

An aerial view of a city, likely San Francisco, with a prominent blue skyscraper (Salesforce Tower) in the center. The image is overlaid with a digital network of glowing blue lines and nodes, suggesting smart buildings and data connectivity. The sky is blue with white clouds, and mountains are visible in the background.

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# Smart buildings

Striving for the perfect place

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## Smart buildings

# Striving for the perfect place



Buildings are an integral part of everyday life. With people spending an estimated 90 percent of their lives indoors, the drive to ensure that those buildings are comfortable, safe, secure and provide the functionality that we want is more important than ever. But how do we take what are essentially inanimate, silent and passive structures and turn them into living environments that can interact with their occupants, learn from them and ultimately adapt to their changing needs? Welcome to the world of the smart building.

Let's start with a definition of 'smart building': in essence it relates to the increasing digitalization of buildings meaning that technology works seamlessly together to provide benefits for the people connected to the building.

This includes occupants, organizations and tenants, landlords and investors, developers and those responsible for the building's operation. In short, a smart building is one which is an active contributor to the experience and success of its stakeholders by continuously interacting, learning and adapting.



*“We spend more than 90% of our lives in buildings, so individuals and businesses are right to expect more from their buildings.”*

*Smart buildings today should actively contribute to the well-being and business success of those who rely on it.”*

Cedrik Neike, CEO Smart Infrastructure

The world is facing many challenges: globalization, climate change, urbanization, shifting demographics and technological innovation to name but a few. While the effects of these challenges are not confined to the built environment, they are all influencing the way that we live and work. Digitalization is happening everywhere, from the ever-increasing shift away from physical money to the ways in which we consume information. However, buildings represent one of the most significant areas for harnessing the potential it has to offer.

The ultimate objective is to create the ‘perfect place’ in our buildings. We mean that we strive for perfection, recognizing however that, ultimately, perfection does not exist. Our buildings need to continually learn and adapt to needs that are constantly changing and in doing so get ever closer to that ideal, perfect place.

### **Buildings: passive assets**

Typically buildings have little or no connectivity and are therefore inflexible and unable to adapt. This approach is based on a somewhat simplistic view of buildings as an expense – a place just to do business and house people and assets. This is an outdated view and does not recognize the potential for a building to become more agile and flexible.

In doing so, it can actively contribute as a member of the team. If the building is not being put to work to optimize performance and efficiency and drive employee and revenue streams, then a vital element of the team is being ignored.

# “Technology is not an end in itself – we need to take the conversation beyond technology.”

Chris Pountney, Associate Director, AECOM

## The shift to the smart building

People now expect more from their buildings and with the advance in digitalization, they are seeing rewards. There are now billions of connected devices installed throughout the world, enabling buildings to communicate with their owners, their occupants, their tenants and their maintenance teams: effectively giving buildings a voice. The amount of data being generated by these devices is immense and is only set to grow. Projections suggest that up to 50 billion IoT (Internet of Things) devices will exist by 2020, with around one fifth of those being in building applications. What is important is how to derive benefits from these connections. The power comes when data is properly structured, analyzed and put to work. Starting on the right path to a smart building is not as intimidating or as expensive as it might first appear. Contrary to some opinion, it does not require a rip and replace. Current infrastructure can usually be employed as the foundation from which to make smart innovation investments. These can also be made in phases to spread the cost.

## Active new team member

The concept of the building being part of the team is one which is increasingly gaining traction. In so many different businesses and operations, the collective efforts of a team far outweigh those of the individual. Whether you are an office worker, a retail manager, a healthcare professional, a university researcher or a facilities manager, the team around you is essential. If the building effectively becomes a member of that team, then this can be a further invaluable contributor to how effective you are in performing your job. Smart building technologies have the potential to significantly improve the work experience. Just imagine employees having smart services to help them decide the optimum route and the most effective mode of transport to get to work, to order their coffee just how they like it ahead of their arrival and to connect with other people in the building who might be able to make a useful contribution to the projects they are currently working on.

Continuing with the notion of team, it is important to recognize that people are pivotal to this approach. It is people's needs that need to be addressed – a people-centered philosophy is required, which identifies needs, drivers and motivators, how they operate as a team and what it is that generates success. Too often the focus is on the technology itself rather than on what that technology can do for the people working with it and being affected by it. In terms of the building, it is about understanding what people need from a building and then adopting the appropriate technology to meet those needs. Digital technology provides the platform, but the value lies in the way it benefits individuals and organizations.

## Smart building device connections



## The stages of the smart revolution

Smart buildings are only in their relative infancy in terms of the evolution of the built environment. However, they are already very much a reality. If we take the smart office as a guide, then there have so far essentially been three stages.

**Stage 1 (1996 – 2006)** – the adoption of smart technology effectively started. The use of laptops, mobile phones and the Internet were introduced to enhance productivity.

**Stage 2 (2006 – 2016)** – marked a significant development in the sophistication of the technological innovations, with the introduction of smartphones and other devices. This heralded the development of apps, software and cloud computing.

**Stage 3 (2017 to date)** – smart spaces are now a trend, with companies increasingly understanding the concept and integrating automated systems to improve efficiencies, reduce operating costs and create a well-connected and better working environment for employees.

## The value of smart buildings

Smart buildings can create true competitive advantages for their stakeholders by providing differentiation and top-line growth, improving cost structures and reducing exposure to risks. These competitive advantages are in real terms and can be illustrated in many different situations and environments.

## Differentiation and top-line growth

Within an office environment, smart buildings can improve employee productivity, well-being and satisfaction. Increasingly employees are given a variety of preferences for room conditions and smart buildings can learn these preferences and dynamically adjust spaces to create the environments most conducive to achieving their business objectives.

In hospitals, adaptive building systems can provide ideal conditions for patients' recoveries by leveraging artificial intelligence to optimize temperature, air quality, lighting and other variables within patient rooms. Ultimately, patient outcomes improve, length of stay is reduced and patient throughput for the hospital increases. In schools around the world, smart buildings are enhancing comprehension and the ability to focus. By improving various factors like temperature, air quality, and lighting, smart buildings will not only know what the ideal learning conditions are but automatically adjust the classroom environment to create the perfect place to learn. At airports, smart building technologies can improve revenue streams through increases in passenger satisfaction. For example, airline passengers can check an app to determine how long their wait in the security line will be. As they exit security and head to their gate, they are guided to their favorite nearby restaurants or shops. Deboarding the plane, they know how long they may have to shop or dine before their baggage is ready for collection. Passenger satisfaction goes up and airport and airline revenues increase.

*“In the past, individual elements such as energy efficiency, safety or even e-mobility were addressed separately – today, we are proud to pioneer holistic smart buildings, which are so much more than the sum of their parts.”*

Matthias Rebellius, COO Smart Infrastructure

### **Improve cost structure: reduce operating costs and increase productivity**

Smart buildings detect potential problems before they become real issues. An example is the building being alerted to a spike of energy usage and identifying a fan belt that is slipping. Alerts are triggered to order the part and initiate maintenance of the system. Facilities staff might otherwise have spent hours troubleshooting the cause once the system failed. The result is lower maintenance costs and increased productivity while minimizing interruptions to the business. Smart buildings leverage their knowledge to ensure resources are not spent unnecessarily. For example, a smart building knows to only provide lighting during the time that it is being occupied and only to the spaces that require it. This saves money on energy and extends the useful life of the lighting systems. In the past, many lights were simply left on throughout the day. Energy spend can be minimized through smart buildings. When a manufacturing facility understands its possible energy sources and the environmental conditions around it, the building can intelligently choose when to consume the energy that it has generated and stored and when to consume energy directly from the grid. This saves money daily and ensures a safe and reliable energy flow for the building's needs.

### **Reduce risk: enhanced safety and increased uptime**

Smart buildings can also offer significant advantages in terms of safety and in ensuring less disruption to day-to-day operations. In schools around the world, smart buildings technologies guide the occupants by voice, lights and visual alerts to the safest escape routes. Furthermore, detailed information

on the event is provided to first responders to aid in the response, with occupants in the building tracked to ensure that everyone successfully evacuates the building out of harm's way. In the event of a security breach, the building can not only shut down access to specific spaces, but also provide first responders with up-to-date, accurate information on who is in the building and, importantly, where. Smart buildings limit the risks associated with poor or non-available energy from the grid. The building knows when the grid is under strain and how much energy it needs for operations. With this knowledge the building ensures that backup power is available and ready to switch on, without any downtime. Intelligent systems continuously monitor the performance of equipment in order to predict maintenance needs and system optimization opportunities. They also help predict the potential failure of critical pieces of equipment before they go down, reducing unplanned maintenance and increasing uptime.

### **Taking the team with you**

In recognizing that it is difficult to predict and plan for the future of a building when it is unclear just what the impact and benefits of the technological innovations could be, it is even more problematic given that the building means different things to different people. As discussed, there are a number of stakeholders in a building, but the main groups can be identified as the occupants, organizations and tenants, landlords and investors, developers and operators. For a smart building approach to be truly successful, it needs to appeal to the needs of all of those stakeholders. The ability of digitalization to allow a building to interact, to learn and to adapt provides a range of deliverables, with a respective focus from the different stakeholders depending on their perspective.

## People focus brings economic benefits

In terms of economics, the assumption is that the greatest financial benefit of adopting digitalization will be through improving efficiencies in the operation of the building. This is understandable given that globally buildings consume 41 percent of all energy (up to 50 percent of which is wasted). However, putting that into context, research shows that in a typical company 90 percent of operating costs are due to staff, 9 percent for buildings (rental) and only 1 percent for energy. The people-first approach, looking after employees and thereby improving productivity, can therefore have a much bigger impact on the bottom-line. Achieving just a 1 percent reduction in staff costs through improved productivity and retention will almost offset the entire energy costs.

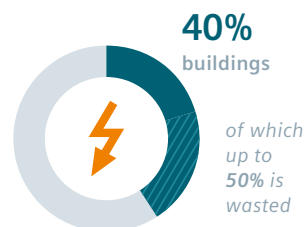
This is not to argue against the importance of securing efficiencies in buildings and energy, particularly as these will have a positive impact on people and society, as well as the life-cycle of equipment. However, it does need to be considered in relation to the total operating costs, appreciating the much greater cost of people and therefore the benefit of adopting a more human-centric approach in transforming the built environment.

## Health and well-being

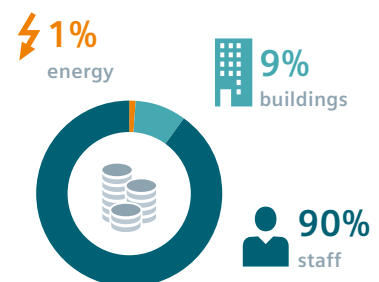
Occupational health and the well-being of employees is higher on the agenda today than at any other time. Employers are recognizing that this is becoming a significant driver, not only in terms of attracting staff but, importantly, in retaining them.

There are a number of smart office features that highlight how those that work within a building can shape and control their own environment. These are wide ranging and can include self-adjusting lighting and window shades, personalized heat and light settings for a person's immediate space, circadian lighting systems that mimic daylight and heat and light systems that adjust automatically according to weather and occupancy levels. All of these features (and many more) can help to make a working environment more comfortable and therefore conducive to a healthier working life for a building's occupants.

### Global energy consumption



### Companies' operating costs



*“Building occupants will start to expect information about the internal office environment, with a particular focus on air quality. The impact of buildings on staff health will become increasingly prominent in decision making.”*

Cat Hirst, Director of Learning and Innovation, UK Green Building Council (UKGBC)

*“Decision making around building is increasingly led by the health and well-being agenda. Lots of clients have clear views of how buildings should perform in relation to staff, and a key decision maker is now often HR. Demographic patterns are changing and people are less loyal to their employers, keeping people is therefore important with increasing competition for talent.”*

Alan Somerville, Partner, Head of Energy, Infrastructure & Sustainability, EMEA, Cushman & Wakefield

The focus on well-being and creating an environment which fosters a happy workforce is only going to intensify. The introduction of the WELL Building Standards, whereby buildings are rated on how they impact and influence health and well-being, are an indicator of this. People are already actively seeking out where they want to spend their working lives based on a wider range of criteria, with well-being becoming a central aspect of that decision-making process. Employers providing facilities such as gyms and creches, social spaces and flexible working will continue to contribute to this agenda, but increasingly the building itself has a role to play in providing holistic solutions to improving the work place.

The prevalence of sick building syndrome (SBS) is also an issue which needs to be addressed. Those suffering from SBS can experience a range of symptoms including headaches, runny noses, itching, lethargy, irritability and poor concentration. This could be due to problems with the building, the working environment or the way in which work is organized. Typical sources of contaminants range from dust and microbes to carpets and ventilation. By adopting digitalization technology through which occupants are able to control their own working environment, the potential for SBS can be significantly reduced and with it the

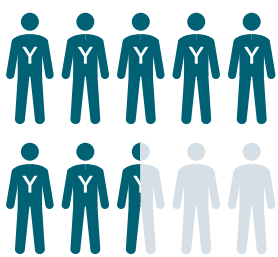
considerable costs resulting from reduced staff efficiency, increased absenteeism and staff turnover, and lower productivity.

Issues such as SBS have helped to raise the profile of the importance of indoor air quality and there is, quite rightly, legislation requiring the minimum standards that need to be met. However, there are many buildings which could benefit from the improvements that could be achieved in this area through digitalization.

### Controlling the environment

The focus on air quality in buildings is further heightened by the fact that we tend to work in increasingly urban environments. Urbanization is one of the major megatrends that is impacting globally on the way we live and work, particularly for the younger members of the workforce. Estimates suggest that millennials will represent 75 percent of the workforce in office buildings by 2025. As this move towards employment and resource-centric living intensifies, so urban areas are extending and increasing in density. This has a negative impact on air quality, with high levels of CO<sub>2</sub> shown to have a detrimental impact on workers' alertness, decision-making and performance. Digital buildings can monitor and autonomously ventilate buildings in real time to optimize air quality for occupants.

By 2025 millennials



will represent  
**75%**  
of the workforce  
in office buildings



*“Lots of data is currently being generated by the buildings sector but it’s not always being utilised. As an industry, a clean simple interface is required to allow people to make use of the available data in individual buildings and across portfolios. If the information is easily available, and simply presented people will use it.”*

Cat Hirst, Director of Learning and Innovation, UK Green Building Council (UKGBC)

### Technological trends to watch

Turning to the trends and technologies that will enable a shift from passive, unconnected buildings to ones that are flexible and constantly interacting, learning and adapting, there are a number of areas to consider.

#### I. Data connectivity and analysis

A fundamental requirement in this transformation is enabling the data connectivity and, importantly, having the means to analyze the data generated through which a building’s self-learning can take place. This is common across all the themes and is the fundamental foundation on which the digital revolution will be built.

The requirement for increasingly complex systems over large sites has required the development of networks which can capture data for analysis and modify system performance.

The Internet of Things (IoT) is effectively a network where Internet connected individually addressable devices can share data between each other using a set of commonly understood communications standards and protocols, and act upon instructions. Taking this and applying it to the built environment, the building Internet of Things (BIoT) will become increasingly dominant over the coming years.

*“We need to ensure that the technology installed today is future-proofed and can interact easily with other devices/control systems – this is critical for smart buildings. There is an emerging danger period where we have technology that is quickly becoming redundant.”*

Richard Hardy, Managing Director, BRE Global

*“There has been the expectation that a digital twin model will improve the operational efficiency of a building. But in order to do so, the digital twin will need to contain both static data from the construction phase of the building and the dynamic data of the technical systems and the occupants during the operational phase. I think the industry is only at the beginning of learning how to connect the static and dynamic data into the digital twin.”*

Philip Chan, Strategy Manager, Smart Infrastructure

BloT aggregates data from, and controls, all connected systems, devices and assets in a building, whether they are part of the building automation systems (BAS) or not. The BloT comprises a number of basic building blocks: sensors to capture the data; actuators which use data and analytics to provide a response; network standards over which data can be communicated (traditionally hardwired but increasingly wireless such as WiFi or Bluetooth); application platforms to provide the language for communication; data storage and analytics to form the brains of the system and the functionality in terms of automation.

Crucial to this increasingly inter-connected world are common standards and flexible, open architecture to enable the seamless communication of different technologies and systems. This will also allow future developments and innovations to be easily integrated without having to resort to new infrastructures to accommodate them.

## II. Digital twin

The term digital twin refers to the virtual models of buildings which are increasingly being used in building information modelling (BIM). It involves developing the entire building with its many disciplines first on a computer and then simulating, testing and, if necessary, correcting it in a virtual model.

This model, or ‘digital twin’, makes it easy to eliminate any errors or inconsistencies before physical construction begins, analyzing a building’s response to changes such as increased occupancy levels or different energy supply options.

Such joined-up planning, with the various disciplines considered simultaneously rather than individually, allows for the creation of a coordinated multi-discipline solution to optimize building performance. An example would be the adding of a door or window and using the digital twin to see what effect this would have in terms of evacuation scenarios, comfort or heating costs.

Digitalization is central to this digital twin philosophy in focusing on the construction and operation of the building to meet the demands of the market to shift from being facility-centric to tenant-centric. By using comprehensive live sensory data combined with design information, digital twins can articulate an accurate and real-time representation of a building. This provides a platform for unlimited testing and optimization, as well as providing a central repository for all information associated with the building.

### III. Security

The term security applied to a smart building encapsulates both physical and cyber security. Physical security technologies are used to monitor and control the access and movement of occupants, protecting against hazards such as fire as well as providing information on the location and usage patterns of occupants. In terms of smart buildings, the focus is on the latter, for example, the occupation data, which can be invaluable in space management.

Cyber security is an important issue in smart buildings given that, by their very nature, they have multiple connected devices via the IoT and therefore offer many more points of potential entry. It is no longer just information technology (IT) systems that are possible targets for cyber attack. Operational technology (OT) systems are also at risk. With critical building systems increasingly networked to allow remote management and monitoring, securing assets is crucial because they open up new avenues of cyber risk across both the networks. As the IT and OT networks no longer operate autonomously but rather communicate with each other, there is the potential for cross-contamination. Continued vigilance is therefore vital with cyber resiliency requiring a systemic commitment that runs throughout an organization, from top to bottom.

While no business can be 100 percent secure, taking preventive action can certainly minimize the risks. There are essentially three steps to take to optimize the security threat to a smart building.

**Step 1:** this involves general physical security, including physical access to the facility, organizational measures such as security policies, and monitoring the facility for anomalies that could indicate a cyber attack.

**Step 2:** this requires the safeguarding of networks, including the installation of firewalls and the encryption of data transmission.

**Step 3:** the focus here is on ensuring system integrity – protecting individual terminals and systems from access by unauthorized individuals, as well as unauthorized changes.

In short, while digitalization delivers substantial benefits and opportunities, it must always be pursued hand in hand with cyber security measures. However, it is also important to understand that cyber security is already a risk, whether or not smart building technology has been employed. The adoption of intelligent solutions can actually provide enhanced security by identifying vulnerabilities in the protection of systems.

*“The Corporate Real Estate industry will increasingly engage with occupiers to understand space needs better and clever optimized use of space will be a major future factor. Space will become more activity based with overall reduced area and higher utilization. Ongoing monitoring of space use will allow these learnings to constantly improve.”*

Ruairi Revell, Sustainability Advisor Real Estate, Standard Life Investments

#### IV. Space management

The data provided in smart buildings provides significant opportunities to improve management of spaces. It provides the means to analyze and understand how buildings are used through adaptable, agile work-space management systems that monitor the real time location of people as they move throughout the building. This identifies spaces that are available and alerts occupants as they require them, as well as identifying which spaces are best suited to their specific needs.

One of the biggest areas of inefficiency in much of the building stock is their under-utilization, with research highlighting that in offices adopting a permanently assigned desk policy, the desks are unused some 40 percent to 50 percent of the time. Meeting rooms or shared areas also often sit empty. To address this issue, there is a very definite trend towards activity based working (ABW), illustrated by the 'hot desk-ing' approach which has been around for a number of years and which continues to grow in popularity as a means of operating a more flexible approach to space provision. Taking healthcare and educational establishments as examples, ABW means that adaptable consultation or tutorial rooms can be more readily available, as required.

Through digitalization, ABW can be enhanced through real-time monitoring of desk and room occupancy. A wide range of technologies to facilitate this are already being widely adopted, from wireless desk sensors and building occupancy sensors through to employees' mobile phones and even live CCTV video feeds analyzed by facial recognition software.

Occupancy detection is central to this evolving focus on space optimization and is already becoming a more common feature in smart buildings. Looking ahead, the technologies are expected to shift from simply maximizing space utilization to actively assisting building occupants to interact with their environment and increase their productivity.

#### V. Predictive operation and maintenance

By providing an integrated platform for all elements of building management, digitalization can transform the approach to building operation and maintenance. Typically, the current approach sees the majority of buildings rely on a combination of control and management systems with the knowledge held by individuals of the configuration and operation of the plant and building systems. Performance data typically plays a very limited role in determining actions.

Just-in-time maintenance is a big area of development and can significantly benefit from the adoption of digitalization. Through tracking the age of plant and equipment, its service record, the level of usage, how critical it is to the functioning of the building and estimating the cost of repairing or replacing, maintenance schedules can be substantially improved and costs reduced. There are fewer unplanned downtimes or outages, with any necessary replacement or repair optimally scheduled. Cost savings are achieved through not replacing parts prematurely and by minimizing the impact on the operation of the business through predictive and structured maintenance.

In some buildings energy management has become completely digitalized, with facilities managers in such buildings able to review and optimize the building's energy performance using a combination of real-time and historical data to adjust or upgrade equipment such as the HVAC system. This is a good illustration of how facilities managers in a smart building are adopting a more strategic role, driven by data provided by new technologies which are improving the performance of facilities.

*“Digitalization hits all the sustainability elements. It can provide efficiency improvements through optimization way beyond the current building management system (BMS) capability. It will also be key for improving health and well-being, and occupiers will soon want to know about internal air quality, driving landlords to monitor and improve air quality levels.”*

Ruairi Revell, Sustainability Advisor Real Estate, Standard Life Investments

## **VI. Environmental sustainability**

The digitalization of buildings provides a level of monitoring and control which seamlessly enables systems to be optimized based around not only the needs of all users but also wider environmental drivers. Adopting the concept whereby the smart building is seen to be an active member of the team, it is a member with responsibility at its heart, ensuring that it has minimal impact on future generations with a focus on becoming a more resource efficient place.

Sustainable buildings have lower operational costs through minimizing demands and automating operation. They also have lower future risk in a world where the costs of environmental damage are becoming ever more apparent and a direct liability to organizations.

Sustainable environmental design has traditionally relied on a materials and equipment approach – one where the material sourcing and construction phase is the focus. However, with the advent of the smart building, digitalization offers the potential for a much more proactive and continuous environmental building strategy which is also less capex intensive.

A building’s operational phase provides the highest environmental impact so shifting the emphasis here offers greater potential benefits in terms of reducing a building’s overall environmental footprint. Through smarter digital management of services and systems, improvements can be secured in optimizing performance, with the building automatically responding to use-changes, bringing in learnings from other buildings, resulting in more productive occupants and buildings. Improvements through digitalization and inter-connectivity can provide a reduction in a building’s ecological footprint of up to 80 percent compared to the average building stock.

*“We have reached the tobacco moment of climate change, and people are starting to take action against companies and organizations. Pension funds have a duty to look at the long term and therefore responsibility to manage this risk. Digitalization can help with demonstrating this risk management.”*

Tatiana Bosteels, Director, RPI & Sustainability, Hermes Investment Management

### **The Siemens commitment to smart buildings**

Siemens Smart Infrastructure is at the heart of the smart buildings revolution. The company has a long and global history in understanding buildings, with a range of digital capabilities that makes it uniquely qualified to support stakeholders in developing a digitalization strategy which extracts real value from investments in technology. Siemens recognizes that while capturing data is important, it is how that data is used and acted upon which ultimately allows a building to be more flexible, more personal and, ultimately, more productive.

Siemens is committed to an approach which is moving from a facility-oriented focus to a user-centric one. This requires bringing people, technology and services together to add value for all stakeholders. It is based on an appreciation of the limitations of many existing buildings – their inefficiencies and the issues relating to lack of comfort, control, disconnections and under-performing productivity that this can bring – and the significant opportunities that digital services can offer.

The commitment and vision that Siemens has to the evolution of smart buildings is demonstrated by the investment the business has made in the digitalization agenda. This includes the acquisition of three innovative start-up companies specifically to strengthen its portfolio of solutions for smart buildings. These strategic investments – the purchase of Comfy by Building Robotics (provider of a building occupant app), Enlighted (provider of sensor and building analytics) and J2 Innovations (building automation and operating system vendor) – demonstrate a commitment towards staying at the leading edge of technology.

There is no doubt that the digital transformation is a disruptive evolution for the building automation, construction and real estate sectors. Selecting a technology partner that has experience, expertise and a real knowledge is therefore crucial.

## And to the future?

Buildings are playing an ever more important role in the landscape with the interaction between buildings and the grid opening up new markets and potential business models for the respective players. Whether we look at the possibility of buildings becoming an integral part of the energy grid as prosumers or the increasing opportunity for buildings to go off grid, the energy transition sees buildings at its heart.

With buildings increasingly becoming part of the larger energy ecosystem, finding ways to achieve both smart connections and smart supply options is a growing focus. Through intelligent and connected infrastructure across the grid, the potential global electrical energy can be maximized. This involves the management of increasingly distributed sources and complex grid infrastructures to transmit and distribute energy more efficiently and reliably. Where the grid meets buildings and industries, it also requires the management of energy supply into and out of those buildings, along with the generation and storage of energy within them.

Coming back to smart buildings alone, interaction between buildings and their users is undoubtedly already happening and it is a trend that is continuing to gain traction. The gradual dispelling of the misapprehension that this is an expensive process is helping to drive adoption of the smart technology required. At present, these interactions are predominantly manual in nature, such as occupants operating an app

on a smartphone with relatively little automation available to meet their specific needs. We are now seeing a transition with smart buildings moving towards more conscious interaction, still drawing on information consciously provided by occupants but using automation and data analysis to decide on the best outcomes. Unlike manual interaction which is characterized by vertical integration, with conscious interaction there is an increase in integration across sectors.

The holy grail of the smart building is to get to a point of unconscious interaction. This is where occupants go about their daily activities with no direct interface with the digital building: the interaction is much more discrete, with the building's sensors, data analysis and actuators doing all the work in the background. Now the building is constantly learning from and acting for the end user, with full automation and integration across different vertical sectors. By continuously interacting, learning and adapting, the smart building becomes an active member of the team, predicting occupants' needs without even asking them – creating an environment that cares for its occupants and those living nearby. At this point, we really are getting close to achieving that perfect place: an environment that is a magnet for talent, a hospital that makes patients feel better even before the treatment begins, a school in which students can learn in ideal conditions, or an airport in which passenger satisfaction is enhanced. Ultimately, a place where innovation thrives and one in which productivity is constantly improving.

*“We’ve found that simply collecting and analyzing general building data isn’t enough – we focus on selecting the right data from the very beginning and don’t stop until meaningful insights are generated and tangible results are achieved.”*

Eike-Oliver Steffen, CEO Solution and Service Portfolio, Smart Infrastructure

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