# Empowering Decarbonization Through Post-Construction Monitoring

*Ellen Richer, Kimberly Cullinane, and Sherina Mutuluuza, Eversource Energy*
*William Gnerre and David Venturoso, Interval Data Systems*

**ABSTRACT**

The path to net zero emissions by 2050 will be challenging, but new construction offers a bright spot, as decarbonizing new buildings is far less difficult and costly than retrofitting. However, newly constructed buildings can still fall short of modeled performance targets, undermining affordability and confidence in electrified design. Even third-party building commissioning is not a fail-safe because it does not always require verification of operational energy use or HVAC system control strategies that ensure buildings use the energy the project team expects. Post-construction energy use intensity (EUI) tracking and corrective action, deployed soon after completion, ensures that buildings operate as intended, protecting budgets and advancing market transformation. Some utility-administered energy efficiency programs for new construction and major renovations have embedded post-construction performance verification and corrective action into their electrified net-zero-ready incentive pathways to bridge the gap between design and operation. This paper demonstrates the impact of early post-construction monitoring, corrective action, and maintenance education on affordability and decarbonization outcomes through a case study of two Eversource-supported school projects. The case studies examine best practices for effective post-construction monitoring, including submetering and near-real-time data analysis, that aligned both schools' energy performance with predicted EUIs. Finally, we examine the role of utility incentive programs in normalizing post-construction energy tracking as a market standard by equipping building operators with tools, ensuring accountability, and sharing lessons learned from a range of projects. By turning performance verification into standard practice, programs can accelerate the market shift toward resilient, cost-effective, and truly net zero buildings.

## Introduction

Building electrification and high-performance new construction are central to decarbonization strategies. Yet newly constructed buildings can fail to achieve their predicted energy performance once occupied. Measured energy use intensity (EUI)[1] often exceeds modeled targets during early operation, revealing a gap between design expectations and real-world outcomes. For all-electric buildings in particular, this gap carries significant consequences: higher operating costs, diminished carbon reductions, and reduced confidence in electrification as a cost-effective strategy. Studies of high-performance buildings have shown that measured performance can exceed modeled projections due to operational practices, changes during construction, control strategies, occupant behavior, and unresolved commissioning issues (de Wilde, 2017; Turner & Frankel, 2008). Although energy codes, advanced modeling tools, and

[1] Energy use intensity will be expressed consistently as kBtu per square foot per year (kBtu/sf/yr)

building commissioning improve design quality and functional system performance, they are not structured to ensure that modeled EUIs are achieved in operation. Energy models rely on standardized assumptions that rarely reflect real occupancy and scheduling conditions, and traditional commissioning verifies functional compliance rather than sustained energy optimization.

Modeled savings underpin incentive structures, carbon reduction pathways, and building performance standards (BPS), while ordinance compliance and policy progress are evaluated using measured operational data. When measured performance diverges from projections, both project-level outcomes and broader decarbonization goals are affected. Because new buildings enter regulated stocks at occupancy, their actual performance directly affects progress toward statutory targets and BPS compliance. Electrification also raises system planning stakes. NREL projects electric demand could increase 29% by 2050 under reference scenarios and up to 81% under high-electrification scenarios (Zhou & Mai, 2021). As thermal loads shift to the electric grid, accurate interval load characterization becomes essential for forecasting peak demand and infrastructure needs. Post-occupancy monitoring provides empirically derived load shapes that reduce planning uncertainty while supporting emissions reductions goals.

By integrating whole-building EUI tracking, interval data analysis, and active engagement with facilities teams during early occupancy, EUI verification establishes an operational feedback loop that extends beyond project completion to close the gap. EUI serves as the primary performance metric because it provides a normalized, consistent comparison across design models, operational performance, and portfolio or policy benchmarks. This paper examines a utility-administered post-construction monitoring approach implemented through the Path 1: Net Zero and Low EUI Buildings program, which incorporates post-occupancy incentives and verification support into electrification program design. The Path 1 program is available to customers in Connecticut, Massachusetts, and New Hampshire and administered by the Sponsors of Energize CT℠, the Sponsors of Mass Save®, and the NHSaves® utility partners. Preliminary findings from participating projects illustrate a consistent trajectory. Figure 1 compares modeled EUI at 100% construction documents (CDs), initial measured EUI at the start of the verification period, and final verified EUI at the conclusion of the verification scope of work across participating projects:

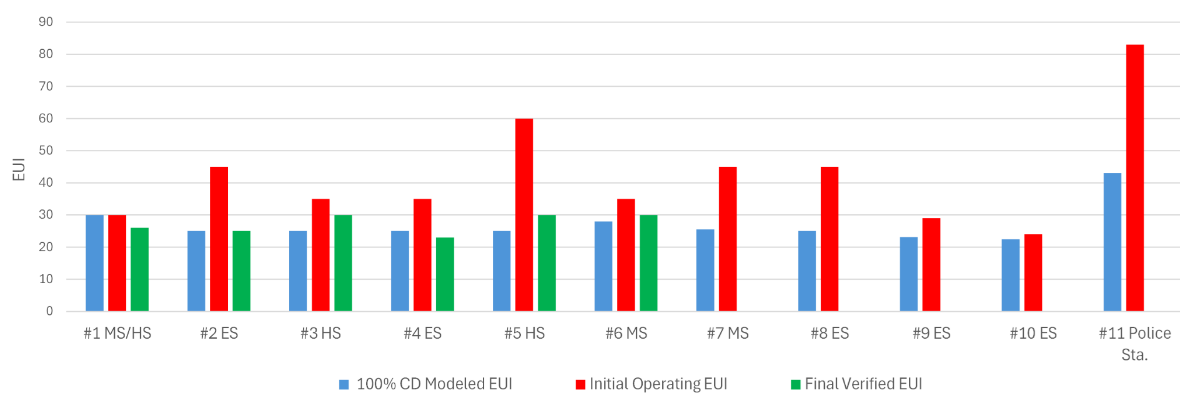


Figure 1: comparison of 100% CD modeled EUI, initial operating EUI, and final verified EUI. *Source:* Interval Data Systems

Across participating projects, EUI initially[2] exceeds modeled values by an average of 57%, reflecting control misalignment with sequence of operation (SOO) intent, scheduling discrepancies, incorrect setpoints, and unresolved system optimization issues common during early occupancy. Through structured post-occupancy monitoring and targeted corrective action, final verified EUIs begin to close the performance gap.

The trajectory illustrated in Figure 1 reflects a broader industry challenge: high-performance design alone does not guarantee high-performance operation. Without structured operational feedback in early occupancy, modeled decarbonization outcomes do not reliably translate into measured results. Embedding post-construction performance verification within utility program design and policy frameworks provides a scalable pathway for aligning modeled expectations with operational reality.

## Limitations of Standard Tools and Delivery Practices

The discrepancy between predicted and actual building energy performance stems from gaps in the delivery process. The industry lacks a formal structure that assigns clear responsibility for achieving specific energy goals. Although buildings are expected to perform as designed after commissioning, they often fail to meet the target EUI after handover. The commissioning process aims to ensure systems are installed and working as intended by using functional tests to verify equipment and controls. While these tests identify immediate operational issues, they do not assess long-term performance or energy efficiency under real-world load, occupancy, or weather conditions. Although functional tests attempt to simulate realistic scenarios, they are likely to miss high-impact energy issues that only surface during actual operation. Functional testing produces a deficiency log, which contractors use to gauge project completion and compliance with specifications. Once deficiencies are addressed or scheduled for resolution, the contractor typically considers their work complete. However, this approach introduces several challenges.

Due to tight timelines between substantial completion and building occupancy, commissioning tests cannot identify every potential issue. Commissioning teams often must expedite system testing, frequently even conducting commissioning activities after occupancy because certain systems are not fully completed. Additionally, construction contracts primarily focus on meeting design specifications and closing the punch list. Commissioning teams are incentivized to find and document deficiencies, but not to iterate across trades until measured energy performance converges with modeled performance. The delivery process defines success as “all items resolved,” which is not the same as “EUI achieved”. A core limitation is that no single party is contractually responsible for the EUI target after occupancy. Once comfort levels are deemed acceptable and functional test deficiencies are resolved, contracted scope is typically complete even if the building’s actual EUI exceeds the modeled value.

Many projects also do not require standardized or easily accessible time-series trending of building automation systems (BAS), whole-building energy, or submeter data. Even when data is available, it is often underutilized because downloading and visualizing the data is time-

[2] “Initial” EUIs may, in some project cases, include a partial year of performance data and projected usage to facilitate comparison.

consuming, and suitable analytical tools are lacking. Design and commissioning teams typically lack a streamlined method for extracting, aligning, and visualizing large datasets to effectively identify all energy and operational issues. Functional testing aims to confirm that equipment operates according to the engineer's SOOs. These SOOs are primarily designed to optimize building functionality and maintain occupant comfort, rather than to minimize energy usage. Engineers often use established, high-level sequences and rely on controls contractors to interpret and implement specific details, which can result in operational inconsistencies. Few projects systematically validate control sequences against measured energy outcomes after occupancy across seasons.

## Post-Construction Monitoring as a Solution

In this paper, post-construction monitoring refers to a defined process that integrates whole-building EUI tracking, interval energy usage analysis, and end-use submetering or other data granularity solutions. These data streams are combined with near-real-time analytics and active engagement with facilities teams to support iterative operational improvement. EUI is a particularly effective metric for post-construction verification because it bridges the design and operational phases of a project. As a normalized measure of energy consumption per unit area, EUI allows for direct comparison between modeled performance, measured operation, and portfolio or policy benchmarks. For owners, early EUI tracking provides critical budget predictability by revealing emerging operational cost risks before many monthly billing cycles or annual compliance checkpoints have passed. This is especially important for all-electric buildings in regions where natural gas is less expensive than electricity: the lower operating costs associated with high-efficiency electric systems like heat pumps depend on high performance to ensure a return on the investment (O'Rear et al., 2019).

EUI also provides a common reference point for utilities, designers, and policymakers. While energy models may rely on assumptions that deviate from real-world conditions, they still establish an expected performance range. Measured EUI allows project teams to assess the magnitude and persistence of deviations from that expectation and to evaluate whether corrective actions are closing the gap. At the same time, the simplicity and universal applicability of EUI makes it accessible to non-technical stakeholders, supporting its use in incentive programs, compliance reporting, and broader program evaluation.

The timing of post-construction monitoring is critical for its effectiveness. As our findings and prior evaluative research indicate, the most substantial and cost-effective performance improvements occur early in a building's operational life, when systems are still being tuned and operational habits have not yet become entrenched (Fedoruk et al., 2015). Studies of high-performance buildings demonstrate that unresolved control issues, misaligned schedules, and conservative default settings persist well beyond occupancy without active monitoring, even in buildings that have undergone comprehensive commissioning (Zheng et al., 2024). Implementing post-construction monitoring within the first several months of occupancy allows for the identification of inefficiencies while corrective actions remain relatively low-cost and minimally disruptive. If issues are identified early enough, corrections may still fall during contractors' warranty periods, further reducing costs and protecting the construction investment.

With a rigorous monitoring and remediation process, evidence suggests it is possible for many buildings to reach close to design EUI within the first 6-8 months. Typical rigors to achieve design EUI include aligning system schedules with actual occupancy, narrowing temperature setpoint bands, removing temporary overrides left in place during construction, integrating packaged controls with general building controls, and improving coordination between interconnected systems. While individually modest, these adjustments compound quickly, producing meaningful EUI reductions that benefit the project while more complex optimization efforts continue.

Near-real-time data enables prioritization. Interval data analysis reveals which systems and end uses contribute most significantly to excess consumption or peak demand, allowing facilities teams to focus limited time and resources where the potential impact is greatest. This capability is particularly valuable in electrified buildings, where operational inefficiencies can amplify peak electric loads and undermine anticipated grid and emissions benefits. Research has shown that control-related and operational issues account for a substantial share of excess energy use in high-performance buildings, even when envelope and equipment efficiencies are high (Granderson et al., 2010). By revealing these issues early, post-construction monitoring shifts energy performance from a reactive concern to a manageable operational variable.

Existing literature supports the effectiveness of this approach. Studies of LEED-certified and other high-performance buildings have documented performance gaps of 20% or more between modeled and measured energy use, identifying operational factors as significant drivers of underperformance (Bandak et al., 2025; Turner & Frankel, 2008). At the same time, monitoring-based interventions have demonstrated persistent energy savings of 7-8% without capital investment, particularly when implemented early and paired with ongoing engagement (Kramer et al., 2019, Lin et al., 2020). In tandem with this existing research, the following case studies illustrate how structured post-construction monitoring closes the gap between modeled and measured performance.

## Case Study A

School A is a new 113,000-square-foot elementary school in eastern Massachusetts. Opened to students in late February 2024, the building was designed as a fully electrified, net-zero-ready facility with a target operational EUI of less than 25 kBtu/sf/yr. The project incorporates a high-performance building envelope and all-electric HVAC system centered on a ground-source heat pump chiller plant.

IDS was engaged at the start of occupancy to support the project's energy goals and ensure that building operation aligned with the engineer's design intent. IDS established whole-building energy performance tracking using utility interval data combined with BAS trend data. Tracking energy and BAS operations from "day one" of occupancy allowed the project team to identify and address operational issues during the warranty period, when corrective action is most effective and at the lowest cost for the owner.

Initial post-occupancy observation indicated that occupant comfort maintained, and major systems appeared complete and operational. However, energy data revealed that the building was not yet operating at designed/modeled performance levels. Early whole-building load profiles showed elevated nighttime and weekend energy use, irregular startup behavior, and inconsistent central heat pump operation as evidenced by peak demands exceeding the energy model expectations. Overlaying actual utility 5-minute demand with the modeled 8,760-hour electric profile quickly confirmed that these discrepancies were primarily driven by unoccupied operation rather than daytime classroom loads.

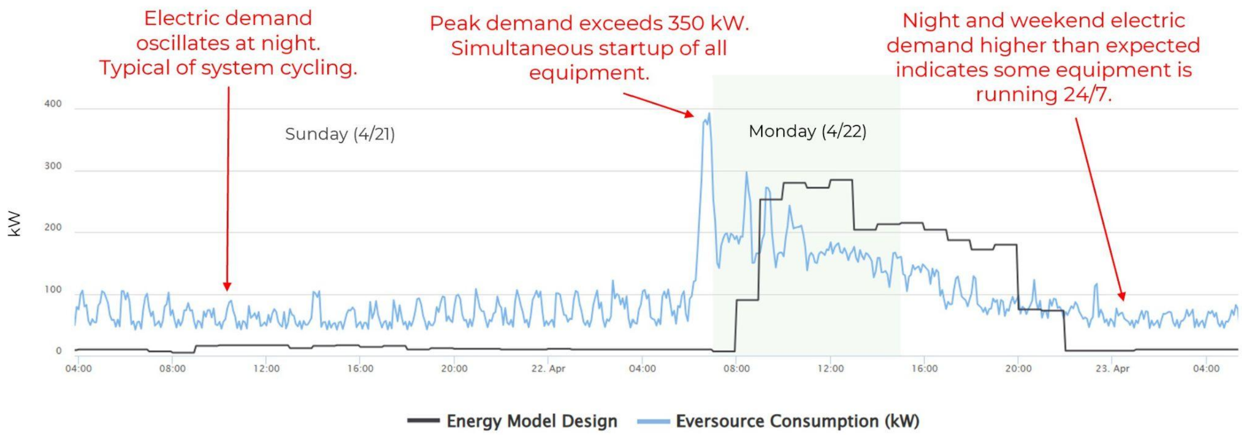


Figure 2: Case study A weekday whole-building load profile (actual vs. modeled)
*Source:* Interval Data Systems

IDS utilized a data-driven approach, beginning at the building level and then narrowing the investigation using BAS data. This process revealed several operational deficiencies contributing to excess energy use, generally falling into three categories: schedules, nighttime operation, and system-level control behavior.

Scheduling proved to be one of the most significant drivers of unnecessary energy consumption. Initially, HVAC schedules extended well beyond actual occupancy, with systems starting 3-4 hours before teachers arrived and remaining active into the evening. IDS used space temperature data to demonstrate to the facilities staff that the building's envelope performance allowed for much tighter schedules without compromising comfort. Once the facilities staff were confident with envelope performance, schedules were adjusted to better align with occupancy, the building achieved reductions in fan energy, chiller energy, and overall EUI. Schedules were iterated multiple times, with a level of improvement at each iteration.

Nighttime operation of central systems was another major contributor to elevated energy use. Whole-building energy data showed oscillating demand overnight, suggesting cycling of large equipment. BAS trend analysis confirmed that heat pump chiller modules and associated pumps were cycling on and off during unoccupied hours, even though individual components were following their programmed sequences. Further review revealed that system-level control logic did not adequately prevent operation at very low load conditions. Through collaboration with the controls contractor and equipment manufacturer, control logic was refined so that systems fully shut down when unoccupied. These changes eliminated overnight cycling, reduced base load, and lengthened expected equipment lifespans.

As corrective actions were implemented incrementally, School A's operational EUI followed a clear downward trend. The building initially operated at an annualized EUI in the mid-30s kBtu/sf/yr but was reduced to approximately 24 kBtu/sf/yr, aligning with the project's design target within the first year of occupancy. These improvements were achieved without capital upgrades, relying instead on data visibility, operational refinement, and close coordination among the owner, facilities staff, and HVAC delivery team.

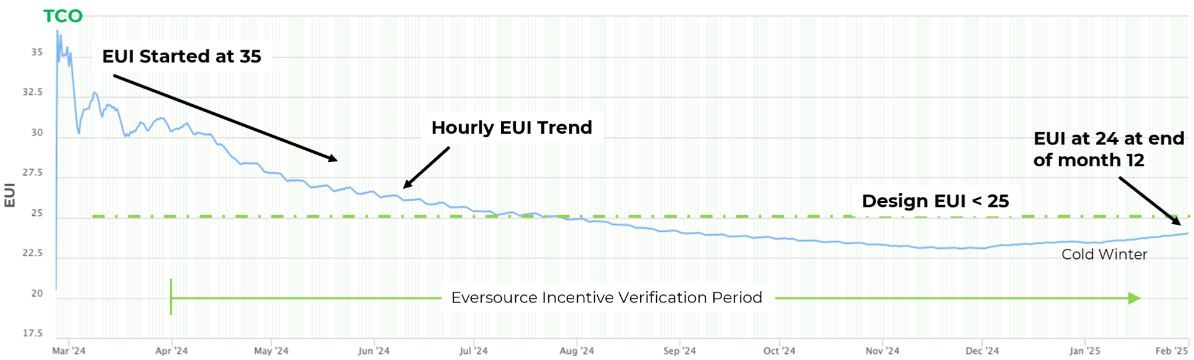


Figure 3: EUI trend during first 12 months of operation
*Source:* Interval Data Systems

## Case Study B

School B is a new 104,855 square-foot elementary school, also located in eastern Massachusetts. Completed in September 2023, the building was designed as an all-electric, net-zero-ready facility with a target EUI of 25 kBtu/sf/yr. To achieve this target, the project team incorporated a high-performance building envelope, all-electric HVAC systems, and a ground-source heat pump plant capable of producing both hot water and chilled water. The HVAC design includes dedicated outdoor air systems with energy recovery, distributed air handling units with hot and chilled water coils, and terminal units with reheat to serve classrooms and other occupied spaces.

IDS was engaged approximately 15 months after occupancy, initially to support the Mass Save post-construction verification incentive process. Using whole-building utility data and submetered systems data, IDS established an initial post-occupancy EUI of approximately 45 kBtu/sf/yr, which was nearly double the modeled target of 25 kBtu/sf/yr, but not uncommon with similar projects. IDS utilized a data-driven verification approach, leveraging utility data, trend logs from the building automation system (BAS), and comparisons between modeled and actual hourly energy profiles. By overlaying modeled and measured load profiles, IDS identified that daytime, occupied energy consumption tracked within roughly 5% of modeled expectations. In contrast, nighttime and weekend energy consumption was approximately 56% higher than modeled, immediately focusing the investigation on unoccupied operation. Owner and facilities team engagement was critical to this effort. IDS worked closely with facilities staff, the controls contractor, and the mechanical engineer through recurring meetings to review findings, establish priorities, and ensure corrective actions were implemented.

.

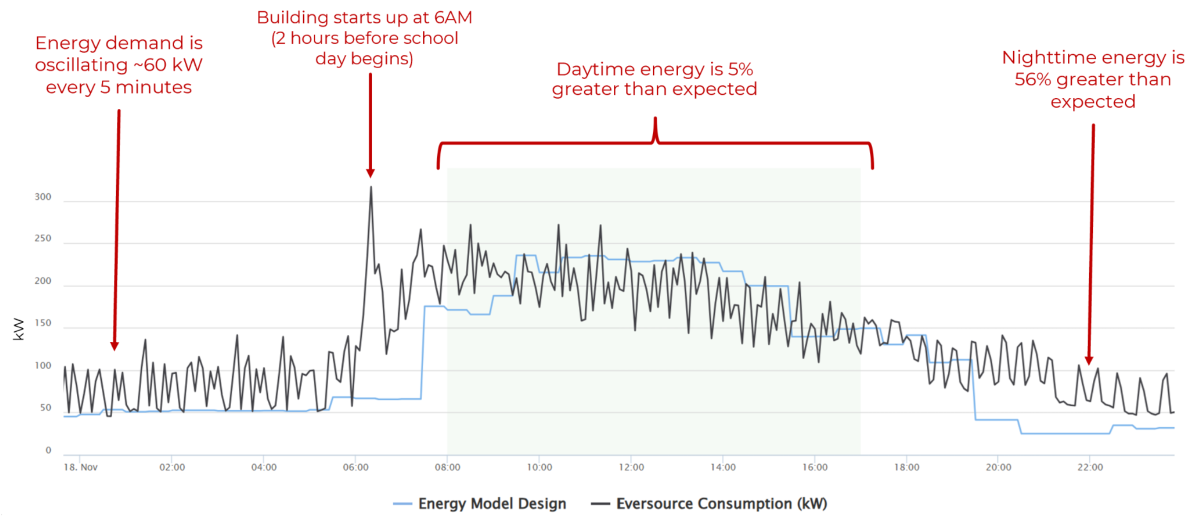


Figure 4: Case study B weekday whole-building load profile (actual vs. modeled)
*Source:* Interval Data Systems

The elevated initial EUI was driven primarily by operational issues rather than design flaws, and these issues fell into three categories: schedules, setpoints, and control sequences. Early corrective actions focused on tightening BAS schedules to better align system operation with actual building occupancy. In several cases, equipment was starting hours earlier than necessary and remained active well into unoccupied periods. Additional issues were identified with cabinet unit heaters serving vestibules and stairwells that were not placed on schedules, which resulted in hot water pumps and central plant equipment operating continuously.

Setpoint-related issues also had a high impact on unoccupied energy use. Nighttime temperature setbacks were not fully implemented, causing consistent heating calls that kept central systems energized overnight. IDS verified that space temperature recovery times during winter morning startup were typically less than 30 minutes, and recommended lowering nighttime heating setbacks, allowing pumps and heat pump chillers to fully shut down. Similarly, electrical and intermediate distribution frame (IDF) rooms were configured with unnecessarily low cooling temperature setpoints, driving cooling operation during nights and weekends.

Additional impactful improvements came from clarifying language within the HVAC control sequences. While equipment passed functional performance tests, sequences lacked clarity around when systems should turn off under low or zero load conditions. IDS worked with the engineer, who then issued field bulletins clarifying shutdown logic for air handling units, hot water pumps, and chilled water pumps. Once implemented by the controls contractor, these changes produced an immediate reduction in nighttime and weekend energy use, which was visible in the BAS data and whole-building energy load. The figure below shows the hydronic system pump speed plotted over a seven-day period. The chart on the left shows the pumps operating continuously. The chart on the right shows the pumps shutting down at night after the changes were made.

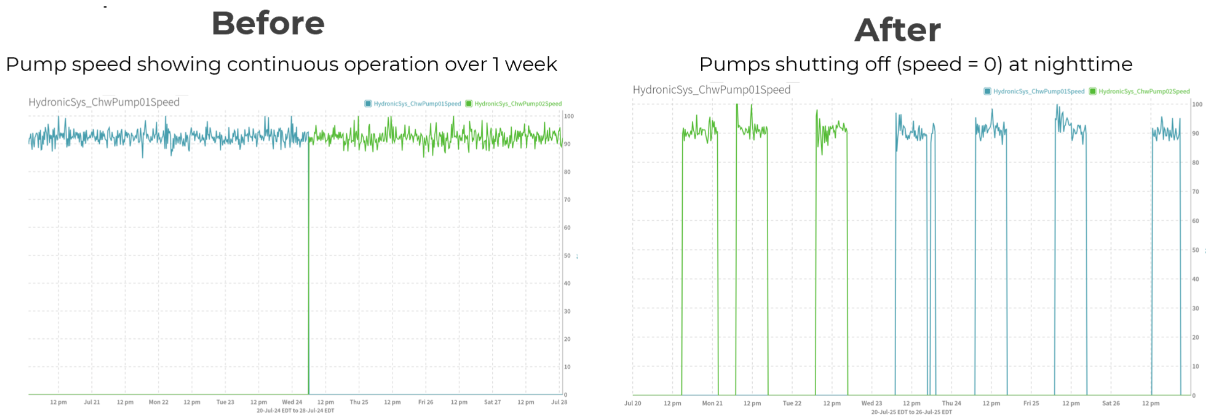


Figure 5: Trend data showing hydronic pump speed before and after shutdown
*Source:* Interval Data Systems

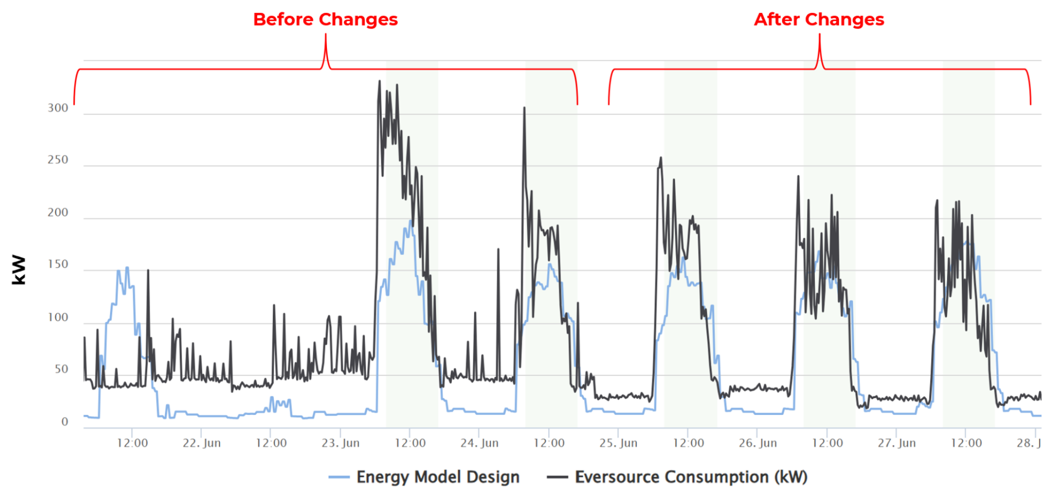


Figure 6: Whole-building hourly electric load profile before and after unoccupied shutdown adjustments *Source:* Interval Data Systems

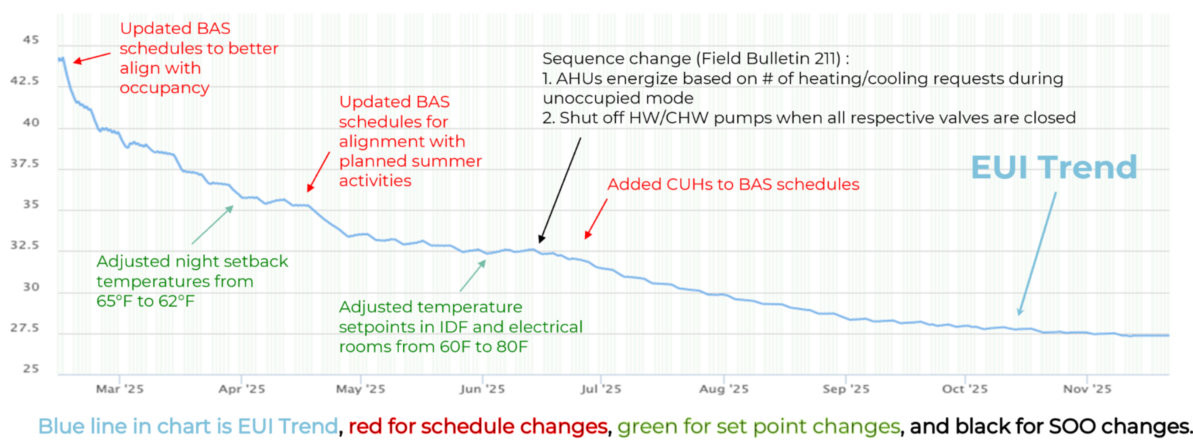


Figure 7: Remediation actions and effect on EUI
*Source:* Interval Data Systems

As corrective actions were implemented incrementally, the building's EUI reduced over a 12-month period from 45 to 28 kBtu/sf/yr. Figure 7 illustrates the EUI decline due to system adjustments. Continued remediation shows further improvement toward the original target of 25 kBtu/sf/yr. The end-uses with the highest impact reductions were pumping, air handling unit fan energy, and hot water production during unoccupied periods.

## Findings

Based on analysis of multiple new construction projects, several consistent findings have emerged that help explain why actual energy use often exceeds modeled performance. The findings show ongoing issues in design, construction, and early building operations:

**Finding 1: Achieving Low-EUI Requires Precision Control of Every Piece of Equipment.** Achieving low-EUI performance requires precise control across all systems and operating conditions. Small issues such as schedule drift, setpoint overrides, or sensor errors can significantly increase energy use, making continued tuning and verification essential during early operation.

**Finding 2: Packaged HVAC Systems Limit Visibility and Control.** Many new commercial buildings rely heavily on packaged HVAC equipment with built-in manufacturer controls, such as variable refrigerant flow (VRF) systems, packaged air handlers, ground source and air source heat pump chillers or pump skids. Many packaged HVAC systems function as operational "black boxes", limiting visibility into internal control logic. Troubleshooting often requires manufacturer involvement, and fragmented responsibility among contractors and vendors can make it difficult to achieve intended performance.

**Finding 3: Unoccupied Operation Is a Major Source of Excess Energy Use.** Unoccupied does not mean equipment is "off." In many buildings, energy use during unoccupied periods is much higher than anticipated in the energy model. Design sequences of operation typically address how systems start up for occupancy but give less attention to how systems shut down, stay off, or restart during unoccupied periods. For building types that spend more hours occupied than unoccupied (e.g. schools), even small issues during these periods can significantly impact energy use.

**Finding 4: Rogue Zones Quietly Drive Whole-Building Energy Use.** A small number of spaces can significantly impact building operations. Vestibules, mechanical rooms, and other spaces without proper temperature setbacks often behave differently than the rest of the building. These "rogue zones" can call for heating or cooling overnight and unintentionally force upstream equipment, such as pumps, fans, and compressors, to run continuously. A small problem in one room can lead to increased energy use throughout the building when it is unoccupied.

**Finding 5: Whole-Building Utility Interval Data Is Rarely Used, But Extremely Valuable.** Although whole-building utility interval data is highly valuable, it is infrequently used during construction, commissioning, first-year operations, and ongoing operations. Through experience on many projects, IDS has learned that this single data stream provides the clearest picture of how the building is actually operating. It captures the combined effect of all systems and operational decisions and is often the fastest way to identify issues such as equipment cycling, excessive nighttime operation, and early morning startups. Even with extensive BAS trending, the utility meter remains the most effective starting point for diagnosing issues.

**Finding 6: Energy Models Add Value in Operations.** Energy models are typically not used after 100% CDs despite providing useful reference during all phases of operation. Modeled load profiles can provide a baseline for comparison and quickly highlight where reality differs from expectations. This comparison is especially useful for identifying unoccupied operation issues and building team alignment around corrective actions.

**Finding 7: Design Intent is Not Well Understood by Facilities Staff.** High performance buildings must be operated consistent with design intent. We have found, pervasively, that facilities staff have not been given adequate knowledge transfer into the required way of operating the building and how changes they make will affect performance. Typically, facilities staff make changes to their new low EUI buildings based on what they know from prior generation buildings.

## Best Practices

Once a building operates as designed, its energy performance depends on the building operators. Their daily decisions regarding system scheduling, adjustments, and maintenance significantly impact a building's ability to meet energy goals. A valuable best practice is to add frequent reviews (weekly or more) of energy usage to facilities staff contracts. Whole-building, 15-minute interval data from the main utility meter offers immediate feedback on building operation. Load profiles provide insightful evidence of occupancy- and schedule-related issues not seen in the monthly utility bills. Examining key systems and equipment trends from the BAS should be standard practice. However, data access alone is insufficient; many facilities staff are not trained to interpret it. A gap often exists between the capabilities of modern control systems and the preparedness of facilities staff to use them. Some operators may lack training or incentives to prioritize energy performance, leading to energy goals being superseded by concerns like maximizing comfort, minimizing risk, and prioritizing convenience. Implementing a plan during the design phase is crucial for determining how to visualize data and use it to identify operational problems.

Furthermore, building operators must understand the engineer's original design intent. Without this understanding, operators may lack the confidence to modify system settings or diagnose problems that may arise. Consequently, they may adopt a more cautious approach with longer runtimes and higher setpoints, which might temporarily resolve issues, but ultimately increase energy consumption, and potentially trigger future operational problems. Schedules also significantly influence a building's energy consumption and require regular updates to accurately reflect current usage. In buildings with variable occupancy, operators must consistently update the BAS schedule and check it against the energy data to make sure they compare. While scheduling equipment for “unoccupied mode” is often assumed to shut the system down, this is not always the case. Investigate comfort complaints rather than applying permanent overrides, which can mask or create new problems.

Ultimately, someone must take ownership of energy performance. Whether it is a staff member or external support, building owners must clearly define the responsibility for tracking performance, asking questions, and helping operators improve over time. Without support from facilities staff, buildings designed for high-performance will rarely perform as intended.

## Ongoing EUI Maintenance: Appropriate Expertise, Proper Training, and Continued Accountability

As discussed, energy performance monitoring is critical during the first year of occupancy, but ongoing EUI monitoring and maintenance beyond year one further extends the financial and environmental returns. Without continued monitoring, even optimized EUIs can drift upward over time due to factors like staff turnover, competing operational priorities, and the complexities of building systems.

**Staff turnover:** Even well trained and engaged building operators who understand the value of consistently low energy use may not pass on the same level of engagement or focus to replacement staff. To maintain building operator support for EUI monitoring, building owners must ensure staff accountability. One solution is to incorporate building energy performance metrics into the job descriptions for building operators or other appropriate roles.

**Competing operational priorities:** Building operators are responsible for ensuring the safe and reliable operation of a building’s mechanical and electrical systems while also maintaining occupant comfort and optimizing energy use. These demands can sometimes conflict, and addressing occupant comfort promptly may require overriding energy efficiency set points or schedules. Again, proper staff education and sufficient training, informed by real building data, can help.

**Complex systems:** Modern buildings have become significantly more complex, incorporating advanced mechanical systems, digital controls, and integrated technologies that require specialized expertise to operate effectively. Staff whose experience is rooted in older, more traditional building systems may lack the training or technical background needed to manage these newer environments. As a result, relying solely on legacy skill sets can lead to operational inefficiencies, an increased risk of system failures, and missed opportunities to optimize building performance.

To achieve long-term energy optimization, building owners must: (1) secure specialized expertise commensurate with the complexity of their new building, (2) provide staff with thorough education and ongoing training, emphasizing the importance of energy management amidst competing priorities, and (3) assign explicit accountability for sustained EUI performance to a specific staff member.

## Utility and Market Impacts

Market transformation is the ultimate goal of policymakers in the decarbonized building sector. Successfully decarbonized buildings encourage further adoption by demonstrating the viability of low EUI and net zero concepts to spur demand. Conversely, if new buildings fail to meet their energy, carbon, and utility expenditure expectations, market hesitation could arise hindering the market acceleration needed to meet local, state, and regional carbon reduction targets. As affordability continues to rise to the forefront of new construction priorities, ensuring that the current wave of decarbonized buildings avoids excessive utility bill spending is critical.

Energy efficiency program administrators can play a significant role by normalizing post occupancy performance accountability and linking it to design predictions. This approach compels an outcome-based perspective throughout the entire project team, from designers and contractors to building owners and operators. While designers can deliver building designs capable of achieving an ultra-low or net-zero EUI, achieving the predicted EUI in operation requires the building to be constructed according to the design, properly commissioned, and operated as intended. This necessitates alignment and accountability from all parties throughout all stages of project development.

Normalizing post-occupancy performance accountability also establishes feedback loops that channel lessons learned into all stages of the design-construction-operation continuum. By tying incentive dollars to the achievement of operational energy performance targets, energy efficiency program administrators give designers a vested interest in their buildings performing well, aligned with modeled predictions to ensure client success. Knowing that their designs will be “road-tested” in occupancy and that their energy models will be used for measurement and verification naturally encourages designers to understand how their buildings truly perform. This, in turn, allows them to refine their designs for future projects and adjust their modeling assumptions for greater accuracy. These feedback loops create a formula for better buildings overall.

## Embedding Post-Construction Performance in New Construction & Major Renovation Program Design

Eversource transmits and delivers electricity and natural gas and supplies water to approximately 4.6 million customers in Connecticut, Massachusetts, and New Hampshire. Across its tri-state service territory, Eversource also serves as an energy-efficiency program administrator, collaborating with other utilities and energy service providers to deliver incentives, technical assistance, training, and additional program support under the Energize CT, Mass Save, and NHSaves brands. In 2020, Eversource, along with its statewide partners, launched an innovative new EUI and performance-based initiative within its Commercial and Industrial New Construction and Major Renovation offerings. This initiative, called “Path 1”, supports net-zero or net-zero-ready non-residential new construction or major renovation projects using an absolute energy target of a site EUI as its guiding principle. Buildings must be entirely fossil fuel-free to participate in Path 1 with narrow exceptions for fossil fuel use in laboratories or emergency generation.

Eversource's approach is notable for its reliance on site EUIs to drive project outcomes and to determine both project savings and project incentives, rather than primarily using modeled energy savings. The net-zero-ready EUI targets in Path 1 (1) require design teams to focus both on minimizing fossil fuels and optimizing for energy efficiency; (2) are a single number that is easily understood by project team members, where percent reduction approaches often are not; (3) can be readily used to check against the impact of design choices in projects with whole building energy models; and (4) are measurable once buildings are operating. Building owners can use EUI to benchmark the energy performance of one building against itself over time, or one building against similar buildings.

The Path 1 program offer includes the following specific components:

- A 50% cost share, up to $10,000, to support the engagement of a qualified net-zero advisor (required) who provides guidance and expertise throughout the project's design phase;
- Customer incentives on a dollar-per-square-foot basis (varying by state), based on the applicable project tier. Incentives are paid in two parts: a Construction Incentive, paid upon construction completion and a Post-Occupancy Incentive, which is a significant retainage of the dollar-per-square-foot-incentive, paid upon demonstrated achievement of the predicted EUI after at least one year of monitoring. Final incentives are based on operational EUI performance, not predicted EUI performance.
- Adders for qualifying heat pump technologies (in Massachusetts and Connecticut) on a dollar-per-ton basis[3].
- A 50% verification scope cost share (in Massachusetts and Connecticut), up to $10,000, to support the engagement of a verification consultant to help assess building energy performance and manage corrective action during a one-year period after occupancy.

Other program requirements include submetering to facilitate corrective action after occupancy and whole-building energy modeling. Energy modeling is an essential element of the program, linking a building's predicted energy performance to its actual operating energy performance. Importantly, the Path 1 program design naturally disincentivizes any "gaming" of the energy model because it requires owners to reconcile the operational EUI with the design-based predicted EUI. This aligns the interests of all project participants: designers want satisfied clients and building operation that validates their predictions; program administrators want the project to achieve anticipated energy and carbon savings; and building owners want to achieve the expected levels of energy use, carbon reduction, and utility costs that they may have promised to investors, or in the case of public buildings, voters.

The Post-Occupancy and Verification Incentives, along with their associated scopes of work, are critical to the Path 1 program. While typical new construction incentive programs end with building occupancy, Path 1 support extends into the first year or more of operation. When Eversource and other program administrators launched Path 1, the Post Occupancy Incentive was

[3] For this program, heat pump incentives are based on heating "tonnage" such that one ton is equal to 12,000 Btu per hour.

in place, but the Verification Incentive and its associated scope of work were optional. In response to early findings, like the ones outlined in this research, program administrators for Massachusetts and Connecticut have made the Path 1 Verification Incentive a requirement as of January 2026, recognizing its value in helping owners monitor energy performance as soon as the building opens, rather than waiting a year and discovering unexpectedly high energy use (and utility bills). Additionally, program administrators in Massachusetts have placed greater emphasis on building performance by shifting a larger percentage of the dollar-per-square-foot portion of the Path 1 incentive to the Post Occupancy Incentive from the Construction Incentive. Aligning building performance with predicted outcomes is emerging as an important and impactful area for program intervention, and Eversource is considering future program changes that may further emphasize this point. Post-occupancy data allows program administrators to book savings for projects that are accurate to true performance. This has a positive impact on program evaluations and can vastly improve realization rates and allow administrators to make strategic program improvements without waiting years for impact analyses.

Finally, the Verification Incentive encourages customers to remain accountable for their energy performance going forward. Eversource and the other program administrators are currently revising the Verification vendor scope of work to accomplish this by: identifying submetering or other data collection methods applicable to most projects; strengthening guidance on identifying and reporting on areas for improvement; and requiring vendors to provide durable educational materials that encourage project teams to continue measurement beyond the program's post-occupancy period.

## Conclusion

Closing the gap between predicted and measured performance is not a question of technology availability but of delivery structure, accountability, and early operational feedback. The case studies in this paper show a consistent arc: despite high-performance envelopes and all-electric systems, initial EUIs exceeded modeled targets due, in large part, to unoccupied operation, unclear shutdown logic, scheduling, and "rogue zones." When whole-building interval data, BAS trends, and targeted corrective action were applied in the first months of occupancy, EUIs declined rapidly without capital upgrades and aligned with design intent. Energy models retained value as operational yardsticks and operator engagement turned data into durable practice. Embedding this verification into incentive program design creates feedback loops that translate to repeatable results that ensure a meaningful return on investment for owners and program administrators.

To ensure high performance, the new buildings industry must realign success metrics and responsibilities beyond substantial completion. We recommend an outcome-based approach that 1) assigns explicit responsibility for post-occupancy energy performance; 2) requires standardized, accessible BAS and meter trending from day one; 3) prioritizes the design and field verification of the control sequences that govern energy; and 4) replaces the punch-list endpoint with ongoing operator engagement and EUI maintenance. This shift, already ongoing in pioneering energy efficiency programs like Energize CT, Mass Save, and NHSaves, protects project and energy affordability, strengthens confidence in electrification, and accelerates market transformation toward a decarbonized built environment.

**References**

Bandak, A., Sreenivasan, A., Hamid, A. A., & Wilde, P. de. (2025). The energy performance gap–a Swedish perspective. Journal of Building Performance Simulation, 1–22. https://doi.org/10.1080/19401493.2025.2567993

de Wilde, P. (2014). The gap between predicted and measured energy performance of buildings: A framework for investigation. Automation in Construction, 41, 40–49. https://doi.org/10.1016/j.autcon.2014.02.009

Fedoruk, L., Cole, R., Robinson, J., & Cayuela, A. (2015). Learning from failure: understanding the anticipated–achieved building energy performance gap. Building Research & Information, 43(6), 750-763 https://doi.org/10.1080/09613218.2015.1036227

Granderson, J., Piette, M. A., & Ghatikar, G. (2010). Building energy information systems: user case studies. Energy Efficiency, 4(1), 17–30. https://doi.org/10.1007/s12053-010-9084-4

Kramer, H., Lin, G., Curtin, C., Crowe, E., & Granderson, J. (2019). Building analytics and monitoring-based commissioning: industry practice, costs, and savings. Energy Efficiency, 13, 537–549. Springer Nature. https://doi.org/10.1007/s12053-019-09790-2

Lin, G., Kramer, H., & Granderson, J. (2020). Building fault detection and diagnostics: Achieved savings, and methods to evaluate algorithm performance. Building and Environment, 168, 106505. https://doi.org/10.1016/j.buildenv.2019.106505

O'Rear, E., Webb, D., Kneifel, J., & O'Fallon, C. (2019). Gas vs electric: Heating system fuel source implications on low-energy single-family dwelling sustainability performance. Journal of Building Engineering, 25, 100779. https://doi.org/10.1016/j.jobe.2019.100779

Turner, C., & Frankel, M. (2008). Energy Performance of LEED for New Construction Buildings: Final Report. New Buildings Institute (NBI). https://newbuildings.org/resource/energy-performance-leed-new-construction-buildings/

Zheng, Z., Zhou, J., Jiaqin, Z., Yang, Y., Xu, F., & Liu, H. (2024). Review of the building energy performance gap from simulation and building lifecycle perspectives: Magnitude, causes and solutions. Developments in the Built Environment, 17, 100345–100345. https://doi.org/10.1016/j.dibe.2024.100345

Zhou, E., & Mai, T. (2021). Electrification Futures Study: Operational Analysis of U.S. Power Systems with Increased Electrification and Demand-Side Flexibility. National Renewable Energy Laboratory (NREL).