LoRaWAN®

LoRa Alliance®

White paper:

Sustainable smart buildings for the planet, people, and profit

TIA®

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INTRODUCTION

According to recent reports, the smart building market is expected to grow from $43.6 billion in 2018 to $160 billion by 2026.[1] Fueled by an increased focus on carbon emissions, market demand, potential savings, and evolving laws and regulations, the commercial construction industry is now embracing the concept of sustainable smart buildings. What constitutes a sustainable smart building has also evolved significantly over the past two decades to now consider not only a building's environmental impact, but also its safety, security, and overall social performance and cost reduction over its lifecycle. As the commercial real estate market becomes increasingly competitive, building owners need to answer the call to make their buildings smarter and more sustainable in a way that considers impact on the planet, the people, and the profit of the business itself or run the risk of lower occupancy rates and property values.

To make informed decisions that ensure sustainable smart buildings, stakeholders need insights and benchmarks that can only come from measurable assessment criteria and based on actual data. To effectively collect that data, building owners and operators need to consider emerging technologies and infrastructures that enable cost-effectively connecting a wide range of smart devices and systems within a building and across campus environments, smart communities, and smart cities.

In 2020, the Telecommunications Industry Association (TIA) and UL teamed to launch SPIRE, the industry's first comprehensive smart building assessment and rating program that holistically measures building technology and performance, taking into account the entirety of a smart building. Built in conjunction with UL, the leading global safety science company, and with a criteria developed by the TIA industry working group of more than 60 leading commercial real estate, asset management, technology and telecommunications industry leaders, SPIRE is built around six distinctive categories - connectivity, health and wellbeing, life and property safety, power and energy, cybersecurity, and sustainability. A key part of these criteria is the assessment of advanced, interoperable technology that enables the collection and analysis of data to improve building performance, occupant experiences, and operational efficiency that support sustainability.

The LoRa Alliance® is a fast growing technology alliance committed to the worldwide deployment of Internet of Things (IoT) solutions through the development and promotion of the LoRaWAN® open standard designed to wirelessly connect devices that collect actionable data to improve a variety of processes. Building optimization and sustainability is one of them. Members of the LoRa Alliance form an ecosystem of companies offering products and solutions that can be applied across all of SPIRE's smart building assessment criteria and have the potential to reduce environmental impact, improve health and wellbeing, and lower operational costs.

Thanks to the synergy of the SPIRE assessment criteria and LoRaWAN technology in enabling sustainability, TIA and the LoRa Alliance are collaborating to drive innovation and technology deployments that will ultimately enable vital data collection and analysis needed to assess, monitor, and maintain sustainability in a smart building. To that end, these two non-profit organizations work with their members to gain insight into how the industry and companies are achieving smart building sustainability goals in a complex, challenging marketplace that is undergoing increasing and evolving environmental concerns, regulations, and expectations. Based on detailed research, recent statistics, and interviews with leading TIA and LoRa Alliance member companies, this paper presents expert viewpoints on smart building sustainability, including:

- The evolution of sustainability concepts
- Primary industry and global driving forces to sustainability
- The foundational role of data in achieving sustainability
- Technologies, solutions, and strategies for achieving sustainability goals
- Key challenges to sustainable smart building implementation
- The need for sustainability assessment and certification programs
- The future outlook for sustainable smart buildings

THE EVOLUTION OF SUSTAINABILITY

The concept of a sustainable building, or "green" building, has evolved significantly over the past two decades. What traditionally constituted a building's sustainability was focused primarily on energy consumption, conservation of natural resources, and material reuse and recycling. Today, industry experts believe that sustainability has become a much broader concept that relates to a building's overall ability to provide a comfortable, healthy, and productive environment over the lifecycle of the building without negatively impacting the natural environment.

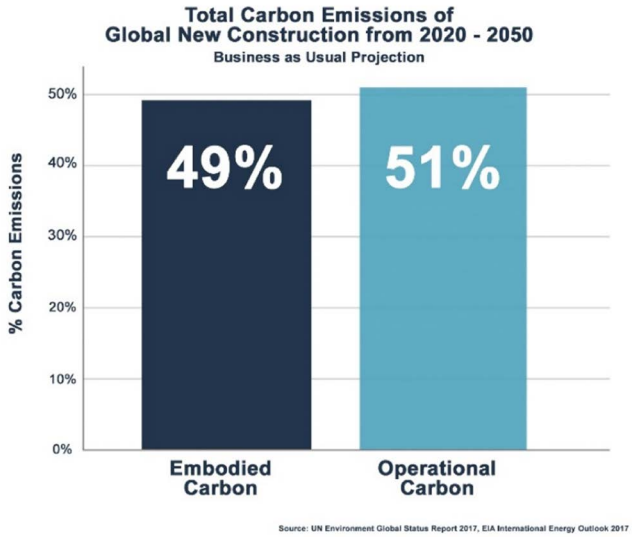
The "blue" building is a newer concept that expands sustainability beyond its conventional "green" metaphor, adopting the position that sustainable buildings can no longer be just about the impact on the natural environment but rather should focus on three key pillars—planet, people, and profit. When it comes to designing, constructing, and operating a building that embraces the future of the planet, the prosperity of its people and surrounding community, and the success of the business itself, there are also far more factors to consider.

More than just energy consumption

The impact a building has on the planet should now factor in more than just energy consumption and operational carbon (greenhouse gas emissions from operating a building). Industry experts believe that embodied carbon, which represents the emissions of greenhouse gases during building construction, should also factor into a building's impact. While operational carbon currently accounts for 28% of total greenhouse gas emissions and embodied carbon accounts for only about 11%, estimated increases in building construction have industry experts predicting that by 2050, the levels will be nearly equal.[2,3]

[2] *Smart Building market Size, Share, Trends, Growth Opportunities and Forecast, 2019 – 2026, Acumen Research and Consulting Embodied vs. Operational Carbon, UL, August 16, 2020*
[3] *UN Environment Global Status Report 2017 and EIA International Energy Outlook 2017*

Determining embodied carbon also requires in-depth information such as environmental product declarations (EPDs) from manufacturers and certification companies like UL that indicate the composition of components and their impact on the environment. Sustainability from an environment perspective should also now consider modern concepts such as net-positivity where buildings create more energy or resources in their lifetime than they consume.



It's all about the people.

The health and wellbeing of people in a building has a lot to do with air quality and temperature, but is expanding to also consider the physical, psychological, and social impacts on the human experience of building occupants. This encompasses everything from the layout and lighting of spaces that enable an interactive and productive environment, to the ability to prevent disease and eliminate volatile organic compounds (VOCs) and odors in the air. It also means providing a sense of individual engagement and purpose for occupants, as well as ensuring diversity, equality, and other factors that provide occupants with a sense of acceptance and inclusion.

> *"We need buildings to do less harm and not negatively impact our health and wellness. Buildings should be places where we feel safe to sleep at night and where we can do our best work."*
>
> - Josh Jacobs, Director of Environmental Codes & Standards, UL

Considers all operational expenses

Business profit considerations that rely on a sustainability approach now include much more than the cost of energy. Today's sustainable smart building must consider all costs associated with operations and maintenance by implementing circular economy principles that aim to reduce waste, increase reuse and recycling efforts, and keep products and materials in use as long as possible. Operational costs reduction should also consider practices like demand response capabilities and net-positivity that can further reduce expense over the lifecycle of the building. Practices like predictive maintenance to prevent problems before they arise, and even the ability to efficiently handle building emergencies and prevent cybersecurity attacks, have an impact on operational expense and the sustainability of a building. Industry experts also agree that how a building impacts the productivity, safety, and satisfaction of occupants has a direct impact on operational expense, including tangible costs associated with healthcare and employee turnover.

KEY DRIVING FORCES

What now constitutes a sustainable smart building is determined by a variety of drivers from marketability, consumer expectations, and evolving regulations, towards an increased focus on climate change and an overall shift in the way people live, work, and play in today's society.

Climate change

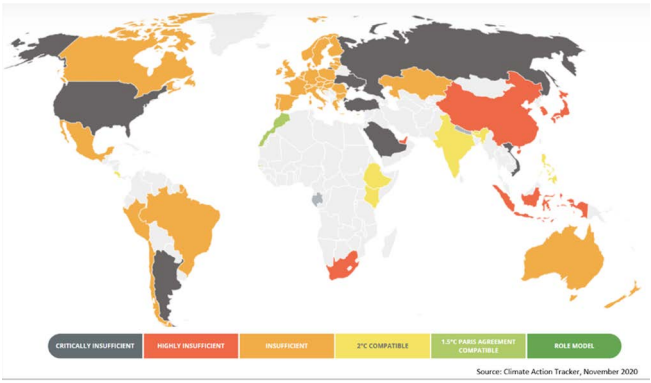
The world today is not meeting previously set climate goals. In 2016, nearly 200 countries signed the landmark Paris climate agreement with its goal of limiting global warming to well below 2°C and commitment to curtailing greenhouse gas emissions by 2030. By the end of 2020, most countries were not on track to meet their targets.[4] Buildings are a significant contributing factor, with an estimated 40% of global carbon emissions attributed to the built environment, including 28% attributed to operational emissions alone.[5] In addition, building construction in general is on the rise. Two-thirds of new building construction is expected to occur in countries that do not have mandatory energy codes in place. On top of it all, rising temperatures are worsening extreme environmental events. Increasing wildfires, rising sea levels, and other environmental problems have increased societal focus on limiting climate change, leading to new regulations, incentives, and market demand that is further driving the need for sustainability.

The human factor

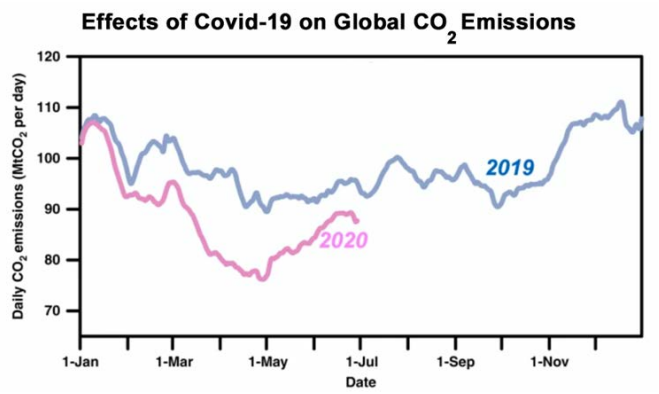
The human factor and changes in building occupant behavior also significantly impact carbon emissions. Obviously, the vast increase in population and human consumption over the past century are a contributing factor. The expanding globalized economy also means the delivery of more goods and services in the global supply chain and a greater movement of people around the globe that produces more emissions and waste, creating a society that, unfortunately, sustains unsustainability. This became very clear during the current COVID-19 pandemic where stay-at-home orders around the world resulted in a sharp 8.8% decrease in global CO2 emissions in the first half of 2020 compared to the same period in 2019.[6]

We also spend more time in commercial and public buildings today than we did a century ago, with studies indicating that humans

[4] The Climate Action Tracker
[5] Global Status Report 2017, United Nationals Environment Programme
[6] Near-real-time monitoring of global CO2 emissions reveals effects of the COVID-19 pandemic, Zhu Liu et. Al, Nature Communications Journal, December 2020



spend an average of 90% of their time indoors.[7] While real estate decisions used to be about location, it's now equally important to tenants to have an optimal space with the latest technology and capabilities. This places more emphasis on thermal comfort and indoor air quality. At the same time, there is an increased demand among occupants for buildings that meet physical, psychological, and social expectations such as diversity, equality, and other factors that provide a sense of acceptance. Engaging occupants in sustainability efforts through awareness campaigns, feedback, and empowerment are also driving a culture of sustainability. Employees want the ability



to set their own temperature and lighting levels in their work space and to have ample Wi-Fi coverage, along with encouraging, collaborative environments.

Younger generations today are also more concerned about sustainability and the planet, and as these individuals move into management roles, sustainability will be a significant factor in their decision-making process.

The COVID-19 Impact

The recent COVID-19 pandemic increased the focus on health and wellbeing within buildings. Smart building technologies that improve safety and prevent sickness were once considered "nice to have" but are now being considered "need to have." For example, smart solutions like UVC disinfection lighting have experienced growth in the market, as well as touchless technologies that allow users to operate doors, vending machines, and elevators with their smartphones.

"The marketplace is changing dramatically. Ten years ago it was essentially 'location, location, location' and size of space was a primary driver. Tenants had to manage their own technology and building systems, but today they expect their spaces to have the latest technology and capabilities built in. Millennials are also more concerned about our planet and they support corporations that are good stewards of our scarce environmental resources. As these younger individuals start their own businesses and move into higher levels of corporate management, they will be in the position to decide where to put their business."

- Ken Koffman, Senior VP of Standards & Technology, TIA

At the same time, surveys indicate that many workers will maintain some level of work-from-home practice, with one New York City survey indicating that employers expect 56% of workers to continue working from home at least part of the time.[8] The pandemic is therefore also driving changes in how office spaces are organized. Building operators and facility managers are striving to optimize efficiency of unused spaces and distribute work areas in a way that maintains social distancing and enables desk sharing, while ensuring safety, comfort, and productivity. Industry experts believe that the pandemic will ultimately create competition in the commercial real estate market and favor buildings that offer an overall healthier and safer user experience.

"Corporate revenue is directly correlated to the number of people working safely in buildings. Companies are going to have to maintain a workplace where wellness remains important. If they don't, valuable employees will refuse to go back to the office. Covid-19 will eventually disappear from the headlines, and while many question if the focus on cleanliness is only short term, the smart devices and infrastructures that were put in place to address the issue will remain and can unlock huge possibilities."

- Michael Moran, Chief Markets Officer, Microshare

Despite an estimated 80% drop in occupancy in 2020, the pandemic did not reduce building energy use as much as expected, with studies showing that 25% of building energy use did not change and another 60% only showing a reduction by 23%.[9] Most industry experts attribute this to building loads that cannot be turned off regardless of occupancy, lease agreements, and simply maintaining proper air temperature and humidity for building operation systems and critical IT equipment. However, the lack of energy savings recognized in 2020 is also motivating many building owners and operators to take a closer look at why energy consumption did not decrease and how they can improve.

Regional Drivers

Sustainability is also very much a regional phenomenon that depends on regulations, government initiatives, urbanization, culture, and other market variances. Due to growing concerns over climate change, some governments around the world are developing and imposing a variety of laws and regulations that encourage the development of sustainable smart buildings. For example, the European Union (EU) has established several directives to reduce energy consumption and

[7] The National Human Activity Pattern Survey (NHAPS): A Resource for Assessing Exposure to Environmental Pollutants, by Neil E. Klepeis et al., Lawrence Berkeley National Laboratory
[8] Return to Office Survey, Partnership for New York City, March 2021
[9] Covid Shows That Even Empty Buildings Must Use Energy, Carbon Lighthouse

meet the goal of zero-energy buildings. Many European governments are also implementing financial incentives and subsidies that further drive the development of sustainable smart buildings in the market.

Overall, the development of sustainable smart buildings is occurring at a faster pace in high urbanization areas. In the U.S., the Seattle region is a hot spot for sustainable development, as well as San Francisco, San Diego, Portland, the greater Washington D.C. area, Boston, and Austin.[10] The vast urbanization happening in the Asia-Pacific region, especially China, is pushing rapid digital transformation and sustainability in this region. Sustainable smart building development also varies globally depending on culture. For example, while regulations certainly come into play, Europeans in general are more focused on sustainability, from an individual, building, and community standpoint. As cities across Europe undergo urban renewal and revitalization, they are being revamped as smart, sustainable cities. In particular, sustainability is becoming a key criterion for investors in Sweden where commercial real estate holding companies demand a certain percentage of certified sustainable buildings.

Smart buildings can also play an active role in regional smart grid use and resiliency via grid-connected renewable energy generation like solar, wind, or geothermal that reduce peak demand and feed excess electricity back into the grid, as well as through the use of intelligent management systems that manage energy production and enable load balancing. The implementation of peak load management protocols, demand response capabilities, and integrated building-to-grid power management allows smart building owners and operators to reduce energy costs and tariffs by automatically responding to real-time price and smart grid requests and taking advantage of financial incentives from local utilities—all of which ultimately helps lower regional electricity rates and reduce grid instability.

DATA AS THE FOUNDATION

Effectively maximizing and assessing sustainability in a smart building requires actionable insights that can only come from data. This requires technologies and solutions that collect and analyze real-time data about the building performance and the environment in which buildings operate to continually make adjustments that improve sustainable operations throughout the building lifecycle. In fact, most smart building experts agree that data is the number one enabler—data about everything from energy and natural resource consumption, to air and water quality, system status and required maintenance, occupancy, parking availability, and more.

> *"Smart buildings generate data and in turn, you need that data to optimize functionality and deliver on sustainability. It's the number one focus. We can't measure or know if we're moving forward without it."*

- Jiri Skopek, Vice Chair Board of Governors, 2030 Districts Network

While data is considered "gold" in a sustainable smart building, it is important to ensure that the data being captured is "clean." Clean data is considered relevant, reliable, and actionable, meaning it can be acted upon. In contrast, "dark data" is typically dormant, often incorrectly formatted for use, and cannot be acted upon, meaning that it holds little or no significant value or insight. Digital transformation such as the implementation of smart sensors, data analytics, dashboarding, and business intelligence platforms can help ensure that captured data is clean and actionable.

For efficient operations and reduced cost, the data should also not be standalone but instead be transferable across a variety of interoperable, integrated systems, including both Information Technology (IT) and Operational Technology (OT) networks. For example, information about the number of people or amount of CO2 in a room collected via sensors should be shareable with HVAC systems and modeled with social data, energy costs, weather predictions, and other building information in a way that enables automatic response to increase ventilation or lower the temperature and sets optimal steering parameters for the HVAC system. Key to success is data democratization that enables always-accessible, easy-to-understand information for all systems and stakeholders to leverage for effective decision-making.

Infrastructure and Protocol Matters

While data is the foundation behind sustainable smart buildings, the physical layer infrastructure that enables wired and wireless data transmission needs to be properly designed and implemented to support real-time communication. Careful consideration must therefore be given to the cabling media and wireless communications. Ample coverage - both wired and wireless - throughout the building and its surrounding property must also be in place, with plenty of capacity for expansion to support future building needs. Additionally, networks can connect over a wide variety of communication protocols, and for various systems to "talk" to one another and leverage cloud-based solutions, the data must be able to be shared via open standards and protocols like Internet Protocol (IP) that has become ubiquitous for communicating information across premises and service provider networks. Standardization will therefore be crucial as more smart building technologies enter the market.

> *"Traditionally, data has been locked in different silos across various systems, which makes it virtually impossible to access and act upon. But with open standards, data becomes more accessible, crosses silos, and provides the building insight needed to optimize sustainability."*

- Stefan Lindgren, Chief Technology Officer, Talkpool

[10] 2019 U.S. Cities Sustainable Development Report, Sustainable Development Solutions Network

At the same time, wired and wireless infrastructures need to be physically secure with proper encryption and cybersecurity practices in place to prevent increasing cyberattacks and back-door mechanisms that threaten to disrupt smart building operations. Management and use of personal data (i.e., name, email, geolocation, etc.) is also a consideration given evolving privacy data regulations around the globe that prevent sharing personal data about building occupants.

"Power over Ethernet enables sustainability, and if you're designing a building today that doesn't leverage PoE and smart technologies, you're missing the boat. Smart systems like PoE are more cost effective; these systems can help project teams reduce energy usage as well as operational carbon emissions. Through sensors and monitoring, we've seen improved occupant health and wellbeing. PoE not only enables smart applications but has a large impact on the sustainability of a space as well."

- Annie Bevan, Global Head of Sustainability, Superior Essex

To improve sustainability, the infrastructure should also be designed to support efficient, safe powering of devices via remote powering technologies like power over Ethernet (PoE) that delivers up to 90 Watts of safety extra low-voltage (SELV) power over the same network infrastructure that transmits data to and from devices such as cameras, Wi-Fi access points, cameras, LED lights, sensors, access control panels, and building automation controllers. The use of PoE eliminates the need to deploy traditional AC power circuits to devices, saving material, labor, and pathway space for a greener, more sustainable approach. To support sustainability, it's important to also consider Environmental Product Declarations EPDs, health product declarations (HPDs), Declare Labels and other green product certifications when selecting the components that comprise the infrastructure, such as cables manufactured in a zero-waste landfill facility.

Long Range Wireless Expands Capability

It is important to acknowledge that sustainable smart buildings are often part of a larger smart campus, smart community, or smart city with multiple and often remote smart devices transmitting information. Beyond the internal operations and short-range wired and wireless (i.e., Wi-Fi) communication over a local area network in a single building, data from remote and mobile smart devices enables smart community/city applications like smart traffic and parking, smart lighting, wayfinding, asset tracking, smart waste management, damage detection, air quality monitoring, weather detection, and even pet and animal tracking.

While 5G/6G cellular is ideal for remote smart devices that need high data throughput (e.g., video, autonomous vehicles), coverage is not yet widespread, and the fact remains that the majority of smart building solutions do not require high throughput. Cellular communications also place significant battery strain on devices and are therefore only able to support most battery-powered devices for a limited number of hours. Many remote smart IoT devices only need low-speed (< 1 Mb/s) communications to transmit tiny amounts of sensor data, which is where low-power, wide-area wireless networks (LPWAN) come in.

LPWAN open protocols like LoRaWAN are ideal for connecting battery-operated remote smart devices that do not require high-speed data rates. It is also well suited for large-scale smart technology roll-outs. These deployments are achieved via LoRaWAN gateways that wirelessly receive data and forward that data via IP over service provider or local area networks to systems that interpret the data. Unlike cellular where devices consistently synchronize with the network and drain batteries, communication via LoRaWAN only happens when devices are ready to send data, in response to events, schedule, or other actions. Batteries on remote devices can therefore last much longer; in some cases up to ten years.

"Older buildings typically have the lowest level of technology and the highest energy consumption, so they can especially benefit from metering and data collection. However, a wired upgrade in these buildings is costly, time-consuming, and sometimes impossible with the potential for building damage and substantial disruption. Older buildings are especially ideal candidates for wireless sensors using technologies like LoRaWAN."

- Stefan Lindgren, Talkpool

Depending on the environment and obstructions, LoRaWAN also offers long-range coverage for large campus and community deployments, typically up to 3 km wide in an urban environment and reaching to 7 km in rural areas on a single gateway. With low susceptibility to interference and the ability to penetrate dense building materials, LoRaWAN is ideal for supporting smart device communications throughout all areas of a building, including basements and underground locations like parking garages. Using multiple gateways, a LoRaWAN infrastructure can also cover entire communities, cities, and regions, which is ideal for companies needing to collect data from multiple remote locations.

TECHNOLOGIES, SOLUTIONS, AND STRATEGIES

Leveraging actionable data to achieve smart building sustainability that focuses on the planet, people, and profit is achieved via a broad range of technologies, solutions, and strategies. Growing demand, digital transformation, and emerging technologies are currently driving the development of new smart building solutions.

Emerging Technologies

Several emerging technologies can leverage actionable smart building data to improve sustainability, including artificial intelligence (AI), machine learning (ML), and virtual and extended reality (VR/XR). For example, while still in the early phase of adoption, AI can be leveraged to analyze data from smart sensors and devices to monitor for anomalies, enabling predictive maintenance. It can also generate data patterns to make improvements over time and share that data with other building systems and devices that through machine learning can teach themselves to respond accordingly.

"Digital twins are one the hottest emerging technologies that the architecture, engineering, construction, and owner industry is taking very seriously. But it does require partnerships and integration between technology and solution providers."

- Salla Palos, Director of Transformation Services, Microsoft

One of the newest emerging technologies that relies completely on data and can leverage virtual and extended reality to optimize sustainability is the digital twin. Using building information modeling (BIM), real-time data about the environment, and advanced analytics, a digital twin is essentially a digital replica of a building and its spaces, systems, assets, and occupants. Using virtual reality, a digital twin can provide full visibility of a building and how it operates to assess performance and gain insight into how it will perform in the future. Digital twins can help uncover opportunities for energy savings, as well as to simulate the impact of adding technologies, modifying systems, changing space layout or occupancy, and other changes to the built environment. Digital twins will continue to evolve and become more mainstream, but they will also require greater collaboration among solution providers and integration among building systems to provide a complete digital representation of an entire building.

Cloud-based Platforms

Clean, interoperable data is also vital to leveraging cloud-based solutions that support integration and enable data analytics and reporting. Bringing data from smart sensors and devices into cloud-based platforms can ease the process of achieving greater building intelligence by providing a comprehensive framework and dashboarding that refines and clusters information in a way that supports decision-making and response by both people and systems. Cloud-based platforms will also enable the advancement of digital twins, as cloud environments better facilitate analytics and simulation. They can also leverage stored data to support emerging gamification applications that make data more consumable and support game-based learning for visualizing long-term financial and sustainability implications.

Smart Building Devices

Advanced sensor technology has given rise to more smart building devices that can collect information about the surrounding environment, share that information with other systems, and analyze the information to make adjustments. Today's smart sensors can detect a wide range of factors for optimizing operations efficiencies and sustainability, including:

- Temperature, humidity, CO2, VOC, radon, toxic and combustible gases, and other contaminant sensors to monitor air quality and adjust ventilation as necessary
- Occupancy, daylight harvesting, and optical sensors to detect people and ambient/sunlight levels to adjust lighting, ventilation, temperature, shading, and other actions that save energy, improve health and wellbeing, and increase productivity
- Pressure, level, and water-quality sensors to detect the presence of or changes in gases or liquids for leak detection, equipment condition monitoring, and waste and water characteristics
- Information about local energy production and storage from on-site energy generation like solar, wind, or geothermal
- Proximity sensors, accelerometers, and geolocation sensors that detect objects and movement for crowd control, parking availability, asset/fleet tracking, wayfinding, assembly line optimization, and even rodent control
- Infrared sensors to detect heat and movement for intrusion detection, body temperature monitoring and a variety of other uses

These smart sensors are perfect examples of devices that do not require high-throughput communications and can therefore be easily and cost-effectively deployed via LPWAN infrastructure like LoRaWAN.

"We're using sensor technology with LoRaWAN for everything from monitoring plumbing pipes in washrooms and kitchens to prevent damage from leaks, to monitoring paintings in art galleries to prevent humidity and human contact. We're even monitoring the needs of individual trees in greenspaces."

- Roman Nemish, Co-founder and President, TEKTELIC

With advanced sensor technology, the possibilities are virtually endless for maximizing sustainability. Some of these sensor technologies are being leveraged by insurance companies to prevent damage and costly claims, while others are more focused on safety and security or energy efficiency. However, when actionable data from a multitude of these sensors can be shared across building systems and come together for analysis via advanced technology and software-based smart building applications, cloud-based platforms, or digital twins, it provides complete visibility to assess, report on, and both simulate and stimulate the sustainability of a building.

CHALLENGES TO IMPLEMENTATION

The reality is that implementing solutions for a sustainable smart building comes with a number of potential challenges. With advancements in sensor technology and an increased number of IoT solutions to choose from in the marketplace, building owners and operators are challenged with ensuring they select reliable components and devices that support interoperability and provide the actionable data and functionality they need. Third-party verification of standards compliance and EPDs can help determine the impact of products on sustainability and ensure that hazardous materials don't end up in a building. For a greenfield development, this holds true for more than just components and devices—everything from building materials and furniture, to fixtures should be verified for sustainability.

Selecting well-established solutions with a proven track record can also help ensure success. For example, because LoRaWAN has been widely deployed and proven across a wide range of markets, experts around the globe have accumulated considerable experience and an understanding of best practices that can inform successful deployments. Additionally, given the highly diverse marketplace and complex value chain, those embarking on implementation should choose partners wisely and engage in an established ecosystem that allows them to collaborate with industry experts rather than risk going it alone. IoT connectivity providers in particular are recommended partner for enabling an effective and successful technology roll-out.

"Recent health concerns due to the pandemic are causing ventilation rates to increase considerably, with some estimating a 10 to 15% energy penalty. Buildings need to pay more attention to health, but it becomes a balancing act between maintaining air quality and still meeting energy consumption goals and savings."

- Jiri Skopek, 2030 Districts Network

Even when smart building technologies are in place, building owners and operators need to ensure best practices in how those technologies are utilized and strive to balance sustainability goals across planet, people, and profit to avoid generating future debt. For example, energy and carbon reduction goals can compete with health and wellness goals. While increased ventilation rates can improve indoor air quality for occupants, building owners and operators need to ensure that they are not over ventilating and adversely impacting energy consumption and the carbon emissions of the building. This will be a significant challenge as employees come back to the office and ventilation is increased to improve air quality in response to the COVID-19 pandemic.

Integrated smart systems will be integral to tackling these challenges as they can regulate the appropriate levels of outdoor air to be brought into a building, provide an understanding of how that air is processed, and quantify the overall indoor air quality. Through the collection of clean, actionable data and technologies like ML/AI, systems can analyze trends to understand how the building has been operating over time and make adjustments as needed. As weather patterns shift due to climate change, these capabilities will become invaluable to understand the impact and adjust accordingly.

Siloed data isn't the only barrier to optimizing sustainability. Siloed thought processes across all stakeholders—developers, engineers, owners, and operators—can also be a limitation to implementing smart building technologies. It is therefore important to ensure collaboration for project delivery goals, implementation, and data usage. Democratizing data and demonstrating how it can be leveraged for achieving different goals across an organization can help break down silos. However, sustainability goals often compete with capital planning, and the total performance of the built environment versus the total cost can be a barrier when there is a lack of value consensus and understanding of the return on investment (ROI).

While some goals such as energy consumption, waste reduction, and others with bottom-line impact have a clear ROI, the complexity of systems in a sustainable smart building can make determining ROI more difficult. This is particularly true for solutions that aim to improve occupant health, wellness, and satisfaction.

"Sustainable smart buildings are not about investing in technology for the sake of technology. We want to make sure that the solutions we implement provide our customers with the ability to recoup their investment within 2 to 3 years. If there is no clear ROI with a technology, it's very difficult to justify its deployment."

- Roman Nemish, TEKTELIC

Expected ROI can also vary based on stakeholder goals, region, and industry maturity. For example, where the use of PoE lighting is readily accepted and doesn't require an electrician, labor costs are easily calculated to demonstrate capital savings, and the energy savings of LED lights is easily calculated for operational savings. In regions where real estate portfolios are boosted via sustainable smart buildings, or where smart building technologies are more mature, there may also be a greater focus on value versus cost and ROI may be easier to obtain. Both Capex and Opex can impact ROI, and it's important to consider cost and ease of implementation, recurring costs, and overall scalability. As a case in point, setting up a LoRaWAN network is fast and easy with roll-outs that can be completed in a matter of days or weeks. The small recurring charge of the LoRaWAN gateway is also far less than traditional cellular fees, and once the network is in place, it paves the way for massive scaling and new technologies.

"It no longer just about how the physical plant is performing, but also how it is affecting the people. Covid has changed the constituency within large organizations and stakeholders now include human resources, corporate council, chief wellness and sustainability officers, and the executive suite—and staff, tenants, and customers are demanding clean, healthy buildings. But post-covid, these technologies will still show up on the bottom line. In modern office buildings, carbon dioxide builds up throughout the day to the point that it affects worker productivity. There are millions to be regained just by monitoring and adjusting air quality."

- Michael Moran, Microshare

Most smart building experts cite education as vital to ensuring that key stakeholders understand the importance of integration that starts with the design phase. They also need to understand that sustainability can be achieved in a way that ultimately saves money. Educating these individuals about the type of data that can be analyzed and leveraging digital data to simulate outcomes through technologies like digital twins and gamification can broaden their perspective. At the same time, organizations need to educate employees on how to make better decisions and adopt practices that support sustainability via incentives and a sense of inclusion.

The good news is that as technology continues to evolve and smart building technologies become more predominant, the industry is starting to better understand the importance of sustainability and progress toward more quantifiable measurements that can help determine ROI.

THE NEED FOR ASSESSMENTS AND CERTIFICATION

While data is the foundation of a sustainable smart building, holistic assessments that take into account all aspects of a smart building and are built on a measurable, verifiable, and objective repeatable framework of criteria are vital to benchmarking efficiency, operations, and occupant experiences to determine investment strategies. Assessment is also vital for building owners and operators to know where they stand, identify solutions that will have the greatest impact, and achieve ratings and certification that can be leveraged to promote their commitment to sustainability.

Self-Assessment as the First Step

For companies looking to determine areas where they can improve sustainability, they first need to have a baseline for where they are today. For example, TIA QuEST Forum's Sustainability Assessor is ideal for companies in the information and communications technology (ICT) industry to rapidly self-assess and benchmark their sustainability and corporate social responsibility programs against industry best practices. By simply answering key questions, the Sustainability Assessor gives an organization a rating of how they perform in ten different areas of sustainability. These areas include environmental management, resource efficiency optimization, carbon footprint and ozone depletion, corporate and social responsibility, supply chain management, stakeholder engagement, organizational engagement and capability, eco design, and end-to-end delivery. Sustainability Assessor then maps these different areas to the scale of impact it will have on the top and bottom line of the company and provides customized recommendations for improvement.

"Self-assessment tools can be extremely helpful for organizations that don't necessarily know where to start. These tools probe into areas they may not have thought about and provide them with specific guidance on which sustainability efforts to consider pursuing that align with their business priorities."

- Julio De Jesus Flores, Global Quality Manager, iQor

While TIA QuEST Forum's Sustainability Assessor is based on the ICT industry's TL 9000 standard and is geared more towards assessing the sustainability of a company's, or their supply chain's, operations, the online self-assessment tool of TIA UL's SPIRE Smart Building Assessment and Rating Program is designed to assess physical buildings in any market or industry. The SPIRE self-assessment tool provides an automated user-friendly platform for entering building information based on the six distinctive SPIRE assessment criteria—connectivity, health and wellbeing, life and property safety, power and energy, cybersecurity, and sustainability. It allows building owners and operators to gain valuable insights into the current state of their smart building and acquire an assessment of building functionality that can be used as a roadmap for future improvements to help increase asset values. Through UL and other testing services, building owners and operators can also assess their indoor air quality and other building factors that can help identify problem areas to address. All of these assessment tools are important as building owners and operators are coming to realize they need to do their part in protecting the planet, while delivering quality occupant experiences and reducing cost.

Certification Programs

Over the past couple of decades, sustainability has been the focus for several nationally or globally recognized smart building certification programs in the marketplace. Many of the following certifications are considered prestigious and offer organizations the means to promote their commitment to sustainability and the environment.

- LEED – U.S. Green Building Council Leadership in Energy and Environmental Design
- BREEAM – Building Research Establishment Environmental Assessment Method
- Green Globes – Used primarily in Canada and the U.S.
- Living Building Challenge – Created by the International Living Future Institute
- WELL Building Standard – Administered by the International WELL Building Institute (IWBI)
- Fitwel – Operated by the Center for Active Design (CfAD)
- Building Owners and Managers Association (BOMA) 360 Performance Program
- Other nationally and globally recognized rating systems, such as Singapore BCA Green Mark, Australian Green Star, German Sustainable Building Council's DGNB, France's Haute Qualité Environnementale (HQE) and China Academy of Building Research (CABR)
- Codes such as ASHRAE 189.1, International Green Construction Code and CALGreen

"When a building owner has a knowledgeable third party evaluate their assessment data, they have confidence that the result can be used to benchmark their space against others. And whether using the Sustainability Assessor or SPIRE assessment tool, the evaluation of sustainability goes beyond energy efficiency and waste, looking at everything from tenant engagement, to whether concepts of circular economy are being leveraged in the design process, ensuring that a building can evolve over time. As these certifications are more widely deployed, they will accelerate the implementation of smart technologies, which will have a significant positive impact on end user experience."

- Ken Koffman, TIA

While these certifications create awareness and fulfill green building criteria, they have not had as strong of an impact as most proponents of sustainable smart buildings would like. Many of these certifications also focus primarily on the conventional concept of "green" buildings rather than taking a more holistic approach. Another challenge with some certifications is that adoption varies from region to region, due to the origin of the certification, culture, and government influence. In areas of Europe for example, a LEED or BREEAM certified building enables real estate companies to apply for bonds and incentives such as reduced interest rates, which provides significant savings. In other regions where government grants or subsidies are available, developers may focus on those incentives rather than opting for non-government-based certifications.

To thoroughly address environmental issues on a global scale, smart building experts see the value in harmonizing certifications and cross pollinating the best practices from different regions, thereby supporting those regions that have not yet reached maturity.

The need for harmonization and a broader more holistic approach to sustainability are key driving factors behind the development of TIA UL's SPIRE Smart Building Assessment and Rating Program. Existing certifications like LEED, BREEAM, and others are brought into the fold as part of the sustainability criteria of the assessment, but the SPIRE program takes a much broader approach to also consider connectivity, health and wellbeing, life and property safety, power and energy, and cybersecurity. Based on measurable data, these six criteria together consider the planet, the people, and the profit of a sustainable smart building. Using an objective, evidence-based assessment framework based on data, organizations have a complete smart building evaluation and can earn a UL Smart Building Verified Mark, plaque, and building performance rating.

"Organizations collaborating more closely could go beyond regional goals, sustainability metrics, certifications, or evaluation tools. It could take years, but once we have global harmonization, it will be easier for different regions to start adapting and get on the right path towards sustainability. Otherwise, we risk having different levels and niches of sustainability that are solely based on the existing competencies and capabilities of various regions."

- Salla Palos, Microsoft

It is not just whole-building certifications that deliver value. Device certifications also play a critical role in ensuring that a building can effectively support and collect data from IoT devices and sensors. For example, several mobile carriers certify modules, chipsets, or devices for their 5G service, and organizations like the Ethernet Alliance certify devices for PoE to ensure interoperability and compliance with industry PoE standards. Microsoft certifies IoT devices to ensure they can connect with their Azure IoT Hub, and the LoRaWAN Certification Program provides assurance to end customers that their application-specific end devices will operate on any LoRaWAN® network. Certified devices provide end-users with confidence that the device is reliable and compliant with the LoRaWAN specification, allows manufacturers to carry the LoRaWAN CertifiedCM mark, and ensures proper operation.

Role of Codes and Regulations

While certification programs offer significant value, they are optional, unlike codes and regulations. Building codes and regulations are often at the very base level of sustainability with minimum requirements, but with an increased focus on climate change, most industry experts believe that will shift as the regulatory requirements catch up with the markets and legislation is introduced.

Codes and regulations also vary from region to region based on culture, market status, and other factors. While regulatory bodies in Europe are primarily interested in safety and privacy for example, others may focus more on energy consumption or the impact of wireless communication frequencies. Codes and regulations can even vary from city to city where authorities having jurisdiction (AHJs) have different requirements and varying concerns around sustainability and the environment.

"Regulatory bodies are often not able to react as fast as the market due to emerging technologies that are continuing to flood the market. While we need regulations, the competition we're seeing in the market will drive sustainability much faster than regulations."

- Julio De Jesus Flores, iQor

As regional markets focus more on smart building concepts, some AHJs may begin to focus on carbon emissions and adopt smart building requirements, which can help encourage a sustainable smart building approach in regions where it has been lacking. In markets where sustainable smart buildings are becoming the norm, real estate organizations are working closely with the public sector to push for ways to bring focus to sustainability into local laws and regulations.

THE FUTURE IS BRIGHT

Regardless of the driving factors—from growing concern surrounding climate change, to market demand and even the impact of the COVID-19 pandemic—industry experts all agree that the increased focus on the sustainability of smart buildings and the shift to a broader "blue" building concept that takes into consideration a building's impact on the planet, the people, and profit over its lifecycle is a step in the right direction.

There's no doubt that both sustainability and smart buildings are here to stay, and with an estimated 40% of all carbon emissions globally attributed to the built environment, there's also no doubt that the two together can have a significant impact. Sustainability must be an absolute baseline for smart buildings, and as the sustainability concept has evolved, that means deploying and integrating smart building technologies that address all aspects of a building's impact—plant, people, and profit.

"The pandemic gave us an opportunity to take a step back and really look at the issues impacting our world. Climate change is something we need to address. The built environment is a significant contributor that we can work on together and define actions through technology to reduce its impact."

- Annie Bevan, Superior Essex

Supporting building owners and operators on the path to a sustainable smart building can only come from clean, interoperable, and actionable data via infrastructures like LoRaWAN, combined with certification programs with verifiable assessment criteria like SPIRE that provide a starting point and a benchmark for any organization. As organizations around the world come together to address and tackle building sustainability head on, they will ultimately discover that it's not just about the technology or the ROI, it's also about seizing the opportunity to make changes today for a better tomorrow.

"My hope is that in five years, we don't have green buildings, blue buildings, and regular buildings—we just have buildings. And they all have sustainable concepts throughout because that's just smart. It is where we need to get to if we want to minimize the climate crisis that we're in."

- Josh Jacobs, UL

TIA®

Learn more about TIA's Smart Building Program and the SPIRE smart building assessment and rating program at sbinfo@tiaonline.org or by visiting www.tiaonline.org or www.spiresmartbuildings.ul.com.

Learn more about the LoRa Alliance and LoRaWAN specification at admin@lora-alliance.org or by visiting www.lora-alliance.org

LoRa Alliance®