



# Beyond smart: the future of **autonomous buildings**

A roadmap to human-centric buildings that serve people better  
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Imagine this. It's Tuesday morning and you have a meeting scheduled for 9:00 a.m. You don't feel stressed because before you even step inside, the building has already anticipated your needs. It knows from your calendar that you have reserved Conference Room B with five colleagues in attendance.



The room has automatically set the temperature to the optimum level for six people and configured the lighting to reduce glare, with the acoustics adjusted for your meeting room size and format. As you approach the office, the building guides you to your preferred parking spot and seamlessly grants access without any interaction.



The building's predictive algorithms are already analyzing incoming weather patterns and occupancy data. Detecting that cloud cover will arrive in 12 minutes, the HVAC system proactively reduces cooling to prevent the room from becoming uncomfortably cold when natural sunlight fades.

Meanwhile, knowing that 40% of today's workforce is working from home, the building has automatically adjusted energy consumption across less-occupied floors.





This isn't legacy automation responding to conditions after they occur – this is true artificial intelligence (AI) that learns, predicts and personalizes. Gone are the days of facilities teams fielding countless calls from frustrated occupants or responding needlessly to false security alarms. The building monitors itself 24/7, 365 days a year, detecting, prioritizing and resolving issues before they impact human comfort, productivity, safety or security.

For example, when a slight pressure imbalance is detected in the ventilation system at 3:00 a.m., an AI agent collaborates with remote maintenance teams to diagnose and correct the problem before it becomes an issue. The previous week, the AI system detected an intruder after office hours, alerted the building's security team and sent the information straight to the police. What's more, to avoid future issues, the system learns from each of these interactions, continuously improving its capabilities.

But consider the stakes when we move beyond the office to mission-critical environments. In a hospital operating room, for example, autonomous building systems don't just optimize for comfort and security – they maintain precise temperature, humidity and air pressure parameters that can mean the difference between life and death.

When a life sciences laboratory requires specific environmental conditions for sensitive research, the building's AI ensures that temperature fluctuations never compromise years of work or millions of dollars in research investments.

These buildings are not only fully-integrated – with safety, security, energy and maintenance systems all talking to each other – they are also connected to the environment around them and beyond, communicating with the grid, drawing in renewable energy when it's most affordable, managing EV charging intelligently and supporting wider electrical grid stability.

Using advanced AI algorithms, they continuously heal and optimize themselves, reducing operational costs and providing long term value for owners, streamlining workflows for facility managers and their teams, and most importantly, creating environments that adapt to human needs rather than forcing humans to adapt to building limitations.

# Breaking down the vision: what is a human-centric autonomous building?

The building you've just been picturing yourself in is not only smart; it's autonomous and human-centric.

For Siemens, human-centric means technology that learns individual preferences and behavioral patterns to create personalized environments – from your preferred temperature settings to optimal lighting for your tasks – while eliminating the need for occupants to manually adjust their surroundings.

An autonomous building processes vast amounts of data from multiple sources – including occupancy sensors, weather feeds and energy grids – along with insights on user behavior and system performance, to learn, predict and adapt at both building-wide and individual user levels, all without continuous facility management involvement.

This makes it more advanced, in three crucial ways, than a smart building:

- The level of integration
- The level of automation
- The depth of predictive personalization.

Smart buildings typically integrate HVAC, lighting, fire, security and other building systems from multiple vendors through proprietary operational technology (OT) integrations – the networks and controls that run the physical infrastructure. These OT-only systems can detect and predict anomalies, helping to pinpoint what's wrong, where and why.

An autonomous building unifies vendor systems with external data streams – such as weather forecasts, service case histories and self-monitored occupancy patterns. It then deploys digital agents to execute automated workflows, including deploying predictive maintenance systems, optimizing energy usage and trading, optimizing space utilization, coordinating with cleaning requests and orchestrating complex multi-system responses.

## The enabling technology stack – **how it works**

Autonomy isn't about a single technology; it's about multiple technologies working as one:

- **Building automation and operational control systems:** an essential source of real-time data and the means of implementing operational decisions.
- **IoT devices and sensors:** to capture data on everything from temperature and humidity, to equipment vibration and occupancy levels.
- **Edge connectivity and cloud platforms:** to move and process data wherever it's most efficient – some locally for speed, some in the cloud for scale.
- **Machine learning, AI and advanced analytics:** to spot patterns, predict issues and prescribe the best course of action to optimize performance in real time.
- **A new generation of user experience (UX):** dynamic interfaces that make complex building insights and actions easy to understand and act on.

When all these components are integrated and “speak” to each other, they create the conditions for autonomy – a building that serves people better, because it has the intelligence to manage itself.

## Humans at the center

Crucially, autonomy does not eliminate the human role. Instead, it frees people to focus on the things that matter most and do a better job of what they're tasked with doing, enhancing the experience and effectiveness of all stakeholders.

Facility managers aren't replaced – AI highlights the most critical issues and infers their root causes, freeing up the facilities team to focus on validating insights, tailoring solutions and pursuing long-term strategy rather than daily problem firefighting. It enables automatic work order (or ticket) creation and streamlined workflows. Instead of an everlasting list of to-dos, a human-centric building empowers facility managers to use their skillset to take action.

Occupants don't need to worry about the minutiae – they have an optimized environment that allows them to do their best work while knowing their wellbeing is front and center. Investors and owners don't face new complexity – they gain significant cost and energy efficiencies, long-term value and improved tenant retention.

It's not technology for technology's sake; it's autonomy for the benefit of people. And this future isn't as far off as it might seem. It's already taking shape – and it's more urgently needed than you might imagine.

## Why now?

We've reached an inflection point where technological advancement and industry pressures have converged, making a new approach essential for customers and for Siemens to remain competitive. First of all, the energy landscape is changing fast. Heating and cooling needs are rising – and with them, energy use and costs.

"If you're not managing it smartly, you miss your CO<sub>2</sub> targets – and your energy bills go through the roof," explains Susanne Seitz, CEO, Siemens Smart Infrastructure Buildings.

It makes sense, then, that according to Siemens Smart Infrastructure's most recent Infrastructure Transition Monitor (ITM) 2025, which brought together insights from **1,400 C-suite respondents across 19 countries** to explore the current state of the structures and systems that keep our world functioning, fewer organizations are confident of meeting their 2030 CO<sub>2</sub> reduction targets in 2025 compared to 2023.

"If you're not managing it smartly, you miss your CO<sub>2</sub> targets - and your energy bills go through the roof."

explains Susanne Seitz, CEO, Siemens Smart Infrastructure Buildings

And almost half (49%) of organizations in the energy, heavy industry and buildings sectors believe they need to reinvent their business models to decarbonize, with autonomous technologies emerging as a key enabler.



**49%** of survey respondents see the need to reinvent business models to decarbonize

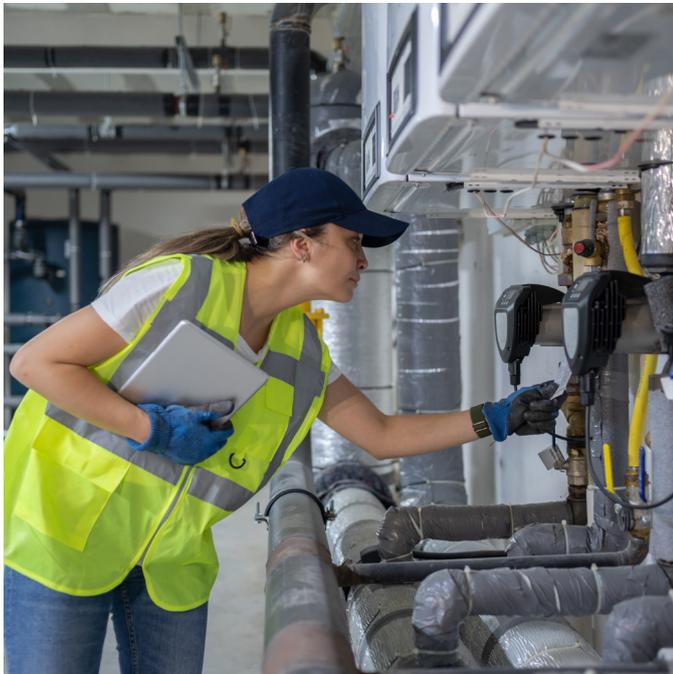
Infrastructure Transition Monitor (ITM) 2025 by Siemens Smart Infrastructure



## Workforce challenges

Knowledge gaps and skills shortages are also rising higher on facility managers' list of concerns. "Almost every customer we visit has the same issue: much of their building information isn't documented," Seitz adds. "They don't know where their assets are, what firmware they have or even when systems were last updated. When experienced facility managers retire or leave, that knowledge goes with them – and suddenly they're exposed to huge operational risks."

Finding qualified people to fill those gaps is harder than ever. In the UK, for example, approximately 75% of employers reported difficulty sourcing talent in building operations roles, with more than 40% specifically struggling to fill property management positions.<sup>1</sup> Meanwhile a 2024 survey focused primarily on the US, found that 42.6% of facility management teams are understaffed.<sup>2</sup> Many current facilities management professionals are also aging out: nearly 20% of the UK engineering workforce will retire by 2026, exacerbating knowledge loss.<sup>3</sup> "Qualified staff are incredibly hard to find, and many customers don't even realize how big a risk this is until it hits them," Seitz notes.



## Outdated planning approaches

Traditional capital planning approaches aren't keeping up. "CapEx planning is often an afterthought," Seitz says. "They'll spend big one year, then do nothing the next. That stop-start approach creates major disruption when assets fail, budgets don't align and tenants are impacted." And when maintenance isn't predictive or well-coordinated, inefficiency piles up fast: "You end up rolling trucks three times to the same site for the same issue. That's wasted time, wasted money and unnecessary disruption," she stresses.

The pressures are piling up – but so are the solutions. "Right now, it's energy costs, it's people shortages, it's asset value," Seitz summarizes. "The difference today is that the technology exists to tackle these issues, where just a few years ago it didn't."

1. Royal Institution of Chartered Surveyors, H2 2024 UK Facilities Management Survey, 2024. [www.rics.org/content/dam/ricsglobal/documents/market-surveys/uk-facilities-management-survey/h2-2024-rics-facilities-management-survey.pdf](https://www.rics.org/content/dam/ricsglobal/documents/market-surveys/uk-facilities-management-survey/h2-2024-rics-facilities-management-survey.pdf) [accessed 23 October 2025].
2. CBRE, Redefining the facilities-management engineering skill gap, 2023. [www.cbre.co.uk/insights/articles/redefining-the-facilities-management-engineering-skill-gap](https://www.cbre.co.uk/insights/articles/redefining-the-facilities-management-engineering-skill-gap) [accessed 23 October 2025]
3. Jones Lang LaSalle Technologies (JLLT), Facility managers will do more with less in 2024, 2024. [www.jllt.com/blog/facility-managers-will-do-more-with-less-in-2024/](https://www.jllt.com/blog/facility-managers-will-do-more-with-less-in-2024/) [accessed 23 October 2025].

# Siemens' journey to autonomy: not a revolution, but a natural evolution

## Pre-2017

Our longstanding experience in automating deterministic workflows for lighting, shading, HVAC and more – setting the foundation for smarter systems.

## Pre-2019

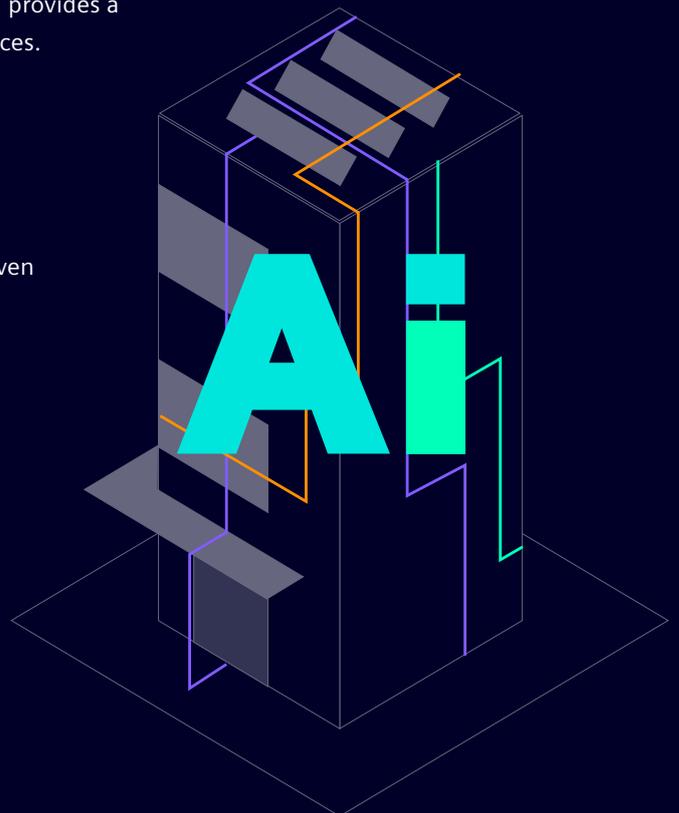
The beginning of our autonomous building journey. We launched our first rule-based fault detection and diagnostics platform, focused on maintenance rather than just energy efficiency – a major shift in mindset at the time.

## 2022

Launched the pioneering **Building X**, which provides a platform to bring in data from multiple sources.

## 2025

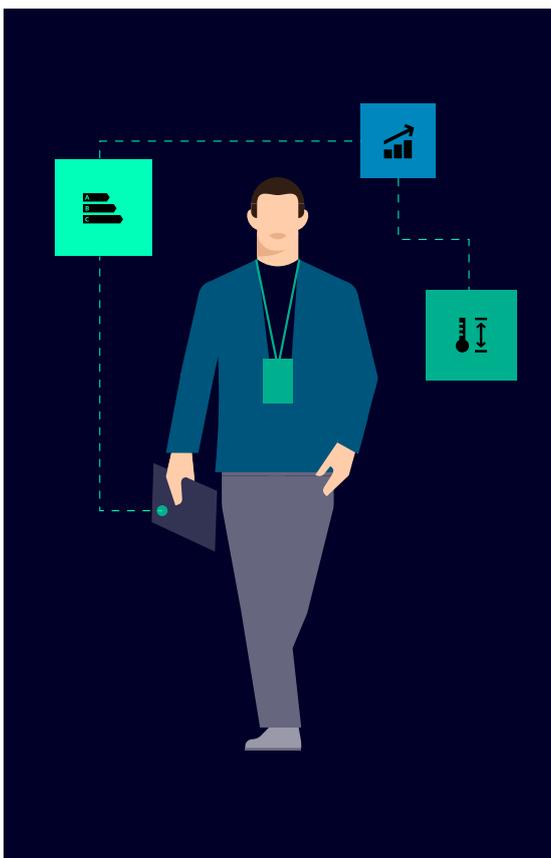
We are rolling out our first predictive, AI-driven service – a key step toward full autonomy.





# The humans across the building lifecycle

The big picture may be clear, but a building is a complex ecosystem – and every stakeholder within it has different priorities. That’s one reason autonomous building projects can feel daunting to start. By looking at autonomy through the lens of human stakeholders, we can see how it delivers tangible benefits across the building lifecycle.



## I’m a building owner. What’s in it for me?

**The challenge:** Reducing operational costs, maximizing asset value and delivering stronger ROI.

**The benefit:** Autonomous buildings help optimize ROI by prioritizing high-impact investments and minimizing energy waste – offsetting upfront costs through long-term savings. They also improve tenant comfort and sustainability, reducing turnover and keeping spaces occupied. This protects asset value, enhances resilience and accelerates ESG progress, making the building more attractive to future tenants and buyers.

**The bottom line:** "For building owners, it comes down to three cost buckets: labor, energy and capital. Autonomous buildings tackle all three – reducing staffing needs, cutting energy waste and prioritizing high-impact upgrades – so facilities can run at their optimum performance at the lowest possible cost."

**Brad Haeberle, Executive Vice President Services at Siemens Smart Infrastructure Buildings.**



## I'm a facility manager. Why should I care?

**The challenge:** Reducing downtime, meeting rising service expectations and managing complex systems with fewer staff and resources.

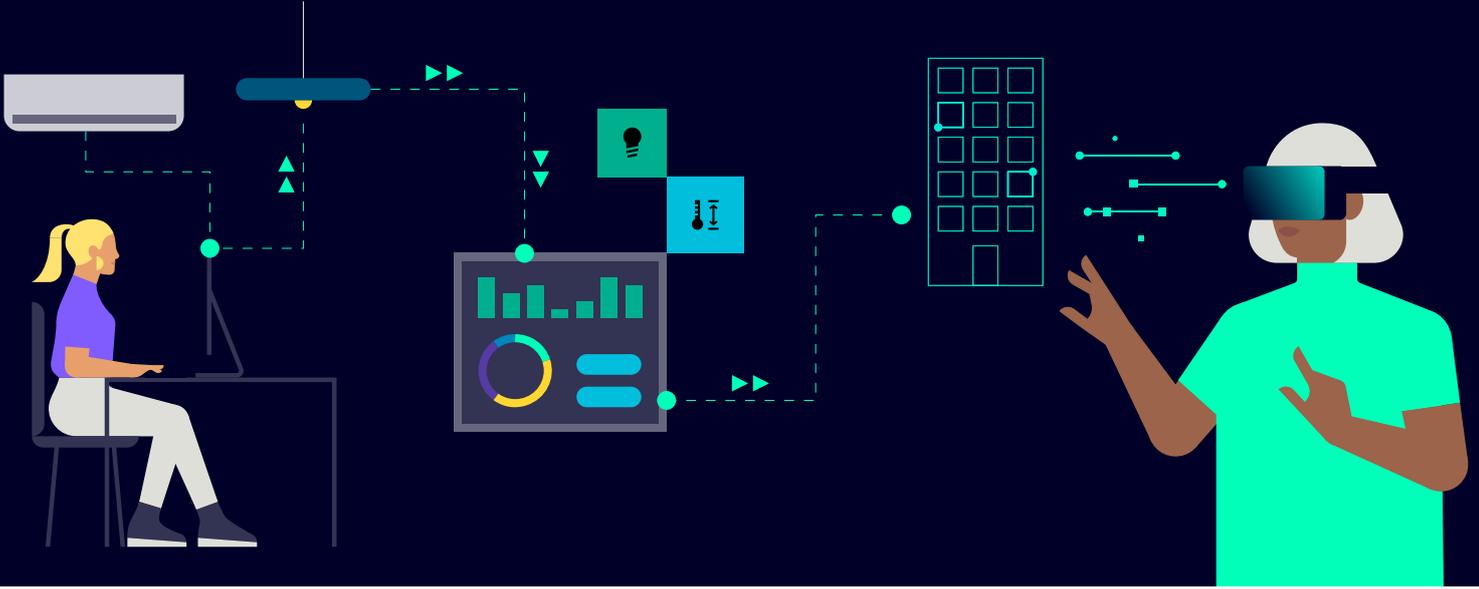
**The benefit:** Autonomous buildings will shift operations from reactive to proactive by monitoring and optimizing performance in real time. Predictive diagnostics and AI-driven prioritization reduce manual oversight and unplanned interventions, giving managers clear, ranked actions instead of overwhelming alarms.

With routine tasks automated or pre-prioritized, teams gain back time to focus on root causes, strategic improvements and higher-value work.

**The bottom line:** "Facility managers don't have enough staff and it is increasingly difficult to find talent with the required skillsets and training to operate their spaces. Too frequently, the total cost-saving action conversion rate in buildings sits at 20% or less (leaving many opportunities on the table).

Autonomous buildings help these teams do more with the team they have – ranking issues, prioritizing critical tasks and automating routine fixes – so they can move from constant firefighting to long-term strategy unique to their own business needs, for example their focus as hospitals, labs or data centers."

**Ben Crowe, Global Head of Product Management for the Digital Service Innovation team at Siemens Smart Infrastructure.**



## Human + Machine: A virtuous cycle of learning

The beauty of autonomous buildings is that they create a virtuous cycle of learning by using vast amounts of data – humans learn from machines and machines learn from humans, continuously pushing each other forward to optimize building operations.

Take the example of service teams and technicians. Autonomy provides better diagnostics, clearer system data and fewer on-site surprises. Many issues can be identified and fixed remotely, reducing unnecessary travel and downtime. And when technicians do need to go to a site, they arrive better prepared – with the right tools and parts – for efficient, planned interventions rather than reactive firefighting.

This is where symbiosis comes in. Humans benefit from machine intelligence that ranks tasks, predicts failures and provides actionable insights. In turn, machines benefit from the expertise of the technicians – validating root causes, reprioritizing tasks and adding context that is not available from sensors. Every feedback loop helps the AI self-learn and improve, while technicians and facility managers spend less time on day-to-day firefighting and more time on strategic improvements.

“Only through this positive reinforcement – humans learning from machines and machines learning from humans – can autonomous building technology reach its full potential.”

**Bertrand Goddard, Tech Lead for Siemens Infrastructure Building Service.**

**Case in point:** Autonomous buildings will gather and correlate data across all devices, highlight critical issues and infer root causes. Instead of hours of manual troubleshooting, facility managers get a clear narrative: “Airflow in room 512 has dropped, likely due to a clogged filter; last time, replacing it fixed the issue.”

The AI handles initial diagnostics, which can then be confirmed, refined or overridden by the manager, freeing teams to focus on long-term improvements.

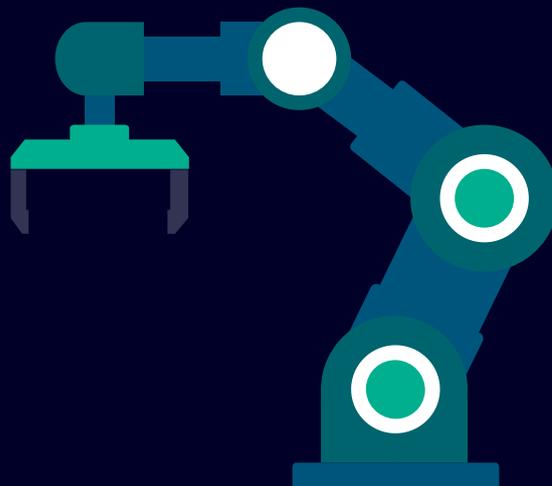
**Case in point:** One facility manager faced endless complaints about hot upper floors and freezing ground floors in an old building with a shared atrium. Rather than constantly adjusting AC settings, AI analysis recommended installing internal windows to prevent unwanted airflow – fixing the root cause and ending the daily firefight.



## Looking ahead: **the role of robotics**

As the autonomous buildings market evolves, robots – including “cobots” – are beginning to enter the conversation. From cleaning and maintenance bots to more advanced humanoids capable of performing manual tasks, robots will increasingly administer the physical on-site work in buildings, shifting day-to-day operations away from staff on the ground and enabling remote oversight by a small number of experts.

This might feel futuristic, but significant investment is accelerating progress. Siemens is already a leader in the code design and programming of robotics applications in industrial manufacturing. Our view is clear: these technologies should augment, serve and support humans, not replace them.



# I'm a sustainability lead. Will autonomous buildings really make a difference in the race to net zero?

**The challenge:** Meeting ambitious sustainability targets and stringent regulatory requirements, while facing pressure from investors, customers and employees to accelerate climate action – often with limited tools, fragmented data and constrained resources.

**The benefit:** Autonomous buildings will turn sustainability ambition into measurable action. They automate energy and resource optimization, streamline sustainability reporting and – when integrated with the grid – enable buildings to draw cleaner, cheaper energy while supporting wider grid stability.

This shifts sustainability from a manual, compliance-driven task into an automated, continuous process in real time, making it easier to cut emissions, hit net zero targets and demonstrate verifiable progress in real time.

**The bottom line:** Technology is no longer optional in the race to decarbonize. The most recent Siemens Infrastructure Transition Monitor shows it's essential, with 61% saying technological breakthroughs are needed to stop global warming and AI coming through as the most impactful technology to achieve decarbonization.

Autonomous buildings give sustainability leaders the digital foundation they need to achieve net zero faster and more effectively. And the best news is they also cut energy costs by optimizing when and how energy is used, including drawing cleaner, cheaper power from the grid.



Infrastructure Transition Monitor (ITM) 2025 by Siemens Smart Infrastructure



# My company operates out of an autonomous building. How much difference will it make to my working life?

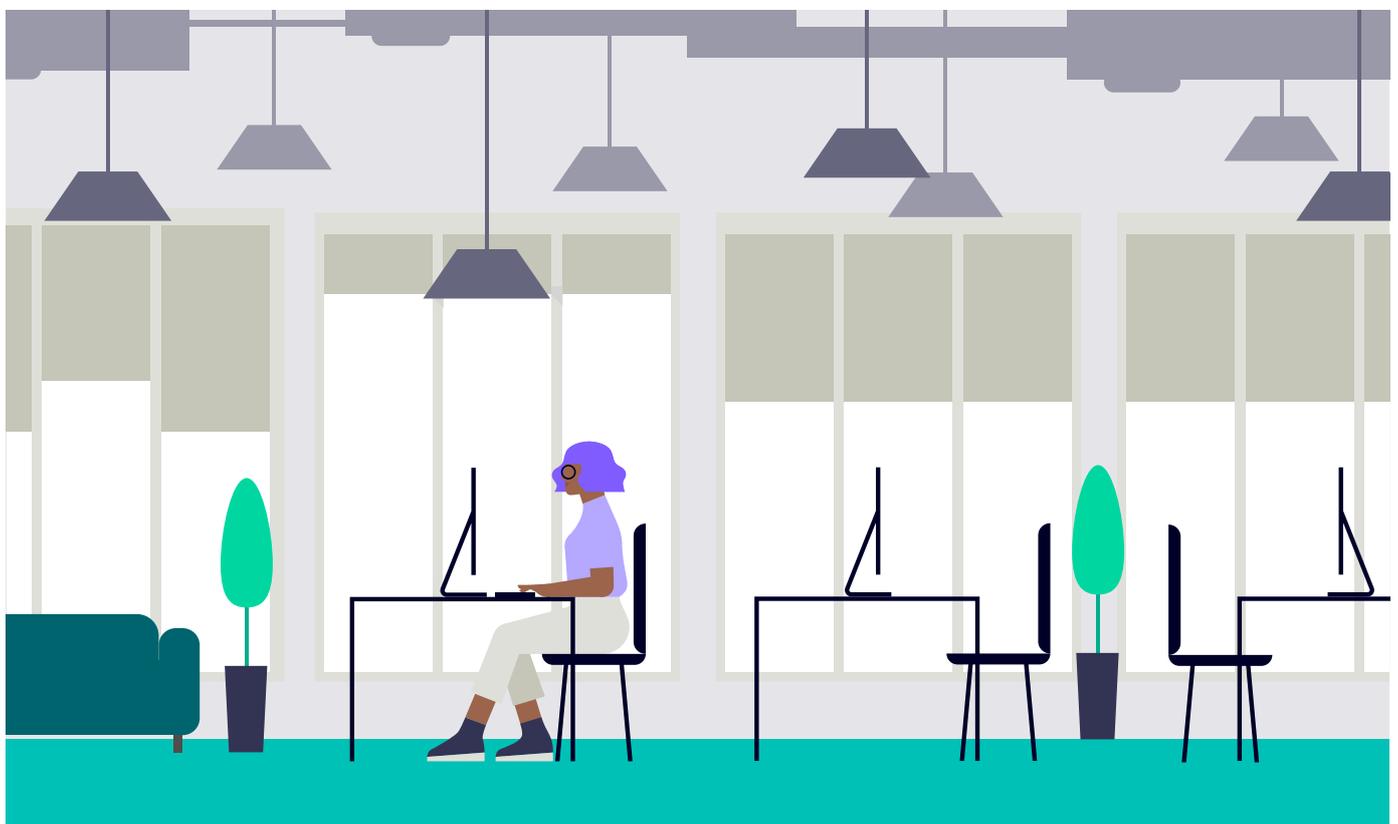
**The challenge:** Poor environmental conditions, inconsistent comfort and lack of personalization in conventional buildings often lead to distraction, fatigue, and frustration – with limited options for occupants to intervene or improve their environment. Responses to security issues are also limited – there aren't enough people to distinguish false from real alarms or to staff cameras in real time.

**The benefit:** Autonomous systems will continuously respond to real-time needs, optimizing air quality, lighting, thermal comfort, safety and people flow, even during emergencies. They quietly learn occupants' habits and preferences to deliver healthier, more personalized and seamless comfort, striking the right balance between user control and automated optimization. The result: improved wellbeing and safety, greater focus and better overall performance.

**The bottom line:** "Siemens' Comfort AI application – part of the cloud-based Building X platform – adds an average of 6.5% energy savings on top of the 30% achievable through automation, data aggregation and analytics.<sup>1</sup> Leveraging proprietary AI and model predictive control algorithms, it continuously optimizes indoor comfort and energy performance across building portfolios without manual intervention.

The shift to autonomous buildings isn't just a sustainability milestone – it's a smarter, faster, more efficient way to operate, freeing operational teams from routine adjustments to focus on delivering the best possible environment for occupants while improving performance across the board."

**Susanne Seitz, CEO, Siemens Smart Infrastructure Buildings**



4. How AI is powering a new era of energy-optimised, autonomous buildings, 2025. [www.pbctoday.co.uk/news/digital-construction-news/construction-technology-news/how-ai-powering-new-era-of-energy-optimised-autonomous-buildings/153778/](http://www.pbctoday.co.uk/news/digital-construction-news/construction-technology-news/how-ai-powering-new-era-of-energy-optimised-autonomous-buildings/153778/) [accessed 23 October 2025].



# The future of building security

When it comes to security, there are only so many screens a guard can monitor. That means that cameras are often used retrospectively, to understand what happened after an incident and, hopefully, avoid repeats in the future.

In an autonomous building, that would change completely. “AI would shift security from a retrospective to a live event,” says Alexander Rohweder, Head of Building Security Business at Siemens. “The camera is a building’s most powerful sensor. What AI could do is look at 100 cameras, prioritize what matters and show the guard: ‘this is something you should really look at.’” To ensure issues are addressed immediately, the system could also alert the police, close doors or trigger alarms.

Much of the value of AI-enhanced security will come from the system’s ability to sift through the vast amounts of data security systems generate.

“AI will help make sense of the flood of alarms – whether from video, access control or intrusion systems,” Rohweder explains. “It will filter out the noise, identify what’s real and highlight the issues that need urgent attention.”

In an emergency, AI could validate what the issue is and recommend evacuation routes, which areas to cordon off and when to alert the authorities. The key will be striking the right balance between automation and human oversight.

“AI can analyze data from cameras and sensors to recommend the safest actions, but because some of those recommendations carry real risks, it should remain a support tool rather than making the final call,” Rohweder emphasizes. “The system will provide guidance, while humans will need to retain ultimate responsibility for the decision making.”

# Where are we now and what's stopping us?

At Siemens, our digital transformation spectrum spans from traditional buildings – where most systems operate in silos and processes are manual – to autonomous ones that use AI to continuously learn and adapt, working symbiotically with their occupants to optimize comfort, efficiency and performance. But the reality is that the vast majority of buildings still sit at step one.

According to industry estimates, only one in eight buildings has a building management system (BMS), with most facilities managers still working in a reactive rather than a proactive way. Even among buildings with a BMS, adoption of digital platforms like Building X is still limited. According to the Siemens Infrastructure Transition Monitor 2025, although organizations were making significant progress on adoption of digital technologies, the least progress was being made on building collaborative digital ecosystems.

When a digital system like Building X is adopted, it's often for isolated use cases such as energy monitoring or visitor access.

Most buildings rely on a patchwork of disconnected systems that aren't fully integrated, making it difficult to get a coherent, real-time view of building performance, which is essential to progress to true autonomy.

This is made harder by the fact that there is no one-size-fits-all solution for every building, or even type of building.

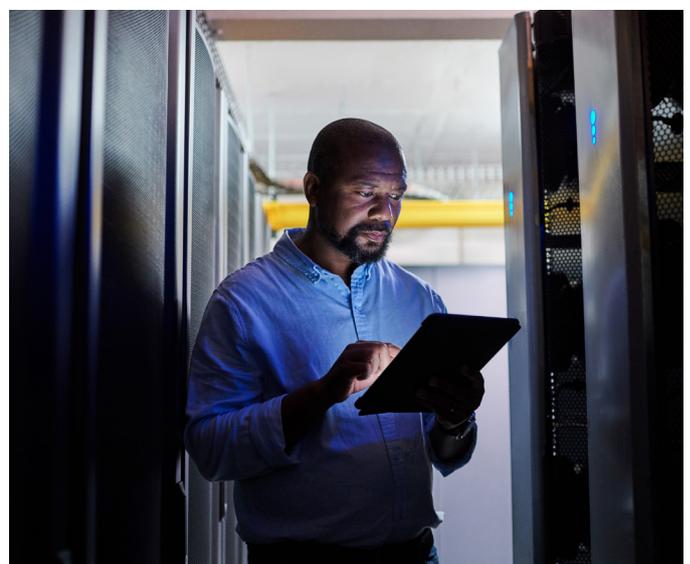
**"Every building is a prototype. With a car, you have a standard model with a clear interface – you know what you're getting and how it will behave, apart from the driver. But every building is different; no two are ever the same, and that's a big challenge."**

explains Andre Muff, Global Head of Technology and Innovation at Siemens.

## Perceived threat of AI

Another key barrier to adoption is the fear that AI will replace staff. "Some customers see it as a threat to their jobs. In reality, it's the opposite. Even with the option to fully automate decisions using agentic AI – letting systems act independently – most customers prefer to maintain advanced supervisory control, keeping their finger on the pulse and approving actions before they're taken," says Richard Dasugo, Vice President of Digital Service Innovation at Siemens.

AI can define what is important, but a human must validate decisions. Meanwhile, for physical interventions, human action is still required – for example if hardware needs to be replaced. As Toni Neal, Head of Service at Siemens Smart Infrastructure, emphasizes, "Our solutions are there to make their jobs easier, not replace them. We're helping them do their jobs better with the resources they have."





## Changing the **cybersecurity equation**

Cybersecurity risks are another big challenge – and understandably so. Achieving autonomy means involving both OT and IT, and that changes the cybersecurity equation entirely. It's no longer just about securing traditional building systems; it's about protecting interconnected networks, AI-driven decision engines and data flows in real time. This came through strongly in the ITM survey, with 34% expressing concern about potential vulnerabilities.

At Siemens, cybersecurity is not an add-on – it is not only designed into every technology and process, and aligned with global standards and certifications, it's baked into the autonomous building offering itself.

"Inside the building, we've had secure device-to-cloud connections in place for years – it's already a very secure technical system, even before the advent of autonomous buildings," explains Bertrand Goddard, Tech Lead for Siemens Infrastructure Building Service.

"Now we're adding new systems that scan customer networks to detect insecure devices. So, along with faults like a misconfigured heating system or a blurry security camera, we can also flag outdated devices and firmware vulnerabilities. It's part of our autonomous building offering to deliver even better security."



## **Openness** must be the baseline for autonomy

Fear of vendor lock-in is also a common barrier – the worry that adopting autonomous building technology will mean losing the ability to manage or modify systems independently. The reality is that openness and interoperability must be baseline principles for any autonomous building. No single vendor can, or should, do it all. Instead, the focus must be on creating flexible, scalable solutions that allow customers to integrate the best tools for their needs without being locked into one path.

Siemens' customers and partners have access to documentation, training and support if they want to develop integrations or even write their own applications, an offer that will be improved over time, incorporating customer feedback.



University of East London

**59%** of survey respondents said that the benefits of an autonomous buildings outweigh the costs

**54%** say they are ready for autonomous buildings

Infrastructure Transition Monitor (ITM) 2025 by Siemens Smart Infrastructure

## Early adopters – the beginning of a fundamental shift

Despite the barriers, we are starting to see a step change occur. According to the Siemens Infrastructure Transition Monitor 2025, respondents knew the risks and benefits of autonomous technologies, including cybersecurity, and were overwhelmingly in favor of adopting it.

59% said that the benefits of autonomous buildings – including its potential to reduce operating costs, increase energy efficiency and better respond to anomalies – outweighed the costs, with 54% saying their organization is ready for autonomous buildings.

Even with limited adoption, we are seeing striking figures come through.

Just look at **the University of East London**.

Although it's far from an autonomous campus at this point, the university is seeing enormous energy and cost savings due to a thoughtful and integrated approach to energy management.

This has involved integrating data from IoT sensors installed across operations into Siemens' Building X platform to create a unified view of energy use.

The implementation of Siemens Building X allows the campus to continuously monitor, analyze and adjust energy use based on occupancy and real-time conditions, contributing to:

- **Over £500,000 in annual utility savings**
- **Enhancing comfort and responsiveness across campus spaces**
- **A 470-tonne reduction in carbon emissions in just the first year of the net-zero strategy**

And moving ahead, there's growing potential in integrating space, energy and timetabling systems to optimize how spaces are used – not just for efficiency, but to enhance the overall campus experience. Going further, linking with Student Information Systems or Learning Management Systems can offer even deeper insights into how people interact with the campus environment.



Southern Methodist University (SMU) in Texas

Due to rapidly reducing onboarding time to systems like Building X, other universities – and businesses across other sectors – can now meet their goals even faster. Take **Southern Methodist University (SMU) in Texas**, for example. Onboarding an energy management system used to be a slow, manual process, with someone having to sit and tag each asset by hand. And with more than 65,000 individual data points – covering everything from HVAC units and lighting systems to smart meters and occupancy sensors – the potential insights were huge, but so was the workload.

Now AI has started to handle the heavy lifting: automatically tagging assets, with engineers only stepping in for quality assurance. This single improvement has cut onboarding time by around 70%, significantly accelerating the point at which universities can start realizing efficiency and sustainability savings.

**In the pharma sector**, the predictive maintenance use case is a key driver. Companies that have adopted predictive maintenance are reporting dramatic improvements: up to 85% better downtime forecasting, 50% fewer unplanned outages and maintenance cost reductions of up to 40%.<sup>5</sup>

Take fume hoods, critical to both safety and energy efficiency yet often unmonitored between maintenance checks. Without real-time visibility, they may run outside compliance parameters or remain open when unused, driving up energy costs and operational risk.

Advanced platforms now provide early alerts – for instance, if sashes are left open too frequently – enabling managers to prioritize high-impact fixes based on energy-saving potential.

The integration of AI with remote diagnostics capabilities represents another leap forward in reimagining pharmaceutical infrastructure management. Where traditional remote monitoring provides data, AI-powered systems provide insight and action.

For example, when a frequency drive error occurred at a pharmaceutical manufacturing facility, the AI system didn't just detect the fault – it immediately analyzed the error pattern against thousands of similar incidents, predicted the most likely failure mode and recommended the specific replacement part before a human technician even looked at the alert.

The AI system guided a field service engineer through remote diagnosis, providing not just historical data but intelligent analysis. This approach doesn't just save time – it transforms decision-making from reactive guesswork to intelligent, data-driven precision. The system learned from this incident, making future predictions even more accurate.

Single improvement has  
reduced onboarding time by

**70%**

5. The Strategic Role of Predictive Maintenance in the Pharma Industry, 2024. [www.resources.sw.siemens.com/en-US/white-paper-strategic-role-predictive-maintenance-pharma-industry/](http://www.resources.sw.siemens.com/en-US/white-paper-strategic-role-predictive-maintenance-pharma-industry/) [accessed 23 October 2025].

## Embracing autonomy for the human-centric buildings of the future

To accelerate adoption, the industry needs clearer evidence of ROI. Even with limited use cases, we are already starting to see it, with early adopters reporting significant gains in operational efficiency.

But full ROI calculations require broader deployment and time to measure long-term value. The early signs are promising – autonomous capabilities can deliver huge efficiencies – but widespread acceptance will depend on building trust and demonstrating clear, tangible returns on investment.

What's clear is that autonomy is no longer a future vision. It's a practical response to today's most pressing challenges – and a path to long-term, people-centered value creation. And customers are ready for it.

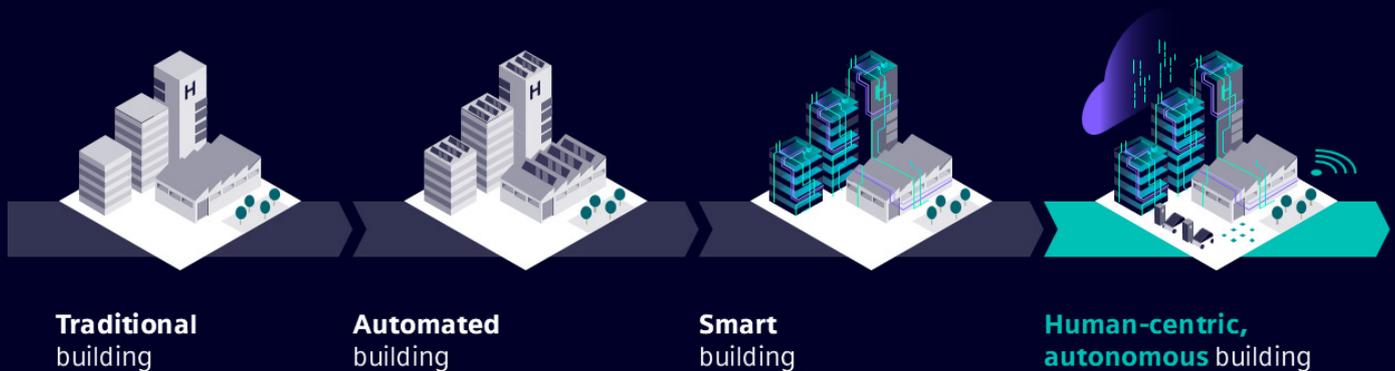
“Back in 2019, the resistance we got to using the term ‘autonomous building’ was so strong we had to rename the project ‘Smart Building Intelligence’ – most people laughed at the idea and thought it would never be possible,” Dasugo recalls. “Now the market is embracing it.”

There is a growing recognition that rather than removing people from the picture, autonomous buildings empower them with smarter tools, more comfortable and productive environments and longer-term value. The future isn't one to fear – but it is one to prepare for. Those who wait risk being left behind.



# Our vision for the future

## The human-centric, autonomous building



# Roadmap to autonomous buildings

As no building is the same and different sectors have different immediate priorities, no single journey to an autonomous building will look exactly alike. How far an organization gets on the journey will also depend on many factors – including business objectives, budget and the level of coordination across the business and with technology partners. However, every journey must start with an open, frank and collaborative discussion about outcomes.

- *What's the mission of your building or facility?*
- *What are your KPIs to ensure you meet those objectives?*
- *Which KPIs can you impact today?*
- *How will you know when you have been successful?*

**Then the real work can begin.**

## Step 1: Establish basic digital connectivity

- Identify key use cases, whether that's energy management, predictive maintenance or security.
- Connect necessary systems and IoT devices either locally or to a cloud-based platform like Building X to enable those use cases.

**Early implementation of impactful use cases is a crucial first step to demonstrate the ROI of smart, connected systems and establish the groundwork for autonomy.**

## Step 2: Broaden system integration

- Build a solid data-management backbone by curating and contextualizing information through Retrieval-Augmented Generation (RAG) frameworks and Model Context Protocol (MCP) servers, ensuring future AI models are trained on structured, meaningful data rather than raw telemetry.
- Expand connectivity across IT and OT environments to gain full visibility into building performance – bridging protocols like Matter and Zigbee, connecting MCP with GenAI-based systems, and breaking down silos between FM, IT, energy and occupant-facing teams to align goals and data access.

**By prioritizing structured data and interoperability across systems, you lay the foundation for meaningful AI and automation powered by real-time, reliable insights.**

### Step 3: Start wider data collection and monitoring

- Start continuously collecting and storing equipment and system performance data across the building and outside it, such as weather conditions, incoming traffic, as well as energy and water supply.
- In parallel, begin capturing detailed records of human decisions – tracking specific actions taken by operators in response to issues, not just generic outcomes like “problem fixed”.

**You can then use data to establish performance baselines and monitor for deviations from expected behavior, enabling more accurate diagnostics and future automation.**

### Step 4: Implement predictive models

- Use Siemens’ pre-trained AI models – or develop custom models trained on specific building subsystems – to detect early signs of performance degradation, energy inefficiencies or potential faults before they escalate.
- To support this, data lake access is being introduced, enabling large-scale data analysis and more robust model training across multiple assets, systems and sites.

**By deploying targeted AI models and enabling large-scale data analysis through data lake access, you unlock early detection of inefficiencies and accelerate the shift from reactive to predictive operations.**

### Step 5: Enable predictive functions

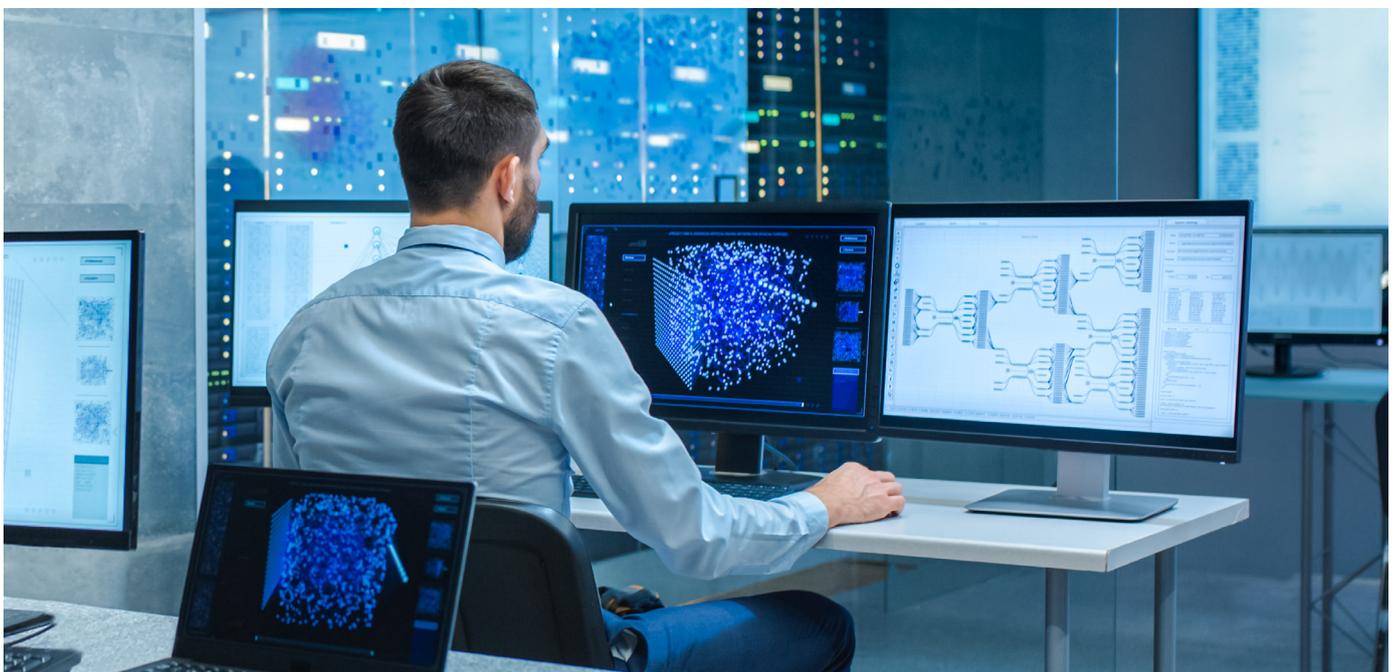
- Use data-driven models to anticipate issues and opportunities before they arise – for example, to detect early signs of equipment degradation or inefficiencies, or to predict energy demand based on patterns like occupancy and weather. These insights can then be surfaced through dashboards or real-time alerts when performance thresholds are exceeded.
- Build trust in AI outputs by gradually integrating foundational AI/ML tools across domains. Gather detailed human operator feedback on model performance to continuously refine predictions and pave the way for safe, confident progression toward automation.

**By applying predictive models and validating them through human feedback, you create a trusted, insight-driven environment that reduces risk and readies the organization for automated decision-making.**

### Step 6: Introduce agentic AI

- Implement event process orchestration to connect real-time signals with coordinated, cross-system workflows.
- This enables AI agents to trigger actions like system reconfigurations, SLA updates or technician assignments.

**By enabling AI systems to act autonomously in defined domains, such as cycling valves or recalibrating sensors, you set the scene for wider autonomy, always leaving the option open for a human operator to intervene.**



## Step 7: Enable prescriptive functions

- Use prescriptive services powered by integrated IT/OT systems to generate actionable, data-informed recommendations – evaluated against cost, resource availability, occupant impact and past learnings – to prioritize and trigger the right response.
- Coordinate intelligent actions such as load shifting, equipment adjustments and technician dispatch through a mix of human teams, agentic AI and hybrid models, all guided by real-time, context-rich data.

**A continuous feedback loop – incorporating customer input, system performance and process data – drives ongoing optimization and better decision-making over time.**

## Step 8: Human-AI collaboration

- Introduce natural-language interfaces, powered by generative and agentic AI, allowing users to interact with the building via voice or text.
- These agents can autonomously diagnose issues, generate service tickets and resolve faults, all while maintaining transparency, safety and traceability.

**It is crucial to always keep a human-in-the-loop, with manual override options and a strong focus on user comfort and control.**

## Step 9: Continuous optimization and scaling

- Use performance data to train better models and scale across portfolios via standardized processes.
- Extend autonomy to the design and construction phases of future buildings using automated design tools.

**By continuously optimizing models and scaling proven processes across portfolios – and applying autonomy from design through operation – you multiply efficiency gains, accelerate ROI and unlock long-term value at enterprise scale.**

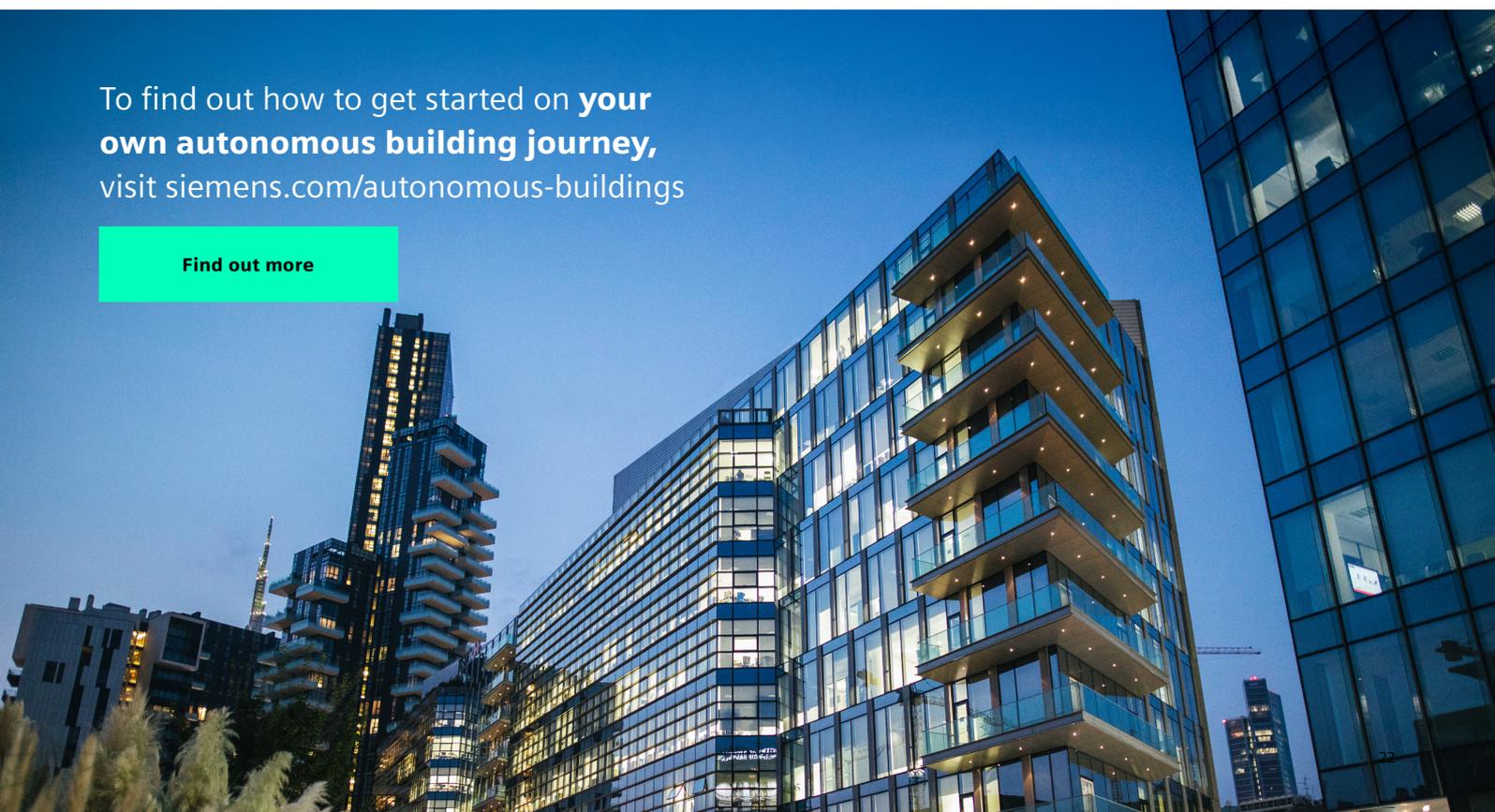
## Step 10: Prepare for ecosystem integration

- Consider long-term interactions with external systems like the energy grid, which would allow buildings to respond dynamically to external signals – such as real-time pricing, demand-response events or renewable energy availability.
- To support this, infrastructure must be designed with built-in flexibility, including interoperable systems and digital interfaces capable of adapting to evolving regulations, technologies and energy market structures.

**By embedding flexibility and grid connectivity into your building strategy, you future-proof investments, unlock new revenue streams and ensure alignment with evolving net-zero and decarbonization goals.**

To find out how to get started on **your own autonomous building journey**, visit [siemens.com/autonomous-buildings](https://www.siemens.com/autonomous-buildings)

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