WHITE PAPER

Policy-Driven Development of Smart Buildings in Europe

Make Sensing Matter

CONTENTS

INTRODUCTION

The European building sector is undergoing a profound transformation. Driven by ambitious climate targets, rising energy costs, and a growing demand for efficiency and comfort, the continent is shifting from traditional construction to intelligent, sustainable building management. This transition represents a strategic imperative, supported by robust EU policies, significant funding, and accelerating technological innovation.

This report provides a comprehensive analysis of the current state and future direction of Europe's smart building industry. It examines key market dynamics, policy frameworks, renovation challenges, and the expanding role of IoT and smart technologies in reshaping how buildings are built, managed, and experienced.

Designed for professionals involved in building technology and integration, this document offers valuable insights into:

- The growing dominance of building renovation over new construction
- The critical impact of EU directives such as EPBD and the Renovation Wave
- Emerging opportunities in energy management, facility optimization, and occupant comfort
- The integration of smart technologies like BMS, IoT sensors, and automation systems
- Market segmentation and growth projections across building types and regions

For those engaged in upgrading built environments or developing advanced building solutions, this report serves as a strategic guide to understanding the forces driving Europe's smart building transition—and the evolving landscape of opportunities it presents.

ABOUT MILESIGHT

Milesight is dedicated to pioneering intelligent sensing solutions that capture meaningful data and make it accessible across a wide range of applications. By innovatively applying emerging technologies such as AI, 5G, and IoT to distinct use scenarios, we enable new possibilities in data-driven decision-making and operational efficiency.

With extensive experience across the European smart building market, we have come to a pivotal insight: the region's building transformation will be defined by integration. As policies like the EPBD accelerate smart retrofits, success requires seamlessly bridging IoT innovations with legacy infrastructure. This is the foundation of our People Sensing Driven Smart Building strategy—creating spaces that are not only energy-compliant but also intuitively responsive to human presence, transforming regulatory mandates into tangible operational and human benefits.

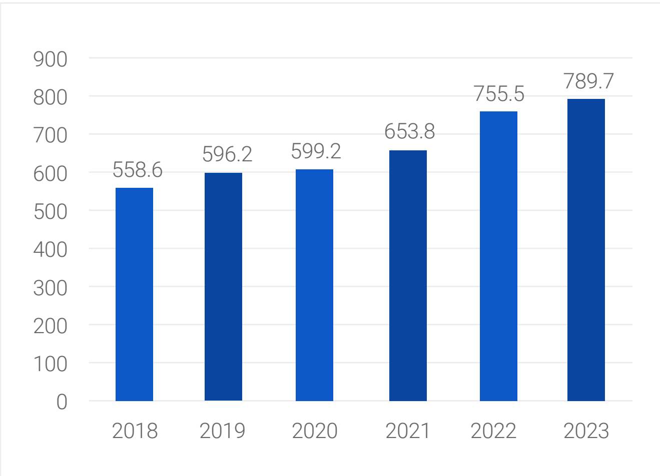
This report embodies our commitment to making sensing matter. By sharing this analysis, we aim to equip industry partners to navigate Europe's evolving landscape, demonstrating how integrated, human-aware solutions bridge the gap between policy compliance and operational excellence.

1.CURRENT STATE OF THE EUROPEAN BUILDING SECTOR

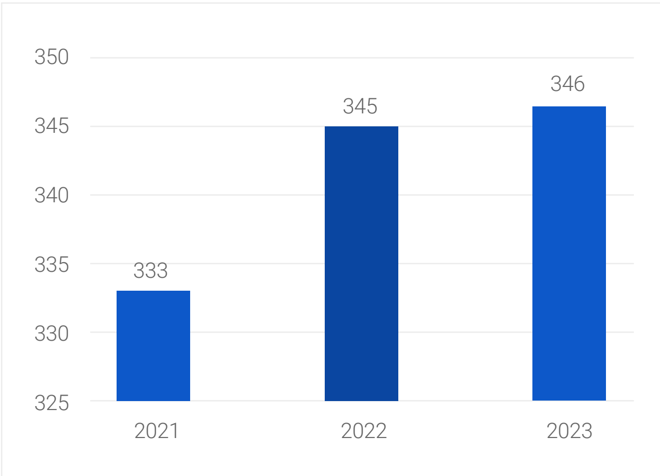
The construction industry remains a cornerstone of the European economy, accounting for over 5%[1] of the EU's GDP as of October 2024. Although its relative share in economic activity has seen a slight decline in recent years, the sector continues to play a vital role, providing direct employment to 18 million individuals and supporting an additional 24.2 million jobs indirectly. As of April 2025, construction output in the EU increased by 2.5% year-on-year, reflecting sustained momentum.

Building construction, a key segment of the broader construction industry, demonstrated a market size of €789.7 billion in 2023, representing 34% of the total European construction market with a compound annual growth rate of 5.94%. This segment supports more than 3 million jobs, with employment numbers continuing to grow. From an investment perspective, the European real estate market attracted €206 billion in investments in 2024, a 23% increase compared to 2023, signaling strong investor confidence.

Despite challenges such as the pandemic, the building sector has maintained its position as a stable and expanding economic pillar, characterized by a large market volume and steady growth.



European Building Construction Industry Market Size
(in billion EUR)[2]



Number of People Employed in European Building Construction
(in ten-thousands)[3]

1.1 Building Stock and Typology

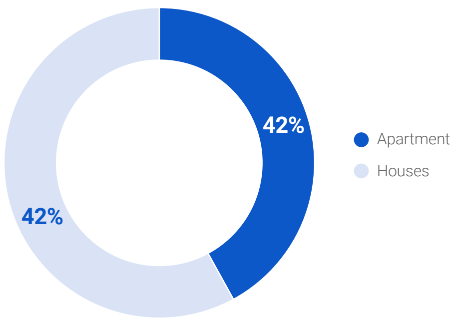
According to data from the EU Building Stock Observatory, the entire EU has approximately 1.1 billion buildings with a total floor area of 272.9 billion m^2 (2020 data)[4]. Residential buildings account for about 80% of the total number of buildings and around 90% of the total floor area.

We can further categorize the building stock in different dimensions.

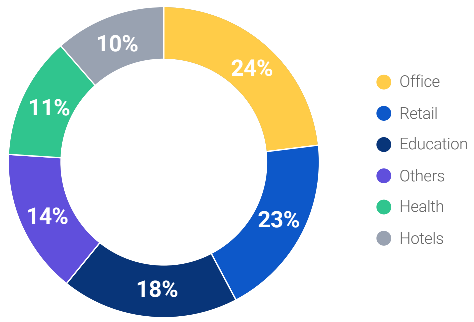
Classified by residential and non-residential types

	Buildings(numbers)	Floor Area(m^2)
Total	111.58M	27,229M
Resident	101.47M	18408M
Non-Resident	10.11M	8,821M

Classified by quantity[5]

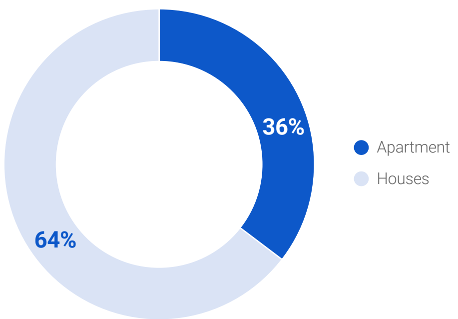


Percentage Breakdown of Residential Building Categories

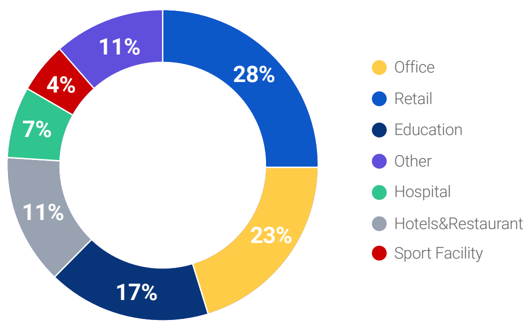


Percentage Breakdown of Non-Residential Building Categories

Classified by floor area[6]



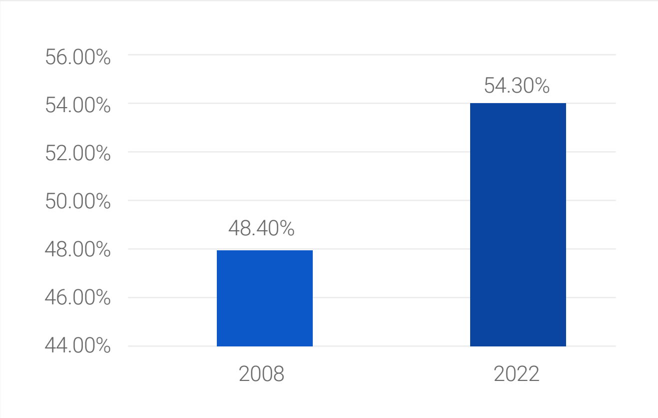
Proportion of Residential Building Types



Proportion of Non-Residential Building Types

Residential buildings constitute the predominant building type in the European Union. Among non-residential structures, office spaces, retail establishments, and educational facilities represent the most common categories.

Research indicates that the total building area is expanding at an annual rate of approximately 1%. This growth in floor area subsequently leads to increased energy demand in buildings. Beyond implementing strict standards for new net-zero constructions, it is equally crucial to enhance the energy efficiency of existing buildings.



Share of renovation of Total building Market[7] in EU

1.2 Market Trend: Less Construction, More Renovation

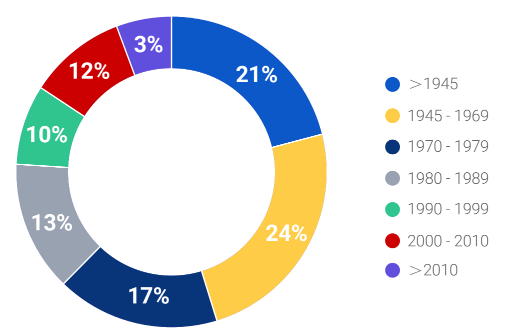
Since 2010, the renovation and maintenance (R&M) market in Europe has surpassed new construction in terms of market share. Although individual new construction projects typically generate higher revenue per building, the overall volume and value of renovation work now exceed those of new builds. This shift highlights a growing focus on upgrading existing buildings, a trend expected to accelerate further due to supportive policy measures.

1.3 Why is the trend of renovation/retrofitting becoming increasingly strong?

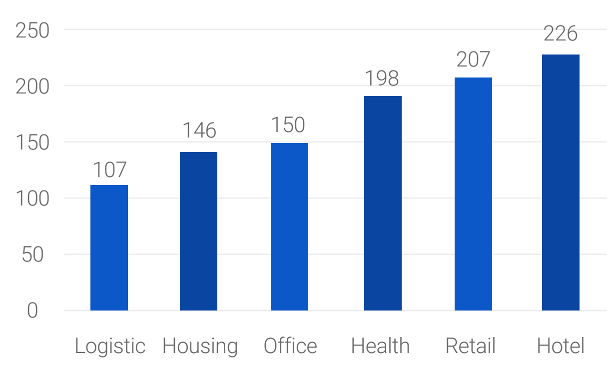
1.3.1 Unsatisfactory Energy Performance

Buildings are responsible for approximately 40% of the EU's energy consumption and 50% of its natural gas use. About 75% of existing buildings in Europe underperform in terms of energy efficiency. More critically, due to constraints in land resources and the prevalence of historical structures, around 80% of these existing buildings are expected to remain in use until 2050, placing significant pressure on the environment. Nevertheless, buildings represent a vital source of economic activity and serve as essential spaces for both daily life and commerce.Therefore, improving energy efficiency is urgently needed. Without targeted renovation measures for existing structures, energy waste caused by buildings will persist. According to data from Deepki, hotels currently have the highest average energy consumption among all building types in Europe, making them a key target for potential renovation initiatives across the continent.

The high energy consumption is largely attributable to Europe's aging building stock. Approximately 85% of buildings[8] were constructed before the year 2000, resulting in a relatively old average building age. Older buildings suffer from poor energy performance due to factors such as historical design flaws, aging materials, outdated technology, and inadequate maintenance.



Building Age Distribution in Europe



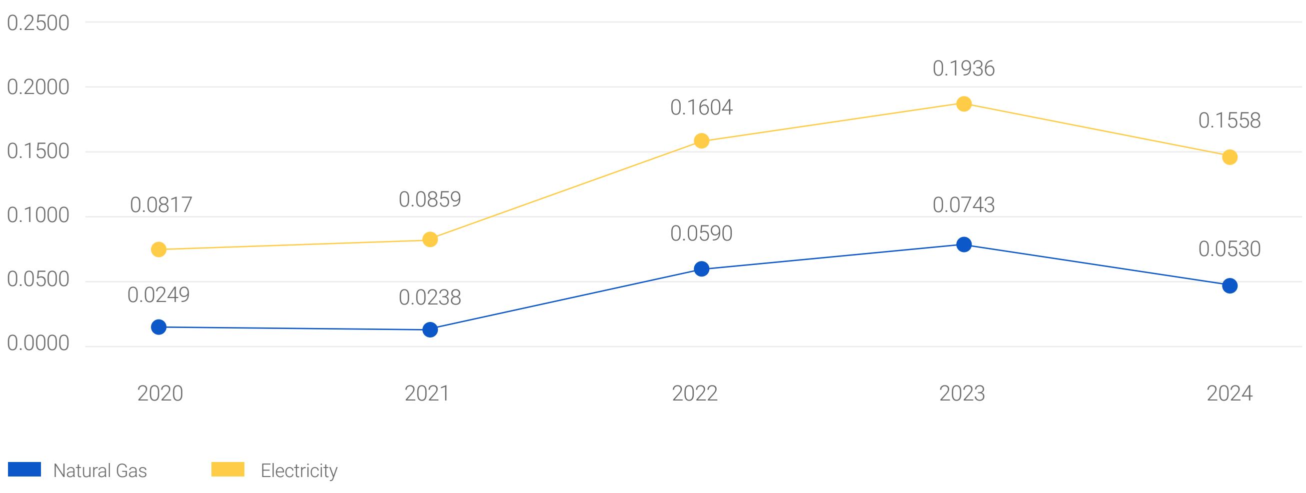
Average Final Energy Consumption by Building Type[9]

1.3.2 Rising Energy Prices

Over the past few decades, declining primary energy production within the European Union has led to increased imports of both primary and secondary energy products. In 2023, the EU's energy import dependency rate reached 58.4%[10]. Energy serves as the "lifeblood" of a nation's economy and society, and over-reliance on imports leaves the stability of energy supply entirely subject to external factors. Any disruption in external supply could directly impact normal national operations. Moreover, energy prices are prone to fluctuations, affecting both households and businesses. Against this backdrop, in addition to measures aimed at securing supply, improving domestic energy efficiency has become increasingly crucial.

Taking electricity and natural gas prices as examples, overall energy prices in Europe surged beginning in 2021. Although prices began to stabilize in 2023, they remain high compared to pre-2020 levels. As previously noted, buildings account for 50% of total natural gas consumption in Europe. Rising energy prices have increased operational costs for building owners, and high energy expenses are, to some extent, driving the transition toward energy efficiency and accelerating building renovation efforts.

European Electricity & Natural Gas Price Trends (Unit: EUR/kWh)[11]



1.3.3 Suboptimal Comfort Levels

Older buildings generally offer lower comfort levels compared to modern constructions, which has further incentivized renovation efforts. Due to poor insulation and air tightness, heat often escapes through roofs, walls, floors, and windows in aging structures. As a result, residents need to set heating at higher temperatures or intensity, leading to both energy waste and reduced comfort. In addition, building materials such as asbestos, aging pipelines, and outdated ventilation systems in older buildings are prone to releasing pollutants, directly impairing indoor air quality.

By improving the indoor environment, stabilizing temperatures, and enhancing air quality, building renovations are projected to save over €9 billion annually in healthcare and social welfare expenditures.[12] The urgency of enhancing building resilience was underscored during the summer of 2022, when heat-related causes resulted in more than 61,000 excess deaths across Europe. A 2022 EU survey revealed that residents living in homes older than 40 years reported 23% lower overall comfort satisfaction compared to those in newly built residences. This pursuit of improved comfort is also driving building renovation initiatives.

2.CHARACTERISTICS OF BUILDING RENOVATION IN EUROPE

2.1 Current Renovation Landscape

According to a study by Ipsos and Navigant (2019), building renovation types can be categorized into energy-related and non-energy-related renovations. Furthermore, based on Schimschar (2011), non-energy renovations can be subclassified into comprehensive renovations, partial renovations, and specific-purpose renovations.

Renovation Types

Energy renovations	Deep renovation: saving >60% of energy consumption.
	Medium renovation: saving 30-60% of annual energy consumption.
	Light renovation: saving <30% of annual energy consumption.
Non-energy renovations	Complete renovation: complete renovation of the building.
	Partial renovation: renovating or replacing one component of the building is affecting all occupants.
	Particular renovation: carried out by private individuals for a specific part of a building.

There remains a significant gap between Europe's current renovation rate and the pace required to meet energy-related policy targets. The annual renovation rate currently stands at just 1%. At this speed, it would take approximately 100 years to achieve carbon emission goals. However, accelerating renovation progress is not merely a matter of raising awareness—it also demands substantial financial investment. Considerable effort remains necessary for Europe to bridge this gap and reach its objectives.

	Annual renovation rate	Annual deep renovation rate
Current:	1%	0.2%
Needed for 2030 targets:	2%(renovation wave)	3% overall (BPIE)

The current renovation rates in Europe and the targets needed by 2030 to meet climate goals[13]

2.2 Key Challenges in Building Renovation

A. Direct Costs

For local governments, the cost of building renovations is undoubtedly a major challenge, with over 90% citing it as one of the largest investment gaps in the EU. According to BPIE estimates, medium-level renovations require approximately €290 per square meter, while deep renovations cost around €405 per square meter. To achieve the 2030 climate target of reducing emissions by 55%, an additional annual investment of about €275 billion[14] is needed in building renovations—equivalent to 1.5% of the EU's GDP. Given limited public funding, mobilizing private sector involvement through complementary investments has become a critical issue. However, for private investors, building renovation remains a relatively unfamiliar area, with perceived uncertainties regarding returns, resulting in lower investment willingness compared to other sectors.

B. Indirect Costs

During building renovation projects, key construction activities—such as structural upgrades, pipeline replacements, and equipment modernization—often require site evacuation, utility shutdowns, or area closures. This forces businesses to suspend operations, residents to relocate temporarily, or organizations to halt onsite activities. For example, shopping mall renovations may lead to store closures for several weeks, office retrofits could require companies to lease temporary alternative spaces, and residential upgrades might necessitate short-term tenant relocation.

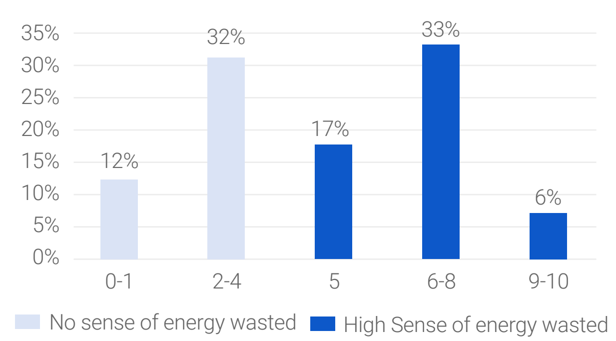
Such interruptions directly result in economic losses, including reduced revenue for retailers, decreased operational efficiency for businesses, and potential customer attrition—particularly in sectors reliant on continuous service provision, such as food service and healthcare.

C. Talent and Technology Shortages

More than 90% of local governments identify labour shortages as a critical barrier to improving building energy renovation rates[15]. They also report a significant lack of talent with "green" skills, noting that not only is the traditional workforce insufficient in size, but its skill set is misaligned with the demands of green retrofitting. The adoption and integration of existing green building technologies—as well as smart building solutions emerging from digital infrastructure, AI, and IoT, such as intelligent HVAC controls, energy monitoring devices, and BMS—pose another major challenge. Furthermore, there is insufficient technological penetration and database infrastructure to monitor the status and energy consumption of Europe's building stock. Better data sharing across European countries and regions regarding their building inventories is also needed.

D. Public Awareness

In Europe, approximately 16%[16] of buildings undergo partial to comprehensive renovations each year. However, only 1% of these include energy-related improvements. According to a 2024 survey by OBS Cetelem, 44% of property owners are not aware of energy waste issues in their buildings. At the same time, awareness of the Energy Performance Certificate (EPC)—which helps owners understand a building's energy consumption—remains low, with only 51% of owners indicating they are familiar with the certificate.



Perception of Energy Waste in Buildings Across Europe
(0=Not Aware at All, 10=Highly Aware)

Regarding government policy subsidies, 63% of people are aware of public financial support programs, but only 15% can describe the specific policy details. European citizens' understanding of building renovation remains focused on short-term economic benefits: 46% cite reducing energy bills as their primary motivation for renovation, while only 23% consider environmental protection a major driver. This "utilitarian approach" often leads renovation projects to overlook long-term social benefits.

E. Tenants and Property Owners

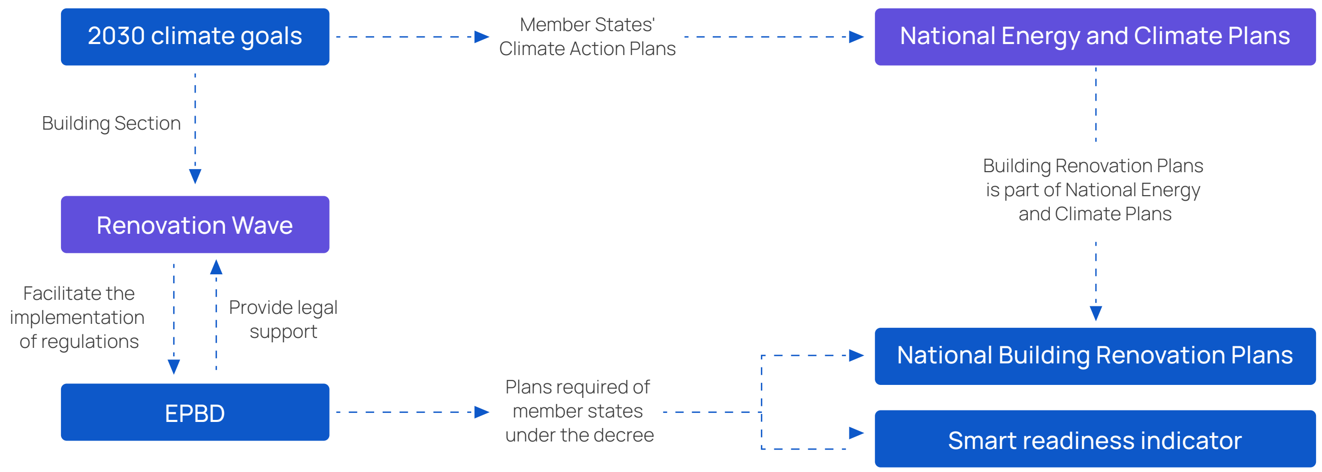
Another major challenge lies in reconciling the differing perspectives between property owners and their commercial tenants regarding renovations. Tenants often expect landlords to undertake building improvements, as these can help reduce energy costs. However, landlords, concerned about the substantial upfront investment and the fact that tenants may reap most of the immediate benefits, frequently request that tenants share the cost of renovation. Tenants, in turn, argue that such upgrades enhance the property's commercial value—which primarily benefits the owner—and are therefore reluctant to contribute. They also often oppose any resulting rent increases.

In multi-tenant buildings, coordinating the preferences of various renters adds further complexity, as not all are willing to support renovation efforts. These conflicting interests create significant barriers to energy retrofits and slow market adoption. In response, green clauses are increasingly being incorporated into commercial leases—stipulating that tenants must implement energy-saving measures, while landlords commit to covering a portion of the costs.

3.THE EU'S POLICY ENGINE FOR BUILDING RENOVATION AND THE PATH TO BREAKTHROUGH FOR SMART BUILDINGS

The European Union fully recognizes the complex challenges inherent in building renovation, including a vast stock of existing structures, varying renovation capabilities across member states, difficulties in standardizing technologies, and fragmented funding. In response, the EU has introduced a range of targets and policy directives to accelerate the renovation pace, with the most transformative approach being the deep integration of smart building technologies, thereby injecting a "smart gene" into traditional retrofits.

From the overarching logic of EU policy, the 2030 climate targets serve as the core driver for decarbonization. These targets not only require member states to develop National Energy and Climate Plans (NECPs) but also identify the building sector as a key area for action within this framework. The EU is promoting building energy efficiency renovations through its ambitious "Renovation Wave" strategy. To underpin this initiative, the EU has enacted the Energy Performance of Buildings Directive (EPBD), providing the legal foundation for building emissions reduction. Under the EPBD, member states are obligated to submit National Building Renovation Plans. Furthermore, the directive mandates, under certain conditions, the installation of Building Management Systems (BMS) and introduces the Smart Readiness Indicator (SRI) as a technical tool for assessing a building's level of intelligence.



3.1Renovation Wave[17]

Initiated as a cornerstone of the European Green Deal, the Renovation Wave represents a comprehensive effort to enhance the energy performance of buildings across both public and private sectors. It was launched by the European Commission in 2020 and seeks to address pressing energy and climate challenges while supporting economic recovery in the post-pandemic context.

Core Objectives

The central goal of the Renovation Wave is to significantly increase the rate and quality of building renovations throughout the European Union. It aims to renovate 35 million buildings by 2030, which would effectively double the annual renovation rate. These efforts are intended to lower energy consumption and greenhouse gas emissions, generate employment opportunities within the construction industry, and elevate living standards and alleviate energy poverty.

The Renovation Wave is closely linked to other key programs. For example, the Affordable Housing Initiative aims to extend renovation benefits to social and affordable housing through district-level upgrades, partnerships, and innovative construction techniques. Furthermore, a critical element of the strategy involves expanding and upskilling the workforce.

Programs such as BUILD UP Skills and the European Year of Skills (2023–2024) are designed to meet the growing demand for expertise in energy-efficient construction and heating decarbonization.Through a mix of regulatory reinforcement, financial instruments, and capacity-building efforts, the Renovation Wave aims to establish a sustainable and inclusive pathway for Europe’s building sector transition.

Key Action Areas

To achieve these targets, the strategy introduces a range of measures structured around several priority domains:

- Enhancing clarity, incentives, and legal frameworks to motivate building owners and tenants to undertake renovations.
- Improving access to targeted financing, combining public funds with private investments to support renovation activities, technical assistance, and innovation.
- Encouraging smart building technologies and digitally enhanced renovation practices.
- Strengthening the construction sector’s capacity to deliver sustainable renovations with an emphasis on circular materials.
- Leveraging renovations to reduce energy poverty and accelerate the decarbonization of heating and cooling systems.

3.2 EPBD - Energy Performance of Buildings Directive (EU/2024/1275)[18]

The EPBD is a key policy tool of the European Union aimed at improving the energy efficiency of homes and buildings. Initially adopted in 2002, its latest revised version was formally passed in May 2024.

This newest iteration requires Member States to transpose the provisions of EPBD IV into national law by May 29, 2026. The policy's ultimate goals are for all new buildings to be zero-emission by 2030, and for the existing building stock to be transformed into zero-emission buildings by 2050.[i]

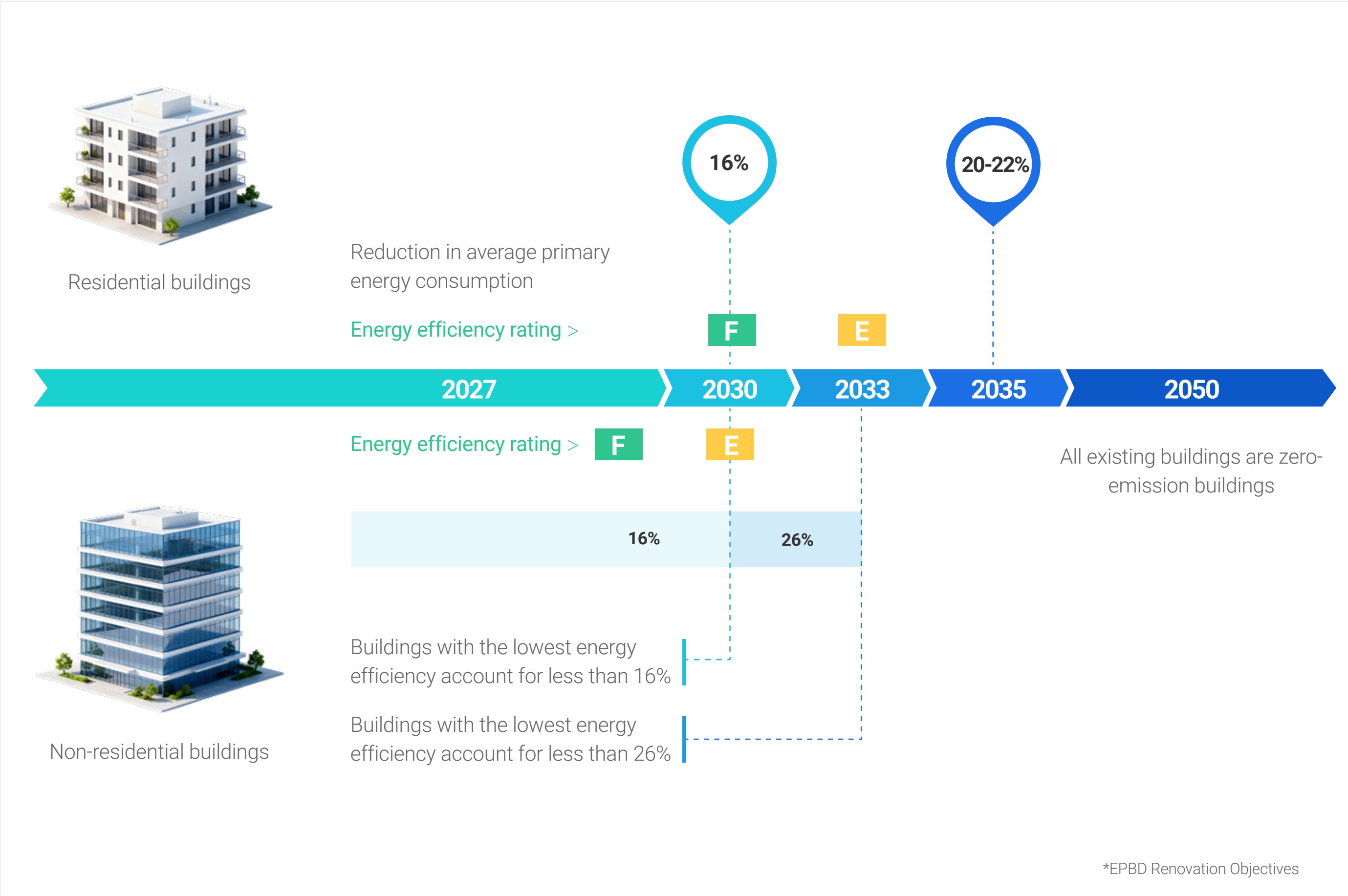
Its key elements include:

3.2.1 Renovation Objectives

Each EU member state will develop its own National Building Renovation Plan, outlining a national strategy for decarbonizing the building stock. This plan will be submitted as part of the updated National Energy and Climate Plan (NECP), with a preliminary draft due by December 31, 2025, and the final version required by December 31, 2026.

For non-residential buildings, the revised directive introduces minimum energy performance standards. These standards will ensure that at least 16% of the least energy-efficient non-residential buildings are renovated by 2030, increasing to 26% by 2033.[ii]

For residential buildings, member states must ensure that the average primary energy use (in kWh/m² per year) of the entire residential building stock is reduced by at least 16% by 2030 compared to 2020 levels, and by 20–22% by 2035.[iii]



3.2.2 Smart Building Technology: Introduction to Building Automation & Control Systems

A. BMS System Requirements

Member States are required to mandate that, where technically and economically feasible, non-residential buildings with an effective rated output of over 290 kW for HVAC or combined ventilation systems must be equipped with Building Automation and Control Systems (BACS) by December 31, 2024[iv]. Similarly, non-residential buildings with an output exceeding 70 kW must comply by December 31, 2029.

B. Lighting Control Requirements

By December 31, 2027, non-residential buildings[v] with an effective rated output over 290 kW[vi] must install automatic lighting controls. For those with an output over 70 kW, the deadline is December 31, 2029. These controls must be zoned appropriately and include occupancy detection functionality.

C. Indoor Air Quality Requirements

For the first time, environmental requirements are being introduced for buildings. Zero-emission non-residential buildings, as well as existing ones undergoing major renovation, must be equipped with measuring and control devices for indoor air quality[vii]. By May 29, 2026, these Building Automation and Control Systems (BACS) must include the monitoring of indoor environmental quality[viii].

D. Smart Thermostat Requirements

Where technically and economically feasible, new buildings must be equipped with self-regulating devices for individual temperature control in each room or designated zones. The same applies to existing buildings when replacing heating or cooling generators. Hydronic balancing should also be included where appropriate.

Smart Readiness Indicator (SRI)[19]

In addition to promoting the adoption of smart buildings, the European Union has introduced a framework to guide and standardize smart building assessments through the Smart Readiness Indicator (SRI). Established under the Energy Performance of Buildings Directive (EPBD), the SRI is a concept designed to measure and evaluate a building's capability to incorporate smart technologies. It focuses particularly on the building's ability to enhance energy efficiency, improve occupant comfort, and increase operational flexibility.The SRI provides building owners, operators, and other stakeholders with a clear framework to assess the current level of a building's smart readiness and identify areas requiring improvement.

SRI Assessment Framework

3.3 European Funding Support for Smart Buildings

In addition to the policy framework established to guide the development of smart buildings, both EU member states and the Union itself have allocated diversified funds and financial resources. This has created a coordinated advancement mechanism for smart buildings characterized by "policy setting the direction, and funding ensuring implementation."

Funding Name		Total Funding (€ billion)	Allocation Purpose
Co-financing investments	RRF[20]	811（2021-2026）	€45 billion for improving energy efficiency in private buildings, including window and door replacement, wall insulation, green facades and roofs, and replacing boilers, oil burners, and gas stoves with cleaner alternatives. €22.5 billion for energy-efficient renovations of public buildings and infrastructure, focusing on schools, universities, sports facilities, and historical buildings. €13.5 billion for constructing new high-efficiency public and private buildings.
	Cohesion Policy Funds	3730（2021-2027）	Approximately €12 billion for building energy renovation, including investments in insulation and heat recovery, lighting optimization, and the digitalization of building systems.
	Modernisation Fund[ix][21]	154（2021-2024）	€1.4 billion for building renovation and the promotion of smart meters. (Note: The Modernisation Fund is a dedicated fund under the EU ETS Directive, primarily for lower-income Member States).
Horizon Europe[22]	HORIZON-CL5-2021-D4-01-01	955（2021-2027）	€10 million for high-energy-performance buildings (deployment of smart sensors is included in the assessment).
	HORIZON-CL5-2021-D4-01-02		€16 million for deep energy renovation of buildings.
	HORIZON-CL5-2021-D4-01-03		€10 million for building digitalization and smart technologies.
	HORIZON-CL5-2021-D4-01-02 Jointly implemented with Built4People[x]		€15 million for integrated technological solutions for buildings (requires integration of automation components).
	HORIZON-CL5-2022-D4-01-01		€12 million for building energy renovation.
	HORIZON-CL5-2022-D4-01-02		€12 million for residential energy efficiency and renewable energy solutions.
	HORIZON-CL5-2022-D4-01-03		€12 million for smart buildings (includes installation of BACS, smart building systems, etc.).

4.SMART BUILDINGS CONTRIBUTE TO MORE SUSTAINABLE CONSTRUCTION

4.1 Trends in Smart Building Retrofitting

From the perspective of the EPBD directive, smart buildings represent one of the key intervention areas outlined and emphasized by the directive. Making a building “smart” means equipping it with sensors, controllers, software, and user interfaces. These devices work together—including with the building's internal systems—to monitor building conditions and optimize resource usage. This combination of technologies is commonly referred to as Building Automation and Control Systems (BACS).

From the viewpoint of building retrofit costs, a significant concern for governments, IoT-based smart retrofitting can generate considerable cost savings. For the same investment, IoT technology can drive greater economic benefits through higher reductions in energy consumption. According to CSL's white paper "The Future of Construction"[23], IoT systems can reduce building energy consumption by 30%, facilitating deep energy-efficient retrofits. Furthermore, AI-driven analytics can increase energy savings up to 50%.

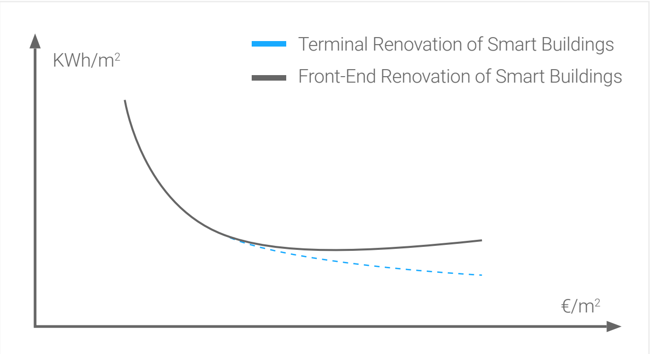
Building retrofits can be categorized not only by energy performance but also by the type of intervention: front-end and back-end retrofits. Front-end retrofitting involves upgrading a building’s envelope, windows, electromechanical equipment, and HVAC systems, primarily through the replacement of materials and equipment or efficiency upgrades. These interventions often involve wired solutions such as RS232 or RS485 protocols. In contrast, back-end retrofitting focuses on the installation of sensor devices. These sensors collect operational data—such as energy usage—enable control of connected equipment, and are integrated into a unified management platform via software interfaces.
Back-end retrofitting effectively addresses challenges encountered in conventional retrofitting. Initially, significant energy efficiency gains can be achieved through front-end upgrades.

For example, replacing an old boiler or a high-power HVAC system with an energy-efficient model can lead to substantial improvements. However, as retrofitting progresses,the same level of investment yields diminishing returns. Achieving each additional 1% in energy savings requires increasingly greater capital, making the final 30–60% of energy savings targets particularly challenging. Sometimes, merely investing more in front-end solutions cannot overcome this bottleneck.

IoT-based back-end retrofitting, however, can achieve greater energy efficiency gains with smaller investments, thereby reducing capital requirements and breaking through the energy reduction bottleneck. It helps building owners achieve the final 30% in energy savings. Additionally, wireless sensors reduce indirect costs: they require no structural modifications, avoid disrupting building operations, and provide a seamless experience for tenants without noticeable intrusion.

A Building Management System (BMS) connects sensors, controllers, and building equipment to record performance data, providing facility management departments and building owners with operational insights and supporting decision-making. According to data from eu.bac, equipping existing and new non-residential buildings with an effective rated power above 290 kW with a BMS can save up to 14% of the building’s total primary energy consumption annually. This would lead to energy bill savings of €36 billion, delivering more than nine times the value of the investment.

In summary, smart buildings reduce energy consumption through intelligent, data-driven control; lower operational and maintenance costs by minimizing manual inspections; and enhance occupant comfort and health through improved environmental monitoring. Ultimately, they support compliance with government regulations related to net-zero emissions and energy efficiency initiatives.



① In the early stage, there were many old buildings, involving numerous old equipment with energy waste, and the renovation mainly focused on the front - end.

② With the increase of new buildings (with building equipment of higher energy efficiency) and the popularization of equipment renovation for old buildings,it began to gradually develop towards terminal renovation and explore more energy - saving ways in energy - saving building equipment (current stage).

③ When the building equipment is basically renovated, terminal renovation will become the mainstream.

Front-end transformation

Equipment renovation: The front - end renovation products mainly adopt the wired 485 protocol. The key is to renovate systems such as electromechanical, heating, ventilation and air - conditioning. It mainly involves the replacement of building equipment, and focuses on the equipment on the roof of existing buildings and in the basement machine rooms.

The effect is significant, but the cost is high:a. It affects normal living, work, and other production and life activities.
b. Equipment replacement involves a series of processes such as equipment procurement.
c. Equipment replacement will affect the wiring of other devices, meaning that improvements are not limited to a specific piece of equipment.

Terminal renovation

The terminal renovation products for building systems mainly about IoT. It is called "terminal renovation" because it primarily relies on control rather than direct renovation of energy generation sides (such as HVAC systems).They prioritize the lighting systems, equipment and facility management, and safety management in key public spaces. The renovation scope mainly covers conference rooms, offices, public office areas, school dormitories,hotels etc.

a. It facilitates data acquisition, providing a factual basis for building operations.b. It is easy to install, does not affect the normal operation of the building, and does not require changes to the building structure or wiring, resulting in relatively low costs.c. Even for newly constructed buildings with the latest equipment, better optimization of equipment performance can be achieved on this basis.

4.2 LoRaWAN: The Wireless Answer to Core Retrofit Challenges

4.2.1 Wireless Sensors are Gaining Increasing Market Favor

Sensor devices can be categorized into wired and wireless types. In traditional Building Management System (BMS) installations, systems are almost exclusively wired due to their relative reliability. Wired sensors are powered through the same cable (e.g., RS-485 or Power over Ethernet (PoE)), eliminating the need for battery replacement or monitoring – a crucial advantage for sensors embedded within walls, ceilings, or located in distant equipment rooms. In buildings with metal piping, concrete walls, elevators, and dense equipment, where wireless signals can attenuate, wired sensors have historically been the standard choice installed in new constructions.

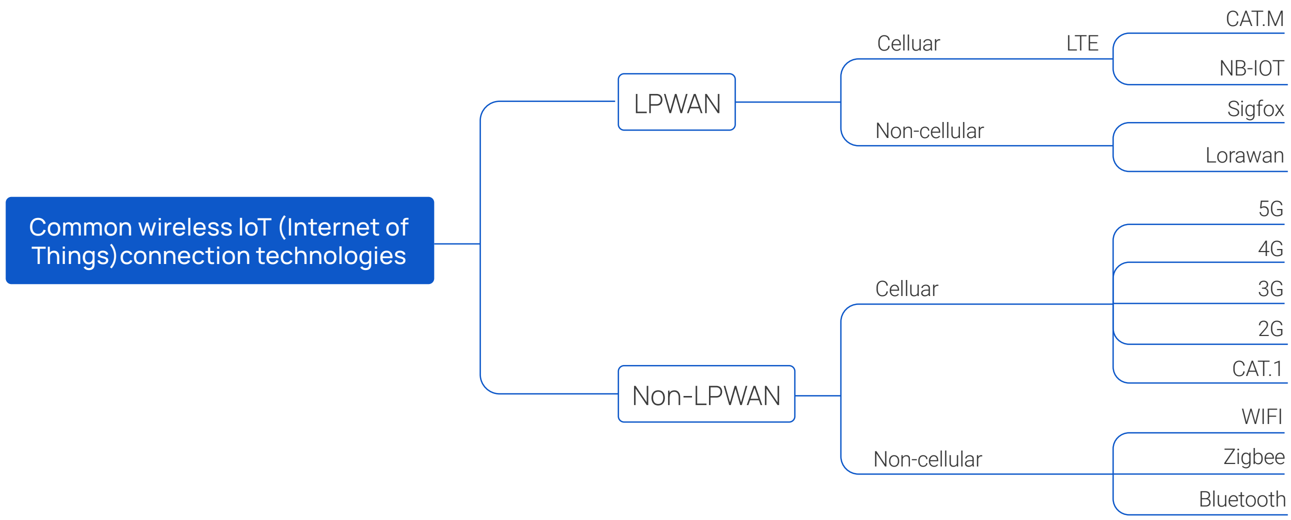
However, in terms of overall deployment, buildings equipped with sensors are still in the minority. Over time, driven by policy push and rising energy-saving demands, particularly in Europe, an increasing number of buildings require sensors for intelligent management and reduced energy consumption. Europe's building market is predominantly focused on retrofits. In retrofit scenarios, the wiring costs for wired sensors are prohibitively high, especially in occupied or historical buildings.

Installing new cables or altering existing lines disrupts normal building operations. Furthermore, in some older structures, wiring modifications or additions might be impossible due to safety or preservation reasons.

Additionally, the functional richness of early-generation wired sensors falls short of meeting today's demands for smarter applications. Modern IoT use cases require more granular data, such as diverse gas detection capabilities and more accurate occupancy sensing technologies – functionalities that early wired devices lacked and which many current wired solutions still do not fully possess. To achieve smarter BMS, the earlier generation of "simple" wired sensors will be phased out. The convenience and enhanced functionality of wireless solutions are already enabling them to capture market share from wired systems. Importantly, wireless devices are not intended to replace existing market BMS systems outright, but rather to augment and enrich current BMS, making them more specialized, intelligent, and capable.

Project Aspect	Details	Wireless Protocol Products	Wired Protocol Products
Project Type	New Construction	Disadvantage	Advantage
	Retrofit/Renovation	Advantage	Disadvantage
Application Scenario	Large Spaces (Building, Multi-room)	Advantage	Disadvantage
	Small Spaces (Single Room)	Comparable	Comparable
Product Ecosystem	Product Ecosystem	Advantage	Comparable
Integration Requirements	Protocol Openness	Advantage	Disadvantage

4.2.2 LoRaWAN's Distinctive Edge in Smart Building Retrofits



4.2.3 The Comprehensive Advantages of LoRaWAN

In smart building application scenarios, the requirements for data size and transmission rates from end devices are generally not high. Although LoRaWAN offers the lowest data transmission rate among common options, it is fully adequate for primary smart building use cases.

Regarding overall scenario compatibility, LoRaWAN inherently relies on gateways for transmission. This facilitates native integration with BMS, as sensor nodes can achieve direct, "wired-like" integration into existing BMS through gateways and converters (compatible with Modbus, BACnet, MQTT). This approach extends the capabilities of the original BMS rather than rendering it obsolete. Furthermore, the LoRa protocol is simpler than alternatives like NB-IoT, making it easier to develop and offering better suitability and compatibility with microcontrollers.

LoRaWAN supports free network formation, independent of existing telecommunications infrastructure. This reduces costs and increases deployment flexibility. Even in areas with poor NB-IoT/CAT-M infrastructure coverage, LoRaWAN performs excellently. Moreover, even where NB-IoT/CAT-M coverage exists, their wall-penetration capability is generally inferior to LoRaWAN; signal attenuation when passing through walls is more pronounced for these technologies. Concrete walls, elevators, and other signal-obstructing structures significantly impact their transmission, giving LoRaWAN a greater advantage in older buildings.

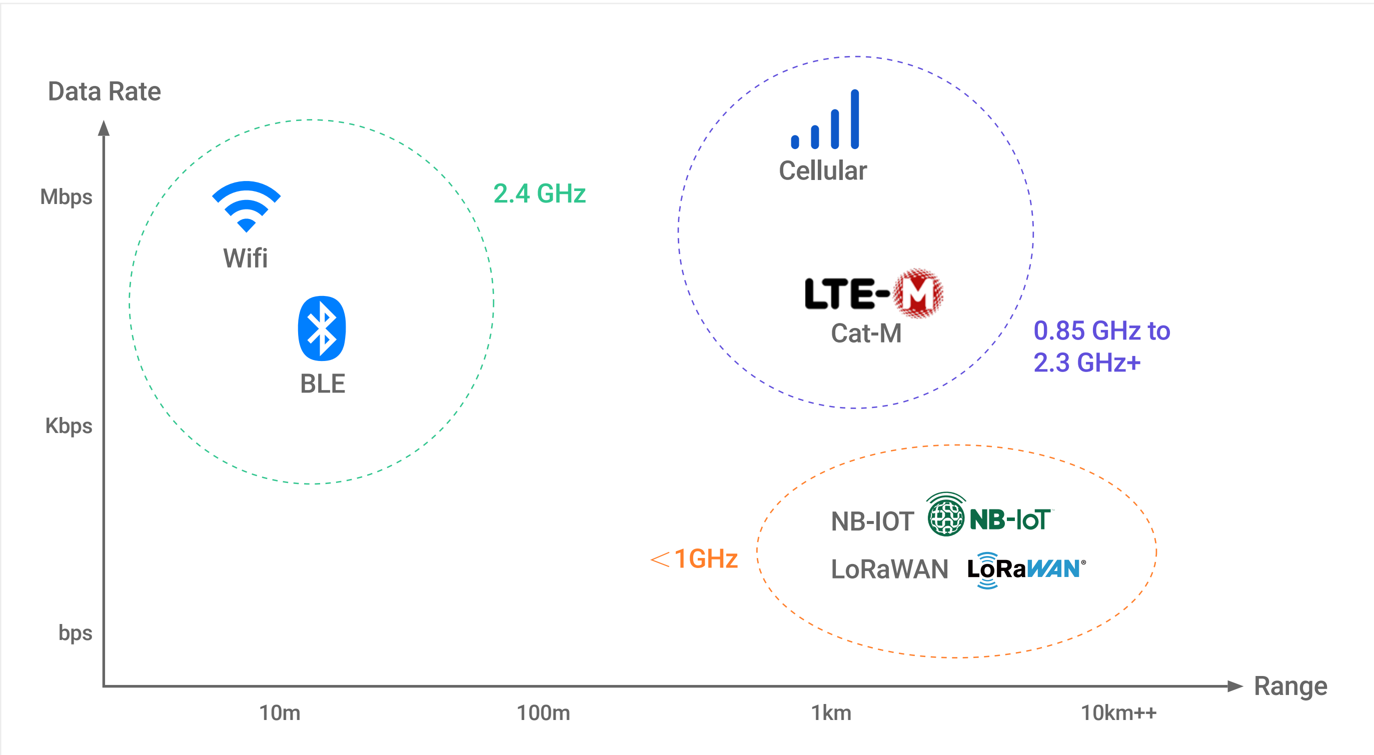
LoRaWAN boasts an exceptionally long transmission range, making it highly suitable for comprehensive buildings and cross-floor transmission. In contrast, Wi-Fi, Zigbee, and Bluetooth are typically limited to small rooms. When covering multiple floors and rooms, these technologies require hundreds of access points (APs) and more extensive infrastructure, considerably increasing the overall deployment cost.

Most importantly, a key objective of smart building retrofits is to reduce building energy consumption and lower daily operational costs. If the sensors themselves have high power consumption, it conflicts with this energy-saving goal. Compared to Wi-Fi, Bluetooth and Zigbee may save power, but they still typically require battery replacement every 1-2 years. Under similar conditions, devices utilizing LoRaWAN can last 3 to 5 times longer. The energy efficiency of LoRaWAN technology sets an industry benchmark, making it seem naturally conceived for smart building applications.

In summary, LoRaWAN stands out from numerous technologies due to its superior penetration capability, long-range transmission, energy efficiency, and deployment freedom, making it exceptionally well-suited for building-level and campus-level deployments.

Parameter	LoRaWAN	Wi-Fi	BLE (Bluetooth Low Energy)	NB-IoT	CAT-M	Zigbee
Data Rate	Up to 50 Kbps	Up to 9.6 Gbps (Wi-Fi 6)	Up to 2 Mbps (also provides 125 kbps and 500 kbps rates - Bluetooth 5)	Up to 250 Kbps	Up to 7 Mbps	250 kbps
Range	Rural: Up to 15 km Urban: Up to 5 km Designed for long range & building penetration	Outdoor: Up to 100 m Indoor: 3-50 m Limited range in offices, typically covering single rooms	Outdoor: Up to 100 m Indoor: 1-50 m High interference limits coverage to immediate surroundings like a single room	Urban: ~1 km Rural: Up to 10 km Highly dependent on operator coverage	Theoretical Avg: 10-20 km Dependent on operator LTE voice/data service coverage	30-100 m
Penetration	Excellent building penetration. A single gateway can often cover an entire building, including multiple floors and basements.	Low building penetration. Requires many access points for full coverage.	Very low building penetration. Typically covers only a few meters, possibly reaching adjacent rooms.	Good, but NB-IoT relies on cellular base stations. Signal attenuation through walls is more noticeable vs. LoRaWAN.	Strong penetration, but slightly inferior to NB-IoT.	Weak wall penetration. Requires deployment of many devices.
Power Consumption	Very Low	High	Medium	Low	Medium	Low
Deployment Cost	Excellent building penetration. A single gateway can often cover an entire building, including multiple floors and basements.	High power consumption, frequent device replacement. Short range necessitates multiple APs, increasing cost.	While BLE offers higher data rates, its power consumption is relatively high, and its typical star topology can increase deployment costs. Smaller coverage requires more devices for the same area, raising costs.	In large-scale deployments, costs for SIM cards, etc., rise. Operates in	In large-scale deployments, costs for SIM cards, etc., rise. Operates in licensed operator	Requires many nodes, leading to higher application deployment costs.

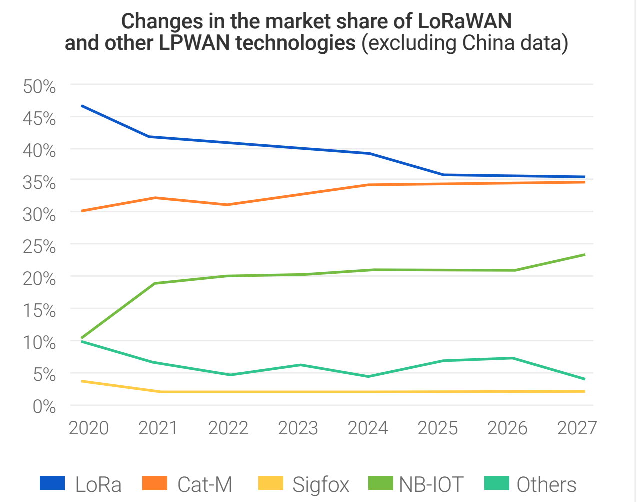
Comparison of Wireless Sensor Transmission Technologies for Smart Buildings



4.2.4 Market Acceptance of LoRaWAN

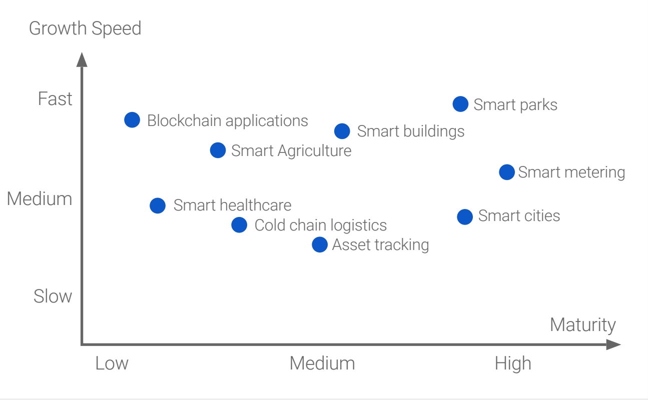
By the end of 2023, there will be nearly 1.3 billion active LPWAN IoT connections globally, accounting for approximately 8% of the world's more than 16 billion connected IoT devices. This number is projected to grow at a Compound Annual Growth Rate (CAGR) of 26%[24], reaching around 3 billion by 2027. This would represent about 10% of all global IoT connections.

When data from China is excluded—where national policy strongly promotes NB-IoT and its vast population significantly skews global statistics (NB-IoT comprises 81% of all LPWAN connections in China)—LoRaWAN's market share approaches 40% by mid-2024. This establishes it as one of the most widely adopted and accepted LPWAN technologies in terms of market scale.

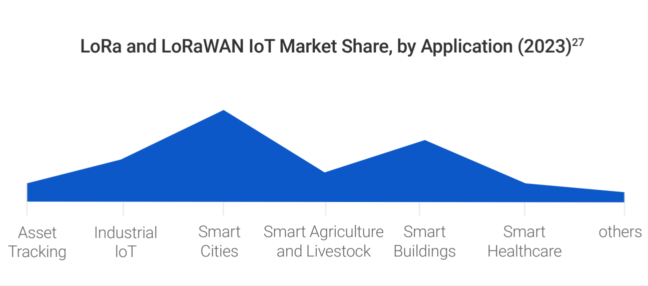


Data ource :IOT Analytics

Similarly, findings from MMR's research arm align with this view, highlighting smart cities (particularly in metering applications, which often fall under the smart buildings umbrella) and smart buildings as primary application fields for LoRaWAN today.



AIoT Research Institute's View on LoRaWAN Applications



The main application distribution in LoRaWAN

4.2.5 LoRaWAN Adoption in Smart Buildings

The application of LoRa technology in smart buildings is projected to grow at 20% annually in the coming years. According to the LoRa Alliance, smart buildings have become the fastest-growing vertical market for LoRaWAN deployments. The global market size for LoRaWAN sensors in building automation was valued at USD 2.1 billion in 2024 and is expected to register a compound annual growth rate (CAGR) of 17.8%[25] from 2025 to 2033.

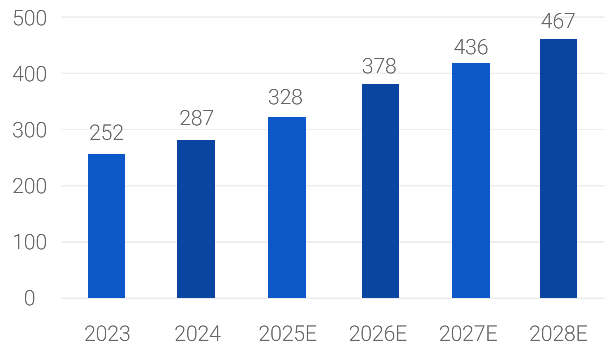
This sentiment is echoed by research from the China AIoT Research Institute[26], which identifies smart buildings and smart parks as currently the most mature and rapidly expanding application areas for LoRaWAN.

In summary, the application of wireless sensors in smart buildings is becoming increasingly widespread. Due to its technical advantages, ease of deployment, and more compatible ecosystem, LoRaWAN continues to hold a core position in the global LPWAN market, even in the face of competition from technologies like Cat-M and NB-IoT. From the perspective of the current market application landscape, within vertical sectors, smart buildings (including smart parks and related smart city applications) represent the scenario with the highest application maturity and greatest growth potential. The current market scale has already demonstrated LoRaWAN's capabilities. LoRaWAN is helping smart buildings adapt to the trends of the era, driving innovation, and reducing the complexity of implementation.

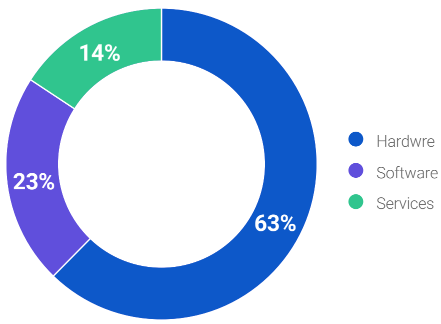
4.3 Current State of the European Smart Building Market

Policies such as the EPBD have accelerated the rapid development of smart buildings in Europe. The European smart building market accounts for approximately 30% of the global market share, with an estimated market size of €32.8 billion by 2025. The United Kingdom, Germany, and France are currently the leaders in the European smart building market.

Driven by digital technological advancements and supportive European policies, the smart building market in Europe is experiencing robust growth, with a compound annual growth rate (CAGR) of around 15%. Hardware components dominate this market, among which controllers and sensors are the most fundamental and critical devices. IoT sensors alone account for 20%[28] of the hardware market share in smart buildings and continue to flourish.



Overview of the European Smart Building Market Size (Unit: € Billion)

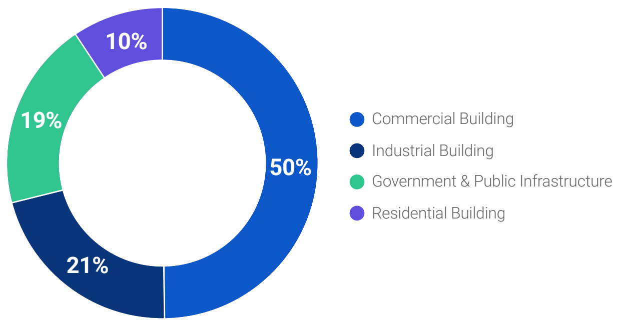


Overview of the European Smart Building Market Size (Source: Confidential)

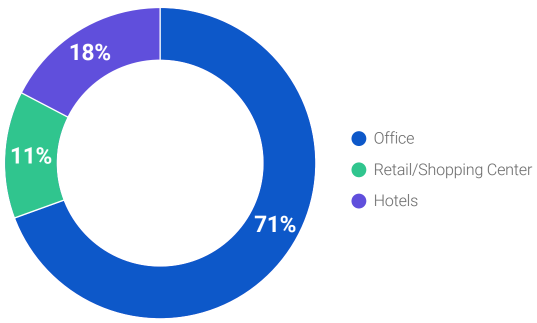
Currently, the commercial building sector represents a key focus in the smart building retrofit market, with office buildings receiving significant attention. In my view, the hotel industry is poised to become another major area of growth. This is not only because hotels currently exhibit the poorest energy performance among all building types, but also because future EPBD regulations will require buildings with HVAC systems rated over 70 kW to install Building Management Systems (BMS). This indicates that future policies will increasingly target small and medium-sized buildings—a category that includes a large proportion of hotels.

Furthermore, tourism plays a vital role in Europe's economy. In 2023, Europe welcomed approximately 60% of all international tourists worldwide, totaling over 700 million arrivals, making it the largest tourism destination globally. As a critical component of the tourism experience, hotels hold substantial strategic importance.

Moreover, based on observations from business operations in the market, it is evident that private sector stakeholders—such as those in the hotel industry—demonstrate high efficiency in adopting and scaling new technologies.



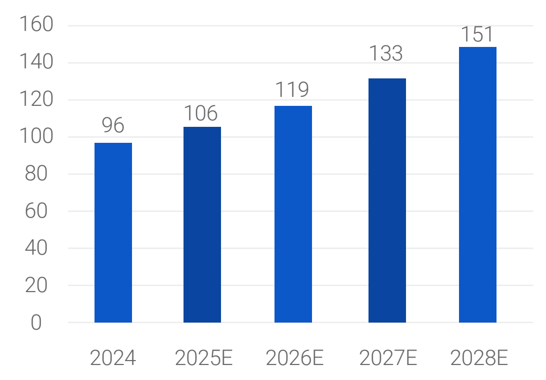
Smart Building Market Size - Distribution by Building Type (Source: Confidential)



Smart Building Market Size - Distribution by Building Type (Source: Confidential)

Another critically important system to analyze is the Building Management System (BMS). In 2024, the European smart building market identifies BMS as the largest segment within the global smart building market. These systems are designed to integrate all independent control and monitoring systems into a single point, enabling seamless control over all subsystems. A BMS consists of software, servers, sensors, and other key components—such as HVAC, lighting, and emergency control systems—and provides centralized monitoring for all equipment.

As mentioned in the earlier policy analysis, regulations related to Building Automation and Control Systems (BACS) require buildings meeting certain energy performance thresholds to install a BMS. According to the EN ISO 52120-1 standard, BMS systems in Europe are classified into four grades—A, B, C, and D—based on their energy efficiency and level of intelligence. In some European regions, Grade C represents the minimum level legally required for BMS systems.



European Building Management System Market Size

(Source: Technavio)

4.4 Impact of Smart Buildings on the Building Retrofit Industry Chain: Integration Matters

Within the smart building industry chain, the key upstream role is that of the building owner. Driven by both policy guidance and subsidy incentives, an increasing number of building owners have initiated or are planning building retrofit projects, thereby expanding the overall market. These customers have a clear core demand: they are less concerned with the specific technical pathways or solutions provided by midstream vendors, and more focused on achieving maximum energy savings with minimal investment. Among them, large high-energy-consumption buildings—often prompted by regulatory requirements such as those related to Building Automation and Control Systems (BACS)—are frequently the first to adopt smart building BMS (Building Management System) solutions. This demand, in turn, directly drives the market for downstream IoT sensors.

For retrofit solution providers in the midstream segment of the industry chain, the landscape has evolved significantly. Prior to the emergence of smart buildings, the midstream market was populated by numerous retrofit providers offering solutions such as more efficient HVAC systems, energy-saving lighting, and wall retrofits. This market was characterized by innovation in materials and equipment, yet such innovations eventually faced diminishing returns and saturation. It became increasingly difficult to meet market demands relying solely on traditional retrofit methods.

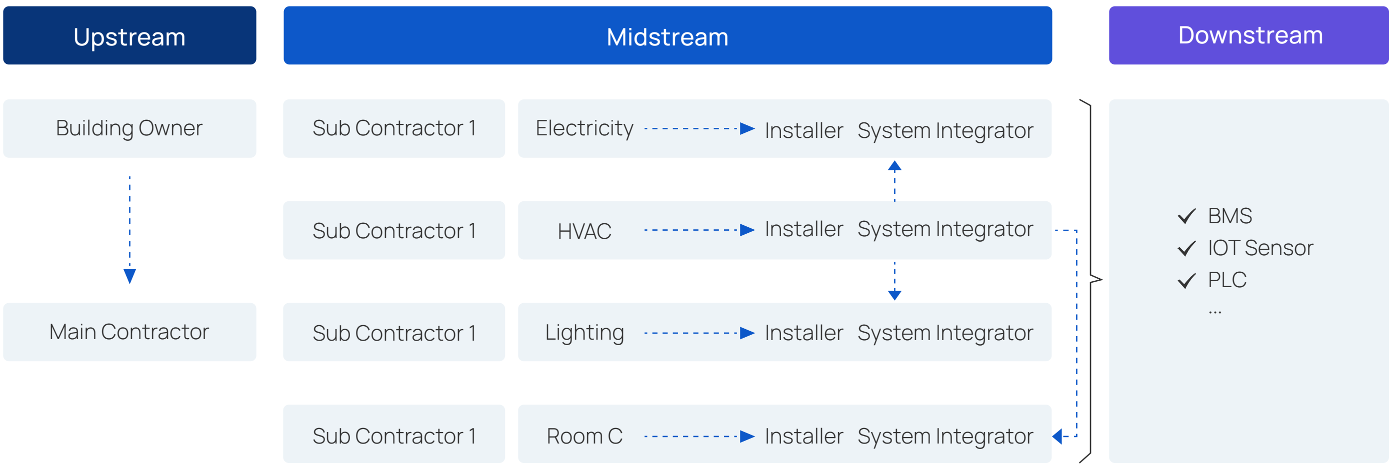
The rise of smart buildings, accelerated by supportive policies, has created new business opportunities for equipment suppliers, energy efficiency retrofit companies, and IoT solution providers. The future direction of the industry lies in the deep integration of smart, energy-saving technologies with conventional retrofit approaches. This requires providers not only to possess expertise in traditional areas such as HVAC and electrical systems, but also to incorporate digital technologies like IoT, big data, and artificial intelligence. By building intelligent management platforms, they can deliver new solutions capable of holistic monitoring of energy usage, equipment operation, and environmental quality. Leading industrial players such as Schneider and Siemens exemplify this trend, introducing new solutions that combine various sensors with existing building equipment. For retrofit providers lacking industrial equipment capabilities, pursuing partnerships with smart technology firms has become essential to attracting customers and maintaining profitability—many architectural design firms, for instance, are already collaborating with smart device manufacturers. At the same time, this shift has spurred the growth of specialized smart system providers and smart building solution vendors, breaking the monopoly of traditional retrofit models and opening new development pathways.

Downstream demand is expanding as policy-driven initiatives stimulate upstream activity, with midstream players relying on downstream software and hardware solutions. For downstream BMS providers, enabling technical integration and overcoming interoperability and protocol barriers are crucial to the efficient operation of smart buildings and represent a core link in unlocking value across the industry chain. In practical terms, a BMS in a smart building must integrate data from dozens or even hundreds of different types of IoT sensors, which may come from various manufacturers and use divergent communication protocols (such as Modbus, BACnet, LonWorks, etc.). It also needs to incorporate data from existing building equipment. Moreover, the existence of different BMS standards and solutions makes vendor selection challenging for upstream clients. Buildings often host other management systems—such as IWMS, PMS, and EMS—making cross-system compatibility another critical consideration.

From the perspective of solution diversity, the application scenarios for smart buildings are complex and varied. Different building types have significantly different requirements for IoT technology, necessitating that IoT manufacturers not only understand key market needs but also offer diversified and highly customizable solutions. The Smart Readiness Indicator (SRI) offers a useful reference framework, covering areas including heating, cooling, domestic hot water, ventilation, lighting, dynamic building envelope, electricity, electric vehicle charging, and monitoring and control.

Additionally, IoT devices must achieve ecosystem compatibility, requiring manufacturers to overcome "three major technical barriers": first, compatibility with BMS systems; second, interoperability with IoT platforms; and third, integration with existing building equipment. In Europe, approximately 70% of retrofit projects involve legacy equipment over ten years old, most of which are non-smart models. The diversity of solutions determines an IoT manufacturer's market breadth, while compatibility determines the depth of its technology penetration. Many existing BMS systems are proprietary or semi-closed (e.g., certain older Johnson Controls, Siemens, or Honeywell systems). Adding new equipment typically requires authorized contractors, software updates, and compatibility verification, which limits the flexibility and scalability of data capture.

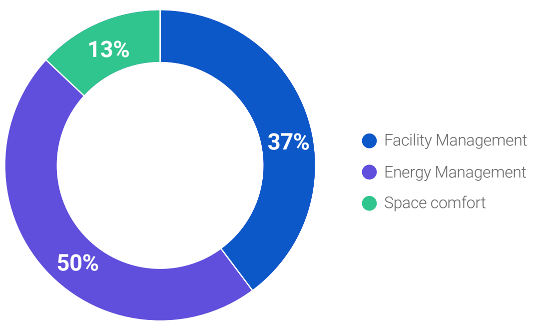
Only by achieving both solution diversity and cross-system compatibility can IoT manufacturers create genuine value for customers and advance the development of smart, energy-efficient buildings in the policy-driven European market.



5.MILESIGHT'S PERSPECTIVE ONSMART BUILDINGS: THE FES PLUS FRAMEWORK

5.1 The People Sensing Driven Smart Building Strategy

Based on the comprehensive information presented above, we believe the current smart building market can be segmented into three key opportunity areas: Facility Management, Energy Management, and Space Comfort. These three aspects, while distinct, collectively reflect the evolution of the European smart building market—progressing from ensuring basic equipment operation, to energy-efficient operation, and finally to human-centric value-added services. Currently, the market is transitioning from the second phase (Energy Management) toward the third phase.



European Smart Building Market Segmentation — Milesight's Perspective

Phase 1: Facility Management

Before the concept of smart buildings emerged, buildings were already equipped with a wide variety of devices covering areas such as lighting, HVAC systems, elevators, and security cameras. These devices performed distinct functions to ensure normal building operation. A key challenge during this period was achieving effective communication and coordination among these devices while ensuring they functioned properly. Centralized control via Programmable Logic Controllers (PLCs) and wired transmission technology became the primary method for data transfer between devices due to their stability and reliability. Toward the end of this phase, in addition to interconnecting devices, monitoring equipment operational status gradually began to ensure continuous and reliable building performance.

Phase 2: Energy Management

Europe is currently in the second phase of smart building development, which is deeply tied to energy-related issues. This orientation is particularly evident in market policies. The EU's "Renovation Wave" strategy positions building energy renovation as a crucial part of the energy transition, explicitly aiming to significantly increase building retrofit rates over the next decade. By upgrading building energy systems and optimizing resource allocation, the goal is to reduce overall energy consumption in the building sector. Meanwhile, the updated and strengthened Energy Performance of Buildings Directive (EPBD) sets stricter energy efficiency standards at the regulatory level, requiring both new and existing buildings to integrate energy-saving principles throughout their entire lifecycle—from design and operation to renovation. Smart controls are even promoted as key tools for enhancing energy efficiency. In this phase, smart building development has moved beyond basic device connectivity and elementary automation to a more advanced stage centered on data-driven energy consumption optimization. By incorporating external environmental data such as light intensity, CO_2 levels, and occupancy status, systems like HVAC, lighting, and ventilation are dynamically adjusted to meet government energy-saving targets.

Phase 3: Space Comfort

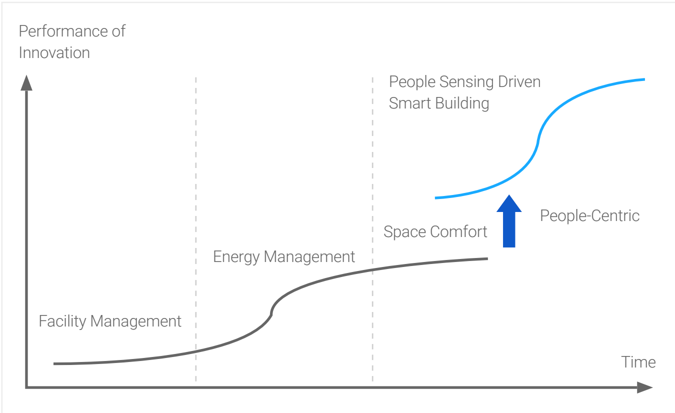
We believe the next phase of smart building development will focus on space comfort. The EU has already recognized the importance of this area. The EPBD IV, which member states are required to transcribe into national law by May 29, 2026, establishes standards for healthy indoor air quality and mandates compliance at the national level. Smart technology is regarded as essential for effectively monitoring and reporting indoor air quality and for enhancing the functionality of building automation systems. The goal is to provide building users with a comfortable and healthy working/living environment. Different markets offer various potential solutions that may overlap in application but serve distinct purposes in practice.

	Fundamental Needs	Key Needs	Advanced Needs
	Facility Managemenrt	Energy Management	Space Optimization & Comfort
Basic logic	Ensure the normal and optimal operation of building equipment, increase efficiency through data-driven approaches, and reduce human resource consumption.	Reduce energy consumption to cut costs and save money for the building.	Enhance reputation; Increase attractiveness; Expand social influence and impact (to boost revenue)
Definition	Manage the facilities/equipment involved in the daily operation of a building, use data-driven methods to quickly reflect the operational status of the equipment, and improve the efficiency of building operations through linkage and other means, while reducing losses caused by emergencies.	Record and optimize the building's electricity performance, reduce its electricity consumption through smart devices and solutions, and improve its energy-saving performance.	Provide a comfortable and healthy working /living environment for building users.
Key point	Requirement 1: Understand the basic status of existing facilities (including operational status, water leakage and other intrusions). Requirement 2: Realize efficient equipment operation and management.	Requirement 1: Digitize electricity operation to provide strategies for energy conservation. Requirement 2: Optimize energy consumption.	Requirement 1: Digitize the current space usage and environment Requirement 2: Optimize space comfort Requirement 3: Establish a comprehensive ESG framework

According to innovation scholar Everett Rogers[29], the evolution of technology inevitably follows the S-curve, and smart building technology is no exception. Milesight believes that the concept of People Sensing will drive a new S-curve in smart buildings—ushering in a new wave of disruptive innovation.

People Sensing enables personalized customization based on human presence and behavior. By using AI to analyze collected occupancy and behavioral data, it interprets the status of building occupants, elevating the approach from the Phase 3 model of "uniform" environmental comfort to a "personalized" building experience. This allows buildings to "Adapt to me" and "Find what people need".

This represents the future—and the future as Milesight envisions it. Facility Management, Energy Management, Space Comfort, and People Sensing together constitute Milesight's interpretation of the smart building market.



The Technology S-Curve in Smart Buildings

Facility Management	Total Funding (€ billion)	Allocation Purpose
Water/Gas/Heat Meter	Connected HVAC	Air Quality Monitoring
Smart Waste Management	Connected Lighting	Space Management
Leakage Detection	Electricity Monitoring	Hygiene Management
Smart Fill Level Detection	Smart Electricity Meter	Bacteria Detection
Parking Management	Smart Renewable Energy	Thermal Comfort
Asset Tracking	Domestic Hot Water	Light Comfort
Predictive Maintainance	EV Charger Management	Smart Natural Ventilation
Water Efficiency		Blind Control
Lift/Elevator Maintainance		Sound Comfort
IAQ Management（For Asset Preservation)		

Corresponding Types of Potential Solutions Across Different Markets

5.2 An Interoperability-First Approach to Smart Building Retrofits

While policy frameworks like the EPBD provide clear direction for smart building retrofits, practical implementation reveals a fundamental challenge—the integration gap between innovative IoT solutions and established building management infrastructure. This divide represents the crucial bottleneck where many smart building projects encounter technical and economic barriers.

As established in Chapter 4, LoRaWAN provides the essential wireless connectivity for sensor deployments in retrofit scenarios. However, the true value of this connectivity emerges only when sensor data can be effectively integrated into the Building Management Systems (BMS) that serve as the operational backbone of modern buildings. These systems, coordinating everything from HVAC and lighting to security, rely on established communication protocols—primarily BACnet, Modbus, and MQTT—as their technical language. The challenge lies in creating seamless communication between wireless sensing networks and these protocol-specific environments.

The Integration Challenge: BMS and Niagara Framework

At the heart of this integration challenge sits the Niagara Framework, a widely adopted integration platform in the building automation industry. Niagara serves as a universal translator that enables different building systems and protocols to communicate within a unified management environment. Its significance stems from its ability to bridge the gap between diverse systems from multiple vendors, making it a cornerstone technology for complex smart building projects across Europe.

However, even with Niagara's capabilities, integrating LoRaWAN sensor networks with traditional Building Management Systems (BMS) has remained challenging. Most BMS platforms communicate through established protocols like BACnet, Modbus, and MQTT, while LoRaWAN-based sensor networks operate on fundamentally different communication paradigms. This protocol mismatch has traditionally required complex middleware and custom engineering solutions.

Bridging the Gap: Milesight's BACnet Driver Solution

Milesight addresses this specific challenge through the development of the BACnet Driver for Niagara environments. The implementation eliminates the need for custom coding or additional middleware layers, creating a seamless data pathway from wireless sensors to established building management platforms.

The technical architecture of this solution ensures that Milesight's sensor data becomes immediately accessible within Niagara-based systems while maintaining full compatibility with major BMS platforms from vendors like Siemens, Schneider Electric, and Johnson Controls. This approach supports comprehensive functionality, including not just data collection but also two-way communication for control capabilities through the same integrated pathway.

For European building owners and system integrators, this interoperability-focused approach delivers substantial practical benefits. The reduction in integration complexity translates to shorter implementation timelines, lower project costs, and decreased technical risk. Building operators can deploy comprehensive wireless sensor networks for environmental monitoring, occupancy tracking, and energy management while preserving their existing BMS investments and working within familiar operational interfaces.

The broader impact on the smart building ecosystem is equally significant. By removing the technical barriers associated with system integration, this approach accelerates the adoption of IoT technologies in building retrofits. It enables building owners to focus on achieving energy efficiency targets and operational improvements rather than navigating complex integration challenges, making smart building projects more accessible and economically viable across different building types and scales.

Ultimately, Milesight's interoperability strategy represents a crucial enabler for Europe's smart building transition. By ensuring that innovative sensing technologies can work seamlessly with established building systems through platforms like Niagara, it helps transform policy vision into practical reality, moving the industry closer to widespread adoption of intelligent, efficient, and sustainable building operations.

6.PRODUCT SOLUTIONS AND ECOSYSTEM

The European Commission has established a set of standards and accompanying technical reports to support the Energy Performance of Buildings Directive (EPBD), collectively known as the Energy Performance of Buildings Standards (EPB standards). These standards are managed by the European Committee for Standardisation (CEN). Their purpose is to provide professionals, building owners, and legislators with a structured and logical framework for Building Management Systems (BMS), while also offering guidance to EU member states on implementing the EPBD requirements.
A key standard within this framework is Energy performance of buildings - Contribution of building automation, controls and building management - Part 1: General framework and procedures (ISO 52120-1:2021, Corrected version 2022-09). This standard categorizes BMS systems into four distinct classes—A, B, C, and D—based on their level of functionality and automation Class A represents the highest level of automation, capable of monitoring and controlling a wide range of parameters and systems within a building while delivering highly optimized energy management. Class D corresponds to systems with minimal automation and the poorest energy performance. For example, in France, non-residential buildings with an effective rated power output exceeding 290 kW are required to install at least a Class C BMS system.

Class	Description
Class A	Corresponding to "high energy performance," it possesses a high level of precision and completeness in automated control. Room control equipment must be capable of managing HVAC systems by considering multiple factors (e.g., occupancy detection, air quality, and other preset parameters), and must include integrated functionalities for multi-device coordination between HVAC and various building services such as electricity, lighting, shading, etc. Additionally, it should be able to regulate power generation and electricity distribution.
Class B	Equipment equipped with advanced Building Automation and Control Systems (BACS), along with dedicated building technical management functions for centralized coordination and control of various devices within the building. A typical manifestation is room control devices capable of communicating with the building automation system, enabling coordinated control of certain key parameters.
Class C	Suitable for solutions equipped with "traditional" Building Automation and Control Systems (BACS), which may include communication buses and are capable of meeting basic energy standards requirements and providing fundamental equipment control.
Class D	Traditional and non-energy-efficient automation and control systems.

6.1 The EU BMS Standards

The standard categorizes BMS into four performance classes (A to D, with A representing the highest level) across seven core functional domains:
core functional domains:

- Heating Control
- Domestic Hot Water Supply Control
- Cooling Control
- Ventilation and Air-Conditioning Control
- Lighting Control
- Blind Control
- Technical Home and Building Management

Advancing to a higher class requires meeting progressively more sophisticated control criteria in each domain. The specific capabilities needed to fulfill these requirements are detailed in the table below.

A common thread enabling these advanced capabilities is their reliance on real-time data. The transition from basic functionality to intelligent, demand-based control hinges on the continuous stream of precise environmental information provided by IoT sensors.

1 Heating control

1.1 Emission control

1.2 Emission control for TABS (heating mode)

1.3 Control of distribution network hot water temperature (supply or return)

1.4 Control of distribution pumps in networks

1.5 Intermittent control of emission and/or distribution

1.6 Heat generator control for combustion and district heating

1.7 Heat generator control (heat pump)

1.8 Heat generator control (out door unit)

1.9 Sequencing of different heat generators

1.10 Control of thermal energy stor age (TES) charging

2 Domestic hot water supply control

2.1 Control of DHW storage charging with direct electric heating or integrated electric heat pump

2.2 Control of DHW storage charging using hot water generation

2.3 Control of DHW storage charging with solar collector and supplementary heat generation

2.4 Control of DHW circulation pump

3 Cooling control

3.1 Emission control

3.2 Emission control for TABS (cooling mode)

3.3 Control of distribution network chilled water temperature (supply or return)

3.4 Control of distribution pumps in hydraulic networks

3.4 Control of distribution pumps in hydraulic networks

3.6 Interlock between heating and cooling control of emission and/ or distribution

3.7 Generator control for cooling

3.8 Sequencing of different chillers (generators for chilled water)

3.9 Control of thermal energy storage (TES) charging

4 Ventilation and air-conditioning control

4.1 Supply air flow control at the room level (e.g. fan on/off)

4.2 Room air temperature control by the ventilation system (all air systems; combination with static systems as cooling ceiling, radiators, etc.)

4.3 Coordination of room air temperature control by ventilation and by static system

4.4 Outside air (OA) flow control

4.5 Air flow or pressure control at the air handler level

4.6 Heat recovery control: icing protection

4.7 Heat recovery control: prevention of overheating

4.8 Free mechanical cooling

4.9 Supply air temperature control at the Air Handling Unit (AHU) level

4.10 Humidity control

5 Lighting control

5.1 Occupancy control

5.2 Light level/daylight control (daylight harvesting)

6 Blind control

6.1 Blind control

7 Technical home and building management

7.1 Set point management

7.2 Runtime management

7.3 Detecting faults of technical building systems and providing support to the diagnosis of these faults

7.4 Reporting information regarding energy consumption, indoor conditions

7.5 Local energy production and renewable energies

7.6 Waste heat recovery and heat shifting

7.7 Smart grid integration

*BMS Standards Referenced in ISO 52120-1:2021

A core principle of advanced BMS standards is that true energy efficiency cannot come at the cost of occupant comfort. Even with stable temperatures, comfort can be compromised by factors like poor air quality or inadequate lighting, demanding integrated, multi-system regulation. Higher-class BMS standards (such as Class A and B) address this by mandating intelligent control strategies—including "modulating," "demand-based," and "automated" control—across all functional domains. For instance, heating systems must support "individual modulating room control with communication and occupancy detection," while lighting systems require "automatic control." These functions depend fundamentally on real-time external inputs—such as occupancy, illuminance, and indoor air quality (IAQ)—to enable dynamic adjustment. As stated in the standard:

"Variable control: the system is controlled by sensors which detect the number of people or indoor air parameters or adapted criteria (e.g. CO_2, mixed gas or VOC sensors)."

IoT Sensors: The Foundation of Compliant, Intelligent BMS

It is this sensor-driven approach that makes IoT devices not just beneficial, but mandatory for achieving Class A and B compliance. Without granular, real-time data, the required level of automated and demand-based control is simply unattainable.

Traditional BMS setups—relying mainly on scheduled operation and fixed setpoints—cannot provide the continuous feedback needed for such precision. Retrofitting with wired sensors is often costly and disruptive, making wireless IoT sensors the most viable and scalable path to compliance. Moreover, while conventional systems focus primarily on equipment control, they lack the integrated intelligence and zonal monitoring required to holistically address key modern challenges: reducing energy use, cutting operational costs, improving space utilization, enhancing well-being, and meeting sustainability targets.

By delivering room- or zone-level insights—from IAQ monitoring to leak detection—IoT sensors enable the precise, responsive, and human-centric building management envisioned by European BMS standards. At Milesight, we build this intelligence into every solution, ensuring compliance is just the starting point—true occupant comfort is the ultimate goal.

6.2 Milesight's Comprehensive Smart Building Framework: From Compliance to Competitive Advantage

Milesight's Smart Building Strategy: FES Plus

Milesight addresses Europe's smart building transformation through its integrated FES Plus framework, which augments Facility, Energy, and Space Management with People Sensing technology. This approach shifts building operations from static equipment monitoring to dynamic, human-aware environments—where real-time occupancy and behavioral data drive efficiency, comfort, and compliance.

Facility Management for Seamless Building Operations and Asset Protection

Milesight's IoT facility management solution delivers a unified platform that integrates real-time monitoring of environmental conditions, equipment status, and occupancy. Our specific capabilities—encompassing HVAC performance optimization, automated lighting control, predictive maintenance for critical systems, and data-driven space utilization—enable proactive operations. This translates directly into enhanced safety, reduced energy consumption, and lower operational costs, moving building management from reactive to intelligent.

These capabilities are realized through key application scenarios, including:

- HVAC System Performance Monitoring
- Circuit Operational Status Monitoring
- Facility Protection
- Unified Lighting Control
- Centralized HVAC Control
- Remote Meter Reading
- Water Supply Control
- Restroom Cleaning Schedule Management
- Restroom Supplies Management
- Facility Utilization Management

Space Management for Enhanced Building Efficiency and Well-being

Milesight's human comfort solutions create optimal indoor environments through continuous monitoring and intelligent control of six core comfort dimensions: Indoor Air Quality, Thermal Comfort, Visual Comfort, Psychological Well-being, Noise Levels, and Bathroom Environment. By leveraging LoRaWAN® technology and comprehensive sensor networks, we deliver real-time insights and automated system adjustments that directly enhance occupant productivity, well-being, and happiness while maintaining energy efficiency.

Our approach delivers measurable value across multiple dimensions, including:

- Real-time IAQ monitoring with multi-parameter sensors
- Automated HVAC control based on occupancy and
- environmental data
- Intelligent lighting adjustment for visual comfort
- Noise pollution monitoring and mitigation
- Data-driven comfort strategy optimization
- Seamless integration with building management systems
- Wellness certification compliance support
- Occupant feedback and comfort analytics

Energy Management for Sustainable and Profitable Buildings

Milesight's energy efficiency solutions leverage LoRaWAN® sensing technology to monitor key parameters like equipment status, people presence, and environmental data. Our capabilities enable automated control over HVAC, lighting, and other systems, alongside data-driven insights for centralized management. This approach helps reduce energy costs and lower carbon emissions while maintaining operational comfort.

Specifically, our system excels in the following critical functions:

- HVAC Automation Adjustment
- Real-Time Local HVAC Interaction
- Data-Driven HVAC Operation Strategy Optimization
- Smart Lighting Control
- Real-Time Local Energy Interaction
- Data Driven Energy Strategy Optimization

People Sensing: Driving Smart Building and Beyond Applications and Value

People Sensing can effectively provide data related to people and integrate with the three main application areas of smart building management: safety and security management, energy management, and building infrastructure management. By combining different solutions, it enhances the operational efficiency and value of buildings. Additionally, the application of People Sensing technology extends to retail, public utilities, and elderly care and medical sectors, unlocking the higher potential and value of IoT.

In summary, the "People Sensing Driven Smart Buildings" strategy transforms traditional building management into a human-centric ecosystem. Through the integration of People Sensing technology across Facility, Energy, and Space Management domains, buildings evolve from static structures into dynamic environments that intelligently adapt to human presence and behavior. This approach delivers not only unprecedented operational efficiency and compliance, but more importantly creates spaces that actively enhance occupant well-being and productivity - representing the true future of intelligent built environments.

7.SUCCESS STORY SPOTLIGHT

The following case studies demonstrate how Milesight's FES Plus framework delivers tangible value across diverse European building scenarios. Each implementation showcases the real-world application of People Sensing technology in enhancing facility operations, optimizing energy usage, and creating human-centric environments—turning regulatory requirements into sustainable business advantages.

Seamless BMS Integration in Italian Residential Retrofit

Location: Trieste, Italy
Partner: OpenSense

The Challenge:
To integrate energy monitoring into the existing Building Management System (BMS) across 100+ occupied buildings, avoiding costly wiring and ensuring seamless data flow for EU compliance.

The Solution:
A wireless LoRaWAN® network using Milesight's UC100 controllers and UG56 gateways, leveraging native BACnet/IP support to bridge sensor data directly into the Niagara BMS without protocol changes.

The Outcome:
A scalable, non-intrusive retrofit that delivers auditable data for EPBD compliance and enables centralized, data-driven energy management—turning policy ambition into operational reality.

Sustainable Modernization of a Historic Rome Theater

Location: Rome, Italy
Partner: iComfort

The Challenge:
To transform a 19th-century heritage theater into an energy-efficient smart building while preserving its historic integrity and overcoming structural limitations like thick walls and lack of cabling.

The Solution:
A comprehensive LoRaWAN® sensor network deploying 175+ Milesight wireless devices—including IAQ sensors, people counters, and occupancy detectors—integrated with the iComfort platform for real-time environmental and occupancy analytics.

The Outcome:
The theater achieved significant gains in energy efficiency, optimized space usage through people flow intelligence, and ensured healthy indoor air quality—all without structural modifications, demonstrating a scalable model for modernizing heritage buildings under EU sustainability directives.

People Sensing Transformation in Barcelona Office

Location: Barcelona, Spain
Partner: Monolitic

The Challenge:
To transform a conventional office into a data-driven smart building that optimizes space utilization, enhances occupant comfort, and enables efficient facility management through real-time sensing.

The Solution:
A comprehensive people sensing IoT deployment featuring Milesight's AI people counters (VS351, VS133), occupancy sensors (VS121), and environmental monitors (AM307, AM103) to capture real-time data on space usage, indoor air quality, and facility status.

The Outcome:
The building achieved data-driven decision making with 25% improved space utilization, enhanced occupant comfort through automated environmental controls, and proactive facility management—demonstrating the practical implementation of people-centric smart building strategies.

Heritage Conservation Through Microclimate Monitoring

Location: Castenray, Netherlands
Partner: Bat Habitat Preservation

The Challenge:
To protect Europe's largest Serotine bat colony during potential church repurposing by maintaining the exact microclimate conditions of their attic habitat.

The Solution:
Deployment of 11 Milesight EM300-TH wireless sensors creating a precise monitoring network, tracking temperature and humidity differentials between interior and exterior environments with 0.x°C accuracy.

The Outcome:
Established a 3-year baseline microclimate profile enabling future building modifications without disturbing the protected species, demonstrating how IoT technology enables sustain-able heritage building adaptation.

Smart Cleaning Optimization in Swiss Offices

Location: Zürich, Switzerland
Partner: Akenza & Soobr

The Challenge:
To transition from rigid cleaning schedules to demand-based services by accurately monitoring room usage patterns across corporate offices.

The Solution:
Deployment of Milesight WS202 occupancy sensors connected via LoRaWAN® to the Akenza platform, enabling real-time space utilization data to drive Soobr's smart cleaning management system.

The Outcome:
Achieved 30% more efficient cleaning tours through data-driven scheduling, reduced operational costs via demand-based resource allocation, and enhanced workplace experience with minimal infrastructure impact.

8.YOUR SMART BUILDING ACTION GUIDE

The European building sector is undergoing an irreversible transformation. Between stringent policy mandates, ambitious renovation targets, and rapid technological evolution, the rules of the game are changing. This represents not just a series of projects, but a fundamental opportunity to redefine your role in the value chain.

The following diagnostic is designed to help you critically assess your readiness for this new era. Use it to identify strategic gaps, validate your direction, and build a resilient, future-proof business model.

Policy & Regulatory Foresight

- How will your service portfolio adapt as National Renovation Plans take effect in 2025-2026?
- What specific mechanisms do you have to verify compliance with evolving EPBD mandates (BMS, SRI, IAQ)?
- How are you preparing for the 2027/2029 deadlines for lighting and BACS requirements in non-residential buildings?
- To what extent does your current offering align with the Renovation Wave's target of doubling renovation rates?

Technical & Integration Strategy

- How does your solution stack address the critical challenge of integrating with Europe's aging building stock?
- What percentage of your projects currently utilize wireless protocols to overcome retrofit complexity?
- How are you building capability to meet the demand for Class A/B BMS systems under EN ISO 52120-1?
- What's your strategy for the coming convergence of energy management and occupant comfort requirements?

Market Positioning & Client Impact

- Which building segments in your portfolio are most exposed to the 2030 EPBD renovation targets?
- How are you translating policy requirements into tangible ROI calculations for clients?
- What specific data points are you collecting to validate energy savings claims for subsidy applications?
- How does your offering for commercial buildings with 70+ kW HVAC systems differ from your standard approach?

Operational Excellence

- What measurable improvements have you achieved in reducing integration costs through protocol standardization?
- How are you addressing the talent gap in green skills and smart technology integration within your team?
- What percentage of your revenue now comes from recurring, data-driven services versus one-time projects?
- How does your implementation methodology minimize business disruption during retrofit projects?

Forward-Looking Capacity

- What concrete steps are you taking to position for the next S-curve of people-centric building innovation?
- How is your organization developing expertise in the Smart Readiness Indicator framework?
- What partnerships have you formed to address the full spectrum of renovation challenges (financing, technology, implementation)?
- How will your business model evolve as the market shifts from basic compliance to enhanced occupant experience?

These questions are not merely for reflection—they are a blueprint for building the resilient, future-ready organization that the European market demands. The gap between today's capabilities and tomorrow's requirements defines your strategic opportunity.

The most successful players in the coming years won't just respond to change; they will anticipate it, shape it, and build sustainable businesses around it. This begins with honest assessment and leads to decisive action.

As the building sector evolves, the ability to navigate this complex landscape of policy, technology, and human needs will separate industry leaders from followers. The journey starts with understanding where you stand today—and having the right partners to help you build what comes next.

1 Eurostat, "Construction Production (Volume) Index Overview," European Commission, data extracted October 2024.
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Construction_production_(volume)_index_overview

2 Eurostat, "Enterprises by detailed NACE Rev. 2 activity and special aggregates" [sbs_ovw_act], European Commission, last update: 13 October 2025.
https://ec.europa.eu/eurostat/databrowser/view/sbs_ovw_act__custom_17597870/default/table

3 Eurostat, "Enterprises by detailed NACE Rev. 2 activity and special aggregates" [sbs_ovw_act], European Commission, last update: 13 October 2025.
https://ec.europa.eu/eurostat/databrowser/view/sbs_ovw_act__custom_17597870/default/table

4 European Commission. "Factsheets." EU Building Stock Observatory, European Union.
https://building-stock-observatory.energy.ec/ .europa.eu/factsheets/. Accessed 23 May 2024.

5 Crosthwaite, David. "Building Stock in the EU: Energy Efficient Retrofits in Renovations." RICS, 27 July 2020.
https://www.rics.org/ .

6 Europe's buildings under the microscope

7 van Sante, Maurice. "Renovation Is Taking Centre Stage in the Construction Sector." ING, 3 July 2023.
https://www.ing.com/.

8 BPIE (Buildings Performance Institute Europe). (2011). Europe's buildings under the microscope: A country-by-country review of the energy performance of Europe's buildings. Retrieved from https://www.bpie.eu/publication/europes-buildings-under-the-microscope/

9 Deepki. (2025). Deepki Index: European building energy performance benchmarks. Retrieved from
https://www.deepki.com/solutions/deepki-index/

10 Eurostat. "Energy Statistics - an Overview." European Commission, 12 Aug. 2024,
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_statistics_-_an_overview.

11 European Commission. (n.d.). Building Stock Observatory database. Retrieved from
https://building-stock-observatory.energy.ec.europa.eu/database/

12 The Climate Group, How to Deliver a Renovation Revolution in Europe's Buildings, November 2024.
https://www.theclimategroup.org/sites/default/files/2025-02/Climate%20Group%2024353%20EP100%20-%20Renovation%20Revolution%20Handbook%20v4.pdf

13 BPIE. Report on the Evolution of the European Regulatory Framework for Buildings Efficiency. BPIE, 24 Feb. 2022,
https://www.bpie.eu/wp-content/uploads/2022/02/rev6_SPIPA_EU.pdf.

14 European Commission. Questions and Answers: Renovation Wave. 14 Oct. 2020,
https://ec.europa.eu/commission/presscorner/api/files/document/print/en/qanda_20_1836/QANDA_20_1836_EN.pdf.

15 The Climate Group. How to Deliver a Renovation Revolution in Europe's Buildings. Nov. 2024,
https://www.theclimategroup.org/sites/default/files/2025-02/Climate%20Group%2024353%20EP100%20-%20Renovation%20Revolution%20Handbook%20v4.pdf.

16 Allianz SE. "The Great Green Renovation." Allianz, 2 June 2022,
https://www.allianz.com/en/economic_research/insights/publications/specials_fmo/buildings-sector-transition.html.

17 European Commission, "Renovation Wave," Directorate-General for Energy, accessed 2025.
https://energy.ec.europa.eu/topics/energy-efficiency/energy-performance-buildings/renovation-wave_en

18 European Union. *Directive (EU) 2024/1027 of the European Parliament and of the Council of 11 April 2024 amending Directive (EU) 2018/2001 and Regulation (EU) 2018/1999 as regards the Union's renewable energy financing mechanism in the period 2021-2030 and repealing Directive (EU) 2015/652*. 17 Apr. 2024, Official Journal of the European Union, L series, vol. 2024, no. 1027, pp. 1-21, eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401275.

19 European Commission, "Smart Readiness Indicator," European Commission, accessed 2025.
https://energy.ec.europa.eu/topics/energy-efficiency/energy-performance-buildings/smart-readiness-indicator_en

20 European Commission, "Country Pages," European Commission, accessed 2025.
https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/country-pages_en

21 European Commission, "Modernisation Fund," Directorate-General for Climate Action, accessed 2024.
https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/modernisation-fund_en

22 European Commission, *Horizon Europe Work Programme 2021-2022: 8. Climate, Energy and Mobility* (Decision C(2022)2975), 10 May 2022.
https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2021-2022/wp-8-climate-energy-and-mobility_horizon-2021-2022_en.pdf

23 Siemens, "Building Smarter: How IoT, AI, and Edge Technologies Are Powering the Future of Sustainable Construction," Siemens Xcelerator Community, July 30, 2025.
https://community.xcelerator.siemens.com/public/blogs/building-smarter-how-iot-ai-and-edge-technologies-are-powering-the-future-of-sustainable-construction-2025-07-25

24 [1] Satyajit Sinha, "LPWAN market 2024: Licensed technologies boost their share among global 1.3 billion connections as LoRa leads outside China," IoT Analytics, March 21, 2024.
https://iot-analytics.com/lpwan-market/

25 Raksha Sharma, Building Automation LoRaWAN Sensor Market Research Report 2033, Growth Market Reports, 2024.
https://growthmarketreports.com/report/building-automation-lorawan-sensor-market

26 Shenzhen IoT World Media Co., Ltd., IoT World China, accessed 2024.
https://www.iotworld.com.cn/AIOT.aspx

27 Maximize Market Research, *LoRa and LoRaWAN IoT Market: Global Industry Analysis and Forecast (2024-2030)*, December 2023.
https://www.maximizemarketresearch.com/market-report/lora-and-lorawan-iot-market/218493/

28 Verified Market Reports, Smart Building Sensors Market Size, Competitive Overview & Forecast 2033, February 2025.
https://www.verifiedmarketreports.com/product/smart-building-sensors-market/

29 Rokon Zaman, "Innovation S-curve – episodic evolution," THE WAVES, March 13, 2022 (last updated November 30, 2023).
https://thewaves.tech/innovation-s-curve-episodic-evolution/

[i] All new buildings should be zero-emission buildings by 2030, and existing buildings should be transformed into zero-emission buildings by 2050.

[ii] The minimum energy performance standards shall ensure that all non-residential buildings are below:
a. the 16% threshold from 2030;
b. the 26% threshold from 2033.

[iii] Member States shall ensure that the average primary energy use of the entire residential building stock:
a. decreases by at least 16% compared to 2020 by 2030;
b. decreases by at least 20-22% compared to 2020 by 2035.

[iv] Member States shall ensure that non-residential buildings are equipped with building automation and control systems, where feasible:
a. by 31 December 2024, for buildings with systems over 290 kW;
b. by 31 December 2029, for buildings with systems over 70 kW.

[v] Member States shall ensure that non-residential buildings are equipped with suitably zoned automatic lighting controls capable of occupancy detection, where feasible:
a. by 31 December 2027, for buildings with systems over 290 kW;
b. by 31 December 2029, for buildings with systems over 70 kW.

[vi] Member States shall require non-residential zero-emission buildings to be equipped with devices for monitoring and regulating indoor air quality. This is also required for existing non-residential buildings undergoing major renovation, where feasible. Member States may require this for residential buildings.

[vii] Member States shall require new buildings to be equipped with self-regulating devices for temperature in each room (or zone) and hydraulic balancing, where feasible. In existing buildings, this is required when heat or cooling generators are replaced.

[viii] The Modernisation Fund is a dedicated fund under the EU Emissions Trading System, primarily allocated to lower-income EU Member States.

[ix] Built4People is a European Partnership initiative under Horizon Europe, dedicated to achieving a sustainable built environment through human-centric innovation.

[x] Built4People is a European Partnership initiative under the Horizon Europe framework, dedicated to achieving a sustainable built environment through human-centric innovation.

Milesight

+86-592-5085280

www.milesight.com

iot.support@milesight.com

Building C09, Software Park Phase III, Xiamen 361024, Fujian, China