Better Buildings®
U.S. DEPARTMENT OF ENERGY

A Primer on Organizational Use of Energy Management and Information Systems (EMIS)

Second edition

Lawrence Berkeley National Laboratory

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Acknowledgments

This guidance was developed with the input of Better Buildings Alliance public- and private-sector members with the aim of developing a holistic primer on the planning, implementation, and usage of Energy Management and Information Systems (EMIS) technologies, including multiyear guidance for organizational integration and scale-up. It represents a synthesis of best-practice insights gained through several years of collaboration between Lawrence Berkeley National Laboratory and key members of industry, including EMIS vendors, users, and subject matter experts. This second edition, released in 2021, provides updates to terminology and examples.

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Section 1. Introduction to the Primer

Energy Management and Information Systems (EMIS) are a broad family of tools and services used to manage building energy use. EMIS include monthly data analytics, energy information systems, fault detection and diagnostic tools, and automated system optimization software. An EMIS can be used to provide a number of recognized benefits:

- Identify energy efficiency opportunities
- Detect system or equipment faults
- Track and compare building and equipment performance
- Track and manage demand charges
- Validate utility bills
- Measure and verify project-specific savings
- Provide data to ground and set energy goals

EMIS technologies have been shown through recent research by Lawrence Berkeley National Laboratory to enable a median whole-building savings of 3% for energy information systems and 9% for fault detection and diagnostic systems (Kramer et al., 2020). Best practice EMIS implementations (top quartile) result in 11%–22% portfolio savings for energy information systems and 15%–28% for fault detection and diagnostic tools. This primer is designed to help owners reap the energy savings and other benefits of EMIS from planning to ongoing use. Users of this primer will be able to identify:

- Different types of EMIS technologies and their associated benefits
- Steps that an organization can take to maximize the success of an EMIS implementation
- EMIS procurement, installation, commissioning, and training issues
- Effective ways to scale up and evolve EMIS use over time

The target audience for this primer consists of organizations either considering or in the early phases of implementing an EMIS, including building owners, facility managers, energy and sustainability managers, and commercial property management companies. Secondary audiences that may also benefit from this primer include analysis-as-a-service and facilities management service providers.

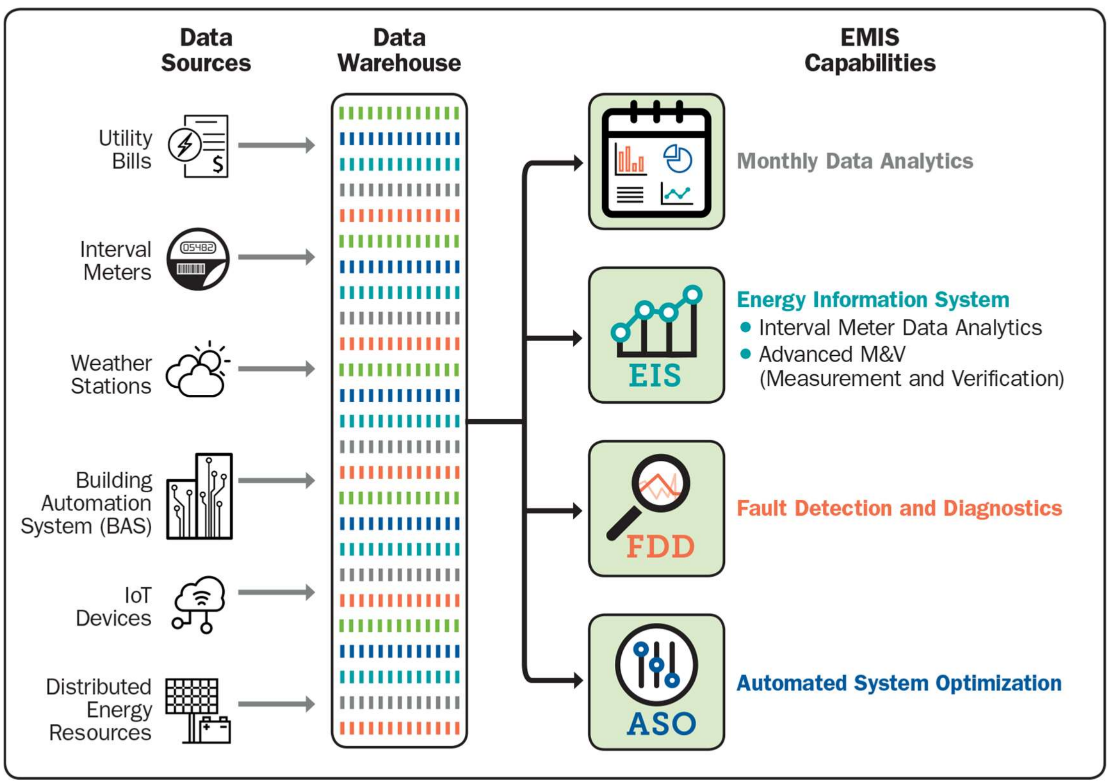
The primer is organized as follows: Section 2 provides an overview of EMIS and the associated terminology. Sections 3 through 5 address the overall process of planning, implementing, and using an EMIS. Section 6 provides guidance on best practices to get the most out of an EMIS.

Section 2. EMIS Overview and Terminology

Energy management and information systems (EMIS) are the broad and rapidly evolving family of tools that monitor, analyze, and control building energy use and system performance. The data generated from EMIS tools enable building engineers and facility/energy managers to operate their buildings more efficiently and with improved occupant comfort by providing visibility into and analysis of the operations of lighting, space conditioning and ventilation, and other end uses. EMIS is another tool in their toolbox to unlock improvement opportunities that are not typically apparent without automated analysis.

Based on over a decade of EMIS research, Lawrence Berkeley National Laboratory (LBNL) has established the EMIS categorization framework (Figure 1), which reflects input from EMIS vendors, users, and subject matter experts (Kramer et al., 2020). This framework provides a common reference that can be used to orient users to the key distinguishing factors and primary applications of different EMIS technologies. Users can match their desired organizational energy management activities to the EMIS capabilities that help streamline those activities. A single software tool often incorporates more than one of the EMIS capabilities shown in Figure 1, and a few EMIS vendors include all the capability areas in their software.

FIGURE 1: EMIS FRAMEWORK – DATA INPUTS AND EMIS CAPABILITIES



The left-hand side of Figure 1 shows that building operations data are available from many sources, and with the proliferation of new technologies (e.g., Internet of Things [IoT] devices, distributed energy resources) the volume of data has increased exponentially in recent years. EMIS have emerged to enable building owners to extract accurate and actionable insights from large amounts of data. For example, modern building automation systems (BAS) monitor hundreds of points per building, and an owner may have a portfolio generating many thousands of data points at 15-minute intervals. The BAS can provide alarms for data that are out of range, but the analytical capabilities fall well short of helping to identify solutions to achieve an optimized system. EMIS provide the needed analytical horsepower to help building owners find meaning from data.

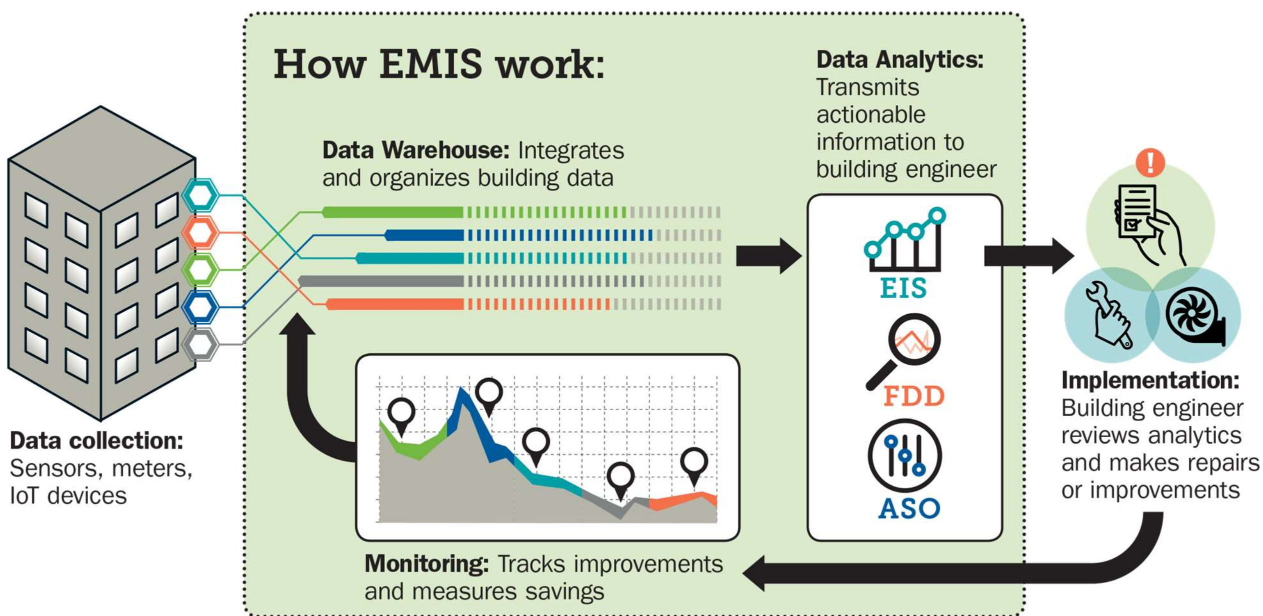
EMIS and MBCx

While EMIS are powerful tools, any tool needs a process that utilizes it to have impact. Monitoring-based commissioning (MBCx) is an ongoing process that monitors and analyzes large amounts of data on a continuous basis, and EMIS are an integral part of streamlining analysis and automating the MBCx process.

MBCx has roots in the existing building commissioning (EBCx) process. Traditionally, EBCx has been implemented by commissioning providers manually analyzing a short-term data snapshot of building performance; the advent of EMIS has enabled these commissioning providers to use real-time data to provide automated analytics and address problems as they are identified. EBCx and MBCx address the same type of operational issues in buildings (e.g., reduction in excess heating or cooling, identification of faulty equipment, and optimization of controls), and achieve similar levels of savings. Energy savings from EBCx processes from a database of almost 1,300 projects have been documented to be 3%–12% (Crowe et al., 2020b).

MBCx may be used after EBCx to track whether energy savings has persisted and to find additional opportunities. Alternatively, an MBCx process can be used from the outset, instead of EBCx, to find and correct issues. Figure 2 illustrates the three main elements of EMIS tools (data warehouse, data analytics, and monitoring) and shows how these tools are incorporated into the MBCx process. While MBCx is a recommended best practice, many organizations have successfully implemented EMIS without a defined MBCx process. The EMIS may be integrated into daily building operations as a support tool, enabling data-driven decision making for facilities teams.

FIGURE 2: MONITORING-BASED COMMISSIONING (MBCX) PROCESS



EMIS TOOLS: Energy information systems (EIS) help find energy waste using smart meter data. Fault detection and diagnostic tools (FDD) detect and prioritize HVAC system faults. Automated system optimization (ASO) includes control algorithms to minimize energy use across systems.

EMIS Terminology

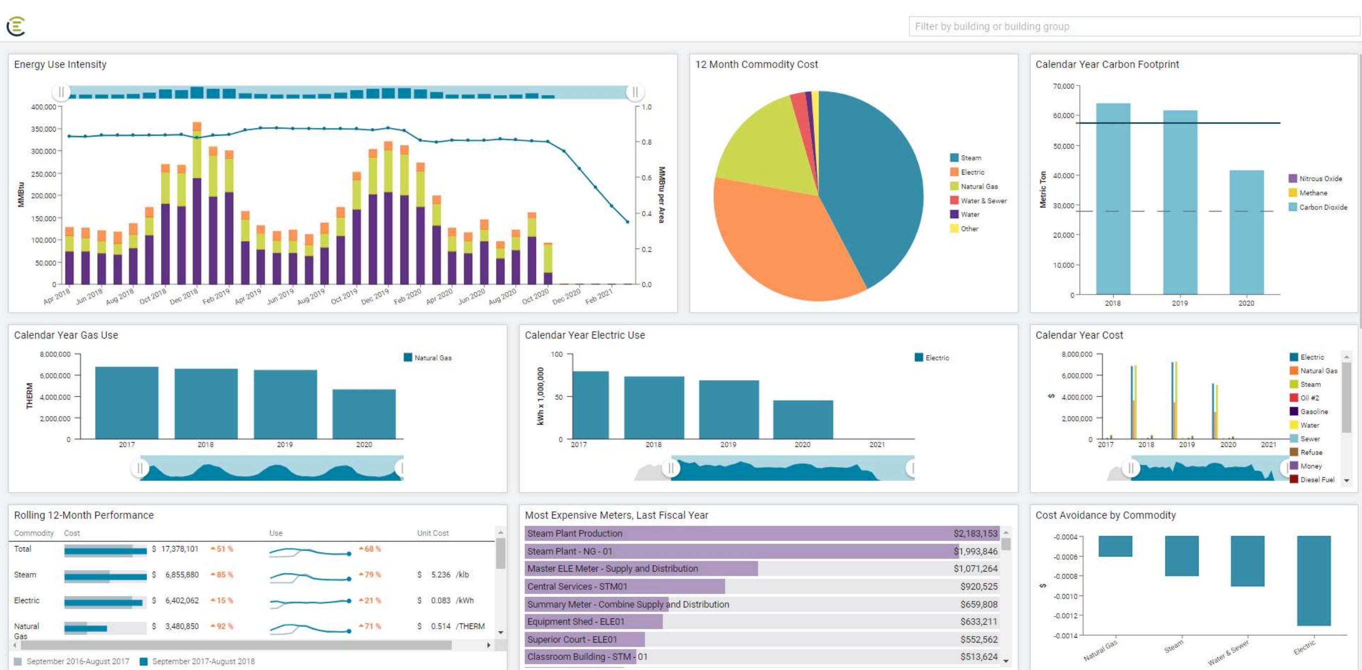
The range of EMIS capabilities available in current products includes monthly data analytics, energy information systems (EIS), fault detection and diagnostic systems (FDD), and automated system optimization (ASO) software. An EMIS product can have capabilities in multiple categories and can accept a wide range of data inputs. Data from multiple systems and devices are often brought together into a data warehouse, which may be hosted in the cloud or on the premises. EMIS tools supplement the BAS to facilitate analysis and management of building performance, including energy, comfort conditions, and ventilation. The following descriptions provide more in-depth information about the EMIS technologies that are the focus of this primer, including the formal names for these technologies as well as some of the other terminology you may encounter in case studies or marketing materials.

Monthly data analytics

Monthly data analytics are software used for managing and validating monthly utility bills and for energy performance benchmarking, a process of measuring a building's performance against its own past performance or against similar buildings. Benchmarking can be implemented within an owner's portfolio or compared to a national database (e.g., using ENERGY STAR Portfolio Manager). The benchmarking process helps identify underperforming buildings to target for efficiency improvements. Monthly data analytics tools use monthly whole-building energy data and some offer weather normalized energy use. Figure 3 shows the types of plots and analyses common in monthly data analytics tools.

Monthly data analytics tools may also be referred to as *benchmarking, utility tracking,* or *billing reconciliation tools,* or as *monthly energy monitoring systems.*

FIGURE 3: EXAMPLE MONTHLY DATA ANALYTICS SCREENSHOT



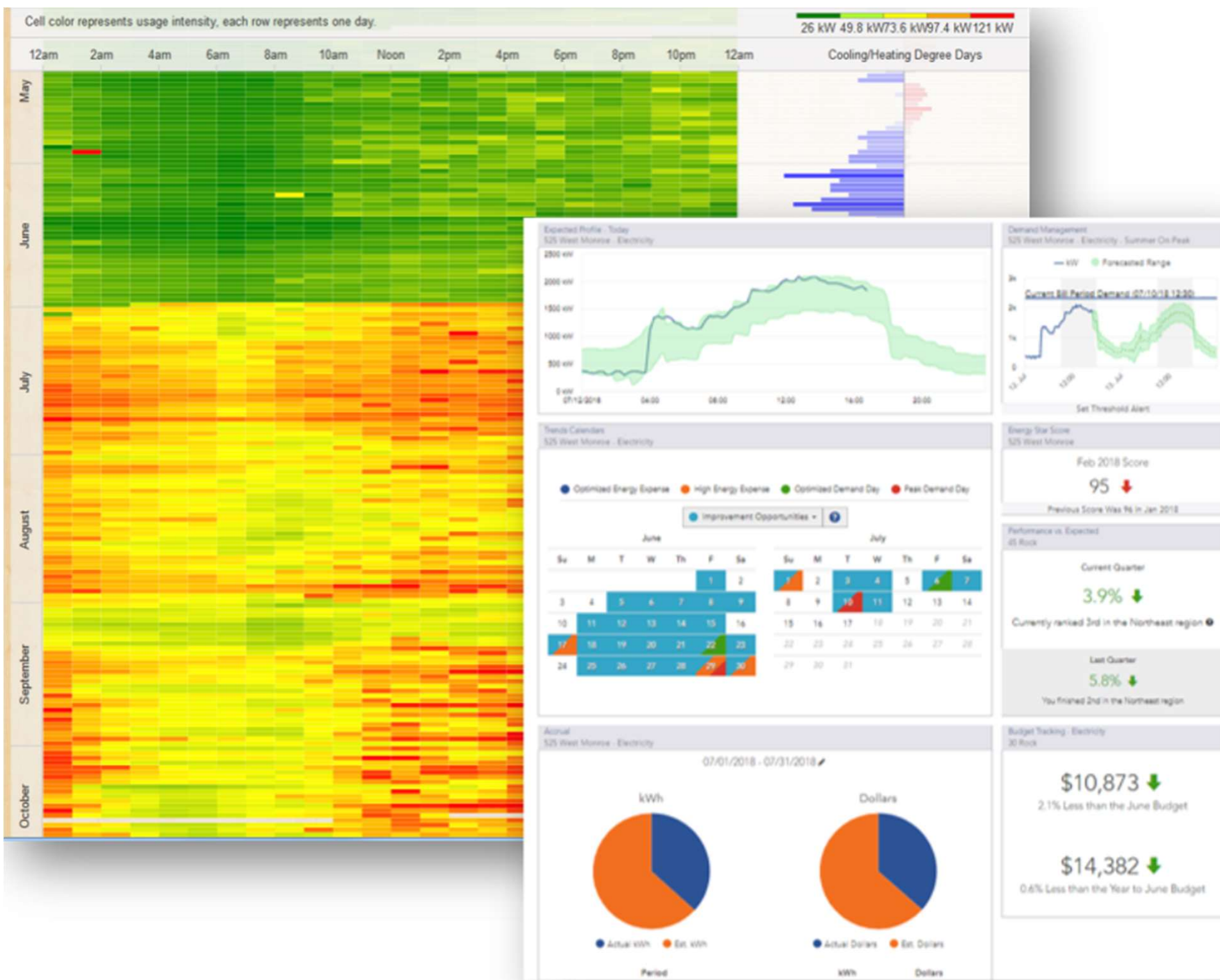
Source: EnergyCAP

Energy information systems

Energy information systems are software, data acquisition hardware, and communication systems used to store, analyze, and display energy meter data. EIS are a subset of EMIS that are focused on meter-level monitoring (hourly or more frequent). Data are primarily acquired from whole-building electricity and gas meters, but also can include submeter and system-level data, depending on the depth of monitoring at the site. External data sources such as time-series weather data, energy prices, and demand response information may be integrated into the EIS to enhance its analytical capabilities. Basic EIS features include data visualization or dashboard viewing; portfolio, building, or submeter energy tracking; time-series load profiling; and peak load analysis. More advanced EIS offerings provide a higher degree of automated analytics, in combination with baseline models used to normalize for key energy drivers such as weather and day/time of week. Figure 4 shows the types of plots and analyses common in EIS.

EIS may also be referred to as *whole-building* or *continuous energy monitoring systems, energy performance tracking systems, meter visualization* and/or *energy analytics tools,* or *enterprise energy management systems.*

FIGURE 4: EXAMPLE EIS SCREENSHOTS



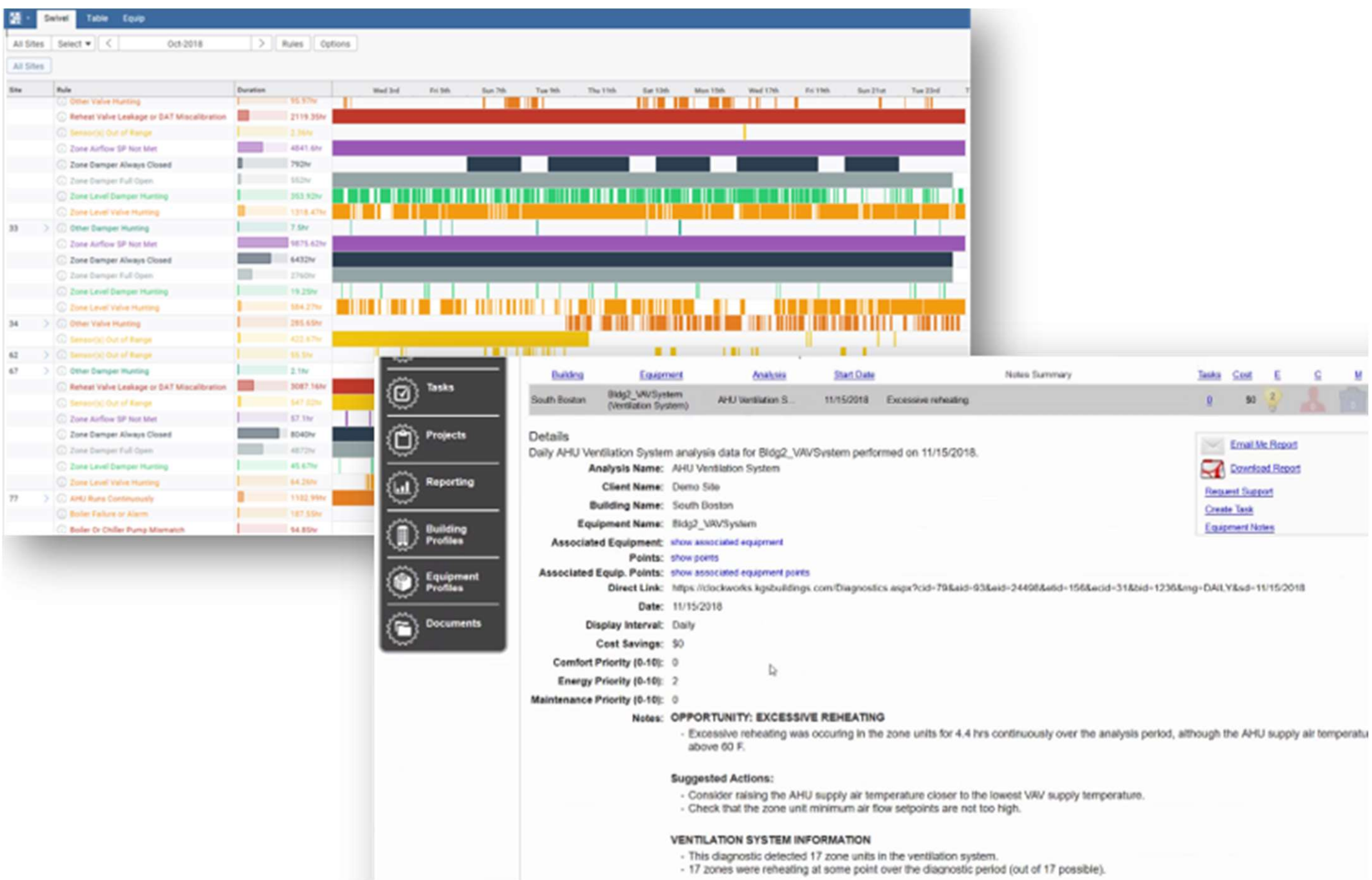
Source: Left to Right: Carleton College (Building OS), Tishman Speyer (Mach Energy)

Fault detection and diagnostic systems

Fault detection and diagnostic systems are software that automates the process of detecting faults and suboptimal performance of building HVAC systems and helps to diagnose their potential causes. FDD are a subset of EMIS that focus on system-level monitoring using BAS and IoT data. In contrast to BAS alarms, which can detect sensor value deviation associated with a specific point based on real-time conditions, FDD systems allow for sophisticated logic that interrelates multiple data streams and performs rule-based or model-based diagnostics. FDD tools are most often applied as a separate software application that obtains data from the BAS and may provide a report of the duration and frequency of faults, as well as their cost and/or energy impacts and relative priority levels. They usually provide several possible causes or recommendations for correcting each fault, requiring either additional data analysis of the time-series data (conveniently linked to the fault report) or on-site inspection. Figure 5 shows examples of plots and fault notifications available in commercial FDD tools.

FDD may also be referred to as *system monitoring and analytics tools* or *ongoing* or *monitoring-based commissioning systems.*

FIGURE 5: EXAMPLE FDD SCREENSHOTS



Source (Left to Right): LBNL (SkyFoundry) - individual faults with duration; Demo Site (Clockworks Analytics), fault details

Automated system optimization

Automated system optimization consists of software that continuously analyzes and modifies BAS control settings to optimize heating, ventilation, and air conditioning (HVAC) system energy usage while maintaining occupant comfort. These tools read data from the BAS and automatically send optimal setpoints back to the BAS to adjust control parameters based on data such as submetered energy use. Two-way communication with the BAS distinguishes ASO solutions from FDD. These tools generally focus on optimizing chilled water plant and air handling unit (AHU) reset strategies based on outdoor conditions. For example, an ASO tool may determine a day-ahead optimal start time for a chilled water plant based on weather and load forecasts, with an objective to minimize total plant energy use. Control settings that may be altered by ASO tools include chilled water/condenser water supply temperatures, air handler discharge air temperature and duct static pressure, and thermostat cooling and heating setpoints.

ASO technologies are the newest in the EMIS family, with a more limited number of commercial offerings and users. Figure 6 shows an example of an ASO tool with two-way communication for optimizing setpoints on a chilled water plant; the bottom left chart shows the differences between the setpoints driven by the BAS (dotted lines) and the ASO software (solid lines).

ASO may also be referred to as: *control optimization software, continuous optimization,* or *automatic energy optimization systems.*

FIGURE 6: EXAMPLE ASO SCREENSHOT

Source: Demo Site (Yardi Pulse)

EIS, FDD, and ASO systems can be implemented individually or in combination and are intended to support facility staff and management in meeting high levels of building comfort and performance. Using an EMIS to track energy metrics and system faults provides significant operational benefits, including finding and fixing problems more quickly, ensuring efficiency investments pay off, and identifying additional energy performance improvements. Overall, EMIS provide organizations a better understanding of their energy use. Further, EMIS tools can enable a healthy building environment by continuously monitoring systems that provide ventilation to occupant spaces. Table 1 summarizes key characteristics for the EMIS family of technologies.

TABLE 1: KEY CHARACTERISTICS OF EMIS TECHNOLOGIES

	Monthly Data Analytics	EIS	FDD	ASO
Primary Applications	Utility bill reconciliation, energy use and cost tracking; peer-to-peer building comparisons of energy use	Whole-building or portfolio energy tracking at an hourly data level; data visualization	Automated identification of system-level faults, often with associated causes, usually HVAC focused	Automated modification of control parameters to optimize efficiency, energy use, and/or energy costs
Benefits	Provides insight into whole-building energy performance; assists in streamlining bill payment processing and/or tenant billing	Provides granular energy consumption history and summary of use patterns; notifies user when energy exceeds expectation	Early identification of faults can prevent mechanical failure, extending equipment life; Faults flag energy waste for specific equipment	Dynamically change HVAC settings to optimize energy use and comfort
Frequency of Use	Monthly, annually	Daily, weekly, monthly	Daily, weekly, monthly	Instantaneously with review weekly or monthly
Typical Data Scope	Whole building or campus	Whole building, may include submetering and system-level monitoring	BAS data including central plant, AHUs, and zone-level data	Systems, components, BAS trends; may include whole-building or system-level submetering
Typical Data Interval	Monthly	Hourly to 15-minute	15-minute and less	15-minute and less
Energy Savings	2.4% average annual energy savings[a]	3% median annual energy savings ($0.03/sq ft)[b]	9% median annual energy savings ($0.24/sq ft)[b]	Depends on system type Case study: 0%–9% energy savings[c]
Costs	Free or low cost[d]	Base: $0.01/sq ft Annual: $0.01/sq ft[b]	Base: $0.06/sq ft Annual: $0.02/sq ft[b]	Depends on base HVAC system configuration

Notes: (a) The energy savings estimate for monthly energy analytics tools of 2.4% is based on a study of 35,000 buildings that used ENERGY STAR Portfolio Manager to benchmark energy performance (U.S. EPA, 2012); (b) EIS and FDD savings and cost data were key findings from the Smart Energy Analytics Campaign (Kramer et al., 2020); (c) Field evaluation of five buildings (Granderson et al., 2018); (d) ENERGY STAR Portfolio Manager is free of charge, and monthly data analytics tools may have similar cost to EIS, depending on features.

Viewing the EMIS technologies in table format makes it easy to compare and contrast the information to see where the four categories are different and where they are similar. The granularity of data used by the systems decreases from left to right, with monthly data analytics systems focused on monthly data and ASO systems using intervals of 15 minutes or less. When looking at the energy savings and cost data, both the savings and costs tend to increase with system complexity and capabilities (from left to right).

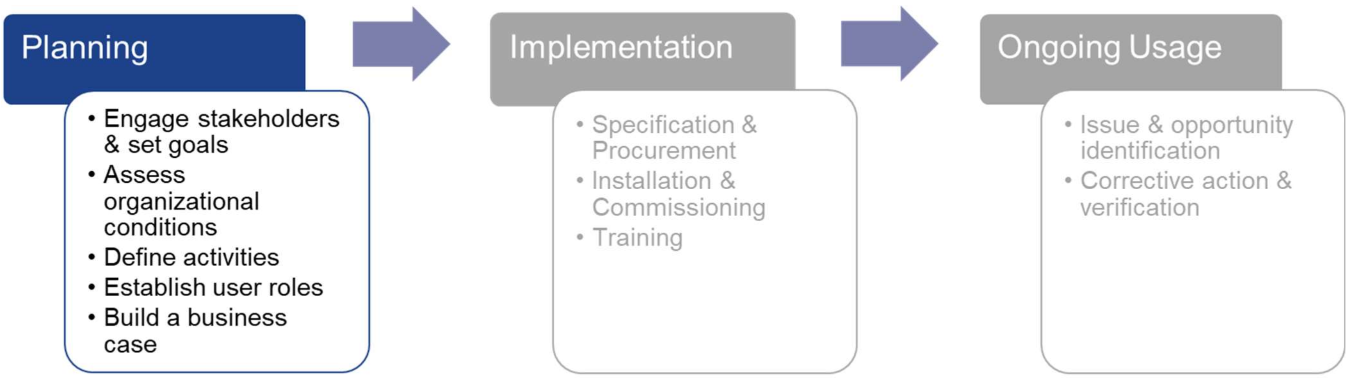
Reliable EMIS energy savings and cost data can be difficult to obtain. To overcome this barrier to EMIS adoption, the U.S. Department of Energy (DOE) and LBNL conducted the Smart Energy Analytics Campaign from 2016 to 2020, as part of a public-private partnership. The Smart Energy Analytics Campaign provided technical assistance, recognized exemplary organizations, and collected data from 104 organizations across the United States, totaling 567 million square feet of gross floor area and more than 6,500 buildings. The campaign produced the largest dataset on EMIS costs and benefits, with findings including a median two-year simple payback (Kramer et al., 2020).

The EIS and FDD energy savings and cost data in Table 1 represent key findings from the Smart Energy Analytics Campaign, in which almost all the participating organizations implemented or planned to implement EIS or FDD. While two organizations with ASO participated in the campaign, the data were insufficient to determine savings and cost estimates. One study of five field demonstrations of ASO resulted in a range of savings, depending on the baseline conditions and software application (Granderson et al., 2018). The energy savings estimate for monthly energy analytics tools of 2.4% is based on a study of 35,000 buildings that used ENERGY STAR Portfolio Manager to benchmark energy performance (U.S. EPA, 2012). ENERGY STAR Portfolio Manager is a no-cost monthly data analytics tool that facilitates building performance benchmarking.

As indicated in the introduction, the intent of this framework is to provide a common reference to orient users to the different solutions within the family of EMIS technologies and to allow for further exploration of feature sets and tool selection. The following sections draw upon this framework to introduce a process for planning, implementing, and using an EMIS tool.

Section 3. EMIS Planning

Planning for an EMIS requires an organization to set goals, define the activities to meet those goals that fit within the organizational constraints, then obtain funding for the work. An outline for key steps for EMIS planning, implementation, and ongoing use is shown below. Overall, the planning effort should specify what information will be collected, how it will be used (and by whom), and how it will be acted upon. To streamline EMIS implementation, determine the data needs by considering first what analytics are needed to help achieve the organizational goals. Then focus on the EMIS capabilities needed to get there.



The information and insights gained using an EMIS can be relevant to different departments within an organization, so stakeholders across the organization should work together to define requirements. As a simple example, energy managers may leverage EMIS technology features to track utility cost savings from efficiency projects, and those savings may be reported to financial business units. Carefully selecting (and not overspecifying) the number of metering points and sensors necessary to support the desired activities will help reduce data overwhelm and EMIS implementation cost. Lawrence Berkeley National Laboratory developed an EMIS specification and procurement support materials that includes a request for proposals (RFP) template (Granderson et al., 2020). Owners can use this RFP template as a starting point and pare it down to the functionality and services that meets their needs.

The planning process presented in this section can be applied to both existing and new buildings, however much of the detailed guidance is most relevant to existing buildings and portfolios. The process of designing an EMIS for new facilities should be integrated with the design phase of mechanical, electrical, and building automation systems. Including consideration of the analysis and monitoring infrastructure and technologies throughout the building and controls design process can minimize costs and maximize effectiveness.

Engage Stakeholders and Set Organizational Goals

Engage key stakeholders from management (construction and engineering for new buildings), facilities and building operations, and IT to help establish goals and security requirements. Executive sponsors are critical to the success of the implementation, and it is important to engage them early.

Through this planning process, the stakeholders that will use the EMIS daily, weekly, or monthly can be identified and included in the planning process. If resources permit, set up a small group, like a technical committee, within the organization. Empowering this group to own the process and to make the ultimate decisions is a great way to engage your organization and get support for the system. Key stakeholder groups that often play a role in the EMIS deployment include Facilities, Procurement, IT, Legal, and Finance. Including these stakeholders early can prevent months of delay once a decision to procure an EMIS has been made.

Some examples of organizational goals include:

- Lowering energy use by 20% over the next three years
- Achieving a building energy use intensity (EUI) benchmark
- Achieving an ENERGY STAR rating of at least 75
- Improving occupant comfort and reducing hot/cold calls
- Reducing carbon footprint
- Reducing facilities operation and maintenance costs
- Assist risk management in areas that require specific operating conditions related to temperature, relative humidity, and ventilation

To inform your goals, benchmark your buildings against similar buildings and conduct audits to estimate technical potential (U.S. EPA, 2013).

Case Study: Organizational Goal Setting: Jamestown

Jamestown is a real-estate investment and management company with nearly $12 billion in assets under management. In 2012, Jamestown launched Jamestown Green to spearhead environmental sustainability at the property, portfolio, and corporate levels. As part of this initiative, Jamestown set out to reduce company-wide energy use and greenhouse gas emissions by 20% by 2024.

Managing a multistate portfolio of buildings to achieve aggressive sustainability goals is simply not possible without having a good handle on data. In 2017 Jamestown embarked on an effort to make their energy data more transparent and easier to analyze. They chose to implement energy information systems (EIS) that allow their operations and sustainability teams and building engineers to view hourly energy data in real time.

With visibility into how the buildings were operating, Jamestown averaged 4% savings in the first year, and five properties achieved savings from 16% to 21%. The EIS has provided building engineers with a powerful tool for finding operational issues and seeing the positive impacts of the improvements they make. In this diversified portfolio of office, mixed use, and retail assets, Jamestown takes a customized approach for achieving savings at each building. Where feasible they target annual ENERGY STAR certification for all properties through ongoing operational improvements and retrofits.

In 2019, the Smart Energy Analytics Campaign recognized Jamestown for their exemplary use of EIS. Read more about Jamestown’s success with EIS here.

Assess Infrastructure and Organizational Conditions

Understanding existing building and information infrastructure, as well as personnel considerations, are critical steps in the planning process to ensure the EMIS selected will be well utilized and effective. This section covers building characteristics, assets and systems, and energy management procedures and staff resources. This information is necessary to realistically select specific activities to meet the organizational goals. The EMIS is specified by selecting technology attributes that support these activities.

Building characteristics

To begin, the project manager should record the characteristics of the targeted EMIS implementation sites. Table 2 shows the building characteristics that should be known and related issues that need to be considered in the EMIS planning process.

TABLE 2: BUILDING AND SITE CONSIDERATIONS WHEN PLANNING FOR EMIS

Characteristics	Considerations
BAS and networking infrastructure	Implementation of EMIS requires knowledge of the BAS and how many systems are connected to it. FDD and ASO tools require digital controls, and for mechanical systems to be in relatively good condition. EMIS cannot make up for limited control capabilities or mechanical systems in a poor state of repair. If the controls are stand-alone, pneumatic, or partially pneumatic, a BAS upgrade may be required to make sure that HVAC data will be available for the EMIS. Specifying EMIS as part of an HVAC capital upgrade or controls replacement project can be a highly effective practice.
Number of Sites	Implementation of EMIS for a large portfolio of buildings is different from that for a small number of buildings. For large portfolios, enterprise reporting and data visualizations are important. The number of sites will also affect the scope and timing of the eventual technology deployment effort. Geographic diversity may influence technical considerations such as comparative analyses that require weather normalization, a range of utility tariffs, and the variety of HVAC systems. Consider whether a limited pilot would be a good starting point.
Building Type	Building performance metrics that are monitored and tracked using an EMIS are different for various building types. For example, energy use intensity (EUI, e.g., kBtu/sq ft/yr) is a common metric for all building sectors. For hotels, number of rooms or occupants may be critical factors to normalize and interpret energy use. Note that EMIS vendors may have more experience serving specific commercial sectors (e.g., office, higher education, hospital, food service).
Utility Costs	The potential energy cost savings from EMIS should justify the up-front and ongoing costs, and usually do, given the significant opportunities for operational efficiency.
Building Size	Building size often drives HVAC system complexity, as well as utility costs, and therefore EMIS complexity and monitoring. There are economies of scale when implementing EMIS in larger buildings.
Tenants	Benchmarking mandates require the owner of each building to report energy usage data to the city on a regular basis. In instances where utility providers cannot disclose data directly to landlords, the landlords need to obtain energy use data from tenants.

In specifying an EMIS, carefully consider how it will be integrated with existing building systems. The planned EMIS should use existing infrastructure as much as possible. For example, some sites may already have interval meters that can be directly integrated into the EMIS, reducing project costs. A list of existing metering and monitoring infrastructure in the RFP for an EMIS will provide proposers with key aspects of the project scope and estimated project costs. The following building equipment should be surveyed in the EMIS planning and design process:

- **Metering:** Identify the meter type and level of existing submetering available
- **Equipment and BAS:** Identify the BAS system, age, and points generally available through the BAS for the HVAC systems (a complete points list is not necessary at this stage of planning). However, it is necessary to know if significant pneumatics still control HVAC systems. A building that is entirely or mostly pneumatic is not

a good candidate for an EMIS. Also identify if networking speed is a concern and if BAS or network upgrades may need to be in place prior to EMIS installation.

- **Other data sources:** Identify existing IoT data streams or other monitoring systems such as lighting control systems that may provide data to the EMIS.

Organizational energy and facilities management procedures and staff

EMIS are tools primarily used by energy managers, facility managers, and operators to support the organization's energy and facilities management and operational practices. The purpose of understanding current energy management procedures is to gain insight on how the organization typically documents and manages energy information and consumption. This knowledge provides insight as to how the EMIS could fit into the standard energy management architecture and streamline the daily energy management process. For example, if the organization currently produces spreadsheet-based energy performance summary reports, EMIS that offer customizable reporting features could streamline associated labor time and cost while maintaining continuity with current practice.

The following questions highlight energy management procedures that should be considered for continuity and enhancement through use of the EMIS:

- What are the organization's models for managing energy? Some organizations assign one individual to lead all energy management tasks. Others have energy management groups that consist of representatives from different departments, such as engineering, maintenance, and utility accounts payable. Other models may feature a headquartered position for energy and sustainability management, with local site-level building operators. In addition, energy service providers may be contracted for specific project functions. Understanding the model that is in use will help determine the most effective means to integrate the EMIS vertically and horizontally throughout the organization.
- How much staff time is allocated for energy management activities?
- Are there performance incentives in place that relate to energy, operations, or maintenance?
- What are the "standard operating procedures" (work order system, authorizations, etc.) that are in place to enable operational improvements once an opportunity is identified?
- Is there periodic review of energy performance? If yes, what are the review contents and frequency? What is the chain of accountability?
- What reports are currently used in energy management practices? What information systems, metrics, time horizons, and data sources are used to generate those reports? Who receives and evaluates the reports?
- Is any information on energy performance presented to external stakeholders or reporting agencies (e.g., project savings, emissions, ENERGY STAR scores)?

EMIS are not the same as efficient equipment upgrades; they are "human-in-the-loop" tools that need to be integrated with organizational processes to be fully effective. Therefore, a well-resourced, knowledgeable team must be engaging with them to enable energy savings. Understanding the skills and current responsibilities of in-house staff is critical to maximizing EMIS benefits and determining which functions are ideal for in-house delivery versus service-based delivery. The following items should be considered when evaluating staff capacity for managing an EMIS:

- Awareness of the staff's role in reducing the energy consumption of the building components or items under their direct/indirect control
- General experience using information and analysis technologies, with the ability to analyze and interpret quantitative energy and operational data

- Training and expertise with the characteristics of building systems and equipment, as well as efficiency measures
- The degree to which energy management is explicitly represented in staff position descriptions, roles, and responsibilities
- Staff decision making authority relative to building operational parameters, setpoints, schedules, etc.

Leading organizations view EMIS as a way to empower existing operational teams with a tool to more effectively maintain comfortable environmental conditions, reduce energy costs, and make the shift from reactive to proactive maintenance practices. By communicating these aspirations, organizations can avoid the possible perception that EMIS is a tool for downsizing operational teams.

Define Activities to Meet Goals

To specify an EMIS, its capabilities and uses must be established in advance. As described in Section 3.1, the first task in EMIS planning is to establish organizational goals. These goals can only be achieved with specific actions. The inventory or understanding of building and system characteristics, as well as an organization's energy management procedures and staff resources can be used as information to ground the definition of these actions.

This section defines the specific EMIS-based activities and reporting that will help meet an organization's goals. The following list includes activities for which internal stakeholders may wish to utilize the EMIS. Depending on the organization, these stakeholder roles may be handled by multiple individuals, and/or multiple roles may be handled by a single individual.

EMIS and Energy Management Programs

Energy management programs provide systematic processes and procedures to achieve control and improvement of energy performance. ISO 50001 is one such program, designed to help organizations build a culture of energy improvement that leads to deep and sustained energy savings.

EMIS provide data, analytics and reporting to support many aspects of energy management programs, such as calculation of baselines and energy performance indicators, and verification of results. Setting goals and establishing stakeholder roles and responsibilities are two key steps in planning both EMIS and energy management programs.

Resources for developing and implementing an energy management program include:
EPA's ENERGY STAR Guidelines for Energy Management

The U.S. Department of Energy (DOE) 50001 Ready program

- **Utility Bill Manager**
  - **Utility bill allocation:** Allocate utility costs to different tenants or occupant groups sharing a building according to actual energy usage.
  - **Utility bill validation:** Flag potential billing errors.
  - **Utility budgeting:** Forecast future energy use and utility costs.
  - **Billing support:** Streamline account processing.
- **Sustainability Manager**
  - **Renewable energy tracking:** Monitor renewable energy generated and consumed on site.
  - **Greenhouse gas (GHG) tracking:** Monitor, calculate, and report site GHG emissions that comply with any associated regulation requirement.
- **Energy Manager and/or Building Engineer**
  - **Building energy dashboard:** Review energy dashboards to understand performance and report high level metrics to executive management.
  - **Benchmarking:** Compare energy consumption with similar buildings and prioritize buildings for efficiency

improvements. Compare energy usage for the site, system, or equipment against past performance. Automate data transmission and facilities' certification with ENERGY STAR Portfolio Manager.

- **Efficiency project management:** Identify, log and track the status of energy efficiency operating and capital projects and descriptions of measures and expected savings.
- **Measurement and verification:** Establish baseline energy use and post-project energy use to determine the efficiency project savings.
- **Regular performance review:** Set regular meetings with stakeholders to review EMIS findings.
  - **Portfolio reporting:** Provide regular energy, cost, or equipment health reports and track progress toward goals on reduction of energy consumption or costs.
  - **Energy anomaly detection:** Identify and flag unexpectedly high or low energy use.
  - **Energy tracking:** Monitor and track the energy consumption and intensity at the site, system, or major energy-consuming equipment level.
  - **Load profiling:** Inspect 24-hour periods of interval meter data to understand the relationship between energy use and time of day.
  - **Peak load analysis:** Identify peak demand at the site and implement demand management strategies.
- **Ongoing system fault identification:** Detect specific operational faults in systems or equipment and provide recommendations to guide investigation and resolution.

The intent of this step is to demonstrate a full picture of potential EMIS use across the organization, considering functionalities enabled by the EMIS. These activities need to be prioritized based on the resources and staff time available. When prioritizing activities, keep in mind that they may not all be able to be covered by a single EMIS vendor.

Specify an EMIS that Supports Selected Activities

Once the EMIS activities are selected, determine what is necessary to support the targeted activities. There are data needs, equipment needs, and security needs.

Each activity requires certain types of data. For example, to verify a project's savings, it is necessary to have the interval meter energy data (e.g., electricity and natural gas) at the whole-building level or from specific systems and equipment project impacts.

Table 3 shows some examples of the specific data elements necessary to support EMIS-related activities.

Resources for EMIS-based Analysis Activities

To learn more about specific EMIS-based activities and their data requirements, consult the following handbooks:

Energy Information Handbook: Applications for Energy Efficiency Building Operations

The Building Performance Tracking Handbook

TABLE 3: EXAMPLE DATA REQUIREMENTS FOR EMIS-RELATED ACTIVITIES

Activity	Data Type	Minimum Resolution
ENERGY STAR Portfolio Manager Benchmarking	Whole-building energy use	Monthly
	Gross floor area, ZIP code, building type, year of construction, # of occupants, # of computers	Static information, updated as needed
Utility Bill Validation	Utility bills; EMIS-metered whole-building or account-level energy use and demand	Monthly (from utility bills) or hourly (if interval data are available)
	Utility tariff	Static information, updated as needed
Portfolio-specific Benchmarking	Whole-building energy use	Annual
	Gross floor area, ZIP code, building type, and year of construction	Static information, updated as needed
Measurement and Verification	Energy and demand; Weather condition (outside air temperature or degree days)	Based on depth of savings and M&V accuracy requirements. Monthly, hourly, and sub-hourly data may be used depending on data availability
Demand Management	Whole-building electric	15-minute
Greenhouse Gas (GHG) Tracking	GHG emission conversion factors	Static information, updated as needed
	Energy use	Monthly
Whole-Building Load Profiling	Whole-building energy use	Hourly or sub-hourly
Energy Tracking of Major Energy Consuming Equipment	Submetered energy use at the end-use or equipment level	Hourly or sub-hourly
Energy Anomaly Alarming	Energy use; Weather conditions (outside air temperature)	Hourly or sub-hourly
System/Equipment Fault Identification	Depends on the targeted system; usually includes temperature, flow rate, on/off status, and pressure sensor data	15-minute or a shorter interval
Regular Reporting	Depends on the reporting requirement, energy and demand for consumption-related reports, prioritized issues for operation-related reports	Depends on the reporting requirement

New equipment such as meters, sensors, and data acquisition hardware may be needed in addition to the EMIS software. This equipment is usually installed with the EMIS and commissioned at the same time the EMIS is configured; over time, additional metering can be added and integrated into the system. Lawrence Berkeley National Laboratory has more discussions on key performance metrics for performance monitoring and associated meter and sensor requirements in the Monitoring-Based Commissioning (MBCx) Plan Template (Kramer et al., 2017).

Meter and sensor data are transmitted to data servers and/or the cloud via a data acquisition system (transmission to the cloud may be scheduled as a batch process every night, to prevent network overload during building operational hours). A common strategy to simplify the process is to specify the desired metering capabilities and rely upon the vendor or service provider to design and implement the metering and data acquisition system. Due to budget constraints, up-front procurement of all desired and preferred functionalities and hardware may not be a practical option. Therefore, when identifying data and equipment requirements, consider future potential needs and scalability.

In addition, data and network security is an increasingly important aspect of business information systems. Secure access and communications should be ensured to protect the data and reduce the risk of vulnerability. For help in ensuring sufficient security measures are in place, involve representatives from the organization's information technology (IT) departments early in the EMIS planning process. Cybersecurity specifications related to the EMIS are included in LBNL's EMIS Specification and Procurement Support Materials (Granderson et al., 2020).

Establish Roles and Responsibilities of EMIS Users

Once an EMIS approach and activities are selected, it is time to establish roles and responsibilities for the team of EMIS users. When determining EMIS team roles, consider the following factors:

- **Frequency of use:** How often will the operations staff access the EMIS to identify savings opportunities? Daily, weekly, monthly, or annually?
- **Setup standard operating procedures:** What will the standard operating procedures for prioritization be once savings or other issues have been identified? For example, if the number of hours that lights operate needs to be reduced to achieve savings, which key stakeholders must be notified for that to happen? If a chiller issue is identified, do you wait until non-cooling season to address?
- **Data review by key stakeholders:** How often will the data reports from the EMIS be reviewed with senior management or key facilities staff?
- **Alarms and push notifications:** What thresholds and length of occurrence should be established to cause an alarm and/or push notification via email or text messaging? For example, the zone temperature is more than 3°F above setpoint for one hour.

Personnel who may be involved internally could include, but are not limited to:

- Senior executive/sponsor
- Facility managers
- Energy manager
- Finance
- IT
- Environment, health and safety
- EMIS vendors and MBCx service providers
- Consultants
- BAS vendors

Successful EMIS implementations typically have a strong internal technology champion who supports and encourages regular use of the tool throughout the organization. At the facilities and operational level, staff roles and responsibilities should be aligned with use of the tool and sufficient time allocated to permit a thorough data review. Management can encourage proactive use of the data by: (1) including EMIS analyses in regular operational and energy management tasks and (2) taking leadership in instilling a performance-based, data-driven approach to operations. Similarly, executive staff can incorporate EMIS information into regularly viewed reports and hold the organization accountable for energy performance. Enterprise-wide EMIS use and shared energy awareness are key for maximum impact.

Build a Business Case

The business case justifies to management the costs and benefits associated with EMIS implementation. Setting clear and measurable goals can be used to convince stakeholders about the value of investing in an EMIS and can also be used to communicate goals to motivate staff. The costs and savings enabled by EIS and FDD tools are documented in the research report *Proving the Business Case for Building Analytics* (Kramer et al., 2020) and the results are summarized here in Table 4 and Table 5.

EMIS Cost-Benefit Research Results

The Smart Energy Analytics Campaign found that EMIS technologies enable a median whole-building savings of 3% for EIS and 9% for FDD. Analyzing cost and savings data for 24 organizations (representing over 200 million sq ft of floor area), both EIS and FDD installations had a median two-year simple payback period. A complete report on costs, savings, and cost-effectiveness is available in *Proving the Business Case for Building Analytics* (Kramer et al., 2020).

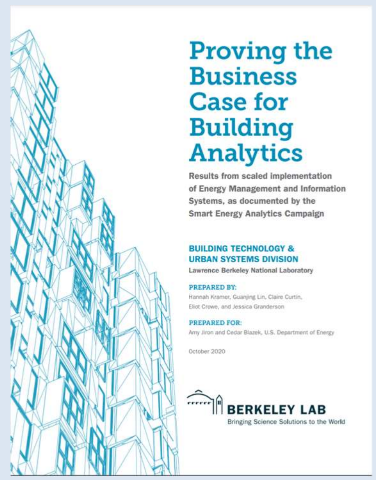


TABLE 4: EMIS COST SUMMARY

Type of Costs, by EMIS Type	Median Costs		
	Per Point	Per Building	Per Sq Ft
EIS (n = 37)			
Base software and installation (one-time) cost	$400	$1,500	$0.01
Recurring costs ($ per year)	$150	$400	$0.01
FDD (n = 35)			
Base software and installation (one-time) cost	$9	$13,000	$0.06
Recurring costs ($ per year)	$4	$3,500	$0.02

EMIS costs can be broken into hardware costs and software costs. The hardware costs include additional required metering, submetering or sensors, investigation of security issues, installation costs, and data communication or storage costs. Software costs are most often broken into a single up-front cost and a recurring ongoing cost that is usually assessed annually. Up-front costs cover software licensing and initial system installation, configuration, integration, and training. Ongoing costs are charged for technical support, annual licensing, service, and maintenance. Cost drivers include the complexity and extent of hardware and software components, scale of the implementation, and the degree of customization required. Funding assistance and incentives may be available to offset first costs of EMIS implementation.

Table 5 summarizes median savings in the second year after installation, in percentage and dollars per square foot per year. Second-year savings are emphasized, since in many cases we found that the EMIS became better utilized over time, as users gained experience with the technology and established routine processes to act upon findings.

TABLE 5: SUMMARY OF ENERGY SAVINGS FROM COMMERCIAL BUILDINGS WITH EMIS

Energy Savings	EIS	FDD
Number of portfolios	10	18
Floor area (millions sq ft)	82	90
Median savings (%)	3%	9%
Median savings ($/sq ft per yr)	$0.03	$0.24
Top quartile savings (%)	11–22%	15–28%

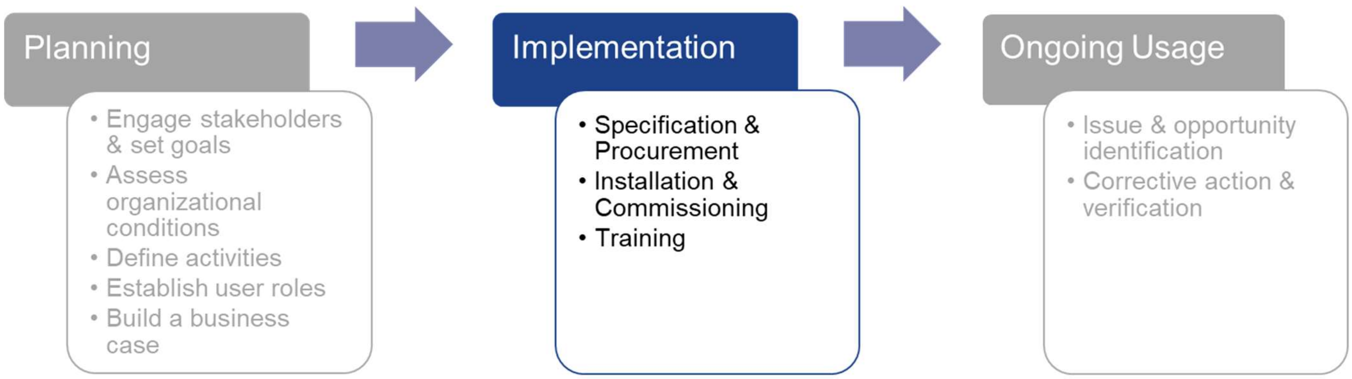
These savings demonstrate the reduction in energy use achieved at buildings that are utilizing EMIS. Owners shared that it was essential to have the data and analysis readily available from their EMIS to enable savings from their overall energy management program. Almost 80 percent of organizations reported using their EMIS to inform retrofit strategies at their facilities, including identifying retrofits, sizing equipment, and verifying savings. It should be noted, however, that the savings cannot be attributed solely to the operational improvements achieved with the support of the EMIS, since energy savings are determined at the whole building level, and other energy-impacting projects may be occurring simultaneously.

The results show a three-fold increase in the median savings achieved by users of EMIS with FDD capabilities (9% savings) versus those with EIS capabilities (3% savings). This result stems from the nature of the software; EIS provides big-picture trends in energy use while FDD pinpoints faults at the equipment level. Best practice implementation includes both EIS and FDD capabilities. Best practice EMIS implementations (top quartile) result in 11%–22% portfolio savings for EIS and 15%–28% for FDD tools.

The median simple payback period for both EIS and FDD is two years with a total of 206 million sq ft of floor area analyzed. Moreover, they are well within the two- to four-year payback requirements that drive most energy efficiency decision making. Organizations in the Campaign used their EMIS as part of an integrated energy management strategy, informing operational improvements, the need for retrofits, and retrofit sizing. Determining cost effectiveness of an EMIS (a tool in the MBCx process) is akin to determining the cost-effectiveness of any business-specific software—the software is one of many tools needed to effectively perform the job.

Section 4. EMIS Implementation

This section provides an overview of best practices and supporting resources for specifying and installing an EMIS. Commissioning the EMIS and providing training for facility staff on effective use are key to successful EMIS implementation.



Specification and Procurement

After the intended scope and use of the EMIS is fully defined, a specification and RFP can be developed and issued. The specification should include (1) the requirements for the EMIS technology capability; (2) technical warranty, support, training, and commissioning; and (3) any ongoing services needed to support onsite operations staff in utilizing the EMIS.

A template RFP, specification, and selection guidance have been developed to provide standard language for an EMIS, or related monitoring and diagnostic technology. By editing, adding to, and deleting from the template, potential EMIS adopters will produce a custom specification based on their organization's specific goals and energy management processes. Table 6 provides illustrative examples of specific items that are covered in the RFP template (Granderson et al., 2020). The full set of procurement support materials can be accessed from DOE's Better Buildings Alliance EMIS Technology Solutions team website.

To manage technology costs, take care that your specification does not result in a highly customized solution. For example, most interval data analysis technologies such as EIS will not provide extensive utility billing management capabilities or control capabilities. However, increasingly, EMIS provide both EIS and FDD functionality in a single software offering. In addition, each section of the specification should distinguish between "required" capabilities and "preferred" capabilities, to help responding vendors identify high-priority technology needs.

The technology specification represents the starting point of the procurement process. Following completion of the specification, issue an RFP to obtain proposals from EMIS vendors. Alternately, a less formal process of EMIS vendor interview and selection may be used; creating a technical specification is useful to set the scope of implementation in either case. Table 6 identifies the components in an EMIS specification.

TABLE 6: EMIS TECHNOLOGY AND SERVICES SPECIFICATION COMPONENTS

Categories	Specific Items
Technology Capabilities	Data integration Utility bill analytics Interval meter data analytics System data analytics Automated system optimization Project management and reporting Ability to identify and address missing or inaccurate data
IT Requirements	Data storage and backup Software hosting and data ownership Cybersecurity Permissions and access control Usability Network protocols
Technical Warranty, Maintenance Support, and Training	Technology support, updates, user training, testing, and commissioning
Ongoing Services	Manage the MBCx process Maintain benchmarks and an energy baseline Review EMIS diagnostic results and prioritize findings Implement corrective actions Track issue close out Evaluate MBCx benefits Develop ongoing analytics Conduct ongoing training

The following EMIS selection criteria may also be considered:

- How do the proposed technology and services satisfy the required and preferred capabilities and functions defined in the specification?
- Does the proposed technology include capabilities that are considered “best practice” or “state of the art” relative to similar products?
- How well do any additional features or capabilities that were highlighted in the proposal meet the owner’s current and future needs?
- Does the proposer have a good history of experience with portfolios or sites like yours?
- Does the proposer demonstrate strong experience with technology design, provisioning, installation, and commissioning?
- Are the protections and assurances for continuity of services, in the event of disruptions to the proposer’s business-as-usual operations sufficiently addressed?

Installation and Commissioning

Once the intended use of the EMIS has been defined and an EMIS product has been selected to meet those needs, the next step is to install the system and make sure all features are working properly. The vendor will handle most of the installation work, but they will need assistance from the organization to support their process. Table 7 lists items that are relevant to the EMIS installation that may be requested by the vendor. The organization needs to assign key points of contact to work with the vendor's installation team, arranging for site and network access as needed.

TABLE 7: ITEMS TO IDENTIFY IN BUILDING SYSTEMS FOR EMIS IMPLEMENTATION

Existing Metering System	Existing Building Automation System (BAS)	Other
▶ Meter type (fuel measured, and make and model) ▶ Meter functionality (can it communicate to external monitoring and control systems?) ▶ Meter location (what loads are downstream of, or captured in, the meter readings) ▶ Data interval ▶ Data communication protocols ▶ Availability of historical data and storage location	▶ Make and model ▶ Points list ▶ Sequences of operation ▶ Data communication protocols ▶ Any centralization or Internet access to the system ▶ Availability of historical data, ability to access trend log data from the historian ▶ Trend logs currently used/viewed by operators ▶ Data interval	▶ Data storage software and hardware ▶ Other data sources/IoT, monitoring and diagnostic systems, e.g., power quality or energy/fault analytics systems, variable frequency drives

If an EMIS with FDD capability has been specified, control drawings that show the BAS control points and sequences of operation are required to define the existing control strategy and facilitate the point mapping between the BAS and the EMIS. In many cases, mechanical and electrical drawings and control sequences will be incomplete or outdated, particularly for older buildings or those that are not as well maintained. A site visit to access and verify actual current conditions is highly recommended.

Commissioning is the systematic process for verifying and documenting that the EMIS is designed, installed, and tested, and is capable of being operated and maintained according to the requirements. Just as traditional building systems and equipment are commissioned to ensure optimal and intended performance, an EMIS also should be commissioned. During commissioning, the EMIS goes through an intensive quality assurance process to verify that it will operate as the owner intended and that staff are prepared to operate it as needed. Benefits of commissioning are as follows:

- The system operates according to its design intent.
- Newly installed meters and sensors that were part of the EMIS project are calibrated and reliably reporting accurate data.

- Communications and networking are fully functional and robust.
- Key performance indicators and tracked metrics are correctly calculated.
- Data connectivity with BAS points and meters are maintained and operational.
- Points are correctly mapped from the BAS and meters to the EMIS.
- Weather feeds are accurately integrated.
- Historical data can be exported in the desired formats.
- The user interfaces and reports are configured as desired.

To learn more about the EMIS configuration phase, see Section 2 in the MBCx Plan Template (Kramer et al., 2017, Section 2). In addition, energy meters require periodic maintenance. Periodic maintenance requirements are described in the *Metering Best Practices Guide* (Federal Energy Management Program, 2011).

The EMIS provider should produce a commissioning report that documents the end-to-end testing and verification of the system. Key steps to discuss with the vendor during installation and commissioning are summarized below.

- Have data quality checks been performed? For example, an end-to-end metering system check to verify meter setup, programming, networking, and configuration.
- Do any critical sensors need to be calibrated? Owners should plan for potential time and cost to calibrate or replace sensors if found to be faulty during the EMIS configuration process.
- Have the BAS trends all been enabled, and can the control system / network handle the additional traffic?
- Has the user interface been customized per the contract to meet the owners needs?
- Have the faults been configured to the system type and thresholds and length of occurrence appropriately set?
- Has the baseline energy use model been configured?
- Have access levels and permissions been set?

Training

Deriving maximum benefit from EMIS technology, particularly when the technology is newly introduced to the organization, requires user training. Focus this training not only on key technology features, but also on how they connect back to key activities and goals that were framed earlier.

In considering the training that will be most useful to your organization, it can be helpful to ask the following questions:

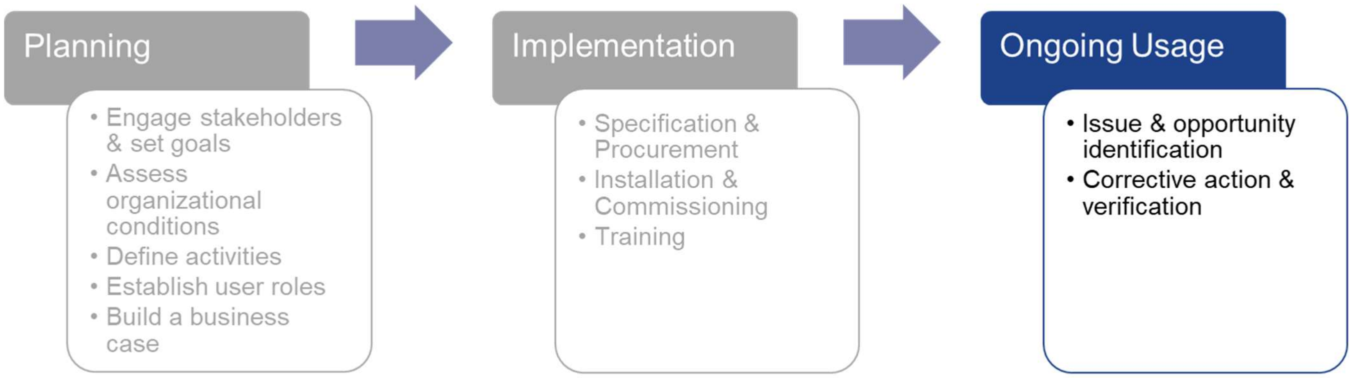
- On which aspects of the EMIS do people need training (e.g., reporting, data visualization, fault prioritization, fault root cause analysis)?
- Who needs to be trained, and how are their different roles and responsibilities accommodated in training materials?
- Will there be an on-site system administrator who manages and maintains user access rights?
- How must training materials, sessions, and documents be archived and made available for future reference?
- What are the required qualifications of the trainer?
- What is the desired medium? For example, is it in-person training, video tutorials, user guides, or on-call help services?
- Will it be useful to have an initial training session, followed by subsequent sessions after some period of initial use of the system?

Training may be conducted by the technology provider, MBCx service provider, internal EMIS project lead, or by a combination of those. Training topics may include the following:

- Login and navigation to access dashboards, screens, trend charts, tables, and other visualization
- Access to key performance indicators and metrics
- Access to alert log and reports
- Detection of data integrity issues
- Detection of communication and network interruptions
- Access to online or in person support
- Interpretation of analytic outputs
- Interpretation of faults and method for changing thresholds or other FDD parameters
- Programming additional faults as needed
- Adding shortcuts, recommended workflow, and best practices in using the EMIS

Section 5. EMIS Ongoing Use

Once the EMIS has been installed and commissioned, the use of the EMIS moves to the MBCx Phase (or EMIS Ongoing Use Phase). In this phase, the EMIS will continuously monitor and analyze the performance of building systems, and in-house staff or a service provider will support actions related to the findings. If a service provider is utilized, the EMIS technology and the MBCx services may be delivered by the same firm or by different firms.



Identify Issues and Opportunities Using EMIS

Ongoing EMIS review includes two main activities: (1) review of the diagnostic results and (2) prioritization of findings and identification of root cause of issues. To implement these strategies effectively, they need to be a part of a systematic process that maintains ongoing engagement with the EMIS.

Review EMIS fault detection and diagnostic results and prioritize findings

One of the most critical steps in using EMIS is monitoring the analytic results on a regular basis, identifying faults and opportunities for improvement, and identifying areas for potential future capital upgrades. Organizations can prioritize issues and opportunities based on impact to asset health, comfort, and energy cost. Through regular reporting and/or the EMIS interface, the team will track low-cost energy conservation measures or system optimization recommendations. The MBCx team will track whole-building and system-level benchmarks as specified by the owner and flag significant benchmark changes. The frequency of review can be selected to suit preferences. For example, EMIS review can form part of a daily operations team meeting, or it can be covered in a more comprehensive monthly report or meeting. The issues uncovered by an EMIS may require immediate attention or may be less critical items that can be added to the next scheduled maintenance plan.

Through this process, data quality issues may be identified, such as gaps in data or a need for sensor calibration. The team will also review planned maintenance schedules and move toward conditions-based and data-driven maintenance practices using the EMIS. The ongoing review may also result in adjustments to EMIS algorithms; for example, if an FDD tool is issuing nuisance alerts due to oversensitivity.

Root cause identification

The root cause of the top priority issues identified in EMIS will be determined by the MBCx team through review of the BAS trends and controls programming, and through field investigation. Then plans will be developed for correcting the issues, including internal work order creation and development of scopes of work for contractors to implement improvements.

EMIS process management

The MBCx service provider or internal EMIS champion organizes and facilitates regular meetings to review and prioritize EMIS findings. These meetings generally are focused on reviewing ongoing findings reports delivered through the EMIS or in a separate report outside of the EMIS. Any equipment failures or critical items will be communicated immediately, and energy saving opportunities and proactive maintenance measures will be documented and prioritized. As a part of this process, the energy savings measurement approach should be set up within the EMIS with appropriate baseline data.

Corrective Action and Verification

The corrective actions implemented during MBCx may be a maintenance/repair action, setpoint modification, control sequence modification, or recognition of needed capital improvements (although capital improvements may be outside of the MBCx process).

The MBCx team should closely coordinate with the building operation staff for the follow-up and corrective actions. Implementation of findings and future recommendations will be tracked in an issues log or work order management system, and changes will be updated in relevant building documentation.

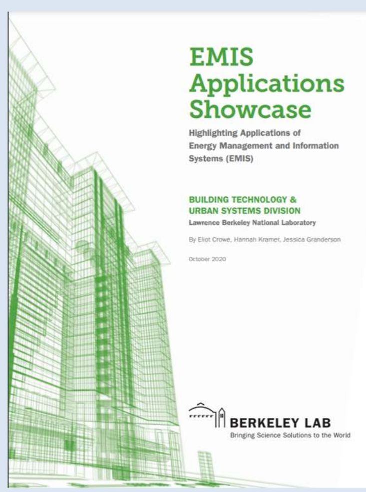
The MBCx team uses the EMIS to verify that issues have been corrected and that the corrections are persisting. One way to do this on a comprehensive level is to evaluate savings at the main meter against a baseline period, and update this analysis on a regular basis to track increasing or decreasing savings. Alternatively, many EMIS include avoided cost calculations for each fault, which can be used to calculate overall savings. The embedded energy savings calculations in an EMIS may not take into account interactions between measures that could reduce total savings.

The team may also track qualitative benefits, including actions that extend equipment life, reduce maintenance labor, improve safety, and provide other benefits to the facility and maintenance organization.

EMIS Applications Showcase

The EMIS Applications Showcase is a resource that highlights EMIS implementation from 32 of the organizations recognized by the Smart Energy Analytics Campaign. The Showcase shares the common strategies being deployed today by leading organizations across multiple market segments as they capitalize on the promise of building analytics. These examples illustrate a maturing market for EMIS, with a wide range of tools being deployed successfully at scale.

Success stories for 24 organization provide additional detail on best practice EMIS implementation.



Section 6. EMIS 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. Section 6 focuses on best practices to scale your EMIS, effectively respond and prioritize EMIS findings, and provide incentives to EMIS users.

Scaling EMIS

This section discusses two ways of scaling EMIS: (1) ramping up EMIS complexity and (2) scaling up EMIS usage in a portfolio.

The complexity or sophistication of EMIS use and capabilities often evolve as an organization becomes more proficient with the EMIS. For an organization that has never implemented an EMIS, beginning with the features that only require existing data, or data that can be obtained with little additional cost and effort, is a good strategy. This allows savings to be obtained before gaining approvals for further investment.

Beginning with a pilot is highly recommended for EMIS implementation. The pilot provides an opportunity to prove the usefulness of the EMIS, test the system's ability to satisfy organizational needs, and refine system uses and requirements. Once the efficiency is demonstrated, the pilot can be expanded to other sites in the campus or portfolio with greater confidence and user experience.

Standardization is an important element in achieving successful scale-up. For example, the same data may be planned for collection across all sites in a portfolio and using a standard data format can streamline the process of establishing associated metrics, trend analysis, and performance comparison between sites. Standard naming conventions for loads, meters, and BAS trend logs can simplify data integration and point mapping activities and analysis between buildings or sites. As highlighted in the EMIS Procurement Support Materials (Granderson et al., 2020), it is recommended to define your standardization requirements in RFP and statement of work documents.

The improvement opportunities that are revealed through EMIS use can range from no-cost and low-cost measures to those that are more capital intensive. Particularly in the case of enterprises and campuses, a common question is: where to begin in prioritizing facilities and measures for performance improvement efforts? To manage staff resources and cash flow, many organizations have found success in the following strategies:

- "Triage" a portfolio by identifying and focusing more intensive analysis efforts on those sites with the highest EUI.
- Bundle packages of no- and low-cost measures and upgrades that require more capital investment so quicker payback measures "buy down" the overall project.
- Identify project "bundles" of like-measures that can be deployed across many sites in a single effort, thereby leveraging economies of scale.
- Use the EMIS metering and analysis capabilities to document and quantify the utility cost savings that are achieved; use these successes to justify future efforts.
- Use the EMIS utility bill analysis capabilities to audit or automatically process utility bills. This speeds data entry time and reduces errors.
- In areas where demand response programs are available, consider participation as a means of generating additional revenue. Use the EMIS to help evaluate demand management opportunities.
- For campuses or portions of portfolios with a large utility footprint, contact efficiency program managers to identify potential incentives to offset EMIS first costs, as well as rebates and other performance incentives.

Managing and Responding to EMIS Findings

Ownership and integration of the EMIS into standard business practices is important, and a defined workflow is essential for planning how insights will be acted upon. In addition, the EMIS itself must be maintained; in most cases, the vendor will offer system maintenance and data quality assurance services, either in bundled or optional offerings.

Once the efficiency opportunities have been identified by the EMIS, either by in-house staff or service providers, there needs to be a standard set of processes defined for taking action that will generate savings. Facility staff need to identify who is going to respond to each finding, what permissions or authorizations are needed, which departments or business units need to be involved, relevant work order request systems, and the relative priority level of actions that have been identified. Sometimes actions such as equipment scheduling can be addressed by site-level operational staff. In other cases, further investigation may be required to determine the specific root inefficiencies. Having a “standard operating procedure” in place will save time and maximize the likelihood that fixes will be implemented.

Prioritizing the findings is important. The downside to taking the findings on a first-come first-served basis is that engineers or technicians are possibly working on lower priority incidents while higher priority findings are not addressed. A useful way to prioritize actions is to establish thresholds for energy/cost impacts that have a bearing on how quickly the problems must be addressed once they are detected. Many automated fault detection and diagnostics tools will provide prioritization. Figure 7 provides an example from an FDD tool.

FIGURE 7: FAULT PRIORITIZATION EXAMPLE FROM AN FDD TOOL

Top 5 Issues

Energy

Building	Equipment	Notes	Cost/Qtr.
Anon Hospital	AHU_6_CAVs	Low Damper Position – opportunity for static pressure reset.	$11,120
Anon Hospital	AHU_11	No supply temp reset. Cooling valve issues.	$7,778
Anon Hospital	AHU_6	No supply temp reset. Cooling valve issues.	$6,163
Anon Hospital	AHU_5	Supply temp lower than setpoint. No supply temp reset. Cooling valve issues.	$5,029
Anon Hospital	AHU_4	Supply temp lower than setpoint. No supply temp reset. Cooling valve issues.	$4,318

Maintenance

Building	Equipment	Notes	Severity Priorty
Anon Hospital	AHU_11	Static pressure lower than setpoint. Supply fan speed constant. Return fan speed constant.	6
Anon Hospital	AHU_10	Static pressure lower than setpoint. Supply fan speed constant.	6
Anon Hospital	CAV8_2	Room temp lower than setpoint. Stuck reheat valve.	4
Anon Hospital	CAV5_82	Supply flow lower than setpoint. Stuck reheat valve. – May be sensor error.	4
Anon Hospital	CAV3_11	Sensor error. Stuck reheat valve.	4

Source: Demo Site (Clockworks Analytics)

Functional or energy performance problems will be identified during the regular EMIS evaluations. Creating an issues log to document the key findings and how they were resolved helps maintain institutional knowledge and can be used to support an ongoing business case for the EMIS. An "energy champion" could be assigned whose responsibility is to start each day by reviewing the energy use of key components and using that information to formulate a plan for the days to come.

Case Study: Operational Practices that Embed EMIS

In 2020, Kaiser Permanente achieved their goal to become carbon neutral, just five years after making a pledge to do so. A cornerstone of their plan was to use data analytics to reduce their facility energy use as much as possible. Kaiser Permanente started by monitoring monthly energy bills and benchmarking facilities using a monthly data analytics tool and ENERGY STAR Portfolio Manager. Systematic review of energy use paired with energy audits allowed the team to capture savings to reinvest and build momentum towards FDD.

In 2015, Kaiser Permanente implemented a four-site pilot of FDD software to test their building optimization approach. The FDD analysis identified energy savings that would repay the cost of the pilot in less than six months. Based on those findings, they expanded their FDD implementation to seven locations and 69 buildings covering seven million square feet, achieving 12% average energy savings at these locations.

The organization has paired EMIS with an ongoing monitoring-based commissioning (MBCx), showing how embedding EMIS into operational practice can lead to consistent savings. They have identified a champion for each medical campus to collaborate as a distributed team on fault review each month. The champion is the lead for reviewing faults on a weekly basis through the following process:

- Starting with faults with the highest estimated impact, the champion reviews the data and equipment to confirm the diagnosis, then creates a work order to fix the issue.
- In some cases, this process uncovers a false positive. The FDD vendor is contacted to discuss how the diagnostic can be fine-tuned. In this way, the team continuously improves the fault identification process.
- The champion tracks task status, resolution, and sums the avoided energy cost from the FDD program to provide visibility on results for the executive level.

Kaiser Permanente was recognized by the Smart Energy Analytics Campaign for using MBCx and FDD to reduce energy use. Read more their success here.

Remember, EMIS are human-in-the-loop technologies that require regular use to derive insights for improved efficiency. Dedicating sufficient resources is a critical component of maximizing the value of the EMIS. Allocate sufficient labor hours to regularly review the EMIS analysis and reporting, detect anomalies, take follow-up actions to fix the problems identified, and communicate the results to the organization's leadership and employees. In addition, conduct periodic maintenance, such as calibration, on the meter/sensor system to ensure data accuracy. The extent to which work is performed by an in-house engineering team or by outside service providers is dependent on the organization. If the organization has the people or time to manage the EMIS, all the work can be done in house. If not, the organization can hire a service provider (possibly the EMIS vendor) for day-to-day monitoring, analysis, and measure identification and prioritization. In that case, the internal operations and energy management team would take actions based on the service provider's findings.

Case Study: Prioritizing Findings

In 2017, the University of Iowa (UI) implemented FDD software at 20 buildings to help them move from reactive to planned and predictive facility operations. By implementing a process to prioritize FDD findings, UI's efforts have shown impressive results. In 2019, UI achieved 9% average portfolio energy savings and the four buildings with the most focused efforts achieved 13%–24% savings.

With their FDD implementation, UI's in-house resources have been able to concentrate on what they do best: maintenance, engineering, and troubleshooting of their mechanical systems. UI's Analytic Response Group meets each morning to prioritize, plan, and coordinate the response to the FDD software's recommendations. This approach has enabled a shift toward proactive maintenance decisions informed by data and away from reactive responses to emergencies.

Prior to implementing FDD in 20 buildings, UI tested their approach through a one-building pilot. Lessons learned from the pilot were incorporated when scaling FDD to additional buildings. Key lessons learned included the following:

- BAS point tagging and FDD rules development was time consuming during the pilot, so UI added these activities to the vendor scope of work.
- Fault prioritization based on cost, comfort, and maintenance impact is critical to avoid information overload.
- Work order system integration was key to embedding FDD into UI's organizational process.

UI received recognition from the Smart Energy Analytics Campaign for their exemplary work to save energy through the use of FDD. Read more about their success here.

Incentives and Motivation

Incentives are critical to keep staff motivated and meet performance targets. There are a variety of ways to motivate staff, including bonuses. Some examples include the following:

- Create company-wide recognition for staff and occupant efforts to save energy based on performance targets established within the EMIS.
- Give occupants access to the dashboards and introduce efforts to improve efficiency.
- Release a monthly scorecard and engage occupants in building performance tracking.
- Establish accountability: Create a flow of information about building performance up and down the chain of command; where appropriate include efficiency-related goals and expectations into position descriptions and performance review processes. Well-defined reporting procedures help ensure accountability and drive action.
- Establish a training program: By running a training program you can increase awareness of the benefits of using the EMIS and understanding of features and capabilities to support and streamline job activities.
- Make performance visible: Use the EMIS to generate visibility into energy performance relative to specific organizational goals. Share reports that reflect progress toward the goals and objectives and reflect the impact the EMIS is having through these reports.
- Involve organizational and employee development or human resources as a strategic partner, and make the energy management program transparent and available to all employees.
- Make a public pledge to improve the energy intensity of your portfolio, delivered by a senior executive, illustrating organizational priorities and backing.

EMIS Toolkit: Bringing it all Together

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 Smart Energy Analytics Campaign Toolkit where you can find guidance, templates, success stories, research reports, and many other resources, as shown in Table 8.

TABLE 8: RESOURCES FOR THE EMIS JOURNEY

Resource Name (with Link)	Description
Final Campaign Report: ***Proving the Business Case for Building Analytics: Results from the Smart Energy Analytics Campaign***	The final report from Smart Energy Analytics Campaign collected various data on EMIS from the commercial building owners and operators who joined as participants — the largest known dataset of information on EMIS use. The campaign supported 104 organizations with 6,500 buildings covering more than half a billion square feet of combined floor area, with a projected total savings of $95 million and 4.1 trillion Btu.
EMIS Infographic: **EMIS Offers Proven Savings and Return on Investment**	The data generated through the Smart Energy Analytics Campaign provides industry with the largest existing body of evidence of the value of EMIS and expected payback. This one-pager summarizes the business case for EMIS adoption and how it was established.
EMIS Applications Showcase	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.
Smart Energy Analytics - Success Stories & Recognition	The Smart Energy Analytics Campaign regularly recognized participants for exemplary implementation of EMIS tools and technology in their commercial buildings. This page highlights the success stories of 24 awardees.
EMIS Procurement Specification and Support Materials	This report contains an RFP template and specifications for EMIS technology and ongoing services that can be tailored to an organization's requirements.
MBCx Infographic: What you need to know about MBCx	MBCx is a way to maintain and continuously improve building performance over time. This one-pager describes MBCx and its benefits and provides information to get you started with implementing MBCx.
MBCx Plan Template	The template is designed for use by building staff (e.g., an Energy Manager) or a third party (e.g., Commissioning Provider). Once created, the MBCx Plan drives a thorough, methodical MBCx process and helps ensure that all team members (internal and external) are fully aware of the plan and their responsibilities.
Better Building EMIS Webinars	The EMIS Tech Team has hosted many webinars about a variety of EMIS-related topics. Access all recordings and slide decks under Webinars in the Smart Energy Analytics Toolkit.

Glossary of Terms

Baseline: A representation of "standard" or typical energy performance, used for comparative purposes. Baseline may be expressed according to a variety of metrics and may account for weather or other independent variables that influence energy consumption.

Benchmarking: Comparing building energy performance to that of similar buildings (cross-sectional benchmarking) or its own historic performance (longitudinal benchmarking). Benchmarking may also be performed at the system or component level.

Building Automation System (BAS): A system that is designed to control building operations and indoor climate.

Communication Protocols: Standardized rules governing the transmission of information between devices. Common protocols for building data include, for example, BACnet, LonTalk, and Modbus.

Degree Day: A measure of the heating or cooling load on a building relative to a "base" outside air temperature (e.g., 65°F). It is commonly calculated as the difference between the mean daily temperature and the "base" temperature.

Demand: The rate of energy use by a particular building or system, i.e., power. Common units of energy demand are kilowatts (kW) for electricity, tons for chilled and hot water, and therms per hour or cubic feet per minute for gas.

Demand Response: Changes in electric usage by customers in response to changes in the price of electricity over time or when system reliability is jeopardized.

Energy Information System (EIS): Software, data acquisition hardware, and communication systems used to store, analyze, and display building energy data.

Energy Management and Information System (EMIS): A broad family of tools and services to manage commercial building energy use. These technologies include, for example, energy information system, equipment-specific fault detection and diagnostic systems, benchmarking and utility tracking tools, automated system optimization tools, and building automation systems.

Energy Savings: A reduction in energy use often quantified by accounting for key normalization factors such as weather or hours of operation.

Energy Use Intensity (EUI): A unit of measurement that describes a building's energy use, relative to its size, on an annual basis. The common metric is kBtu/sf/yr.

Greenhouse Gas (GHG) Emissions: The carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) gases released into the atmosphere as a result of energy consumption at the facility.

Measurement and Verification (M&V): The process of using measured data and other operational information to confirm the energy savings from energy efficiency projects. The international Protocol for Measurement and Verification defines four standard M&V approaches.

Peak Load: The highest power demand on an electrical grid during a specified period of time.

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