Smarter Buildings, Smarter Savings: Harnessing AI for Building Management

Andrew Volent, Guidehouse
Scott Vangilder, DTE Energy

ABSTRACT

Artificial intelligence is rapidly changing how commercial buildings are managed, opening new pathways to energy savings, operational efficiency, and building energy waste reduction. This paper examines the practical applications of AI-driven building automation, drawing on recent pilots and industry deployments to highlight best practices and lessons learned.

We will focus on three core areas: (1) Predictive Control and Occupancy Optimization: AI-enabled systems use advanced occupancy sensing and analytics to dynamically adjust heating, cooling, and ventilation. By learning occupant patterns and building behavior, these platforms deliver targeted energy savings while maintaining comfort. Recent pilots in large commercial buildings have shown that combining AI with granular occupancy data enables room-level conditioning and measurable energy savings. (2) Continuous Commissioning and Issue Detection: Modern AI platforms provide ongoing optimization and oversight, identifying operational anomalies and fine-tuning equipment in real time. This continuous approach reduces wasted energy and improves reliability, supporting building performance with minimal disruption. (3) Grid-Interactive Buildings: AI-driven automation is enabling buildings to respond to grid signals, supporting load flexibility and resilience. Many solutions can be integrated as software overlays with existing building management systems, allowing for adoption without major capital investment or risks to building system performance.

Key Takeaways are that : AI-driven automation unlocks deeper energy savings and operational control down to the room-level; Occupancy-based and predictive strategies enhance building responsiveness and efficiency, while maintaining system reliability; Easy to implement software-overlays are making grid-interactive, smart buildings achievable at scale while reducing risk to building system operations or reliability. Artificial intelligence is no longer a future promise; recent pilots and case studies are delivering measurable results in commercial buildings today. This session will provide actionable insights for building owners, operators, and program designers, including discussion of recent pilot projects and transferable lessons from real-world applications.

I. Introduction

Artificial intelligence is rapidly changing how commercial buildings are managed, opening new pathways to energy savings, operational efficiency, and building energy waste reduction. This research examines the practical applications of AI-driven building automation, drawing on recent case studies and industry deployments to highlight existing technology and lessons learned.

Predictive Control and Occupancy Optimization:

AI-enabled systems use advanced occupancy sensing and analytics to dynamically adjust heating, cooling, and ventilation. By learning occupant patterns and building behavior, these platforms deliver targeted energy savings while maintaining comfort. Recent pilots have shown that combining AI with occupancy data enables room-level conditioning and measurable energy savings.

Continuous Issue Detection:

Modern AI platforms provide ongoing optimization and oversight, identifying operational anomalies and fine-tuning equipment in real time. This continuous approach reduces wasted energy and improves reliability, supporting building performance with minimal disruption.

Key Takeaways:

- AI-driven automation unlocks deeper energy savings and operational control down to the room-level.
- Occupancy-based strategies enhance building responsiveness and efficiency, while maintaining reliability.
- Easy to implement software-overlays are making grid-interactive, smart buildings achievable at scale while reducing risk to building system operations or reliability.

Artificial intelligence is no longer a future promise; recent pilots and case studies are delivering measurable results in commercial buildings today. This session will provide actionable insights for building owners, operators, and program designers, including discussion of recent pilot projects and transferable lessons from real-world applications.

The Saturation of Traditional Building Energy Efficiency Interventions

For decades, existing utility building energy efficiency programs relied on interventions such as direct hardware retrofits, to meet regulated energy savings targets. Some interventions such as LED lighting have reached a point of near saturation and utilities are scrambling to find defensible and reliable alternatives to meet increasing energy waste reduction goals.

This research examines a transformative solution to this challenge, technology with the potential to save large buildings more than 10% of total annual energy usage through modifying room heating and cooling loads with high accuracy using a smart damper and zone system. AI-driven or smart software overlays that enable occupant centric micro-zone control of HVAC systems and ventilation system dampers. By leveraging machine learning and granular, room-level sensing, this technology allows for the minute adjustment of HVAC setpoints and airflow in real-time, moving beyond the limitations of schedule based systems. This technology is especially useful in large Commercial buildings such as office, hospital, primary and secondary education, university, and retail.

AI driven software overlays provide a high return on investment pathway to room level efficiency and grid resilience. Unlike traditional mechanical retrofits, these solutions can often be integrated into existing Building Management Systems (BMS) with minimal capital expenditure.

The following analysis explores the technology, applied case studies, and:

- The Strategic Efficiency Shift: Moving from hardware saturated markets to algorithmic intelligence led software overlays.
- Technological Components: Identifying the key pieces to an AI enabled building management system.
- Measure Level Performance: Empirical evidence from case studies in education, retail, and data center facilities.
- Benefits and Challenges: Analysis of the trends in utility program and customer benefits and challenges across each case study.

By synthesizing these findings, this paper demonstrates how AI enabled controls can serve as a cornerstone for the next generation of utility energy efficiency portfolios, delivering the defensible savings required to navigate the coming decade of grid volatility.

II. Technology Overview

To better understand the potential impacts of this technology, along with the costs and benefits to both customers and utility programs, it is important to first understand the major components of the BAS system and the role each plays. This technology is most useful for buildings that already have well integrated BAS systems and HVAC control schemes such as systems with VAV controls. At a high level, these systems represent a more advanced and granular method for controlling ventilation and conditioning in commercial or industrial building spaces. Rather than relying on static schedules or large HVAC zones, the technology adjusts system operation based on real time information about how spaces are actually being used. Table 1 below includes a summary of this technology at the component level;

Table 1: Overview of AI enabled Smart Building System Technologies

Layer	Technology	Role
Sensing layer	Occupancy + environmental sensors	Detect space usage and conditions
Control layer	Smart dampers + actuators	Physically regulate airflow at the distribution level
Optimization layer	AI / machine learning software	Predict demand and control HVAC dynamically

Control Strategy and System Operation

Rather than relying on simple binary occupancy signals (occupied/unoccupied), the technology uses a more advanced control approach to continuously regulate airflow and temperature at the room level. The system can be broadly described as operating similar to an intelligent proportional–integral–derivative (PID) control framework. Using real-time feedback from a Wi-Fi enabled distributed sensor network, the algorithm maintains indoor temperature and ventilation within a defined comfort band while minimizing unnecessary energy use. The control system relies on high-resolution environmental and occupancy data collected throughout the building. These inputs allow the algorithm to dynamically adjust airflow and conditioning based on actual space utilization rather than static schedules.

Key inputs monitored by the sensor network include:

- Indoor air temperature
- Networked lighting controls and vacancy/occupancy controls
- Indoor air quality indicators
- CO2 concentration levels
- Wi-Fi or Bluetooth enabled device presence

These inputs are continuously analyzed to estimate room level occupancy and environmental conditions.

Temperature and occupancy or vacancy control monitoring are typically the most cost-effective inputs and can deliver meaningful energy savings on their own. More advanced IAQ sensing which is common in medical or high-performance buildings can further refine occupancy detection but comes with higher installation and integration costs. As a result, many retrofits rely on existing thermostats and vacancy or occupancy control sensors, though additional temperature sensors may still be needed to improve room level control.

Despite its advantages, this technology introduces several implementation challenges. The deployment of a high-resolution sensor network and micro-zone control system can significantly increase project scope and upfront costs. Existing HVAC infrastructure may require substantial modification, including the installation of motorized dampers that must be wired for power and integrated with control systems. Similarly, distributed sensors must be installed throughout the building, each requiring power and reliable wireless connectivity to function effectively. These requirements can make retrofits more complex and financially prohibitive, particularly in older buildings with limited existing controls infrastructure.

However, these limitations are less pronounced in new construction projects, where building systems can be designed from the outset to accommodate advanced control strategies. In these cases, integrating sensor networks, communication systems, and controllable dampers during the design phase can significantly reduce incremental costs and enable more seamless adoption of AI-driven building management technologies.

Physical Control of Airflow

The algorithm converts these control decisions into physical system adjustments through a network of actuated dampers installed in the HVAC air distribution system. These dampers communicate with the Building Management System (BMS) through standard building automation protocol. Rather than operating in simple open/closed states, the system adjusts dampers incrementally on a zone by zone level. This incremental control allows the system to maintain stable static pressure and airflow while directing conditioned air only to spaces with active demand.

This approach effectively creates micro-zoning within the building, allowing individual rooms or small groups of rooms to receive customized ventilation and conditioning.

Predictive Optimization

In addition to responding to real time conditions, the system uses learning techniques to identify longer term patterns in building usage. Over time, the algorithm learns nonlinear occupancy patterns that may not be visible to building operators.

For example:

- If a conference room is consistently unoccupied on Friday afternoons, the system may automatically transition the space into a Standby State.
- During standby operation, temperature setpoints are relaxed to reduce HVAC energy use.
- The system remains ready to rapidly cool or heat the space if sensors detect unexpected occupancy.

III. Empirical Case Studies

CalNEXT Pilot

The CalNEXT pilot in Southern California Edison's territory evaluated AI driven, occupant-centric micro zone HVAC controls in two commercial buildings. The retrofit targeted persistent pre-existing comfort issues, such as uneven heating and inadequate airflow, while measuring potential reductions in HVAC electricity consumption.

The technology utilizes a distributed sensor network to monitor real-time space conditions and occupancy patterns. These data points feed an AI algorithm that dynamically adjusts micro-zone airflow and temperature deadbands through the existing Building

Management System (BMS) and newly installed actuated dampers. Performance was verified using IPMVP Option B (Retrofit Isolation), comparing alternating baseline and technology-enabled periods with high-resolution, one-minute interval data (Occupant Centric Micro Zone Control for Commercial Buildings). The descriptions and summary table 2 below describe the characteristics of the buildings in this case study.

Building Characteristics
Building 1 was a university facility where micro-zone controls were integrated with an existing variable-air-volume (VAV) system. The building already contained 34 VAV boxes, allowing the technology to leverage existing zoning infrastructure while deploying additional sensors and software integration.

Building 2 was a small office building originally served by a single-zone packaged rooftop unit. In this case, the pilot introduced micro-zone control by subdividing the building into nine micro-zones, each equipped with sensors and airflow control devices (Occupant Centric Micro Zone Control for Commercial Buildings).

Table 2. Summary of Building Characteristics in CalNEXT Pilot

	Building 1	Building 2
Building Type	University	Small office
Space Types	Classroom, lecture hall, corridors, offices	Offices, conference rooms
Conditioned Floor Area	~18,000 sq-ft	~4,000 sq-ft
HVAC System	VAV distribution system with two rooftop heat pumps (25-ton and 12.5-ton)	Constant-volume rooftop unit
HVAC Manufacturer	CaptiveAire	Rheem
System Capacity	37.5 tons combined	5 tons
Climate Zone	California Climate Zone 8	California Climate Zone 8

Source: Occupant Centric Micro Zone Control for Commercial Buildings

The technology deployed in the pilot divides traditional HVAC zones into smaller micro-zones, each monitored by sensors measuring temperature, air quality, and occupancy.

Key System Components
This localized control is achieved through an integrated stack of sensing, actuation, and logic technologies.

The key system components enabling this high-resolution environment include:

- Environmental sensors measuring temperature, humidity, CO_2, particulate matter, and VOC levels
- Occupancy detection sensors using infrared, light, sound, and wireless device signals
- Smart dampers capable of modulating airflow to individual micro-zones

- AI-based control algorithms that predict occupancy patterns and dynamically adjust HVAC operation
- Integration with the building management system (BMS) via standard control protocols

The control system operates using three occupancy states:

- Occupied – HVAC operates normally to maintain comfort
- Standby – temperature deadbands expand slightly when occupancy temporarily disappears
- Unoccupied – airflow and conditioning are reduced to minimize energy consumption

The system can operate in several control modes, including:

- Comfort mode – prioritizes thermal comfort
- Balance mode – balances comfort and energy savings
- Energy savings mode – maximizes reductions in HVAC operation

Due to comfort constraints at the test sites, the pilot primarily evaluated comfort mode and balance mode, with energy-savings mode not deployed during testing.

CalNEXT Results and Successes

Both sites demonstrated measurable reductions in electricity consumption when micro-zone controls were enabled.
The pilot estimated annual energy savings using regression modeling based on field measurements and representative weather data for California Climate Zone 8. The table below summarizes the results of the study.

Table 3. Estimated Annual Total Building Electricity Savings from Micro-Zone Controls

Site	Baseline Electricity Use (kWh)	Post-Retrofit Electricity Use (kWh)	Annual Savings (kWh)	Percent Savings
Site 1 – University Building	108,124	68,859	39,265	38%
Site 2 – Small Office	5,216	4,773	443	9%

Source: Occupant Centric Micro Zone Control for Commercial Buildings

Unlike traditional systems operating on fixed schedules, the micro-zone system dynamically adjusted HVAC runtime based on real-time occupancy.

This resulted in:

- Earlier system shutdown when occupancy ended
- Later system start when buildings remained unoccupied
- Reduced operation during low-occupancy periods.
- Consistently resolved prior occupant comfort issues especially in smaller more isolated spaces such as conference rooms and individual office spaces.

The results suggest that micro-zone control technologies represent a promising emerging measure for commercial HVAC efficiency programs, particularly in buildings with highly variable occupancy patterns such as offices, classrooms, and conference spaces (Occupant Centric Micro Zone Control for Commercial Buildings).

KenergyAI Offerings

The following case studies are derived primarily from marketing materials and public case study summaries. Reported savings values should therefore be considered vendor-reported estimates rather than independently verified measurement and verification results such as those used in the CalNEXT pilot.

KenergyAI is a software based artificial intelligence platform that optimizes HVAC system operation through live control of existing building systems. The platform integrates with existing building management systems (BMS) using BACnet communication and leverages occupancy information from networked lighting controls, smart thermostats, and existing occupancy sensors to adjust HVAC operation. KenergyAI functions as a software overlay on existing HVAC control infrastructure, enabling deployment with minimal hardware or software modifications, making this a minimally invasive system for implementing machine learning or AI controls in HVAC systems with existing VAV controls. The system is integrated with common networked lighting controls and IoT devices such as for example, those made by Ecobee and Global Lighting and Controls which allows seamless pairing with common existing brands and systems, reducing the challenge and costs of setting up an independent sensor network.

Through machine learning algorithms, the platform continuously evaluates occupancy patterns, building thermal characteristics, and HVAC performance to optimize temperature setpoints, setbacks, schedules, and equipment runtime. The system also offers live monitoring of HVAC systems and alerts building operators when HVAC setpoints and parameters are outside typical operating schemes. The objective is to reduce HVAC energy consumption and increase system reliability while maintaining occupant comfort and minimizing operational impacts.

KenergyAI reports that the technology can achieve:

- Up to 15% electricity savings (CSUN Lilac Hall case study)
- Up to 35% natural gas savings (CSUN Lilac Hall case study)
- Typical HVAC savings ranging from 10%–30%, depending on building characteristics and operating conditions
- Software is affordable and has a rapid payback period in favorable applications

The KenergyAI platform utilizes machine learning HVAC optimization algorithm that continuously adapts to building occupancy and thermal behavior.

Key system components include:

- Machine learning optimization algorithms
- Integration with existing building management systems (BMS)
- Occupancy driven control using lighting and occupancy sensor data

- Zone level predictive scheduling
- Real time adjustment and monitoring of HVAC setpoints, setbacks, and schedules
- Operator visibility and manual override capabilities

Unlike the micro-zone damper approach evaluated in the CalNEXT occupant-centric controls study, KenergyAI does not create new HVAC zones or install additional physical airflow control devices. Instead, it optimizes operation within existing VAV box zones by leveraging occupancy information and predictive analytics from networked lighting controls to improve control decisions and reduce conditioning of underutilized spaces.
KenergyAI deployments have focused primarily on education and office portfolios using packaged rooftop HVAC units and chillers.

KenergyAI Case Study: CSUN Lilac Hall

California State University Northridge (CSUN) partnered with KenergyAI to reduce HVAC energy consumption and improve operational efficiency within Lilac Hall an educational research facility containing office, laboratory, and meeting room space types. The deployment utilized KenergyAI's software platform to integrate with the building's existing management system and occupancy sensing infrastructure. The platform leveraged existing occupancy information and machine learning algorithms to optimize chiller schedules, setbacks, and temperature control strategies within the building's VAV boxes across 23 months. A summary at a glance appears below in table 4.

Table 4. Summary of KenergyAI Case Study CSUN Lilac Hall Building Characteristics

Organization	Building Type	Deployment Timeline	Building Size	HVAC Equipment
CSUN Lilac Hall	Education/ Large Office/ Laboratory	23 months	~10,000 sq ft/	District Chiller Plant

Source: KenergyAI Case Study CSUN Lilac Hall

The project was designed to continuously learn building occupancy patterns and thermal characteristics, enabling more aggressive setback strategies while maintaining occupant comfort. Through dynamic adjustments of HVAC operation based on actual building usage, the system reduced the conditioning of lightly occupied or unoccupied spaces and improved overall HVAC efficiency. Reported outcomes of the CSUN Lilac Hall case study appear in table 5 below.

Table 5. Reported Outcomes

Metric	Result
Total Building Electricity reduction	15%
Natural gas reduction	35%
Energy cost reduction	$7,017/year per 8,000 sq-ft
Estimated ROI	3 months

Source: Reported by KenergyAI website and case study materials.

The deployment reportedly reduced HVAC runtime and contributed to both energy and natural gas savings. The relative affordability of the system and the ease of implementation yielded a swift 3-month return on investment for the facility demonstrating the affordability of software overlays combining integration with existing networked lighting control systems and thermostats.

DeepMind Datacenter Cooling Pilot

Data centers are among the most energy intensive building types, with cooling systems accounting for a large share of total electricity consumption. To reduce operational energy use and associated carbon emissions, companies such as Google have explored the use of artificial intelligence and reinforcement learning algorithms to optimize cooling system operation. These systems analyze real time building and equipment data to dynamically adjust HVAC setpoints and operating strategies, improving efficiency while maintaining required operating conditions for reliable data center performance.

This study named Controlling Commercial Cooling Systems Using Reinforcement Learning evaluated the use of reinforcement learning (RL) to optimize the operation of commercial building cooling systems, specifically the chiller plant portion of HVAC systems. The RL system functions as a supervisory control layer that recommends real time operational setpoints to the building management system (BMS) to reduce energy consumption while maintaining operational and comfort constraints.

The RL controller was tested in two large commercial buildings and benchmarked against the buildings' existing industry-standard heuristic control strategies (provided by Trane). The system uses historical BMS data and real-time operating conditions to learn control policies that minimize energy consumption while respecting operational constraints such as temperature limits and equipment safety thresholds (Chen, Xiaoyu, et al. "Controlling Commercial Cooling Systems Using Reinforcement Learning.).

Energy Savings Results

Table 6 below details the high level savings summary of the cooling pilot demonstrating notable reductions in overall energy at the building level.

Table 6. Reported Energy Savings

Building Site	Energy Savings
Site 1	~9% reduction in cooling energy use
Site 2	~13% reduction in cooling energy use

Source: Chen, Xiaoyu, et al. "Controlling Commercial Cooling Systems Using Reinforcement Learning.

These savings were achieved while maintaining system operational constraints and acceptable occupant comfort conditions. Given that cooling accounts for the largest share of non-computational loads, even modest reductions in cooling energy use meaningfully decreases total energy consumption in data centers.

Key findings from this pilot include the following:

The reinforcement learning (RL) controller consistently outperformed the existing control strategies used by the building automation systems. The results demonstrate that AI based HVAC control has the potential to improve system efficiency relative to traditional control methods. Additionally, the same RL framework was successfully deployed across two separate commercial buildings, suggesting that this approach can generalize across facilities without requiring highly customized physics-based models for each individual building.

The study also identified several practical challenges associated with implementing reinforcement learning control algorithms in real-world building environments, including:

- Noisy or incomplete sensor data (sensor data contains gaps or large variability of highs and lows)
- Different HVAC operating modes across seasonal conditions
- Multi-timescale system dynamics that complicate control optimization
- Safety and operational constraints requiring the building management system to override AI-generated control actions when necessary

Despite these challenges, the overall results from the pilot demonstrated measurable reductions in cooling energy consumption through continuous monitoring of ventilation rates, temperature conditions, and system performance. The reinforcement learning algorithm dynamically adjusted control setpoints based on real-time system data, enabling more efficient HVAC operation while maintaining acceptable indoor environmental conditions.

IV. Discussion

General Themes Amongst Case Studies

AI or machine learning enabled building management platforms demonstrate remarkable versatility, but the case studies reveal a common thread of high occupancy variability.
The studies targeted several distinct building types that demonstrate a pattern of implementation in large variable occupancy commercial spaces or spaces with precise cooling demand needs such as:

- Educational and University
- Small/Large Office Spaces
- Mass Retail or Big Box Retail
- Assembly
- High Energy Intensity Facilities (i.e. Data Centers)

Technology and Implementation Components

- Physical Micro-Zoning involves installing smart dampers and high-resolution sensors. It physically subdivides a building into smaller "micro-zones," allowing for granular airflow control.
- Sofware overlays such as KenergyAI integrates directly with the existing Building Management System (BMS) or smart thermostats. It optimizes setpoints and runtimes using cloud-based predictive algorithms.

- Reinforcement Learning (RL) shown in the DeepMind study, uses a platform that sits on top of the BMS. It learns the non-linear dynamics of the building to suggest the most efficient chiller settings in real-time.

Opportunities at Scale

The evidence from the case studies suggests this is a dynamic measure that offers recovery of wasted energy in heating and cooling of unoccupied spaces.

- Rapid Scalability: KenergyAI was able to swiftly implement a packaged overlay solution that allowed plug-and-play abilities at low cost to implement HVAC adjustments using the machine learning algorithm.
- Generalizability: The DeepMind RL framework worked across different buildings without needing custom models, proving the AI can learn any structure.
- Defensible Savings: Unlike behavioral programs, these systems provide verifiable, metered data (IPMVP Option B) that utilities can report to regulators.
- Grid Resilience & Load Shaping: By relaxing setpoints in unoccupied zones, these systems naturally reduce peak demand. This helps utilities manage the projected increase in demand from EVs and AI data centers without building new power plants.
- Low Barrier to Entry: Because many of these solutions are "software overlays," utilities can offer them as high-ROI rebates that don't require the customer to perform a rehab of their existing mechanical systems.

Potential Drawback and Costs

While the case studies demonstrate strong potential for energy savings and operational improvements, these systems are not without limitations. In practice, several technical and cost factors can impact their feasibility, particularly when applied to existing buildings. Key considerations include:

- This technology can require significant upfront investment, as motorized dampers, expanded sensor networks, and system integration must often be added to existing buildings or integrated during planning – otherwise packaged solutions that integrate with existing systems are the only low cost alternative.
- Retrofitting can be complex and costly, particularly in buildings without existing zoning infrastructure or sufficient power and connectivity for distributed devices.
- Buildings with simpler HVAC systems or limited occupancy variability may see lower savings, making the investment harder to justify.
- As a result, these systems are generally more cost-effective in larger, high-performance, or new construction buildings where controls and sensors can be integrated during design.
- Software overlays and AI controlled programs installed onto a BMS may be difficult to scale due to public perception and potential for security risks or reliability issues.

V. Conclusions

The transition from the hardware centric era of energy efficiency to an era defined by AI-driven intelligence represents a significant shift in energy and demand reduction management strategies for utility energy eff8icency programs. As traditional measures like LED lighting and high-efficiency motors reach market saturation, AI enabled software overlays offer a critical savings opportunity that is both highly granular and rapidly scalable. By shifting the focus from how efficiently a component runs to how intelligently a system is managed, these technologies recover the massive amounts of energy previously wasted on conditioning empty spaces or maintaining rigid, legacy schedules.

The evidence demonstrates large potential for energy savings, ranging from a 38% reduction in university facility electricity use to double-digit savings across large customer retail portfolios. AI can deliver good return on investment for customers and utility programs with a ROI of around 1-5 years (Occupant Centric Micro Zone Control for Commercial Buildings.) of a major mechanical overhaul with the capital footprint of a software update. Beyond the meter, the secondary benefits of improved occupant comfort and extended equipment life transform energy efficiency opportunities and the potential to attract new customers into existing savings programs. For building owners, this could be the new low-hanging fruit: a way to modernize aging infrastructure without the disruption or costs of a full-scale HVAC replacement.

With domestic energy demand projected to surge due to the dual pressures of electrification and data center expansion, utilities need novel, impactful, and reliable solutions that are verifiable to evaluators and stakeholders. AI driven controls provide exactly this. As we look toward a more volatile grid future, the ability to turn buildings into responsive, intelligent assets is the most promising opportunity to maintain a resilient and affordable energy future.

References

Chen, Xiaoyu, et al. "Controlling Commercial Cooling Systems Using Reinforcement Learning."

"CSUN Lilac Hall." KenergyAI, KenergyAI, https://kenergyai.com/case-study/csun-lilac-hall. Accessed 8 July 2026.

Karasawa, Akane, et al. Occupant Centric Micro Zone Control for Commercial Buildings. CalNext Pilot Program, 29 Oct. 2025.

Landsec. Our Approach to Sustainability. Landsec, https://content.landsec.com/media/lschdqki/our_approach_to_sustainability.pdf.

Lilac Hall Raw Data 2022–2026. Microsoft Excel spreadsheet, n.d.

Lawrence Berkeley National Laboratory, http://eta-publications.lbl.gov/sites/default/files/lbnl-1005775_v2.pdf.

Masanet, Eric, et al. LBNL-1005775 Analysis. Lawrence Berkeley National Laboratory, http://eta-publications.lbl.gov/sites/default/files/lbnl-1005775_v2.pdf.

Shehabi, Arman, et al. United States Data Center Energy Usage Report. Lawrence Berkeley National Laboratory, https://eta.lbl.gov/publications/united-states-data-center-energy.

"University of Michigan-Dearborn." KenergyAI, KenergyAI, https://kenergyai.com/case-study/university-of-michigan-dearborn. Accessed 8 July 2026.

AI Tool Disclosure

- AI-assisted tools used: Co-Pilot, Gemini
- Used for: Research of sources and source gathering, summarizing of documentation and sources, copy editing and wordsmithing, table formatting.
- Extent: drafting sections / citation research / generating tables/figures.
- Human review: The authors reviewed and verified all content, calculations, and citations.