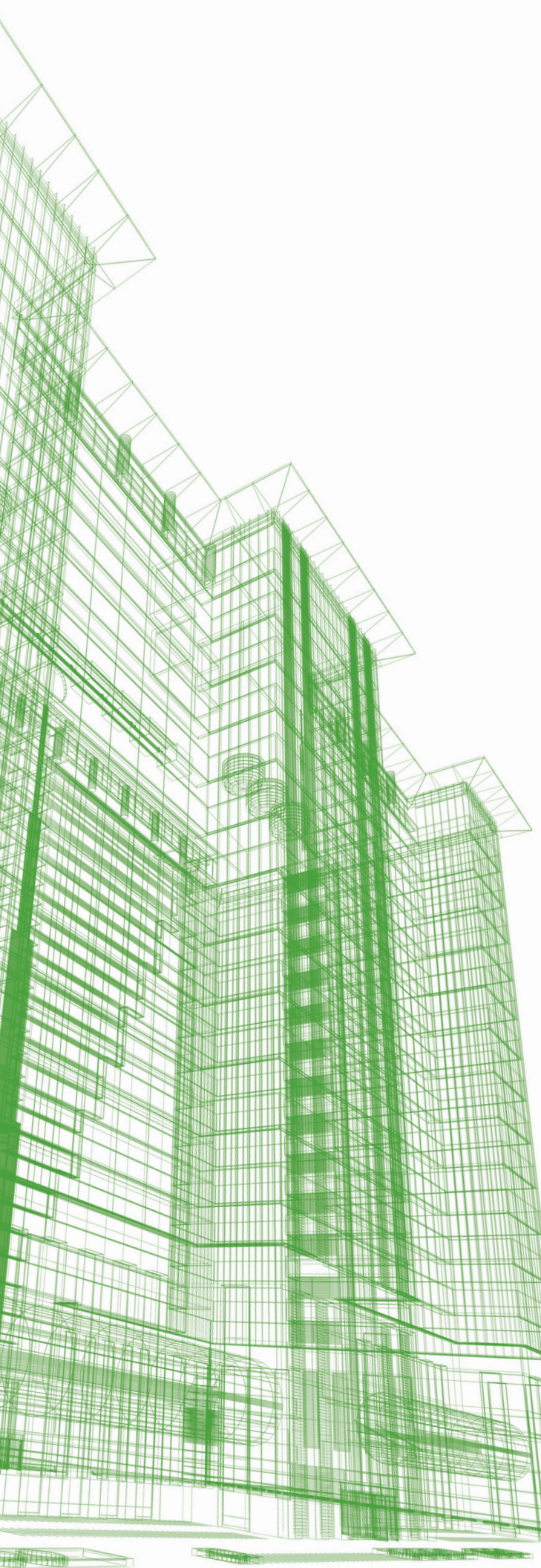

EMIS Applications Showcase

Highlighting Applications of Energy Management and Information Systems (EMIS)

BUILDING TECHNOLOGY & URBAN SYSTEMS DIVISION

Lawrence Berkeley National Laboratory

By Eliot Crowe, Hannah Kramer, Jessica Granderson

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BERKELEY LAB

Bringing Science Solutions to the World

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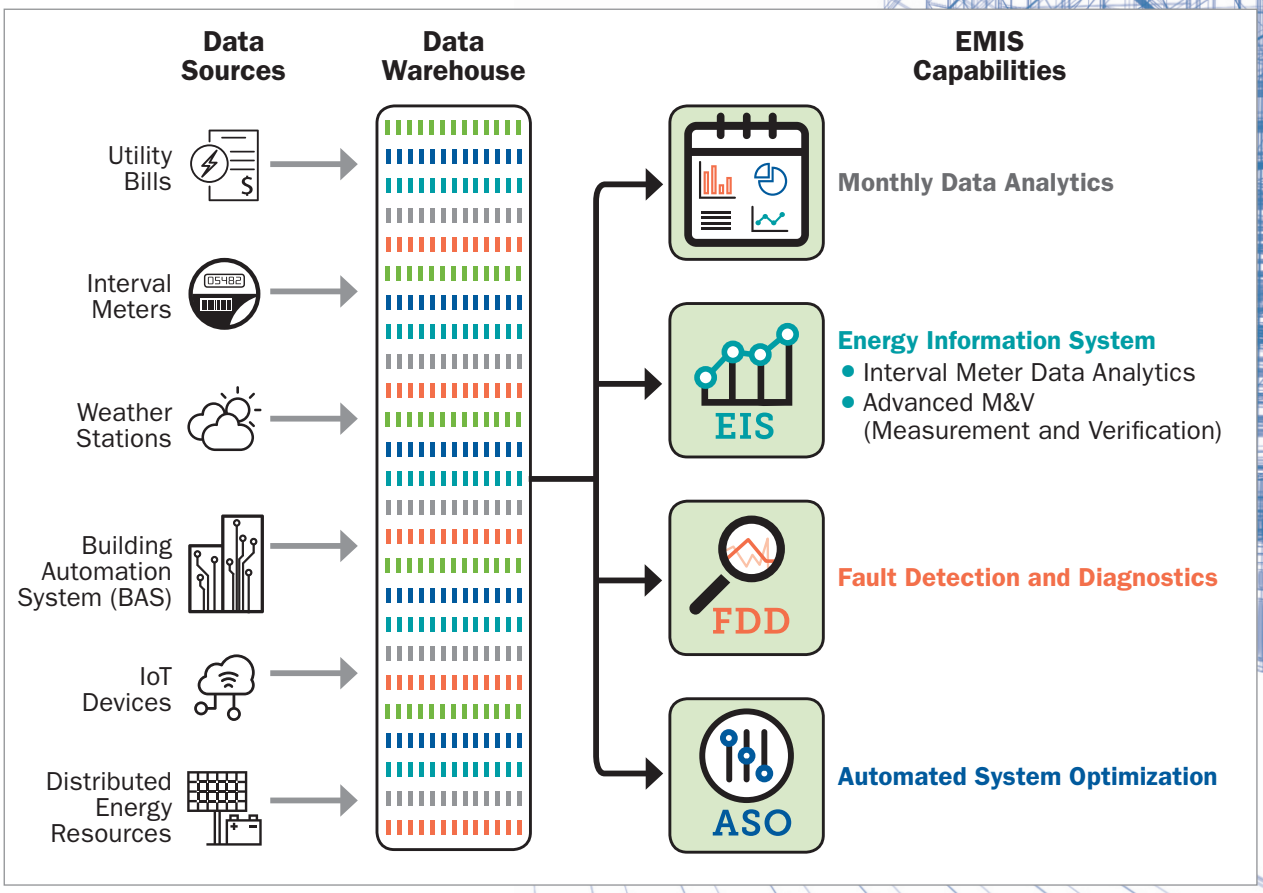
Introduction

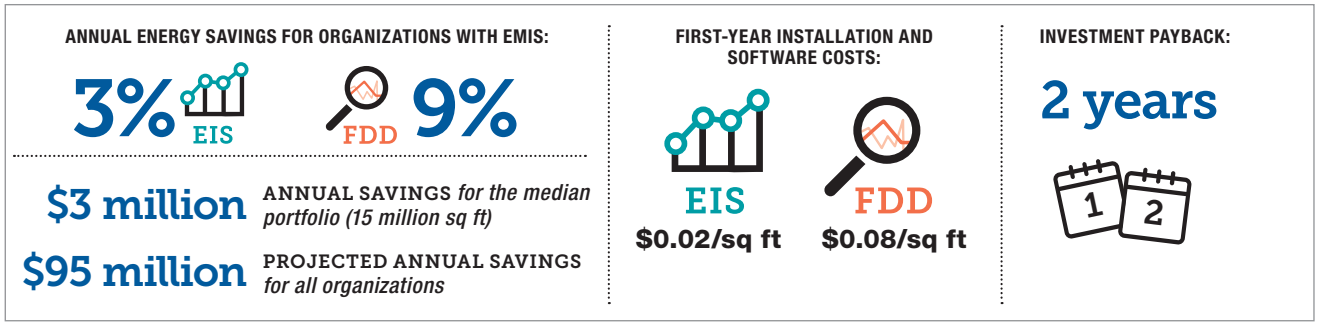
The 2016–2020 Smart Energy Analytics Campaign was a public-private sector partnership program focused on supporting commercially available Energy Management and Information Systems (EMIS) and monitoring-based commissioning (MBCx) practices for commercial buildings. The Campaign was conceived as an opportunity to assess the costs, benefits, and common practices of EMIS when deployed at scale across a wide array of building types and sizes.

This EMIS Applications Showcase highlights examples from many of the organizations recognized by the **Smart Energy Analytics Campaign**, providing snapshots of how to get the most out of an EMIS (for more details on recognized organizations, along with a host of other useful resources, check out the Campaign Toolkit[1]).



Data Inputs and Key Capabilities of Energy Management and Information Systems (EMIS)

[1] https://betterbuildingssolutioncenter.energy.gov/smart-energy-analytics-campaign-toolkit



Cost/benefit metrics based on Smart Energy Analytics Campaign data

This Showcase is not intended to be a data-heavy research report, nor is it a "how-to" guide. The Showcase highlights the range of strategies being deployed today by leading organizations across multiple market segments as they capitalize on the promise of building analytics, and it demonstrates that there is no single way to successfully apply EMIS.

After four years in operation, the Smart Energy Analytics Campaign has gathered data from 104 organizations across the United States, encompassing 6,500 buildings and over half a billion square feet of floor area, making this the most comprehensive dataset available on analytics installation and use. The Campaign participants' data were analyzed to provide a characterization of EMIS costs and benefits, MBCx services, and the current state of the building analytics market, based on the proven practices demonstrated by these organizations.[2] Campaign data covered the two most prevalent types of EMIS capabilities:

- **Energy Information Systems (EIS)** help find energy waste using smart meter data.
- **Fault Detection and Diagnostic Tools (FDD)** detect and prioritize HVAC system faults.

The Campaign provided technical assistance to participating organizations and opportunities for their outstanding application of EMIS tools to be recognized. In total, 32 organizations received recognition, across several categories. EMIS are 'enabling' technologies, and maximizing their benefits is dependent upon how they are integrated with organizational practices. The organizations recognized by the Campaign demonstrated leadership in effectively installing new EMIS, establishing an array of best practice management approaches, and moving beyond well-established uses toward greater innovation.

Taken as a whole, the Campaign data and the stories in this Showcase illustrate a maturing market for EMIS, with a wide range of tools being deployed successfully at scale. Over the past decade EMIS have moved from being a niche tool with great potential to being an essential energy management tool for leading organizations to improve building performance, enhance occupant comfort, and achieve aggressive carbon reduction goals.

The examples in this Showcase are presented under three main headings:

- **Getting Started with EMIS**
- **Best Practices**
- **Innovation**

More details on the Campaign Toolkit and a full list of all organizations recognized by the Campaign can be found on pages 15–17 in this Showcase.

[2] Kramer, H., Lin, G., Curtin, C., Crowe, E., and Granderson, J. *Proving the Business Case for Building Analytics.* Lawrence Berkeley National Laboratory, October 2020. DOI: https://doi.org/10.20357/B7G022.

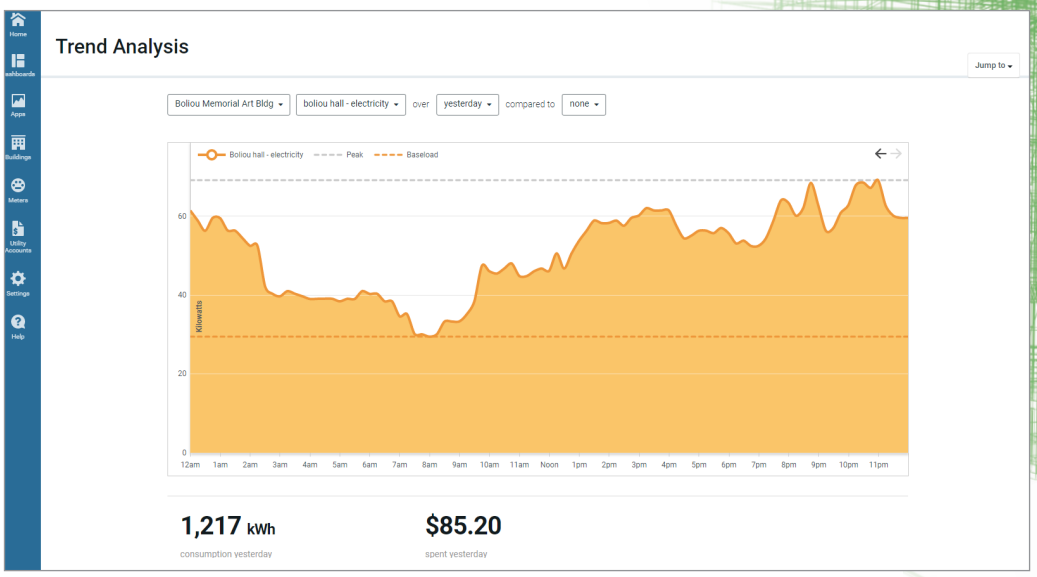
Getting Started

Once you've decided that you want to access the energy and cost savings achievable by installing an EMIS, it can be daunting to decide on the right tool and get your organization up and running. This section summarizes helpful insights from Smart Energy Analytics Campaign participants as they installed their EMIS:

- **Start with good data**
- **Kick off with a pilot to avoid overload**
- **Combine with other efforts like commissioning**
- **Consider EMIS as enhancing staff capabilities**
- **Start with a specific goal in mind**
- **Consider using third parties to manage risk**

Start with good data

Everything starts with good data. All the owners in the Campaign installed an EMIS to bring greater visibility to their building operations. In particular, **Carleton College**, like many large campuses, focused on "taming the data beast" as their first step: electricity (a combination of interval and monthly meters), natural gas, fuel oil, wind turbine generation, solar PV generation, steam production, condensate return,



Carleton uses EIS time series charts to identify unusual nighttime patterns, oscillations, spikes, and other signs of suboptimal building system performance.

and domestic water were all targeted for Carleton's EIS program. Considerable effort and time were invested in pulling all these data (135 meters and 120 utility accounts) into a reliable database that could feed into an energy information system (EIS). Once they had data they could trust, they were able to leverage a range of analytics to support their energy management team's daily, weekly, and annual operations and maintenance (O&M) practices.

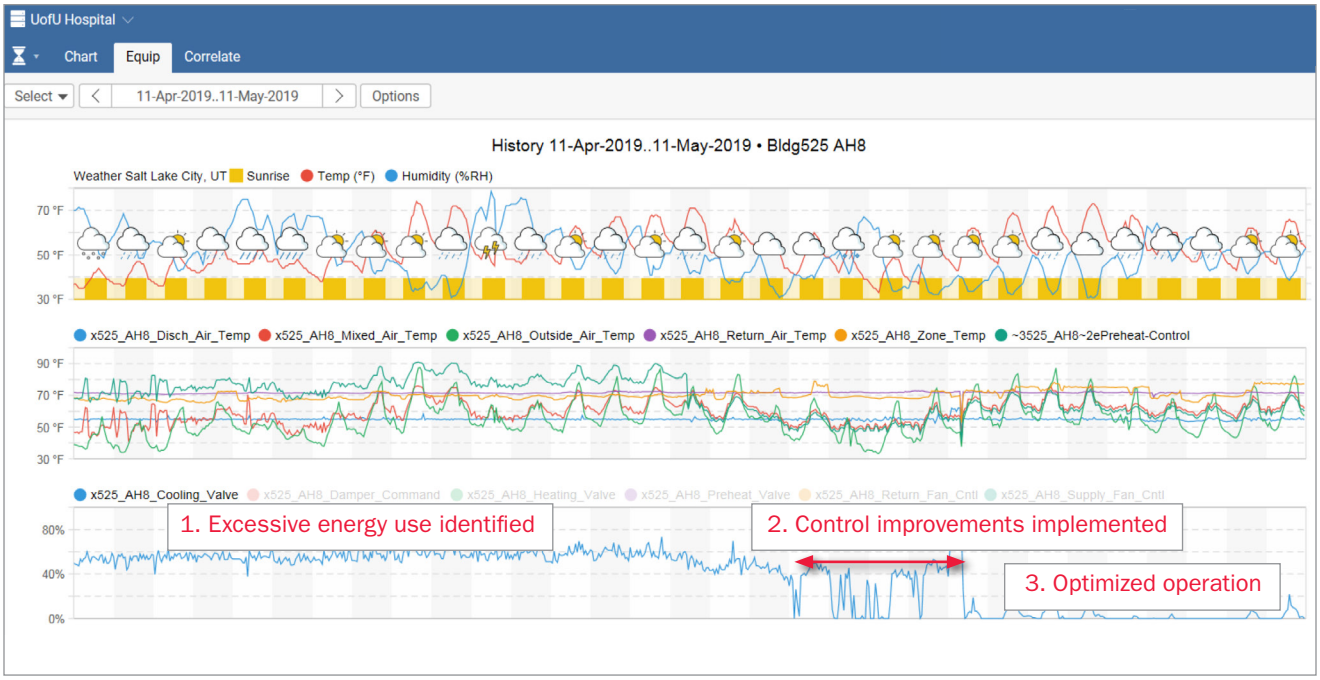
Kick off with a pilot to avoid overload

A large portfolio generates millions of data points on system performance and energy consumption. Given the risk of data overload when getting started with EMIS, it's strongly recommended to begin the process with a pilot. If you own or manage a large portfolio, this may mean starting with a single building; if you own a single building, it may mean initially focusing on specific systems with known performance issues.

University of Utah Health started out with a single-building fault detection and diagnostics (FDD) pilot in 2018. With the support of a third-party engineering firm, they were able to hone their internal energy management processes to take advantage of the FDD analytics capabilities and reduce energy consumption by 10% in just one year. Building on that success, University of Utah Health is now embarking on an expansion of their FDD installation to more than a dozen buildings.

Combine with other efforts like commissioning

Combining EMIS installation with an existing building commissioning (EBCx) project is another way to support a successful initial implementation of EMIS. In 2018 the facilities staff at **Kerry's** Technology and Innovation Center in Beloit, Wisconsin, decided they needed a better view into how heating, ventilation, and air conditioning (HVAC) systems were operating at their 320,000 sq. ft. office/laboratory/manufacturing facility. Installing FDD software appealed to Kerry as a way to make it easier for their small facilities team to address building automation system (BAS) data review challenges. With the help of FDD software they found systems that weren't well-controlled, were wasting energy, or were in need of repair. The facilities team was planning an EBCx project as they began learning about FDD. They worked with their commissioning provider to combine those efforts and achieve energy savings, and then use their EMIS to dig for even deeper savings in the long term.



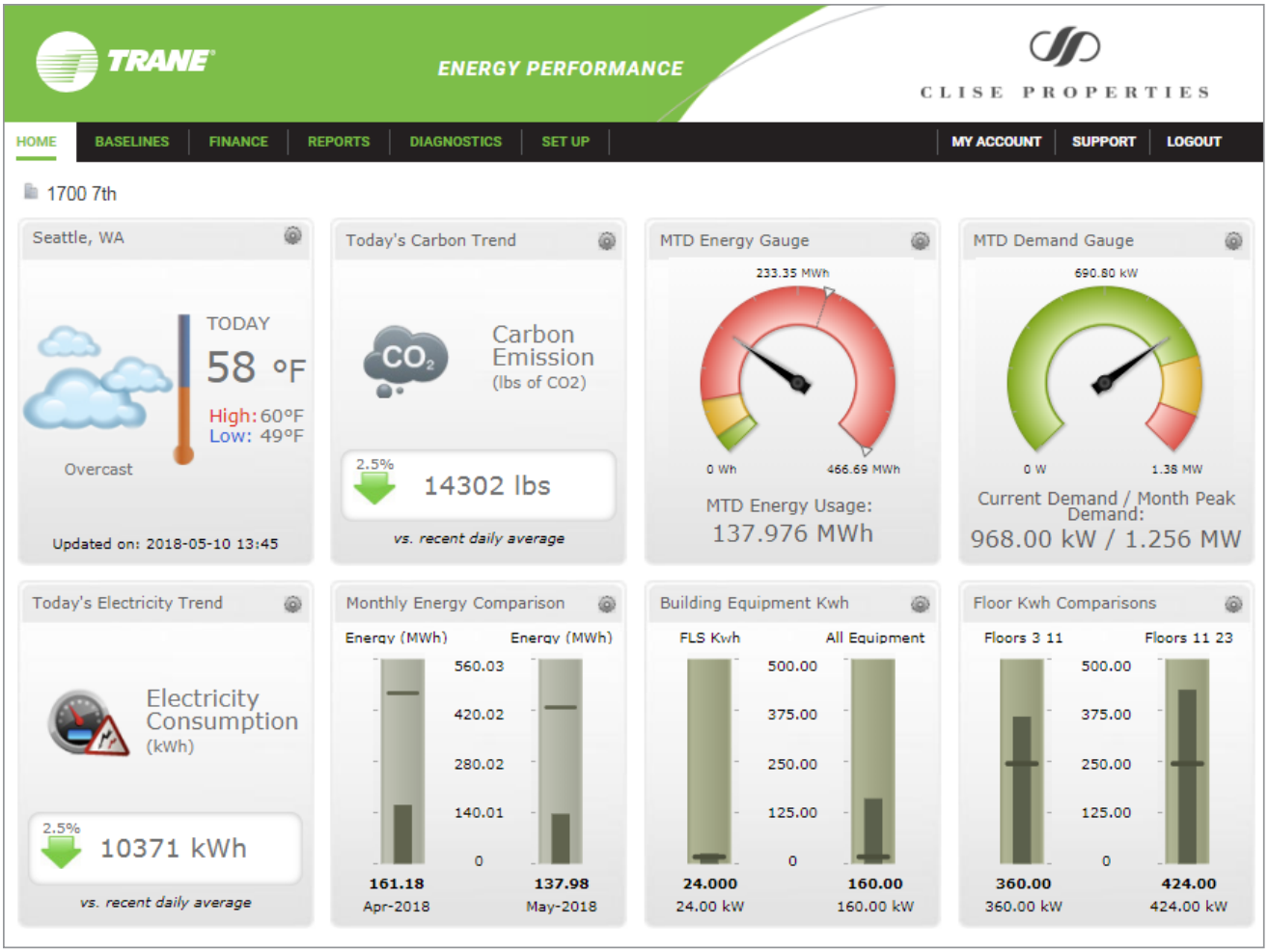
University of Utah Health uses FDD visualization to identify excessive energy use [1], monitor the necessary operational improvements [2], and verify and maintain the optimized performance [3]

Consider EMIS as enhancing staff capabilities

Kerry's experiences reinforce the notion that EMIS is a tool for boosting the capabilities of your staff rather than replacing them. The same staff, equipped with analytics, can shift their efforts toward value-adding activities like energy reduction, proactive maintenance, and addressing operational issues before they show up as occupant comfort complaints.

Start with a specific goal in mind

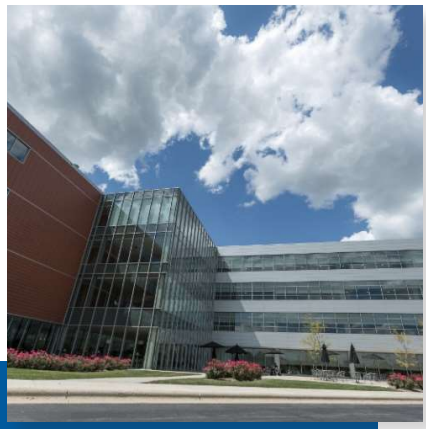
With such a broad range of functionality available it can very helpful to start out with a specific goal in mind when considering installing an EMIS. When **Clise Properties, Inc.** discovered that peak electric demand charges had almost doubled in the space of a few years, they saw a strong need for a tool to manage and reduce those costs. Using their EIS they were able to identify exactly when they were reaching their demand peak each day, and with some controls modifications have been able to reduce their peak demand during morning warm-up. The EIS enabled the size and time of the peak, as well as total energy usage, to be closely tracked and analyzed. Once Clise was familiar with their tool and had reaped significant early benefits ($17,000 savings in the first quarter after implementing their EIS), they started to explore the additional benefits that could be achieved using their tool's FDD functionality.



Clise Properties, Inc.'s EIS dashboard helps operations staff identify and track energy-saving actions

Consider using third parties to manage risk

Despite a rapidly growing body of research demonstrating the benefits and cost-effectiveness of EMIS, it can still be challenging for an energy manager to convince senior management to invest in analytics when there are many competing priorities for building owners' annual budgets. **Swedish Medical Center** and **Universal Health Services** are examples of organizations that took a creative approach to managing EMIS investment risks. They procured their FDD through third-party service providers who helped implement improvements and provided assurance of savings. This type of arrangement is well-established for major capital investment projects, but is a relatively new development for EMIS/MBCx. Both Swedish Medical and Universal Health Services have since expanded their FDD installations to additional buildings, built on their initial success with the service provider-led use of their FDD software.



> **"The idea that the faults can be pushed to us instead of us needing to search for them convinced us to move forward with installing an FDD tool. We have a small team on site and the faster we can find issues, the more quickly we can get them solved."**
>
> – James Swarthout, Facility Manager, Kerry

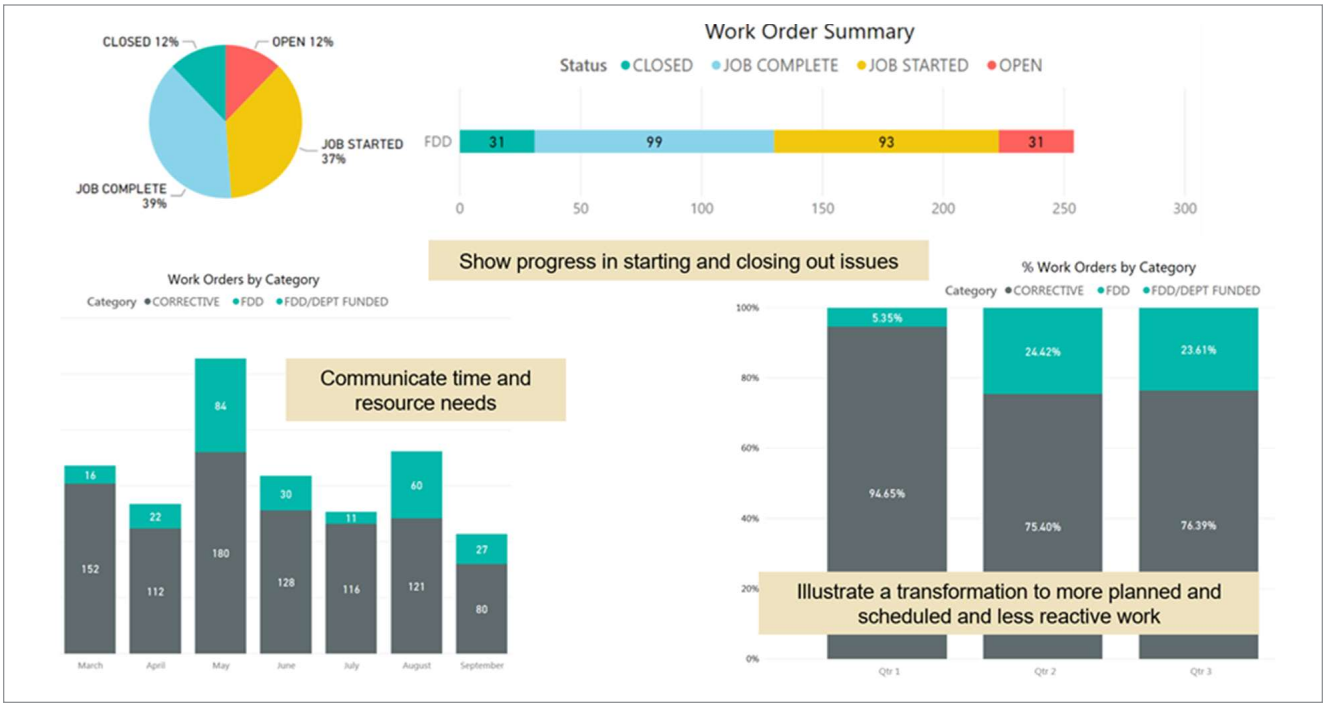
Best Practices

Long-term success with EMIS requires integration of the technology with an organization's operational practices. EMIS is a tool, and like any other tool, it needs to be well used to get the best results. Smart Energy Analytics Campaign participants have shown that EMIS, applied consistently, helps evolve an organization's operations from reactive to proactive mode. This section highlights the following examples of EMIS management best practices demonstrated by Campaign participants:

- **Monitoring-based commissioning**
- **Link EMIS to a work order system**
- **Integrate EMIS with regular meetings**
- **Leverage EMIS to maintain management support**
- **Use EMIS analytics to make energy waste visible**
- **Use EMIS in newly-construction buildings**
- **Create public dashboards to raise energy awareness**

Monitoring-based commissioning

Monitoring-based commissioning (MBCx) provides a structured approach to identifying, resolving, and verifying operational improvements. It is a powerful way to ensure that identified opportunities are acted upon, and is an example of a best practice process that takes full advantage of EMIS functionality. Whether using a third-party commissioning firm or managing the process in-house, MBCx supports operator training, improved documentation, enhanced comfort, and direct cost savings. Further, it's not simply a case of fixing problems and then maintaining what you have achieved. **California State University Dominguez Hills** reaped annual energy cost savings of $100,000 in the first wave of their MBCx program, then six months later they went deeper and uncovered opportunities for another $100,000 in savings. FDD has been critical in achieving and maintaining those savings.



University of Iowa's work order summary dashboard supports proactive O&M practices

Link EMIS to a work order system

Linking an EMIS to a computerized maintenance management system (CMMS) is a reliable way to support fault resolution that is fully integrated with daily maintenance practices. The **University of Iowa (UI)** is one organization that has embraced this integration approach with their FDD tool, and saw $780,000 in energy cost savings within 12 months. In addition to helping resolve critical issues, UI uses their FDD tool's CMMS integration to help with resource planning; work orders for urgent operational issues must be addressed immediately, but the FDD tool also identifies less critical issues that can be added to longer term planned maintenance schedules.

Integrate EMIS with regular meetings

UI's Analytics Response Group meets each morning to prioritize, plan, and coordinate the response to their FDD software's recommendations. Their efforts have led to data-driven decision-making rather than decisions based on gut feel or response to emergencies. Results from the Smart Energy Analytics Campaign show that integrating analytics with ongoing operational processes through regular meetings is a significant enabler for successful outcomes from analytics. Whether it's daily, weekly, or monthly meetings, a regular schedule helps to

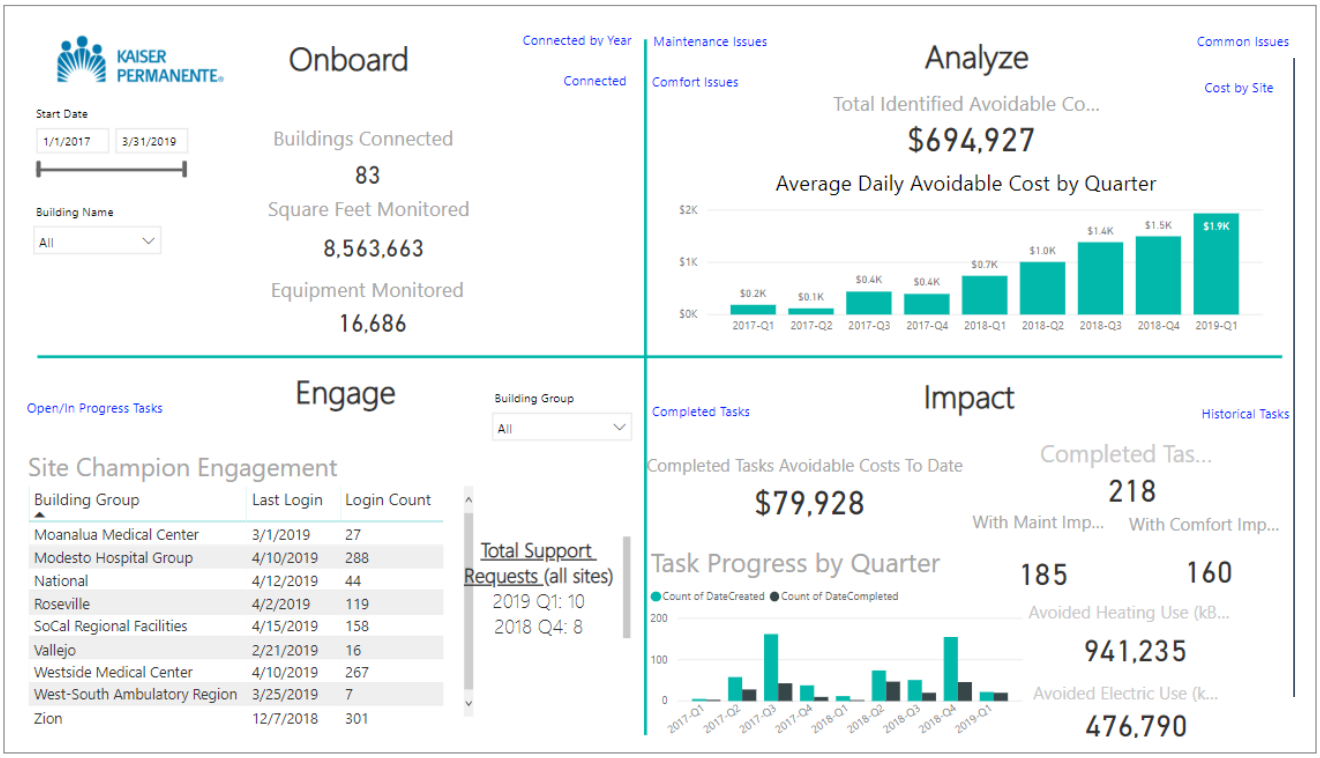
> **"We saved $780,000 in energy cost in the first year and had 24% of work orders generated by FDD — helping us transition the organization from reactive to proactive mode."**
>
> – Katie Rossmann, Manager, Building Analytics and Ongoing Commissioning, University of Iowa

integrate analytics into an organization as opposed to considering it an occasional add-on tool for projects or when time is available.

Leverage EMIS to maintain management support

Moving from the mechanical room to the board room, getting financial commitment from upper management can be key to any energy efficiency investment, and EMIS is no exception. Beyond the initial EMIS investment, ongoing resources are needed to resolve the issues uncovered, manage building analytics, and cover software subscription costs. A well-crafted portfolio-level dashboard can be a powerful management communication tool for reporting progress on an EMIS roll-out, ongoing energy and cost impacts, site-level engagement, and other metrics. Many EMIS have portfolio dashboard options, and organizations can also choose to pull EMIS data into custom-built reporting platforms, as **Kaiser Permanente** has done. Kaiser Permanente's Impact Report dashboard provides the right level of information to decision-makers in a simple graphical format, which supports continuous improvement as they roll-out FDD across their portfolio.

> **Top-down support and corporate-level energy goals have been critical to the success of our FDD deployment.**
>
> – Gary Mullaney, Senior Energy Consultant, Kaiser Permanente



Kaiser Permanente's Impact Report summarizes analytics results (developed in Microsoft Power BI utilizing FDD data)

Use EMIS analytics to make energy waste visible

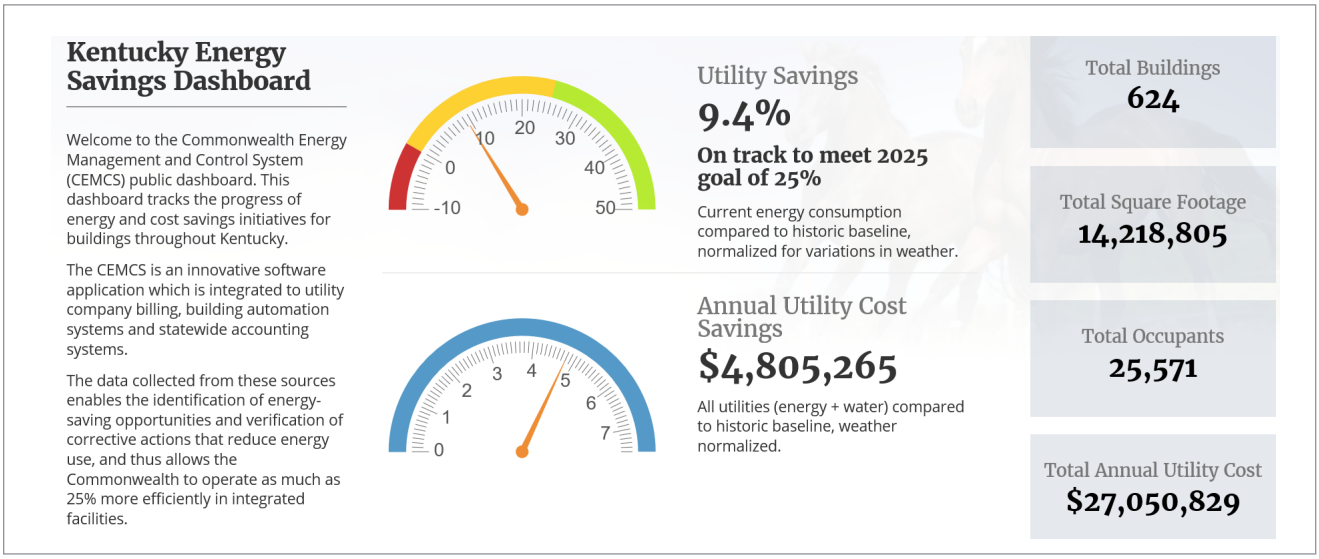
Modern commercial buildings are becoming ever-more complex, and EMIS can be a valuable tool for managing that complexity. For example, **Hewlett Packard Enterprise** (in partnership with ISS Facilities Services) had several buildings with water-side economizers installed, but operation had been so challenging and unreliable that the equipment wasn't being used. FDD software was useful for estimating the energy impact of resolving the water-side economizer issue (based on actual chilled water plant data), and the continuous FDD analytics capability gave operators more confidence that they could maintain the economizers once they were restored to operation. This process convinced the O&M teams that it was worth the effort to get the systems up and running. Some of the chilled water systems had an estimated $35,000 per year in energy savings from integrating their water-side economizers.

Use EMIS in newly-construction buildings

All the examples cited so far have involved applications of EMIS for buildings that have been in operation for many years. However, EMIS can offer significant benefits even for newly constructed facilities. **Salt Lake City** designed their Public Safety Building to achieve net-zero energy performance, but after a year of operation the building wasn't performing to its maximum capability. Systems were operating to original design specifications, but actual electricity and natural gas usage was higher than expected for the net-zero design. To reach performance targets, the Salt Lake City energy team initiated an MBCx project using FDD. Optimizing control of the air handlers, chilled beams, and radiant floors contributed to an overall 57% reduction in natural gas consumption from the MBCx project, and demonstrated the benefits of EMIS for newly-constructed buildings.

Create public dashboards to raise energy awareness

Another best practice when deploying EMIS is to leverage the analytics in sharing relevant data with occupants and the public. This keeps occupants aware of energy-saving initiatives, demonstrates an organization's commitment to transparency and improved building performance, and drives greater accountability for continuous improvement. The **Commonwealth of Kentucky** has developed a public dashboard built upon their portfolio-wide EMIS platform. Users can check consumption and energy savings for 860 buildings across the state using the Energy Savings Dashboard. With statewide energy savings of almost 10% the Commonwealth of Kentucky is well on the way to meeting its aggressive long-term goals.



The Commonwealth of Kentucky's Energy Savings Dashboard is a valuable tool for promoting energy awareness among building occupants and the general public.

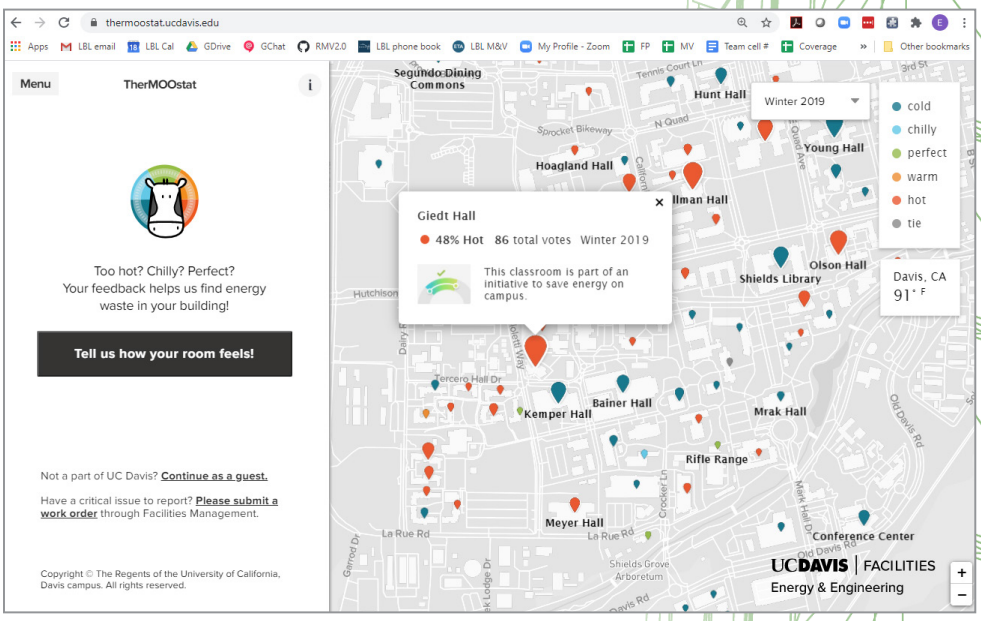
Innovation

Employing foundational best practices when using EMIS has been shown to generate significant long-term savings. From that foundation, leading organizations are striving to reach higher through innovative uses of the data and platforms they have established. This section discusses examples from organizations who have demonstrated innovative uses of EMIS, including:

- **Integration of an occupant engagement platform with EMIS**
- **Use of EMIS to support energy savings competitions**
- **Development of custom energy performance metrics**
- **Leveraging internal resources for EMIS development**
- **Monitoring Wi-Fi connections as a proxy for building occupancy**
- **Application of EMIS to manufacturing processes**

Integration of an occupant engagement platform with EMIS

Using EMIS to actively engage building occupants is an innovative approach to help owners reach those often elusive occupant-driven savings. The energy management team at the **University of California, Davis**,



UC Davis "TherMOOstat" occupant engagement platform

built an occupant engagement tool to complement their campus-wide EIS. The online platform, "TherMOOstat," enables occupants to "vote" in real time on building temperature conditions, and compiles all feedback into a color-coded campus map that highlights temperature control issues. With so much data and analytics available through the EMIS, this type of engagement tool can help users prioritize areas for action; UC Davis' energy management team can review the occupant feedback and use their EIS to analyze energy consumption trends for problem buildings (and FDD where installed).

Higher education, comprising over 30% of Campaign participants, is a market sector taking a strong lead with EMIS. **Stanford University Residential & Dining Enterprises** took their occupant engagement to the next level using an EIS. A student energy-saving competition targeting the low-occupancy period over winter break achieved a 17% energy reduction by driving energy-saving behavior and sharing the results tallied by their EIS. They also addressed a common challenge with dining facilities: while many buildings' energy consumption can be normalized by readily available weather data or building area, dining facilities' energy consumption is driven by meal production volume. To address this issue, Stanford's EIS is configured to monitor an innovative metric — "energy cost per meal" — to further raise awareness of consumption. As a result of these and other EMIS initiatives, Stanford has gone from "just paying the bills" to proactively monitoring consumption and motivating occupants to drive energy-saving actions.

When **Macalester College** decided to introduce an EIS, they took an innovative approach to the development process. After installing submeters across the campus, a computer science student was tasked with developing a user-friendly real-time EIS dashboard in partnership with campus stakeholders. Macalester's EIS is helping them identify energy savings opportunities and track progress toward long-term goals, while also engaging students actively in the process. Early data showed 5% electric savings across 26 buildings equipped with Macalester's EIS. Many

> **"We have over 50 individuals responsible for building management that had never seen any consumption information. With EIS, now we can all be utility managers."**
>
> – Kristin Parineh, Sustainability & Utilities Manager, Stanford University

higher education institutions (and some high schools) often have "living lab" connections between operations and research/engineering faculty; EMIS provides a solid foundation to capitalize on those connections.

Another educational institution, **Pomona College,** is pushing the boundaries of EMIS in a different way. Building occupancy levels can have a significant impact on energy use and are also key to optimizing system control strategies. Real-time data on buildings' occupancy, however, is very rare, and can raise valid concerns around protecting individuals' personal data. Pomona College is exploring the use of Wi-Fi data as a proxy for building occupancy; tracking and analyzing the number of Wi-Fi connections can be used to infer occupancy levels, without needing to collect any information on who is connected or the data that are

being transferred over the network. Importing real-time Wi-Fi connection data into the EMIS can support improved control sequences and more accurate measurement and verification of energy savings.

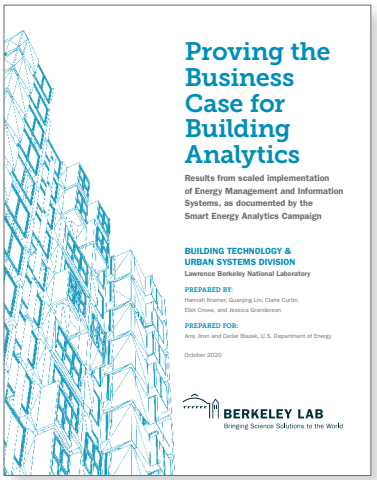
Amgen Inc., a biotechnology company, saw the benefits of adding FDD to their operations management processes beyond the typical facility types in which FDD is deployed. After successfully launching their FDD efforts on office and lab facilities, Amgen decided to expand to their manufacturing facilities. Installing FDD for manufacturing is relatively rare, but Amgen is successfully using analytics to track key performance indicators (KPIs) in wastewater treatment plant operations. The use of FDD is a key element of Amgen's long-term strategy for meeting carbon reduction goals.

> **"Standardizing the visualization of global site utility data facilitates decision-making and is key to measuring Amgen's global carbon reduction."**
>
> – Tom Spooner, Director, Amgen, Inc.

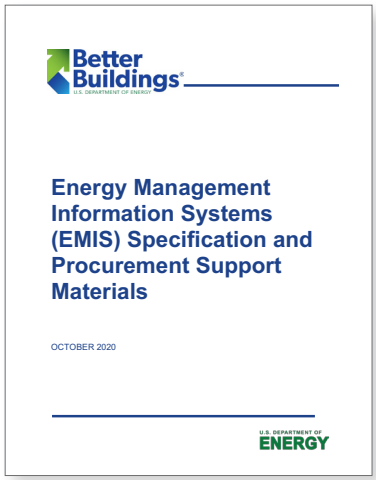
Campaign Toolkit

Whether you are looking to get started on your EMIS journey, integrate more best practices for your existing EMIS, or explore innovative ways of getting more from building analytics, the U.S. Department of Energy's Better Buildings Solution Center has a comprehensive Campaign Toolkit where you can find guidance, templates, success stories, research reports, and many other resources.

Examples of resources available from the Campaign Toolkit:

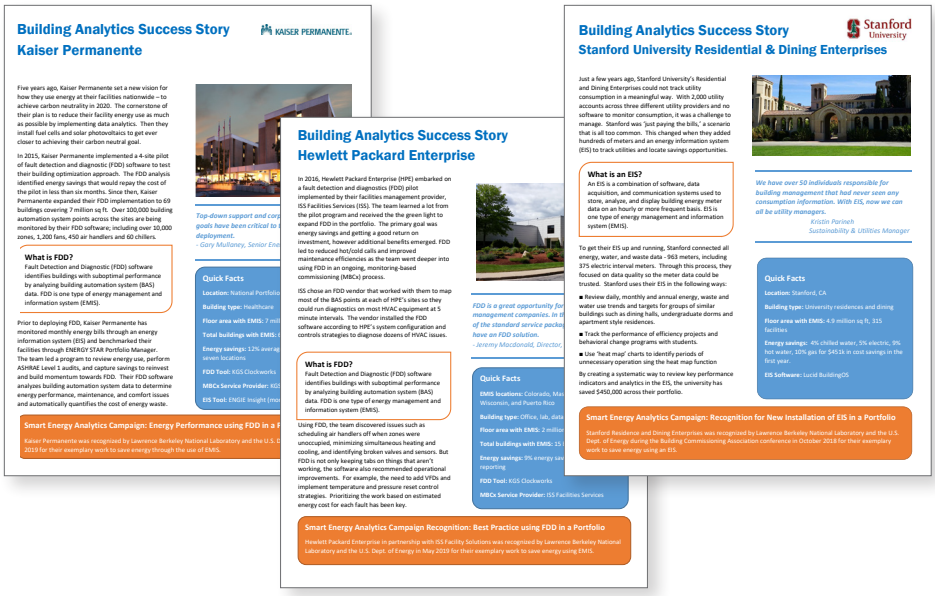


Proving the Business Case for Building Analytics



EMIS Specification and Procurement Support Materials

Monitoring-Based Commissioning (MBCx) Plan Template

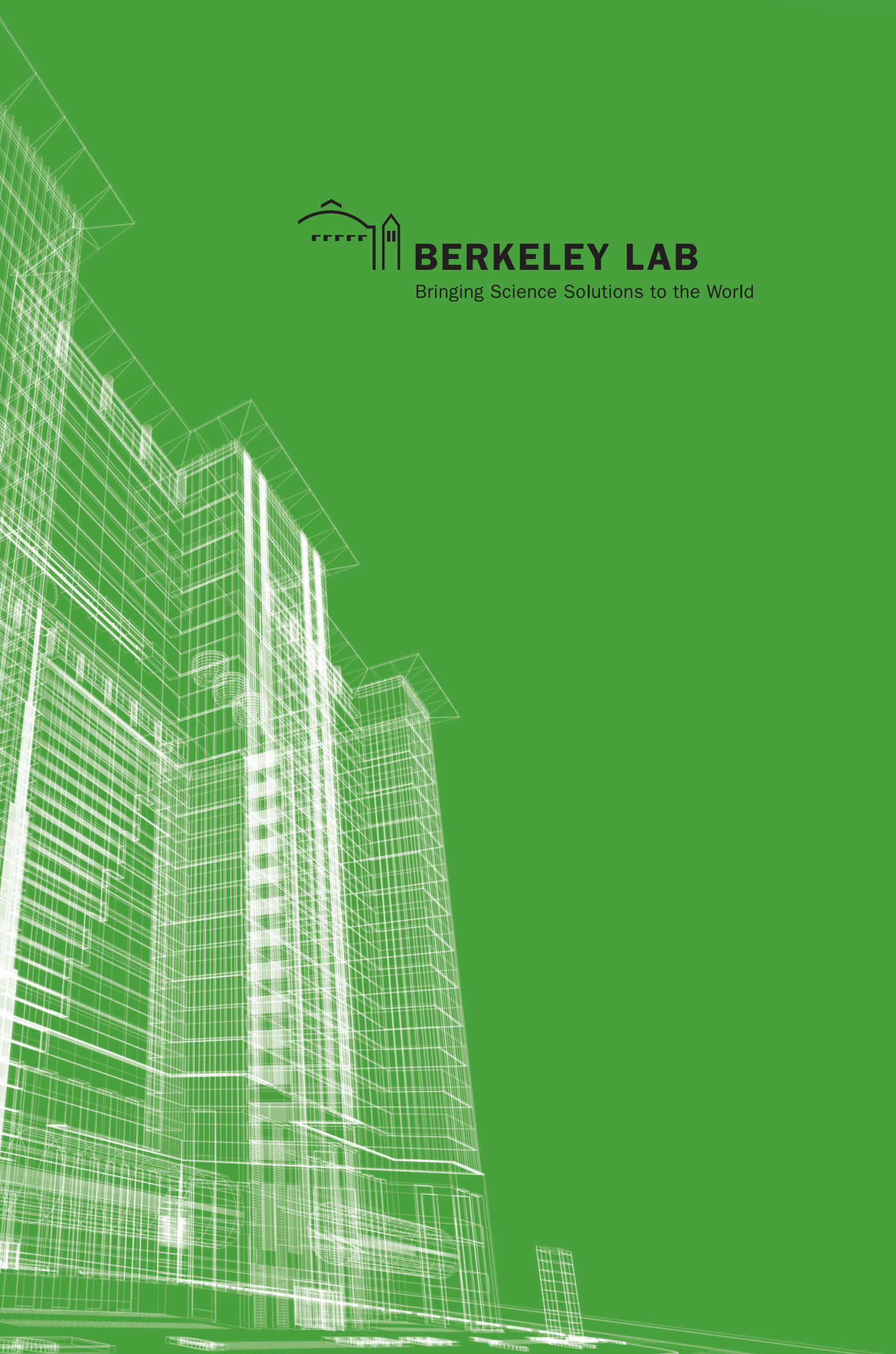


Success stories for 24 organizations recognized by the Campaign

Smart Energy Analytics Campaign Recognition

Organization	Property Type with EMIS	Year	Recognition Category
Sprint Headquarters	Office	2017	Best Practice (FDD)
The Franklin	Office	2018	Energy Performance in a Single Site (EIS / FDD)
Clise Properties, Inc.	Office	2018	New Installation of EIS in a Single Site
Jamestown	Office	2019	Energy Performance Using an EIS in a Portfolio
Hewlett Packard Enterprises in association with ISS Facility Services	Office	2019	Best Practice using FDD in a Portfolio
LBA Realty	Office	2019	New Installation (EIS / FDD / ASO)
Commonwealth Partners	Office	2020	Best Practice using an EMIS
Kerry	Office/Laboratory/ Manufacturing	2018	New Installation of FDD in a Single Site
Amgen, Inc.	Office/Manufacturing	2019	Innovation in the Use of FDD
Benchmark Electronics	Office/Manufacturing	2019	Energy Performance for a Single Site (EIS)
Commonwealth of Kentucky	Office, Food Service, Higher Education, Healthcare	2017	Expansion of EMIS (EIS / FDD)
District of Columbia Department of General Services	Office, K-12 School	2018	Largest Portfolio Using EMIS (EIS/FDD/ASO)
General Services Administration (GSA)	Office, Other	2018	Energy Performance in a Portfolio (FDD)
Commonwealth of MA - DCAMM	Office, Healthcare, Higher Education, Public Safety	2019	Largest Portfolio Using an EMIS (EIS)
Emory University	Higher Education	2017	Energy Performance in Portfolio (FDD)
University of California, Davis	Higher Education	2017	Innovation (EIS / FDD)
Carleton College	Higher Education	2017	New Installation of EIS
Central Piedmont Community College	Higher Education	2017	New Installation of FDD
Stanford University Residence and Dining Enterprises	Higher Education	2018	New Installation of EIS in a Portfolio
University of Iowa	Higher Education	2018	Best Practice in the Use of FDD

Organization	Property Type with EMIS	Year	Recognition Category
California State University, Dominguez Hills	Higher Education	2018	Innovation in the Use of EMIS (FDD)
Vanderbilt University	Higher Education	2019	New Installation (FDD)
Macalester College	Higher Education	2019	Innovation Using EIS for a Portfolio
Stony Brook University	Higher Education	2020	Largest Portfolio (EIS)
Pomona College	Higher Education	2020	Innovation using an EMIS
Universal Health Services, in association with Grumman Butkus Associates	Healthcare	2019	New Installation (FDD)
Swedish Medical Center, in association with MacDonald-Miller Facility Solutions	Healthcare	2019	New Installation (FDD)
Kaiser Permanente	Healthcare	2019	Energy Performance Using FDD in a Portfolio
University of Utah Health	Healthcare	2020	New Installation (FDD)
Salt Lake City Public Safety Building	Public Safety	2017	Energy Performance in a Single Site (FDD)
Aurora Public Schools	K-12 School	2017	New Installation of EIS
MGM Resorts International	Hospitality	2017	Largest Portfolio using an EMIS (FDD)



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