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# GEORGIAN PRACTICES IN ENERGY EFFICIENCY AND BUILDING AUTOMATION

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**Abstract**

Drawing on recent literature and empirical data, this article examines an issue of strategic importance for both science and practice: energy efficiency and building automation in Georgia.

The focus is on identifying which technological solutions are most relevant for different functional building types and which solutions are currently most widely adopted.

The article concludes that the development trajectory of modern buildings is closely tied to innovative technologies whose deployment is aimed not only at user comfort, but also at optimising energy use and strengthening safety mechanisms.

**Keywords:** *Energy efficiency; building automation; technological solutions; innovative technologies; energy management; smart technologies; intelligent buildings*

## I. Introduction

Energy efficiency and energy management are among the most significant and topical priorities in the development of modern residential and commercial spaces. These two concepts are closely interlinked: when implemented correctly, they not only reduce energy consumption but also lower environmental impact and enable more efficient cost control.

Energy efficiency means achieving maximum results with minimal energy input. This can be realised at the technological level. For example, through LED lighting or thermal insulation, as well as at the system level, including overall building design, space planning, and material selection. An energy-efficient building reduces heat loss in winter and heat gain in summer, thereby easing the load on heating and cooling systems. Ultimately, this approach lowers both energy use and utility costs.

Energy management, by contrast, is a broader and more dynamic process that involves continuous monitoring, analysis, and optimisation of energy consumption. It is implemented both programmatically (via energy management systems) and through human engagement (energy audits and changes in consumption behaviour). Energy management typically integrates digital technologies, sensors, IoT devices, and smart algorithms, enabling real-time assessment of energy use and prompt corrective action.

In contemporary smart homes, energy management systems control heating, cooling, lighting, household appliances, and other electrical devices. Such systems not only record device operation but also learn user behaviour and automatically regulate energy consumption to maintain maximum comfort with minimal expenditure. For example, lights automatically switch off or heating shifts to an economy mode when a room is unoccupied, producing immediate savings.

Energy management systems are often integrated with renewable energy sources, such as solar panels or heat pumps, and can store, redistribute, and even feed surplus energy back to the grid. Through this integration, buildings become energy-active units, which is especially important in the context of sustainable development.

Energy efficiency and energy management help buildings meet standards such as Nearly Zero-Energy Building (nZEB) and Passive House, both of which aim for minimal energy consumption and reduced environmental impact. With these approaches, buildings are no longer merely energy consumers; they increasingly act as active managers and, at times, producers of energy.

To analyse these issues in practice, a study was conducted in three major cities of Georgia -Tbilisi, Batumi, and Kutaisi. The objective was to determine which specific solutions are most in demand in different building segments. The study relied on individual interviews and on-site review of existing systems.

## II. Results and Discussion

The analysis of existing energy-efficient and automated buildings highlights a transformative process underway in recent years across urban and industrial architecture, both in Georgia and globally. A clear trend emerges: the development trajectory of modern buildings is inseparable from innovative technologies aimed not only at comfort but also at optimising energy performance and enhancing safety mechanisms.

The goal was not merely to map the popularity of specific technologies but to analyse their functional distribution by building type. Accordingly, a detailed methodology was designed to observe a broad spectrum of facilities, from residential apartments to GDP-standard pharmaceutical buildings. The findings show that, despite an overarching trend toward automation, concrete solutions are adopted at different speeds and for different purposes across building types (Table 1).

**Table 1.** *Functional distribution of specific technologies by building type*

| Building Type | Lighting Automation | Heating/ Cooling (HVAC) | Door/ Entry Control | Motion Sensors | Thermostats | Gas/ Water Sensors | Security Cameras |
|---|---|---|---|---|---|---|---|
| **1. Apartments (Residential)** | H (H - High priority) | H | M (M– Medium priority) | H | H | M | M |
| **2. Detached Houses** | H | H | H | H | H | H | H |
| **3. Hotels** | H | H | M | H | H | M | H |
| **4. Industrial Facilities** | M | H | M | M | H | H | H |
| **5. Office Buildings** | H | H | M | H | H | L (L– Low priority) | M |
| **6. Warehouses** | M | M | L | H | M | M | M |
| **7. GDP-Standard Pharmaceutical Buildings** | H | H | H | H | H | H | H |

The functional distribution of specific technologies by building type is as follows:

1. Apartments (Residential): Lighting and ventilation/thermal regulation are typical priorities, supported by motion sensors for comfort. Door automation and security cameras are of medium importance; they are frequently used, but continuous control is not always required.
2. Detached Houses: A maximally automated environment where all components tend to be prioritised, including security cameras and convenient access (entry automation), alongside widespread use of thermostats and sensors.
3. Hotels: Similar to residential apartments, but with increased emphasis on guest safety (security systems) and on heating/cooling.
4. Industrial Facilities: Cameras, thermal control, and safety-related sensors (e.g. gas and fire detectors) are key. Lighting and motion sensors are selectively deployed, particularly for nighttime operations.
5. Office Buildings: Lighting and HVAC automation are widely implemented to save energy. Solutions are designed to manage building operations efficiently during off-hours as well as working hours.
6. Warehouses: Motion detection and security are the primary needs. Other components are generally lower priority.
7. GDP-Standard Pharmaceutical Buildings: These are among the most demanding environments, requiring high-level control across virtually all domains: lighting, access, safety, heating/cooling, and tightly regulated conditions for gas, water, temperature, and humidity.

Across building classes, lighting automation and HVAC control play central roles. Because these subsystems account for the bulk of energy consumption, their optimisation has an outsized impact. Lighting automation has become both an economic and environmental imperative, particularly in urban and commercial spaces. HVAC automation is tightly coupled to overall energy performance and, especially under zonal control and mechanical ventilation, forms the spine of system integration.

Adoption patterns are not uniform. Segments such as GDP-standard facilities and hotels exhibit high levels of technological integration, whereas logistics-oriented spaces like warehouses tend to deploy only critical elements (e.g., motion detection and security cameras), guided by economic rationale and functional specificity. Regulatory strictness, intended use, and operational characteristics also shape the pace and depth of adoption.

Importantly, the effectiveness of smart systems increases markedly when they operate as an integrated whole. For example, via Building Management Systems (BMS), IoT, and PLC/SCADA platforms using protocols such as KNX and Zigbee. Buildings that centralise control of voice assistants, sensors, lighting, and thermostats demonstrate clear gains in energy efficiency and user comfort, which in turn enhance asset performance, value, and service quality.

## III. Conclusion

Energy efficiency and building automation practices in Georgia are developing incrementally. The level of adoption depends directly on a building's functional purpose as well as the owner's vision and investment readiness. To achieve comprehensive and long-term benefits, a systemic approach is essential, one that goes beyond selecting technical solutions to embrace user-centric, flexible, and multifunctional architectures. This direction has emerged as a core strategic priority at the intersection of sustainable urban development, energy-economic optimisation, and environmental responsibility.

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