AN INTRODUCTION TO

ENERGY MANAGEMENT SYSTEMS

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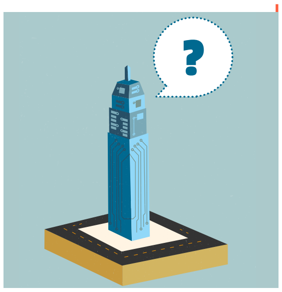
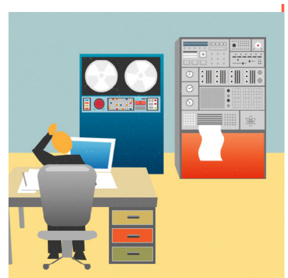
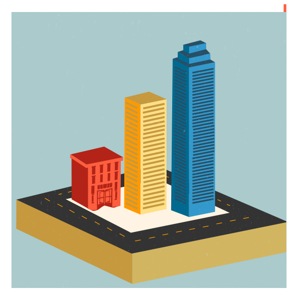
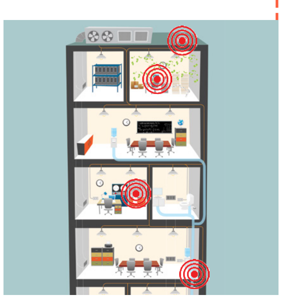
An Introduction to Energy Management Systems









INTRODUCTION TO ENERGY MANAGEMENT

The global economic environment over the past 4 years has been a difficult one for many businesses and industries. Countries in the developed world are struggling to maintain their levels of growth and economic stability, but are facing significant headwinds brought on by years of growth that was fueled by debt. The developing world is complicating the economic mix with high growth rates and a seemingly insatiable demand for energy and other natural resources. Many global leaders are faced with navigating this complex economic environment in the desire to assure a prosperous future for their countries.

The world is also faced with the fact that at current consumption rates, natural resources are becoming depleted, and the use of carbon producing fuel sources is causing significant harm to the environment. With these facts in mind, increasing attention has been placed on the built environment for solutions. Why?

COMMERCIAL AND RESIDENTIAL BUILDING ENERGY USE

The US Environmental Protection Agency claims that we spend upwards of 90% of our time indoors. Buildings and residences have become our “natural habitat”, but spending time indoors consumes energy. According the US Department of Energy (DOE), commercial buildings consume almost 20% of the energy produced in the US, while both commercial and residential buildings produce about 38% of the greenhouse gas emissions. Additionally, buildings consume over 70% of the electricity produced in the United States (Source: US Energy Information Administration). With such large consumption and pollution rates, making global buildings more efficient represents a significant opportunity to contribute to a less wasteful energy future, as well as one with less environmental impact. Energy management is one of the many tools that can be used to operate buildings more efficiently.

CHAPTER 1

WHAT IS ENERGY MANAGEMENT?

Energy management can mean a variety of things to different types of energy users or even to energy producers. Obviously, in the case of energy producers (i.e. utilities), energy management is a matter of managing energy generation and energy supply, and efficiently meeting the demands of the energy users who are their customers. For energy users, Energy Management can be described as the sum of measures planned and carried out to achieve the objective of using the minimum possible energy while the comfort levels (in offices or dwellings) and the production rates (in factories) are maintained. Saving energy can be extremely easy if we just shut things down, but that is impractical. The important thing to remember about energy management is that comfort and production levels remain somewhat the same as before any energy was conserved.

To make an efficient use of the energy, actions can be focused on a variety of different areas and approaches including energy conservation, energy recovery, and energy substitution. Brief definitions of these actions are described on the next page.

Energy Conservation

Efforts that are made to reduce energy consumption through economy, elimination of waste, or more rational use.

Energy Recovery

The reuse of a byproduct of one system for use as input energy for another system. An example of this is taking waste heat generated from a manufacturing process and using it for another purpose such as heating water.

Energy Substitution

The substitution of one energy source or fuel type for a more economical or less polluting energy source or fuel type.

Energy Management for commercial buildings mainly focuses in the area of energy conservation measures or programs. Energy recovery is largely implemented in industrial settings, however there are innovative solutions for commercial buildings such as air-to-air heat exchangers on the HVAC system. Energy substitution can be done in a commercial building by selecting renewable sources of energy through a retail electricity supplier (if available), or by implementing some form of renewable energy to supply power to the building itself.

Energy management can be a difficult proposition without having a more detailed understanding of how and where energy is being used within an organization. Although the situation is improving both nationally and globally, many organizations still resort to an "after the fact" understanding of energy use by checking and comparing energy bills that are received from the utility. At the most basic level this is a start, and serves to at least raise awareness of the energy being consumed by the company or organization. From this basic activity, a dialog about energy can be initiated within the organization, which may spur ideas of where energy can be saved. If, however, the energy bill never leaves the accounting office, there is really nothing to be gained. The organization leaves itself exposed to unexpected and unplanned-for expenses, which can add significant business risk to many organizations, especially in less-than-favorable economic conditions. Further, unless this increased awareness initiates change within the organization, no sustained benefits will be realized.

ENERGY MANAGEMENT AS AN ORGANIZATIONAL COMPETENCY

The US DOE's Office of Energy Efficiency and Renewable Energy (EERE) defines Corporate Energy Management (CEM) as an "integrated, company-wide effort that involves making business decisions about commercial and industrial equipment, establishing procedures that ensure greater energy and process efficiency, and encouraging behaviors that save energy and money." The main point to note in this definition is that energy management is a company wide effort, and requires sustained management "buy in" or support at the highest levels of the organization. Without this support, a company is destined to fumble around with haphazard or ad hoc efforts that will most likely not produce sustained results. Without sufficient time and resources allocated to these energy related projects or activities, the efforts generally die out to other "more important" or more "worthy" business related activities that add to the top line. The fallacy of this is that there are also many monetary and other benefits that go along with a corporate energy management program that can help add to both a business's top line (i.e. increased revenues) as well as its bottom line (i.e. reduced costs, increased profitability).

WHAT ENERGY MANAGEMENT IS NOT

Building Management Systems (BMS) and Energy Management Systems (EMS) have been around since the 1970's. The terms and are often misused to describe older control systems that adjust thermostats in response to temperature, humidity, and airflow, as well as timers. These systems are usually monitoring environmental parameters and may not be measuring energy use at all. They're actually temperature control systems, but the terminology has been in place for years. There are dozens of vendors who supply energy monitoring software. Most systems will perform complex functions including collecting large amounts of data, centralizing it, analyzing it and re-presenting it in the form of graphs, charts and reports. This has enormous value in providing real operational numbers to facilities managers and general management, especially for trending analysis, but energy monitoring is not the same as energy management.

Some of the limitations of these energy-monitoring systems include:

- Difficulty in integrating with, or using data from, legacy systems that still may be in use.
- Difficulty with historical data acquisition for comparison purposes against current performance.
- Difficulty in overlaying or comparing data from separate systems such as electrical, water, gas, occupancy, security and others.
- The systems can't automatically adjust data for outside temperatures – i.e. degree-days.
- The systems can't benchmark data against similar buildings in similar geographies.

Energy monitoring is far more beneficial than a traditional energy audit, but it doesn't go far enough. An energy management system, on the other hand, collects data from 'legacy' and/or new sources, centralizes it, analyzes it, and presents it to decision-makers to enable informed decisions about immediate energy-saving potential as well as future investments in larger energy saving projects.

Beyond simply monitoring, a comprehensive energy management system should provide multiple additional capabilities, including:

- Gathering data from ALL available sources, whether old, new, standalone or integrated.
- Analyzing single-variable data or multi-variable data to help identify problems and trends.
- Clearly identifying waste and recommending fixes, allowing easy payback/IRR calculations.
- Providing alerts if energy consumption exceeds user-set parameters.
- Providing 'early-warning' of mechanical or electrical failures.
- Integrating with control systems to automate responses to input data.
- Benchmarking a facility's energy use against others in similar climates.

CHAPTER 2

FUNCTIONALITY OF ENERGY MANAGEMENT SYSTEMS

There are as many different types of energy management systems as there are companies providing them. That being said, building energy management systems from different vendors can have multiple common functions due to the nature of energy management in general. Differences of these functions can vary by implementation (e.g. the interface), depth of detail, timing (e.g. real time vs. after the fact), number of systems or components measured (if any at all), and a host of other factors. Not every energy management system is right or applicable to every business, industry, or building. The following is a comprehensive list of the functions that commercial building energy management systems can include. Further discussion of the applicability of these functions to various different business sizes will be included in a following section on the next page.

List of ENERGY MANAGEMENT SYSTEM FUNCTIONALITY

ADVANCED BUILDING ANALYTICS
The analysis of a building's performance using more in depth data from sub-meters, building components, and outside sources including weather data. Advanced analytics can include real time data acquisition and processing to automatically detect and correct building performance issues, patterns, and faults. Advanced analytic solutions may also be integrated with other systems in an organization to provide an enterprise wide view of energy related spending including maintenance, preventative maintenance, carbon emissions, and ROI.

AMI DATA ANALYSIS
Advanced Metering Infrastructure (AMI) data is acquired from a utility at certain time intervals (e.g. 15 minutes) to allow for a more granular understanding of a building's energy consumption.

AUTODR
Automated Demand Response (AutoDR) allows automated control of a buildings components or systems so that energy consumption can be automatically curtailed during peak load events (e.g. a hot summer afternoon).

AUTOMATED BUILDING CONTROL
The ability of a building energy management system to actively interact with a building's components and systems.

BASIC ENERGY INFORMATION PORTAL
A web site or standalone terminal in a publicly accessible place (e.g. building lobby) that displays basic energy consumption information for a property. It can include educational and other energy savings tips and suggestions.

BASIC RETROFIT PROGRAMS
Generally low cost equipment replacement programs designed to make a business more energy efficient (e.g. light bulb replacement).

BEHAVIORAL AND EDUCATIONAL ENERGY SAVING SUGGESTIONS
Basic energy related suggestions and tips designed to teach building occupants how to easily and inexpensively conserve energy through modified behaviors (e.g., turn out the lights when you leave a room).

BENCHMARKING
Comparison of an entity's historical and current energy consumption with itself (over time) and other similar entities (e.g. by size and geographic location). Benchmarking is generally the first step in understanding the relative and on-going performance of a building.

BUILDING OPTIMIZATION
Functionality that enables the building energy management system to interact with the building's systems, optimizing their integrated performance within the building on a real time, or near real time basis.

CONTINUOUS COMMISSIONING

Ongoing analysis of a building's performance to assure that it is operating as designed.

CONTINUOUS OPTIMIZATION

Automated building controls that continually adjust a building's components and settings so that it operates in an integrated manner at the highest efficiency levels.

DEEPER RETROFIT PROGRAMS

Replacement of a building's operational (or other) components to make the building operate more efficiently. Deeper retrofit programs are often more capital, time, and resource intensive, and require replacement of some of the main components of a building, such as the HVAC system, windows, insulation, and/or the building envelope.

DEMAND RESPONSE

The reduction of end use electrical consumption in response to high electricity prices, system resource capacity needs, or system reliability events. This reduction can be achieved through curtailment (e.g. turning off lights) or self-generation (e.g. turning on backup generators). Some energy management systems have integrated demand response functionality to manage demand response events.

ENERGY DASHBOARD

A virtual and visual representation of an entity's energy consumption data intended to turn the data into information that can be understood relatively quickly.

ENERGY KIOSK

A publicly placed energy information portal for a site or group of sites intended to give building occupants visibility into the energy consumption of the site or group of sites.

ENERGY MONITORING

The regular collection of energy related data so that energy consumption can be understood, and anomalies can be investigated.

ENTERPRISE INTEGRATION

Integration of building energy management system data and information with other enterprise level IT systems so that these systems can interact for additional organization-level understanding and coordination.

HISTORICAL BILLING DATA TRENDS

Basic energy analysis performed using historical billing data.

INCENTIVE AVAILABILITY

A building energy management system capability that identifies the availability of utility demand management or energy efficiency programs for a specific entity in a specific location.

MAINTENANCE MANAGEMENT

Automation of a building's maintenance and preventative maintenance schedule.

MEASUREMENT AND VERIFICATION

The process associated with ensuring a particular energy efficiency measure or system improvement is producing the expected results. M&V is a critical component of determining the success and return on investment (ROI) of a particular energy efficiency project or EMS.

NOC AVAILABILITY

A Network Operations Center (NOC) (similar to a call center) allows BEMS clients access to building efficiency personnel and expertise for general problem resolution. Some vendor NOC's provide 24/7 monitoring of a building's systems so that alerts and problems can be dealt with appropriately and immediately if necessary.

NOTIFICATIONS AND ALERTS

BEMS functionality that notifies a building owner/operator of building maintenance needs, faulty equipment, or operational set points that need adjustment.

PREDICTIVE ANALYTICS

The use of algorithms or data processing functionality to anticipate optimal building settings for upcoming events that will affect building performance (e.g. a weather event such as a hot afternoon).

PREVENTATIVE MAINTENANCE

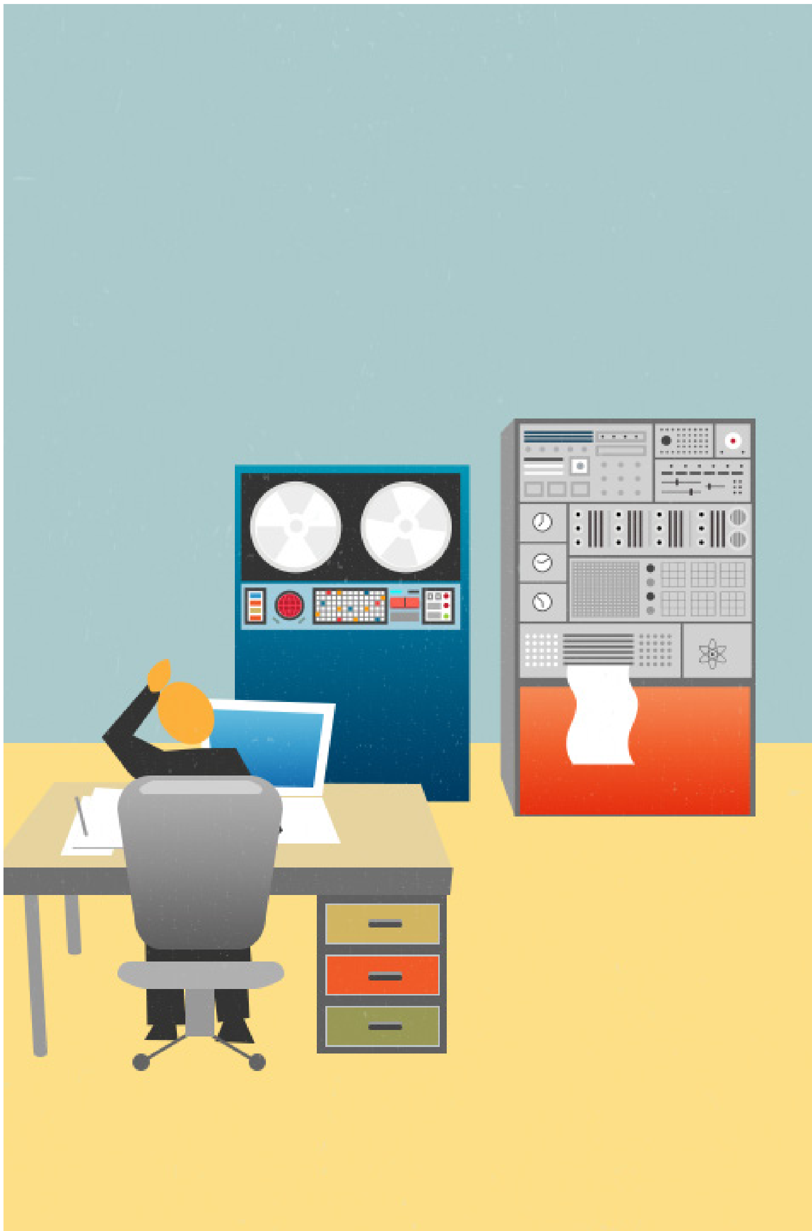
Some EMS's have the capability to detect when building components are drifting from their ideal settings or performance. In these situations, the EMS can identify preventative maintenance actions that will bring the component or building back in line. In general, preventative maintenance is less costly than a "break/fix" approach to maintenance, and it may also prevent significant business disruption (e.g. tenant comfort on a hot summer day if the HVAC is broken).

RETRO-COMMISSIONING

The application of the commissioning process to an existing building.

TROUBLE TICKET MANAGEMENT

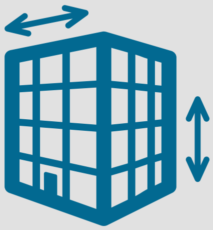
Automation and tracking of maintenance and repair action items, at times coordinated with outside maintenance firms.

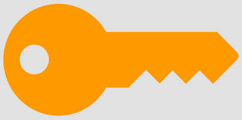


THE DECISION PROCESS

CHAPTER 3 ENERGY MANAGEMENT SYSTEMS

It may be human nature to desire all the bells and whistles when it comes to technology related matters. When dealing with energy management system acquisition, however, a more practical approach should be taken. The first gauge of the type of EMS that should be chosen is the energy spend of the facility or facilities in question. Ultimately, energy spend will determine the return on investment that is possible, and this must be in acceptable ranges for the company making the decision. For example, if the energy management system costs $20,000 to install with additional expenditures on a monthly basis for a software subscription, but the energy spend of the company on an annual basis is $10,000 with an optimistic potential savings of $2,000 (20%), the payback period and ROI for this system is simply not worth the expense.

DECISION INPUT	CONSIDERATIONS
Building Size 	Building size determines a host of details of an energy management system's usefulness and appropriateness. The size of a building generally can determine the overall energy spend, the types of equipment that is installed to heat and cool the building, the number of occupants, etc. Generally, the larger the building, the more sophisticated the EMS can be.
Energy Spend 	The monthly or annual energy spend of a company or building is one of the first determinants of selecting an EMS. Sophisticated and expensive systems are not appropriate for small buildings that use little energy. The savings from the EMS can't overcome the initial and ongoing costs, and ROI and payback won't meet acceptable levels. The greater the energy spend, the more sophisticated (and expensive) the EMS can be as the savings created by the EMS will produce a more acceptable ROI and payback period.
Geographic Location 	Geographic location generally determines climate related effects on energy consumption. For example, the extremes of hot summers in southern locations and cold winters in northern locations significantly affect a building's energy spend. In any case, an EMS that can effectively deal with weather related energy effects on a building (including demand response, where applicable) should be a consideration for certain size properties.
Number of Sites 	Having an EMS for one building is different than procuring one for a campus or portfolio of buildings. When more than one building is involved, it should be a consideration that the EMS can "roll up" and summarize the data from all sites as well as make comparisons of individual buildings.

Geographic Dispersion of the Buildings 	If there is more than one building, the dispersion of those buildings is an important consideration. Campuses of buildings can be located relatively close to one another, while national chains can be widely dispersed. The main consideration here is if the EMS in question can acquire and manage data from a number of buildings based on their proximity to each other. Other considerations for widely dispersed buildings can be the availability of utility incentives in numerous locations. Utility programs can vary widely. It may be beneficial to acquire an EMS that can handle the identification of utility programs in multiple areas.
Building Use(s) 	Building use can determine the requirements for an EMS. A warehouse has different requirements than an office building which must consider things like occupant comfort. Data centers have different needs than office buildings, hospitals, or schools…and so on.
Occupancy 	Occupancy is a factor in a building's energy consumption. Occupant comfort while still managing energy is one of the most important considerations for selecting an EMS. Un-occupied spaces can create misleading information regarding a building (e.g. less energy use than "normal"), so the EMS should be able to normalize energy spend based on occupancy, or determine the energy intensity of the building.
Intended Use of the System 	Intended EMS use affects the choice of system in many ways. This should be discussed at length prior to making the EMS choice. Some companies may just want better visibility into their energy consumption while not needing the sophistication and capabilities that some EMS's contain. Other businesses may face situations where an EMS is a critical component of their business…such as a laboratory or hospital where the inside environment of the building may be critical for safety reasons.

Type of Building	Older buildings are different than new buildings. There are a host of considerations to be made based on the building type including the equipment that is installed, insulation, windows, lighting, digital capability vs. pneumatic, etc.
Intended Use of the System	Intended EMS use affects the choice of system in many ways. This should be discussed at length prior to making the EMS choice. Some companies may just want better visibility into their energy consumption while not needing the sophistication and capabilities that some EMS's contain. Other businesses may face situations where an EMS is a critical component of their business…such as a laboratory or hospital where the inside environment of the building may be critical for safety reasons.
Business Risk	Some businesses have more business risk related to energy supply and consumption than others. Examples of this include hospitals and data centers versus a warehouse or even office buildings. Data centers rely on stable power supply and also effective and precise temperature control within the center. Critical data system failures can occur if the HVAC system is not operating correctly. In these situations, an EMS that has precise control and even predictive analytics may be necessary to support the mission critical systems of the business.
Responsibility	An EMS must actually be used to be worth anything to a company or building owner. Resources must be available and assigned to utilize the system to its full capabilities. Additionally, EMS's generally can make recommendations for repairs or preventative maintenance procedures. Resources must be available to schedule and perform this work, or to call a service company to have the recommendation addressed. It is not uncommon in today's economic environment to see EMS's go unused or underused. Responsibilities should be assigned or understood prior to making an EMS decision.

Knowledge Base

Not only must there be resources to operate the system, these resources must have the capability to understand how to use it and determine what the EMS is actually saying. For some of the simpler EMS's on the market, this may not be an issue. For larger and more sophisticated buildings and EMS's, appropriate personnel must be trained or assigned to work with the EMS.

Organizational Maturity

An EMS is a technology-based system (in one definition), but it is also an organizational competency. Immature organizations (with regard to structured processes and procedures) may find themselves disorganized and working in an ad hoc manner regarding energy management initiatives. This can be detrimental to the overall effectiveness of the EMS resulting in less energy savings and reduced ROI/payback. More mature organizations will necessarily have repeatable processes in place to afford the most effective use of the EMS and the energy management program that is in place.

Financial Considerations

Although many of the above EMS considerations are deemed important to the decision process, the reality is that the selection process ultimately boils down to the numbers. Does this EMS make financial sense to the company? What is the return on investment that this EMS will provide, and how long will it take to pay back the initial and ongoing costs related to the system. Generally, the EMS vendor can help with determining this with or for the company, but caution and due diligence must be performed on these numbers. It is easy to show savings with an EMS if it just turns equipment off…but what is the effect on things like operations and tenant comfort? Many companies will perform their own analysis of the financial considerations of an EMS in a way that is comfortable to them and justifiable to the ultimate decision makers.

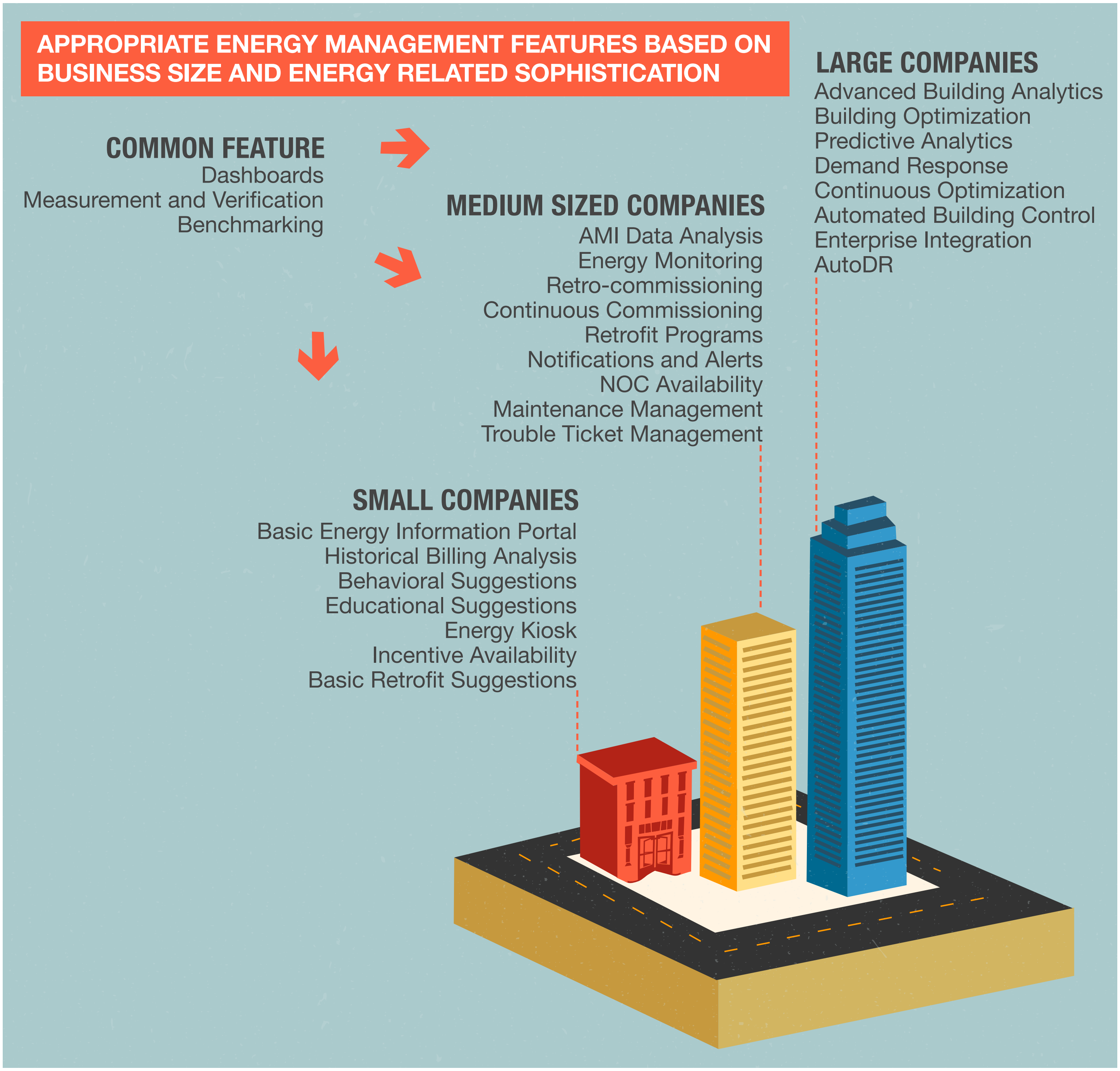
CHAPTER 4

COMPANY/ BUILDING SIZE

ENERGY MANAGEMENT SYSTEMS

Not all companies will need to go through an extensive process for acquiring an EMS. Small companies do not have the resources, skill levels, or need to operate a sophisticated EMS, nor do they have the resources necessary to pay for one of the advanced systems. Still, they can find a system that is appropriate for their situation.

In general, the larger the company, building, or energy spend the more advanced the EMS can be, and the more realistic it is for the company to utilize the EMS's full capabilities, while earning an acceptable ROI. This has limitations as well depending on the resources and skill levels that exist within the particular facility. Nonetheless, a variety of solutions exist for most any situation as will be described in later sections of this book.



The following figure is a graphical depiction of the relevant capabilities that are appropriate for various sized businesses and buildings. The functions identified in the figure match the list of EMS functions described previously. Once again, one size does not fit all, and the graphic is not intended to be carved in stone. Items listed as appropriate for small companies may also apply to some less sophisticated medium sized companies and some medium sized companies may be able to effectively utilize functions listed as appropriate for large companies. Common features that generally apply across the board because they are basic to energy management include a visual dashboard of energy consumption and use patterns, measurement and verification functionality that helps to verify the energy savings, and benchmarking which is critical to establish a history of energy use and performance comparison to other similar buildings.

SMALL COMPANIES/BUILDINGS

Small companies (<25,000 sq.ft.,<100 employees) can essentially be treated in much the same manner as residential electricity users. In this size and price range, behavioral suggestions, education concerning electricity use, and simple energy consumption information are as valuable as more sophisticated techniques. Other valuable EMS functions include finding utility incentives and programs such as light bulb replacement or rebates for purchasing more efficient equipment. Small companies don't have the time, resources or training to perform anything but the most basic energy efficiency tasks, and generally, their energy spend doesn't warrant much more than that anyway.

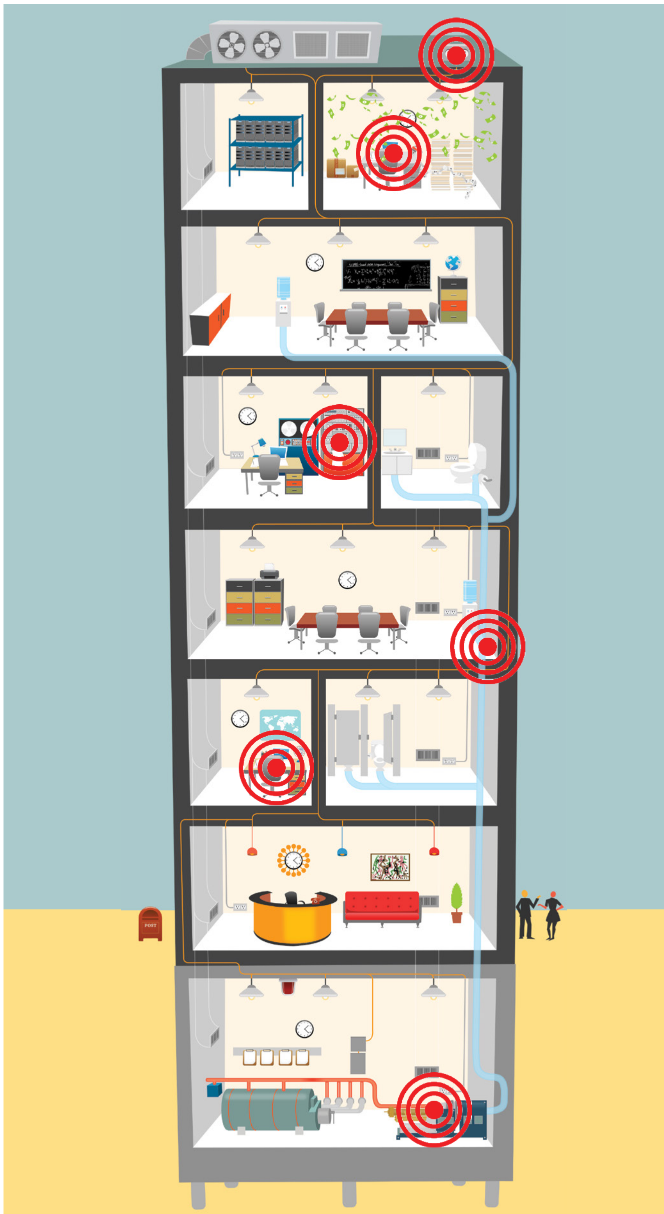
MEDIUM SIZED COMPANIES/BUILDINGS

Medium sized companies (25,000 – 150,000 sq. ft., 100 – 500 employees) may still have limited resources to work very deeply with energy initiatives, but others may be as sophisticated and have enough available resources to utilize more advanced EMS technology. Each company must go through a process to determine which system is appropriate for their needs, resources, and financial position. It is not enough to have a system that meshes well with the building components to provide more detailed energy consumption information. Resources must also be available to address issues identified by the particular EMS. For certain sized buildings, this may be a dedicated task for one or more trained or skilled individuals – and these are not minimum wage positions.

If appropriate personnel are available and the financial considerations work for the company, much more detailed energy management information can be obtained for the building or portfolio of buildings. These include commissioning and retro-commissioning functionality, more granular energy consumption data (either AMI or sub-meter data), problem alerts, call center availability, and maintenance management tracking. Because of this increased functionality, increased savings can also be realized – generally in the range of 7% - 15%.

LARGE COMPANIES/BUILDINGS

Many large companies (>150,000sq.ft., 500+ employees) have the energy spend and resources that make acquiring an EMS almost an imperative. Significant savings can be achieved in larger buildings, and these savings can positively and some times dramatically affect the bottom line of the business. Large buildings can still fail to achieve the full potential of an EMS if the energy efficiency initiative is not organized, planned, and resourced appropriately. In this category of EMS user, the buildings can be more sophisticated, but that too is not always the case. Large companies can be widely dispersed nationally and internationally, and that can pose problems for the company and EMS vendor in acquiring and rolling up data fro all of the locations (if required). The most promising way to proceed is to address the energy efficiency initiative in a holistic manner. Many times in a portfolio of buildings there is a variety of different building components (HVAC etc.) with varying levels of available data and different types of building communication protocols. It is also possible that there are already different EMS installed in the buildings. To attain a comprehensive solution, the acquiring company must look at all of these factors, again working with the chosen set of EMS vendors, to assure that the solution meets the needs and goals of the overall initiative.



CHAPTER 5

WHAT CAN BE MEASURED BY AN ENERGY MANAGEMENT SYSTEMS?

Technology based energy management systems can range from simple to complex, and from "no touch" systems, to systems that include an extensive array of sub-metered equipment with automated sensing and controls. The qualifier "technology based" was used to categorize energy management systems because many in the industry include internal process or behavioral related energy initiatives as an "energy management system". Although a valid and sensible definition, this article will focus more toward the technology side of energy management systems.

Energy management and energy management systems are not a new idea. Most of the existing building stock has some form of equipment installed that is used to control the building's operational equipment. In older buildings (pre-1980), these systems are mainly pneumatic, and are used to control the heating ventilation and air conditioning (HVAC) system. These systems use pressurized gas or air as their mechanism of control, and include a host of associated regulators and actuators to make them work. Many of the older buildings in the US have these types of systems, and until recently were mostly excluded from the ability to digitally control them. Retrofitting a pneumatic system can be a costly and disruptive process due to the nature of the physical aspects of the installed system. Today, technology is available that can convert pneumatic or analog systems to digital data so that the benefits of digital management can be realized. These new technologies also make the retrofit process less costly since extensive demolition does not have to be performed. Conversion of these systems also allows for the application of a more sophisticated energy management system to be utilized to monitor and control a facility's operations.

The precursor to today's vastly improved energy management systems was the shift to direct digital control (DDC) of a building or facility's operational components. Digital systems can allow full integration and automation of a building's components and environmental characteristics. When the shift to digital systems occurred, however, many vendors developed their own proprietary methods of communicating with these devices which limited interoperability with other makes of building systems. This may have been a strategic move by these vendors as it locked in customers or owners of a building to that particular manufacturer's products. During the past decade, however, there has been significant progress made into defining more open standards for communication between systems (e.g. BACnet) so that customers can choose the best and most appropriate equipment for their particular situation.

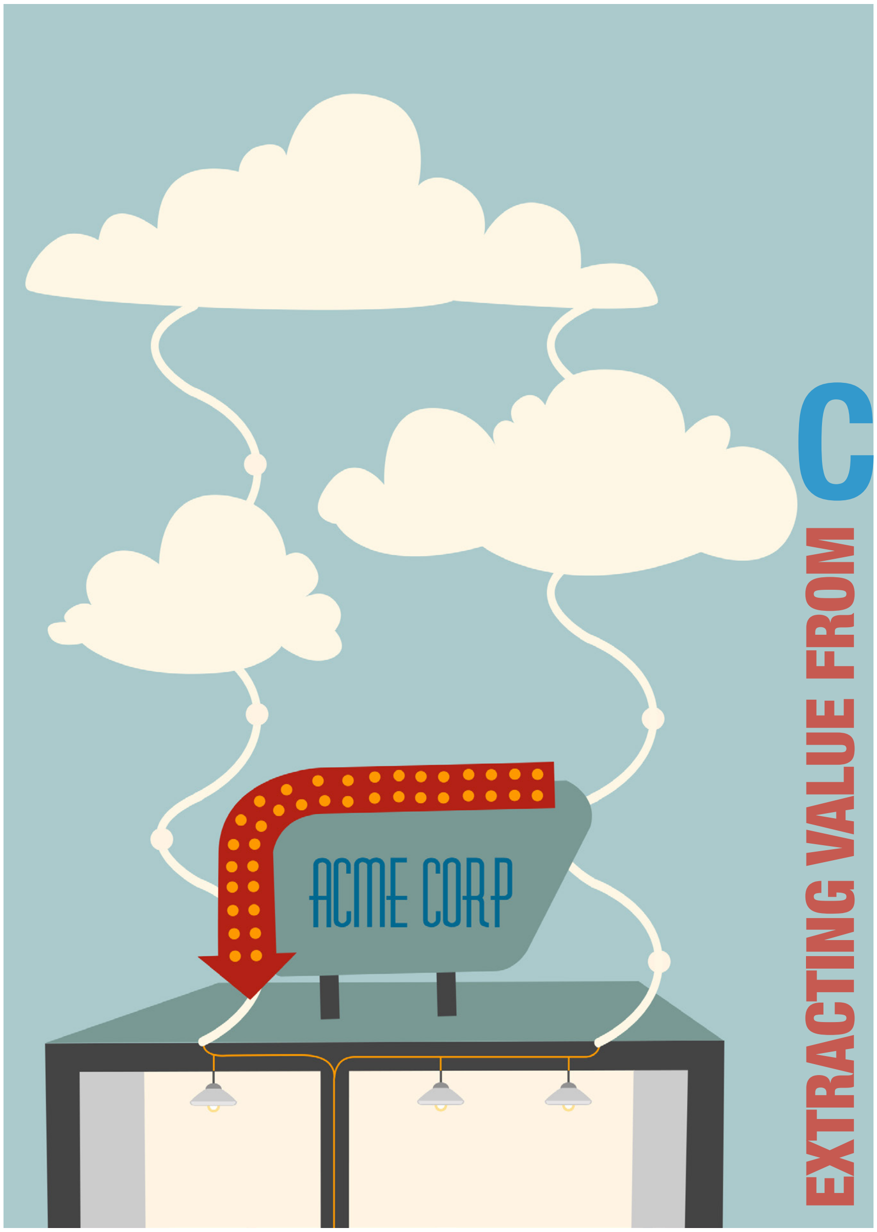
The main issue that needs to be overcome with regard to increasing the knowledge base of a building's energy use is the granularity of the information that can be gleaned from the various building automation components. This can be accomplished through the use of sub-meters, or meters that are placed "inside" the utility master meter so that individual pieces of equipment, buildings, facilities, or departments can gauge their energy or resource usage. Meters can be placed on equipment to measure the use of electricity, water, gas, or steam at a more granular level than what a utility needs to measure - which is total energy used by the facility. In essence, an energy management system that measures system performance at this more detailed level can be considered an enterprise level "smart grid". This integrated network of meters and sub meters, software, and hardware provide the tools to add visibility into energy consumption and enable decision-making and planning support to management. During the beginning phases of an energy management implementation it is important to establish a baseline of historical energy use as well as a comparison of that baseline to other facilities or buildings of similar size and use. Energy management tools can perform these tasks relatively easily, and with the abundance of data that is available for comparison, the results can be considered highly reliable.

In general, and depending on the nature of a business's activity, the main building devices or components that are monitored and controlled in a building or facility relate to the building's mechanical, electrical, and plumbing systems (MEP). These systems are composed of lower level components such as sensors, which measure critical data from the piece of equipment or elsewhere (temperature, humidity, outside temperature, etc.), and controllers that manage or control the operation of the equipment. Some of the building components that are included in MEP systems include chillers, boilers, roof top units, fan coil units, heat pumps, variable air volume boxes, and air handling units. IN addition to MEP systems, lighting monitoring and control is another area where significant savings can be realized. According to the US EPA Energy Star Program, between 25% and 40% of the electricity used in a commercial building goes toward lighting the facility. Along with changing to more efficient light bulbs and fixtures, simple lighting monitoring and management techniques, enabled by an energy management system, can add up to large savings.

Many studies have been performed on the efficiency of other operational systems in commercial and industrial settings. Some the largest users of electricity include pumping systems, fan systems, compressed air systems, and other materials processing systems. According to the Lawrence Berkeley National Laboratory (LBNL), these motor systems account for over 60% of the electricity consumed in the US industrial sector. An energy management system that is capable of measuring the energy consumption of these systems and intelligently controlling their operation can not only save a significant amount of energy, they can also improve the cost of maintaining the systems, improve overall reliability, and extend their useful life.

The advancement of technology in this area has allowed for a quickly evolving landscape of innovation. Traditional areas of application are being broadened and deepened, and are starting to include areas that could not be considered even a few years ago. Air quality within a building can be monitored and managed which can enhance the quality of the work environment as well as ensure occupant safety in facilities that work with toxic substances.

Weather data is now a major part of most energy management systems, and is utilized for anticipating cooling or heating requirements as well as a host of other energy related calculations and reporting capabilities. Demand management and demand response actions can be included in some energy management systems, and this helps to efficiently manage time of use impact to operations and can even mean an additional revenue stream for the business. Exercises such as utility invoice reconciliation with actual energy use are now much more straightforward to accomplish. Operations with multiple facilities can now integrate these facilities into one reporting system so that energy consumption across facilities can be compared and managed with better detail, and prioritization of maintenance and improvement projects can be initiated with more certainty. For the enterprise, energy can now become a variable cost that can be planned and managed similar to other business input.



CHAPTER 6

EXTRACTING VALUE FROM ENERGY MANAGEMENT SYSTEMS

A building energy management system is just that – a management system. Left unmanaged or incorrectly managed they offer limited benefit. Although there have been significant advancements and innovations in the technology that operates a commercial building, the question remains as to the true value that this technology is providing. In 2010, the Lawrence Berkeley National Laboratory (LBNL) released a study on the energy management systems that were installed in commercial buildings, and included statistics on how they were being used. The study showed some startling numbers. More than half of the respondents to this survey reported that they actually used the energy management system less than once per month. The Institute for Building Efficiency's annual Energy Efficiency Indicator survey has backed up these numbers until just this year where the statistics say that 56% of respondents now monitor their energy consumption at least weekly. This is an improvement, but taken with other statistics provided in the report, it can be surmised that there is still a long way to go for buildings to become as efficient as they can be.

There is an abundance of technology, products and components available for managing a smart building, and adoption rates of these systems have been relatively strong. It is the proper and cost effective integration, implementation and management of those products and services that is lacking in the current building environment today. The misunderstanding and lack of knowledge on how to effectively utilize what is currently available is limiting the efficient operation of a building as well as the return on investment of these installed systems. Correct building management requires knowledge and an understanding of how to interpret a wide range of building data. There must also be an understanding of how controlling various aspects of operation affects both comfort and energy use. Unless properties that utilize EMS systems have in-house technical expertise, which can be very expensive, it is likely they do not gain the benefit of the system as it was intended. Recent economic conditions have compounded the ineffective use of technology within a building. Although one of the main considerations for the purchase or use of an EMS is cost savings, interest in cost savings has also driven cutbacks in the numbers and skill levels of the personnel who are managing a building on a day-to-day basis.

Vendors in the energy management market tout the many benefits and the sophistication of their systems. Similar to what has happened in the financial and other industries, complex data analysis and algorithm development has become a highly desirable skill set for many vendors in the production of their tools and technology. Technology alone, however, is not always the most effective, or only solution to the problem. Focusing on technology more than delivered value is misguided at best. One can find many examples of IT projects that failed because they threw a bucket load of advanced technology at a "problem" only to find that it either didn't solve the original problem, created additional problems, and didn't result in more productive work. In fact, it may be the definition of the "problem" that has potentially led to the development of tools and technology that are less useful than they can and should be.

Some buildings or properties are fortunate enough to have the necessary numbers and skill levels of personnel managing and operating the buildings. In this case the technology and its output can be understood and utilized appropriately. In many cases today, however, building management and operation has devolved into a "break/fix" mentality. With the lack of resources that many properties are experiencing, there is just not the time or the expertise to schedule efficiency initiatives or projects with any regularity or effectiveness. All of the focus of the building maintenance staff is spent on ad hoc activities necessary to keep the building operational. The break/fix maintenance process increases the risk that a catastrophic and disruptive failure will occur that can compromise tenant comfort, security, and safety.

Several movements are being seen in the market for building energy management systems that are the result of some of the issues mentioned above. The first is the increasing popularity of energy as a managed service. A managed service offering essentially outsources the energy management activities of a smart building to a third party. Managed service providers have personnel with deep knowledge and experience with commercial buildings and their operation, as well as the toolsets and components installed within a building. In general, managed service providers have a network operations centers (NOC) staffed with these experts that monitor client's buildings around the clock. For a relatively modest monthly fee, building owners can effectively extend their building's operational staff eliminating the expense of building this capability themselves. It is expected that managed services will become an increasingly more popular solution to managing building efficiency, taking market share from standalone energy management offerings over the next decade.

The second recognizable movement in the energy management market is the move toward networks of individuals and communities where learning, sharing of knowledge, best practices, and experts can come together to provide or develop solutions to the needs of businesses or the community at large. Outdated hierarchical models of organization can be replaced with collaborative co-creation of solutions that are tailored to specific individual problems, only to be re-organized or re-created as problems, situations, and experience levels evolve. For a majority of the buildings that are experiencing difficulties with knowledge of how to manage their energy consumption and energy initiatives, simple solutions can be the best place to start. Access to sophisticated tools and expert advice is no longer something that needs to be costly or involve a time-consuming procurement process. As in other competitive industries there will be the similar market forces driving the cost of these tools down to the point where many will be available for free…a process which is well underway.

CHAPTER 7

BUILDING DRIFT

DON'T REST ON YOUR LAURELS

So, now that you have identified and fixed some areas of your building that were less than efficient, you can sit back and enjoy years of energy savings. Not so fast! Beware the dreaded building drift. Even the most sophisticated buildings experience drift in efficiency over time…as much as 10% - 30% over the course of just a year or two of normal operation [Lawrence Berkeley National Laboratory]. Standard maintenance practice in many cases amounts to physical observation - or if the building's occupants complain, hardware system alarms go off, or through routine maintenance. This is not enough to maintain the efficient operation of a building, and in most cases problems are found after much energy and money are wasted.

Commercial buildings are complex organisms involving electrical and mechanical systems that are integrated to control the operation of a building. Facilities that have dedicated staff to consistently monitor a building's components can still experience building drift. The causes of drift can be many, and they are difficult to detect or even realize from a causal standpoint. Causes can include dirt in the system components, temperature and time overrides that are set incorrectly, improper control settings, seasonal changes, stress on aging mechanical systems, component failures, and malfunctioning components. Other causes include duct or valve leakage, improperly balanced airflow, incorrectly sized equipment (e.g. HVAC), simultaneous heating and cooling, and still others. So, one can see that there are many areas where building efficiency can be compromised, and the larger the property, the more difficult it will be to find the actual causes.

Today's building energy management systems can provide some insightful relief of the problem of building drift. These systems allow for constant monitoring of a building's systems 24/7/365. Once a baseline for a building is established, the energy management system can constantly and consistently monitor for deviation from this baseline to see if there is meaningful change. The EMS allows you to isolate and pinpoint specific components of a building that might be contributing to the decay in performance so that problems can be resolved before they become larger issues or catastrophic or disruptive failures. Determining errors in this fashion will also help the facilities personnel to prioritize work tasks, eliminating some of the ad hoc nature of the maintenance process and moving away from a break/fix mode of operation. Commissioning, re-commissioning, and retro-commissioning are all valuable services that can be performed to help understand if a building's components are operating in accordance with original plans and specifications. Once these services are complete, however, drift in efficiency will still occur. However, if a baseline is established, and the building's performance can be monitored around the clock, performance comparisons can be continuously performed to identify areas that need attention or maintenance allowing for a building that is in tune more often than not.

CHAPTER 8

THE BENEFITS OF AN ORGANIZATIONAL ENERGY MANAGEMENT INITIATIVE

Some of the benefits of a corporate energy management program include reduced operational costs, increased productivity, and more efficient operations. But, this is not all. Companies around the world are realizing more and more that the stakeholders of a business are requiring responsible actions with regard to the use of resources and their environmental impact. Stakeholders consist of a varied group of constituents which include other businesses, governments, tenants, building owners, employees, standards organizations, environmental organizations, customers, suppliers, investors, students, patients, community members, and national citizens to name a few. Not only can an organization realize monetary benefits through the consistent implementation of an energy management program, they can also realize an enhanced brand image. Many organizations are realizing the benefits of publicly announcing energy management initiatives, and progress made toward their goals. Additionally, leading suppliers and retailers are requiring more responsible business actions, with severe restrictions on B2B transactions if these requirements are not met (e.g. Wal Mart). Finally, the employees of an organization that is involved with energy management activities can feel more empowered and satisfied in their organizational roles knowing that their company is a good corporate citizen.

Energy management initiatives provide companies with an opportunity to improve business performance, increase brand appeal, and contribute to a smaller environmental footprint. Employees will be more apt to feel connected to the business through a meaningful cause, and clients and customers will feel more connected to a brand that exhibits good corporate citizenship. With dedication and a commitment to improve its energy use profile, most any company can realize the benefits of an internal energy management program.

ENERGY MANAGEMENT ASSISTANCE PROGRAMS

There are many sources of assistance in establishing a company-wide program and plan for more efficient resource utilization. Some of these programs include the EPA/DOE Energy Star, Save Energy Now LEADER, and Better Building Initiative programs; the US Council for Energy Efficient Manufacturing's (US CEEM) Superior Energy Performance (SEP); ISO 500001 (International Standard); and the US Green Building Council's LEED certification program. Some of these organizations have global chapters for programs outside the US. Many other global governments have also established energy standards and programs that serve a similar purpose, although they may lag the US in their development. The variety of programs is expanding to serve most any type or size of business with localized assistance and incentive programs. Utilities have also joined in with demand side management programs that are expanding and offering businesses financial and other incentives for improved energy efficiency.

EMS VALUE IN ADDITION TO COST SAVINGS

Commercial building energy management systems provide building owners with the opportunity to understand and manage energy consumption and reduce green house gas emissions. There are a wide variety of systems available on the market today with as many differing characteristics. The market for energy management systems is highly competitive, and this is a good thing for end users. As system capabilities advance and evolve, so will pricing structures, simplicity of the systems, and interoperability. When personal computers first came to mass market, they were expensive and somewhat of a novelty for home users. Today, they are inexpensive, extremely useful, and part of the fabric of everyday life. Commercial energy management systems may follow a similar course where capable systems will be a standard part of every building's operational components. The opportunity to save up to 30% on building energy consumption for a majority of the existing and new building stock will be a boon for building owners and operators as well as for the environment, national energy security initiatives, and the general population.

Many in the business world today are advocating the use of triple bottom line accounting practices. Triple bottom line entails taking into consideration not only business profitability and results, but also including social and environmental aspects. “People, planet, profit” is a term coined by John Elkington in 1995 to succinctly describe the intentions of socially responsible business practices. The basic premise is that businesses need to take a more systemic view of how they operate in the world, taking into consideration all of the stakeholders, and not just shareholders of a business. Stakeholders include employees, community members, the environment, and all aspects of the world that may be affected by the businesses operations. Things like waste management, water use, materials composition and decomposition, supply chain, transportation, emissions, safety, and comfort, among others must be considered, understood and managed when adopting a triple bottom line strategy. In other words, what is the total overall footprint of the business all things considered.

Energy management systems are mostly marketed to end users for their ability to provide cost savings through reduced energy consumption. The question becomes, what other benefits – or triple bottom line considerations – are there to implementing an energy management system or energy efficiency program within a commercial building? Actually, the triple bottom line benefits are many, and well documented. The following paragraphs will present some holistic considerations of a commercial energy management system and other efficiency or green building initiatives.

PLANET

According to the US Energy Information Agency (EIA), buildings represent 38.9% of U.S. primary energy use (includes fuel input for production), 38% of all greehouse gas emissions, and 72% of US electricity consumption. There are significant opportunities to reduce this consumption, conserving valuable fuel sources and providing a measure of energy security for the country. Aside from operational cost reduction, the benefits of reduced energy use transfer to the environment and other areas. Water is an area that is critical to the planet’s sustainability. Although two thirds of the planet is covered by water, less than .5% of that water is fresh water. The rest is either in the form of seawater or locked up in icecaps or the soil. Buildings consume almost 14% of all potable water, or 15 trillion gallons per year according to the US Geologic Survey. Water efficiency efforts can decrease energy use by up to 11%, provide cost savings of up to 12%, and reduce water use by up to 15% [McGraw Hill Construction]. Buildings are also high users of raw materials – approximately 3 billion tons annually or 40% of total raw materials used globally [Worldwatch Institute]. The EPA estimates that 170 Million tons of building-related construction and demolition (C&D) debris were generated in the U.S. in 2003, with 61% coming from nonresidential sources. The EPA also estimates that 209.7 million tons of municipal solid waste was generated in the U.S. in a single year. The US Green Building Council (USGBC) estimates that green building efforts can reduce energy use by 24 - 50%, CO2 emissions by 33 - 39%, water use by 40%, and solid waste generation by 70%.

PROFIT

Cost savings of energy management and other efficiency and green building initiatives can go directly to the bottom line of a business. Other profit related factors come into play as well. For example, energy efficiency projects generally entail improvements to lighting along with heating, ventilation, and air conditioning performance. Studies have been performed that show that energy efficient air and lighting contribute to increased employee productivity, reduce absenteeism, and also increase sales in retail environments. In a study by the California Energy Commission, daylighting was positively and significantly linked to higher retail sales — as much as 40% higher, compared with a non-daylit store.

In a study performed for the National Environmental Education & Training Foundation, the following statistics were generated to show the financial benefits of reducing energy consumption. Energy use represents the single largest operating expense in an office property. Reducing energy use 30% is equivalent to increasing net operating income and building asset value by 5%. Businesses that lead in energy efficiency use about 30% less energy than their competitors. Reducing energy use 30% lowers operating costs by $25,000 per year for every 50,000 square feet of typical office space. U.S. hotels spend close to $4 billion on energy every year. Reducing these costs by just 10% is equivalent to a $0.62 average daily rate (ADR) increase for limited-service hotels and a $1.35 ADR increase for full service hotels. Every $1 a nonprofit healthcare organization saves on energy is equivalent to $20 in new revenues for hospitals or $10 for medical offices. For-profit hospitals, medical offices, and nursing homes can boost earnings per share by a penny by reducing energy costs just 5%.

In a survey that was conducted by McGraw Hill Construction, building owners identified the following statistics about how green building and efficiency practices affect their businesses: Operating costs decrease 13.6% for new construction and 8.5% for existing building projects; building value increases 10.9% new construction and 6.8% existing building projects; return on investment improves 9.9% new construction and 19.2% existing building projects; occupancy increases 6.4% for new construction and 2.5% for existing building projects; and rent increases 6.1% on new construction and 1% on existing building projects.

Finally, a series of studies by Innovest Strategic Value Advisors, a financial research firm, found basis to conclude that stock performance of companies that were involved with energy management activities outpaced that of companies that were laggards in this area. For example, in the grocery sector, leaders outperformed laggards in stock price by 17% over a three year period, and also had better financial measures such a price to earnings, price to book, return on assets, return on equity, and return on capital. Commercial real estate companies who are leaders in energy initiatives outperformed others by 34% over a two year period, and larger retailers outperformed laggards by an astonishing 71% over a five year period.

PEOPLE

The EPA estimates that people spend about 90% of their time indoors. They also estimate that indoor pollutant levels can be up to ten times higher than outdoor levels. The indoor environment can have a dramatic effect on how we feel, as well as how productive and healthy we are. In an experiment conducted by Applied Ergonomics, it was found that there is a link between improved lighting design and a reduction of 27% in the incidence of headaches which can account for almost 1% of employee health insurance cost and approximately $35 per employee annually. Additionally, improvements in indoor environments are estimated to save between $17 and $48 billion in total health gains and $20 to $160 billion in worker performance [Annual Review of Health and the Environment]. Students also have shown increased performance with better indoor environments, progressing 20% faster on math related subjects, and 26% better on reading performance. Lawrence Berkeley National Laboratory also concluded that there is significant correlation between low ventilation levels and higher carbon dioxide concentrations which is a common symptom in facilities with sick building syndrome.

With all of the above statistics in mind, it would seem to make sense that companies should pay attention to their energy consumption, which as a matter of course improves other aspects of the overall work or building environment, not to mention the environment in general. Unfortunately, in today's world, business leaders are judged on short term performance with hard financial numbers based on standard accounting practices. If, however, they make decisions based on a long term perspective as well as a more holistic view with regard to accounting practices, they would see that energy efficiency and sustainable practices provide benefits that significantly outweigh actions taken with a more short-sighted viewpoint. The evidence is there, as are the tools and information necessary to implement a more sustainable footprint. The good news is that increasingly, customers, suppliers, partners, investors, employees, and a host of others are changing the way that they think about what is important to them – and also changing the landscape of doing business in a more sustainable way.

TOM MACHINCHICK BIO

Tom Machinchick is a freelance writer, industry analyst, content marketing specialist, and business consultant to startup and early stage businesses. His diverse background includes work, or work assignments, in a variety of industries including IT, investment management, finance, high technology, energy, renewable energy, body care, retail, food and beverage, and market research to name a few. Recognized by colleagues and clients alike for his ability to understand complex business strategies, technologies, and market dynamics, Tom has been relied upon to write effective company communications - from business plans and company financials to marketing materials and white papers. Over the course of his career, Tom has held operational and senior management roles leading to his broad understanding of business and organizational dynamics. Tom's most current assignments include contract writing for Pike Research, a leading green technology market research and consulting firm, as well authoring articles, blogs, and eBooks for Noesis Energy. His main areas of focus and expertise have been in the commercial and industrial energy management and building information modeling markets. Tom is also working with a few select clients in these markets to develop content marketing strategies and publications.