LoRaWAN® Sector Reports Series

Smart Buildings with LoRaWAN®

LoRa Alliance®

beecham research

Shaping the IoT future

LoRaWAN® is particularly well-suited to buildings. Requiring few gateways per building, it is quick and low cost to install, can penetrate concrete and steel and transmit underground. It is an open standard with device certification available and has a large ecosystem of vendors offering wide choice of solutions.

Why do we need smart buildings?

Buildings cover a wide range of functions, including:

Business
Commercial, Hospitality, Office Blocks Including Government/Educational

Residential
Homes, Flats, Multitenancy Units, Mixed Use

Industrial
Airports, Factories, Hospitals, Ports, etc.

A 'Smart Building' uses its intelligence to collect and analyse actionable data from user devices, sensors, systems, and services on the premises. Right now there are important drivers for making buildings 'smarter'. They include:

- Improving the overall physical, mental and social wellbeing of building occupants.
- Reducing carbon emissions for meeting specific environmental targets.
- Optimizing the design and use of space.
- Increasing operational efficiency, resulting in lower costs.
- Collecting and analyzing high-quality, reliable data to identify new business services, obtain insights to support business goals, and make informed decisions.

There is a real sense of urgency perceived by governments and businesses worldwide to counteract the effects of climate change and reduced global resources. Healthy buildings contribute to a thriving economy. To this end, the buildings sector must address the following high priorities:

- Energy savings are a high priority because resources and costs are escalating. Energy management systems are key applications for this sector. Smart buildings monitor and analyse consumption so that areas where there is wasteful energy spending can be identified and reduced or eliminated. The data collected can help identify trends so that demand spikes can be managed or maintenance can be scheduled during low-demand hours.
- Water and gas leak detection also relate to sustainability, safety and savings from insurance costs.
- Occupant safety and health particularly following recovery from the Covid pandemic – There is an increasing emphasis on worker safety and comfort in workplaces post-Covid. Making workplaces more comfortable, ensuring clean air, avoiding overcrowding and extremes of temperature should encourage workers to return to their offices.
- Basic functions, including automation where possible, to increase efficiencies and save costs and time – elevators, escalators, HVAC controls, lighting controls, access control, security.
- Security – safeguarding from ever-increasing risks of cyberattack.
- Additional costs of introducing new technologies.

- The cost relates to escalating energy costs and growing unpredictability in supply following the pandemic, and global shortages resulting from political uncertainty worldwide.
- Many applications come with strong reporting imperatives to the authorities – these relate to explicit and not so explicit mandates e.g. sustainability, zero carbon.

According to the International Energy Agency, the current decade is pivotal for reaching milestones needed for transforming the building sector to meet net zero targets by 2050. The world needs to deploy all available clean and efficient energy technologies in buildings in the 2020s, and also prepare to integrate the innovations needed to achieve longer-term decarbonisation targets.

Reporting requirements are also getting stricter. Recent legislation covering building safety impose additional reporting requirements. For example: In March 2024 the European parliament approved a law to make buildings more energy efficient and reduce carbon emissions. Buildings account for 40% of the European Union's energy use, and most are heated by fossil fuels.

Managing commercial properties has also become increasingly challenging, with having to choose between the conflicting needs of owners to keep costs down and renters wanting a safe and comfortable experience.

The Growing Market Demand for a Wide Variety of New Applications for Buildings

In response to these requirements, revenues from smart building solutions are set to grow substantially over the next few years.

Figure 1 shows Beecham Research estimates drawn from a wide range of different analyst forecasts – all pointing towards growth of around 16% per annum in global smart buildings solutions revenues during the period 2022 through 2028.

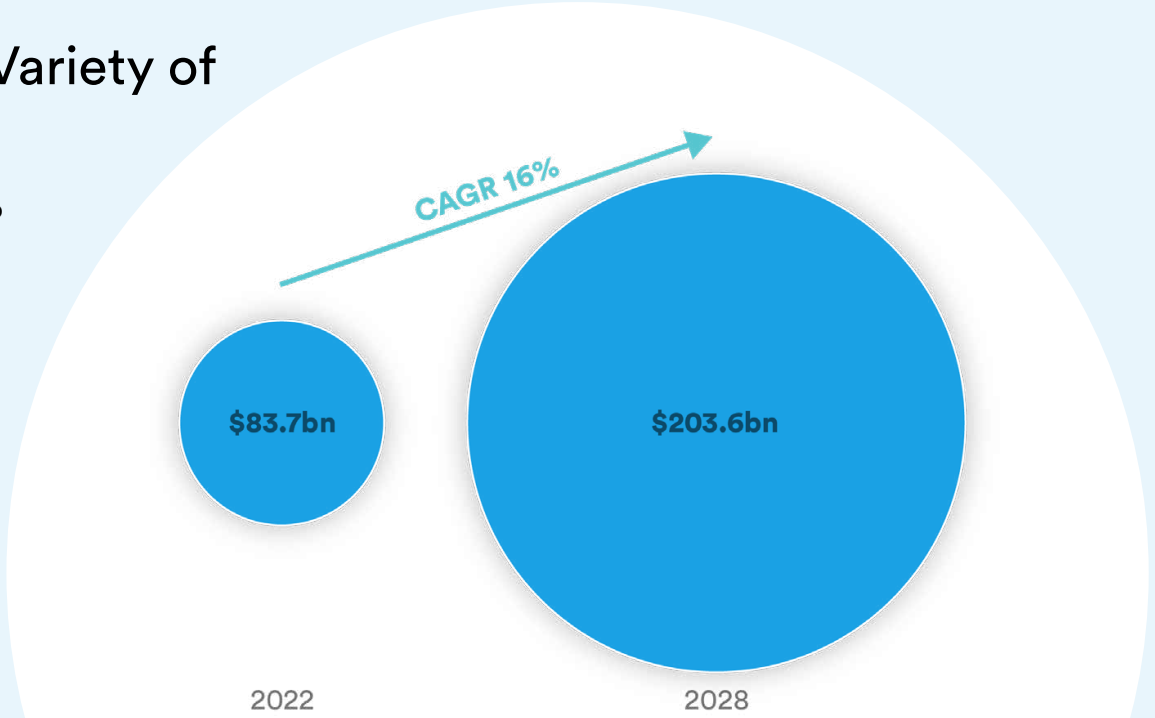


Figure 1: *Forecast of Global Smart Building Solutions Revenue 2022-28*

How LoRaWAN® Addresses Key Building Needs

LoRaWAN® is suited to a wide variety of applications in buildings.
These are characterised by the following technical considerations:

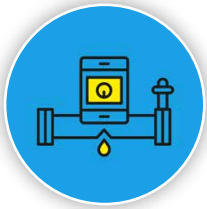
- Applications with small data payloads, typically limited to 100 byte messages.
- Where continuous real time monitoring is not required.

LoRaWAN® addresses smart buildings applications in four key groups:

Environmental Monitoring and Safety

Applications include:

- Climate monitoring (temperature, humidity)
- Air quality (carbon monoxide, carbon dioxide, particulates, allergens)
- Occupancy monitoring for workplace usage optimization (healthy distance between workers)
- Optimising lighting levels throughout the day (including blinds control) air quality monitoring, temperature monitoring



Utilities and Leak Detection

Applications include:

- Water Leak detection, in particular detecting and preventing excess moisture and flooding caused by broken pipes and faulty appliances
- Gas leak detection, in particular hazardous gas leaks
- Gas flow control, typically monitoring flow of gases such as liquefied petroleum, oxygen, and natural gas
- Water metering
- Sub-metering of all utilities, particularly for multi-dwelling units

Building Operations

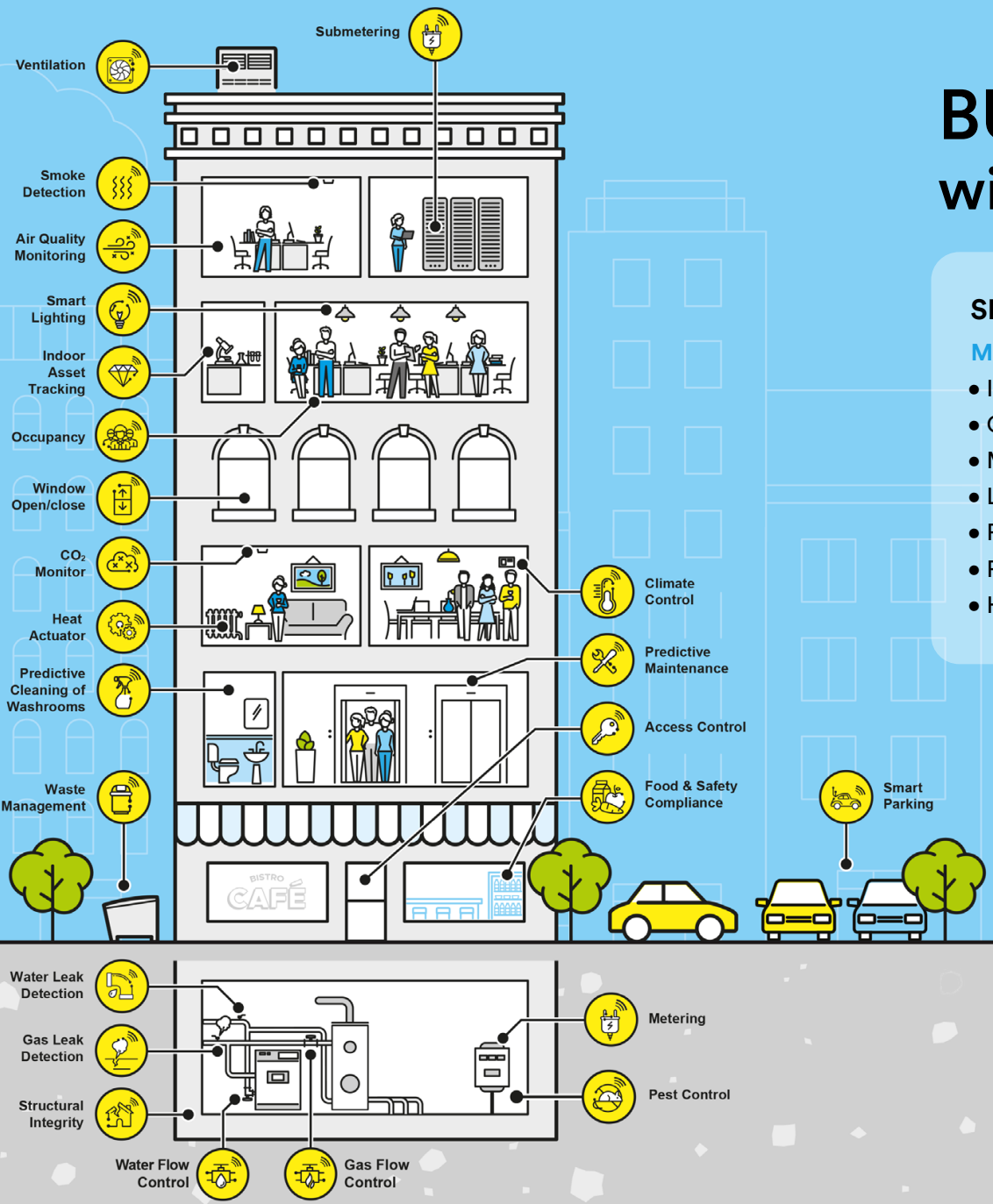
Applications include:

- Building monitoring systems. Many buildings already use building management systems (BMS), which are often hardwired systems installed during construction that automate building management with limited functions.
- Automated fire detection and extinguishing systems
- Wayfinding to assist occupants in case of evacuation
- Asset tracking and management including movable assets e.g. locating furniture, equipment
- Facilities management operations monitoring to manage the temperature, humidity and lighting to make the most efficient use of resources
- Heating ventilation and air conditioning (HVAC), to protect from Coronavirus and other airborne pathogens that might be blown around on the ventilation system; detecting carbon monoxide, carbon dioxide, particulates, allergens etc.
- Lift and escalator safety; structural monitoring
- Smart window blind and lighting control, controlling daylight level shading through blinds control
- Rodent control
- Site security and access control, including panic buttons (e.g. for hotel staff) and active shooter buttons

Predictive Maintenance and Maintenance Services

Predictive maintenance relies on real-time monitoring of equipment conditions and data to predict equipment failures before they occur. Data models, analytics, and machine learning (ML) can assess when and where failures are most likely to occur, including which components are most likely to be affected. Application areas include:

- Vertical transport – ecalators and lifts
- HVAC systems
- Predictive cleaning, optimising cleaning schedules to boost efficiency and target most used locations
- Waste management systems, to optimise outflow quality



BUILDING INTELLIGENCE
with LoRaWAN®

SMART BUILDINGS

MONITOR & CONTROL

- Indoor air quality
- Occupancy
- Metering
- Leak detection
- Regulation compliance
- Predictive maintenance
- Heating & climate control

ACHIEVE

- Healthier conditions for occupants
- Early crisis mitigation
- Save time and money
- Reduce labor
- Optimized use of energy with LoRaWAN®

www.lora-alliance.org/buildings-vertical-market

LoRa Alliance®

Why LoRaWAN® is well suited as the connectivity technology for these applications:

- LoRaWAN® operates in the unlicensed industrial, scientific, and medical (ISM) band, over a range of approximately 5-10km, and needs line of sight between devices and gateways. Its main purpose is for battery-operated devices to send small amounts of data at infrequent intervals to the internet.
- Devices broadcast data via radio waves to a nearby LoRaWAN® gateway. The gateway forwards the data to an internet server, which relays the data to an application in the cloud or a data centre. Remote monitoring operations suit these actions.
- LoRaWAN® is considered secure by default; it uses two layers of 128-bit encryption to secure data sent from devices. One encryption key authenticates the device against the network server and the other against the backend application.
- LoRaWAN® security is designed to fit the general LoRaWAN® design criteria: low power consumption, low implementation complexity, low cost and high scalability. As devices are deployed in the field for long periods of time (years), security must be future-proof.
- LoRaWAN® networks can simplify IoT setups; it is easier to install a few gateways in a contained area rather than installing many Wi-Fi routers or fitting SIM cards into each individual device.
- LoRaWAN® can penetrate concrete and steel, and underground. By enabling relay, coverage can be extended even further. This can be especially useful in areas like underground sub-floors where there may be insufficient coverage from the gateway.
- LoRaWAN® networks are suited to IoT applications as they need minimal cost for deployment. A single LoRaWAN® gateway device is engineered to handle thousands of end devices or nodes.
- LoRaWAN® is an open standard backed by a large ecosystem of vendors, giving building managers a wide variety of solutions that can be tailored to meet their specific needs. It also means that building managers do not need to worry about being “locked-in” to a single source vendor, ensuring flexibility over the building’s lifetime.
- Firmware Update Over the Air (FUOTA) is a standard for distributing firmware updates using unicast or multicast. Its greatest benefit is delivering updates over the air to many devices at the same time in an efficient and secure manner, without disrupting operations. It also provides future-proofing of connected device deployments, ensuring that devices will continue to operate over long lifetimes.
- LoRaWAN® Certification of IoT devices ensures devices made by different OEMs operate correctly with each other once they are deployed in the field. Interoperability between different OEMs products is critical to growing the LoRaWAN® market.
  LoRaWAN® Certification of end-node devices is also critical to an efficient and reliable LoRaWAN® network deployment: devices which misbehave can degrade network capacity and in extreme cases, make a network unusable.
- A LoRaWAN® Certified mark indicates that a LoRaWAN® device has been tested, de-bugged, and will function on any LoRaWAN®-compliant network.
- LoRaWAN® networks can co-exist with other wireless networks. They are complementary with Wi-Fi, Bluetooth, 5G, RFID, and BACnet, making IoT deployments more event-driven.
- LoRaWAN® is suited to event driven measurements or alerts. In each sensor application example, there is some event or state change that the sensor is trying to capture.
- LoRaWAN® works with public wireless, private wireless, satelite & hybrid networks.
- Manages buildings efficiently by readily adding LoRaWAN® sensors to both new and existing construction and integrating with legacy Building Management Systems (BMS).
- Deployments create data that enables real-time alerts and save on mitigation, labor, and operational costs.

Key Properties of LoRaWAN®

Long Range

Connects devices up to 30 miles apart in rural areas and penetrates dense urban or deep indoor environments

Low Power

Requires minimal energy, with a prolonged battery lifetime of up to 10 years, minimizing battery replacement costs

Secure

Features end-to-end AES128 encryption, mutual authentication, integrity protection, and confidentiality

Standardized

Internationally recognised standard offers device interoperability and global availability of LoRaWAN® networks for speedy deployment of IoT applications anywhere

Geolocation

Enables GPS-free tracking applications, offering unique low power benefits untouched by other technologies

Mobile

Maintains communication with devices in motion without strain on power consumption

High Capacity

Supports millions of messages per gateway, meeting the needs of public network operators serving large markets

Low Cost

Reduces infrastructure investment, battery replacement expense, and ultimately operating expenses

Case Studies and New Technology Examples

LoRaWAN® sensors are battery powered, and work is ongoing to reduce battery consumption even further. To this end, implementors are looking at energy harvesting solutions. An example solution is as follows:

Dracula Technologies – Energy Harvesting
The deployment of IoT solutions has revolutionized buildings by providing real-time data and has increased automation and improved decision-making processes. However, IoT deployments often include thousands of battery-powered sensors that require periodic replacement, which make IoT deployments in some cases not economically viable. In other words, batteries kill the business case!

When companies do their business case or total cost of ownership (TCO) for a large LoRaWAN® deployment, they discover that the cost of replacing batteries during the lifecycle may be higher than expected. Calculating the TCO will show the costs for maintaining the battery-operated sensors for large-scale deployments with tens of thousands of sensors operated at multiple locations at difficult-to-reach locations.

The costs of labour to replace batteries multiple times during the lifetime of the IoT deployment can accumulate significantly. When sensors are no longer sending data due to drained batteries, the systems relying on those data could be compromised.

To counteract this problem, energy harvesting makes IoT solutions more reliable, reducing TCO and contributing to a greener world by saving on millions of batteries.

Dracula Technologies (Valence, France) recently published a whitepaper that compares two scenarios, one with batteries and one based on its organic photovoltaic (OPV) technology. (www.dracula-technologies.com). It found that the TCO of the OPV-powered can be reduced by about 40% over a 10-year period. This is based on a real-world case study of a non-disclosed enterprise client with 25 locations worldwide deploying tens of thousands of LoRaWAN smart-building sensors.

Dracula Technologies' technology is based on harvesting energy from very low-intensity light similar to what is typically found inside buildings. Dracula's thin-film product called LAYER® modules are inkjet printed in any shape or form on flexible PET substrate without using any rare earth or toxic materials.

Case Study – Creating a healthy working environment in schools in Quebec

The Challenge

Real-time data collection and reporting are critical for effective indoor air quality monitoring. The solution aims to ensure the best possible learning and working environment for students and staff. The system monitors CO_2, humidity and temperature levels at 5 minute intervals during school hours.

The Solution

Encouraging results were obtained from two pilot projects. In each pilot, Milesight's LoRaWAN Certified℠ AM107 devices were installed in some 30 classrooms, and Assek's software provided the tools to monitor the air quality in the classrooms.

The success of the 2 pilots proved LoRaWAN® was the right technology. Approximately 47,000 classrooms were equipped with this LoRaWAN® monitoring solution with 2,600 gateways. In order to reduce the draining of the batteries in the sensors, Milesight engineered an automatic mode switch in its sensors between day and night.

The Benefits

The solution helped the schools authority understand the indoor air quality situation in all schools. This knowledge was not available prior to this project; the Schools Authority can now prioritize and implement corrective actions, and expand the solution to thousands of schools across Quebec.

Quebec is the only Canadian province to equip its classes with CO_2 sensors. It has created an information system without the use of Wi-Fi or cellular internet, while also reducing maintenance and installation costs. The Schools Authority can use the analysis results to identify higher level trends and target buildings that require broader intervention plans and/or larger scale corrective work.

Case Study – Reducing the high cost of water leaks in a high rise apartment block

The Challenge

Water damage costs U.S. insurance companies and property owners $14 billion annually. Leaks often go undetected for weeks before being discovered. The capital invested into premium residential properties is immense, but it is the skyrocketing insurance costs that are causing the most pain for owners; insurance premiums have increased by more than 300% in the past five years – with some premiums doubling year-to-year for specific Class A properties.

The Solution

Kairos Water created a patented, LoRaWAN Certified℠ water technology system that is designed to tackle the threat of water damage and utility waste from virtually any source; it uses advanced wireless sensors in its smart Moses Water Meters that feature an automatic shutoff valve.

In a high rise Los Angeles apartment block, Kairos installed five Noah leak sensors monitoring the kitchen, bathrooms and laundry closet in every unit. Each sensor was equipped with its own 10 year battery-powered node and each install took 4-5 minutes per apartment. Kairos established a LoRaWAN® network onsite by installing 7 gateways at strategic points throughout the 42-story structure, deploying over 1,400 sensors. The Kairos software platform could now push real-time leak notifications to the property management team.

The Benefits

The system detected eight leaks within the first six months.

According to the national project manager, “We evaluated 3 top vendor solutions and tested the Kairos leak detection system for 12 months. Kairos provided tremendous value, not to mention providing peace of mind for our onsite team.”

Case Study – Real time monitoring in operations across a Spanish hospital complex

The Challenge

Viamed Salud is a major private hospital group in Spain. Established in 2001, Viamed now has 13 hospitals, 15 healthcare centres, 2,300 healthcare professionals, 1,035 beds and 50 operating rooms, attending 850,000 medical consultations and 85,000 surgeries annually.

In order to ensure the proper operation of all its high-tech equipment and have a comprehensive view of the status of all its facilities, Viamed needed to obtain real-time information on the operations of its centres and infrastructures (climate control, electricity, temperatures, etc.).

The Solution

Viamed collaborated with Aritium to develop an innovative tool to enable smart and real-time management of all Viamed healthcare centres, without undertaking major construction works.

By leveraging the potential of LoRaWAN® and deploying private networks in all its centres, the Aritium Platform achieved a global and comprehensive remote view of Viamed's facilities. A range of solutions have been deployed for the optimization and automation of many processes.

The Benefits

Viamed Salud is transforming itself to "a smart hospital", where efficiency is achieved through the automation of processes, allowing health professionals to focus on patient care. Other benefits include:

Quality of care is ensured from high-quality data and information, with solutions that guarantee the proper functioning of different processes.

Professional experience of healthcare providers is enhanced through preventing potential risks or emergencies (panic buttons), and simplifying tasks by working in a more automated and efficient environment.

This implementation points to a future where integrating new solutions to cover new use cases occurs even more easily and effectively, thanks to the high scalability provided by LoRaWAN®.

Case Study – Assisting compliance with carbon reduction through energy monitoring and energy harvesting

The Challenge

As one of the largest property rental firms in Sweden, Stockholmshem provides homes for almost 60,000 tenants. Stockholmshem controls the heating in each apartment centrally – and heating is the company's single largest operating expense. Stockholmshem wants to become carbon neutral by 2030 and is striving to reduce carbon emissions across its operations.

The Solution

Formed in 2005 out of Umeå University, ELSYS is a leading provider of LoRaWAN® sensors, connected devices, and network solutions.

Stockholmshem decided to install ELSYS's LoRaWAN®-enabled sensors in all of its 22,000 apartments to monitor temperatures. The sensors are discreet and small, making them ideal to install. The sensors ensure excellent penetration through building materials so no wires are required.

Elsys' ERS Eco sensor is a LoRaWAN Certified^{CM} temperature and humidity sensor for the indoor environment. It is an environmentally friendly option, with an organic solar cell as the only power source and an enclosure made from biodegradable material. Eliminating batteries from a wireless IoT device significantly reduces the environmental impact and maintenance costs.

The ERS Eco can last up to 30 days in the dark depending on the sample interval, transmit interval, data rate, and environmental factors. It can be used with a self-adapting feature that will result in lower current consumption, lower network load, and less redundant data sent.

The data is transferred via a nearby LoRaWAN® gateway to Stockholmshem's building operations system. Stockholmshem can then adjust heating to ensure a steady indoor climate of around 20°C in each apartment.

The Benefits

Stockholmshem has estimated a reduction of energy consumption from heating its buildings by over 8,000 MWh per year, the equivalent of heating 1,200 fewer apartments. When fully implemented, the solution will also reduce Stockholmshem´s heating costs by around 6% per year.

https://lora-alliance.org/marketplace/elektroniksystem-i-umea-ab/ers-eco/

Takeaways from this report

- The demand for smart buildings is growing rapidly worldwide at around 16% per annum in revenue growth.
- LoRaWAN® is particularly well-suited to buildings, requiring few gateways per building, quick and low cost to instal, able to penetrate concrete and steel and transmit underground.
- LoRaWAN® addresses a wide range of smart buildings applications in: environmental monitoring and safety; utilities and leak detection; building operations; predictive maintenance.
- LoRaWAN® coverage in buildings can be extended by utilising the Relay feature. This can be especially useful in areas like underground sub-floors where there may be insufficient coverage from the gateway.
- LoRaWAN® is an open standard and has a large ecosystem of vendors offering wide choice with new technology innovations.
- LoRaWAN® Certification of IoT devices ensures devices made by different OEM's operate correctly with each other once they are deployed in the field.
- FUOTA is a standard for distributing firmware updates. It delivers updates over the air to many devices at the same time efficiently and securely. It also provides future-proofing of connected device deployments without disrupting tenants or business operations.
- LoRaWAN® networks can co-exist with other wireless networks, as they are complementary with Wi-Fi, Bluetooth, 5G, RFID, and BACnet, among other technologies.

Beecham Research is a leading technology market research, analysis and consulting firm established in 1991. We have specialized in the development of the rapidly-growing Connected Devices market, often referred to as M2M and IoT, worldwide since 2001. We are internationally recognised as thought leaders in this market and have deep knowledge of the market dynamics at every level in the value chain.

Our clients include component and hardware vendors, major network/ connectivity suppliers, system integrators, application developers, distributors and enterprise users in both B2B and B2C markets. We are experts in M2M/IoT services and platforms and also in IoT solution security, where we have extensive technical knowledge.

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