

Energy Management Systems (EMS) for Food Service Applications

Introduction to EMS and guidance
document on project planning &
implementation

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Disclaimer

This report should be viewed as a general guide to best practices and factors for consideration by food service end-users who are planning or evaluating an Energy Management System (EMS), rather than a comprehensive and exhaustive set of specific steps to perform when doing such planning or evaluation.

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Preface

The mission of the U.S. Department of Energy's (DOE's) Better Buildings Alliance (BBA) is to transform the way that commercial buildings use energy. Through the BBA, members in different market sectors work with the DOE's network of research and technical experts to develop and deploy innovative, cost-effective, energy-saving solutions that lead to better technologies, more profitable businesses, and better buildings.¹ As of 2013, BBA has more than 200 members representing over 10 billion square feet of commercial building space. The five BBA sector groups include:

- ▶ Private sector: Food service, grocery, retail, hospitality, commercial real estate, healthcare, and higher education sectors
- ▶ Public sector: States, local governments, and public schools

Members choose from a variety of program activities with the option to participate in 15 solutions teams, including the following:

- ▶ Technology Solutions Teams: Food Service, Space Conditioning, Lighting & Electrical, Refrigeration, Plug & Process Loads, Laboratories, and Energy Management & Information Systems
- ▶ Market Solutions Teams: Financing, Leasing & Split Incentive, Data Access, Appraisals & Valuation
- ▶ Public Sector Solutions Teams: Data Management, Energy Savings Performance Contracts, Financing Strategies, and Strategic Energy Planning

Members of the BBA Food Service Solutions Team requested DOE to develop this guidance document for use by the food service industry in understanding the basic issues involved in deployment of energy management systems (EMS) in their establishments. This topic is of interest because of both the potential for significant energy savings and the low level of adoption of EMS technology in the sector. The intended audience for the guidance document is food service energy management staff, who may be aware of EMS and are looking for guidance but are not familiar with the nature of the technology or its potential benefits.

According to data in the U.S. Energy Information Agency's Commercial Building Energy Consumption Survey (CBECS), food service establishments are predominantly high-energy, small-footprint spaces.² EMS products for commercial use can be viewed, roughly, as specialized building automation systems and were initially developed for much larger buildings with much lower energy consumption per square foot.³ For a variety of reasons, EMS technology has been slow to penetrate the small- and medium-size building markets and is relatively uncommon in food service establishments.

¹ Additional information on the DOE BBA program can be found at <http://www4.eere.energy.gov/alliance/>

² Data from 2003 CBECS (<http://www.eia.gov/consumption/commercial/data/2003/>)

³ "Advanced Sensors and Controls for Building Applications: Market Assessment and Potential R&D Pathways," Brambley *et al.*, (2005). Available at http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/pnnl-15149_market_assessment.pdf

The EMS products in existence and under development for the food service market range from traditional building automation systems to highly innovative solutions of all sorts. In researching this document, DOE learned that the bottleneck to more widespread adoption of EMS by the food service sector lies less in the existence of suitable EMS technologies than in the challenges facing enterprises wishing to adopt them.

Such challenges include:

- ▶ Evaluating these complex, multifaceted products
- ▶ Incorporating them into facilities and operations
- ▶ Operating and maintaining the products effectively under the stringent constraints on time and resources inherent in food service

Cost, of course, is also an important factor. However, this has been improving in recent years, and a number of food service enterprises have found it cost-effective to implement an EMS. Some users have found the ancillary benefits to operations and maintenance especially valuable, in addition to direct energy savings from control of equipment schedules and settings.

As a result of these findings, this document presents basic information about the nature and benefits of EMS and DOE has made the project planning and implementation challenges listed above the primary focus of the guidance document.

This report was developed through collaboration between DOE, the BBA Food Service Team members, and key members of industry, including EMS vendors and experts on the implementation of EMS in food service establishments.

I. Introduction

Energy Management Systems (EMS) are strategic, energy-saving tools for commercial buildings. More specifically, an EMS is an installed hardware and software system that uses control, automation, information, and analysis functions to:

- ▶ Save energy
- ▶ Reduce energy costs
- ▶ Identify building or mechanical problems impacting your buildings' energy use
- ▶ Control equipment settings and schedules across a single site or group of sites

EMS technology is finding greater application, and achieving greater penetration, within the energy-intensive food service industry. In fact, EMS typically save on the order of 5% to 25% of the energy used in food service buildings whose energy consumption is initially not controlled.⁴

This guidance document provides general information about EMS as used in food service applications. To help prospective energy managers avoid common pitfalls and overcome typical issues, **this document provides a generic process for EMS sourcing, installation, commissioning, and field testing in food service organizations.** The document also touches upon the subject of scaling up to a greater number of locations after field testing.

The content is primarily intended for non-technical food service energy management staff in the early stages of researching or sourcing an EMS. However, more experienced managers with installed energy management systems may also benefit from some of the information in this guidance document

An EMS project typically begins with an initiative from restaurant management to save energy and reduce energy costs. The energy manager investigates the technology and provides management with the information needed to determine whether to consider it further.

An EMS can provide sustained cost savings

Basic terminology

Restaurant: Refers to food-service-related establishments or locations that deliver food onsite, including quick-service restaurants, cafeterias, and full-service restaurants.

Energy manager: Employee responsible for the sourcing, selection, evaluation, and implementation of an EMS for a food service establishment, including the development of system settings and policies for ongoing management of the EMS.

User: Any party involved in day-to-day operation of the EMS. May include the energy manager, local equipment technicians, store personnel, or third-party support partners.

⁴ Source: National Energy Solutions, Dallas, TX (2014). See also: "Energy Efficient Building Management" at http://www.nrel.gov/tech_deployment/climate_neutral/energy_efficient_building_management.html

for the restaurant, along with many non-energy, automation, and operational improvements. However, without prior working knowledge and specialized experience with EMS, food service energy managers may have difficulty in efficiently directing all aspects of a successful EMS project.

Those who are unfamiliar with EMS will want to read the next two chapters, which describe the benefits of using an EMS (Chapter II) and provide a high-level overview of the technology and its adoption by a food service organization (Chapter III). Readers who are already familiar with EMS may wish to skim Chapters II and/or III, but in any case should find useful information in the chapters that follow. Those remaining chapters describe the specifics of the generic EMS adoption process, addressing the issues of planning (Chapter IV), installation and commissioning (Chapter V), field testing (Chapter VI), and scaling (Chapter VII).

Finally, we have provided a detailed case study of EMS implementation by a quick-service restaurant chain organization (Appendix C). The case study documents three phases of EMS testing and scale-up, including lessons learned by the organization in each phase.

II. Benefits of an EMS

“An energy management control system will improve how your building's equipment systems work together. New systems can provide more precise control of your energy consumption, allowing you to improve your bottom line, while creating a comfortable environment for your employees.”

Source: Sacramento Municipal Utility District (SMUD), Energy Management Control Systems: Installation Rebate web page, July 2014

This chapter discusses the benefits of installing an energy management system in a food service application. Benefits of an EMS fall into three categories:

1. Reduction in energy consumption and expenditure
2. Maintenance improvement for energy-intensive equipment; loss prevention
3. Operational and behavioral improvements

As mentioned above, when energy consumption in a food service building is not initially controlled, EMS can save about 5% to 25% of the total energy used. Savings vary by climate, existing building conditions, and the state of maintenance of onsite equipment (including installed heating, ventilation, and air conditioning [HVAC] capacity). The savings and operational benefits from an EMS are ongoing if: (1) the EMS and its policies are maintained; (2) the building equipment and building envelope are properly cared for; and (3) the performance of the installed EMS is monitored.

A. Energy Savings

Energy savings provide the most direct and quantifiable benefit of an EMS, helping restaurants to save money on energy bills by reducing overall consumption and maintaining energy efficiency going forward. The opportunity for improved performance and efficiency of energy-consuming building equipment is provided by appropriate EMS energy strategies and policies, as well as increased visibility into maintenance conditions.

Restaurants can obtain energy savings by selectively changing the way building equipment is operated on a day-to-day basis. A key goal in implementing EMS equipment controls is extracting as much savings as possible without negatively impacting restaurant operations or customer satisfaction.

What is an EMS setting? What is a policy?

An EMS **setting** is a setpoint or schedule for control of building systems or other equipment within a restaurant. For example, setpoints are used to define the allowable temperatures within different building zones. Settings can also describe zone groupings of lights and the timer schedule used to control them.

An EMS **policy** is a group of guidelines for the energy management operations in a restaurant (or multiple restaurants). A policy describes characteristics such as the administration of settings, allowances, and the ability of onsite staff to override parameters.

An effective food service EMS will allow an energy manager to easily implement and standardize energy policy and settings over one restaurant or multiple restaurant locations. A set of managed buildings may encompass multiple climate zones and various building types, building ages, and equipment conditions. An energy manager overseeing EMS installed in multiple locations should expect a range of energy savings and operational improvements across locations.

B. Maintenance and Loss Prevention

EMS allow the user to monitor and analyze the condition of various building systems and other equipment. These can include, but are not limited to, the following:

- ▶ HVAC equipment⁵
- ▶ Indoor and/or outdoor lighting and signage
- ▶ Refrigeration equipment
- ▶ Cooking equipment

Three valuable benefits of EMS in food service establishments include continuous, real-time monitoring of equipment conditions; compliance with operating policies; and early detection of failures. In addition, meaningful equipment performance patterns can be identified and used to prioritize, track, and evaluate predictive and preventive maintenance opportunities. This can increase the life of expensive building systems and equipment, reduce recurring maintenance costs, and provide data for the reprioritization of repair budgets.

Often, operators delay building equipment repairs until scheduled routine maintenance is performed. In the meantime, to maintain comfort or other functionality, employees might attempt to correct malfunctioning equipment by altering its functions. Examples of this behavior are turning off fans, operating in an override mode, turning equipment off completely, propping doors open, or utilizing other

Monitoring

Monitoring refers to an EMS's ability to provide a flow of real-time information from buildings with equipment controls. EMS users can view and extract monitored data, reports, and alerts.

Monitoring provides the user with a range of information, such as:

- ▶ Equipment use: Current and historical ON/OFF status and current thermostat settings, and real-time performance.
- ▶ Restaurant conditions: Current and historical room temperature, humidity, outside lighting or temperature conditions.
- ▶ Energy consumption: Total restaurant electricity or gas consumption, equipment consumption (if sub-metering is available).
- ▶ Diagnostic information for problem conditions.

⁵ HVAC equipment might include rooftop units (RTUs) used for heating, cooling, and/or humidity control, as well as economizers and various fans and blowers.

pieces of equipment to compensate. While this may mitigate the effect of equipment deficiencies, it impacts the efficient use of energy and alters the way the equipment should function. In fact, it can further compromise expensive building equipment, assets, and space temperatures. An EMS can provide previously unavailable remote access to important onsite equipment and building data and, often, real-time visibility into building or equipment practices and conditions that need immediate attention.

EMS can also play a role in food safety and equipment loss prevention. Equipment such as HVAC and refrigeration are essential to everyday food service operation; the failure of either system can materially impact both immediate and long-term restaurant profitability and operational performance. EMS often offer critical alerting functions that can notify operators of such issues, allowing them to take same-day, appropriate corrective actions. In some cases, such rapid action can prevent catastrophic equipment failure and its associated consequences.

For example, if an EMS monitors refrigeration equipment it can alert the energy manager when food supplies are in danger from power failures, equipment failure, or employee operational patterns such as leaving walk-in doors open during inventory. Some EMS also identify and notify operators of problematic patterns related to monitored refrigeration systems (e.g., excessive compressor cycling). Thus, an EMS can help prevent loss of food product, protect food quality, ensure food safety standards, and prevent recurring capital losses.

C. Portfolio-wide Energy Management

At the enterprise level, when many sites have EMS installed a group of buildings can be evaluated, ranked, and optimized. Specific criteria to evaluate include energy usage, equipment performance, and adherence to energy policy and settings.

Sometimes there are site differences that impact the effectiveness of the energy guidelines deployed by an EMS. Site-specific variations in EMS policies and settings can be developed to enable cost- and energy-efficient operations over the portfolio.

Overall, enterprise owners can accrue major benefits from the EMS's ability to remotely view and control energy consumption, and diagnose equipment conditions, at many restaurant locations. Employee behavioral change alone typically cannot achieve such scalable, standardized control of energy use and system-wide compliance with energy policy and settings in an enterprise's buildings.

III. High-Level Overview of EMS

The following discussion provides a high-level view of what an EMS is, as well as what is involved in specifying a system, selecting a vendor, field-testing the equipment, and scaling up to a greater number of stores.

A. How EMS Differ from Equipment Controls

Earlier we defined an EMS as “an installed hardware and software system that uses control, automation, information, and analysis functions” to perform certain control and monitoring tasks, resulting in savings and other valuable benefits. This description may sound similar to that of a programmable thermostat or a lighting control, and, in a sense, such control devices are similar to EMS. In essence, an EMS is an extension of these dedicated controls to a single system that can control multiple pieces of equipment, of nearly any type, and accomplish much more as well.

Here are some additional EMS capabilities that are not found in controls for single pieces of equipment:

- ▶ EMS collect and store the information they receive about the equipment they control. Thus, if complaints about comfort in your dining room lead you to wonder whether your HVAC RTU is operating properly, the EMS will help you examine its behavior.
- ▶ There is a single place to look—the EMS software—for everything related to EMS control and monitoring. You do not need to go to the actual equipment under EMS control in order to change equipment settings, check equipment status, etc.
- ▶ The EMS observes and tracks how much power and energy is used by the equipment under its control, as well as any equipment it may be monitoring but not controlling.
- ▶ As mentioned in Chapter II, companies with EMS installed at multiple sites may configure them to monitor and control all of the sites from a single location. The potential benefits of such centralized management have already been mentioned.
- ▶ An EMS is capable of many more advanced and useful functions, such as diagnostics and alerting.

B. What Comprises an EMS

The types of hardware and software used in EMS, and how they are configured, differ from product to product. There is no single set of components common to all EMS. Even so, some generalizations can be made:

- ▶ Equipment controls, plus any sensors used to measure conditions (such as temperature or open doors), are on the “front lines” of the system.
- ▶ These are monitored and controlled by a software program that communicates with the user via a graphical user interface (GUI).
- ▶ The EMS software usually resides on either a user-owned computer or an Internet server managed by the EMS vendor.

- ▶ Various methods are used to shuttle control signals and other information between the EMS software and equipment controllers and sensors. Whatever the specifics, these critical signals may be transferred wirelessly, via cables, or both.

C. What Is Involved in an EMS Project?

Proposed EMS projects may range in scope and complexity, depending on the availability of funds and personnel and the disposition of upper management. This document provides generalized guidance for common project activities from project start to finish, including planning (research, specification, and vendor selection), installation, field testing, and scale-up.

Because of the complexity of energy management systems and their broad scope of control, execution of an EMS project requires a larger set of skills than is needed for most other projects involving equipment in a food service facility. Among many other factors, the energy manager must deal with issues relating to information technology (IT), energy billing, maintenance, operations, and financial analysis.

In light of the above, it should not surprise you to learn that food service organizations sometimes reach an impasse at one or another stage of the overall process. Chapters IV through VII offer some basic facts and describe a project management approach to improve the chances of success and ultimately realize the benefits of EMS.

D. Product Research and Specification

Among the various EMS vendors there are many choices of equipment and features, not to mention options for configuration, day-to-day operation, and support. The breadth of possibilities can seem overwhelming. Many food service organizations find that a fairly straightforward setup involving control of HVAC and lighting serves their purposes well, at least initially.⁶ For some, monitoring of refrigeration systems is also of significant value.

In any case, each food service organization must consider its own needs and resources to arrive at the best set of choices. These include technical factors, operational issues, and support needs, not to mention the financial component; all of these are discussed in detail in Chapter IV.

E. Vendor Selection and Purchase

Different organizations will have more or less formal acquisition processes – “formal” implying the use of instruments such as Requests for Proposals and Statements of Work. Regardless of the acquisition conventions employed, some process must be used to ensure agreement between what your organization desires and what is purchased, delivered, and installed.

⁶ After the EMS's use has become established, additional points of control and monitoring might be desired. For instance, one organization determined that a properly configured EMS could be used to detect and avoid catastrophic failure of refrigeration equipment. Based on an analysis of historic data, they implemented and validated this valuable application of EMS monitoring.

Acquisition processes should address all of the myriad important factors relating to hardware, software, system functionality, installation, support, and, of course, cost. These key factors are outlined in Chapter IV, along with some best practices.

F. Project Planning

Befitting a complex piece of equipment that controls a variety of essential building functions, careful planning is necessary to (a) minimize the likelihood of undesired consequences in the installation and ongoing operation of the EMS, (b) ensure that the system produces sufficient benefit, and (c) prevent the use of an EMS from being a burden on restaurant and corporate resources. At a minimum, planning should include test site selection, preliminary EMS settings and policy, equipment installation and commissioning, test performance, and contingencies.

G. Installation, Commissioning, and Field Testing

As previously mentioned, an EMS is not a drop-in piece of equipment but, in fact, is highly interconnected with major building systems and equipment. To reduce or eliminate any disruption of business, installation of an EMS may be performed during non-traffic times, such as overnight, before opening, or on a day on which the restaurant is otherwise planned to be closed.

Once EMS components are in place, it is necessary to perform initial testing, adjustment, and other activities prior to beginning a field test. This is referred to as *commissioning* and is analogous to the commissioning of a new HVAC system (though in this case it involves multiple systems and the EMS software).

Field testing entails collection of test data and staff feedback while running the EMS, making needed adjustments, and maintaining building occupant comfort. Testing also includes efforts to improve performance through modification of the initial EMS policy and settings. Finally, the test data must be analyzed to estimate cost savings resulting from the use of the EMS.

H. Scale-Up

A food service organization may decide that the field test results warrant placement of EMS in additional stores. Much in common with field testing, the scale-up process involves acquisition, installation, customization of settings, training, the application of policies to each individual location, and ongoing operation of the EMS.

Scale-up is more of a strategic process than field testing. Thus, the timeframe for scale-up is much longer, usually spanning several years. Also, the larger number of installations generally necessitates greater support, likely on an ongoing basis. Additional vendors might also be considered, for example by performing further field testing as they get identified and considered for inclusion in the program.

IV. Planning

Planning encompasses the decision-making process and design activity that takes place before purchase or installation and testing of an EMS. Because EMS are complex automation systems that interact with so many aspects of the building, operations, and equipment, EMS installations typically require energy managers to work with multiple internal and external groups, such as:

- ▶ IT department (initially)
- ▶ Field facilities teams
- ▶ Restaurant operations support departments
- ▶ Restaurant operators
- ▶ EMS and restaurant equipment vendors
- ▶ Restaurant equipment maintenance technicians
- ▶ Internal finance staff or project savings analysts
- ▶ Leasing and/or new construction teams
- ▶ EMS vendor technical support personnel
- ▶ Utility billing departments or bill payment companies
- ▶ Utility incentive programs and/or third-party rebate companies

Planning tasks include assessing your needs, evaluating EMS vendors, general project planning, and planning of the field test. To provide background for these activities, this chapter begins with a description of EMS technology.

(Please note that this chapter is structured so that basic material is given in the main text and more-detailed information is located in the figures and tables. You may wish to read the main text first and study the figures and tables afterward.)

A. EMS for Food Service

An EMS administers equipment settings and schedules and collects data from equipment and systems, using controls, sensors and other hardware. EMS software uses collected building data to perform various functions for the user. The specific functions offered vary from EMS to EMS, but generally include the following:

- ▶ Controlling and monitoring energy-consuming building systems and other equipment
- ▶ Collecting energy data and providing energy consumption analyses or reports
- ▶ Issuing alerts or alarms to notify the EMS user about equipment performance or energy consumption

The remainder of Section A provides an overview of EMS technology and highlights some important factors to consider when implementing a system in a food service establishment.

1. Characteristics of a Food Service EMS

To serve the needs of the food service industry, a food service EMS should be modular, scalable, affordable, and easy to deploy and use within your operations. We explain these characteristics in Table 1.

Table 1: “Food service EMS” characteristics

Characteristic	Definition
Modularity	Installed with user-desired control components (HVAC, lighting, alarms, etc.) and capable of adding or subtracting services or functions for equipment systems, as necessary, throughout the EMS lifecycle.
Scalability	Capable of being scaled from few to many installed units in a restaurant chain. Offers a standardized look and feel and consistent functionality. Provides a multi-site software interface allowing users to view, sort, and group EMS locations.
Affordability	Provides a reasonable first cost and an acceptable return on investment (ROI). The food service industry generally expects investments to have a payback period of less than two years. Rebates, where available, can be used to improve the payback period.
Usability	Easy enough for any non-technical energy manager, store manager, headquarters (HQ) staff, technician, and support team to use and operate. Easily rolled into existing operations processes. Adequate support for the system is provided.

2. EMS Functions

Vendors of building energy controls offer many different EMS functions. Figure 1 (next page), while not exhaustive, provides a description of EMS functions commonly used in food service venues. Each of the categories is described further below.

a) Control Functions

All food service EMS contain some standard functionality to control and/or automate major consumers of building energy. Automating building systems and other energy-intensive equipment is a primary way to use EMS to achieve energy savings and reduce spending on energy. A variety of energy-intensive restaurant equipment can be automated.

Examples of EMS automation

- ▶ Turning ON/OFF different lighting zones (indoor, outdoor, signs, etc.) based on a schedule
- ▶ Operating air conditioning using predetermined temperature setpoints
- ▶ Deploying standardized setpoints for every restaurant in an enterprise
- ▶ Controlling specific HVAC “zones” (e.g., front-of-house, back-of-house, outdoors) and establishing schedules for important building systems
- ▶ Turning cooking loads ON/OFF remotely, allowing for increased control of power consumption

Control

- Settings and schedule control (remote and/or local) over individual buildings and equipment
- Automated, standardized, recurring settings for building systems controlled by the EMS
- Continuous and real-time monitoring of buildings and equipment controlled by the EMS

Information and reporting

- Power and energy (measured in kilowatts [kW] and kilowatt-hours [kWh], respectively) usage data for the whole building, building subsystems, and/or specific equipment
- Periodic, scheduled, or on-demand reports of monitored data, single-site or multi-site, compiled for energy, equipment, or operations analysis
- Energy meter interval data for equipment or building analysis
- Real-time building rankings or listings, showing important building deficiencies that impact energy
- Equipment failure indications and performance information

Communication

- Website and/or mobile phone access to EMS building alerts, faults, and issues
- Available ongoing, real-time alerts regarding operations, energy, comfort, and equipment conditions

Analytical tools

- Diagnostic reports for monitored equipment and building systems
- Energy usage data, rankings, statistics, trending, and anomaly identification
- Energy settings compliance (e.g., settings, overrides, climate anomalies)

Figure 1: Food service EMS functions

Virtually any piece of equipment or system that draws a significant amount of energy is a candidate for EMS control and automation. The resulting energy savings depends on the size of the load, the existing usage patterns of the equipment, and the constraints that govern how it can be controlled or automated.

It is important to design your EMS solution to manage and control your largest controllable building systems and most energy-intensive equipment. HVAC and lighting systems are two common applications for building controls with the potential to yield significant energy savings in restaurants (and other commercial buildings).

In practice, these two building systems consume a large portion of the total building energy load, have industry-proven opportunities to save energy and money, and are the equipment most commonly selected for initial automation using EMS.⁷

⁷ While estimates of energy usage for various activities in food service may differ, and your own use depends on many factors, combined lighting and HVAC generally accounts for about 20-40% of total energy use in restaurants.

Many EMS vendors also provide control and monitoring of other important food service energy loads, including cooking, refrigeration, and kitchen ventilation equipment. Figure 2 illustrates the types of equipment that can be controlled in a food service building.

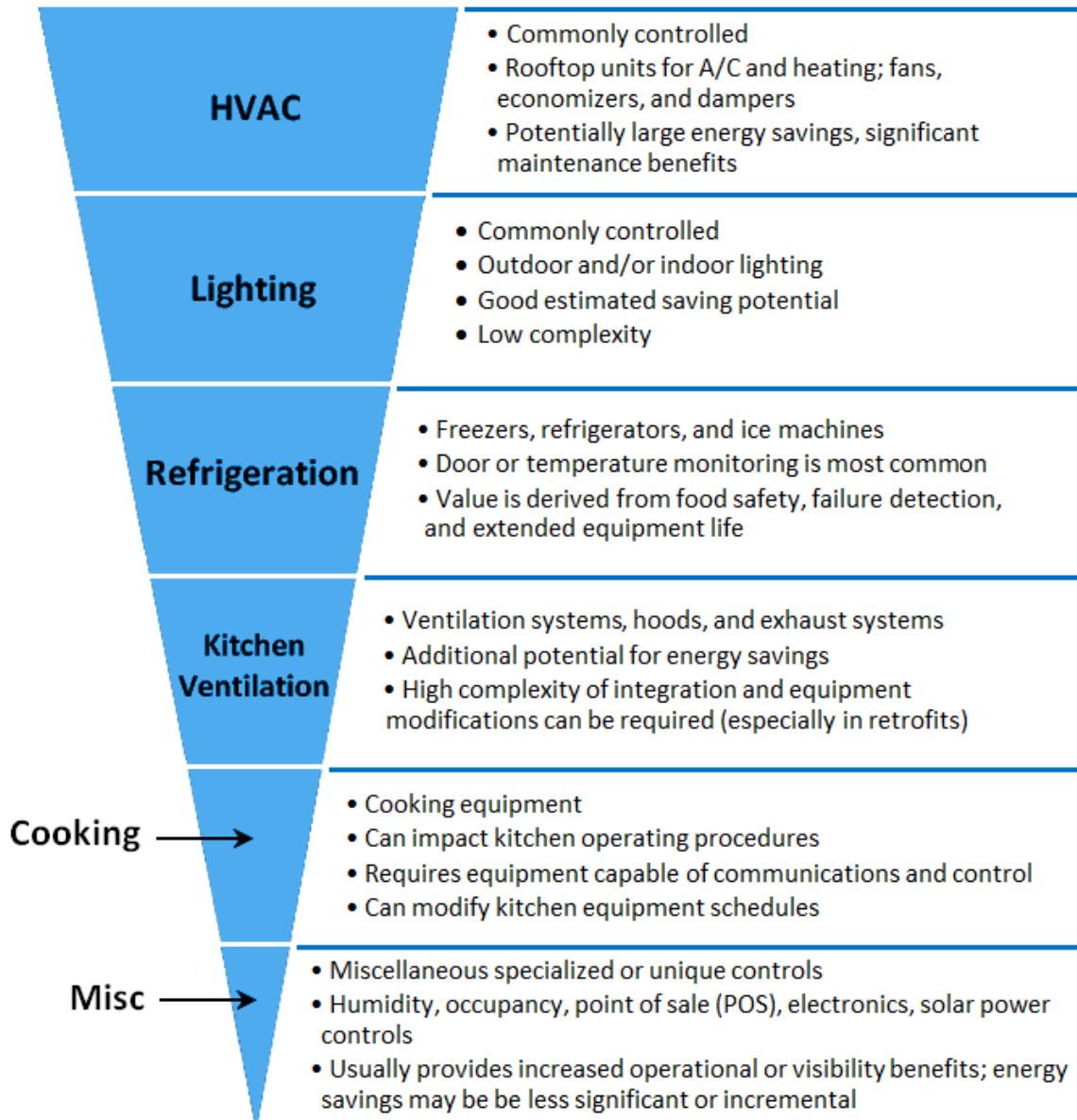


Figure 2: Common restaurant equipment and building systems controlled by an EMS

Within each of these major EMS control categories there are many specific items that can be monitored and/or controlled, some of which are listed in Table 2.

Table 2: Items within each major category to consider for EMS controls

HVAC	Lighting	Refrigeration	Cooking load	Misc. load
▶ A/C	▶ Indoor	▶ Freezers	▶ Ovens	▶ Carbon dioxide (CO ₂)
▶ Heating	▶ Outdoor	▶ Refrigerators	▶ Hoods	▶ Humidity
▶ Rooftop units	▶ Rooftop	▶ Ice machines	▶ Ventilation systems	▶ Occupancy
▶ Fans	▶ Security	▶ Refrigeration door functions	▶ Cooking equipment	▶ Cash registers, POS, electronics
▶ Compressors	▶ Parking lot	▶ Door conditions and use	▶ Exhaust systems	▶ Dishwashers
▶ Economizers	▶ Signage			▶ Solar systems
	▶ Accent			

The decision of which equipment to monitor and control should be based on a number of factors, including: the company's energy automation objectives and priorities; the cost savings; the complexity involved in controlling that equipment; and the operational improvements that EMS controls can provide.

After a new EMS becomes integrated into regular operations of the restaurant—and if the analysis is favorable for adding further automated controls—the scope of EMS controls and features might be expanded from its initial level to include other pieces of equipment or building systems. With a modular and/or open EMS product design and approach, the restaurant can add or test additional equipment, functions, and other features with minimal disturbance to the existing EMS.

b) Information and Reporting Functions

Information and reporting functions for EMS can involve one or more of the following:

- ▶ Collection of data related to energy consumption and building performance
- ▶ Access and retrieval of data on energy, equipment, and other building characteristics
- ▶ Data analysis
- ▶ Presentation of data to the user in a summarized, organized, accurate, and relevant way

The reporting capabilities of EMS products vary greatly by vendor, and they should be evaluated carefully as part of the purchase process. Many vendors offer a standard set of energy and performance reports that the user can generate using the EMS. Also, a number of vendors offer customized reporting services for periodic assembly of the data in a meaningful way. These are added to the vendor scope of work, sometimes for an additional charge.

Best practices for choosing EMS information functions

- ▶ Have users test the EMS software and understand how the information will be presented by the system.
- ▶ Determine what types of reports are needed for energy management activities and what reports your operations and management personnel will want to see.
- ▶ Determine what reports are a standard offering with the EMS package, and the costs to customize additional reports.

For some EMS software, reporting may require the user to log in to the system for information retrieval. Other systems deliver the information to the user

with alerts or periodic reports. Vendors that do not provide any direct reporting functionality can partner with a third party to compile the monitored energy information or to provide additional analytics or dashboards. Often, EMS vendors will request a customer to list important reports for the vendor to design or customize, and may provide assistance in preparing the list.

It is critical to understand what information an EMS is capable of providing, and to evaluate which data and reports are important to you. Trial testing the EMS software is the best way to get a good sense of how the system can present the information. Requirements for monitoring and reporting should depend not only on the intended use of the reports, but also on whether the EMS is being used for a single site or multi-site solution. Specifically:

- ▶ A *single-site* energy manager may want to see details of restaurant equipment performance, energy use, and the energy cost savings achieved (each month, summarized annually, etc.)
- ▶ A *multi-site* energy manager will likely also be interested in enterprise reports, including:
 - Multi-site status and conditions
 - Rankings of restaurant location outliers
 - Summary reports of system-wide alerts
 - Equipment failure trends by building, building type, climate zone, or equipment

Table 3 (next page) summarizes the many types of reports that might be offered.

c) System-User Communication Functions

An EMS communicates with the user by alerting, notifying, and providing building status. Information can be delivered directly to the recipient without website login—i.e., “pushed”—in the form of text or email alerts, notifications, or status reports. Pushed alerts are typically priority alerts, and they require the user to provide more-immediate corrective action or to monitor conditions for further degradation and act accordingly. Additionally, most EMS provide the same critical information on system displays when the user logs in to the system. This includes building status, equipment conditions, and diagnostics.

EMS alert prioritization

Most energy managers find it necessary to limit the number of “push” alerts they receive, limiting them only to very urgent situations so that they do not receive more than they can realistically handle. This also helps them to properly match their response to the level of priority of an event.

Generally, push alerts are designed for critical or immediate mechanical and business-operations conditions. These alerts can be delivered to the user’s email or mobile device. Examples of pushed alerts might be:

- ▶ Power outages
- ▶ Refrigeration failures
- ▶ Lighting groups not operating properly
- ▶ EMS offline or operating under default settings
- ▶ Building temperatures out of specification

Table 3: Common single-site and multi-site EMS reports (continued)

Types of reports	Single-site	Multi-site
Energy usage reports	<ul style="list-style-type: none"> ▶ Whole-building energy consumption or load factors at user-selected intervals such as daily, monthly, annually, or a user-defined range ▶ Equipment-level energy consumption or load factors (if subsystem control of individual equipment is present) ▶ Out-of-spec energy consumption over a date range ▶ Building energy seasonal trends ▶ Energy use during specified time periods (daytime, evening, etc.) 	<ul style="list-style-type: none"> ▶ Multi-building energy consumption or load factors at user-selected intervals ▶ Multi-site equipment-level energy consumption or load factors (If subsystem control of individual equipment is present) ▶ System rankings of locations by energy performance or desired energy metrics ▶ Monitoring of enterprise seasonal energy consumption trends, and energy outliers, across climate zones or operational regions
Administrative reports	<ul style="list-style-type: none"> ▶ Site-level setpoints and settings ▶ Override reporting ▶ Access and activity by users with Administrator permissions 	<ul style="list-style-type: none"> ▶ Enterprise-level setpoints and settings ▶ Override reporting ▶ Reports on out-of-specification locations ▶ Site energy or operational compliance reports
Energy analytics	<ul style="list-style-type: none"> ▶ Site performance against historical energy consumption ▶ Equipment performance against weather, building conditions ▶ Equipment diagnostics ▶ Root cause diagnostics 	<ul style="list-style-type: none"> ▶ Multi-site performance against historical energy consumption, weather, building conditions ▶ Equipment diagnostics (worst cases) ▶ Root cause diagnostics ▶ Trending and energy outlier reports
EMS equipment performance reports	<ul style="list-style-type: none"> ▶ Equipment failure reports ▶ Equipment performance against a user-specified metric (e.g., off-hours energy use, HVAC runtime or failure) ▶ EMS controls reports (e.g., setpoints, temperatures) 	<ul style="list-style-type: none"> ▶ Equipment failure reports ▶ Performance of all locations against a user-specified metric (e.g., identifying outliers or poor performers, off-hours energy use) ▶ EMS controls reports (e.g., setpoints, temperatures)
Maintenance reports	<ul style="list-style-type: none"> ▶ Out-of-spec-equipment reports ▶ Equipment runtime and failure data ▶ Maintenance trending data 	<ul style="list-style-type: none"> ▶ Out-of-spec-equipment reports ▶ Equipment runtime and failure data ▶ Maintenance follow-up data, by group ▶ Enterprise rankings
Connectivity reports	<ul style="list-style-type: none"> ▶ Site-level EMS equipment and network performance status 	<ul style="list-style-type: none"> ▶ Enterprise-level EMS equipment and network performance status

EMS vendors can help you customize the types and content of alerts, notifications, and status reports as needed for your application. Table 4 below shows some types of EMS user alerts, with examples of their use.

Table 4: EMS communication: some examples of user alerts

Alert type	Typical delivery	Description	Example
Equipment faults	Push	Alert the user when there is a failure or equipment malfunction.	Failure of a refrigerator compressor motor to turn on, suggesting a breakdown and loss of cooling. The EMS could alert a manager about the problem immediately.
Operational conditions	Login	Alert user, as requested, based on operating priorities. (For example, temperatures out-of-spec, overrides used too frequently, lighting overridden). Requires the EMS platform to allow user-customized alerts.	To detect indoor lights left on overnight, EMS can flag locations with high electricity use during off-hours or report ON/OFF status.
Anomalies	Login	<ul style="list-style-type: none"> ▶ Alert the user when important equipment is acting outside of normal bounds. ▶ Alert the user when a specific condition has not self-corrected within a reasonable time frame, due to operational, weather, or maintenance variances. 	Alert user if HVAC unit has consumed 20% more power this week compared to a benchmark, an indication that it might need maintenance soon.

d) Analytical Functions and Tools

Advanced energy analytics are tools for investigating various aspects of energy consumption, and other monitored characteristics, of one or more food service locations. These tools differ greatly among EMS products, and if this function is of interest to the energy manager it is important to review the set of system analysis tools available. EMS analytical tools are a rapidly changing and growing field of innovation.

Table 5 (next page) shows some examples of analytical tools that may be included with your system.

3. EMS Software

EMS software is an integral part of the energy management system. It provides all, or nearly all, of the EMS analytical functionality and effectively connects the user with the hardware, equipment, and sensors installed in the building.

Table 5: Examples of some advanced EMS analytical tools

Type	Description
Benchmarking	Comparative tools that allow the user to benchmark and compare current equipment or building energy performance with previous or reference conditions.
Equipment degradation	<ul style="list-style-type: none"> ▶ Algorithms that detect deteriorating equipment condition by comparing performance against expected or target operating behavior ▶ Analytics to determine faults and root causes of equipment failure
Cost analysis	Uncovers cost drivers, avoided costs, and/or cost-related decision making information. EMS-based cost analysis tools are not as common as other tools because of the amount of site-specific data necessary for accuracy.

EMS software contains code and algorithms that accomplish the following functions:

- ▶ Administer system settings and schedules for all controlled equipment
- ▶ Receive building data
- ▶ Perform critical analyses on the data
- ▶ Report relevant information to the user
- ▶ Diagnose building or equipment conditions
- ▶ Alarm, alert, and communicate with the user as necessary

This subsection discusses important EMS software considerations for prospective food-service EMS buyers.

a) **Software Ease of Use and User Interface**

The graphical user interface (GUI) of EMS software is one of the main factors that determines the software's utility and ease of use. The screen display is the primary point of contact between a user and the EMS software, so it is critical for the GUI to deliver the right information, in a quickly digestible form, to support daily use and interaction with the system. This is also true for information on the EMS website and in pushed reports, alerts, and notifications sent by email or text message.

The GUI should provide a logical display of site and/or multi-site information, combining text and graphics to present the various functions available to the user in a clear and easy-to-use manner. Since the EMS will be used for years,

Multi-site GUI considerations

If EMS will be installed in many restaurant locations, it is important to consider how the software design would allow users to interact with and manage all of the locations.

Some multi-site users find that grouping buildings based on various attributes (administrative groups, field groups, facility manager groups, climate regions, building types, etc.) helps to make their management easier. The EMS should be flexible enough for these groups to be user-defined and easily modified.

you should anticipate and plan for the long-term usability, efficiency, and effectiveness of the GUI.

Some parts of the EMS's user interface should be configurable and customizable, which is discussed in more detail in the next subsection. This improves the software's ability to support various required tasks, and it permits the GUI to be changed as needed over time. User configuration can also be used to simplify presentation of information and facilitate rapid assessment of building and equipment conditions.

Vendor software design and usability are vital to successful initial adoption, as well as the ongoing use, of the EMS within your organization. As indicated earlier, be sure to get demonstrations of logged-in EMS software, functionality, and configuration from the vendors to assist you in understanding how the software is designed to operate and interact with users.

EMS software should do the following:

- ▶ Provide the status of individual buildings and the enterprise, efficiently and accurately
- ▶ Organize building and equipment status according to priorities and rankings
- ▶ Present diagnostics and troubleshooting information
- ▶ Rank alerts and conditions
- ▶ Trend overall energy consumption data for your building or enterprise

Some examples of leading EMS software design include:

- ▶ Real-time charts and graphs showing the current state of onsite equipment operation for all EMS-controlled systems, viewable by schedules, date ranges, or problem types
- ▶ A meaningful hierarchy of "actionable" problems, designed to flag issues that require immediate correction by facilities managers or field technicians. These are displayed in reports or upon log-in to the system

b) Software Flexibility and Customizability

Flexible software provides a great deal of control over each function offered to the user. For multi-site users, flexibility also includes the EMS's ability to (a) provide all necessary multi-site or enterprise reports and summaries, and (b) allow users to create a custom set of enterprise analytics and operational reports.

For example, scheduling of lighting and HVAC is a key EMS function requiring software flexibility. Energy managers should consider these questions:

- ▶ Can the software provide lighting controls in different zones and on different schedules that might change?
- ▶ How many lighting zones can be controlled by the software? Can lighting circuit schedules be changed if operational needs change after EMS installation?
- ▶ How many different programmed heating and cooling setpoints or schedules are available in the system for each day? How are temperature overrides and resets designed?
- ▶ Are there global override functions to allow for widespread schedule changes?
- ▶ Can EMS data be collected and analyzed by operating schedule (daytime usage vs. overnight)? By specific equipment type?

- ▶ How can front- and back-of-house HVAC units be grouped for scheduling? Can RTUs be brought on in a staggered format, or are all front-of-house RTUs grouped together for ON/OFF commands? Can you change configuration after EMS installation? Does the vendor charge for this capability?

Whereas *flexibility* pertains to having built-in choices, *customizability* refers to software's ability to create new choices or capabilities, for example through macros, a scripting language, or coding. EMS software customizability becomes important if an end-user needs functions or applications that are outside of the typical suite of functions offered by an EMS vendor. Customization enables software to accommodate future operational changes, new EMS initiatives, or new opportunities that come from the use of EMS.

Note that EMS vendors should disclose future EMS product plans, interoperability with external systems, and upgrades that will supplement existing functions over time.

4. EMS Hardware Components

All EMS involve hardware that (a) collects desired data and (b) controls the user-selected building and EMS mechanical systems. The data that the hardware collects depends on the building systems being controlled or monitored and the functions that the user has chosen. For example, if the user wants to monitor and control HVAC systems, appropriate information must be transmitted between the HVAC equipment and the EMS software.

The EMS hardware package for a food service installation typically includes an EMS controller that communicates with other hardware throughout the building. The main controller sends building status data to the EMS software and, in return, receives equipment automation commands.

A typical EMS hardware kit for HVAC and lighting control might contain the following:

- ▶ Heating/cooling thermostat – Standard thermostats are responsible for reading and controlling temperature. Generally, EMS thermostats (which replace the standard ones) add software, data collection, and thermostat indicators to enhance control, diagnostics, and/or remote networking.
- ▶ Duct temperature sensors – This component is typically placed in the air supply and/or return ducts to measure duct temperatures.
- ▶ Energy meters – There are various types and sizes of energy and power meters for capturing whole-building energy data. The meter leads are clamped around each phase of the power load coming into a building. Often, more than one energy meter is needed per site. Users might also opt to install EMS *submetering* to collect data from specified individual building systems. Note that EMS building controls can operate without energy meters; however, the EMS will then not collect or report building power (kW) and energy (kWh) data. When demand response functionality⁸ is implemented, energy meters are required.
- ▶ Outside light and air-temperature sensors – These sensors can be separate or combined. They capture outside

⁸ “Demand response” (or DR) means planned, system-automated reduction of electricity usage in controlled buildings, in response to changes in the price of electricity, incentive payments offered by utilities, or government-mandated curtailment.

air temperature and light levels for the HVAC and lighting controls. Existing photocells or timers can be used if they are functional and compatible.

- ▶ Remote HVAC zone sensors – These sensors are often used for sensing temperature in remote spaces that don't contain an existing thermostat.
- ▶ Lighting contactors and relays – These are used to control lighting circuitry according to lighting groups and schedules.
- ▶ General sensors and contactors – Current transformers (CTs) and auxiliary sensors can be added additional items to be monitored or controlled remotely. These can include:
 - Refrigeration
 - Kitchen equipment
 - Humidity
 - Occupancy
 - Solar inputs
 - Water
 - Carbon monoxide (CO) or CO₂
 - Other items
- ▶ Uninterruptible Power Supply (UPS) – Power intended for short-term backup and device protection.

5. Other Factors of Importance

a) “Open” versus “Closed”

For an EMS to perform its functions, it must communicate with the equipment it is connected to using a *communications protocol*. The protocol used by a given EMS may or may not be compatible with controls and building equipment from different manufacturers.

There has been significant debate about the nature of EMS communications with equipment, and whether such communications should be “open” or “closed.” These terms refer to the ability of parties other than the EMS developers to access various aspects of an EMS product. There are a number of communication-related terms in the EMS industry that contain the word “open.” It is important for you to realize that different terms containing “open” can refer to different types and levels of access to software and integration.

“*Open system*” is the commonly used term for EMS being able to function with systems or components that the EMS manufacturer does not produce. The term “open system” suggests the scalable integration of building controls, by the same or a different vendor, or additional pieces of a manufacturer’s equipment in the future. This functionality can be useful after the initial system is installed, for example when technologies or user needs change. “Open” building automation systems (such as EMS) use open communication protocols, such as BACnet™, LonWorks®, or Modbus®. This gives the EMS the flexibility to communicate with various building equipment and, if necessary, third-party building control components or software.

Many EMS manufacturers use communications protocols, often referred to as “*closed systems*,” that limit the EMS to interfacing with its own hardware and software. Closed-system EMS have long been a mainstay of the EMS market. However, the last five years has seen significant movement of the EMS market toward open systems, platforms, and architectures.

A third term you will likely encounter with respect to communications is “*proprietary*,” which refers to the ownership of a protocol. A protocol is proprietary when a single organization or individual has the right to make changes to, and license the use, of the protocol. Note that some owners of proprietary protocols choose to publish the details of the protocol, effectively making it an open protocol as well as proprietary. Modbus® is an example of this. However, the term “proprietary” is a bit confusing because it is sometimes used in a different sense; specifically, to mean that a product, or a portion of it, is a closed system. You should be sure to clarify the intended meaning when the term is mentioned in discussions or other communications with vendors and IT representatives.

Currently, energy managers have the option of purchasing the following:

- ▶ Turnkey EMS hardware and software solutions from a single manufacturer
- ▶ Open system EMS products and components
- ▶ EMS containing both open and closed system components and software

Table 6 (next page) lists some general advantages and disadvantages of open and closed system designs.

There is a growing number of independent EMS service providers called “EMS integrators.” These providers act as coordinators, co-developers, and customizers of EMS hardware, software, and client services. EMS integrators can package competitively-priced open EMS hardware and/or software with development services and increased customer service. They can offer custom, integrated products for organizations seeking turnkey EMS solutions in the burgeoning “open systems” environment.

The products that integrators offer may be a combination of open and proprietary hardware and software components. These integrated products typically feature customizable software features, along with technical expertise, support, and consultation. The integrators represent one or more brands or manufacturers and often collaborate on design solutions with controls contractors, system integrators, mechanical contractors, and manufacturers.

If you are considering using an EMS integrator you will want to weigh the costs involved against the expected savings and benefits.

b) Wired versus Wireless Networks

Another area of debate and innovation is how EMS components are connected to each other and to building equipment. Building equipment communicates with a local EMS controller and EMS thermostats using either a wired or wireless network connection (though food service EMS installations with combined wired and wireless components are growing in number). In making the “wired vs. wireless” decision, the energy manager needs an understanding of which EMS components require wiring and which components might be selected as wireless.

Table 6: Open vs. closed systems

	Advantages	Disadvantages
Open system	<ul style="list-style-type: none"> ▶ Can change or replace hardware components, integrate off-the-shelf products and new technologies ▶ Can add more EMS functionality in a piecewise way; you are not committed to one manufacturer or vendor ▶ User can design custom (separate) interface software, or add features or products from other manufacturers ▶ More-competitive hardware prices, as freedom to choose suppliers can lead to increased competition and lower costs ▶ Advantages in customization, interoperability, and third-party partnerships increase EMS value and/or functionality 	<ul style="list-style-type: none"> ▶ Initial product cost may be higher ▶ May require an industry “EMS integrator” to coordinate software and hardware selections, service solutions, and warranties ▶ Support is required for the multiple equipment platforms involved ▶ Sometimes lacks immediate, out-of-the-box functionality ▶ Requires development of precise EMS specifications, which can be challenging for energy managers ▶ Customization may require significant energy manager time and knowledge for design and testing
Closed system	<ul style="list-style-type: none"> ▶ Single-source product line, service, and product plan ▶ User bears no system integration responsibility ▶ All components are guaranteed to work together ▶ EMS purchase and management is generally simpler for energy managers—no need to design or customize ▶ Vendors are experienced with their own systems and can capably provide support and services for all components of your EMS ▶ Designers of proprietary systems are increasing capabilities and services for system customization and integration with third-party software 	<ul style="list-style-type: none"> ▶ Manufacturers may charge for service and system upgrades ▶ Customization usually incurs additional cost and may be expensive ▶ Customization may be limited ▶ If the EMS vendor goes out of business, it may be challenging to find ongoing support ▶ Updates and upgrades are dependent upon vendor product plans and priorities. The manufacturer decides the technical direction of the EMS and what functions are offered

Wired network installations have been standard in the EMS industry for decades and are extremely reliable. They require traditional installation methods in a food service building: any wires running from mechanical and electrical rooms, the rooftop, electrical components, and kitchen components need to be hidden in walls or ceilings to avoid disturbing food service operations. Component costs are sometimes lower, but wiring adds to labor and installation costs.

Wireless EMS are gaining popularity and customer acceptance because of improvements in reliability, performance, ease of installation, and cost. Furthermore, they offer increased flexibility in component placement and can reduce installation costs. Wireless EMS sensors and thermostats are growing in

popularity to solve “hard-to-install” problems, and they allow thermostat locations to be changed after installation. Signal interference can sometimes occur, but is generally minimal.

B. General Project Planning

1. *Understanding EMS Project Support Requirements*

Overall EMS project activities include acquisition, installation, and field testing. Acquisition is discussed in detail in Section C of this chapter, and planning for field testing is described in Section D.

Food service organizations usually dedicate a project manager to plan, manage, and implement all aspects of the project for the company. The term “EMS project manager” need not be interpreted as referring to a person other than the energy manager. In fact, if a company has an energy manager that individual is typically designated as the project manager. In this document we generally use the two titles interchangeably, and we assume there to be an energy manager. In organizations without a formal energy manager, a person may be informally assigned to manage the EMS technology evaluation process.

During the course of the project, the project manager should plan for necessary technical, facilities, and operations support. In practice, restaurant locations with newly installed EMS will need designated support for the following activities:

- ▶ Monitoring the performance of existing building systems and equipment under the new (EMS) controls
- ▶ Modifying EMS settings and parameters for challenging building conditions
- ▶ Correcting equipment deficiencies discovered when the EMS is installed

Once the system is installed, the energy manager will generally participate in EMS operations. He or she will also coordinate any support from other sources. This includes ongoing support for building monitoring, analysis of EMS energy data and reports, and necessary communications with store operators and field personnel. The energy manager may also require a team lead among facilities managers, coordination with maintenance technicians, and an internal or external energy-accounting or utility bill pay specialist to assist with EMS savings measurement.

a) **EMS Project Manager Roles**

As mentioned, the primary responsibilities of an EMS project typically fall on a corporate energy manager or a designated corporate facilities project lead. This can be either an internal resource or a specialized, outsourced resource. To ensure efficient and successful EMS testing and implementation, the project activities involved—research, selection, purchase, and testing of an EMS—typically require expertise in a combination of areas: industry, technical design, strategy, and business direction. As a result, outsourcing of turnkey EMS technical and business project management has grown in popularity.

During the planning, installation, testing, and measurement portions of the project the EMS project manager typically interacts with the following internal support groups:

- ▶ Finance and IT
- ▶ Billing and accounting

- ▶ Facilities and store operations
- ▶ Repair and maintenance department
- ▶ Leasing
- ▶ New construction department
- ▶ Building design groups
- ▶ Marketing and public relations

b) Ongoing EMS Operational Support

After installation, routine monitoring and support is required for ongoing energy and information management activities. Areas requiring such support are listed in Table 7. Depending on the complexity of the EMS and the number of installed locations, additional resources may need to be secured to perform many of these support functions.

Table 7: Support needs and responsibilities for ongoing EMS operation

Potential EMS support areas	Support details and responsibilities
Routine monitoring of building alerts or alarms	These are usually caused by equipment failure, out-of-spec conditions, or degrading equipment or building conditions. Monitoring real-time alarms is typically the responsibility of the energy manager, EMS-trained facilities personnel, or third-party partners.
Management of equipment and building issues	EMS use can uncover existing equipment and building issues or deficiencies. The energy manager, or a support group, will identify the need for onsite mechanical troubleshooting and correction, then direct the information to facilities or maintenance personnel.
Management of compliance to the energy policy and settings	The responsibility for adherence to company EMS energy policy typically belongs to the energy manager, facilities teams, or support personnel. This includes exceptions to policy, as necessary.
Energy management activities, measurement and verification (M&V), and analysis of energy performance	This activity includes analyses related to the business plan and the tracking of energy savings achieved by the EMS. This may be performed by the energy manager, the EMS vendor, or a third-party partner. Access to EMS and meter data, utility bill pay databases, and company financial information is needed for savings measurement.
Troubleshooting the EMS and EMS parts replacement	If there are issues with the EMS hardware or software, the energy manager may be required to coordinate parts replacement and warranty administration with the EMS vendor. EMS hardware replacement in the field typically requires remote coordination with trained field facilities personnel and local maintenance vendors.

For multi-site organizations, the energy manager will need to develop an EMS support plan and a structure to perform many of the required ongoing operational support tasks.

Other factors to consider when designing EMS support operations include:

- ▶ Required availability of EMS technical support personnel – 24x7, weekdays only, etc.
- ▶ EMS training – How much training of restaurant staff is needed, how will they get it, and will it need to recur due to personnel turnover?

2. *Who Has Access to the EMS?*

The energy manager should consider who will have access to the EMS during regular operations. Those with access to the EMS will require some training. Some potential EMS users are listed below:

- ▶ The project manager or other project team members responsible for the installation and performance of the EMS, during or after field testing
- ▶ Field facilities managers
- ▶ Field technicians for relevant building systems and equipment (e.g., HVAC and lighting)
- ▶ Third-party support (vendor or others)
- ▶ Upper management team or project stakeholders

Who operates the EMS?

Enterprise, or multi-site, EMS installations typically limit the extent of store operator responsibility for EMS management and control functions. Instead, they will allocate headquarters and vendor operational support to the locations.

If EMS are controlled at the restaurant sites, the energy manager must prepare for local management of the EMS by ensuring that recurring product training is provided for store operators.

EMS generally allow different levels of permission, ranging from administrative to read-only access. The development of EMS logins and user permissions should be reviewed with management staff, both field and internal, and should be assigned based on who has responsibility for the EMS site and equipment management after installations. Some restaurants may want support staff, such as facilities personnel or technicians, to have access to the EMS to assist in support activities, while others may want to control EMS access tightly.

3. *Upfront Costs Related to EMS*

EMS hardware and software are standard upfront project costs. In addition, food service organizations should anticipate the following other “first costs” during the planning process:

- ▶ Onsite equipment repairs prior to and during EMS installation
- ▶ Installation- and training-related costs
- ▶ Variances in EMS site Installation costs

These are described in the subsections below.

a) Onsite Equipment Repairs Prior to and During EMS Installation

Many restaurant locations have building equipment needing repair or maintenance. Onsite equipment deficiencies, deferred maintenance, and non-standard building design conditions are often exposed during the EMS installation. EMS installation can get delayed as issues are resolved if such problems are uncovered. This can impact project perceptions and timelines and may incur additional, out-of-budget costs.

A pre-installation survey to assess the condition of equipment that the EMS will control, or equipment otherwise affected by the new controls, can prevent these consequences. Some options for pre-installation surveys include the following:

- ▶ The EMS vendor may offer, at no cost or for a survey fee, local site surveys of a limited set of restaurants prior to field testing.
- ▶ While it is usually cost- and resource-prohibitive for the EMS project team itself to perform site surveys for all intended locations, an organization may elect to have pre-installation surveys be conducted remotely. Onsite assessment of any equipment for which EMS controls are planned can be discussed with local facilities managers or local maintenance technicians.
- ▶ Equipment assessment may also be proactively planned for inclusion in regular scheduled maintenance prior to the start of tests involving the EMS.

The EMS project manager should consider site repair budgets and cost allocations for such “site deficiency maintenance” before EMS installation begins.

b) Installation- and Training-Related Costs

The cost of EMS installation and commissioning (discussed in Chapter V) is typically bundled into the total system price. Most often, the EMS vendor (or their subcontractor) performs installation and commissioning. Note that if you require after-hours, weekend, or any other non-standard installation schedule, the installation cost will likely increase and should be discussed with the vendor.

There may be a cost for the vendor to train relevant onsite and remote users on how to operate and use the EMS. Some vendors provide this free of charge, or provide introductory level training for free but charge for more in-depth instruction. Other arrangements may be available.

The energy manager may also need to perform additional training for other audiences or users after the installations are completed.

c) Variances in EMS Site Installation Costs

When developing a budget, organizations define a baseline or standard EMS kit based on a typical facility, but some site-to-site variation is normal. Therefore, prospective EMS buyers should consider field variations that may impact upfront costs, such as:

- ▶ Additional HVAC RTU kits for locations with more RTUs than the EMS base kit
- ▶ Additional building wiring

- ▶ Remote sensors or photocell additions
- ▶ Lighting circuitry modifications
- ▶ Additional energy meters
- ▶ Minor equipment repairs performed by installers (when possible)

Note that even when locations are surveyed for possible variations prior to installation, such surveys do not guarantee the absence of equipment problems when EMS installation begins. Sometimes deficiencies can go undetected, and new issues can arise after the survey. Installers usually only finalize their list of variances during the installation itself. Energy managers should develop a supplemental “installation variances budget” to support any site variances that impact cost during that portion of the project.

4. Ongoing Costs

Ongoing costs generally consist of hardware replacement and EMS support:

- ▶ Ongoing EMS hardware replacement (warranty management and post-warranty). After installation, vendors should provide an ongoing, accurate record of EMS components and their warranties. A budget should be developed for post-warranty maintenance, replacement, or repair of EMS components at each installed location.
- ▶ Monitoring support costs, including:
 - *Self-monitoring* – The cost of dedicated or part-time personnel responsible for management of all EMS activities. This may include energy managers, facility managers, or other dedicated support personnel from within the enterprise.
 - *Vendor monitoring* – Most EMS vendors charge an ongoing monthly monitoring fee for connectivity, technical system support functions, and routine customer service. There are varying degrees of vendor support and associated fees, which should be clearly identified in vendor discussions.
 - *Outsourced EMS support and monitoring* – There are companies that offer EMS monitoring, diagnostics, operations support, and reporting. Outsourced EMS support and monitoring solutions may not be needed during initial testing, but may later become necessary when the EMS is scaled to additional locations. After an initial test period of 9-12 months, the energy manager should have enough system experience to determine the ongoing support infrastructure needed to maintain a larger number of installed EMS locations.
- ▶ Optional analytics or additional reporting services. As discussed, some EMS vendors may offer analytics and/or reporting toolboxes with their product, which can provide additional value. For proprietary EMS, it is important to determine whether integration of third-party analytics is possible.
- ▶ Measurement and Verification (M&V). This represents the cost to measure, verify, and calculate monthly and annual energy savings from installed EMS.
 - Utilities will likely require verification of actual savings after installation as a condition for rebate funding.
 - In addition to satisfying any rebate requirements, M&V is an important ongoing activity that supports the determination of project ROI and other important business results for upper management. The energy manager will need to develop an ongoing plan to accomplish this.
 - The energy manager or an internal billing analyst may perform M&V activities. Alternatively, M&V activities may be outsourced to the EMS vendor, your current utility bill-pay company, or third-party M&V companies.

5. EMS Rebates

Energy efficiency rebates, offered for EMS by some utilities and state governments, can provide a potentially large financial contribution to a food service establishment. However, managing utility rebates for EMS is task-intensive. It requires a great deal of specialization to gather and complete rebate application materials, which, for each location, typically includes utility data, EMS controls specifications, and often pre-EMS construction documentation. Even so, with aggressive management of the EMS rebate process, utility rebates can greatly improve EMS project ROIs.

When available, utility rebates can provide site funding of from \$200 to more than \$10,000 toward installed and verified EMS. Currently, each participating utility has its own EMS rebate application process, guidelines, and requirements for acquiring available rebate dollars. There is no single, authoritative list of available rebates for EMS. However, there are several resources available to those seeking EMS rebates, which we have provided in Chapter VIII (References and Resources).

An important note about EMS rebate logistics!

Most EMS rebate applications must be filed before an EMS is installed in a facility, and a *pre-installation inspection* is typically required. To ensure that the application is not rejected due to premature installation of an EMS, be sure that the project timeline allows for rebate application filing, required pre-installation building inspections, and associated processing and approval times.

Rebates are typically paid anywhere from three months to one year after application and EMS installation. Utility rebate calculations for EMS funding are complex and vary by utility program and EMS. Whether you outsource the application process to a utility rebate partner or use your own internal support resources for applications, to maximize rebate funding you must follow utility rebate calendars for available funding, meet application deadlines, and provide all required documentation.

C. EMS Vendor Selection

The discussion to this point is meant to provide you enough context to consider various EMS vendor options, begin discussions with the vendors, and evaluate vendor proposals.

“Given the wide gap between building energy management systems (BEMS) capability and customer readiness, numerous BEMS vendors are shifting their focus toward innovative marketing and business models ... Many vendors, for example, are starting to offer subscription-based pricing for BEMSs rather than license-based fees, reducing the upfront capital requirements for installation. Additionally, some vendors, especially those with particularly large suites of applications, are selling their software as pilots initially. These vendors are allowing the customer to scale up with additional applications as they become more accustomed to using the system and as the benefits are proven.”

Source: Navigant Research, *Building Energy Management Systems* (Q3 2013)

1. Obtaining EMS Proposals

The two main approaches to obtaining proposals from EMS vendors are soliciting informal invitations for proposals and issuing a formal Request for Proposal (RFP).

A variety of factors (which are beyond the scope of this guidance document) affect the desirability and feasibility of taking the RFP approach. If you choose to issue an RFP, it should provide a set of requirements and/or specifications upon which the vendor can base their proposal. Depending on circumstances, the project manager may or may not have a well-defined list of EMS requirements or desired specifications when approaching vendors, and may wish to start the process with informal requests for information.

Table 8 provides some general guidelines for requesting EMS information from vendors during the evaluation or proposal processes. In addition to the factors listed in the table, financial considerations such as upfront cost, ROI, and simple payback period will also differentiate vendors. See Appendix A for a detailed breakdown and further discussion of important proposal or RFP topics.

Table 8: Categories and items for interactions with vendors (discussions, RFPs, etc.)

Category	Specific items
System functions	<ul style="list-style-type: none"> ▶ Standard EMS functions and features to control building equipment ▶ Optional functions ▶ Upfront and ongoing costs
Hardware	<ul style="list-style-type: none"> ▶ A list of specifications, photos, and prices of the hardware kit ▶ Connectivity and/or infrastructure diagrams, protocols, and integration ▶ Parts replacements and warranty terms
Software	<ul style="list-style-type: none"> ▶ GUI screenshots, design, and software display ▶ EMS functions ▶ Ease of learning and use
Installation	Installation plans and schedules
System support	<ul style="list-style-type: none"> ▶ Vendor access, monitoring fees, and monitoring activities ▶ Custom support fees
Additional	<ul style="list-style-type: none"> ▶ Vendor rebate management services (if available) ▶ M&V (utility rebate and savings analysis support) ▶ Vendor field technician network; national pricing and labor costs ▶ Sample invoice ▶ Sample vendor contracts ▶ Vendor references ▶ Commissioning ▶ Training and ongoing support

2. Evaluating EMS Proposals

At a minimum, evaluation and comparison of EMS proposals should involve consideration of the following attributes:

- ▶ Costs (system hardware, installation, and monitoring)
- ▶ Product and component warranties
- ▶ System feature sets (functions, schedules, overrides)
- ▶ Product GUI; display and web access
- ▶ Vendor services (rebates, project management, financials, measurement)
- ▶ Training services
- ▶ Vendor field maintenance network
- ▶ EMS contract terms

See Appendix I.B for a more detailed example of an evaluation framework.

The energy manager may also request proposal evaluation assistance from facilities, IT, or finance staff. Ultimately, the food service organization needs to judge and assess each proposal against the criteria that are most meaningful for their own restaurants.

a) Selection and Testing of Multiple EMS Products

Some enterprises opt to select and test multiple EMS products during field testing. For medium and large organizations, it is not uncommon to have more than one type of EMS within the enterprise after the initial tests.

The greatest benefit of testing multiple EMS is the ability to use and work with the different software programs for a period of time before investing significant capital expenditure in a single vendor. However, it is important to note that testing multiple EMS increases project complexity and the project evaluation timeline. Challenges in testing multiple vendors include the management of multiple vendor contacts, increased support personnel requirements, integration of multiple sources of data for analytical purposes, and any future de-installation requirements.

3. Vendor Statement of Work

Once the energy manager selects a vendor, a best practice is to request a vendor Statement of Work (SOW) that clearly defines the project goals, expectations, and timeframes to which the vendor will commit. The SOW will help in framing and tracking the progress of the project, whether it be field testing, scaling up, or adding extra controls. The vendor SOW can include, but is not limited to, the items listed in Figure 3 (next page).

D. Planning for Field Testing

Field testing involves activities that are also central to scaling up, evaluating new EMS features, and more thoroughly evaluating existing EMS features.

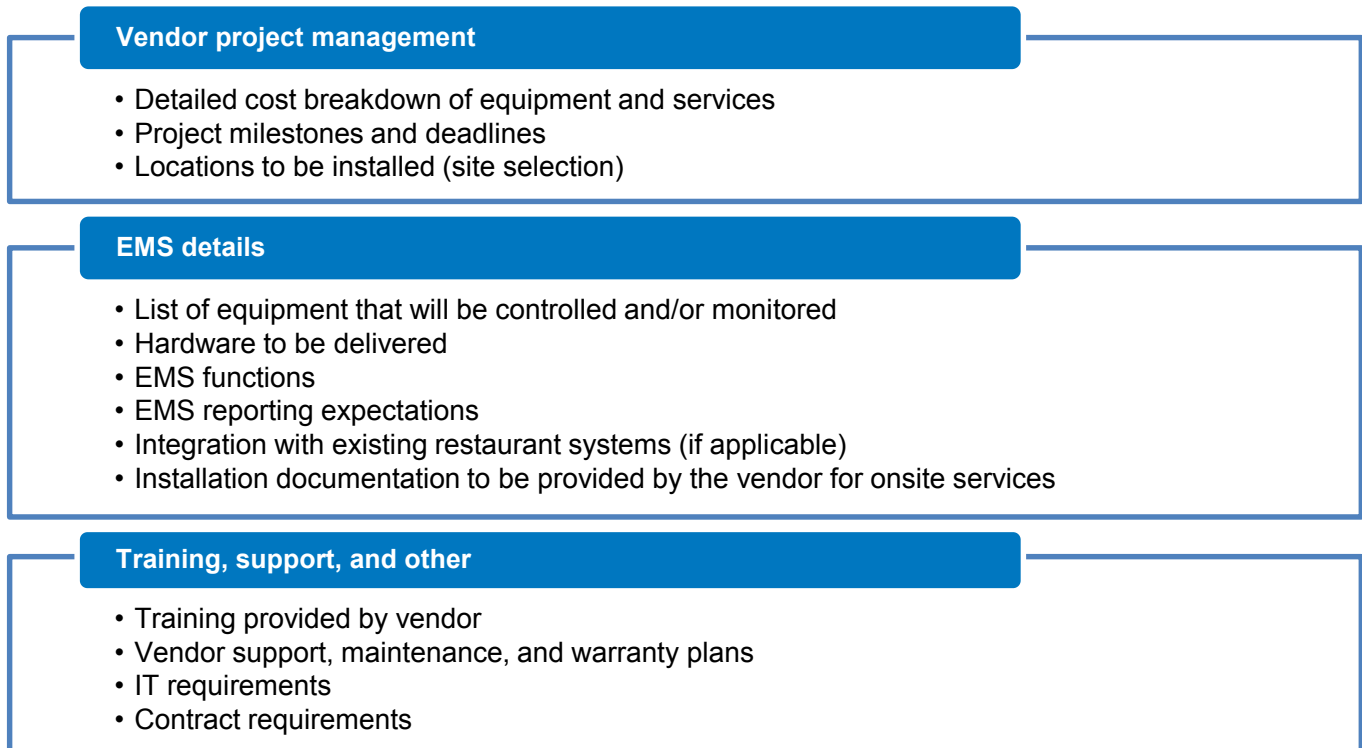


Figure 3: Some items to include in a Statement of Work for an EMS installation

1. *Field Test Planning and Goals*

Creating a field test project plan is useful for developing an effective test design, as well as managing the project once it is underway. Ideally, a field test design (whether formal or informal) will address project-specific requirements and goals, available resources, and project timelines.

a) **Field Testing Goals**

As noted in Chapter I, EMS projects are often initiated in the interest of saving energy and reducing energy costs. Benefits that do not appear as utility bill savings, such as improved customer comfort, reduction or elimination of refrigeration or HVAC equipment failure, and reductions in maintenance costs, have also been discussed.⁹ A company’s environmental concern about sustainability or energy efficiency may also be a motivation.

Field testing is intended to provide management with the information it needs to decide whether and how to pursue those goals. Since every food service enterprise’s circumstances are unique, there is no “universal” set of information to support decision making, nor is such information necessarily the same within a single

⁹ The BBA Food Service Technology Team is aware of specific enterprise-wide implementations of EMS that have achieved notable cost savings in addition to energy reduction.

company at different times. Therefore, the goals of a field test are, in general, specific to that testing project.

Identifying the goals of a field test is a valuable activity, as goals serve as a reference point to ensure that the project stays on track. Staying “on point” is a challenge for any sort of live testing program, even more so for an evaluation of a complex product that interconnects with key building systems and mission-critical equipment. Difficulties and unanticipated events may occur; decisions need to be made on the basis of partial results; and decisions often need to be made in the face of time, budget, and operational pressures, regardless of the level of uncertainty about what is happening. Having well-defined goals, and an understanding of how the field test design relates to those goals, can facilitate making needed midcourse adjustments as effectively and nimbly as possible.

As mentioned, many types of activities that take place in the lifecycle of adopting (or not adopting) EMS technology are similar to field testing. Here are some of these activities, with remarks about goals for each:

- ▶ The initial testing performed after selection of an EMS product for evaluation. This is the primary activity that this guidance addresses, though there is some discussion of scale-up and other downstream activities in Chapter VII.
 - Regarding goals: Whatever else an enterprise desires from an EMS, the financial viability of the technology will need to be proved. Common hurdles are reasonable first cost, acceptable simple payback or ROI, acceptable maintenance requirements, etc.
- ▶ When a significant change is considered to an already-installed EMS product or configuration, such as new settings, policies, equipment to be controlled, or EMS components or features. The value of the change is verified or disproved via field test. This covers a variety of circumstances and goals. Two cases are discussed below.
 - Regarding goals: (1) The testing may be geared toward taking advantage of benefits beyond energy savings, such as improving maintenance, reducing the cost of maintenance, preventing catastrophic refrigeration system failure, etc. In that case, the focus will be on the expected benefits and the results of different methods tested to achieve them, while also verifying that there is only neutral or positive impact on energy savings. (2) A second scenario is testing of new equipment being controlled or new EMS components. This will involve verification of financial expectations, plus any other factors of importance. For example, if the change is a new EMS function that can substantially improve building comfort or simplify recordkeeping, field testing goals will include verification of such improvements.
- ▶ Depending on the results of initial testing, or other factors, the company may choose to evaluate additional vendors and/or products, which requires further testing.
 - Regarding goals: The results of this further testing are not only important with respect to passing financial goals but also in comparison to the performance of other EMS tested.
- ▶ After acceptance of an EMS product for scale-up in the enterprise, each additional location tests and fine-tunes its installed system in a manner similar to the initial product evaluation process.
 - Regarding goals: Unique aspects of planning for scale-up are discussed in in Chapter VII. Organizations only scale up their adoption of an EMS product when testing at some initial sites has shown the equipment to provide adequate benefits. Thus, the emphasis during scale-up is less on proving the benefits of the product and more on ensuring that those benefits are achieved at the specific location.

b) Planning a Field Test

A typical field test plan will include timelines and project milestones for purchasing the EMS components, installing them into selected restaurants, and performing field testing in those restaurants. It might also contain a support plan that details the levels and types of support required to achieve field test objectives.

i. Project Timelines and Milestones

Most EMS testing is conducted over a pre-defined period of time. Field testing timelines are often constrained by the following considerations:

- ▶ Availability and timing of project funding (which is related to annual planning cycles for the enterprise)
- ▶ The EMS vendor's availability to build and provide products for installation
- ▶ Timelines for IT infrastructure evaluations and approvals
- ▶ The rebate application submittal timeline, including any necessary research and pre-inspection requirements, where applicable

Note that, barring large seasonal weather aberrations, peak heating and cooling seasons can present good opportunities to achieve and document EMS energy savings. However, it is important to evaluate or track energy savings opportunities with EMS year-round for the most complete initial picture of 12-month EMS savings patterns in installed locations.

There are several important project milestones for EMS field testing (see Table 9).

Table 9: Major EMS project milestones

Subject	Milestone	Best practice
Rebates	<ul style="list-style-type: none"> ▶ Submission date of appropriate rebate documentation. ▶ Include pre-installation rebate inspections, if any. 	Utilities require all EMS rebate documentation and applications to be filed before any EMS is installed onsite. Rebate application deadlines and submission requirements may vary.
Installation	<ul style="list-style-type: none"> ▶ Equipment shipping ▶ Installations ▶ End of onsite installation and commissioning activities 	To capture the maximum Year 1 opportunity during the field test, complete installation and commissioning before the relevant peak energy season.
Analysis	Beginning of savings analysis activity on field test data (and adequate demonstration of the EMS proof-of-concept)	<ul style="list-style-type: none"> ▶ Items to be completed might include financials and cost savings, ROI, avoided maintenance costs, and estimated rebates. ▶ Results should be presented to management in advance of any annual budgeting. Presenting positive results to upper management will increase EMS project exposure and provide valuable data for use when considering additional EMS locations.

ii. Support Plan

The energy manager should also consider creating a “support plan” for EMS installation and daily operation, including holidays and weekends. This provides a clear delineation of responsibilities among the resources made available to the energy manager throughout the testing, implementation, and ongoing management of an EMS.

In addition to the support needs outlined in Understanding EMS Project Support Requirements in Section B, the energy manager may wish to identify several liaison roles, such as those described in Table 10.

Table 10: Additional EMS communications support responsibilities

Support responsibilities	Details
Field communications	Field points of contact or team members, such as facilities managers, for EMS-related questions, issues, and communications
Installed-location liaisons	Onsite general managers or assistant managers who are aware of the project objectives and technology, as well as an appropriate corporate contact or project lead, for questions and feedback
IT/network coordination	Energy project management will need to work with IT staff during EMS installation and commissioning; both groups need a contact or liaison
Landlord coordination	EMS installations in locations with landlords usually require additional project management activities related to the landlord and leasing issues

2. Test Site Selection

The characteristics of the sites chosen to participate in the field test should align with the field test goals. For example, suppose an enterprise expects a primary benefit of deploying EMS to be reducing high HVAC costs throughout their chain, and it decides to conduct a field test to verify and quantify the savings. A store with low HVAC expenditure for its climate should generally not be selected for the field test, unless there is another important reason to do so.¹⁰

On the other hand, practical factors can influence *which* of the many feasible locations for the field test is chosen. A restaurant in a region with good utility rebates might be a more attractive candidate than a restaurant in an area with no available rebate. Table 11 lists some common criteria, both general and practical, for consideration during the selection of EMS test locations.

¹⁰ For instance, there may be a number of stores with low HVAC energy spend that have very high electricity bills related to lighting, and the organization also wants to determine if those are good candidates for EMS.

Table 11. Sample field testing site selection factors

Site selection factor	Possible desired attribute	Effect on testing
Proximity to HQ	Location close to HQ, field staff, and the energy manager. A factor for initial test site(s).	<ul style="list-style-type: none"> ▶ Better visibility into operational impacts and more store feedback ▶ Ability to visit, monitor, and communicate directly with operators
Climate zone	Sites in energy-intensive climate zones (hot and cold climates)	<ul style="list-style-type: none"> ▶ Greater energy and cost savings ▶ Can demonstrate improved comfort ▶ Assessments of peak climate value
Utility rebates	Sites for which EMS rebates are available	<ul style="list-style-type: none"> ▶ Increased test ROI, funding support ▶ Reduced total cost of implementation
Historical energy consumption	Historically heavy energy consumers or energy outliers	<ul style="list-style-type: none"> ▶ Larger energy and cost savings ▶ Opportunity for energy outlier correction

It is fairly common for energy managers who are planning their first EMS field test to select one or more of the feasible sites based on proximity to HQ. Generally, selecting a location with HQ proximity can be beneficial to the project manager if hands-on evaluation or local building access is important. Local proximity is not always necessary, but it can allow upper management and project stakeholders to participate in the field test in a hands-on way.

Selecting EMS test sites on the basis of climate can often yield important information on the energy savings opportunity for your facilities. In general, restaurants operating in hot or cold climates tend to use more energy annually to condition their interior spaces.¹¹ Installing an EMS into these locations could offer larger energy savings benefits over the field test period than restaurants in milder climates.

Leased-property considerations

If a test site is in a rented space, there may be lease requirements or other reasons to notify and/or coordinate installation and testing of the EMS with the landlord. There could be other implications of locating a field test site at a rented location, such as the impact of lease renewals, additional insurance requirements, subcontractor selection, and security coordination.

The Better Buildings Alliance website (<http://www4.eere.energy.gov/alliance/activities/market-solutions-teams/leasing-split-incentive>) has links to useful energy efficiency resources for leased buildings.

¹¹ An example of an exception to this trend would be a site with equipment in such poor condition that its energy use is very high in spite of a mild climate.

Selecting sites to take advantage of utility rebate programs will require upfront research of available programs and funding, an understanding of annual incentive program deadlines, and an understanding of the rebate application requirements and process. Utility rebate funding obtained for a test site generally contributes positively to the project ROI and reduces the total cost of implementation. Obtaining rebate funding for field test sites will give the energy manager experience with the application process and familiarity with application requirements, which will help in planning for future rebate applications.

Field testing in the highest-ranking “energy outlier” locations is another common selection criterion, particularly used to evaluate the impact of EMS on sites with large improvement potential. These sites might be heavy energy consumers because of poor restaurant operational practices, unmanaged daily temperature and lighting settings, or operational and equipment variances that use significant additional energy. They might also contain lower-efficiency equipment or have building envelope issues. While these sites could yield significant cost savings, the energy manager should be aware of two factors:

1. Tests in these locations could involve significant equipment replacement or repair, operational changes, or other corrective actions. Adequate resources are required for these potentially challenging situations.
2. Sometimes sites exhibit “energy outlier” behavior because there is something significantly different about them relative to nearly all other locations in the system. If this is the case, results obtained from a field test in that store may not be replicable at many (or any) other stores. EMS can be valuable in all facility design environments, and the field test activity should consider which environments will provide valuable initial feedback or research for future decisions and planning. If assessing the potential for scaling is a critical goal of field testing, this factor should be strongly considered.

3. Developing Preliminary EMS Policy and Settings

Development of preliminary EMS policy and settings is an essential planning activity. Policy and settings define how building systems and equipment that are controlled by the EMS are allowed to operate. Overall policy is used to define energy-saving temperature setpoints, schedules of controlled equipment, and allowances within settings. Implementation of standardized, managed settings (setpoints and schedules) is the primary way that energy use is controlled and reduced by an EMS. Figure 4 (next page) shows some considerations for building an energy policy and developing EMS settings.

For example, the energy manager may assign specific temperature settings for the front-of-house and back-of-house and for occupied and overnight periods. Many EMS products allow additional scheduling flexibility, such as the ability to specify rules for temperature settings during certain time periods. Two examples of such allowances are:

- ▶ Temperature adjustments for lunch and dinner peak hours
- ▶ Permission to override temperatures during peak summer or winter months

Determining the initial policy and control settings is usually done before the first EMS installation of the field test. Note that there will be opportunities to iterate on the preliminary settings throughout the test phase, or as needed.

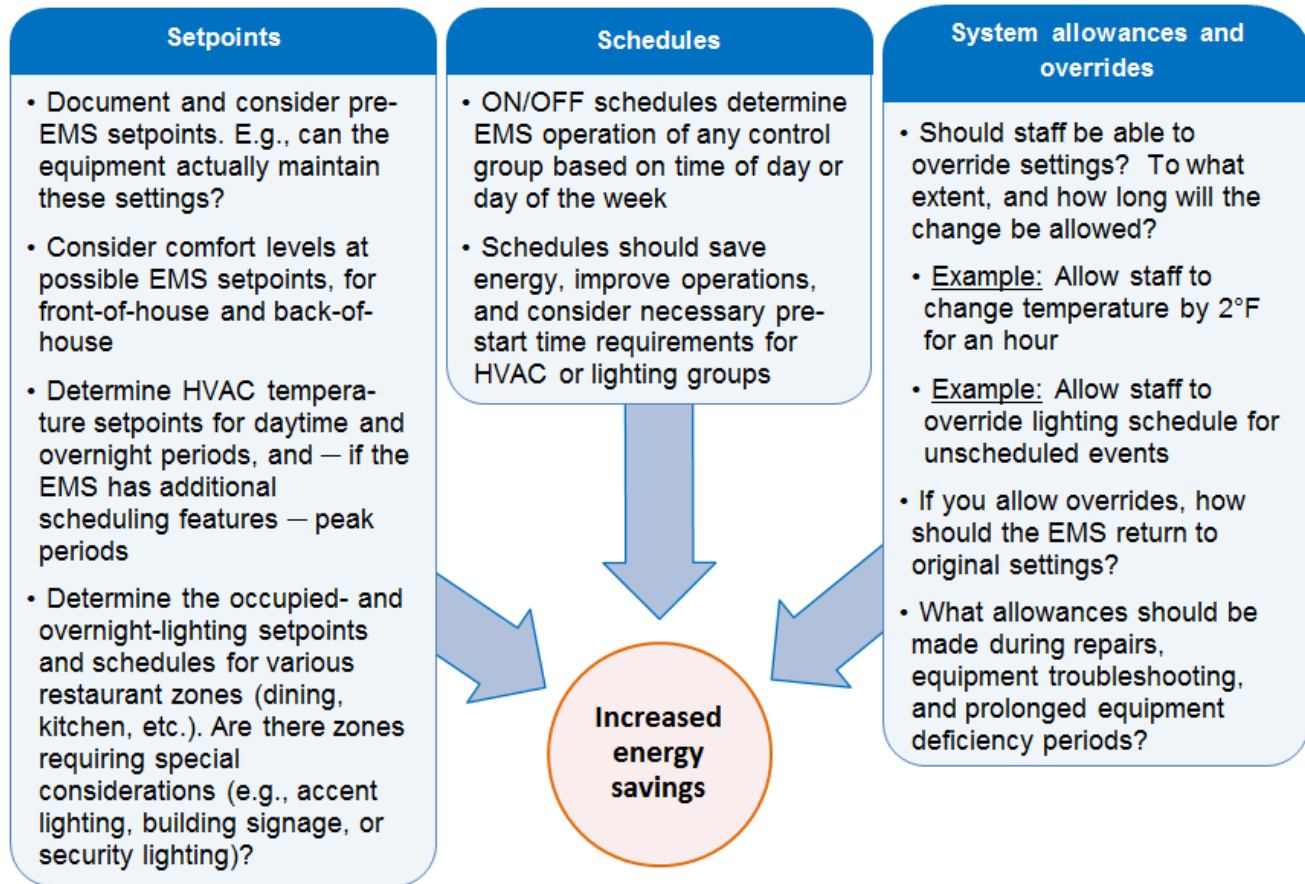


Figure 4: Considerations for settings and policy to maximize energy settings

a) Designing EMS Groups and Schedules

Most EMS allow equipment to be controlled together in *groups*. Groups typically do not mix equipment types; a group will contain, for example, all HVAC equipment or all lighting equipment. Although the setpoints of each piece of equipment in a group can be adjusted independently, typically all members of a group are assigned the same schedule.

Here are two examples of EMS groups for HVAC and lighting systems:

- ▶ HVAC: Separate scheduling groups for dining area, kitchen area, and offices
- ▶ Lighting: Separate groups for interior dining, interior kitchen, exterior security, parking lot, and building signage areas, according to operational needs

Scheduling refers to the timing of ON/OFF events and setpoint changes. Common ways of scheduling HVAC in a restaurant include one or more of the following:

- ▶ Overnight settings, for non-working hours, known as “setback” schedules. Overnight HVAC settings might be the same for all groups.

- ▶ Start times might be staggered for the restaurant's transition from overnight settings to occupied temperature settings. For example, the kitchen HVAC group might activate first.
- ▶ Daily occupied temperature settings. These settings could vary by group. Setpoint changes for peak periods can also be scheduled; e.g., during peak times, the dining area might have a lower setpoint temperature than the kitchen.

Many EMS can configure and reconfigure equipment groups and schedules easily. Flexibility to change settings and group contents is a critical feature and should not require extensive cost or programming. The energy manager should discuss building system scheduling and grouping ability with prospective EMS vendors to ensure that expectations regarding flexibility are met.

V. Installation and Commissioning

This chapter provides background information and an overview of common installation and commissioning steps for an EMS. EMS *installation* refers to putting the various sensors, control units, connections, and other EMS software and hardware parts into service. EMS *commissioning* is a process performed after installation by the vendor or installer. Its purpose is to verify that the EMS has been installed correctly and that the EMS software and hardware is working according to specifications.

Commissioning takes place prior to vendor and end-user sign-off of the location. It includes a series of onsite and remote hardware and software tests to confirm the proper installation and operation of system settings for hardware, software, and networks. It also either (a) verifies that all associated building systems will function as intended after the installation, or (b) identifies remaining issues that must be addressed to complete a successful installation.

The following activities are typically performed during the EMS installation and commissioning process:

- ▶ Receipt, inventory, and accounting of all EMS parts, hardware, and software.
- ▶ Hardware installation. Control panels, sensors, wiring, thermostats, control equipment, and any other EMS-related hardware are put in place.
- ▶ Configuration and testing of EMS software, connectivity, and equipment settings. This ensures that the hardware is communicating with the software as designed, that software settings are correct, and that onsite equipment responds correctly to the automated or remote controls via the EMS interface.
- ▶ Mechanical issues impacting the EMS installation are addressed. Any building or equipment limitations found during the installation should be evaluated, and a plan developed for corrective action or completion of the installation.
- ▶ Installer documentation for the site is provided to the energy manager. See sidebar.

Installer documentation

EMS installer documentation is useful for future reference. Documentation should contain items such as:

- ▶ As-installed EMS equipment configuration and location detail, diagrams, or specifications.
- ▶ Photo documentation of sensor and thermostat placement. (Not all vendors provide this without some discussion or negotiation.)
- ▶ A copy of store manager installation and training signoff forms.
- ▶ EMS policy variances. If there are instances in which standard policy or settings could not be deployed at the site, the installer should document the modifications made during installation
- ▶ A list of any existing building and equipment conditions that negatively impact successful operation of the EMS

The vendor, or a company contracted by the vendor, generally performs installation and commissioning. The time required for installation and commissioning can vary and should be discussed with the vendor.

A. Installation Tips

The following tips may be helpful to the energy manager or project team during the installation:

- ▶ Arrange for product parts delivery to take place before scheduled installation. Installers do not usually carry all EMS equipment, so shipment to the restaurant before installation is necessary for some or all of the EMS parts kit. This may vary by vendor.
- ▶ Prior to equipment delivery, plan the logistics of site receipt and storage of EMS equipment with the locations slated for installation. This should include communications with the energy manager.
- ▶ Request the vendor to equip installers with backup parts (general HVAC and lighting trade components, where possible) for both EMS and non-EMS hardware. This allows for the possible immediate, onsite correction of issues found during installation.
- ▶ Attempt to schedule installations during times that minimize impact on daily restaurant operational schedules. It is not uncommon for installers to perform overnight installations for food service operations. (As mentioned, this may incur additional cost.)
- ▶ Plan for as-needed feedback from store personnel and facilities staff during the installation process.
- ▶ Include a vendor post-installation “debrief” for each site to confirm site status and that all required documentation has been received. The debrief is also important for discussing outstanding issues.

B. Test Site Observation Period

After installation, the energy manager, vendor, and/or facilities team should observe the performance of the newly installed EMS and associated settings for a period of two to three weeks. During this observation period, the energy manager should do the following:

- ▶ Operate the EMS, allowing both project and onsite restaurant staff to familiarize themselves with the new controls and the facility conditions that result from the new control scheme. Get familiar with the EMS reporting capabilities, which should be easy to extract from the system.
- ▶ Learn how to perform typical diagnostic tasks using the EMS.
- ▶ Develop store processes and procedures associated with the EMS (e.g., EMS operations and maintenance).
- ▶ Train staff in EMS use.
- ▶ Solicit and/or permit facilities and store operations staff to provide feedback to the energy manager as they grow accustomed to allowing the EMS to control designated systems and equipment.
- ▶ Attempt to identify any restaurant conditions or deficiencies that may be affecting the test, and address deficiencies having a sufficiently negative impact.
- ▶ Be prepared to present initial findings, operations feedback, energy-savings strategies, and EMS test status to project stakeholders.
- ▶ Improve preliminary EMS policy and settings.

1. Identifying Additional Site Deficiencies

In Upfront Costs Related to EMS in Chapter IV, Section B, we discussed pre-installation inspections and costs to uncover and correct building or equipment deficiencies. We also recommended creating an “installation variances budget” to cover any site deficiencies that are revealed during the installation and commissioning process.

In some cases, site deficiencies are only discovered during an extended period of regular EMS operation. Observing the EMS and its associated building systems and equipment gives the energy manager and operations staff a chance to identify any previously unknown site deficiencies. Addressing these problems as they become apparent could reduce energy consumption, improve EMS performance, and increase customer comfort. Some indications of site deficiencies include the following:

- ▶ Equipment fails to behave as expected when monitored or when EMS data are analyzed (e.g., rapid and repeated cycling of an RTU for no apparent reason).
- ▶ Equipment energy efficiency is unexpectedly low.
- ▶ Equipment fails to perform as the EMS commands (e.g., an RTU may be unable to adequately cool a space, never reaching setpoint temperature despite continued compressor operation).
- ▶ When all controlled equipment is operated according to the EMS setpoints and schedules, the restaurant environment may be somewhat different than before. This change in environment could result in malfunction or failure of some piece of equipment or allow an existing deficiency to be revealed.

Some equipment problems may be relatively easy to detect, showing up as failure or an issue in behavior, performance, or function. With EMS designs that have enhanced visibility by virtue of sensors or other fault detection capabilities, it may be possible to detect other problems before they appear through obvious symptoms.

2. Improving Policy and Settings

By monitoring the energy and operational performance of the restaurant following EMS installation, the energy manager can begin to identify opportunities for improvement of preliminary policy and settings. Continual optimization of settings and the management of equipment performance is critical to successful ongoing energy management. For more details on improving policy and settings during a field test, see Further Improvement of EMS Policy and Settings in Chapter VI.

Energy managers and/or support personnel should develop a process for receiving regular feedback from restaurant staff on the effect of EMS settings. This feedback should be used to ensure that HQ policy and settings do not negatively impact customer comfort or restaurant operations. The following section discusses ways of obtaining and handling test site feedback.

C. Obtaining Test Site Feedback

Staff at locations with newly installed EMS may have concerns about, or offer resistance to, the change in restaurant operations after installation. Also, store operators may need support to deal with the introduction of new processes into existing store practices and maintenance conditions. Furthermore, remote visibility into equipment conditions has an impact on the maintenance process which, although positive, usually involves engaging facilities staff.

Store operators and facilities managers should be given the opportunity to provide feedback to the energy manager about the following:

- ▶ How the store is operating under the new controls
- ▶ How the new control of energy-consuming equipment is affecting the customer experience
- ▶ How the EMS is perceived in daily operations.

Onsite staff members at test sites usually provide feedback soon after installation, before they have become accustomed to the EMS or before the EMS policy and settings have been optimized with existing equipment. Early feedback such as this can be valuable to the effective design of an EMS program. Limited organized feedback sessions (such as focus groups, conference calls, or email surveys) are often an effective way to gather data on how the new EMS is operating in the test locations. Table 12 discusses some of types of feedback an energy manager might expect after installation, and lists best practices for addressing the concerns that are typically raised.

Table 12: Feedback to expect after EMS installation and commissioning

Concerned parties	Description of concerns	Best practice
Local restaurant staff	The initial “invasiveness” of revised energy policies or settings in a restaurant could lead to staff pushback. Facilities and site staff will likely resist changes to restaurant operations, schedules, and settings until they are optimized.	<ul style="list-style-type: none"> ▶ Explain why energy reduction is important and describe other benefits (cost savings, increased comfort, better maintenance via visibility to equipment). ▶ Identify the EMS test as a work-in-progress. ▶ Explain the overall process and describe the need for feedback and partnership. ▶ Optimize settings using feedback and give credit for the staff’s contributions.
Maintenance and facilities	EMS visibility will sometimes identify needed equipment repairs. Operators or facilities managers may have limited repair budgets for restaurant equipment or additional EMS-related equipment.	<ul style="list-style-type: none"> ▶ Work with the HQ finance team: discuss and plan for equipment repair funding and decide where EMS-related repair invoices will be sent. ▶ Communicate any plans for added cost allocations to test locations prior to installation.
Local maintenance technicians and crews	Local maintenance technicians can be impacted by new requirements to understand and maintain EMS equipment controls and thermostats, with minimal additional onsite time to learn and address new EMS issues.	<ul style="list-style-type: none"> ▶ Inform local maintenance technicians that an EMS is, or will be, installed. ▶ Establish clear communications between energy management, facilities, and technicians. ▶ Define changes to local maintenance technician support at test sites, if applicable. ▶ Include local techs in onsite training or post-installation walkthroughs, when possible. ▶ Evaluate the potential roles of maintenance technicians in supporting the test sites.

VI. Field Testing

Field testing of equipment is important to establish proof-of-concept for a system in its field environment. Restaurant upper management often requires strong proof-of-concept results before any further EMS projects, such as increasing the number of installed sites, can be initiated. The results of testing and the evaluation that follows will allow energy managers to provide data to justify additional funding requests, changes, and/or project plan modifications.

EMS field testing begins after full installation and commissioning of the product, including the post-commissioning observation period. Evaluations of a completed field tests include analysis of quantitative (energy and cost savings) and qualitative (operation and maintenance improvement) results.

This chapter provides an introduction to the process of performing an EMS field test. We assume that the energy manager has done the appropriate field test planning activities described in Chapter IV. The chapter also describes, in general terms, evaluation of test performance against field test goals.

A. Performing a Field Test

The energy manager should ensure that test data and staff feedback are acquired throughout the test period. These data will be useful during the field test as well as after its completion.

The energy manager, in partnership with the EMS vendor, often manages the day-to-day operation of the EMS at test locations. The energy manager and vendor work together to support the EMS while ensuring a positive test experience for EMS users, onsite staff, and maintenance technicians. The energy manager should minimize any negative impact of the field test on food service operations. It is also important to attempt to maintain high standards of customer comfort throughout the test.

1. Further Improvement of EMS Policy and Settings

Listed below are some guidelines for making additional improvements to EMS policy and settings:

- ▶ Work closely with staff to get post-installation feedback on comfort and restaurant operations.
- ▶ Continue to optimize EMS settings and schedules through the test period.

Field testing tips

While field test planning is generally unique to each enterprise, some important considerations for successful results have been identified:

1. Develop key performance indicators during the test so that EMS performance can be tracked.
2. Maintain open communications between test locations and the energy manager.
3. Obtain and document feedback from restaurant and facilities staff.
4. Maintain communication with upper management. Tailor your messaging to the project stakeholders and ensure that they stay apprised of field testing progress.
5. Evaluate the EMS product in the field environment and evaluate vendor customer service.
6. Evaluate the impact of the EMS on the integrated functioning of existing building systems and equipment.

- ▶ Monitor building temperatures and HVAC setpoints in dining and kitchen zones to understand if HVAC equipment is capable of meeting the settings applied by the EMS.
 - If temperature settings cannot be met (e.g., because of an equipment or HVAC design issue), adjust EMS settings so that the HVAC equipment is not overburdened while the correction plan is developed.
- ▶ Modify setpoints for specific equipment as necessary to minimize wasteful energy usage.

OPTIONAL – General observations about optimization efforts

There is no single or best way to approach making improvements to EMS settings or policies, particularly in the context of an operating food service business environment. Experience shows that project and site staff members tend to develop their own optimization methods. Thus, we avoid prescribing a specific process for improving EMS settings and policies. With that in mind, we offer a few observations and tips about the process of investigating better control schemes that others, in various contexts, find valuable:

- ▶ Determine the baseline level of performance first, as it is important to have a reference against which you compare the results of “tweaked” settings and policies.
- ▶ Keep a log of settings and policies you have tried, with the resulting energy and operational performance achieved. With a record of what you have done, you can compare the results of the various configurations you tested and perhaps get a sense of why results differ. Operations logs will also facilitate returning to adequate configurations after unsuccessful attempts to improve.
- ▶ It will take some time for a newly instituted change to become apparent. Keep in mind that initial measurements will therefore be partially ascribable to the old settings. You should be able to get a sense of the length of the adjustment period by observing this transition time for several iterations of settings changes.
- ▶ If changes to more than one setting are made simultaneously, it is often not possible to know which of them was responsible for the results and in what way. For example, when two or more changes are made, their effects can be complementary, or they can offset each other, resulting in a net effect that is positive, negative, or neutral. The changes can even have an effect on each other, so that the final result is something different than what you would expect based on what each change alone would produce.

2. Using an EMS as a Diagnostic Tool

As mentioned earlier, an EMS can provide visibility into energy-wasting operational practices and building issues that reduce energy efficiency. The energy manager and site staff can begin to become familiar with this EMS capability during the field test.

a) Store Operational Practices

After installation of the EMS, monitored data and reports may help to uncover specific store practices and patterns that result in inefficient or wasteful use of energy. Some of the operational practices that an EMS can detect include:

- ▶ Leaving refrigerator doors open for excessive time when inventory is taken.
- ▶ Staff practices to self-correct heating, cooling, or air flow problems; e.g., turning off HVAC fans to curb air volumes from diffusers.
- ▶ Lowering temperatures to compensate for poorly cooling HVAC units.
- ▶ Excessive operating hours.

Working together, the energy manager and operations or facilities manager can usually identify the cause of an observed problem and find a solution.

b) Building Design Limitations

Inefficient building design, remodels, previously installed equipment packages, or energy-intensive building attributes (e.g., a patio or glass windows) can also lead to reduced energy efficiency. An EMS can provide valuable information about these constraints. Examples include:

- ▶ Undersized HVAC units that are unable to achieve temperature settings
- ▶ Inefficient design of lighting group circuitry that leads to excessive electricity use (e.g., patio lighting that must stay on because it shares a circuit with security lighting)
- ▶ Glass atriums or window areas that dramatically impact cooling and heating in portions of the restaurant

To the extent that an organization understands building conditions prior to EMS installation, the company can gain insight into how an EMS will perform at the test site. Such insights should help the energy manager to develop policy allowances, make compensating modifications to initial EMS settings, and determine other EMS characteristics for the site.

B. Analyzing Field Test Results

The energy manager is typically responsible for evaluating field test results and assessing whether project goals were achieved. Depending on the field test goals, and any other interests or concerns that arose during testing, some of the following metrics and characteristics might be evaluated:

- ▶ Year 1 energy cost savings from reducing consumption
- ▶ ROI and simple payback (against target)
- ▶ Avoided costs involving energy, maintenance and repair costs, etc.
- ▶ A framework for how the enterprise will test and analyze for Year 2 and onwards
- ▶ The total costs for supporting the EMS (including the cost of assigned project resources, third-party support, etc.)
- ▶ Effects of the EMS on building comfort and overall guest satisfaction
- ▶ Extent to which standardized energy policy and settings led to more efficient use of energy
- ▶ Extent to which equipment visibility resulted in improved equipment diagnostics, increased information for maintenance technicians, and improved quality of repairs
- ▶ Impacts on restaurant maintenance budgets and spending (not including site deficiency correction costs)

- ▶ EMS product quality (software, hardware, functions, features, etc.)
- ▶ Whether the enterprise is able to prevent equipment and food losses through alarms and alerts.

1. Energy and Cost Savings

The most common field test evaluation tasks to determine energy savings and cost savings attributable to implementation of the EMS. Upper management typically focuses on quantitative results, such as direct cost savings and ROI, to make decisions.

Typically, calculations of savings of both energy and money begin with comparing the energy used during the field test (i.e., following installation and the test site observation period) to the energy used during a baseline period. The baseline period is a period of time, typically approximately one year in duration and often occurring just prior to EMS installation, that represents the facility's energy consumption prior to adoption of the EMS. Analysis of energy consumption and associated cost savings can be complex, and multiple approaches are possible.¹² Thorough analyses can often require additional internal or external resources.

It is important to note that most of the reduction in energy consumption at a site occurs in Year 1, when going from uncontrolled energy usage to a tight standard. After the first installed year, cost savings can continue for Year 2 and onward if EMS hardware and onsite building equipment are well-maintained. Greater savings will be realized if EMS policy and settings are continuously improved and enforced and/or additional best practices for EMS operation are developed. A good baseline for comparison will support these efforts, and tracking of their savings, effectively.

The following discussion provides general information regarding energy consumption baselines, sources of field test energy use data, and resources to tap for analysis of data.

a) Establishing Energy Consumption Baselines

As previously mentioned, field test energy data is typically compared to a pre-EMS installation baseline period in order to estimate the energy saved during the test. Ideally, all changes in energy use between the baseline period and the field test can be attributed to the EMS. Thus, to the extent possible measures should be taken to ensure that there are as few differences between the baseline period and the field test period as possible (other than the presence of the EMS in the field test).

For example, a best practice in establishing a baseline is to ensure that it covers the same seasons as the field test. When analyzing results you then compare corresponding seasons in the baseline and field test to minimize weather or seasonal business volume influences.

¹² Note that many EMS vendors and third-party data analytics companies refer to the combined analysis of energy consumption and cost savings as "measurement and verification" or "M&V." This differs from the meaning of the term as used by utilities (and mentioned earlier), which refers *only* to analysis of energy consumption and not cost savings.

Also, test locations should not be influenced by any other energy-usage reduction projects during both the baseline period and the field test. If you cannot avoid this, you should (a) independently estimate the savings from the other energy projects to isolate the net EMS effects, then (b) adjust the baseline and/or field test energy use results as appropriate.

In practice a number of factors that affect the energy consumption of the establishment are likely to be different between the baseline period and the field test. Among others, these factors include:

- ▶ Equipment in use in the building and its condition and/or functioning
- ▶ Actual weather (e.g., a mild baseline winter vs. a severe field test winter)
- ▶ Building occupancy and number of business transactions during operating hours
- ▶ Hours of operation (e.g., seven days per week during the baseline period vs. six days per week during the field test)

Many factors, such as actual weather and business transactions, can be accounted for in the analysis using techniques known as *normalization*. Others, such as the effects of equipment condition, may be more difficult to estimate. The key consideration for choosing a baseline period is to minimize, to the extent possible, factors that cannot be accounted for during the energy and cost savings analysis.

Historical utility billing data will be used for baseline periods that occurred prior to EMS installation if the food service facility involved in a field test has not previously installed energy measurement equipment. Note that it is not mandatory for the baseline period to occur prior to installation of the EMS. The EMS itself can be used to collect energy use data if energy monitoring components are installed but equipment controls are either not installed or not used. While this can permit greater control over, and documentation of, the activities taking place during the baseline period, it does add time (and often cost) to the project.

The two methods noted above for obtaining baseline data for field test locations are summarized in Table 13.

Table 13: Two ways of obtaining baseline data at each test location

Baseline method	Notes
Historical utility billing data	<ul style="list-style-type: none"> ▶ Information is typically available from utilities or from utility bill pay databases. ▶ Sometimes historical utility bill data may not be available, or may be inconsistent, at different field test locations. ▶ You will need to perform some research to characterize the major factors that affected energy use during the baseline period (weather, transactions, etc.).
Pre-field-testing baseline study	<ul style="list-style-type: none"> ▶ Typically involves additional cost and specialized equipment and hardware (energy meter, sub-metering equipment, etc.) to collect real-time energy data for the pre-determined baseline period. ▶ The seasons in which meter data are collected—as well as how closely the measured season conforms to the average weather for that season—are important to consider. ▶ Takes extra time to conduct the pre-testing before realizing the benefits of EMS.

b) Field Test Energy Data Sources

The above discussion concerns data for the period prior to the field test. For energy consumption of a site *during* a field test, one or both of the following sources is commonly used:

1. Electric and gas utility bill data. The energy manager can use utility bill data, if available, to correlate energy cost reductions with internal accounting financial data and budgets. Utility bill data might also be used if energy meter equipment is not included as part of the EMS hardware package. Note that the availability of bill data from the utility company often lags 4-6 weeks, creating a lag as well in reporting cost savings results. In addition, energy managers should be aware that different utilities can have different billing or recording processes, so there is no universal method of aggregating bill data points for cost analysis.
2. EMS energy meter data. Alternatively, if energy meters are installed at field test locations, then the energy manager and/or EMS vendor can track detailed energy consumption directly. Today, the difficulty with directly measuring energy savings is not the availability of accurate energy data from the meter. Rather, the challenge lies with the reconciliation process involved in correlating measured data with internal corporate billing data. Complexities occur when attempting to provide credible, closely matching, realized-cost savings figures that correspond to savings shown on actual utility bills for the test locations.

The energy manager should consult with knowledgeable internal or external resources to determine which source of data should be used for the project's energy and cost savings estimation.

c) Who Will Perform the EMS Savings Analysis?

The analysis of EMS savings typically involves a significant time commitment and, potentially, additional monetary and staffing resources. The energy manager should ensure that personnel assigned to perform the analyses have the required expertise to collect, enter, evaluate, and present the data. Furthermore, the energy manager should make sure that any personnel assigned to this analysis will have access to the necessary energy data. Figure 5 (next page) shows some parties who might be made responsible for performing energy and/or cost analysis.

Internal resources

- The energy manager.
- An assigned internal support resource (financial or accounting departments).
- *Energy savings measurement takes place throughout the field test, occurring at routine intervals and at relevant project milestones.*

EMS vendor

- Some vendors offer to perform energy and cost savings analysis work for the enterprise, either for free or for an associated cost.
- Prior to contracting for vendor-based analysis, the energy manager should discuss the scope of work and request analysis examples.
- Specialized vendor expertise is required if they will be measuring from installed energy meters or using billing data.
- *Analysis at routine intervals to (a) measure EMS performance, (b) compare to baselines, and (c) summarize findings.*

Outsourced third party

- Many energy services companies analyze cost savings and create reports as a contracted service.
- Savings analysis may also be offered by the test site's utility company or utility bill pay company.
- *Outsourcing the savings analysis typically will require additional energy manager resources to coordinate, review, and manage the outsourced scope of work.*

Figure 5: Who will perform the M&V savings analysis?

VII. Project Work After Initial Field Testing

EMS field testing provides valuable information to the energy manager about the operational and financial feasibility of an EMS at restaurant test locations. Field test results will shape expectations for any future EMS installations and may help an energy manager better predict enterprise-specific EMS benefits and value. If a field test yields positive results and achieves important project goals, the energy manager could provide business justification to install EMS at more restaurant locations.

A. Scaling Installed EMS

In general, an organization scales when the energy manager or upper management is satisfied with the results of previous field tests and decide to implement EMS on a larger scale. Scaling up is typically a strategic process in which EMS are installed in additional restaurant locations over the course of several years. The scope of scale-up activities can vary, though it is rare for an enterprise go directly from its first field test to full implementation of EMS in all enterprise locations. Often, enterprises will opt for a more gradual approach, with sustained growth over a longer timeframe.

In a practical sense, a scale-up project will be implemented in a manner similar to a field test. Previous field tests will have given the energy manager some understanding of the overall process of acquiring, installing, and operating EMS that can be applied to scale-up. The main difference between scale-up and field testing is the volume of planning activities.

In determining the scope of a potential EMS scale-up project, the energy manager should consider the following variables:

- ▶ The number of additional sites.
- ▶ The vendor's installation and commissioning availability and schedule.
- ▶ Estimated cost to perform increased EMS planning, acquisition, installation, and operating activities.
- ▶ Unique configurations or conditions at additional sites.

These factors can in turn depend on several project considerations, including the following:

- ▶ Availability of funding. This affects the scope of the scale-up.
- ▶ Availability of project staff and other resources to support the project. Insufficient project support could limit the number of locations. The field test could indicate the relative level of support required.
- ▶ Feedback from site staff during the test.
- ▶ The predicted value of the EMS immediately (Year 1) and thereafter (Year 2+). The quantitative and qualitative benefits observed during field test could limit scale-up to specific site locations and situations. This depends on the site selection criteria defined by the energy manager.

From a planning perspective, scaling emphasizes support requirements and support infrastructure more heavily than the proof-of-concept stage. Although field tests can sometimes be carried out with limited support, the energy manager must consider developing an extensive support network when EMS are to be

installed in a significantly larger number of restaurants. When drafting a scale-up plan it is helpful to perform support-related activities such as the following:

- ▶ Evaluate field test support structure, resources, and support workflow with respect to scaling
- ▶ Determine required support costs and request revisions to the budget as necessary
- ▶ Refine training for EMS access and monitoring for the added locations
- ▶ Gain IT network provisioning approvals and resources for scaling
- ▶ Attempt to streamline the support network

In the event that the energy manager found during field testing, or upon re-evaluation, that the EMS product kit could be improved or modified, he or she should evaluate options with the vendor. Site selection criteria also might be changed for scale-up. For example, field testing might have shown better performance in certain geographical areas, making those regions favorable for scale-up locations. Other factors include the following:

- ▶ Geographic EMS installation groupings, such as proximity of sites, that are most cost-efficient
- ▶ EMS vendor pricing and contracts for added and/or geographically distributed locations

B. Continued Field Testing and Evaluating Multiple EMS Vendors

After field tests are completed with an EMS product, some enterprises might want to perform additional testing using the same EMS but modified hardware and software features. Further field testing might also be performed with different goals and expectations from previous field tests. Another motivation for expanding field testing is an interest in deployment to other geographical regions or climates, especially when the initial field test was modest in scope.

Projects to perform additional field testing generally differ from scale-up projects. They are usually shorter and require less contractual and/or financial commitment from the enterprise.

An energy manager might also consider testing alternative EMS products after the first field test experience. Performing EMS operations for multiple restaurants with EMS from more than one vendor (and/or at different phases of testing) may pose some logistical and integration challenges, both technically and operationally. The following are examples of ways to mitigate these challenges:

- ▶ Expect and allocate appropriate resources for increased day-to-day coordination activities with vendors
- ▶ Standardize technical and operational support across all EMS vendors or testing phases
- ▶ Ensure appropriate training is available for EMS users and restaurant staff
- ▶ Attempt to integrate the multiple vendor or phase performance reports into a single report with aggregated results

A small, but growing, number of companies that provide EMS support or integration are offering multi-EMS platform services. Such support could aid the energy manager in performing the above tasks.

VIII. References and Resources

Readers who would like additional information on EMS-related subjects can access the following resources:

1. Building Performance Tracking Handbook – California Commissioning Collaborative (CCC): <http://www.cacx.org/PIER/handbook.html>.
 - A general reference on the subject of tracking energy performance of buildings, including benchmarking, utility bill analysis, EMS, and more advanced information systems.
2. California Commissioning Collaborative (CCC) main website: <http://cacx.org/index.html>
 - All about *building* commissioning, which is defined as “a process for achieving, verifying, and documenting that the performance of a building and its various systems meet design intent and the owner and occupants’ operational needs.” Special emphasis on buildings in California.
3. Energy Information Handbook: Applications for Energy Efficiency Building Operations – Lawrence Berkeley National Laboratory (LBNL): <http://eis.lbl.gov/downloads/energy-information-handbook.pdf>
 - Excellent compendium of building data analysis methods. Level of sophistication ranges from basic (i.e., can be done easily with a spreadsheet) to advanced (requiring more complex analysis and tools such as computer programming).
4. International Performance Measurement & Verification Protocol – Efficiency Value Organization (EVO): http://www.evo-world.org/index.php?option=com_rsform&formId=113&lang=en (also available at www.nrel.gov/docs/fy02osti/31505.pdf)
 - “Best practice techniques available for verifying results of energy efficiency, water efficiency, and renewable energy projects in commercial and industrial facilities. It may also be used by facility operators to assess and improve facility performance.”
5. Summary of Commercial Whole Building Performance Programs – Consortium for Energy Efficiency (CEE): <http://library.cee1.org/content/summary-commercial-whole-building-performance-programs-continuous-energy-improvement-and-en-1>
 - Detailed descriptions of many utility rebate programs for Energy Management and Information Systems (EMIS), which includes EMS technology. Also covers rebate programs for “continuous energy improvement” activities.
6. Energy Management and Information Systems (EMIS) Technology Classification Framework – LBNL: <http://eis.lbl.gov/pubs/emis-tech-class-framework.pdf>
 - Summary of work performed by the BBA EMIS Team to provide a common reference system for the family of EMIS technologies. The document describes categories of EMIS and provides a high level overview of primary applications within each category.
7. Regional Guide to EMIS Incentives – LBNL: <http://eis.lbl.gov/pubs/emis-incentives-guide.pdf>
 - Introduces incentive and financing programs available to support the installation and use of EMIS in commercial buildings. Note that this document was not intended to be comprehensive.

8. DSIRE™ - Database of State Incentives for Renewables and Efficiency – U.S. Department of Energy and the North Carolina Solar Center: <http://www.dsireusa.org/>
 - Most comprehensive source available of rebates and incentives in the United States.
9. Synthesis of EMIS Resources – LBNL: <http://eis.lbl.gov/pubs/synthesis-emis-resources.pdf>
 - Summaries and highlights of more than 35 publications covering EMIS (which includes EMS), with links to the document source locations.

IX. Appendices

A. Sample Request for Proposal Content¹³

The following sample content for energy management system (EMS) Requests for Proposal (RFPs) is meant to assist the energy manager during discussions with an EMS vendor or a proposal development period. The list may be used to assist with product questions, proposal or quote development, and general discussions with the vendor. See EMS Vendor Selection in Chapter IV, Section C, for additional information.

EMS proposal contents	Specific questions and detail	Notes
Provide a list of building equipment that the vendor product can control and/or monitor to reduce energy	<ul style="list-style-type: none"> ▶ Does the vendor have hardware and software solutions for HVAC, lighting, refrigeration, fans, water heaters, etc.? ▶ Which control equipment have they installed in other, similar buildings and are currently monitoring? ▶ Request samples of diagnostic or performance reports for each. 	Obtain a list of possible equipment for control and monitoring and compare it to your needs. For custom equipment or equipment they have not monitored or controlled before, the vendor may suggest a solution development effort.
Prices and descriptions for hardware offerings, warranty, and replacement parts	<ul style="list-style-type: none"> ▶ What is the manufacturer warranty for each component and the associated labor? ▶ What is the process for onsite replacement and repair? ▶ What is the vendor's national field service network to support installed sites? 	Replacing EMS-related parts during and after warranty periods can incur ongoing costs for your system. It is important to understand the level of vendor support services for onsite replacements.
Photographs and specification sheets for hardware components	Can the vendor provide hardware specification sheets for each of their components?	Vendor equipment documentation will provide important reference material during installation, field testing, and ongoing operations.

¹³ Provided courtesy of National Energy Solutions, Dallas, TX.

EMS proposal contents	Specific questions and detail	Notes
EMS thermostat functionality	<ul style="list-style-type: none"> ▶ Do EMS thermostats have temperature displays, diagnostics, and RESET buttons? ▶ Do thermostats provide onsite or local override ability? ▶ Are thermostats easy for non-users and restaurant operators to understand? 	Understanding the thermostat design for local temperature control and/or remote diagnostics will assist in the development of support practices and troubleshooting.
List of report types available to the user	<ul style="list-style-type: none"> ▶ Which reports does the EMS generate that are available to users? ▶ How are the reports executed and delivered (by email or requiring log-in)? ▶ Are reports pre-designed or do they require user customization? 	Users should review the EMS system reporting capabilities, request a set of sample reports, and discuss additional reporting requirements they may have directly with the vendor.
EMS graphical user interface (GUI) design	<ul style="list-style-type: none"> ▶ Does the system on-screen user design (GUI) present energy consumption in real-time? Is it graphical? ▶ Does the GUI provide exception and alarming information? ▶ How is the website designed for use with single and multiple EMS sites? 	It is important to log in and review the system website and product design. Try to have potential users evaluate the visual appeal, graphical design, efficiency of use, ease of use, and design to manage many locations.
EMS alerts and alarms	Are system alerts and alarms primarily designed for logged-in user access? This would require support personnel to log in routinely and manage alerts. Can they be received via system notifications?	The user should pay attention to EMS alert design, alert conditions, and how the system prioritizes and delivers alerts. Consider also the expected audience or intended recipient of the alerts and alarms.
Additional EMS features and any additional costs	<ul style="list-style-type: none"> ▶ Is there an energy analytics toolset? ▶ Is there advanced report generation functionality? ▶ Is there custom reporting? ▶ Are there additional costs and, if so, what are they? 	Investigate any desired functionality that is non-standard or custom.

EMS proposal contents	Specific questions and detail	Notes
EMS installation plan	<ul style="list-style-type: none"> ▶ Will the vendor itself perform EMS installations or use a subcontractor? ▶ How much installation experience does the vendor or subcontractor have? ▶ What installation options are available from the vendor (overnight, daytime, weekends)? ▶ Will the installer provide project documentation? 	The vendor should clearly present the installation process and associated details. Scheduling options should be discussed and installation reviews should be designed.
EMS connectivity and infrastructure diagrams	<ul style="list-style-type: none"> ▶ Can the vendor provide necessary information technology (IT) documentation, including connectivity options, equipment connection diagrams, and network traffic specifications (if applicable)? Are there any wireless components included? ▶ Will the vendor include technical implementation documentation (e.g., bandwidth requirements, scheduling/throttling/port information, and the process for software and firmware updates)? ▶ Where will host servers be located and maintained? 	IT departments typically request vendor specifications and connectivity diagrams for review and approval. It is important to understand and gain approval for all potential connectivity requirements when purchasing and installing the new EMS.
Vendor system support program	<ul style="list-style-type: none"> ▶ Will the vendor monitor and support installed locations? ▶ What level of vendor service is provided and for how long after installation (service hours, types of calls, and/or additional support to third-parties, as required)? 	The energy manager, a third party, or the EMS vendor can perform ongoing monitoring of EMS systems. Consider the benefits vs. costs of any vendor monitoring support, compared to other options.
Recurring monitoring fees	<ul style="list-style-type: none"> ▶ Which monitoring costs are upfront, one-time charges? ▶ Which monitoring fees are recurring? 	Typically, EMS vendors charge an ongoing monthly monitoring fee for access to the system.

EMS proposal contents	Specific questions and detail	Notes
Vendor national service network	<ul style="list-style-type: none"> ▶ Who will go onsite for any equipment repairs required after installation? ▶ How are warranties managed? ▶ What is the price structure for post-installation labor and support? 	<p>It is important to identify whose technicians will travel to the EMS sites when EMS parts replacement or warranty services are required. Associated costs need to be identified, as well. Is training required?</p>
Sample vendor contracts	<ul style="list-style-type: none"> ▶ Will the vendor include a sample pilot-test or purchase contract in the proposal? Are there terms included, discussing a purchase commitment after testing? ▶ What is the pricing for purchase of additional locations after testing? 	<p>The energy manager should investigate any contractual commitments to the EMS vendor after field testing. This may require a legal review of vendor contracts.</p>
Sample invoices	<ul style="list-style-type: none"> ▶ What is the vendor's invoicing process? Are there any recurring monitoring invoices? Will installation and/or monitoring invoices be provided per site or for the total project? ▶ How should invoicing be designed for ongoing costs? ▶ Does the invoice need to display site name, number, and service provided for accounting purposes? 	
Utility rebate services	<ul style="list-style-type: none"> ▶ Does the vendor provide rebate services? Is this included, or is it an additional charge? ▶ Have utilities previously awarded rebates to the vendor's product? Request examples. 	<p>This is important if the energy manager is interested in pursuing vendor-provided rebates, and it helps with evaluating the vendor's service expertise in this area.</p>
Vendor references	<ul style="list-style-type: none"> ▶ Will the vendor provide current references for installed systems? ▶ References should document how many locations the vendor has installed and what control and monitoring equipment was installed. ▶ Will references discuss EMS energy savings, case studies, specifics on EMS product functionality, and vendor customer service evaluations? 	

B. Vendor Evaluation Framework¹⁴

The following table includes a sample comparison of differentiating factors between EMS product offerings. Energy managers may wish to use this evaluation framework in their vendor research or selection.

Sample EMS vendor comparison list	Vendor A	Vendor B	Vendor C
GENERAL			
IT infrastructure diagrams available; connectivity options outlined	X		
System demonstration available	X		
Site surveys included in price	X	X	
Sample contracts available for review		X	
SYSTEMS CONTROLLED BY EMS		X	
Heating, ventilation, and air conditioning (HVAC)	X	X	X
Multiple daily HVAC schedules	X	X	
HVAC runtime data provided	X	X	X
Lighting group design shown; multiple zones and schedules available	X	X	
Refrigeration equipment monitoring		X	X
Ventilation hoods monitoring		X	
Kitchen equipment monitoring	X	X	
Hot water heater monitoring	X		
Carbon monoxide (CO)/carbon dioxide (CO ₂) monitoring	X		X
Humidity monitoring		X	
EMS demand response functionality		X	
Other		X	X
THERMOSTAT HARDWARE			

¹⁴ Provided courtesy of National Energy Solutions, Dallas, TX.

Sample EMS vendor comparison list	Vendor	Vendor	Vendor
Vendor thermostat specifications provided	X	X	X
Thermostat diagnostic indicators built into thermostat hardware	X	X	X
Remote zone sensors available	X	X	X
Wireless thermostats/hardware available		X	
RETURN ON INVESTMENT (ROI)			
Vendor system cost for base kit (e.g., 5 rooftop units (RTUs))	X	X	X
Monthly recurring monitoring costs	X		X
Annual savings forecasted Year 1		X	X
Replacement parts pricing provided	X	X	
PILOT TEST OFFER			
Pilot test offer	X		
Pilot test terms provided	X		
Installation diagrams provided	X		X
Pre-installation/ installation activities outlined	X	X	
Staff training available (is there a fee?)	X	X	
24/7 test support	X	X	
Detailed vendor support plan documented (hours, phone numbers, response timeframes)	X	X	X
Vendor project manager assigned	X		
EMS REPORTING			
List of standard EMS system reports provided; samples provided	X	X	X
Pricing or terms for custom report development	X	X	
SERVICE AND MAINTENANCE			
Vendor has national EMS maintenance technician network for post-installation repairs or replacements	X		X
EMS parts and labor warranty	X	X	X

Sample EMS vendor comparison list	Vendor	Vendor	Vendor
Length of parts and labor warranty	1 yr.	1 yr.	5 yrs.
Pricing of labor provided	X		
GUI			
Web access available	X	X	X
Mobile app available	X	X	
Real-time online charts and graphs			X
Single-site/enterprise level information (multi-site views and rankings available)	X	X	
Does the system route alarms and alerts to cellphones and email?	X	X	
Clear description of system override and program-change abilities provided	X	X	X
What weather information is provided, and how is weather information designed into the system?	X	X	X
Does the EMS use dashboard designs to show energy usage, performance information, diagnostics, and other relevant information?	X	X	X
ADDITIONAL VENDOR SERVICES			
Vendor offers rebate services		X	X
Vendor performs EMS savings analysis (Measurement & Verification)		X	
OTHER			
Client references provided	X		X
Bank reference provided (if required)	X		X
Vendor history and years in business (if required)	X		X
Vendor insurances provided (if required)	X		X

C. Case Study



The Establishment

- ▶ Quick-service chain restaurants
- ▶ First restaurant opened over 40 years ago
- ▶ Over 3,000 restaurants (domestic and international)
- ▶ Over 20,000 employees

1. Introduction

The information presented in this case study was gathered through a series of interviews with the energy manager of a popular chain of quick-service restaurants. This chain, hereafter referred to as “the establishment,” has over 3,000 restaurants in the United States and internationally. This figure includes both corporate and franchisee-owned stores. Restaurants in the establishment consume approximately 350,000-400,000 kWh of electricity per year and pay between \$0.09 and \$0.14 per kWh. Thus, annual electricity expenditures range from about \$32,000 to \$56,000 per restaurant. In the mid-2000’s, the establishment decided to take steps towards improving energy efficiency via testing and rolling out of Energy Management Systems (EMS) in a series of phases.

The first step the establishment took to manage and save energy was to implement energy savings checklists and train employees, in five stores. The checklists consisted of basic behavior-based energy-saving recommendations for lighting and HVAC. Ultimately this initiative failed because of high employee turnover and lack of time and resources to enforce these best practices.

The establishment concluded that an automated EMS could be a resource- and time-efficient tool for saving energy. It would also allow them to standardize energy usage policies across the entire restaurant chain.

The establishment carried out three phases of EMS testing and installation, each one building upon lessons learned from previous phases. Each phase consisted of several EMS-related activities, including:

- ▶ Setting objectives and understanding EMS requirements
- ▶ Selecting one or more vendors for testing
- ▶ System installation and commissioning
- ▶ EMS operation during the field test and, as applicable, thereafter

This case study describes the above activities at each phase of the EMS project, highlighting the evolution in goals and requirements as more real-world experience was gained. Furthermore, the case study shares several lessons learned by the establishment during the project.

Several franchisees and an HQ department had installed EMS, independently, prior to the corporate initiative. These encounters with EMS were positive; however information about the franchisee experiences only became available to the energy manager after Phase 1 was underway, so the enterprise incorporated the resulting knowledge starting in Phase 2.

2. Phase 1 – The Initial EMS Field Test

The energy manager's first action was to determine restaurant needs, setting initial goals and requirements using internal knowledge of the restaurants and industry estimates of EMS performance.

a) Objectives and Requirements for Phase 1

- ▶ Target energy savings: 10-15% of a store's total energy spend
- ▶ Payback period: 2 years
- ▶ Locations: 5 stores (3 retrofits and 2 new construction)
- ▶ Equipment monitored and controlled: HVAC and lighting (both interior and exterior)
- ▶ EMS selection criteria:
 - Highest claimed energy savings among bidders
 - Non-proprietary software
 - Basic touchscreen hardware for setpoint control

b) Vendor Selection

The establishment's strategy for this initial phase was to determine the savings that could be achieved by EMS that only controlled basic building systems. The selection process involved questionnaires, a Request for Proposal (RFP), and interviews with a number of EMS vendors. Two vendors were selected, both of which provided HVAC setpoint control and claimed energy savings of 10-30%.

c) Observation and Results

Phase 1 field testing lasted approximately one year. The systems achieved a satisfactory level of energy savings (10-12%), which cleared the way for a second round of field testing. One of the vendors was unable to provide repair and maintenance support for EMS issues, which in turn significantly impacted restaurant operations. These experiences during the initial field test allowed the establishment to refine the vendor requirements, particularly with respect to EMS vendor support.

Phase 1 lessons learned

The establishment's energy manager suggested that readers seek to include the entire EMS distribution network – the manufacturer, distributor, and installers – in the planning and negotiation process. This might reduce distribution, installation, or technical support issues, as well as misunderstandings regarding scope and schedule.

The establishment decided not to continue testing in Phase 2 with either of the original vendors.

3. Phase 2 – Follow-on EMS Field Testing

After undergoing a pilot phase of EMS implementation in Phase 1, the establishment initiated Phase 2 with more extensively defined goals and requirements. The overall Phase 2 objective was to see if the level of energy savings achieved in Phase 1 could be duplicated in a larger set of sites.

a) Objectives and Requirements for Phase 2

- ▶ Target energy savings: 10-15% of total energy spend
- ▶ Payback period: 2 years
- ▶ Locations: 20 sites, all in warm climates
- ▶ Equipment monitored and controlled:
 - HVAC and lighting (both interior and exterior)
 - Monitoring only: Walk-in cooler and freezer temperature, doors, and compressors
- ▶ EMS selection criteria:
 - Highest claimed energy savings among bidders
 - Non-proprietary software
 - Basic touchscreen hardware for setpoint control
 - Ease of installation and replacement
 - Ability to automatically alert designated parties when there is a restaurant equipment problem
 - Provide all services related to the EMS, including installation, commissioning, maintenance, repair, replacement, customer service, and troubleshooting

b) Vendor Selection

Due to the Phase 1 vendor issues, the establishment wanted an EMS vendor that would provide all EMS-related installation and support services “from cradle to grave.” Rather than selecting a vendor using an RFP, the establishment consulted the others within the brand who had already used EMS successfully for vendor recommendations. They found that two different systems (from “Vendor A” and “Vendor B”) were in use and the end-users had positive experiences with the different EMS. This was especially true of the EMS in use in the restaurant environment.

The establishment decided to perform field testing of both products, in 10 restaurant locations each, and compare the test results. Each vendor recommended product settings and characteristics that they claimed would provide the best ROI.

c) Observations and Results

Both types of EMS were successfully installed and operated for the duration of the field test, approximately one year. Table 14 details some of the characteristics of each system, as well as observations and results for the two EMS options. Neither vendor was able to fulfill the establishment’s vendor requirements completely.

- ▶ Vendor A failed to provide walk-in compressor status monitoring and “push” user alerting. Vendor A also could not provide the support services that the establishment needed, were not responsive to calls, and did not keep track of service calls adequately. Combined with equipment reliability issues, these problems led to lower energy savings and frequent disruptions of restaurant functioning.
- ▶ Vendor B was able to provide the required controls, functions, and services, but installation was complex.

Table 14: Phase 2 results and observations

Characteristic	Vendor A	Vendor B
Number of installations	Installed in 10 stores	Installed in 10 stores
Relative price of EMS	Less expensive	More expensive
Previous experience with vendor’s product	Installed in three corporate sites as part of a department’s initiative to track cooler freezer temperatures	Installed in some franchisee locations
Installation	Comparatively straightforward	More complex, due to the large number of sensors placed on supply and return ducts, plus additional controls
Support provided	<ul style="list-style-type: none"> ▶ Installation and components ▶ No failure diagnostics or component replacement and maintenance 	<ul style="list-style-type: none"> ▶ 24/7 technical support ▶ Large number of fully trained service technicians
Energy savings results	<ul style="list-style-type: none"> ▶ Achieved internal energy savings goals 	<ul style="list-style-type: none"> ▶ Achieved internal energy savings goals ▶ Higher savings achieved
Control functions	Remote and onsite control of equipment with employee HVAC allowance of $\pm 3^{\circ}\text{F}$ for 30 minutes	Remote and onsite control of equipment with employee HVAC allowance of $\pm 2^{\circ}\text{F}$
Monitoring functions	<ul style="list-style-type: none"> ▶ Supply and room temperatures ▶ Interior and exterior lighting ▶ Ventilation hood (ON/OFF) ▶ Overall store power and energy 	<ul style="list-style-type: none"> ▶ Same temperatures as Vendor A, plus additional points ▶ Exterior lighting ▶ Fans and compressors ▶ Walk-in temperature and door ▶ Ventilation hood (ON/OFF) ▶ Overall store power and energy
Alerting	Users need to log in to the EMS to see alerts. Time-consuming three-tier system for clearing alerts within 24 hours.	Alerts are sent to users. Alert characteristics are flexible.

Table 14: Phase 2 results and observations (continued)

Characteristic	Vendor A	Vendor B
Analytics	<ul style="list-style-type: none"> ▶ Not provided, except for a graph of HVAC temperatures ▶ User downloads data and performs their own analytics 	<ul style="list-style-type: none"> ▶ Customized analytics, programmed by vendor ▶ Reports available online and can be sent to users
Reliability	Several component failures and parts replacements	<ul style="list-style-type: none"> ▶ No failures ▶ Fewer than 1% of parts needed replacement

The establishment found that neither vendor's initially recommended temperature setpoint resulted in comfortable temperatures during hot months, which led to employee and customer complaints. To address this, the establishment employed the following two-part approach that reduced complaints, improved comfort, and preventing store employees from overcorrecting the setpoint:

1. Setpoint rollback, more-gradual change. The establishment first returned the temperature setpoints to a value close to their lower pre-EMS levels, then "ratcheted" the setpoints back up over a length of time. This gave employees and regular customers sufficient time to adjust to the warmer restaurant environment.
2. Ongoing override allowance. The establishment revised EMS settings to allow employees a small temperature override allowance of several degrees in either direction. This gave store management the flexibility to make on-the-fly adjustments according to the needs of employees and customers.

Vendor B's system was able to achieve higher energy savings primarily because their EMS managed energy-saving HVAC characteristics that Vendor A was unable to control, e.g., additional cooling stages.

Phase 2 lessons learned

Vendor selection

While selecting an EMS vendor, it is important to define your internal goals and your expectations of the vendor.

- ▶ These goals and needs might be better-defined for organizations with prior EMS experience. The establishment recommends that organizations without experience in vendor selection or EMS design use an independent third party to help with establishing a scope that fits the internal corporate structure and goals.
- ▶ Prospective EMS buyers should be careful about relaxing defined requirements. The establishment encountered issues with Vendor A because it was selected despite the lack of desired EMS support and service.

Phase 2 lessons learned (continued)

Internal corporate structure

It is important to design a streamlined support framework to facilitate EMS scale-up. In addition to the role of the energy manager, the establishment designated facility managers as liaisons between the field test locations, the energy manager, and the EMS vendors.

Each facility manager oversees a group of restaurants within a geographic region and is responsible for an array of EMS-related tasks (e.g., installation oversight, employee training, and repair and maintenance). They are also the designated responders to any alerts or critical issues for their restaurants.

The development of this EMS support framework in Phase 2 proved essential for the large scale-up activities of Phase 3. Details of the establishment's energy management support system are described at the end of the case study.

The establishment's upper management generally focused on energy savings and cost savings metrics in evaluating EMS and making EMS-related decisions. Thus the energy manager needed to present any justifications for project recommendations (such as vendor selection) in that context. Vendor- and establishment-calculated energy savings often did not match. We have included lessons learned regarding this subject at the end of Phase 3.

4. Phase 3 – EMS Scale-up

As Phase 2 neared completion the establishment had a better idea of the capabilities of the various vendors they had engaged and a clearer vision of corporate goals and objectives. Phase 3 is currently ongoing.

a) Objectives and Requirements for Phase 3

- ▶ Target energy savings: 10-15% of total energy spend
- ▶ Payback period: 2.5 years (relaxed from 2 years based on a better understanding of realistic expectations)
- ▶ Locations:
 - 100 stores spread across several climate zones
 - Restaurants operating less than 24 hours per day
 - No new-construction sites or sites with lease issues
 - Facility managers who are more "tech savvy"
- ▶ Equipment monitored and controlled:
 - HVAC and exterior lights
 - Monitoring only: Walk-in cooler and freezer temperature

- ▶ EMS selection criteria:
 - Energy savings and system cost
 - Alarm/alert system
 - Off-the-shelf hardware components
 - Life and durability of components
 - EMS technical support, customer service
 - Analytics, demand-limiting functions

b) Vendor Selection

In view of the Phase 2 results and other considerations listed in Table 14, the establishment decided to roll out only Vendor B's product to the additional sites of Phase 3. The most important factors in the decision were the support services provided by Vendor B and their higher level of overall energy savings.

With the sheer number of restaurant sites targeted for scale-up, the total cost and overall complexity became a limiting factor in selection of EMS product features. The establishment chose to:

- ▶ Control and monitor only outdoor lighting
- ▶ Not monitor refrigerator door or compressor status
- ▶ Include demand-limiting software capability

As of the writing of this case study, the establishment had not yet used the demand-limiting software feature.

c) Site Selection

The establishment wanted to test EMS effectiveness in different climates, so they decided to scale by splitting the locations for new systems between their regions, in effect covering every climate zone. In general, the establishment chose sites that were likely to perform well with the EMS installed.

Also, they excluded stores that operate twenty-four hour per day, since those locations have no "down time" to save energy by imposing equipment-off conditions. To avoid complications and extra costs, the establishment also excluded new construction, sites requiring significant IT infrastructure upgrades, and sites with lease issues.

d) Observations and Results

The ongoing performance of new EMS locations was evaluated using:

- ▶ Year-over-year energy savings. Energy and cost savings were based on weather-normalized usage data
- ▶ Usage data compared against restaurants without EMS in the same geographical region
- ▶ Qualitative input from restaurant staff and facility managers

According to the establishment, preliminary results for Phase 3 look positive. It appears that they have found a good fit with an EMS vendor and, as discussed in the Phase 2 lessons learned, they now have an organizational structure that manages the large number of sites efficiently.

Phase 3 and Overall lessons learned

Equipment maintenance

The establishment noted that greater energy savings and better overall system operation can be realized if the HVAC equipment is periodically inspected and adjusted to improve performance and efficiency.

Installation tips

Installation of a new EMS during the milder “shoulder” months of the year reduces the likelihood of severe weather affecting restaurant operations while the HVAC system is being modified and tuned.

It is important to document every building issue with photos or videos during EMS installation. This evidence can be used to support resolution of equipment issues.

Size of the vendor

The size of the vendor company could affect project scheduling and invoicing during a large-scale rollout. Smaller companies are likely to be more limited in the number of new installs they can perform per week. Any establishment looking to scale up quickly should ensure that the vendor is available for the task.

Training

Training is a very important component of operating an EMS at any restaurant location. It is critical to receive buy-in from the multiple parties involved with the new EMS: restaurant operators, the facility manager, and equipment service technicians.

Ensure that on-site staff receives simple instructions regarding any overrides and temperature adjustments. The establishment’s energy manager stressed the importance of training service technicians regarding what equipment the EMS controls and how the system accomplishes its control.

Although it is critical to have technicians properly support and understand the new EMS, technician buy-in remains a challenge.

Performing analysis in-house

The energy manager noted that vendors often have elaborate calculations for energy savings, resulting in difficulty verifying the actual energy saved. As the number of EMS-installed locations increases during scale-up, the establishment recommended performing customized analytics and in-house M&V. This could provide benefits because of increased clarity and the ability to consider utility bills, weather normalization, and unique store-by-store characteristics.

Furthermore, the cost-effectiveness of performing in-house, specialized, EMS-related M&V will increase as the number of locations having EMS grows. The energy manager notes that the internal finance staff in this case should specify the format in which to transmit data to them.

Phase 3 and Overall lessons learned (continued)*Technical support: in-house vs. a third party*

Similar to the above, the establishment noted that employing internal technical support staff becomes more cost-effective once the EMS is scaled to a large number of locations. Alternately, energy managers may opt to turn over technical support or EMS operations support to a third party.

Such third-party service providers are a growing subsector within the EMS field; they tend to specialize in aftermarket energy management and provide operations and technical support services. If this option is considered, energy managers should confirm that the EMS vendor will allow third-party access to the relevant data and EMS dashboard.

5. Roles and Responsibilities

Table 15 lists some of the roles and responsibilities of the vendor and the establishment's corporate energy manager and facility managers.

Table 15: Roles and responsibilities

Role	Responsibilities
Energy manager	<ul style="list-style-type: none"> ▶ Corporate staff responsible for energy programs ▶ Determines goals and targets of EMS implementation ▶ Vendor selection ▶ EMS installation and rollout ▶ Oversight of corporate-wide overall EMS performance ▶ Obtains feedback from facility managers ▶ Performs in-house analytics ▶ Reports and liaises with upper management
Facility manager	<ul style="list-style-type: none"> ▶ Liaison between energy manager and vendor ▶ Responsible for several restaurants sites within a geographic area ▶ Overlooks day-to-day functioning of installed EMS ▶ Trains of employees ▶ Coordinates with District Manger on repair and maintenance issues ▶ Tracks repair and maintenance of EMS components ▶ Communicates with vendor in case of failure or breakdown
EMS vendor	<ul style="list-style-type: none"> ▶ Selected based on superior customer service ▶ Provides 24/7 technical support for the EMS ▶ Pushes critical alarms and alerts to responsible individuals ▶ Provides highly trained service technicians in the event of component failure ▶ Coordinates EMS component replacements



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