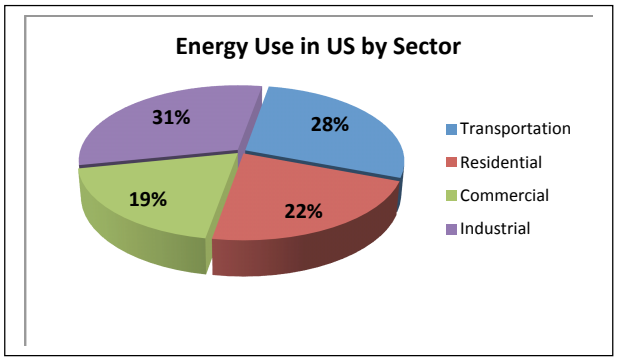
Small Commercial Facilities – Energy Savings Challenges and Opportunities

Buildings are responsible for 78% of the energy use in the United State. Commercial buildings account for 19% of energy use, or 26% of the total building usage, which is the smallest percentage of the 3 building categories (residential, commercial, industrial). When it comes to ***electricity*** usage, however, commercial buildings account for fully 35% of building electricity use – which is more (38% more to be precise) than industrial buildings.



There has been significant attention paid in recent years at all levels of government as well as by the utility industry to energy efficiency in commercial buildings. But, most of this focus has been on large commercial buildings, particularly large office buildings. After all, these are complex buildings that use significant amounts of energy,

However, small and medium size commercial buildings– those that are less than 100,000 sq. ft. in size – actually use a significant amount of energy in their own right. In fact, according to the US Energy Information Administration (EIA), they use 40% ***more*** energy in total than buildings over 100,000 square feet.

Building Size (sq. ft.)	Number (000)	Elec. Usage/ Build. (mWh)	Tot. Elec. Usage (mWh)	Energy Intensity (kWh per sq. ft.)
1,001 - 5,000	2,586	47	121,542	17.8
5,001 - 10,000	948	92	87,216	12.4
10,001-25,000	810	164	132,840	10.5
25,001 - 50,000	261	439	114,579	12.2
50,0001- 100,000	147	927	136,269	13.1
100,001 - 200,000	74	2,181	161,394	15.7
200,001-500,000	26	4,375	113,750	15.0

The reason for this difference is quite simple. While larger buildings are, well, *larger*, there are many *more* smaller-size buildings. In fact, according to EIA, there are approximately 4.7M buildings in the U.S. under 100,000 sq. feet, while there are only about 100,000 buildings that are larger.

In addition, really small commercial facilities use more energy per square foot than commercial buildings as a whole. In particular, restaurants, convenience stores and supermarkets – which represent a sizeable percentage of smaller commercial facilities – use 2.5 to 3 times the energy use per sq. ft. of large commercial buildings.

Moreover, while the vast majority of larger facilities have some form of automated building management systems in place, this is not the case with smaller buildings. There has been a lot of attention recently about control systems that need regular "tune ups", but at least these larger buildings

have some sort of automated controls. At the lower end of the commercial market – say facilities 15,000 sq. ft. and under which represent more than 70% of all commercial facilities – very few have any form of automated control system in place; estimates put the number below 10%. The reason for this is quite simple; on an individual location basis, the benefits of automated controls in smaller facilities have simply not justified the expense.

The lack of controls does not, however, imply that these facilities do not have energy-related issues - or opportunities - akin to those of larger buildings. While there is much less complexity in smaller buildings, this also implies that the solutions are likely to be much less complex.

In this paper we explore some of the energy efficiency challenges and opportunities in small commercial facilities – particularly those 3.5 million buildings in the U.S. under 15,000 sq. ft.

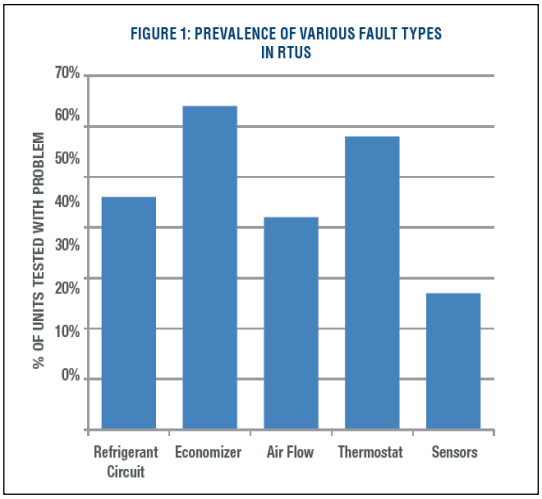
Challenges

Differences and Similarities

While smaller buildings tend to be more similar to each other than they are to larger facilities, there are still some major differences between different types of facilities.

For example, restaurants and convenience/grocery stores have huge amounts of refrigeration equipment that is not found in retail or office environments. Restaurants also have energy guzzling food preparation equipment, as well much more extensive ventilation requirements. On the other hand, you do not find the level of computing equipment in a restaurant that you do in a small office building.

But, all facilities share one major expense in common: heating and cooling. And, many if not most share the same type of problems. Not only do the majority of these facilities have no HVAC control system, many do not even have programmable thermostats. And, where they do, in many cases they have not been programmed, not been updated despite changes in business hours (or programmed to take account of different hours on different days of the week), or perhaps never adjusted for daylight savings time. Having heating and cooling systems on at the same time is a common refrain (as it is in larger buildings). Alternatively, local employee adjustments often undermine planned programs. In an amazing number of situations, employees actually break into thermostats that have been locked away to keep them from making adjustments.



Aside from the problem of controlling HVAC systems, there are problems with the systems themselves. Some reports suggest that 40% of systems develop problems within 2 years of installation – and not all companies are diligent about keeping systems regularly maintained. Faults include air temperature sensor failures, inappropriate refrigerant charge, condenser problems, and much more. For facilities that have economizers,

reports suggest as many as 60% no longer work properly within 2 years, meaning that the benefits of the economizers are often negated very rapidly.[1]

Lighting is another common denominator among different types of facilities, all of whom share the phenomenon of lights left blazing long after they need to be – or long before. However, there are key differences between different types of facilities when it comes to lighting. While lighting may constitute a sufficient enough percentage of energy use in retail stores and small office buildings to make a lighting control system cost-effective, that might not be the case in a restaurant.

Which brings up another challenge common to all facilities regardless of size; how do you know how much energy is being used by different end uses in order to determine whether automation – or other energy saving measures – is warranted? This topic will be addressed further in the section on opportunities.

Compounding Utility Billing Issues

On a different front; most commercial facilities are assessed a "demand charge" by their local utility – or a charge for the peak energy used in any 15 minute window in a month. Demand charges are in addition to the more commonly understood usage based charges. In some areas demand charges can represent a major portion of the bill, particularly in summer months. But, while larger facilities generally have energy managers and control equipment to minimize demand charges, smaller facilities often have no one that even understands these charges, much less any way of addressing them. And, of course, it is hard to manage against any utility bill when the bill comes weeks after the energy has actually been used.

Savings Potential?

What is the real savings potential? You will see varying claims about the potential for wasted energy in commercial facilities – with 50% not being uncommon.[2] Many larger buildings have gone through multiple rounds of energy efficiency improvements – or "commissioning" as it is generally called. And yet, somehow new energy saving opportunities always seem to be found. The term used to define this phenomenon is "drift" – where personnel changes and actions and system deterioration cause some of the improvements to drift away over time. Some estimates of drift are as high as 50% over several years[3]. For this reason, the consensus is that there needs to be what is referred to as "continuous commissioning" to keep buildings operating efficiently.

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[1] See, for example, *Automated Fault Detection and Diagnostics for Rooftop Units*, California energy commission Public Interest Energy Research Program, 2010. Figure 1 was taken from this report.

[2] See for example: "Strategies to Cut Energy Use by 50% in Commercial Buildings", US DOE EERE (Energy Efficiency and Renewable Energy) or "Technical Support Document for 50% Energy Savings in Quick Service Restaurants", Pacific Northwest National Laboratory.

[3] In "Combatting Commercial Building Energy Drift" David Wollins suggests 20% every 1 to 2 years.

Of course, drift is much less of an issue in smaller commercial facilities – because they often have done little if any commissioning work. This implies that there may be not only larger problems, but also larger opportunities in small commercial facilities.

Opportunities

Basic Approaches

Efficiency opportunities typically fall into 2 categories. First are the capital improvements; new equipment, building shell renovations, and building management systems, for example. This category itself can really be subdivided into energy saving "measures" that are relatively inexpensive and pay for themselves very quickly, and those that are more capital intensive and have a much longer return on investment. Capital improvements could easily reduce energy usage by 20-30%.

The next category, often referred to as operational improvement, includes adjustments to HVAC settings and making sure that unnecessary equipment is turned off during non-business hours. Sometimes considered "low hanging fruit", these types of changes can easily save 10-20% of energy costs. But, as noted earlier, settings may often be overridden, and without a building control system it is often impossible to enforce equipment and lighting timing strategies.

Identifying Opportunities

So, where does one start? Energy audits are one way to find out what is going on in a building. Energy audits can be expensive, although many utilities now pay for or at least subsidize audits. One limitation of energy audits is that they tend to be limited to one specific point in time – which may not reflect the true ongoing operations of a building – and often focus more on capital than operational improvements.

In the past couple of years, a number of companies have begun to offer analytics-based audits, tapping into utility meter data and applying algorithms that attempt to analyze what is happening in a building. These systems, however, tend to be focused on larger facilities – in fact, many of them require the inputs of a building management system and offer less value for facilities that do not have one. What they also cannot do is easily identify when equipment is not operating as it should be.

There are also now available some relatively inexpensive new technologies that monitor what is going on in a facility at a very granular level. This can have several major benefits. First, it can let management know what is on when it needn't be – and how much it is costing – as well as help enforce policies by continually monitoring the facility.

Secondly, it can identify equipment problems proactively, potentially lowering maintenance costs and avoiding major disruptions. For example, increasing energy use for a particular piece of equipment may be a sign of a problem or indicate that maintenance is required. In the case of HVAC equipment, there are a number of products that offer what is called "Fault Detection and Diagnosis" (FDD), where a variety of sensors are used to identify system problems.

Third, a monitoring system can identify where there may be opportunities for real savings. For example, by knowing exactly what is being spent on lighting it is possible to determine the cost-benefits of replacing incandescent lighting with LED's, or implementing a lighting control system. One restaurant chain we have worked with went so far as to install a monitoring system in one location to measure the lighting baseline, implemented a lighting control system in that one location, and then decided it was not cost-effective to roll out the control system chain-wide.

Monitoring systems that provide benchmarking capabilities – whether for different locations within a chain or benchmarking against industry averages – offer another major value. For example, chains that always wonder about major cost differences between facilities may now be able to drill down to see whether the problem is related to a specific end use – such as lighting or cooling. Or, they may be able to see which equipment models are more efficient.

Monitoring systems represent a cost-effective way to perform continuous commissioning – or what has now become known as *monitoring-based commissioning*. Since things can change at any time in a building, ongoing monitoring ensures that operations can be fine-tuned at any time, no matter what energy improvements have already been made.

Smaller Facility Control Systems

There are also now available for smaller buildings a number of remote HVAC control systems that may offer less sophistication than a traditional building management system, but at a much lower cost, and typically pay for themselves very quickly. Generally, these just require a thermostat replacement, let management control the thermostats remotely, and give them the power to lock out local overrides if so desired. These systems replace the need for remote temperature sensors, thermostat lock-boxes, and the practice of locking away all thermostats in a manager's office. Most of these are also much easier to operate than a traditional building management system – although complexity does vary.

Paying For Change

There are also now opportunities for significantly reducing the cost of capital improvements, When energy efficiency opportunities are identified, whether by audit, analytics, monitoring or simply observation, there are utility rebates available in many locations for such things as variable speed motors, efficient lighting systems, more efficient HVAC systems, or even monitoring and control systems. Utilities have historically had

Program Overview:	
State:	Massachusetts
Incentive Type:	Utility Rebate Program
Eligible Efficiency Technologies:	Lighting, Lighting Controls/Sensors, Chillers , Heat pumps, Central Air conditioners, Heat recovery, Compressed air, Programmable Thermostats, Energy Mgmt. Systems/Building Controls, Motor VFDs, Processing and Manufacturing Equipment, Custom/Others pending approval, Led Exit Signs, Room Air Conditioners, Evaporative Coolers, Vending Machine Controls, Dual Enthalpy Economizer, Demand Control Ventilation, Refrigerated Dryers
Eligible Renewable/Other Technologies:	Geothermal Heat Pumps
Applicable Sectors:	Commercial, Industrial, Schools, Local Government, Construction, State Government, Installer/Contractor, Institutional
Amount:	Fluorescent Systems: $10-$50/fixture High and Low Bay Fluorescents: Up to $100/fixture LED Interior: $15-$50/fixture LED Exterior: $150/fixture Daylighting and Occupancy Sensors: $20-$60/control HVAC: Varies widely VSDs: $1000-$15,300 Chillers: $10-$20/ton + $1.25-$3.50/ton each 0.1 EER point above or kW/ton point below minimum criteria Air Compressors: $180-$205/(HP Load/No Load); $210-$280/HP Variable Speed or Displacement Vending Machines: $30-$75/unit Energy Management Systems: $200-$300/point
Maximum Incentive:	50% of cost of upgraded equipment, or an amount that buys down the cost of the project to a 1.5 year simple payback.
Eligible System Size:	Air Compressors: 15-75 HP
Equipment Requirements:	VSDs: Motors must operate a minimum of 2,000 hours annually.
Installation Requirements:	Contact MassSAVE for information on pre-approval requirements
Start Date:	1/1/2011
Web Site:	http://masssave.org/business/building-or-equipment-upgrades/

Utility Rebates Available in MA. Source: DSIRE

an extremely hard time addressing the needs of the small commercial market, and some are now trying to do a much better job of reaching out. But, surveys repeatedly show that the majority of small businesses are unaware of energy efficiency programs run by their utilities.

The Bottom Line

Energy is a major cost item for most small commercial facilities. Most still view energy as an uncontrollable expense; it is hard to control something when you get a bill that you cannot understand well after the fact. Until recently, traditional approaches to addressing energy efficiency, such as energy audits and building management systems, have simply been too expensive to pursue in smaller building.

Many small commercial operations have tackled other avenues of inefficiencies, leaving energy as the next frontier. With new products and programs available, there is no reason why small commercial facilities cannot take on the energy problem and see energy costs go way down – and profits go up.