ENERGY MANAGEMENT IN NEW AND EXISTING BUILDINGS: A SUSTAINABLE ACTIVITY

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Buildings consume 39% of all US energy. It is generally practical and feasible to reduce building energy consumption by one third. Thus, facility managers who practice sustained Energy Management can potentially save 13% of all energy used in the U.S. ENERGY MANAGEMENT IS A TRULY SUSTAINABLE ACTIVITY. Using basic management techniques, managers can significantly improve the efficiency of most buildings, and can maintain a high level of efficiency in the few that are actually efficient. This presentation focuses on management issues first, and technology second.

I am pleased to present the following supplemental information on this presentation.

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Feel free to contact me if you would like to discuss or pursue Energy Management in more detail.

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Pearson Engineering

ENERGY MANAGEMENT IS A COST EFFECTIVE, GREEN, AND SUSTAINABLE ACTIVITY

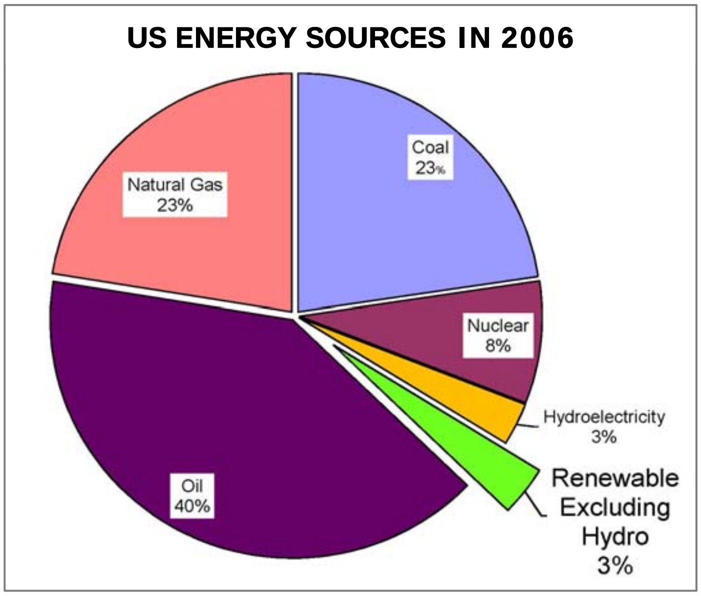


Figure 1

Figure 1 shows DOE statistics of energy sources in the United States in 2006. Renewable energy contributed 3%. Considering the publicized growth of wind, solar, and biomass energy, it is surprising to learn that this percentage has been nearly constant for over 20 years. Why? Simply because total energy use has also been growing.

Figure 2

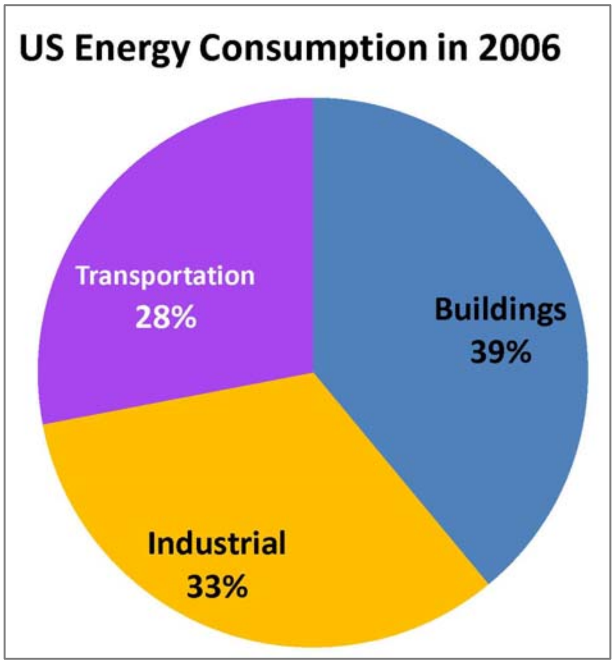
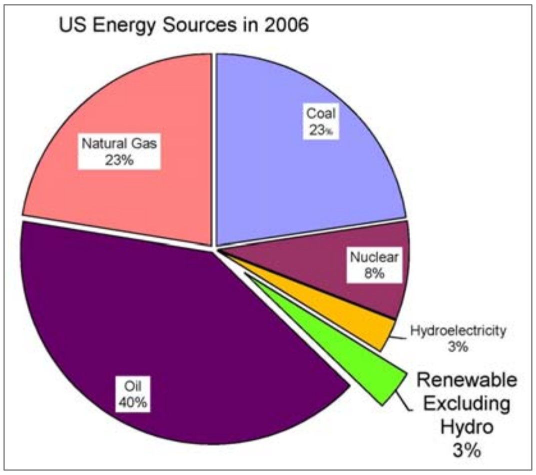
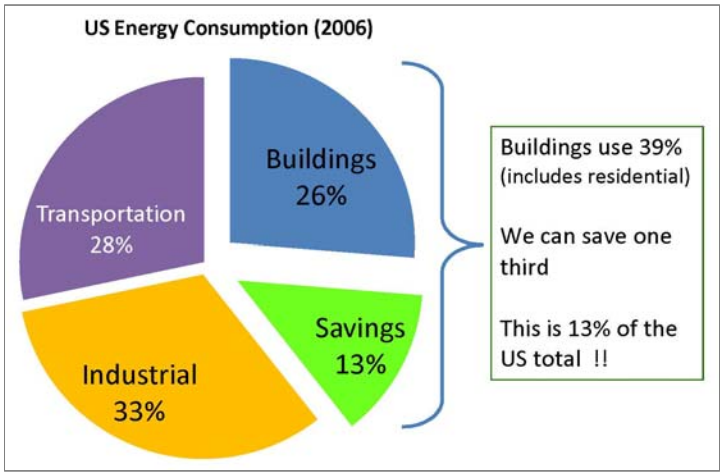


Figure 2 shows how the US used energy in 2006. Buildings used 39%.

When energy management is applied to a cross-section of buildings, it is both feasible and cost effective to reduce building energy usage by 33%.

Energy management is the quickest, cheapest, cleanest way to extend world energy supplies. Energy management can provide four times the environmental impact of renewable energy.

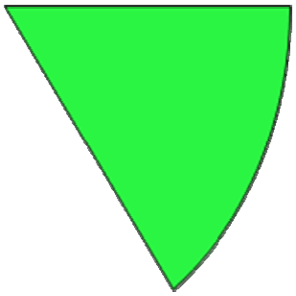




ENERGY MANAGEMENT POTENTIAL

Building Reduction
33%

National Reduction
13%



In Other Words…

- Green
- Sustainable
- Lowers Carbon Footprint
- Lowers CO_2 Emissions
- Reduces Global Warming
- Reduces Cost
- Improves Return on Investment

This is an illustration of the environmental benefits of saving energy in buildings. The following document provides state-by-state emissions factors, to calculate specific reductions of various containments when gas and electric use is reduced:

Emissions Factors and Energy Prices for the Cleaner and Greener Environmental Program
http://www.cleanerandgreener.org/download/efactors.pdf

GREENER PASTURES WITH ENERGY SAVINGS
Emissions Reduction at Madison Area Technical College

Significant energy savings accompany impressive benefits to the environment.

Energy	**Usage FY 01/02**	**Usage FY 06/07**	**Reduction!!**
Electricity	23,000,000 kWh	18,000,000 kWh	**5,000,000 kWh**
Natural Gas	900,000 therms	645,000 therms	**255,000 therms**
Emissions	**Emissions FY 01/02**	**Emissions FY 06/07**	
Carbon Dioxide	30,500 tons	23,000 tons	**7,500 tons**
Sulfur Oxides	138 tons	106 tons	**32 tons**
Nitrogen Oxides	72 tons	55 tons	**17 tons**

Source: MATC Engineering Manager – Wesley Marquardt - wmarquardt@matcmadison.edu
For 50 state emissions data, refer to "Emission Factors and Energy Prices":
http://www.cleanerandgreener.org/download/efactors.pdf

ENERGY MANAGEMENT IS A PROCESS, NOT A PROJECT

Almost every discussion of energy efficiency focuses on the role of "projects" in controlling energy costs. As singular episodes, projects fail to address energy waste attributable to poor awareness, bad work habits, improper maintenance, and discipline. The potential impact of expensive, new hardware is compromised if people don't use it properly. "Human" shortcomings can be addressed through goals, targets, and accountabilities that are the essence of an **energy management process**.

Classic energy projects include new boilers, chillers, cooling towers, or other significant hardware installations, paid for through capital investment. The logic behind projects is straightforward: plug in a new black box, flick the switch, and get back to business as usual. There are a lot of black boxes out there by-passed and collecting dust, because the people who could get the most from them have been reassigned, improperly trained, or simply not held accountable for energy performance in the first place.

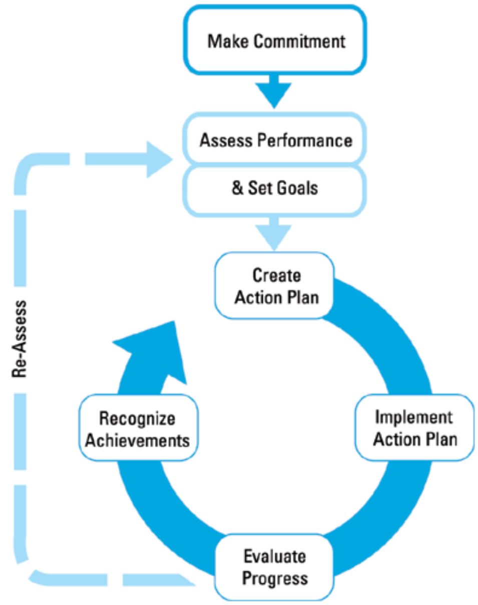
"Project" focus relies on financial payback as the ultimate measure of project approval. For every proposal, there is a sharp-penciled financial director ready to express some doubt about its proposed payback. Such doubts are not unwarranted. Facilities that pursue large capital equipment projects without addressing wasteful practices are actually putting these big investments at risk. A comprehensive investment in people skills and energy-smart procedures will effectively underwrite the costs of capital projects. By having a strong foundation of energy-smart skills and procedures, a facility is better prepared to implement new equipment. This is the approach taken by Kimberly-Clark, Frito-Lay, Merck & Co., Dupont, Unilever HPC, and many others, whose experience is document by Christopher Russell at http://www.ase.org/section/topic/industry/corporate/cemcases.

Energy management is an ongoing process which involves benchmarking energy use, setting goals and standards for improvement, ongoing measurement and verification, and assigning accountability. It is as much a communications effort as it is an engineering pursuit. The effort is ongoing because technologies evolve, labor turns over, and production costs change. Why manage energy? Energy use is pervasive throughout a facility, at every stage of production or hour of operation. If you monitor energy use, you have a pulse on the tempo of activity throughout the facility. If you develop energy management skills, you develop leadership that can be leveraged for managing raw materials, labor, production schedules, and other activities. Energy efficiency then becomes the result of a process – **a process called Energy Management** that recognizes projects as a part of a larger organizational effort.

TIPS FROM THE ENERGY STAR FLOWCHART

Website url: http://www.energystar.gov
Category: BUILDINGS & PLANTS
Click on: Guidelines for Energy Management

Each task in the flowchart links to a pdf document with additional tips and suggestions.



STEP 1: Commit to Continuous Improvement

The common element of successful energy management is commitment.

Form a Dedicated Team
Institute an Energy Policy

STEP 2: Assess Performance

Assessing performance is the periodic process of evaluating energy use and establishing a baseline.

Data Collection and Management
Baselining and Benchmarking
Analysis and Evaluation
Assessing your energy performance helps you to:

- Categorize current energy use by fuel type, operating division, facility, product line, etc.
- Identify high performing facilities for recognition and replicable practices.
- Prioritize poor performing facilities for immediate improvement.
- Understand the contribution of energy expenditures to operating costs.
- Develop a historical perspective and context for future actions and decisions.
- Establish reference points for measuring and rewarding good performance
-

STEP 3: Set Goals

Setting clear and measurable goals is critical for understanding intended results, developing effective strategies, and reaping financial gains.

Setting goals helps the Energy Director:

- Set the tone for improvement throughout the organization
- Measure the success of the energy management program
- Help the Energy Team to identify progress and setbacks at a facility level
- Foster ownership of energy management, create a sense of purpose, and motivate staff
- Demonstrate commitment to reducing environmental impacts
- Create schedules for upgrade activities and identify milestones
-

STEP 4: Create Action Plan

The action plan is regularly updated, to reflect recent achievements, changes in performance, and shifting priorities.

- Brainstorm with various departments to identify ways they can contribute.
- Hold a competition to seek ideas for energy efficiency from across the organization.
- Gather recommendations from the Energy Team and other key personnel.
- Define technical steps and targets
- Determine roles and resources

STEP 5: Implement Action Plan

Gaining the support and cooperation of key people at different levels within the organization is an important factor for successful action plan implementation.

- Immediate – Commence discretionary facility operation to minimize energy use
- Long range – Conduct energy audits and capital improvements

STEP 6: Evaluate Progress

Evaluating progress includes review of energy use data and the activities carried out as compared to your performance goals.

Key steps involved include:

- Measure results - Compare current performance to established goals.
- Review action plan - Understand what worked well and what didn't.

Regular evaluation allows energy managers to:

- Make informed decisions about future energy projects
- Document additional savings opportunities as well as non-quantifiable benefits

STEP 7: Recognize Achievements

Providing and seeking recognition for energy management achievements is a proven step for sustaining momentum and support for your program.

- Provide internal recognition
- Receive external recognition

TIPS FROM THE ASHRAE 2007 HANDBOOK

Chapter 35 – Energy Use and Management

This important Energy Management reference includes the following subjects:

- Organize for Energy Management
- Energy Manager Job Description
- Communications
- Energy Accounting Systems
- Analyzing Energy Data
- Surveys and Audits
- Improving Discretionary Operations
- Energy Conservation Opportunities
- Implementing Energy Conservation Measures
- Monitoring Results
- Evaluating Success and Establishing New Goals
- Building Emergency Energy Use Reduction

ASHE **E^{2}C**

American Society for Healthcare Engineering
of the American Hospital Association

Announcing: A new chapter in ASHE and EPA's long term partnership - ASHE's Energy Efficiency Commitment (**E^{2}C**)

The ASHE Website contains a wealth of thoughtful informatio the subject of Energy Management in Healthcare facilities

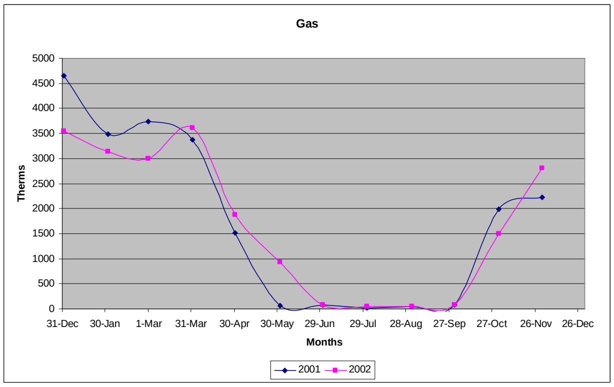
http://www.ashe.org

Click on **Facility Management**, then click on **E^{2}C**

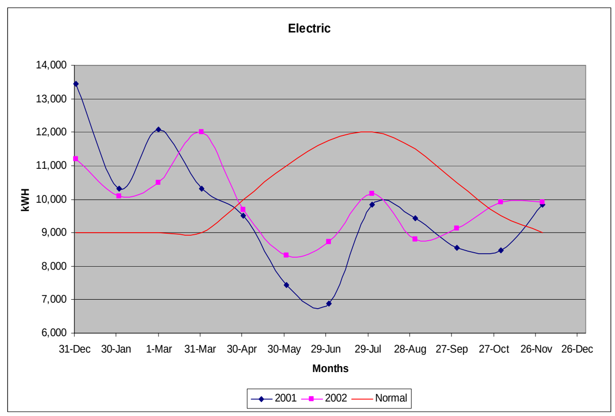
- E^{2}C Home
- Getting Started
- Case Studies
- Resources
- Education
- Recognition
- Grants and Funding
- Energy Toolkit
- Data Management
- ASHE Home

USING MONTHLY DATA TO ASSESS PERFORMANCE AND SET GOALS

Annual Profile of Monthly Data – A Church in Madison Wisconsin



This is an example of an annual profile of monthly data, using two years of gas consumption. Each month is presented on the horizontal axis, and gas usage is plotted on the vertical axis. The gas profile of this building shows, as would be expected, highest gas usage in coldest months, and nearly zero gas usage in summer months, when only domestic hot water heat utilizes gas. Both years presented have nearly identical profiles. This basic profile does not seem to present any opportunities for energy management, or energy conservation measures, and does not have any unusual characteristics.



The slide on the right shows two years of monthly electrical data. The church is electrically cooled, and heated by natural gas. There are no electric heaters in the building. The expected monthly profile is shown as the orange, bell shaped curve. In the expected profile, there is base monthly electrical consumption in cool months, ascribed to lights, fans, office equipment, etc., with higher electrical energy use in summer months, when the air conditioning is added to the base usage.

However, the monthly electric profile for this building does not fit the expected norm, with higher electrical usage in winter and lower electrical usage in summer months. These are unusual and unexpected results. Having observed this unusual performance, a discussion was held with the people who operate and maintain the building, to try to learn the reason for this unexpected performance. It was learned that winter activities include multiple committee meetings every week night, many of which extend until 10:00 p.m. or later. There are virtually no such committee activities in the summer months. Therefore, it is clear that the higher electrical usage in winter months is due to extended hours of lighting in many rooms. The additional lighting energy in winter is greater than summer air conditioning usage.

This analysis makes it clear that future energy conservation and/or renovation of the building should include optimizing the lighting efficiency in all meeting rooms.

ENERGY UTILIZATION INDEX

The Energy Utilization Index (EUI) presents the annual energy use of buildings in a **common denominator** of thousands of BTUs per square foot per year.

EUI = kBTU/sf/yr

(Annual kWh x 3.413) = _____ kBTU
\+ (Annual therms x 100) = _____ kBTU

= Total Annual Energy = _____ kBTU

EUI = Total Annual Energy ÷ sf = kBTU/sf/yr

Example: Lowell Hall, UW-Madison, 1996
(1,209,319 kWh x 3.413) = 4,127,000 kBTU
\+ (83,642 therms x 100) = 8,364,200 kBTU

= Total Annual Energy = 12,491,200 kBTU

EUI = 12,491,200 kBTU ÷ 117,600 sf = 106.2 kBTU/sf/yr

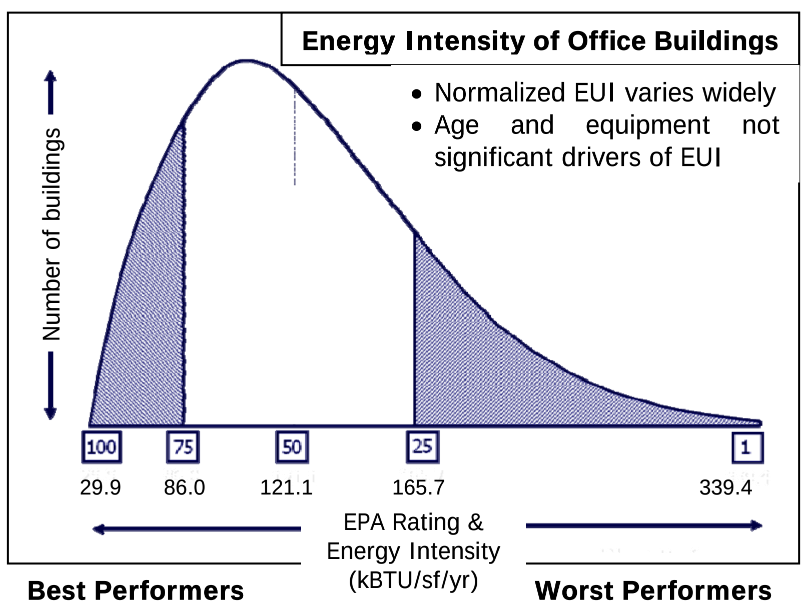
This example shows a typical calculation for electric and gas energy. The annual kWH is multiplied by a factor of 3.413. This results in thousands of BTUs per year. The annual therms of gas consumption are multiplied by 100, which results in thousands of BTUs of gas energy used per year. The sum of these values is the total energy used by the building, expressed in thousands of BTUs per year.

The EUI is then calculated by dividing the total energy use by the gross area of building. The lower portion of this slide is an example of specific arithmetic as applied to a building on the University of Wisconsin campus. The EUI for this particular building in the year 1996, was 106.2 kBTUs per square foot per year. EUI values typically vary between low, or efficient values of 50, to high, or inefficient values of 200, and above.

This example shows the normalized EUI of office buildings in the Energy Star database. Note that the lowest energy users have the highest Energy Star scores. A score of 50 is a median value in the database. The Energy Star database is useful in comparing a building or buildings against national benchmark data.

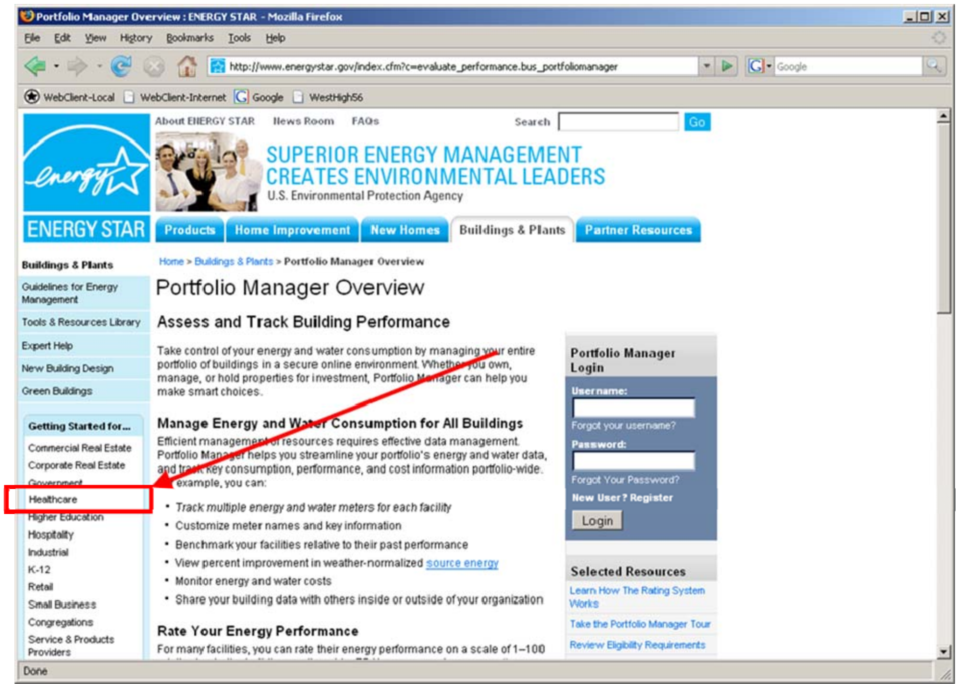
A score of 75 or higher earns **ENERGY STAR** recognition. Such buildings are in the upper 25th percentile of energy users.

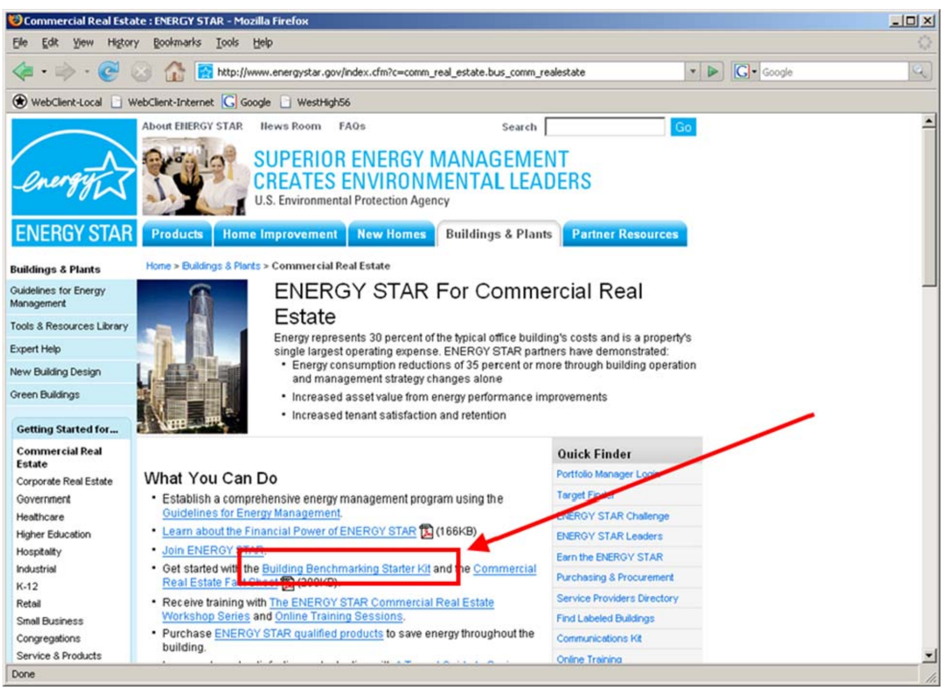
A facility which improves its Energy Star rating by 10 points earns **ENERGY LEADER** recognition.



PORTFOLIO MANAGER

Portfolio Manager, in the Energy Star Website, allows users to enter monthly energy usage, in kWh, therms, etc. The database simultaneously calculates the facility EUI, and develops a normalized Energy Star “score.” Click on http://www.energystar.gov/benchmark :





Using Portfolio Manager as a tool facilitates comparison of multiple buildings and goal setting. ASHE members who provide data to the Portfolio Manager database can elect to share the same data with a growing ASHE database of energy use in healthcare facilities.

A UNIQUE PROCESS USING DAILY DATA

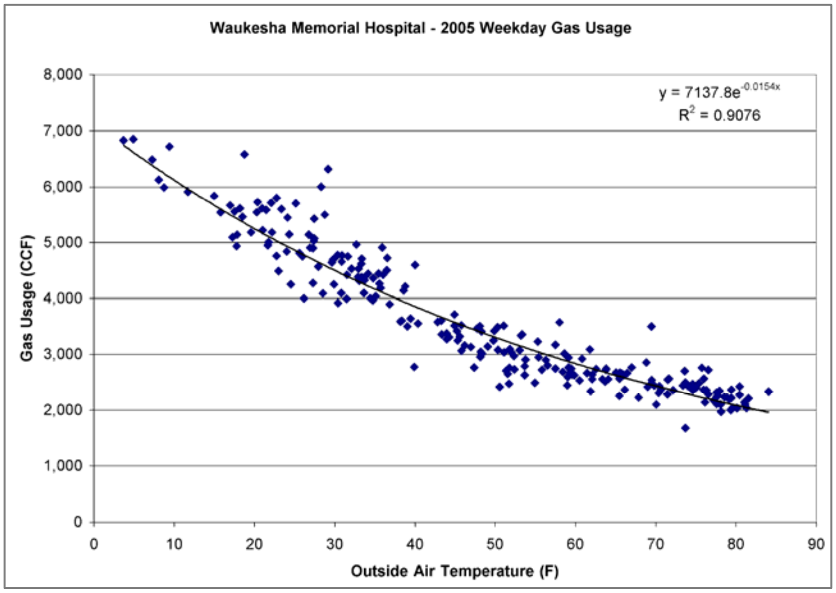


Figure 3

Figure 3 is a plot of daily gas usage versus outside air temperature for a hospital during 2005. The Excel equation for this curve is shown in the upper right hand corner. We also plotted daily KWH in 2005 and arrived at the equation for electric usage. Using the equations, we developed a spreadsheet, and conducted a pilot Energy Management project in 2006, illustrated in Figure 4. Each day's outside air temperature, electric consumption, and gas consumption was recorded. Using the imbedded equations, the spreadsheet predicts gas and electric consumption and calculates the difference between actual and predicted. The building engineer is encouraged to experiment with equipment operation, set points, daily schedules, etc. The spreadsheet provides daily feedback from any changes made. Improvements were made in boiler efficiency, steam pressure, and operating schedules.

As shown in **Figure 4**, gas consumption was reduced 7% in 2006, representing $89,000 cost saving, and a reduction in CO_2 emissions of 530 tons.

Figure 4

Date	OA Temp	OA Dew Point	Actual Boiler CCF	Predicted CCF	Percent	Savings CCF	Actual Electric kWh	Predicted kWh	Percent	Savings kWh
1/1/2006	33.6	33.6	3,958	4,141	95.6%	183	47,958	49,045	97.8%	1,087
1/2/2006	38.6	38.6	3,891	3,939	98.8%	48	49,774	54,578	91.2%	4,804
1/3/2006	38.3	38.3	3,699	3,957	93.5%	258	53,456	54,578	97.9%	1,122
1/4/2006	38.9	38.9	4,189	3,921	106.8%	-268	53,936	54,578	98.8%	642
1/5/2006	34.5	33.3	4,943	4,196	117.8%	-747	54,140	54,578	99.2%	438
1/6/2006	28.3	24.6	4,768	4,616	103.3%	-152	52,441	54,578	96.1%	2,137
1/7/2006	31.5	30.7	4,545	4,273	106.4%	-272	48,884	49,045	99.7%	161
1/8/2006	34.2	33	4,492	4,104	109.4%	-388	48,255	49,045	98.4%	790
1/9/2006	34.1	33.1	4,832	4,222	114.5%	-610	53,642	54,578	98.3%	936
1/10/2006	24.6	23.3	4,303	4,887	88.1%	584	54,025	54,578	99.0%	553
12/21/2006	37.6	35.7	4,323	4,000	108.1%	-323	54,332	54,578	99.5%	246
12/22/2006	42.7	42.3	3,379	3,698	91.4%	319	53,468	54,578	98.0%	1,110
12/23/2006	37.3	35	3,970	3,919	101.3%	-51	48,960	49,045	99.8%	85
12/24/2006	33.6	25.5	3,799	4,141	91.7%	342	48,222	49,045	98.3%	823
12/25/2006	33.8	30.1	3,998	4,241	94.3%	243	47,188	54,578	86.5%	7,390
12/26/2006	29.6	23.5	4,234	4,525	93.6%	291	52,071	54,578	95.4%	2,507
12/27/2006	31.4	24.7	3,741	4,401	85.0%	660	52,698	54,578	96.6%	1,880
12/28/2006	37.6	32.8	3,357	4,000	83.9%	643	53,081	54,578	97.3%	1,497
12/29/2006	38.7	37.1	3,503	3,933	89.1%	430	52,887	54,578	96.9%	1,691
12/30/2006	34.7	33.9	3,236	4,074	79.4%	838	49,211	49,045	100.3%	-166
12/31/2006	43	41	3,243	3,600	90.1%	357	49,071	49,045	100.1%	-26
Totals			**1,168,973**	**1,258,187**	**92.9%**	**89,214**	**21,925,821**	**21,602,617**	**101.5%**	**-323,204**

AN ENERGY MANAGEMENT BREAKTHROUGH

Extra Benefit: After initial changes to improve gas use, the daily data revealed special opportunities for additional savings:

		Gas			Electric			Comment
	Outside Air Temp	Calculated Usage	Actual Usage	Difference	Calculated Usage	Actual Usage	Difference	
Day	Deg F	CCF	CCF	%	kWh	kWh	%	
9/9/2006	61.1	2,749	2,301	83.7	62,238	63,894	102.7	Sat
9/10/2006	61.0	2,753	2,360	85.7	62,137	64,325	103.5	Sun
9/11/2006	60.8	2,799	2,328	83.2	67,354	70,286	104.4	
9/12/2006	64.5	2,644	2,129	80.5	71,048	74,922	105.5	Rained all Day
9/13/2006	60.7	2,803	2,348	83.8	67,255	69,804	103.8	
9/14/2006	62.7	2,718	2,374	87.3	69,251	70,119	101.3	
9/15/2006	65.3	2,610	2,846	109.1	71,886	73,333	102.0	
9/16/2006	69.9	2,410	2,823	117.1	71,141	71,129	100.0	Sat
9/17/2006	72.3	2,325	2,734	117.6	73,558	73,354	99.7	Sun
9/18/2006	59.8	2,842	3,134	110.3	66,346	66,540	100.3	Correct chiller problem
9/19/2006	52.0	3,205	2,345	73.2	58,571	55,413	94.6	Chillers off most of the day
9/20/2006	51.6	3,224	2,394	74.3	58,181	57,429	98.7	
9/21/2006	55.5	3,035	2,393	[illegible]	62,104	61,892	99.7	
9/22/2006	62.0	2,747	2,273	82.7	68,562	69,437	101.3	
9/23/2006	62.1	2,710	2,405	88.8	63,215	65,916	104.3	Sat
9/24/2006	58.1	2,876	2,470	85.9	59,176	60,878	102.9	Sun
9/25/2006	58.1	2,917	2,357	80.8	64,659	62,718	97.0	

Figure 5

This illustrates a few days in mid-September, when gas consumption inexplicably rose from under 100% to over 100% of the baseline year. The building engineer caught the increase after a weekend, and was puzzled, because he was confident that boiler operation and efficiency were unchanged. Note that the average outside temperatures during this time were such that cooling systems were probably utilizing outside air economizer cycles during evening hours and operating one or more large chillers in mid day.

The building engineer learned from his staff that certain cooling set points had been overridden, to minimize the cycling of the chillers. The facility is a hospital, with constant volume reheat air systems. The building engineer reasoned the unexpected gas consumption was the result of excessive cooling, which in turn caused additional reheat energy. Cooling set points were reinstated, and excessive gas consumption ceased.

Note the excessive daily values which triggered this discovery are approximately 300 to 400 ccf each day, in a facility which uses 1,200,000 ccf per year. This is a dramatic illustration of the value of daily, rather than monthly, feedback.

ENERGY MANAGEMENT SUCCESS AT AURORA HEALTHCARE

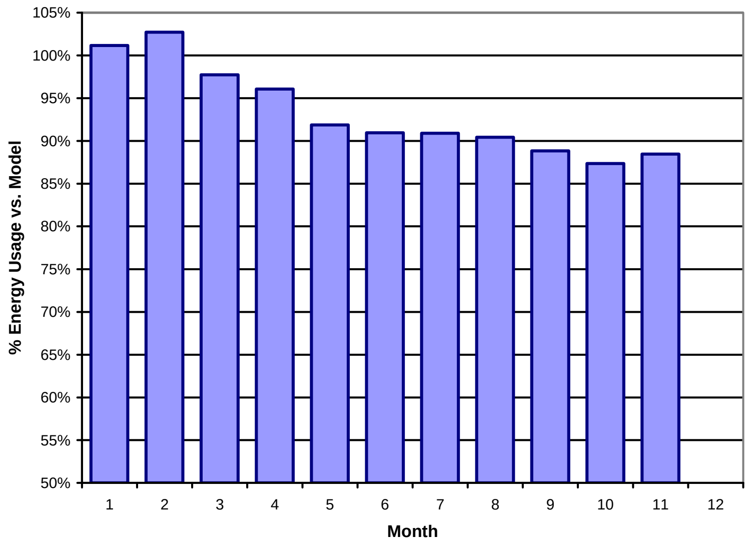


Figure 6

Facility	Sq Ft	2009 Total		
		%	CO2 Diff (lbs)	kBTU/Sq Ft
Baycare Clinic	610,716	101.1%	421,175	273.6
Burlington	265,776	99.4%	(17,962)	178.4
Corporate Building	21,760	84.4%	151,902	170.5
Forest Home	135,000	73.1%	1,820,253	82.0
Hartford	150,000	87.3%	1,017,265	256.5
Heil (Removed Laundry)	173,000	88.6%	1,842,661	251.2
Hospice	31,200	91.6%	119,722	204.0
Kenosha	339,020	99.3%	943,518	201.4
Lakeland	296,280	85.2%	569,396	129.2
Oshkosh	470,000	97.2%	1,385,805	205.0
Psychiatric Hospital	206,074	92.9%	9,145	91.8
Sheboygan	276,000	92.1%	1,134,109	298.6
Sinai Medical Center	858,000	91.8%	4,466,145	225.6
St Luke's	1,600,000	93.0%	7,571,334	229.6
St Luke's South Shore	360,555	93.3%	1,480,687	242.8
Two Rivers	183,500	97.1%	925,209	267.2
West Allis Memorial	848,440	94.9%	2,315,629	277.5
Total	6,825,32	94.0%	26,155,994	227.8

Figure 7

Figures 6 & 7 show the process applied at 17 healthcare facilities (totaling 7 million sq. ft.) during 2009. Each facility utilized the daily spreadsheet to track utility information and outdoor air temperatures. Monthly energy initiative meetings were held to share successful ideas and monthly summaries were distributed to all participants. During this time there were no capital improvements at the facilities, and consulting fees were kept to a minimum. At the end of the year, total energy usage for all 17 facilities had been reduced 6%. This corresponds to a reduction in CO_2 emissions by over 26 million pounds and over $1M in savings, with energy management fees of less than $100,000.

AUTOMATING THE PROCESS

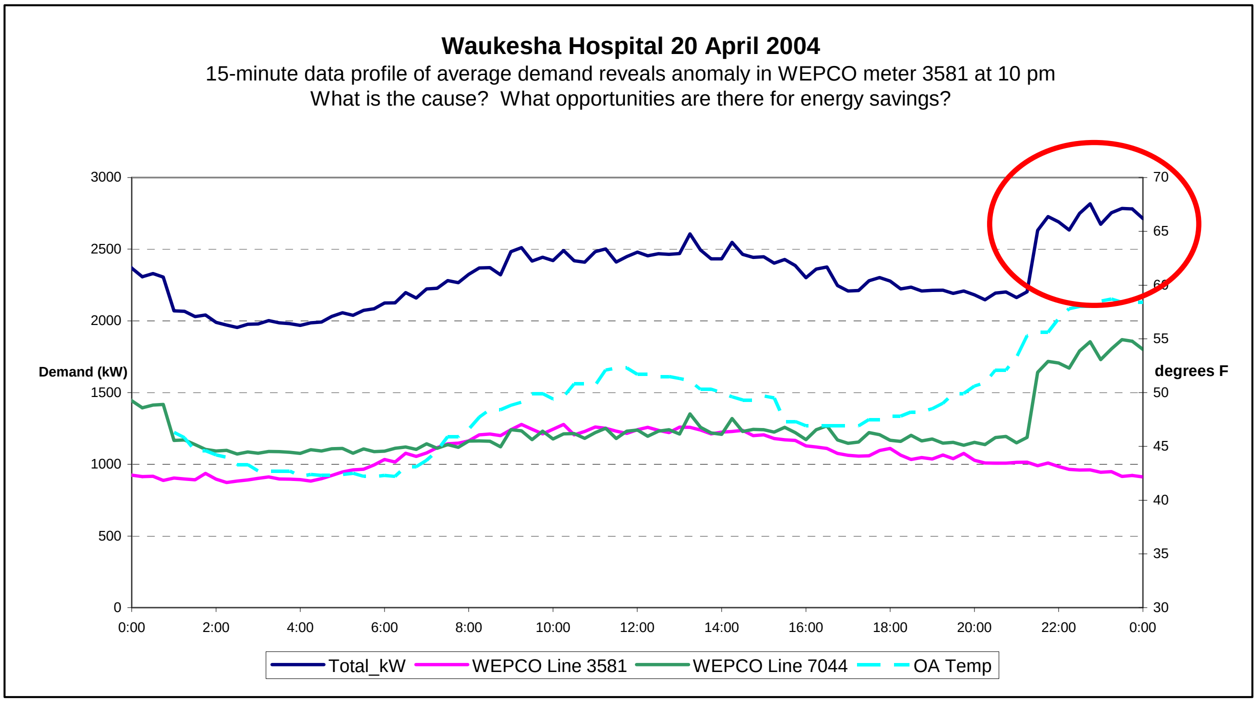
1. The building automation system can automatically input the previous day's average temperature into the database.
2. The database can incorporate the equations for weather-related energy use, calculated from a previous year or years. When plotted against outside temperatures, the data are normalized for variations in outside temperature.
3. Using the equations, the database calculates expected energy usage of the previous day.
4. Using pulse counters on meters, the building automation system can automatically "read" the gas and electric meters and input the previous day's actual usage into the database.
5. The database can automatically calculate the difference between actual energy usage and calculated energy usage, and display % difference.
6. The database can provide an input on "alarm" to the building automation system if actual usage in a given day is higher or lower than the expected range

An automatic routine of this nature will allow the energy manager to avoid a time consuming daily review of building energy performance, but will alert him to unusual performance. The data circled in red on Figure 5 is an illustration of unusual performance in an actual situation. The energy manager was alerted to this performance, and was able to take corrective action within a few days.

THE INCREDIBLE VALUE OF 15-MINUTE (INTERVAL) DATA

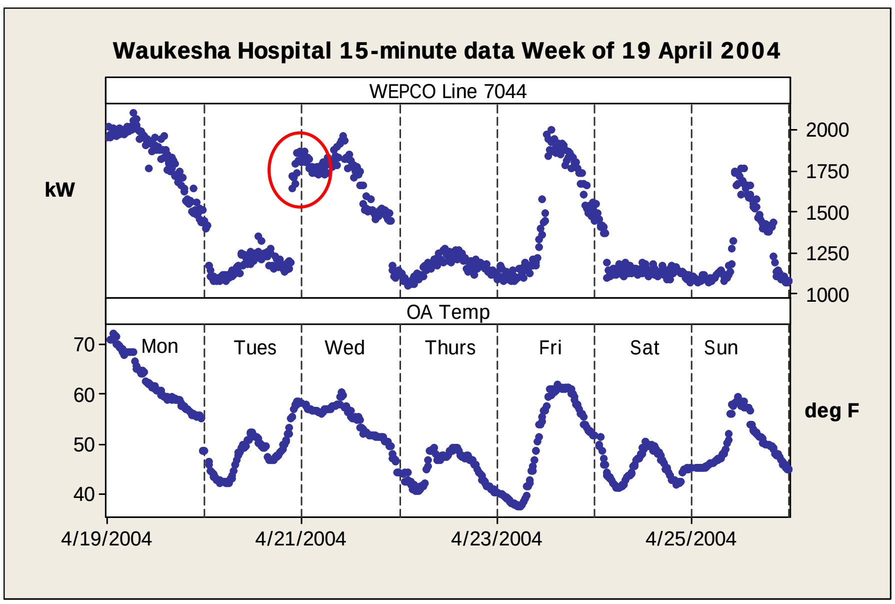
Finding Unusual Patterns: *Waukesha Hospital*

Here's a view of Waukesha Hospital's demand profile for 20 April 2004. You can see the unusual pattern starting at 10 pm. Chillers appear to be cycling on in the evening with the rise in temperature.



Putting patterns in context: Waukesha Hospital

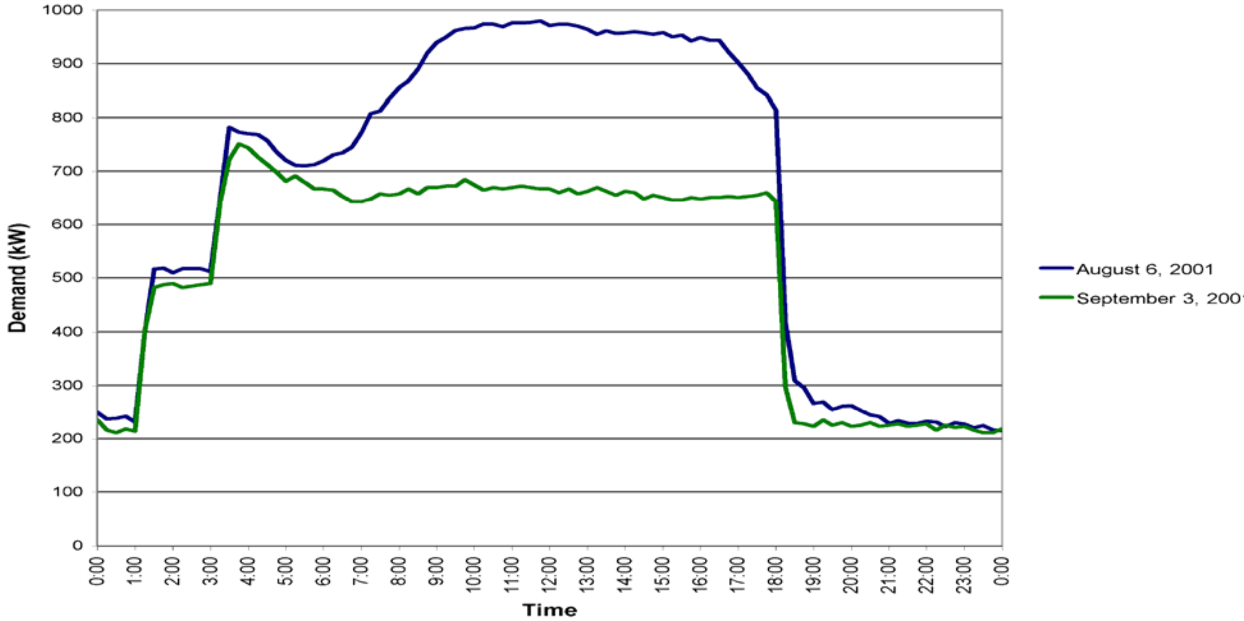
Here's a full week of 15 minute data for Waukesha Hospital, from Monday 19 April through Sunday 25 April. You can see the evening pattern flagged in the previous graph and the direct relationship between the metered data and the outside air temperature, except on Saturday. In this display, we show the 15-minute structure of the data; jumps in power (kW) are evident by the white gaps in the display.



Patterns in the 15-minute data provide you and your energy management consultants with a great foundation for improvement.

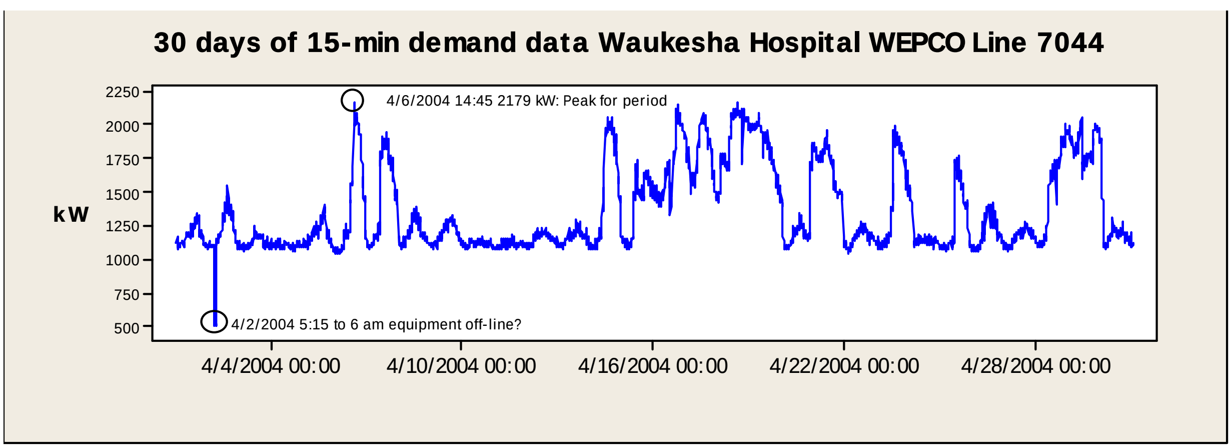
Identifying an incorrect calendar setting: Honolulu office

Labor Day 3 September 2001 should have been set to unoccupied mode but was not. The difference in the two profiles represents the load associated with occupancy: computers, printers, and lights, and cooling load associated with occupancy.



Managing "peak demand" is often a quick way to save money on energy bills. If you can't see the pattern of energy use, it is very difficult to manage peak demand. You need to graph the interval data to gain insight.

Here's a 30-day look at the demand profile for Waukesha hospital:



The peak 15-minute demand was set 2:30 to 2:45 pm on 6 April. The corresponding bill for the 30 day period will have a charge related to the average power during that 15-minute interval, 2179 kWh.

HOW CAN I OBTAIN 15-MINUTE (INTERVAL) DATA?

1. Ask your electric utility—they may already be monitoring your meters. Two typical ways to access data from the utility are through a web-interface or email delivery of spreadsheets.
2. Check your building control system—your meters may already be connected to the control system. If so, you should be able to generate reports—trend logs or graphs of demand and other parameters, like outside air as we did in the Waukesha Hospital example.
3. Install new hardware (and possibly software)

Option	*Advantages*	*Disadvantages*
Connect building meters to your building control system	one vendor to deal with and call for maintenance	Whatever limitations and costs associated with the present building control system
Third-party software to extract and display information from building control system	Displays can be built for web viewing and interaction by staff and specialists; reports can incorporate cost information.	Costs vary depending on the difficulty of extracting information from the building control system. Additional vendor to manage.
Third-party systems to collect and display interval data	Potential flexibility in deployment; installations can be temporary for troubleshooting or permanent. Troubleshooting systems can be stand-alone or PC based; for permanent installations, we recommend web-based solutions	Additional vendor to manage.

Modern electric meters typically can provide a range of parameters (power, power factor, properties of each phase in a three-phase system, etc.) Simple "pulse" technology is often available for electric meters as well as gas and water meters. Pulse technology, with suitable data-loggers and interfaces, provides a way to get started at relatively low cost.

An ideal data system for energy management

An ideal data system for energy management links monthly, daily, and interval data in one place. You can drill down into finer levels of detail to understand patterns at higher levels of aggregation—e.g. unusual patterns in the daily record can be investigated using 15 minute data.

The ideal system should also recognize departures from expected values and send messages and track events in easy-to-understand logs.

Software to Promote Energy Management Accountability

As we have emphasized, management accountability and knowledge of what to do are critical ingredients to energy management. Good data, suitably displayed, are necessary but not sufficient.

To get good results from your energy data, you need to know what to do and then actually take action.

A management action web-application, called Energy Stewards www.energystewards.net has been developed by Rapid Improvement Associates, LLC, www.rapid-improvement.com

The application integrates energy data, action lists, and a journal (web log) to foster communication and transparent accountability. The application is under active development, including a bridge to ENERGY STAR Portfolio Manager.

THE REVERSE ENERGY AUDIT

The process illustrated by the daily monitoring and trial-and-error adjustments at Waukesha Memorial Hospital can be thought of as conducting an Energy Audit "in reverse." The act of reducing steam pressure can be used as an example:

1. Steam pressure was experimentally reduced. The goal was to reduce pressure from over 100 psi to approximately 60 psi, the minimum pressure needed to operate sterilizers.
2. Steam pressure was reduced to 90 psi, resulting in small but immediate savings.
3. One portion of the building did not heat properly when steam pressure was reduced below 90 psi.
4. Examination of the steam distribution system for that portion of the building revealed that a steam pressure reducing rig and steam-to-water heat exchanger both needed to be enlarged, in order to continue reducing steam pressure.
5. The lesson learned in item 4 was, in effect, one portion of an Energy Audit, learned by trial-and-error operation of the steam system.

Thus, the so-called Reverse Energy Audit process utilizes low-cost actions to decrease utility costs, while simultaneously discovering certain needs for capital improvements. This leads to future in-depth audits and capital improvements. This so-called reverse process results in the most desirable cash flow for the owner, since initial savings can be used to fund future, more in-depth activities.

WHERE DO I START SAVING ENERGY?

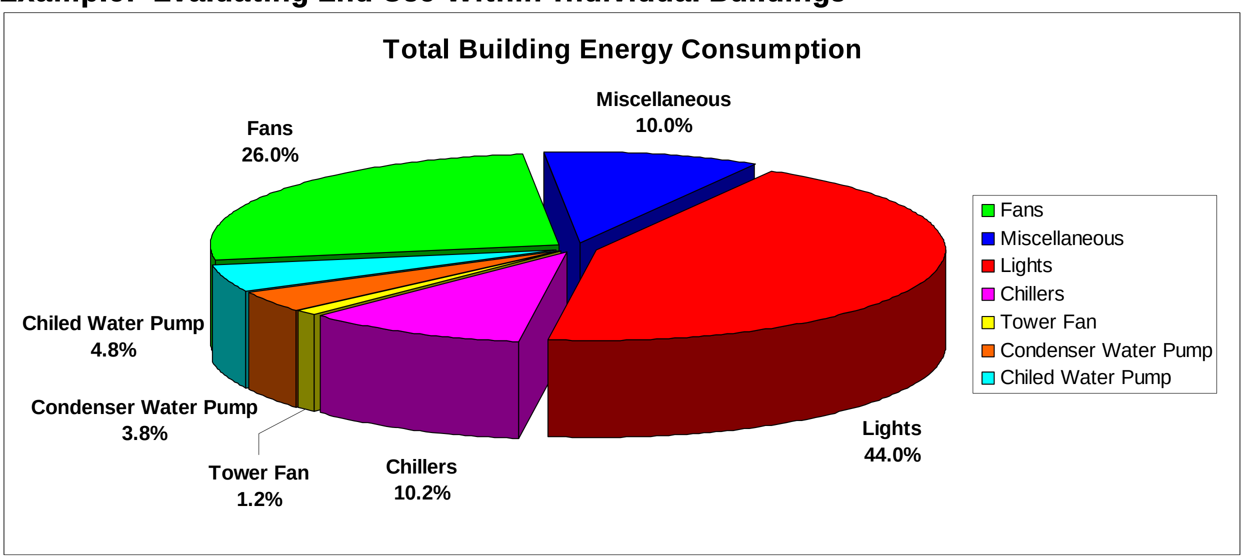
Example: Evaluating Multiple Buildings

Site	SF	Zone	Type	ECI	EUI	Current $
601-Tysons Corner	39,463	4	Homestore	$3.01	193	$118,823
510-Mission Viejo	12,895	4	Housewares	$6.10	177	$78,685
503-Fashion Valley	14,510	4	Housewares	$6.66	177	$96,579
412-Roseville	34,372	4	Homestore	$4.13	176	$142,059
851-Lenox	36,919	4	Homestore	$3.21	175	$118,325
855-Alpharetta	29,282	4	Homestore	$2.52	156	$73,674
511-South Coast II	36,417	4	Homestore	$6.02	154	$219,158
402-Corte Madera	11,632	4	Housewares	$6.29	142	$73,119
404 a - Santana Row	38,017	4	Homestore	$5.96	140	$226,467
507-University Town Centre	12,678	4	Housewares	$5.33	137	$67,561
406-Walnut Creek	37,552	4	Homestore	$6.16	129	$231,358
505-Pasadena	38,566	4	Homestore	$4.26	128	$164,175
506-Topanga Plaza	14,262	4	Housewares	$3.11	121	$44,383
860-Crabtree Valley	13,305	4	Housewares	$1.86	115	$24,761
411-Union Square Furniture	43,167	4	Homestore	$4.91	114	$211,820
502-Century City(Closed)	14,200	4	Housewares	$2.10	79	$29,763
407-Hillsdale	15,238	4	Housewares	$3.24	71	$49,341
403-Palo Alto	38,920	4	Homestore	$0.86	40	$33,588

This illustration is an example of 18 retail facilities, within one climate zone. Each facility is marketing a very similar product, which requires very high lighting intensity. Each facility has nearly identical hours of operation, and all of them are located in United States climate zone 4.

The utility data on this slide are sorted by EUI. The 2nd column from the right presents EUI values from highest to lowest. Note the extreme variance in buildings which should be very similar in energy usage, from 193 kBTUs per square foot per year down to 40 kBTUs per square foot per year. Already in this initial sort of energy data, it becomes clear that certain facilities should be the target of additional evaluation.

Example: Evaluating End Use Within Individual Buildings



A detailed breakdown of "end use" energy, as illustrated above, is only possible when conducting a detailed Energy Audit. However, it is possible to obtain some of the above data using trend logs from a building automation system, or even portable data loggers. Using trend logs or data loggers, it is possible to isolate systems and equipment which have unusual or unexpected operating hours and to focus on them first in energy saving activities.

SAMPLE DISCRETIONARY ACTION PLANS

Lighting

- Match operating hours to activities
- Take advantage of daylight
- Check delays on Occupancy Sensors
- Assure appropriate foot-candles (lumens)

Fans

- Match running time to activities
- Lower hot air temperatures
- Raise cold air temperatures
- Lower fan pressure in ducts
- Adjust static pressure set point:
    - Manual reset
    - Dynamic reset using damper positions
- Minimize outside air quantities
- Minimize exhaust quantities
- Match ventilation to number of occupants
- De-energize exhaust fans and close dampers when unoccupied
- Make best use of economizer operation
- Eliminate simultaneous heating and cooling
- Reduce airflow in constant volume (CV) systems
- De-energize non-essential loads

Pumps

- Match running time to activities
- Verify proper flow
    - Throttle balance valves
    - Trim pump impeller
- Lower pressure set point to optimize variable flow
    - Manual reset
    - Dynamic reset
- De-energize nonessential loads

Boilers

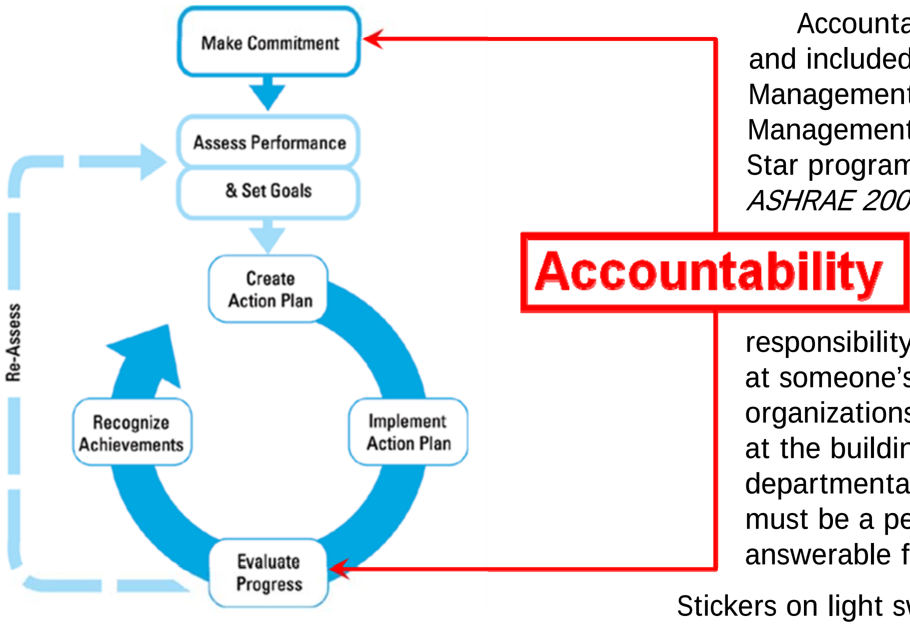
- Lower hot water temperatures
- If steam, lower steam pressure
- Optimize boiler sequencing
- Minimize losses in de-energized boilers

Chillers

- Match running time to activities
- Raise chilled water set points
- Reduce condenser water temperature
- Optimize cooling tower fan speed
- Optimize chiller staging
- Minimize chiller cycling
- Reduce chilled water speed

Additional action items may be found in Chapter 35, *ASHRAE 2007 Handbook* "Energy Use and Management"
Refer to pages 35.11, 13-14

ACCOUNTABILITY – A MANAGEMENT CHALLENGE



Accountability must be developed and included in a successful Energy Management program. The Energy Management Guidelines in the Energy Star program and in Chapter 35 of the *ASHRAE 2007 Guidebook* both hint at accountability. However, the best-planned programs will fail unless responsibility for proven results is laid at someone's feet. In larger organizations, accountability may begin at the building level, or the departmental level, but in the end there must be a person who is clearly answerable for the results.

Stickers on light switches will not suffice. Consider the actions of Jerry Eaton, when he became Energy Manager of Mercury Marine, a manufacturing and sales organization with multiple facilities across the US, and a multimillion dollar utility bill. Jerry learned that the cost of energy was a corporate overhead item. He also learned that stickers on light switches had not shown any obvious impact on utility cost or consumption.

Jerry embarked on parallel activities:

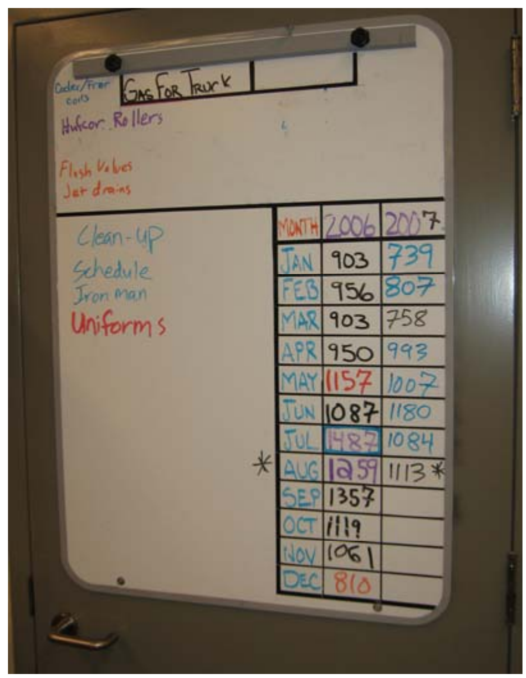
1. Finding waste and inefficiencies
2. Finding ways to be more efficient
3. Developing a significant sub-metering program
4. Developing procedures to monitor the meters on a regular basis
5. Developing a corporate-wide chain of accountability, beginning with buildings (each with a meter), departments within buildings (each with a meter), but in all cases ending with a person in each location who is responsible for proven results.
6. Developing an accountability process in which results are reviewed and discussed on a regular basis. In this context, "regular basis" is not defined as every 12 months. That feedback interval is too long. A monthly interval is reasonably functional, but some type of weekly review has proven to be very effective.

This leads to a discussion of the cost of meters and sub-meters. Meters by themselves do not save anything. There is no direct payback on the purchase of a meter. On that basis, they can't be justified as an investment. However, every effective energy manager has stated, "I can't manage it if I can't measure it." A silly analogy would be to try to determine the payback of a desk and a chair for the energy manager. On the positive side, measurement technology is continuously improving, and becoming more affordable. There is certainly more than one way to develop measurements which are useful in an Energy Management program. Creative thinking and competitive bidding can produce surprising results. One Big Ten campus has described to me, in some detail, a campus-wide metering program which cost $1 million to put in place. A similar size Big Ten campus has stated that metering the campus is unaffordable, since it would cost $12 million.

When Jerry Eaton at Mercury Marine began to have all the above steps in place, the cost of energy ceased to be an overhead item. Buildings and departments learned that their annual budgets had increased by approximately the amount of the cost of energy attributable to each entity. Energy teams were developed in each entity, coordinated by the Energy Manager. The "buck" stops at one person in each entity, who receives regular data from ongoing monitoring and measuring performed by the Energy Manager.

The results at Mercury marine took several years to develop, and have been spectacular, literally producing annual savings of over $1 million, and clearly producing an excellent return on investment for the corporation.

On the other end of the spectrum, consider the success story of Monona Terrace, a medium-sized convention center in Madison, Wisconsin. There is no official position on the staff of Energy Manager. There are no sub-meters, but they are not needed, since the building meters are completely suitable for tracking performance of the facility.



Each week, Jeff Griffith, the building maintenance supervisor, reads his meters and reviews consumption and peak demand with the maintenance staff. They have all participated in retro-commissioning and fine tuning all the systems in the building. They regularly discuss last week's events and upcoming events, with an eye toward minimizing energy usage without compromising the necessary customer functions. The back of the door where tools and uniforms are kept contains a white board with a running comparison of one aspect of energy cost (peak demand). Everyone feels accountable all the time.

Over the period of time during which Jeff has had this program in place, convention activity at Monona Terrace has nearly doubled with virtually no increase in energy consumption. Jeff has achieved this success with virtually no capital improvements.

Some aspects of the Mercury Marine program apply to many organizations. The personal, regular attention of Jeff Griffith's program applies to every organization which desires to achieve successful energy management.

Some organizations have found ways to tie success to various perks or bonuses. However, the most important aspect of accountability seems to be regular attention in a team-oriented atmosphere.

REMEMBER TO MONITOR!!

Buildings are like little children. You can program them to do what they should do. However, when you turn your back on them, they do very unpredictable things.

About the Speaker

Much of Dick Pearson's career has been spent in hands-on analysis of the actual operation of HVAC systems in healthcare facilities. He has been awarded the membership grade of Fellow for his pioneering work with building automation systems, and has received the Distinguished Service Award from ASHRAE. In ASHRAE, he has been Chairman of the Energy Management Committee, and has served on the Board of Directors, as well as serving on the Finance, Professional Development, TC 7.6, and Environmental Health committees, and the Technology Council.

Mr. Pearson is a principal contributor to an ASHRAE publication "Procedures for Commercial Building Energy Audits" (2004). He is also a co-author of the Energy Management Chapter (34) in the 1999 ASHRAE Handbook. He is co-author of "Homeowner's Guide to Energy Decisions," and has published a paper in ASHRAE Transactions on practical applications of rotary air-to-air heat exchangers. Dick is an ASHRAE "Distinguished Lecturer," available to make an Energy Management presentation to ASHRAE chapters throughout the country.

Pearson is a regular presenter at professional development courses at the University of Wisconsin and elsewhere on subjects related to Energy Audits, HVAC design, energy management, system analysis, and renovation of buildings.

He is a member of the National Register of Peer Professionals, and has been selected by the Chief Architect of the General Services Administration to conduct peer reviews of GSA design projects for courthouses and similar projects.

Significant Energy Efficiency projects have included optimizing 7,000-ton and 3,000-ton chiller plants in hospitals, tracking a $3.6 million utility bill, renovation of a 30-story art deco hotel, commissioning of eight thermal storage projects, and energy analysis for eleven buildings at a USMC base in Japan.

Mr. Pearson's awards include First Place, Commercial Buildings, in the ASHRAE Region VI Energy Awards Program; First Place, Commercial Buildings, in the Illinois Chapter Energy Awards Program; Technology Award from ASHRAE Region VI; Excellence in Engineering Award from the Illinois Chapter of ASHRAE; and Distinguished Service Citation from the University of Wisconsin College of Engineering.