



Advanced Controls Systems: Leveraging AI and Data Analytics to Boost Productivity and Save Money

State-of-the-art advances in building controls mean businesses seeking energy savings and improved automation are upgrading their systems.

How would the perfect building operate?

Systems like HVAC and lighting would be ultra-responsive to real-time data like changes in weather. Machine learning would automate faster, smarter systems that react in real time to operation data and occupancy sensors.¹ Worker productivity and comfort would cascade into higher earnings for the business. Smarter systems would reduce upkeep and repair costs — and energy bills.

Cutting-edge advanced control systems are making this futuristic vision a reality today. The latest evolution in building automation technologies combines complex sets of inputs and the power of AI to fine-tune building performance. These automated controls are more precise than past manual-run options, and even surpass the previous generation of controls solutions from decades past.

By upgrading to advanced controls that combine real-time data with AI, businesses can increase their energy efficiency, improve employee productivity and decrease their energy bills in one fell swoop.

Flexible Schedules Can Cause Waste

Many of the HVAC, lighting, refrigeration and compressed air systems that large businesses rely on daily are designed to operate at full capacity. But the need for such full-throttle operation is infrequent. HVAC systems generally operate at full load during winter and summer temperature extremes, typically a fraction of overall annual use. Remote working and hybrid schedules mean that many facilities no longer see steady, consistent occupancy five days a week from nine to five.

Without intervention, equipment will continue to work harder than it needs to. For energy-intensive systems in particular, every second of unnecessary use incurs high costs.

The Solution: Upgraded Controls

Controls have come a long way from the invention of the modern thermostat at the turn of the 20th century. Today, advanced network communications and



cloud-based computing allow managers to adjust a building's energy settings from their mobile devices from halfway around the world. Smart automation means relieving facility managers of much of their current responsibilities—controls can adjust energy systems automatically to reach peak efficiency. And, thanks to state-of-the-art sensors and controls that optimize efficiency and diagnose wasteful equipment operation issues, advanced control upgrades save commercial businesses 29% in annual energy costs, on average.²

How Advanced Controls Save Money

Each of the four main energy-intensive systems in large businesses—HVAC, lighting, refrigeration and motorized equipment—can benefit uniquely from advanced controls. In a modern business, controls and sensors work together, communicating across systems to direct energy use across an entire facility.

HVAC

Heating and cooling are often a business's largest energy expense—accounting for 46.3% of total energy consumption at large commercial buildings, on average.³ Equipment is often sized for maximum operating capacity. This means major opportunities exist for control systems that limit HVAC usage while maintaining comfort.

- **Advanced Thermostats:** Modern smart thermostats wirelessly set a heating and cooling schedule to an occupancy-based control schedule. They

can adapt in real time to occupancy changes and can even be retrofitted to existing systems. Often, smart, internet-connected thermostats can serve as a control and visibility point for an entire Building Automation System, or BAS.

- **Demand Control Ventilation:** The key to HVAC efficiency is ventilating only when necessary. But according to the Environmental Protection Agency, overventilation is a common issue resulting in major energy waste; some buildings have six times more ventilation than is required.⁴ Using CO₂ sensors, demand control ventilation adjusts air dampers, minimizing outside air flow and consequently reducing heating and cooling energy.

Lighting

Lighting accounts for 10.7% of the average energy consumption of large businesses.⁵ Simply switching to LED lighting provides immediate energy savings of up to 75% compared to traditional fluorescent bulbs. High-efficiency lighting combined with advanced control strategies can reduce energy use significantly, too. In addition, advanced controls enable lighting-level adjustments based on the time of day or use of the workspace.

- **Occupancy and Motion Sensors:** When someone enters the room, the lights turn on. When they leave, the lights turn off. In areas with varying foot traffic, like a break room, conference room, bathroom or even refrigerator display cases, they can save large amounts of energy.

Smart HVAC Controls Boost Employee Productivity

Heating, ventilation and air conditioning units get a massive boost from AI-driven controls. Sensors send a complex series of inputs with real-time data, like indoor and outdoor temperature, weather forecasting, building occupancy, energy usage, humidity levels and even sunlight. AI controls adjust systems to create ideal temperature conditions — without any input or worries from you. By anticipating future conditions, adjustments are precise in real time, rather than schedule-based.

All of this makes a big difference. Studies show more comfortable employees are also more focused and productive — a major benefit for companies with advanced HVAC controls. And things will only get more precise from here.

Lighting That Energizes Workers — and Adapts in Real Time

A range of lighting controls — from dimmers to motion and occupancy sensors to photosensors — combine in new AI-driven lighting controls systems. Layered data and machine algorithms process that data to instantly detect patterns, preferences and usage habits — and to react.⁶

The result is lighting that optimizes energy savings, comfort and functionality. Improved lighting can matter quite a lot in workspaces. Because lighting conditions affect our circadian rhythm (the body's internal clock), it's vital for worker efficiency that new systems mimic natural light.⁷ Smart lighting does this better than ever before, dialing in optimal lighting conditions based on the time of the year and even whether clouds have rolled in outdoors. With studies showing that proper lighting improves sleep patterns, boosts mental health, increases alertness and improves cognitive performance, upgrades in AI-driven lighting controls are set to make a huge difference in a range of workspaces.⁸

- **Dimmer Controls:** These controls, also called “task tuning,” reduce a bulb’s wattage and output. Many LEDs can be dimmed anywhere from 1% to 100%. Dimming LEDs reduces internal device temperatures, prolonging the service life of components.
- **Photosensors and Daylight Harvesting:** The most efficient way to light a business is with the sun. “Daylight harvesting” reduces electric lighting usage when ambient daylight is available. Photosensors measure the daylight in a space and communicate with a dimming system to reduce electric light. Daylight harvesting works best in spaces with large windows or skylights.
- **Networked Systems:** Integration of lighting through a wired or wireless networked system maximizes control over energy costs and system design—so you save even more. Facility managers can apply daylight harvesting settings across similar areas of a building or configure different common areas to lighting levels suitable for the space. Networked systems allow individuals to control their personal workspace while still automating lighting in shared areas.

fan controllers sense the flow of refrigerant, then reduce the fan speed when full airflow is not required. Because the motor consumes less energy, less heat is added to the refrigerated compartment, and the compressor runs less often, netting energy savings in the process. Fan controls can yield energy savings of at least 10%.¹⁰

Interconnected VFDs Predict Maintenance Issues and Avoid Downtime

Variable Frequency Drives (VFDs), which allow motor-driven devices to precisely match system demands, are smarter and more connected than ever before. This means the decision-makers within your machines are more responsive than ever.

Modern VFDs collect performance data in real time on themselves and the motors, pumps and conveyors they control.¹¹ Temperature readouts and vibration measurements, for instance, are digested by AI controls for real-time analysis that can predict maintenance needs and opportunities. Predictive maintenance isn’t just about preparing you for repair costs more accurately (though that is a benefit); it also yields productivity benefits. Deloitte estimates businesses using predictive maintenance practices experience 19% less downtime and 87% fewer defects than those using preventive maintenance.¹² That’s a massive advantage — and one you’d be wise to press.

Refrigeration

Though refrigeration accounts for 7% of total energy consumption for large businesses,⁹ that number skews much higher for food service operations and grocery stores. Control systems are especially helpful for industries that need to keep products cold 24/7.

- **Anti-Sweat Heater Controls:** When warm, humid air meets the cold surface of a refrigerator display case, condensation becomes a problem. Anti-sweat heaters clear up this condensation. Most stores with refrigeration run anti-sweat heaters every second of the year. Adding controls ensures anti-sweat heaters run only when necessary. Retrofitting an entire grocery aisle with anti-sweat heater controls nets significant savings.
- **Electronically Commutated Motors:** Shaded-pole fan motors used in refrigeration typically run continuously. Replacing an old motor with an electronically commutated motor (ECM) lowers energy costs and significantly improves the performance of walk-in coolers and freezers.
- **Evaporator Fan Controls:** Evaporator fan motors draw air through evaporator coils to remove heat; they’re also vital for circulating cooled air throughout a refrigerator system. Evaporator

Motorized Equipment

Motors are the workhorses of the modern workplace.

- **Variable Frequency Drives:** Electric motors that drive equipment like pumps and fans normally operate at a constant speed, with fluctuations adjusted by some form of mechanical throttling. A variable frequency drive (VFD) handles fluctuations in demand without wasting energy by varying the current and motor speed. VFDs can be used across a wide range of applications, including HVAC equipment pumps and fans, for more precise airflow and pressure for heating or cooling; air compressors, by matching pressure to demand; water pumps, to control pump speed and save motor energy; and in other uses, like cooling tower fans and industrial equipment.

The Final Piece of the Puzzle: Energy Management Systems

Individually, controls for HVAC, lighting, refrigeration and motorized equipment save energy. But when combined under the umbrella of a dedicated energy management system (EMS), controls truly gain an efficiency edge.

A single EMS can combine integrated building automation and optimization tools, data benchmarking,

communication platforms, billing analysis and fault detection systems. Such tools can result in savings of 20% to 30% when controlling lighting systems, or 15% for HVAC equipment.¹³ And those savings can grow year by year if operational processes and controls stay consistent or improve.

The idea behind EMS is, as the Department of Energy puts it, to “tune it up, turn it off, and check it out.”¹⁴ That is, calibrate your EMS system to your building’s unique needs; schedule it only to run as needed; and check on it periodically to confirm peak efficiency and savings.

Big Savings, Big Incentives

Together with EMS, controls for HVAC, lighting, refrigeration and motors keep systems in check—saving you money every month on energy bills and even extending the life of your equipment.

And because PECO offers incentives on control

solutions, many improvements don’t just improve your business peak efficiency—they can pay for themselves.

For instance, consider a recent optimization project at Two Logan Square, part of a high-rise corporate campus in downtown Philadelphia. By adjusting controls to reduce the operating hours on multiple air conditioning units and resetting air temperature settings, the building stands to save 820,995 kWh of energy per year. What’s more impressive is that the improvements earned a \$82,100 incentive to help cover costs.

“We are constantly, every day, working with PECO to look for new, unique, progressive ways to take advantage of programs and rebates,” said Don Haas, the general manager of the building. “Our greatest partnership is with PECO and the Ways to Save program. We do this a lot, and there aren’t a lot of players out there doing it as well as PECO is.”

▶ Visit peco.com/business/contact-us to learn more about control systems and incentives that can pay for improvements.

¹ Makarevich, Alex. “Why AI Technology for HVAC Is the Next Big Thing in the Commercial Real Estate Market.” Softeq.com, SOFTEQ, 2022, <https://www.softeq.com/blog/why-ai-technology-for-hvac-is-the-next-big-thing-in-the-commercial-real-estate-market>. Accessed 7 December 2024.

² Fernandez, N., S. Katipamula, W. Wang, Y. Xie, M. Zhao, and C. Corbin. 2017. “Impacts of Commercial Building Controls on Energy Savings and Peak Load Reduction.” Pacific Northwest National Laboratory, PNNL-25985.

³ “Commercial Buildings Energy Consumption Survey 2012.” Washington, D.C.: EIA.

⁴ Persily, A. et al. Analysis of Ventilation Data from the U.S. Environmental Protection Agency Building Assessment Survey and Evaluation (BASE) Study (2004).

⁵ “Commercial Buildings Energy Consumption Survey 2012.” Washington, D.C.: EIA.

⁶ Thailand LED Expo 2025. “The Future of Lighting: AI-Integrated and Sustainable.” ledexpothailand.com, 2024, <https://www.ledexpothailand.com/the-future-of-lighting-ai-integrated-and-sustainable/>. Accessed 7 December 2024.

⁷ “Circadian Rhythm: What It Is, How It Works & What Affects It.” Cleveland Clinic, <https://my.clevelandclinic.org/health/articles/circadian-rhythm>. Accessed 7 December 2024.

⁸ Irvine, Jessica. “What Is Human Centric Lighting?” Action Services Group, 2023, <https://actionservicesgroup.com/blog/what-is-human-centric-lighting/>. Accessed 7 December 2024.

⁹ “Commercial Buildings Energy Consumption Survey 2012.” Washington, D.C.: EIA.

¹⁰ “Energy Savings Potential and Research, Development, and Demonstration Opportunities.” U.S. Department of Energy. energy.gov/sites/prod/files/2014/09/f18/residential_hvac_research_opportunities.pdf. Accessed 3 May 2023

¹¹ Townshend, Anna. “5 Ways the Industrial Internet of Things Is Changing VFD Design.” [controldesign.com, Control Design, 2021, https://www.controldesign.com/motion/drives/article/11291957/5-ways-iiot-industry-40-is-changing-vfd-design](https://www.controldesign.com/motion/drives/article/11291957/5-ways-iiot-industry-40-is-changing-vfd-design). Accessed 7 December 2024.

¹² Deloitte. Predictive Maintenance. 2023, <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/process-and-operations/us-smart-manufacturing-predictive-maintenance-infographic.pdf>.

¹³ “Dasheng Lee, Chin-Chi Cheng. “Energy savings by energy management systems: A Review.” Renewable and Sustainable Energy Reviews. [sciencedirect.com/science/article/pii/S1364032115013349](https://www.sciencedirect.com/science/article/pii/S1364032115013349)

¹⁴ Energy Star. “Operation and Maintenance Best Practices.” Energystar.gov, 2024, <https://www.energystar.gov/buildings/save-energy-commercial-buildings/ways-save/om-best-practices>. Accessed 29 January 2025.