THE ROLE OF REAL ESTATE IN ATTAINING NET ZERO

Decarbonizing the real estate sector

How the digital transformation enables solutions that can reduce emissions in real estate and support the transition to a net-zero future

SIEMENS

Index

1 Introduction

Real estate space – in the form of buildings and campuses utilized for living or work – are becoming a key focus area for humans as we journey through our evolution. Indoor spaces in a post-COVID era have gained immeasurable value and significance. Across the value chain, the emphasis is increasing on asset life extension, improving utilization, and reducing operating expenditures on buildings.

There's also a growing trend toward enhancing customization and usage-based adaptability for multi-purpose or hybrid use. This is leading to increased adoption of building automation, digitalization, and energy management solutions – all geared toward achieving greater sustainability through digitalization.

However, as people spend more time indoors, they want entertainment and an improved quality of life – which results in the consumption of more electricity and resources and increases emissions.

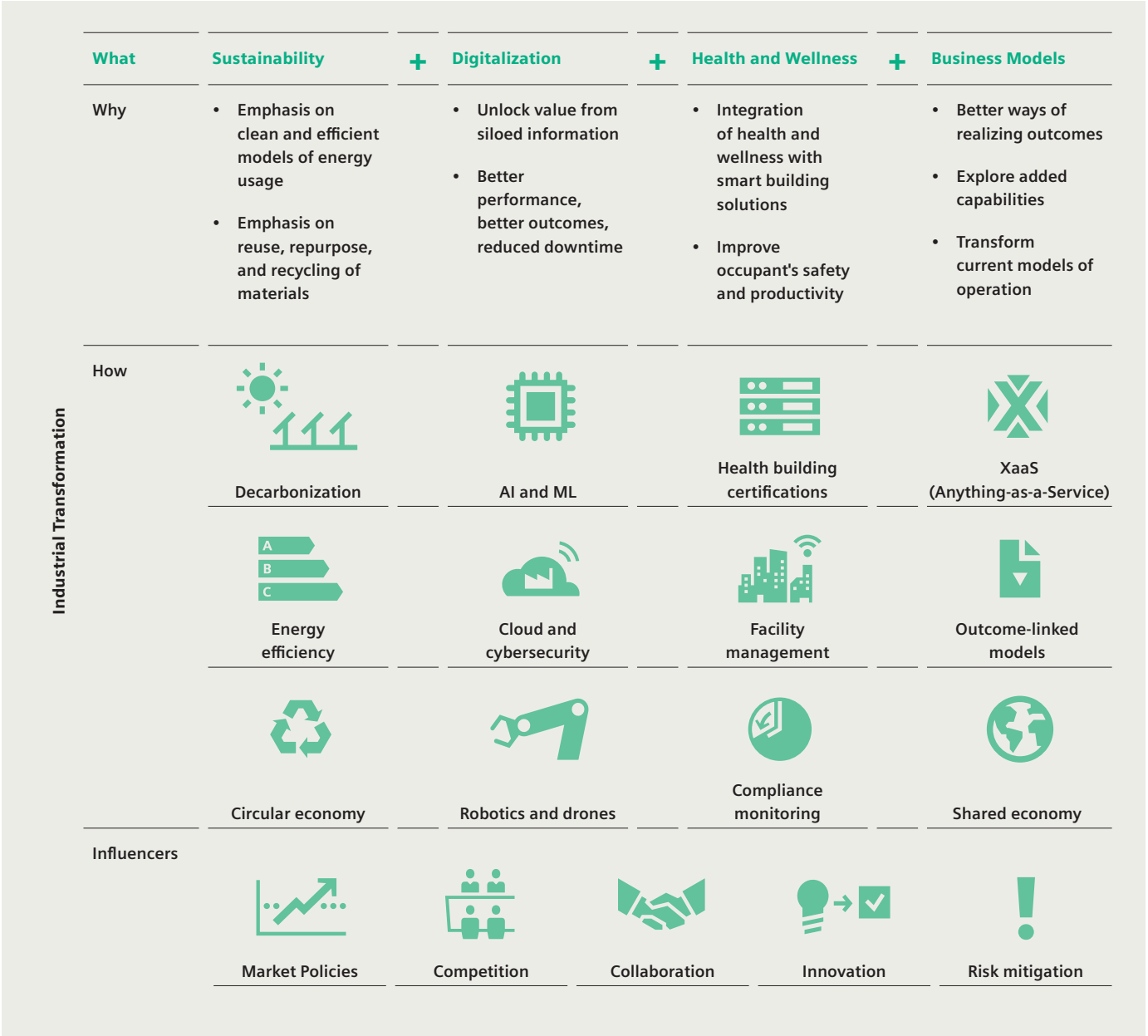


Figure 1: The role of technology in enabling a sustainable future for real estate

Emissions from the real estate sector have been increasing

A recent report by the Global Alliance for Buildings and Construction (GlobalABC) published through the United Nations Environment Program (UNEP)[1] states that CO_2 emissions from buildings reached their highest level ever in 2019 at 10 Gt CO_2, contributing to 28 percent of total global energy-related CO_2 emissions. This is cause for concern, because it seems to negate the various attempts that have been made, especially over the previous decade, to curtail energy consumption by and the environmental impact of buildings. GlobalABC's Buildings Climate Tracker (BCT) cites an alarming finding that our decarbonization progress hasn't just slowed down, it's been nearly halved in the period from 2016 to 2019.

28%

Contribution of buildings to global energy-related CO_2 emissions

The problem is expected to worsen in a business-as-usual scenario, especially when we consider the trajectory of growth in new construction – given that this contributes to 10 percent of the world's total emissions. New construction currently accounts for 15 percent of the world's Gross Domestic Product GDP) and is expected to generate spending of $17.5 trillion by 2030[2].

55%

Percentage share of existing buildings in global electricity

The Green House Gas (GHG) Protocol Corporate Standard is an established framework for monitoring, reporting, and developing mitigation and adaptation strategies for carbon emission reduction. GHG emissions are now classified into three types, or "scopes": Scope 1 emissions are direct emissions from owned or controlled sources (for example, on-site power generation). Scope 2 emissions are indirect emissions (for example, from the generation of purchased energy). Scope 3 emissions are all indirect emissions (not included in Scope 2) that are generated in the reporting company's value chain, including both upstream and downstream emissions. An analysis of the emission increase in real estate shows that Scope 1 emissions (carbon-intensive energy) is the main source of emissions from existing buildings, with the case being reversed for buildings under construction.

Efforts are underway to curb emissions

In an attempt to curb GHG emissions, all 196 countries (plus the European Union) that were parties to the United Nations Framework Convention on Climate Change (UNFCCC) gathered in Paris to define principles for curbing greenhouse gas emissions and tackling climate change impacts: This was called the Paris Agreement. However, every country's unique circumstances, resources, and abilities meant that under the agreement each was given the liberty to define their own goals and contributions to the universal agreement. These countries' pledges are known as Nationally Determined Contributions (NDCs). The takeaway is clear: For countries around the world to meet their NDCs, an improved strategy for decarbonizing real estate is essential. The efforts made to date aren't enough, especially considering how fast the construction sector is growing.

Leveraging technology can accelerate our progress

The technology is available, and it needs to be appropriately leveraged with the end goal in mind. We need to take a consistent approach that will optimize the interaction between building management systems and energy efficiency that will produce outcomes from a reduction in sales and office space, enhance data protection and security, improve service scalability, and optimize space.

Renewable sources of energy and demand flexibility need to be leveraged, especially in a decentralized manner, through on-site generation and power purchase agreements in order to accelerate the transition.

INDUSTRY SEGMENTS	DIGITAL SERVICES	EXAMPLES OF TECHNOLOGIES AND APPLICATIONS FOR ENHANCING REAL ESTATE USABILITY/EXPERIENCE	
Lighting	Digital twin	Building energy performance optimization	Anti microbial paints in washrooms
Energy management	Energy optimization	Voice-enabled lighting control	Foot operated elevators
Smart building management	Fault detection and diagnostics	Human-centric lighting	Touch-free bathroom fixtures
Fire safety and security	Healthy building services	AI-base lighting control	AI-based access control
Facilities management	Predictive maintenance	HVAC optimization	Thermal imaging
Construction management	Data protection and security, enablement of payment models	Occupancy detection-based social distancing	Building health performance benchmarking
	Workplace optimization	Digital twin	Pathogen scanner
		Indoor positioning based contact tracing	Nano-technology based self cleaning surfaces
		IAQ-based ventilation	Touch-free toilet seat cover cleaning
		Predictive maintenance	UV-C disinfection
		Ultraviolet germicidal irradiation	Power over Ethernet
		Cloud-based remote services	Narrowband Communication
		HEPA filters	Bluetooth low energy
		Workplace analytics	WiFi 6
		AI-based face mask detection	LiFi

Figure 2: An illustration of the evolution of digitalization solutions in the real estate sector[3]

A circular approach is essential for success

Keeping resource efficiency and resilience in mind, building design and construction need to incorporate more elements of sustainability to ensure longevity. This means:

- Designing buildings that aren't as energy-intensive and that have a reduced environmental impact across the entire lifecycle
- Incorporating materials that enhance efficiency (example: insulation materials, use of resources that are locally abundant)
- Creating a structured roadmap that commits builders and owners to reducing environmental impact all the way to decommissioning

The operational phase of buildings requires additional focus, given that they represent nearly 55 percent of global electricity consumption[4] and a staggering 30 percent of global energy consumption.

In comparison, the building construction industry contributes just five percent to the global demand for energy. While a variety of energy conservation measures are available for adoption today, improvements are constantly being made and a wider range of options is expected to be available in the future.

The industry environment has never been so conducive

Occupants are increasingly becoming aware in varying degrees of the need for decarbonization, and this is driving increased adoption. Institutional frameworks are being introduced that define the decarbonization pathways for this sector. Suppliers of building materials are increasingly incorporating emissions control in their products and aligning the broader supply chain to this outcome.

Technology improvements coupled with data-driven analytics and decision-support systems are yielding an increased return on investment.

Sustainable real estate is being seen and positioned as a value proposition for acquiring a competitive advantage in the marketplace.

Building owners and operators now have access to enablers and tools, including in the digital domain, that can facilitate decarbonization efforts.

However, adoption has lagged in the past, and a cohesive approach is required in order to accelerate toward a net-zero future.

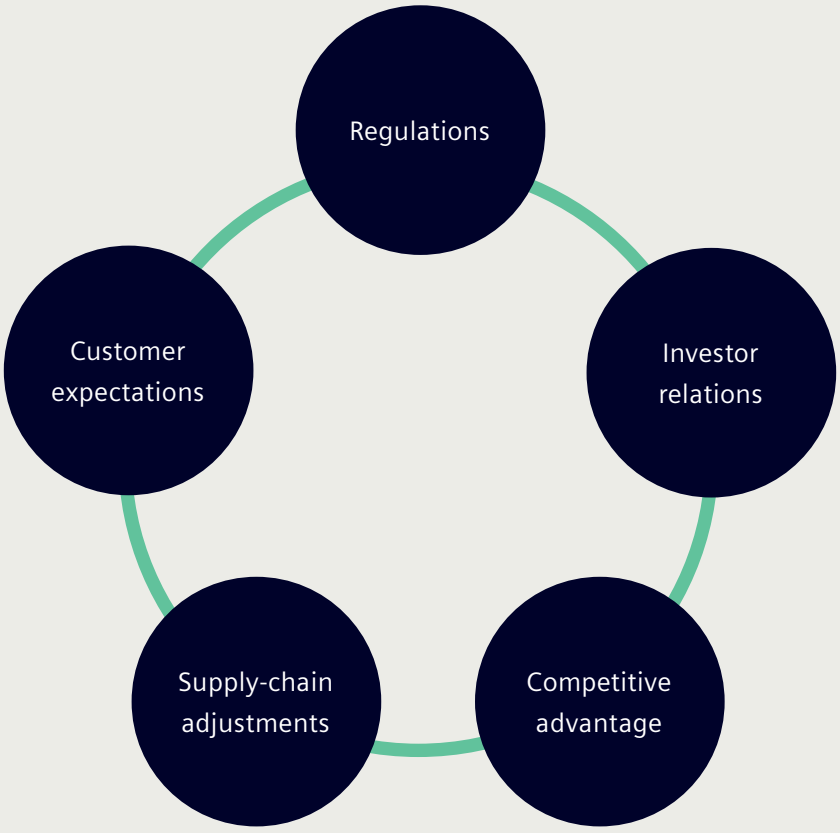


Figure 3: Factors that are creating an increased need for sustainability in the real estate sector

2 How the real estate sector is transitioning toward a decarbonized future

The real estate sector is witnessing a transition. It's focusing more on maximizing space utilization and enhancing asset life performance while reducing its spend/environmental footprint and committing to outcomes of resilience, comfort, flexibility, accessibility, and safety. Future developers of real estate need to emphasize on a new set of themes beyond the conventional means in order to differentiate their offerings.

A radical transformation is underway

Figure 4: Emerging focus areas for the real estate industry

Workplaces are being optimized

A shift is happening toward design, comfort, safety, efficiency, sustainability, well-being, and people productivity and also toward accommodating the emerging needs of work flexibility and social distancing. Acceptability in the market is being driven by data availability and analytics, which ensure that investments are pertinent to the nature of demand.

We’re seeing an increased emphasis on sustainability

As countries increase their commitment to sustainability, especially through NDCs, the real estate sector is being pressured to improve its performance in the area of sustainability. This is being driven by regulations, mandates, and environmental social and corporate governance (ESG). Initial adoption patterns are focused on energy management and building materials: however, an increased need for compliance is spurring investments in digitalization, adoption of renewable energy sources, and solutions that can address both direct and indirect emissions.

Energy management is emerging as a critical focus area

This is a severely under-utilized opportunity. Investments in conventional construction methods outrank those in energy-efficiency solutions by as high as 40 times. Lack of financing and inadequate data on asset conditions and connectivity are cited as the two most critical constraints impeding adoption, and they need to be redressed[5].

Remote operation capability is facilitating optimization

This is a trend that’s cross-evolved with the industrial sector. We expect to see real estate increasingly being operated and maintained remotely, especially in the post-pandemic era, where people mobility is still relatively restricted and connectivity among buildings is technically viable.

While previously a costly proposition, remote operation has gained ground with the advent of supporting technologies like 5G and sensors as well as the reduced cost of solutions like data storage.

Buildings are becoming “prosumers” and will drive the next wave of e-mobility adoption

Buildings are acquiring a significant role in the energy value chain as “prosumers” – both consuming and producing energy – and this trend is supported by the coupling of distributed sources of energy with buildings.

This is being driven by a massive shift toward decentralization, with digitalization supporting in measuring and driving commercial success. $53.14 billion was invested in distributed energy resources (DERs) in 2019 worldwide, and additional investments of $850 billion are predicted for this decade (2020 to 2030). This would result in a total distribution generation capacity of a sizeable 10 percent of the total global installed power generation by 2030[6].

At the same time, e-mobility is gaining traction. This is being demonstrated by declarations by countries (UK by 2030) and by automobile OEMs (GM, Audi by 2035) to phase out internal combustion engines. Research by Frost & Sullivan reports a greater increase of charging infrastructure incorporated in real estate by 2030.

This would be driven by digitalization-enabled business models where charging point operators, utilities, and real estate operators would join forces – supported by renewable energy sources, energy storage solutions, vehicle to grid (V2G) capabilities, and backend solutions for EV management and billing – to offer energy as a service.

This would not only join seamlessly with the evolution of DER, it would also increase infrastructure resilience and risk avoidance when integrated with the right framework and technologies. This is reflected in the success story of CHARGE-V in Germany (a spinoff of Vispiron Energy GmbH), which is increasing revenue for solar park operators by connecting the grid, solar parks, storage tanks, and charging stations. By adopting innovative fast-charging solutions, coupled with a set of digitalization solutions for charging and billing, the company was able to achieve a 50 percent reduction in costs associated with the certification process, while improving stability and expandability.

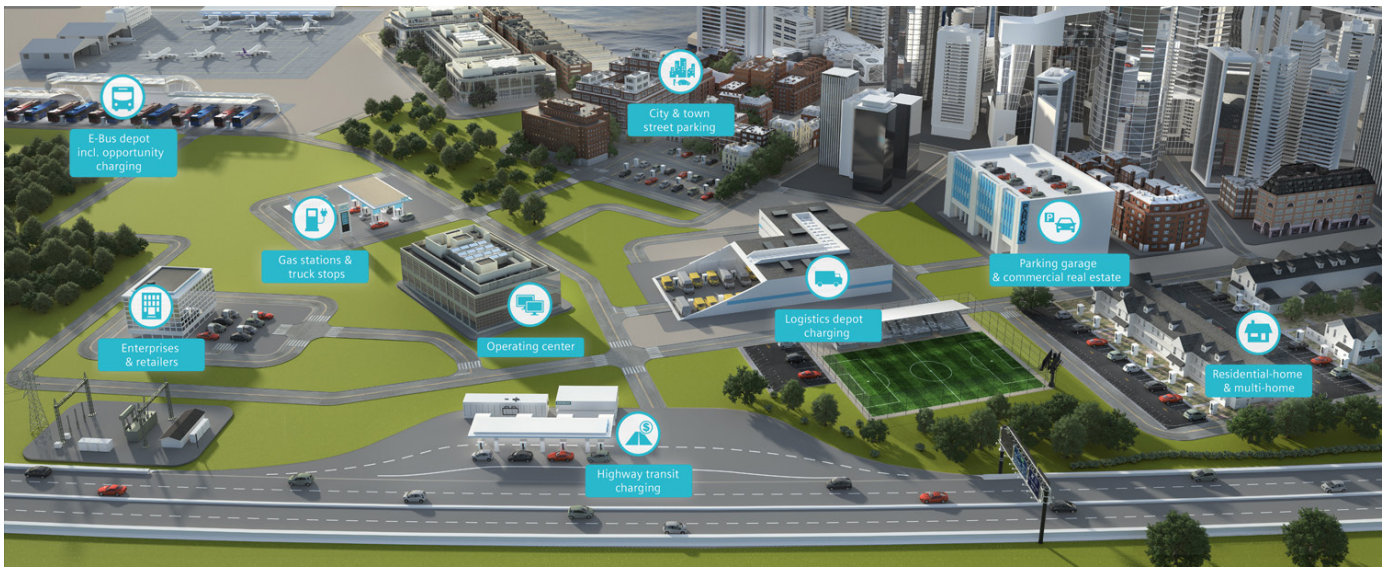


Figure 5: Application scenarios for EV charging infrastructure and its integration potential for real estate

A cascading effect would be seen in sector coupling. Grid management solutions are an ideal solution to consider due to their ability to improve utilization of renewable sources of energy, electrification, and adoption of micro-grids while bringing stability and performance into what would otherwise be a complex environment. This is achieved by facilitating more interactions between energy consumers and power producers.

Leveraging digitalization solutions can result in a successful transition by increasing the electrification of real estate and supporting a steady phasing-out of carbon-intensive sources of energy that the sector currently depends on, ultimately overcoming the barriers that have restricted decarbonization to date.

However, inadequate adoption of data analytics and reporting is impeding progress

The real estate sector is lagging behind in adopting data analytics, and currently adoption levels are less than five percent[7] of the true potential. Data will, however, become a critical asset for real estate operations – not just for asset and performance optimization, but also for compliance reporting and to solicit financing at favorable terms linked to performance.

A case at hand is the emergence of sustainability-linked loan issuance, now a $350 billion[8] and growing market that ties loans to target achievement and finding applications in a market that wasn't addressed by green funds. This would be un-attainable in the absence of supporting data on assets/facilities.

Much more needs to be done

The UNEP estimates that emissions from buildings would need to be cut by 50 percent in order to achieve a 2050 milestone of net-zero carbon stock.

Significant efforts have been made in the past to enhance the sustainability of buildings by focusing on the entire lifecycle, from concept and design to construction and realization and operations and usage, decommissioning/revitalization, and sale.

Services	Products	Applications
• Energy-saving services • Sustainable design • Predictive maintenance and remote services	• Circular materials • Energy conservation • Appliances	• Lighting • Heating/cooling • Data centers • Other applications

Figure 6: Efforts to decarbonize the real estate value chain

Yet in spite of the efforts to curtail energy consumption in real estate, CO_2 emissions from the operation of buildings have been increasing, especially over the last four to five years. This is attributable to the continued use of coal, oil, natural gas, and carbon-intensive electricity by the sector, and it clearly underscores the need for electrification.

Pathways are emerging

A framework initiated by The World Green Building Council (WGBC) defines two goals for achieving net-zero carbon in real estate:

- **Construction:** "When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy."
- **Operational:** "When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net-zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset."

These definitions clearly highlight the areas of focus for real estate decarbonization:

- **Energy efficiency:** Initiatives to reduce energy consumption
- **Renewable energy:** Adoption of carbon-free renewable energy sources covering on-site generation, off-site purchase, and off-site generation
- **Digital services, predictive maintenance, and remote facility management operations**
- **Carbon offsets:** If the combination of energy efficiency and renewable energy doesn't support the reduction of emissions, then carbon offsets are used to compensate for the balance of emissions. This includes investments in renewable energy projects elsewhere and claiming carbon credits.

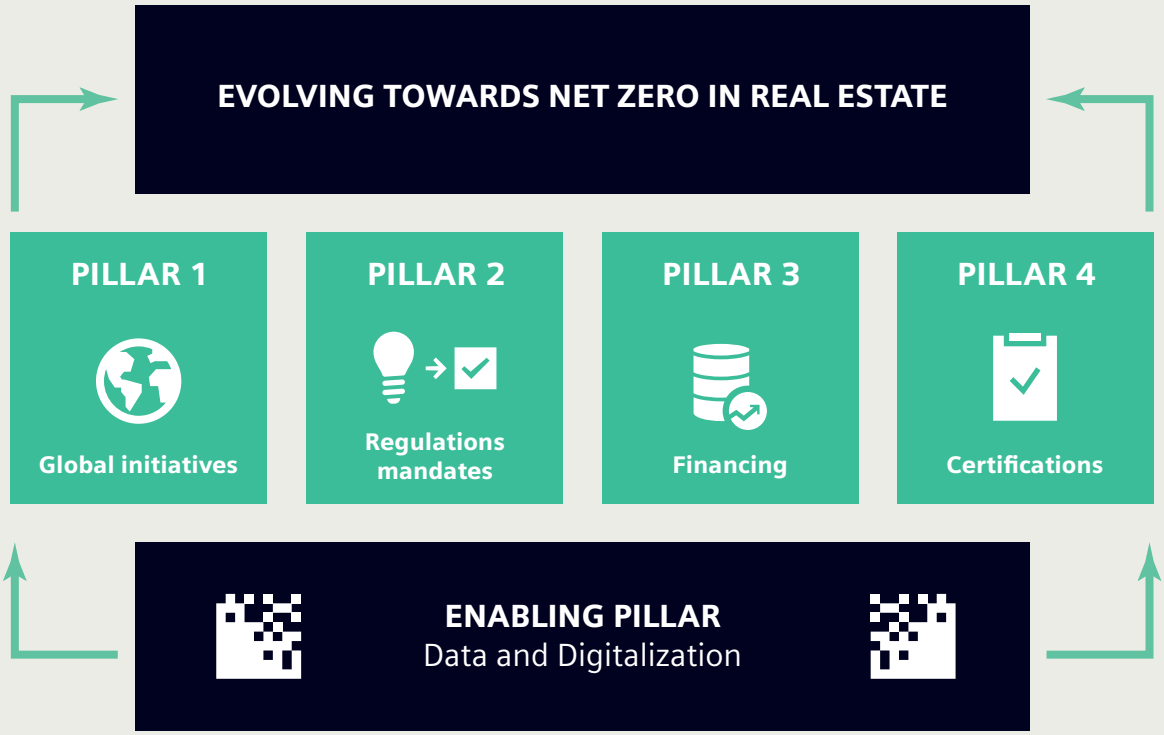


Figure 7: Data and digitalization are the foundation for achieving net zero in the real estate sector

Real estate is seen as one of the most cost-effective climate mitigation solutions available today. According to the World Resources Institute (WRI), every $1 invested in energy efficiency improvements saves $2 in new electricity generation and distribution costs[9].

Regulatory pressure is increasing

Regulations/mandates are an added impetus to these initiatives; they provide the necessary push to remove any hesitation from sceptics. While the underlying principles (of sustainability) remain the same, they're being structured and customized across geographies to increase acceptability and adherence.

- The EU's Green Deal (a set of proposals adopted in July 2021 to align the EU's climate, energy, transportation, and taxation policies with the goal of reducing net greenhouse gas emissions by at least 55 percent by 2030 compared with 1990 levels)
- Tokyo's cap-and-trade program (TCTP) that sets mandatory CO_2 emission reduction targets for the largest energy consumers in the city (estimated at approximately 1,100 office and mixed-use buildings)
- Boulder, Colorado's SmartRegs program that requires all rental housing in the city to demonstrate energy efficiency and linking this to license renewal – resulting in more than 97 percent of facilities becoming compliant
- Building performance standards launched around the world, including in the Netherlands, France, the United States (Washington DC, Nevada), and the United Kingdom. In the UK, for example, it became unlawful to lease properties in England and Wales that don't meet the prescribed (minimum) levels of energy performance.

Global initiatives are adding to the regulatory push

Recognizing the residual value involved, several initiatives are being launched to increase the adoption of net-zero carbon buildings.

- UNEP, WGBC, and WRI launched a Zero-Carbon Building Accelerator (ZCBA) to improve the rate of transition to efficient zero-carbon buildings around the world. This program is structured to coordinate the development of national roadmaps toward net-zero carbon buildings by 2050
- WGBC's Net Zero Carbon Building Commitment: Six sub-national states, 27 cities, and 79 businesses have committed to net-zero building operations by 2050 or earlier)
- The World Business Council for Sustainable Development's (WBCSD) Building System Carbon Framework
- The C40's Clean Construction Forum, Architecture 2030's Achieving Zero
- Buildings need to pay a price for pollution, with emission trading being imposed on buildings worldwide[10], starting in Europe
- Australia's Commercial Building Disclosure program that requires a declaration of energy efficiency information for the lease/sale of any commercial office space of 1,000 square meters or above – linked to the National Australian Built Environment Rating Systems

Corporations are stepping up to take responsibility

Globally, the demand for sustainable commercial real estate is also being driven by an ESG evolution on the part of corporations. Sixty percent of Fortune 500 companies have announced plans and goals for increasing sustainability[11]. An independent global survey commissioned by the Royal Institution of Chartered Surveyors (RICS) and the World Built Environment Forum (WBEF), which polled 4,000 people in total, states that 55 percent of respondents claim that the interest in green/sustainable buildings has increased either modestly or significantly[12]. A common thread being reported across all of these initiatives is the dependence on data, where the ability to store data on performance and supply chain compliance has become the critical link for streamlining reporting to all interested agencies.

Increased support available from the financial sector

The role of finance in the evolution of ESG is significant, specifically in terms of the sustainable investment of private capital. More than $8 trillion in real estate-linked assets were held by institutional investors at the end of 2018[13].

These investors are under pressure to embrace a sustainability-linked portfolio as part of emerging corporate directives linked to impact investing. Of the most widely accepted instruments, sustainability-linked loans (SLL) are overtaking Green Bonds. They're viewed as being fit for purpose for new construction and operating buildings alike – because they're not linked to a specific project but rather provide incentives to borrowers to achieve sustainability performance targets (in the form of interest rates).

Guidelines for KPIs have been defined to promote positive actions (adding renewables, improving energy efficiency, increasing recycling), discouraging activities that have negative environmental impact (decreasing GHGs, reducing water consumption), and tackling the value chain (addressing Scope 1-3 emissions, including embodied carbon). Notably:

- The EU's application of Green Loan Principles for real estate finance investment lending, created by the Loan Market Association along with the APLMA and LSTA, is streamlining the market by providing clear directives on the intended use of proceeds, reporting requirements, and the process of evaluation and selection
- 47 European banks and mortgage lenders have joined the EU-sponsored Energy Efficiency Mortgage Initiative, which provides preferential terms for improving the energy efficiency of existing buildings and for buying out energy efficient buildings
- The International Finance Corporation is now playing an instrumental role in the standardization and adoption of green building finance through joint investments, technical knowledge transfers, sharing best practices and lessons learned, and by demonstrating the business case for emerging markets.

Certifications and standards bring in the requisite levels of assurance

The involvement of institutional investors in real estate investments and the lack of uniformity in legislation has resulted in a boost for the standards and certifications market. This has matured to the extent that financiers are mandating borrowers to obtain independent third-party external validation of performance against specific targets as a condition for financing. Having access to third-party validation for performance and compliance provides critical assurance to investors and stakeholders and has been one of the largest indirect facilitators for the opening up of this market. Two of the most widely accepted systems in this segment are:

- The LEED system (Leadership in Energy and Environmental Design), viewed as the most widely used third-party certified green building rating system in the world
- The BREEAM (Building Research Establishment Environmental Assessment Method) method, with applications in over 80 countries

A range of other certifications have emerged to cater to niches like healthcare and region-specific requirements/nuances, including NABERS, climate bond certifications, RICS SKA, DGNB (Germany), HQE (France), and the Passivhaus and EnerPHit standards.

However, this ecosystem is complex, which underscores the need for accurate data to be captured across the entire value chain and appropriately analyzed to serve the needs of different investor types, while also ensuring scalability and achievability.

The market for these certifications isn't just driven by mandates: The real estate sector is citing improvements in branding and rentals as a result of higher certifications.

- Knight Frank, a leading international real estate consultant organization, found "A positive and significant effect of Very Good, Excellent, and Outstanding BREEAM ratings on prime Central London office rents – ranging from 3.7 to 12.3 percent premiums, while controlling for other property characteristics[14]."
- Research from Jones Lang Lasalle, another leading property investment and management firm, reveals that the sustainable building demand increased rental value from six to 11 percent with fewer void periods.[15]

Data is proving to be a key ingredient for success

Data is playing a pivotal role in this evolution. In the 2020-2021 Work Plan, the Group of Experts on Energy Efficiency explored "The role of digitalization and increased use of big data and geo-spatial data in the provision of energy services." This panel of experts concluded that "Frontier digital innovations have significant potential to help policymakers achieve their objectives through advancements in data, analytical capability, and better connectivity[16]."

Owners and operators need to invest in platforms and infrastructure that would allow data to be analyzed in order to generate value for their assets. Investors and other stakeholders that hold interest in and influence over the real estate sector require periodic empirical evidence on technical and financial performance and compliance.

Property operators will be required to maintain data on metrics/performance for purposes of reporting in order to secure better (financial) deals in the future and prove their compliance.

The wide range of solutions, stakeholders, and suppliers present a daunting picture for real estate owners and operators and underscores the need for concerted action channeled in a systematic way through a clearly defined data-driven framework supported by digitalization.

3 Digitalization will play a pivotal role in enabling real estate decarbonization

A structured approach is required

Real estate companies need to look at decarbonization and sustainability from a long-term perspective, think holistically, and align real estate performance KPIs with business KPIs. Ideally, the primary actors would then be developers and/or operators who would be in a position to envision and stay vested in achieving results over the long term.

A decarbonization strategy must take into account the costs and benefits of the options available, selecting those that are fit for purpose for specific types of assets and their condition in the real estate portfolio.

Stakeholder engagement and even consultation is important before decisions are finalized. Partnerships should be considered in order to fill in the gaps, with the goal of minimizing risk.

The success of decarbonization strategies like in implementing technologies and solutions that are fit for purpose: carefully selected to maximize returns, reduce payback periods, optimize property value, and achieve compliance. An exhaustive range of solutions is already available that's adequate for supporting the achievement of the 2050 decarbonization goals, if configured appropriately.

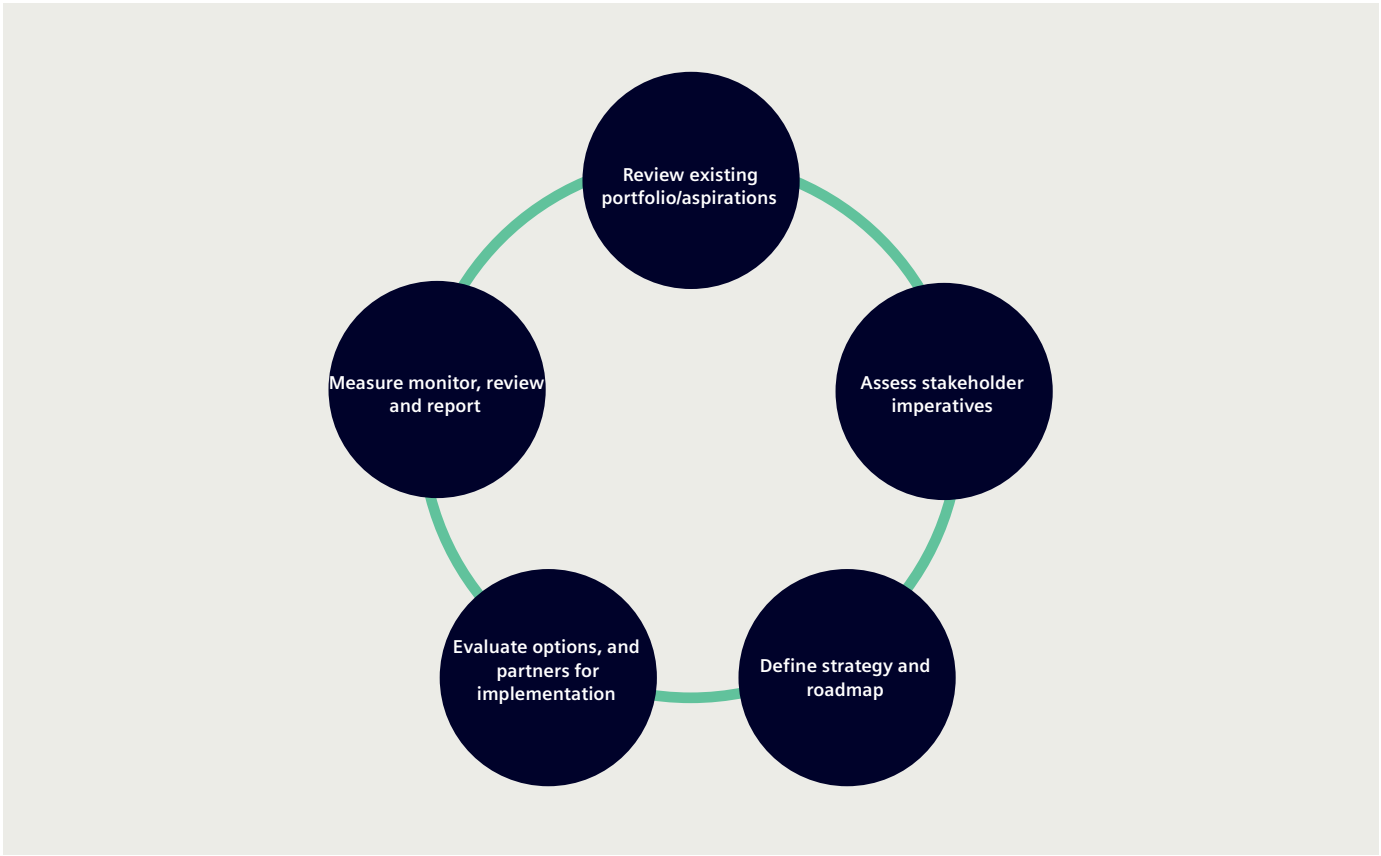


Figure 8: The process for defining a decarbonization strategy (including incorporating BIM and digital twins or building twins as suggested by Siemens, which supports this framework with a data-driven approach)

Reducing energy consumption is a critical first step

Reducing consumption is the first line of action to achieve decarbonization in buildings. Building codes and standards are expected to play an instrumental role in increasing adoption. The availability of financing – especially for retrofitting – in the form of sustainability-linked loans is expected to result in a significant increase in the implementation of efficiency measures. Improvements in the technologies that are driving better performance and ROI for energy conservation measures (ECMs) will be another success factor that will contribute to reducing consumption in buildings.

The Royal Melbourne Institute of Technology, Melbourne, Australia, was able to reduce electricity use by 39 percent per year with a strategically planned set of measures. Similarly, the Sello Shopping Center in Finland was able to reduce consumption by as much as 50 percent with a set of structured measures.

Opting for electrification is a necessary next step to achieve reductions

Using electricity (generated from renewable sources, instead of burning of carbon-intensive fuels) for applications in buildings – especially energy-intensive ones like cooling, heating, and hot water – can result in a significant reduction of carbon emissions from real estate. A report[17] by IRENA reveals that buildings have the highest potential for electrification (between 50 and 80 percent by 2050), which could result in emissions being reduced by 25 percent.

The Royal Melbourne Institute of Technology, Melbourne, Australia, was able to cut its emissions by 536 tons of CO_2 emissions per year using a structured electrification approach. Siemens was similarly able to reduce 2,400 tons of CO_2 emissions per year at their Kalwa factory in Mumbai, India, by implementing electrification measures.

39%

of energy used is generated by electricity on average

Energy Use	Share of energy	Share of electricity
Other Services	40%	49%
Space heating	34%	14%
Water heating	13%	18%
Cooking	8%	17%
Cooling	5%	100%

Figure 9: The share of electricity used in buildings by service worldwide, 2019[18]

Sector coupling (DERs, electric vehicles, renewable sources of generation) are proven to deliver sizeable improvements compared with conventional measures

The importance of coupling demand-drivers with supply sources has been detailed in a previous section of this paper. We emphasized the need to strategize the coupling of DERs (renewable energy-enabled), building electrification, and charging infrastructure for electric vehicles to improve grid stability and resilience. This is also strongly recommended by IRENA in their report on the energy transformation, and is seen as a crucial success factor for energy transition.

Improving and accelerating gains means including digitalization in the overall strategy

Frost & Sullivan sees an increased awareness among building managers and customers of the value delivered by digitalization (software-interlinked technology solutions). Technology enabled solutions seamlessly integrated with existing systems are contributing to building performance optimization, while delivering energy and cost benefits and value-based outcomes. Leading building technology participants are swiftly changing their value proposition to improving the energy efficiency and sustainability of buildings and increasing occupant comfort, further contributing to decarbonization in the real estate sector.

Solutions like building information modeling (BIM) and building energy management systems (BEMS) have been the enablers of the adoption of digitalization in real estate, with $16 billion spent on these systems in 2020 alone[19]. It's estimated that the use of lean principles and methods, including BIM, could reduce completion time by 30 percent and cut costs by 15 percent[20].

These solutions faced unique challenges, specifically in terms of how to deal with multiple tenants/occupants who each have their own requirements/preferences/systems.

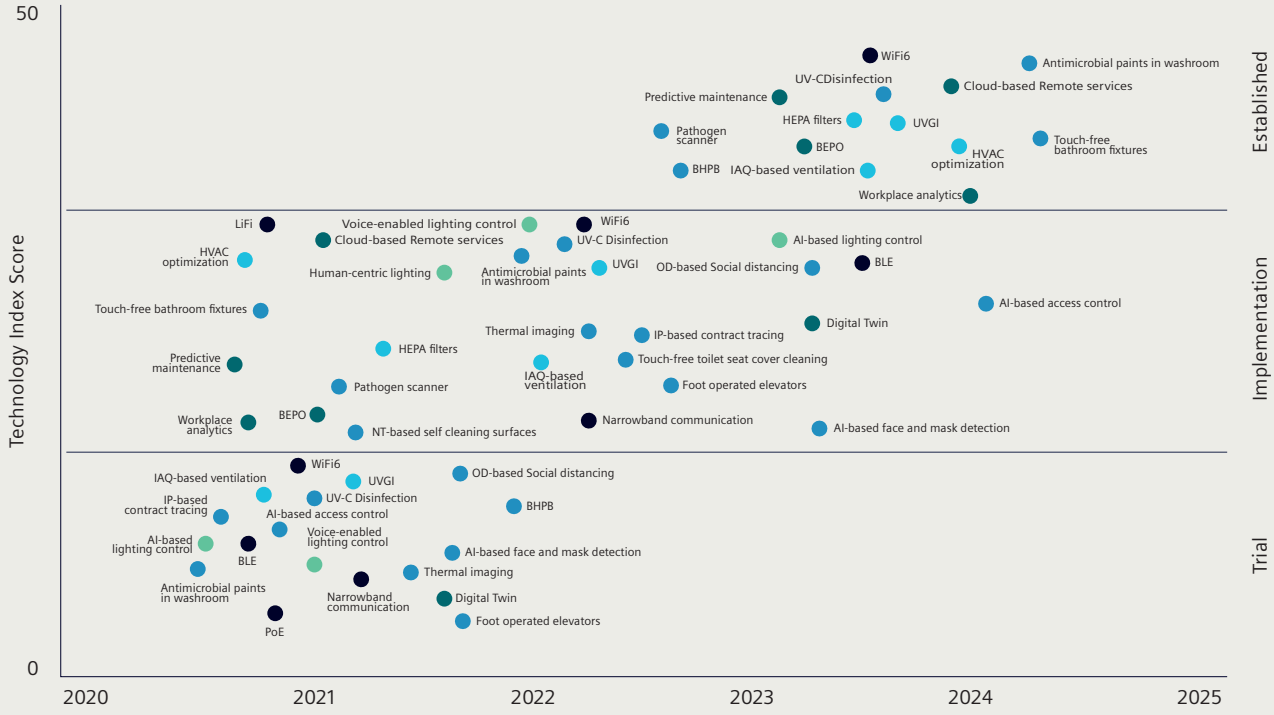
Today this market is evolving, and best practices center on platform-oriented solutions that are open-system, app-centric, and enable interoperability and seamless data exchange. These systems are providing multiple advantages and offering a convincing value proposition: They'll deliver cost savings by enabling remote monitoring, energy management, predictive and preventive maintenance, and asset life extension.

Additional benefits in the form of customizability, versatility, safety, and space optimization are presenting building operators/managers with a comprehensive and compelling offering that's outcome-oriented.

Some of the top technologies that are expected to be rapidly adopted and deliver significant impacts are outlined in Figure 10.

As these solutions are increasingly adopted, the volume of data flowing from each of them will be considerable. This means that true asset resilience and meeting decarbonization goals will only be attainable through a unifying platform. These platforms would ideally allow for seamless storage, assessment, and analysis of multiple and for the most part disparate data streams. Investing in these platforms is expected to yield significant results in terms of cost savings, improvements in safety and resilience, and overall sustainability.

Figure 10: Digital solution architecture for the buildings industry[21]



Lighting Control	Communication	Automation and Energy Optimization	HVAC and IAQ	Post-COVID-19 Applications
AI-Based lighting control	Power over Ethernet (PoE)	Building energy performance optimization (BEPO)	High efficiency particulate air (HEPA) filters	Occupancy detection (OD) based social distancing
Voice enabled lighting control	Narrowband communication	Cloudbased remote services	Indoor air quality (IAQ)-based ventilation	Indoor positioning (IP) based contact tracing
Human-centric Lighting	Bluetooth LowEnergy (BLE)	Predictive maintenance	Ultraviolet germicidal irradiation (UVGI)	AI-based face and mask detection
	WiFi6	Digital twin	HVAC optimization	Antimicrobial paints in washrooms
	LiFi	Workplace analytics		Foot operated elevators
				Touch-free bathroom fixtures
				Thermal imaging
				AI-based access control
				Building health performance benchmarking (BHPB)
				Pathogen scanner
				Nano technology (NT)-based self cleaning surfaces
				Touch-free toilet seat cover cleaning
				UV-C disinfection

University campus in Europe

University Properties of Finland

- Managing more than 230 properties and more than 1.3 million square meters of space
- Complaints about stuffy air, insufficiently heated spaces, and defects in the heating and lighting systems
- While universities get more digital, attracting other tenants is very important to keep the level of occupancy.

Asset Performance Services scope

Maintenance strategy analysis

- Reviewed maintenance plans and identified-site maintenance tasks that can be automated

Predictive maintenance analytics

- Service centre identifies issues with Navigator, the cloud-based energy and asset management platform from Siemens, analytics and providing improvement recommendations directly to their facility management team by seamless integration between Navigator and customer's Computerized Maintenance Management System (CMMS)

Results Delivered

- 65% of onsite HVAC facility management tasks replaced or be supported by data analytics
- 70% of weekly/monthly visual inspection tasks replaced by analytics
- 2 times more identified issues and failures, which were hidden
- 57% of identified issues had also an impact on energy saving
- 50% drop of services requires related to indoor climate

Sustainability in action: Princeton Island grid

Siemens' "living lab" microgrid campus in Princeton, New Jersey serves as primary energy source for the Siemens Technology North American Headquarters.

Key characteristics

- Siemens Building Management System DESIGO CC
- Siemens Microgrid Controller (MGC)
- Siemens battery storage system: 1MWh/500kW
- Photovoltaic system: 836 kWp
- Siemens VersiCharge for electric vehicles: 6x7.2kW

The research analyzes how microgrids can help businesses and communities adapt to climate change and reduce the carbon footprint of energy generation and use.

Optimal microgrid and building operation

Internet of things

Performance monitoring and analytics

Simulation and digital twins

Cybersecurity

4 Real-world cases that demonstrate the potential

Many of these technologies have been deployed and have yielded convincing returns in the form not just of reduced emission but also in energy savings, improvements in space utilization, and overall cost savings.

Energy savings and CO_2 emission reductions are achievable regardless of the size of the facility. One example is Siemens' solutions implemented at a dairy plant that needed capital to be freed up in order to focus on its core business.

- €827,000 in savings guarantee per year
- 62 percent reduction in CO_2 emissions per year
- €0 CAPEX

Smart real estate needs to deliver the appropriate levels of security for occupants. This was achieved at the Vodafone Campus in Dusseldorf, Germany, where the company sought a comprehensive, end-to-end corporate security solution and increased levels of security while also improving the customer experience. Vodafone decided to opt for Siemens' suite of security offerings. The campus implemented a complete set of security and safety solutions including access control, video surveillance, and danger alarm systems across the campus of seven buildings, all integrated and operated from a centralized security control center. Analytics were utilized for monitoring entrances and sensitive areas, and an innovative access control and lock system were deployed using single end-point near field communication (NFC), with access authorizations stored on a mobile phone: This leveraged the technology to the maximum.

More complicated facilities like schools and education institutions can acquire significant value from deploying technology to achieve their sustainability commitments. This can be seen in the case of the Deutsche Schule Madrid (DSM), Spain, which involved the new construction of a school building on approximately 21,000 m^2 of built-up area to provide space for about 1,700 pupils. The school:

- Installed an energy-efficient power supply utilizing renewable energies (thermal labyrinth, photovoltaics, solar heat, CHP)
- Utilized design tools for optimizing space usage and equipment purchases
- Protected the infrastructure from risks from extreme climatic conditions and reduced the need for maintenance.

5 How we can plan for successfully leveraging this opportunity

Benchmark and establish the baseline

Assessing the state of your assets and the level of optimization attainable is a critical first step if you own/operate/manage building assets. It's important to not stop at a baseline assessment but to also define goals that are linked to your corporate aspirations/ESG goals/sustainability strategy so that future investments will be aligned with a bigger picture.

Define future needs and direction

It's important to not stop at a baseline assessment but to also define goals that are linked to your corporate aspirations/ESG goals/sustainability strategy so that any investments in decarbonization are aligned with a bigger picture. While doing so, we strongly recommend that you incorporate future growth plans and potential changes in the use of the assets to ensure that any investments are future-proof.

Engage with experts who understand the entire value chain and solution landscape

There's an extensive range of options and configurations available, and each delivers varying levels of efficiency. By engaging a company like Siemens, your organization can ensure that the options were selected with the highest level of precision and that all solutions are optimized for productivity, return on investment, security, and future resilience.

Look for solutions and platforms, not products/ components

Previous approaches to tackling energy consumption and decarbonization were focused on standalone components, more often than not running on proprietary platforms. This hindered analysis and reporting and posed challenges to optimizing the overall asset. By opting for digital systems/platforms whose operations are coordinated and include open data porting, monitoring, measurement, and verification can be streamlined and compliance reporting simplified.

6 Conclusion

Global targets for decarbonization can't be achieved without increased contributions from the real estate sector. Previous efforts are proving to be inadequate, and a change in approach is required that capitalizes on the immense benefits that digitalization can deliver.

We see a need for stakeholders to strategize for the long term and to embrace business cases that are driven by performance, user centricity, and a focus on safety and security. The focus now needs to be on four areas:

Focus on the asset itself

Building operators and owners (depending on the nature of their involvement) need to work toward improving the usability, security, reliability, and adaptability of their buildings – and improve utilization and the customer experience. By incorporating technologies into existing buildings, gains can be achieved across all these fronts with the outcome of improved monetization. Retrofits to HVAC systems, upgrades to BMSs, improved security systems, and a focusing on energy management systems (in line with ISO 50001, for example) are all examples of actions that can be taken to enhance an asset's quality and lifespan as well. Improvements can also be made to how new buildings are designed, focusing not just on efficiency but on overall circularity.

Focus on the impact of the asset

The environmental impact of buildings and how they interact with the broader environment need to be kept in mind while working on building improvements. As explained earlier, emissions from buildings have been on the rise, in spite of measures taken to address this very problem. For existing buildings, electrification and sector coupling are solutions that will help address this issue and also result in revenue opportunities, provided that appropriate business models are developed and technical integrations are strategized with expert help.

Focus on the stakeholders

Every stakeholder has different requirements, but they share a common need for information about the asset. Implementing mechanisms for measurement and verification is critical to ensuring compliance and delivering assurance. In the future this will be impossible unless frameworks are in place and a systemic approach implemented for seamlessly collecting data, analyzing it appropriately, and delivering it to stakeholders through customized delivery tools. Building managers/owners need to develop comprehensive stakeholder engagement strategies that take these requirements into account.

Focus on digitalization

As outlined in this paper, buildings will no longer operate in isolation; instead, they'll be connected within a broader smart city ecosystem. We can expect to see exabytes of data storage and flows being generated, which justifies the case for investments in data and digitalization platforms that can seamlessly integrate disparate flows also while meeting operation and reporting requirements. Leveraging digitalization solutions can make a significant contribution to supporting the real estate sector in preparing for the evolution towards an interconnected and digitalized society. All current trends are enabling a structured adoption of digitalization in the real estate sector and ensuring an improvement in our transition to a net-zero future.

Smart Infrastructure combines the real and digital worlds across energy systems, buildings and industries, enhancing the way people live and work and significantly improving efficiency and sustainability.

We work together with customers and partners to create an ecosystem that both intuitively responds to the needs of people and helps customers achieve their business goals.

It helps our customers to thrive, communities to progress and supports sustainable development to protect our planet for the next generation.

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