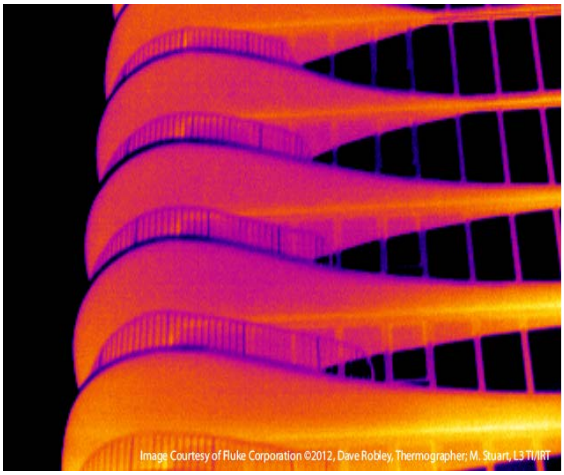
White Paper #1

Managing Energy Use



Energy helps businesses get things done. It also costs money. So where is the balance?

Energy Use or Energy Cost?
Identical energy use in different cities can have markedly different costs. Likewise, a rate increase makes the bill higher even if energy use has not changed. If energy cost is more than it needs to be, it dilutes business profit. How to know?

What Should it Be?
While energy *cost* control is the goal, evaluating energy *use* is a good approach. Similar facilities in different locations can exhibit similar energy use patterns even if costs are different. Benchmark values of commercial buildings are available through the Energy Information Administration, an arm of the Federal Department of Energy. These values are grouped by common "Primary Business Activity" and can be further divided for specific business sub-types. Normal energy use values for manufacturing businesses are not found in convenient tables like commercial businesses, so determining what it 'should be' can be elusive.

When 'normal' levels of energy use can be identified, the first-cut comparison is helpful. Most often expressed as "per SF per year", energy use intensity can also be expressed in other units such as 'per-person', 'per ton of product', etc. If higher than normal, there will usually be a wider variety of cost reduction options than if energy use is already normal or lower than normal.

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Benchmarking Energy Use Intensity values (EUI)
Commercial customers can review their energy bills and see how you compare to similar facilities. The customary units for comparison are Btu/SF-yr.

This can be easily calculated, if you have 12 month total electric (kWh) and gas (ccf) usage data.

Begin with the total yearly amounts

Step 1: Total kWh * 3.413 = kBtu of electric energy
Step 2: Total ccf * 82.0* = kBtu of natural gas energy
Step 3: Add the results of Step 1 and Step 2, for total "kBtu per year"
Step 4. Divide the result of Step 3 by the facility size in square feet.

Compare your results with the National Averages below:

Category	Function Rev 2, 06-07-07	kBtu/SF-yr
Assembly	Entertainment/culture, recreation, social/meeting, library, other public assembly	**94**
	Library	**138**
Education	College/university buildings	**155**
	K-12 school	**72**
Food Sales	Grocery store/food market	**214**
Food Service	Fast food	**451**
	Full service restaurant/cafeteria	**231**
	Catering, bars, donut/bagel shops, coffee shops, ice cream shops	**193**
Healthcare	Hospital	**249**
	Outpatient	**95**
	Assisted living / nursing home	**125**
Lodging	0 - 50,000 SF	**83**
	> 50,000 SF	**100**
Office	0 - 50,000 SF	**82**
	> 50,000 SF	**102**
Residential	With air conditioning	**69**
	Without air conditioning	**64**
Warehouse	Distribution/shipping center, non-refrigerated warehouse, self-storage	**45**
	Refrigerated storage	**98**
Worship	Church	**44**

*Heating value of natural gas varies over time, and by season. This is a typical value as of the date of this document

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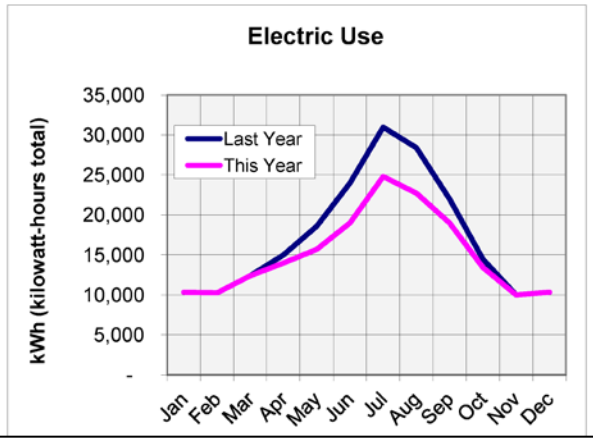
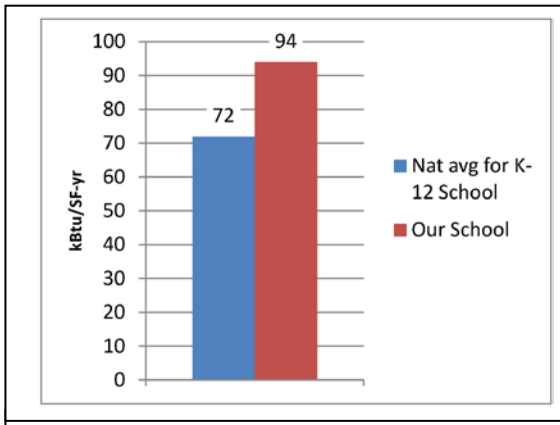
Tracking Your Usage

Is your usage the same as this month last year? Did the lighting replacement project really produce the expected savings? Why am I seeing usage at 2am when the building is closed? These kinds of questions are part of ongoing energy management, and keeping records of energy use is one of the enablers.

It can be as simple as a spreadsheet of usage by month. In some cases daily or hourly records are helpful. Graphing is useful for 'at a glance' information and for reports. Some ideas are shown: a common theme for charts is "compared to what?"

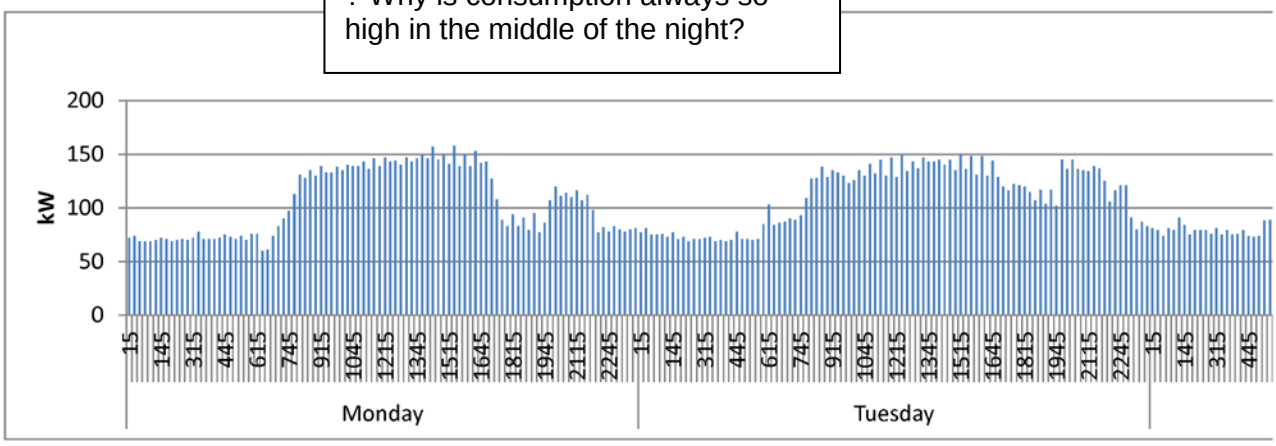


Successive years overlaid.



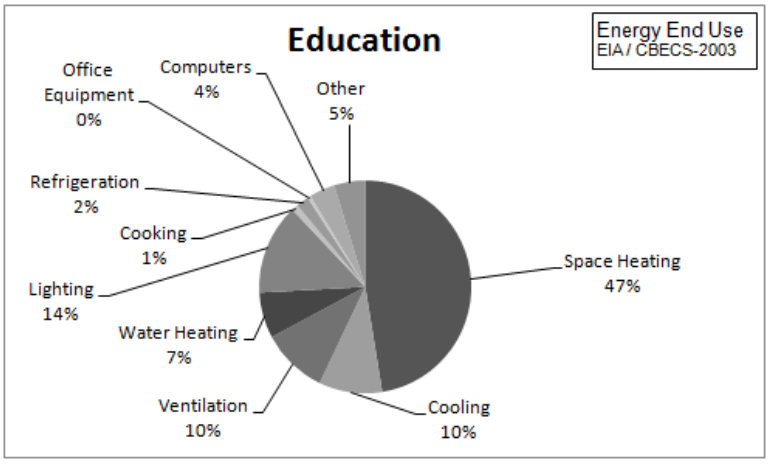
Comparison to a national average similar facility.

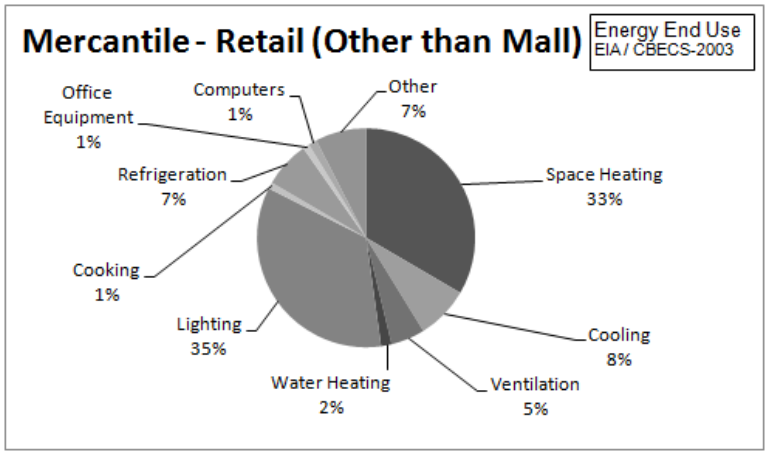
? Why is consumption always so high in the middle of the night?



Have Some Pie

When it comes to energy, "end uses" in a building describe its eating habits. End uses describe where it all goes and are fairly predictable in many common commercial business types. Here are a few examples that show how energy use is different depending upon what goes on inside – and that one-size-fits-all recommendations will have problems. Big slices means more of the energy is going "there". Usually 3-4 uses represent most of the energy use in a commercial building.





Things You Can Do

Begin by practicing this simple phrase: "Why is that??"

Try anything that raises awareness of energy cost, especially feedback and accountability. From reminders and praise, to charts, to sub metering special use areas, to job goals tied to compensation, it is all good. You'll know you've been successful when people make energy impact choices at work as if they were paying the bill.

Look for things that run when they shouldn't. Inside lights on all night? Parking lot lights on all day? HVAC units running on the weekend when nobody is there? Machinery left idling for long periods of time? And about that gas broiler that warms up in a 'hot second

Look for doors that are open or aren't sealed: dock doors left open, walk-in freezer doors propped open, front doors with a large daylight crack under it, oven doors with broken seals, refrigerator gaskets torn. You get the idea.

Look for areas that seem to always be hot or cold? Sometimes this leads to interesting discoveries above the ceiling – just be careful on the ladder. Sometimes automatic controls are broken or located in the wrong spot so they can never be satisfied.

Are there a lot of space heaters being used? Hmmm. Sometimes this is a symptom of a mechanical system that isn't working properly. Folks need to be comfortable, but just remember, those things use a lot of electricity. Sometimes a heated foot mat will do the trick with a fraction of the energy use.

Do you find large cooling units running in winter? Large heating units running in summer? If yes, then you are officially in the Twilight Zone; ask why. If you find a huge heater is running in summer for one person who is cold…. well there may be other options, like a sweater, or a heated foot mat, or re-directing a cold air diffuser. It's worth a try.

Decide if heating and cooling settings are reasonable. A good way to decide is if they are similar to home settings.

Maintenance? Actually, this can be very useful. Some maintenance tasks have a direct effect on energy use (and lack of maintenance goes the other way). Simple things can have nice benefit, like cleaning inside and outside coils once a year so they are clean like new; and making sure the economizers are working to give you free cooling. To show you care, invite yourself along one day to see these practices are being done regularly. If your maintenance is outsourced, take a look at the "as needed" list and inquire when the last time they were truly done. Assert!

Identify equipment that needs replacing, regardless of energy savings. Duct tape is a clue. These are "normal replacements" and opportunities to add efficiency when investing in more than like kind equipment. When it is time to replace it, get some ideas on how to "build in" efficiency as a smart shopper. Engineers call it "specifications" but it's really shopping.

Digging Deeper: the Energy Audit

Not to worry. The people that do this professionally don't understand your business either.

There are different degrees of energy audit. The standard one is called "Level 2". (Level 1 is brief and limited to quick low cost work; Level 3 adds drill-down analysis to portions of a standard level 2 audit and may be used to support pre-construction activities).

Here is a basic description of a standard level 2 audit. It will vary a little by business and will definitely vary if conducted for a manufacturing customer. This is simplified and paraphrased for brevity. By looking at a variety of attempts to describe the energy audit levels, a pattern will emerge.

A Level 2 energy audit typically includes

- Preliminary analysis and review of metrics and available benchmark, using a combination of applicable utility bills, sub meter records, interval data, customer questionnaire and/or interview input.
- Survey of systems and operations, and opportunities for improvement. 'Operations' includes automatic controls review (set points, schedules, and control strategies), maintenance, and operational practices. In cases of older equipment, end of life issues may be pointed out, irrespective of energy saving merit (e.g. equipment that needs replacing anyway). This activity may also point out safety or air quality concerns.
- Items reviewed will vary depending upon what is pertinent. Review can include envelope, HVAC, domestic hot water, and lighting systems for the building. Review significant process areas associated with large energy use.
- Basic measurements as applicable. This will vary but can include light levels, air and water temperatures, pressures, damper positions, etc.
- Review of O/M (operations and maintenance) practices that influence energy cost
- End use breakdown, indicating where the energy is going (like a pie chart)
- Identifying efficiency measures. Low cost measures should be separate from capital expense measures to allow implementation without capital review delays.
- Estimated savings and cost of the capital measures. Low cost measures may not include cost figures. May include measure interactions. Construction cost will likely be based on 'per SF', 'per ton', or other rules of thumb, and provide order of magnitude confidence level.
- Prepare a report with descriptions of systems, findings and recommendations. Review the report with the customer, and prioritize recommendations if funding is limited.
- Recommended next steps that may include long term data collection, additional analysis or pricing of selected Level 2 measures, evaluating variations on measures, modeling, specialty audits (such as thermal scans, process water, or compressed air survey) or preliminary design to improve accuracy of savings or cost estimates. This Level 3 work may be appropriate when large, expensive, or long term measures are recommended, cost estimate detail and accuracy suitable for bidding, or when the added analysis and rigor will help improve the business confidence of the customer's decision.

Choosing an Energy Professional

- This is not rocket science. It isn't a technician job either, although technicians can be good assistants if the audit involves a team. It is an applied engineering function.
- A Certified Energy Engineer (CEM) with an engineering background is a good combination. A CEM and PE (registered Professional Engineer) with design experience adds additional confidence when choosing based on credentials.
- Referrals, recommendations, or samples of work are reasonable to request.
- Independent third party status adds a measure of confidence that the consulting work is not biased toward any particular product.
- Energy savings or losses are often intertwined with design, construction, and operational details, so the more of these related facets of the building the person has a good grasp on the chances improve for bringing effective solutions to bear.
- Years of experience. Pick a consultant who has been doing this for awhile. Separate the years of actually doing the work from time spent managing the work of others.
- A willingness to listen since each facility is unique.
- Skilled at quantifying savings.

Energy Audit Red Flags:

- Savings that add up to more than the existing bill
- Savings look too good to be true. Aggressive low cost work can save 5-10% but usually to have savings beyond that requires capital investment. To achieve energy reduction in excess of 30% usually requires aggressive design embedded in new
- Demand charge or blended rate electric cost savings claimed for measures that are predominantly non-peak times (e.g. parking lot lights)
- Economic payback period should be well within the system life. If it pays for itself right about the time it is worn out, what have you accomplished?
- Exotic – complicated systems – may actually work, but needs to be compatible with facilities operators. Be sure the idea can be understood and sustained
- Anything that compromises comfort or ventilation
- Savings calculations that do not consider interaction with other measures usually indicate lack of experience.
- 8760 hours of use – usually not true
- Continuous 100 percent mechanical equipment loading – usually not true
- HVAC efficiency estimates based solely on summer design conditions
- Cost estimates that do not include design fees, project management fees, escalation, or contingency allowance

Resources:

Commercial

www.eia.gov. Within this site, two go-to places are

CBECS table C3 kBtu/SF-year national averages

CBECS table E1 end uses. These numbers can be made into slices of pie. (these table references apply to 2003 data. 2012 data, with preliminary release in 2014, may be organized differently)

Industrial

www1.eere.energy.gov Within this site are some useful items in the "library"

ITP Tip Sheets Industrial technologies Program, best practices by topic. Such as compressed air, process heating, motors, steam, etc.

Information on energy intensive industries by topic

Software tools

References:
Technical information for this paper from Commercial Energy Auditing Reference Handbook, Fairmont Press