The Future is Now: Sustainable Buildings

How implementing IoT contributes to a smarter, safer future for the climate and the construction industry.

EVALAN

Introduction

Climate change is a major topic of concern in world politics, economics, and scientific research, especially the construction sector. The focus on the construction sector specifically stems from the fact that this sector contributes to 40% of global emissions. For this reason, countries are tightening the rules, and stricter requirements are emerging. One of these rules is that buildings must be CO2-neutral by 2050, with intermediate targets for 2030 and 2040. IoT can play a key role in this. Internet of Things (IoT) technologies enable facility managers to access data about people, assets, and spaces in the building to optimize resource use, reduce emissions and minimize their carbon footprint.

With IoT, sensors in buildings are linked to each other and the internet, making it possible to measure, for example, energy consumption, the energy yield of solar panels or collectors, temperature, and humidity from any location. This makes consumption easier to monitor and adjust. Rooms can be heated independently of each other, and maintenance can be planned efficiently through predictive maintenance. This contributes to reducing costs, increasing sustainability, and raising awareness of energy-neutral management. The US Department of Energy (DOE) and the Building Technology Offices (BTOs) have calculated that annual energy savings in the commercial sector can reach 29% by implementing measurement and monitoring systems, state-of-the-art sensors, controls on the operation of climate control systems, and predictive maintenance on these systems.

In this white paper, we highlight ways in which IoT in buildings can contribute to achieving sustainability goals:

HVAC efficiency

HVAC systems and lighting typically consume most off the electricity in buildings. HVAC equipment represents approximately 40%-60% of a building's total energy consumption. The new sustainability goals of the Climate Agreement direct the focus to regulating these systems more efficiently and reducing their overall energy consumption. With the help of IoT, this can be done effortlessly.

Putting IoT to good use in HVAC systems

HVAC systems have been using smart sensors to control and automate the indoor climate for decades. These systems have already proven that they can improve the user experience, reduce maintenance costs, maximize comfort, and reduce energy consumption. IoT makes it possible to apply even more complex algorithms and collect, combine, and analyze data from multiple sources. Advances in artificial intelligence and the introduction of new mobile telecom networks complement IoT and make data collection and processing easier than ever before. The management of these systems will continue to improve as the implementation of IoT technology expands with new features, at a lower cost.

Reducing energy consumption

Housing associations and building managers are increasingly interested in real-time insights into the indoor climate from smart thermostats to sensors that monitor environmental changes.

According to a report from Zion Market Research, the global market for smart HVAC controls is expected to reach nearly $28.3 billion by 2025, compared to $8.3 billion in 2018. Sustainability is a key driver for implementing IoT in HVAC systems, as several of the key benefits – such as lowering energy needs and expanding equipment lifespan – improve sustainability simultaneously.

IoT sensors continuously collect data, such as temperature, airflow, and humidity, in addition to monitoring external factors. The data collected with this sensors can be combined with other relevant data, such as weather forecasts. By analyzing this data, it is possible to implement smart cooling and lighting strategies that can autonomously control the building's conditions depending on the time of day or to meet the demand and use of space.

Temperature settings can also be automated with self-learning algorithms that keep optimizing the energy performance of the building – delivering an optimal experience to the users of the building at minimum energy consumption. Occupancy patterns, outdoor conditions and the characteristics of the building itself all factor into this optimization.

Predictive Maintenance of HVAC Systems

Maintenance plans typically include site visits which are often scheduled at routine intervals, without considering the actual needs of the system. By connecting IoT sensors to the HVAC system and allowing data to communicate to a dashboard, patterns and trends are identified that can assist in predictive maintenance. An example of this is recognizing patterns that precede a malfunction. With the data from the sensors, corrective measures can be taken immediately to prevent the system from breaking down. This technique can be applied to the need for specific maintenance actions. By including the maintenance requirements in prediction algorithms, the maintenance program can switch from preventive to predictive. This shift can drastically reduce the number of inspection visits to each building, saving time, money, and energy.

Demand driven ventilation

Carbon dioxide (CO2) concentration varies with the number and activity level of people in any given space inside a building. Too high a concentration can lead to fatigue and reduced concentration levels – or even worse, 'Sick Building Syndrome' which causes symptoms such as headaches, irritation of the eyes, nose, and throat, itchy skin, and nausea. Therefore, proper ventilation is imperative for the health and safety of building occupants. Monitoring CO2 levels isn't just about air quality - it can also help with your energy usage, as it is an indicator of over or under ventilation of your facility. Installing CO2 sensors in key areas of the office, such as meeting rooms, lunchrooms, break rooms, and similar areas can contribute to sustainability goals.

CO2 level rises with the number of people

When a room is occupied, the CO2 produced by people increases the concentration in the room from a normal minimum of about 400ppm to higher levels. This increase starts to get noticeable around 800ppm and can affect people's health negatively when it exceeds 2000ppm.

The traditional way to deal with this problem is to set up the airflow to a room so that at maximum occupancy, the CO2 concentration does not exceed certain critical levels. As most of these rooms are not occupied all the time, a lot of energy is wasted on unnecessary ventilation.

Rule of thumb design parameters

The building industry developed rule of thumb design parameters for this. Ventilation systems are usually used based on simple air exchange standards and rules of thumb without information about the actual CO2 levels. For example, ventilation is controlled based on a calculation of the geometry of space. To determine the amount of air exchange required for your ventilation equipment, calculate the volume of the room (LxWxH) and divide it by the number of minutes per air change. Doing this for each room takes a lot of time and is often inaccurate, which means that a lot of energy is still wasted. With real-time monitoring of CO2 via sensors, you can significantly improve this aspect and decrease energy use.

Demand driven ventilation

By implementing CO2 sensors, facility managers get insight into the CO2 level in each room and can adjust the ventilation accordingly. The system can also automatically ventilate the room based on the actual CO2 levels, also known as demand driven ventilation. Without demand driven ventilation, the ventilation will always run at the same settings, even if the building is empty. However, with demand driven ventilation, there is huge potential to achieve energy savings. This is an easy way to increase the operating efficiency of your building while significantly reducing electricity costs and energy waste.

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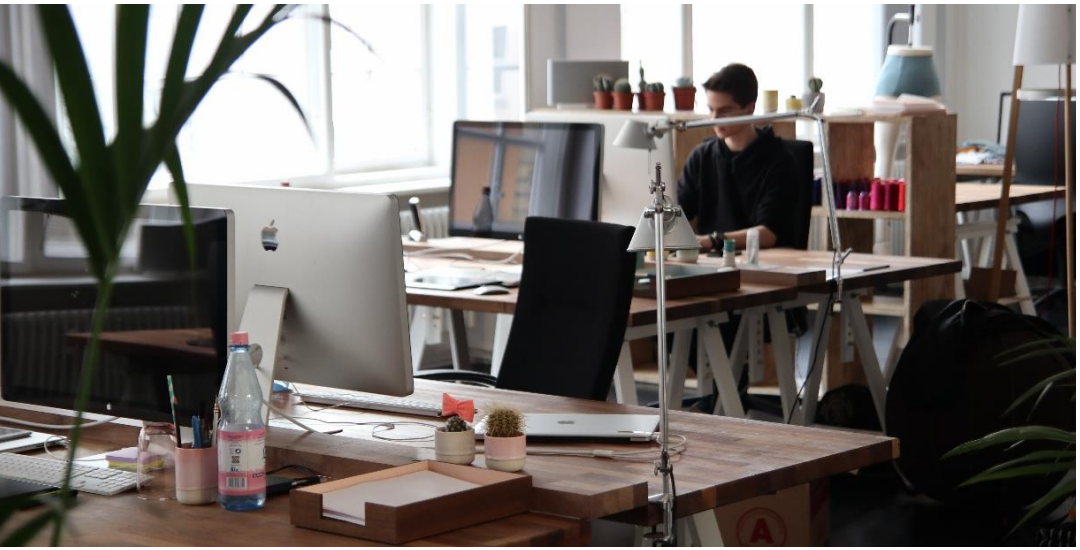
Optimizing space management

With the emergence of new office trends, such as flexible working and working from home, many spaces in buildings remain unused. This is in addition to the fact that, according to a recent report from JLL, the average worker spends only 40% of a regular workday at their desk. Another study by AECOM shows that 40% of the office space that organizations pay is empty. Because there is no insight into the occupancy, much energy and therefore costs are wasted on unused open-plan offices and meeting rooms. IoT can help improve this.



Restructuring the office building

In a quest for a dynamic approach to workplace management, IoT and smart building technologies are answering the call. With the data collected by these systems, managers can, for example, restructure the office or rent out vacant spaces. This offers opportunities for optimization of real estate planning and building management. Think of organizing the current or a new location as optimally as possible and making it more sustainable.

Monitoring occupancy rates

What IoT delivers is an unprecedented level of insight into the use of space. Just imagine how costly and inefficient, if not impossible, to have staff manually record office occupancy data all day long. Given this challenge, facility managers find themselves missing the big picture of how their offices are being used. Presence sensors automatically record the occupancy rate of any room or even desk. By monitoring occupancy rates and associated energy consumption, you can effectively detect waste sources in your building and

streamline consumption and maximize efficiency. The smart sensors communicate data to the facility manager's dashboard, with which decisions can be made about rearranging the rooms based on actual information. It allows managers to reduce energy consumption and save costs.

Self-learning algorithms

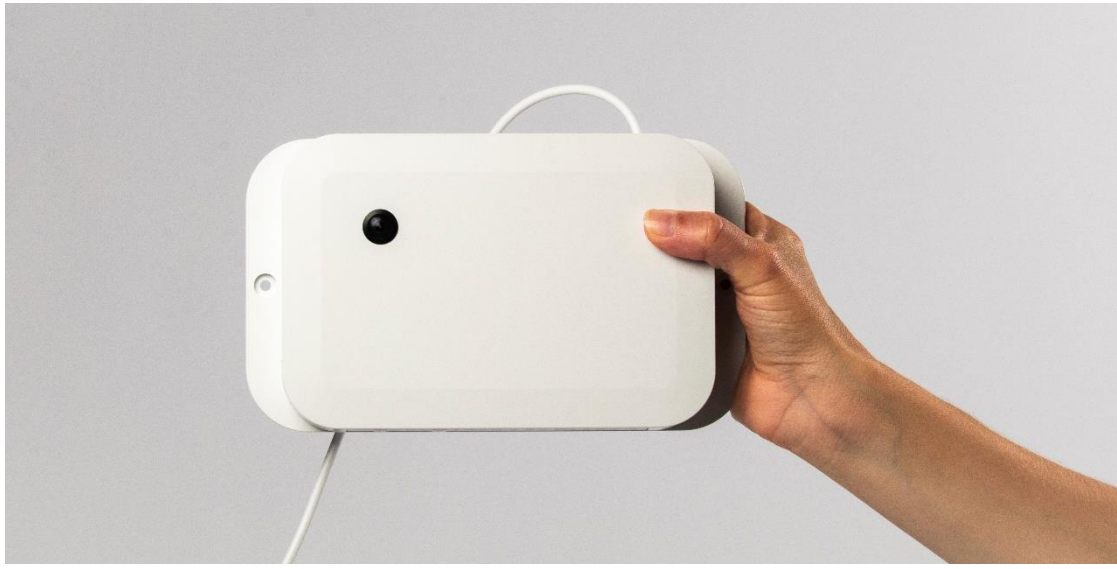
With advanced technologies such as AI and machine learning algorithms, IoT systems are now able to autonomously integrate data from sensors with occupancy patterns and

apply self-learning algorithms, with which performance can be optimized and environmental efficiency can be improved. Accurate and continuous detection of actual occupancy allows the system to use self-learning techniques and perform actions according to contextual changes.

A solution that accurately measures occupancy in offices is SmartEagle.

SmartEagle sensor

SmartEagle is an occupancy sensor that provides insight into occupant behavior and space utilization. SmartEagle uses optical sensors that are trained with Machine Learning (ML) to recognize the difference between people and other objects in the room. SmartEagle provides insights to the facility manager by showing the percentage of the desks are used and which desks are occupied. These insights enable the facility manager to better organize the spaces in the building and save costs by, for example, only cleaning the desks that were used.



Green buildings and renewable energy

In addition to reducing the energy consumption of a building, it is also important to look at the remaining energy needs of a building and how this can be compensated through more sustainable methods.

Green buildings

A green building is a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts, on our climate and natural environment. Integrating renewable energy into smart buildings is one way that can help meet the major challenge of achieving international and national climate goals. Renewable energy sources commonly used for construction applications include solar, wind, geothermal, and biomass. Green buildings incorporate different techniques and practices to use renewable resources. An example is solar panels, both on the roof and on the ground, that convert solar energy into electricity.

Another technology that green buildings use is micro wind turbines. Micro wind turbines are suitable for building scalable applications and are referred to as building-integrated wind turbines. Recent advances in this technology have resulted in improved reliability and efficiency at low wind speeds, and reducing costs.

Green roofs

Green buildings often also contain green roofs with small trees, plants, and rain gardens that conserve water. Green roofs contribute to cleaner air, a reduction in energy demand, more biodiversity, and longer roof life. When dry, the green roof layers act as insulators, reducing heat flow through the roof and thus reducing the energy required to cool the building's interior. In winter, these insulating effects reduce the heat emission of the building so that less heating is required. In summer, green roof vegetation lowers the temperature of the roof and the surrounding air, thus reducing the need for energy for cooling.

Powering sensors through energy harvesting

Energy harvesting is a way to power sensors and devices by converting energy from other sources into usable electrical energy. Energy sources include light, heat differences, mechanical vibrations, transmitted RF signals, or any source that can produce an electrical charge through a transducer. These energy sources are all around us and can be converted into electrical energy, such as a thermoelectric generator (TEG) for temperature difference, a piezoelectric element for vibrations, a photovoltaic cell for sunlight (or indoor lighting), and even galvanic energy from moisture. This creates a self-sufficient and sustainable sensor network independent of energy and extends the operating time of the sensor.

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Wrapping it up

This white paper shows how IoT can be used as a revolutionary technology for the future generation of smart and sustainable buildings. With IoT, the design of a building can be improved, construction processes can be optimized, and buildings can be managed more efficiently to reduce environmental impact and increase sustainability.

By implementing smart cooling and lighting strategies, restructuring spaces more efficiently, and compensating the energy demand with sustainable methods, energy consumption can be significantly reduced. Recent studies in the field, indicate that smart buildings with integrated IoT technology use 25% less energy than conventional buildings. The scope of smart buildings in the future is enormous. Whether you are managing a residential or commercial property, now is the right time to embrace IoT.

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About Evalan

Evalan is a fast-growing and innovative development and engineering partner in the field of the Internet of Things. We cover the complete IoT stack and work in close collaboration with our customers on remote monitoring, sensor, and telemetry solutions in the industry, real-estate, healthcare and government sectors. We develop devices, sensors, data management systems, data processing algorithms, cloud applications and user interfaces for different platforms. We serve around 100 clients, ranging from large multinationals to government departments to hospitals and small technology companies.

Contact details

Evalan BV

Sarphatistraat 638

1018 AV Amsterdam

The Netherlands

T. +31 20 779 03 44

E. info@evalan.com

I: evalan.com

T: @EvalanBV

L: https://www.linkedin.com/company/evalan

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