar, "Sustainable, green, or smart? Pathways for energy-efficient healthcare buildings," Sustainable Cities and Society, 2024.

[3] Y. Xiang, Y. Chen, J. Xu, and Z. Chen, "Research on sustainability evaluation of green building engineering based on AI and energy consumption," Energy Reports, 2022.

[4] S. Tajik and M. H. Jahangir, "Innovative design, fabrication, and evaluation of an integrated smart green facade and photovoltaic," Energy Reports, 2025.

[5] Z. Feng, M. Ge, and Q. Meng, "Enhancing energy efficiency in green buildings through artificial intelligence," Preprints.org, 2024.

[6] A. S. Muritala, A. O. Raji, and A. A. Durodola, "Building integrated photovoltaic systems: A review of recent developments and applications," Journal of Solar Energy Research Updates, 2023.

[7] O. F. Orikpete, S. Ikemba, and D. R. E. Ewim, "Integration of renewable energy technologies in smart building design for enhanced energy efficiency and self-sufficiency," Journal of Engineering and Exact Sciences, 2023.

[8] A. O. Abisuga, L. O. Oyedele, and A. Akanmu, "Sustainable smart buildings: A review of green building design and renewable energy integration," Energy and Built Environment, 2022.

[9] Indian Green Building Council (IGBC), "IGBC Green Homes Rating System – Version 3.0," Confederation of Indian Industry (CII), Hyderabad, India.

[10] Bureau of Energy Efficiency (BEE), "Energy Conservation Building Code (ECBC) 2017," Ministry of Power, Government of India