Practical Energy Tips for Energy Savings in HVAC Systems:
Down to Earth Sustainability

ASHRAE TC 7.6

Richard J. Pearson, P.E.
ASHRAE Fellow and Distinguished Lecturer

December 15, 2011

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Learning Objectives

- Recognize the environmental and economic impacts of energy management
- Assess building energy performance and set energy usage goals
- Create an action plan for saving energy
- Prioritize multiple building projects
- Define accountability for a building's ongoing energy management

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Sustaining our Future by Rebuilding our Past

"Energy Efficiency in Existing Buildings is Our Greatest Opportunity for a Sustainable Future"

Gordon Holness, ASHRAE Presidential Member

Our Greatest Opportunities

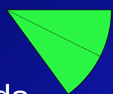
86% of Construction Dollars go into Existing Buildings

75% to 80% of All Buildings that will Exist in 2030

Exist Today!

Energy Management Potential

Building Reduction 33%



National Reduction 14%

In Other Words……

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

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

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Greener Pastures with Energy Savings

Emissions Reduction at Madison Area Technical College

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**	**Reduction!**
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

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GSA
Energy Management Program

US Courthouse

Jacksonville, Florida

Constructed in 2005

Disappointing Energy Use

DOE-ORNL Report

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2005 New Building Performance

- Floor area: 492,000 ft^2
- EUI: 83 kBtu/SF predicted to be 45 kBtu/SF
- Energy Star rating: 41 predicted to be 79
- Utility costs: $664,000/year predicted to be $220,000/yr
- Far less efficient than design intent

More on this building later…

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Energy Management Strategies

- Do Nothing
- Price Shopping
- Occasional O&M Projects
- Capital Projects
- **Sustained Energy Management**

Christopher Russel
www.energypathfinder.com

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Energy Management 101

- Management commitment
- Manual daily meter reading
- Operational changes only
- 33% energy savings in 12 months

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Energy Management 101
The Building

20-Story Office Building:

- 200,000 ft^2
- 5 years old, no energy conservation
- Complex, energy intensive HVAC systems
- High utility bills
- No building automation system

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Energy Management 101
How It Worked

Actions by Facility Manager:

- Reviewed possible operational improvements with building engineer and design engineer
- Read meters daily
- Obtained previous day's weather data
- Harassed/complimented building engineer daily

Savings in one year: 33%!

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Energy Star Guidelines for Energy Management

www.energystar.gov

Accountability

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Energy Star Guidelines for Energy Management

www.energystar.gov

Accountability

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Make Commitment

Top Management Commits to Continuous Improvement

The common element of successful energy management is commitment.

- Form a Dedicated Team
- Institute an Energy Policy

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Energy Manager Job Description

Chapter 36, ASHRAE 2011 Handbook "Energy Use and Management"

- Functions
  - Technical
  - Policy-related
  - Planning and purchasing
- Qualifications
  - General
  - Educational/Professional

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Job Description - Purchasing

- Lower-cost energy
- Other non-building utilities
  - Vehicle fuel
  - Water

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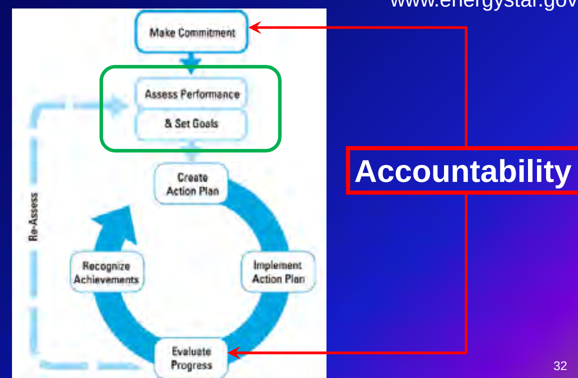
Energy Star Guidelines for Energy Management

www.energystar.gov



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Assess Performance & Set Goals

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Assess Performance & Set Goals

- **Annual Usage**
  - **Energy Cost Index (ECI)**
  - **Energy Utilization Index (EUI)**
- Annual Profile of Monthly Data
- Daily Profile of 15-Minute Data

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Indices

ECI: Energy Cost Index = $/SF/yr

EUI: Energy Utilization Index = 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, 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

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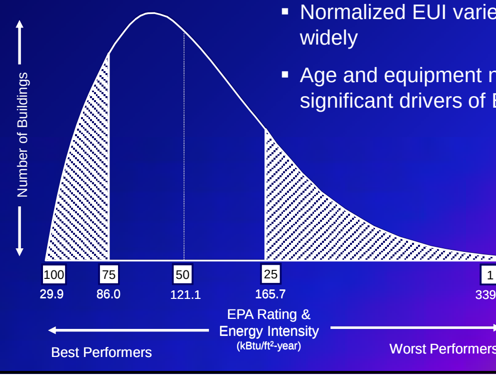
Energy Intensity of Office Buildings

www.energystar.gov

- Normalized EUI varies widely
- Age and equipment not significant drivers of EUI



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Energy Star Benchmarking

www.energystar.gov/benchmark

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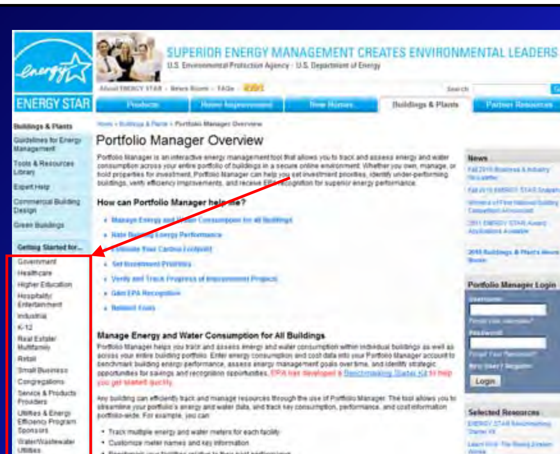

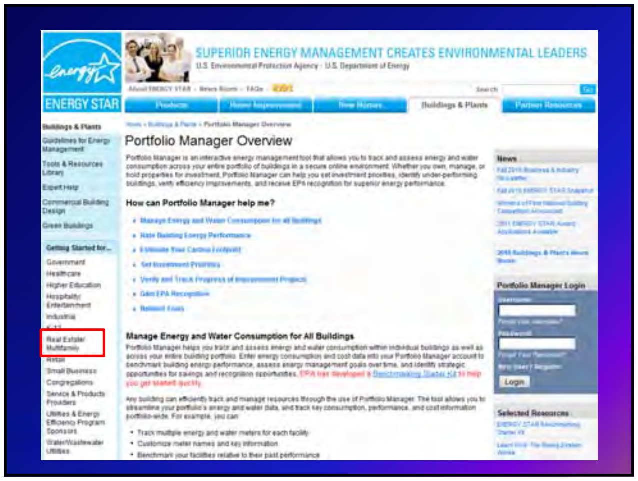
SUPERIOR ENERGY MANAGEMENT CREATES ENVIRONMENTAL LEADERS
ENERGY STAR
Portfolio Manager Overview
How can Portfolio Manager help me?
Manage Energy and Water Consumption for All Buildings


THE NATIONAL BUILDING COMPETITION
And the Winner is...
ENERGY STAR
ENERGY STAR for Real Estate/Multifamily Housing
What You Can Do
Learn more about ENERGY STAR for:
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THE NATIONAL BUILDING COMPETITION
And the Winner is...
ENERGY STAR
ENERGY STAR For Commercial Real Estate
What You Can Do
What Others Are Doing
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SUPERIOR ENERGY MANAGEMENT CREATES ENVIRONMENTAL LEADERS
ENERGY STAR
Commercial and Corporate Real Estate Benchmarking Starter Kit
Get Started
Collect Data
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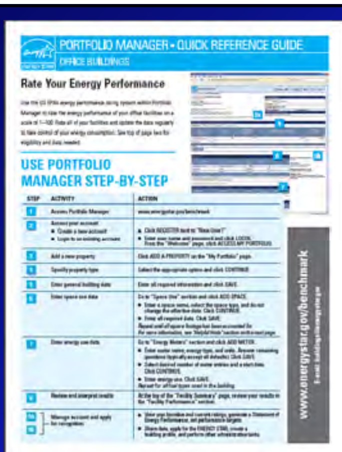

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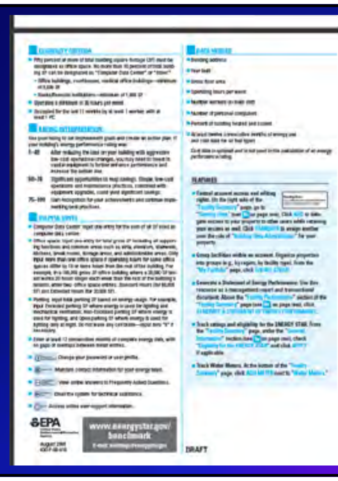

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Energy Star Portfolio Facility Summary

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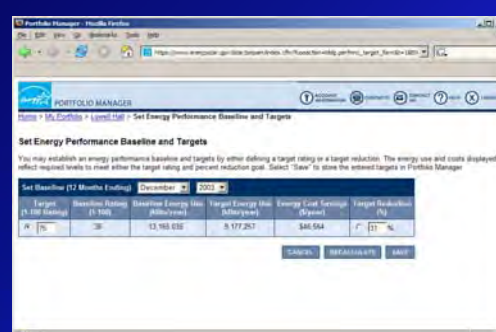
Target Page in Portfolio Manager http://www.energystar.gov/benchmark



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Assess Performance & Set Goals

- Annual Usage
  - Energy Cost Index (ECI)
  - Energy Utilization Index (EUI)
- **Annual Profile of Monthly Data**
- Daily Profile of 15-Minute Data

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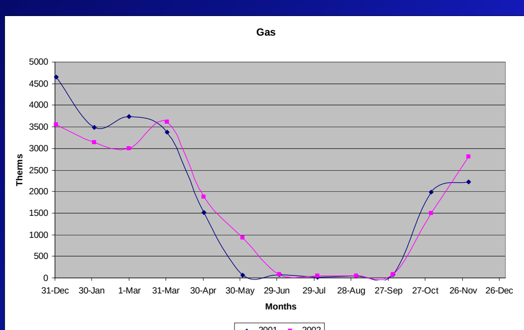
Annual Profile of Monthly Data

Madison Church



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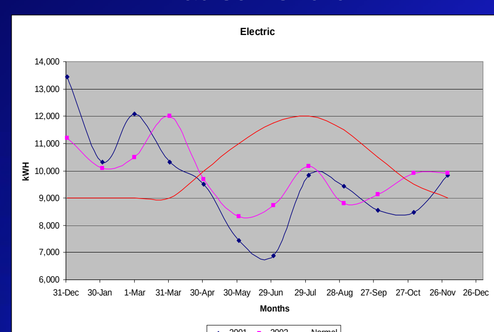
Annual Profile of Monthly Data

Madison Church



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Assess Performance & Set Goals

- Annual Usage
  - Energy Cost Index (ECI)
  - Energy Utilization Index (EUI)
- Annual Profile of Monthly Data
- **Daily Profile of 15-Minute Data**

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Honolulu Office Building: Using 15-Minute Data to Identify Opportunities

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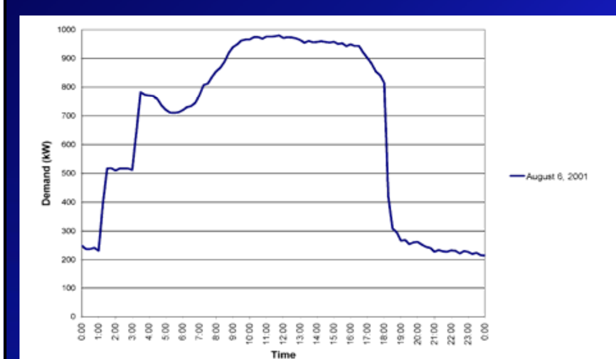
Daily Profile of 15-Minute Data



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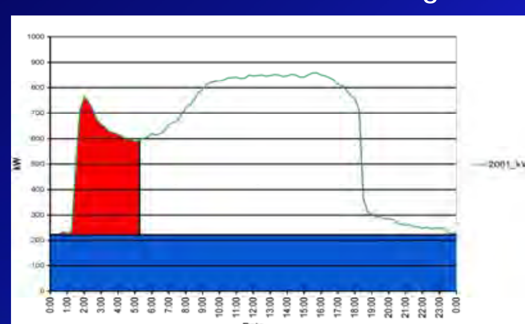
Daily Profile of 15-Minute Data
Honolulu Office Building



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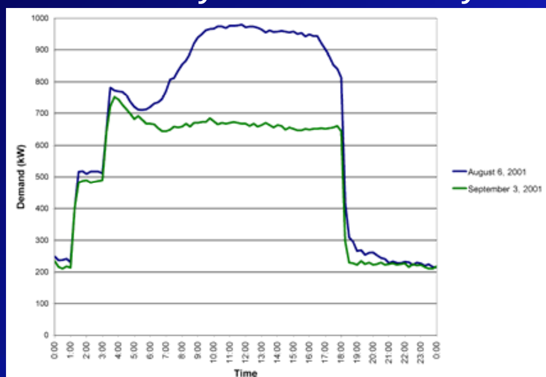
Monday versus Holiday



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Energy Star Guidelines for Energy Management

www.energystar.gov

Accountability

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Create Action Plan

Where Do I Start Saving Energy?

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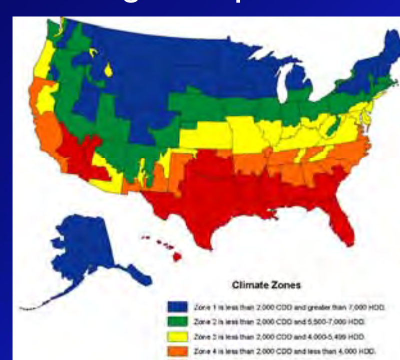
Prioritizing Multiple Buildings



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Action Plan:
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	EMS
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	EMS
507-University Town Centre	12,678	4	Housewares	$5.33	137	$67,561	
406-Walnut Creek	37552	4	Homestore	6.161	129	231357.872	
505-Pasadena	38566	4	Homestore	4.257	128	164175.462	
506-Topanga Plaza	14262	4	Housewares	3.112	121	44383.344	
860-Crabtree Valley	13,305	4	Housewares	$1.86	115	$24,761	Target
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	

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Action Plan:
Evaluating Multiple Buildings

Site	SF	Zone	Type	ECI	EUI	Current $	New $	Savings	
601-Tysons Corner	39,463	4	Homestore	$3.01	193	$118,823	$70,678	$48,146	
510-Mission Viejo	12,895	4	Housewares	$6.10	177	$78,685	$51,093	$27,592	
503-Fashion Valley	14,510	4	Housewares	$6.66	177	$96,579	$62,924	$33,655	
412-Roseville	34,372	4	Homestore	$4.13	176	$142,059	$92,740	$49,320	
851-Lenox	36,919	4	Homestore	$3.21	175	$118,325	$77,619	$40,707	
855-Alpharetta	29,282	4	Homestore	$2.52	156	$73,674	$54,176	$19,498	EMS
511-South Coast II	36,417	4	Homestore	$6.02	154	$219,158	$164,146	$55,012	
402-Corte Madera	11,632	4	Housewares	$6.29	142	$73,119	$59,252	$13,867	
404 a - Santana Row	38,017	4	Homestore	$5.96	140	$226,467	$185,686	$40,781	EMS
507-University Town Centre	12,678	4	Housewares	$5.33	137	$67,561	$56,700	$10,861	
406-Walnut Creek	37,552	4	Homestore	$6.16	129	$231,358		$339,438	
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	Target		
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			
						$2,003,639			

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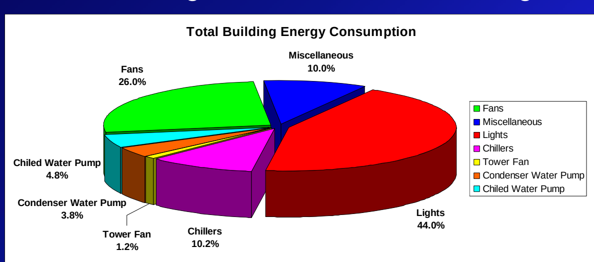
Action Plan:
Evaluating End-Use Within a Building



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End-Use Evaluation

Use trend logs or portable data-loggers
- Runtime
- Temperature fluctuations
- Electrical use
  - Amps
  - kWh

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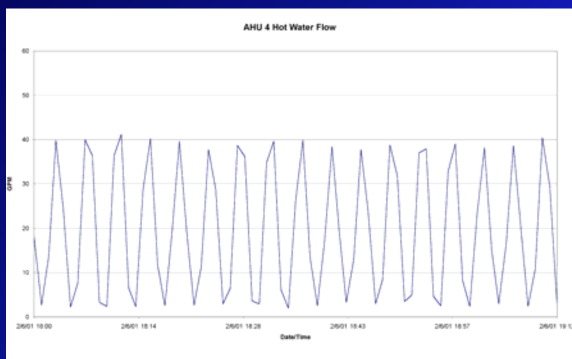

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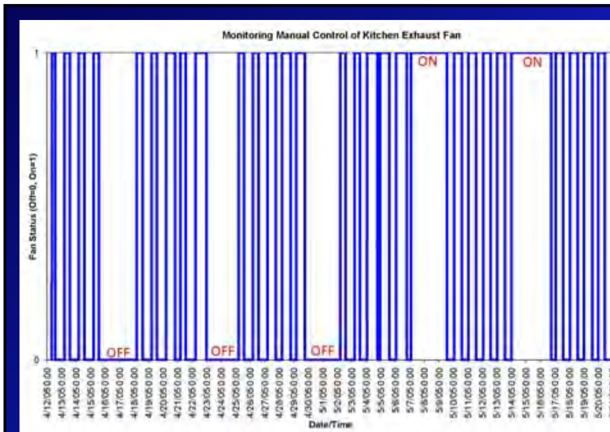

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Office Temperature/RH - Verex

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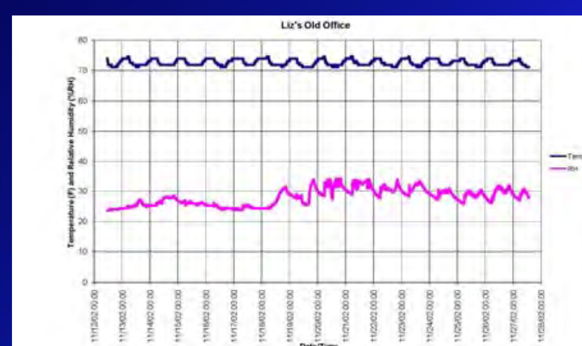
Office Temperature/RH - Verex



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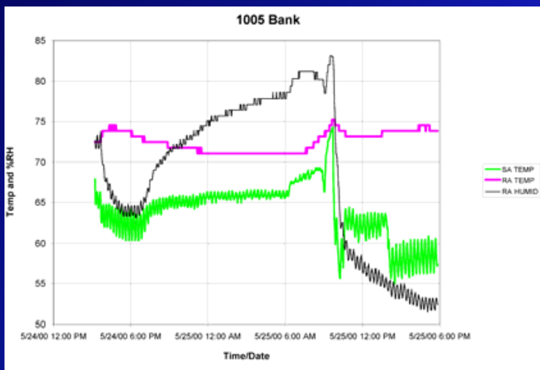
Bank Temperature/RH



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Two Types of Action

- Discretionary Facility Operation
- Energy Audits and Capital Improvements

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BREAK!

Wisconsin's Focus on Energy

Best Practices Spreadsheets

- **Air Handlers**
- **Boilers**
- **Chillers**
- **Cooking**
- **Domestic Hot Water**
- **HVAC**
- **Lighting**
- **Misc. Equipment**
- **Refrigeration**

Available for download at:

http://www.focusonenergy.com/business/commercial-business/cpem/sixsteps.aspx

Air-Handlers Best Practices

- Install Variable Speed Controls on Air Handler Supply Fan
- Convert Air Handling system from Constant Volume to Variable Air Flow
- Convert Dual Duct or Multizone Air Handling System to Variable Air Flow
- Install Premium Efficiency Motors
- Install High Efficiency AC Units or RTUs
- Reduce Outside Air Intake
- Install Night Setback Controls (Heating season)
- Install Night Set Up Controls (Cooling season)

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Air-Handlers Best Practices

Variable Speed Drive on an Air Handler

Converting an air handler from one type of control (constant volume to variable air volume) can save heating, cooling and fan energy. Fan energy savings only are calculated by this spreadsheet.

The heating and cooling energy savings are very dependent on type of air handling system, and how the system is operated. Therefore, those savings are not reflected in this spreadsheet.

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Air-Handlers Best Practices

Install Variable Speed Controls on Supply Fan

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Air-Handlers Best Practices

Premium Efficiency Motors

Premium efficiency motors will generally require a larger up-front investment. However, the incremental cost can usually be recovered in less than 2 years. Additionally, it is typically less expensive to purchase equipment with the premium efficiency component already installed than it would be to retrofit the equipment at a later time.

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Air-Handlers Best Practices

Existing Motor	Sample	Motor 1
Motor Horsepower	10.0	10.0
Existing Motor Eff	87.2%	87.2%
% Full Load	83.0%	83.0%
Annual Operation Hours	2,500	2,500
Conversion Factor	0.746	0.746
kW	5.6	5.6
kWh/yr	13,903	13,903
Average kWh Rate	$0.080	$0.080
Annual Energy Cost	$1,112	$1,112
PROPOSED		
Motor Efficiency	91.7%	91.7%
Conversion Factor	0.746	0.746
kW	5.3	5.3
kWh/yr	13,220	13,220
Annual Energy Cost	$1,058	$1,058
SAVINGS		
kW	0.3	0.3
kWh/yr	683	683
Annual Cost Savings	$55	$54.64
Project cost Estimate	$80	$80
Incentive	$0	$72
Simple Payback	1.1	0.7

Install Premium Efficiency Motors

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Air-Handlers Best Practices

Outside Air Reduction

Air handling units serve several functions including space heating, cooling and ventilation. Facility ventilation is generally accomplished by bringing in outside air, mixing it with "return air" at the air handler, and distributing the resulting "mixed air" throughout the facility. Bringing in outside air increases energy consumption during most times of year because the outside air needs to be conditioned. Therefore, it is important to make sure the correct amount of outside air is being supplied to the facility only when needed. Outside air is needed when the facility is occupied, or when large exhaust systems are being operated. The calculations below estimate gas savings associated with an outside air reduction. If the facility is cooled, and/or the ahu fans are shut down during times of reduced ventilation, then there will also be electrical savings.

Dick's Tips

1. Turn off unneeded exhaust fans
2. Do not open O.A. dampers until occupancy

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Air-Handlers Best Practices

EXISTING	Example	System 1
CFM of Outside Air	3,000	3,000
AHU Motor Size (hp)	5	5
AHU Motor Efficiency	87.5%	87.5%
AHU Motor Load Factor	65%	65%
Hrs/Wk OA is Supplied	45.0	45.0
Wks/Yr OA is Supplied	50	50
Heating Balance Point (F)	[illegible]	[illegible]
Heating Degree Hours	[illegible]	148,282
Heating System Efficiency	[illegible]	80.0%
Is the facility cooled?	Yes	Yes
Cooling Balance Point	65	65
Cooling Degree Hours	[illegible]	12,840
EER of Cooling System	10.2	10.2
Conversion Factor	100,000	100,000
Avg Gas Use (th/yr)	[illegible]	1,485
Average therm Rate	[illegible]	[illegible]
kWh/yr	[illegible]	[illegible]
Average kWh Rate	[illegible]	[illegible]
Annual Energy Cost	[illegible]	[illegible]
PROPOSED		
CFM of Outside Air	[illegible]	600
Hrs/Wk OA is Supplied	37.5	37.5
Wks/Yr OA is Supplied	50	50
Avg Gas Use (th/yr)	248	248
kWh/yr	[illegible]	[illegible]
Annual Energy Cost	[illegible]	[illegible]
SAVINGS		
th/yr	1,237	1,237
kWh/yr	[illegible]	[illegible]
Annual Cost Savings	[illegible]	[illegible]
Project cost Estimate	$0	[illegible]
Incentive	$0	[illegible]
Simple Payback	Immediate	0.3

Reduce Outside Air Intake

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Air-Handlers Best Practices

Install Night Setback (heating) and Night Set Up (cooling) Controls

Setback Controls

Setback controls reduce the space temperature of an area during unoccupied hours. Reducing the temperature means less heat is lost to the outside through walls, roofs and air infiltration. Setback controls may be part of a facility wide energy management system, or separate programmable thermostats may be used. Some setback controls employ "smart" features which determine when to start heating a building to make sure it is warm when occupancy starts. These "smart" controls look at both the outside air temperature and inside air temperature. Costs on controls can range from as low as $40 for a programmable thermostat, to hundred's of thousands of dollars for complete energy management systems for facilities with multiple buildings.

Setup Controls

Set-Up controls allow the space temperature to float upward during unoccupied hours. Increasing the temperature means less heat needs to be removed from the building. Set-Up controls may be part of a facility wide energy management system, or separate programmable thermostats may be used. Some controls employ "smart" features which determine when to start cooling a building to make sure it is at the correct temperature when occupancy starts. These "smart" controls look at both the outside air temperature and inside air temperature. Costs of controls can range from as low as $40 for a programmable thermostat, to hundred's of thousands of dollars for complete energy management systems for facilities with multiple buildings. If the facility is assessed a demand charge, the setback period should end at least 15 minutes before the utility on-peak period.

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Air-Handlers Best Practices

Install Night Setback (heating) and Night Set Up (cooling) Controls

	Example	Area 1
EXISTING		
Square Footage	30,000	10,000
Therms per year	15,000	9,500
Average therm Rate	$0.950	$0.950
Annual Energy Cost	$14,250	$9,025
PROPOSED		
Degrees of Temperature Setback	10	10
Hours per week of Setback	108	108
Constant - total hours per week	168	168
Adjustment factor	0.45	0.45
Average Winter temperature difference	35	35
Percent Reduction	8.3%	8.3%
Average therm/Yr Use	13,759	8,714
Annual Energy Cost	$13,071	$8,278
SAVINGS		
th/yr	1,241	786
Annual Cost Savings	$1,179	$747
Project cost Estimate	$3,000	$3,000
Incentive	$0	$752
Simple Payback	2.5	3.0

	Example	Area 1
EXISTING		
Square Footage	30,000	30,000
Closest City	Madison	Madison
Cooling Balance Point (F)	60	55
Cooling Degree Days	950	1,569
Cooling kWh/yr	15,000	15,000
Average kWh Rate	$0.080	$0.080
Annual Energy Cost	$1,200	$1,200
PROPOSED		
Degrees of Temperature Setup	3	3
Hours per week of Setup	108	108
Constant - total hours per week	168	168
Effective Cooling Degree Days	652	1,174
Adjustment factor	0.45	0.45
Percent Reduction	14.3%	11.3%
Average kWh/Yr Use	12,858	13,304
Annual Energy Cost	$1,029	$1,064
SAVINGS		
kWh/yr	2,142	1,696
Annual Cost Savings	$171	$136
Project cost Estimate	$3,500	$3,000
Incentive	$0	$250
Simple Payback	11.5	20.3

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Boilers Best Practices

- **Test and Adjust Burners**
- **Replace Boiler with High Efficiency Unit**
- **Reduce Steam Pressure**
- **Steam Trap Repair/Replace**
- **Isolate Unused Boiler(s)**
- **Install Heat Recovery on the Boiler Stack (Flue Gas Economizer)**
- **Install Variable Speed Pumping**
- **Reset Boiler System Hot Water Temperatures**

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Boilers Best Practices

Test and Adjust Boiler Burners

Combustion efficiency is primarily a function of the fuel to air ratio at varying boiler loads. If the fuel to air ratio is too rich or too lean, efficiency is negatively impacted. A good way to keep boilers operating near an optimal fuel to air ratio, is to have the boilers tested and adjusted annually.

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Boilers Best Practices

	Example	System 1
EXISTING		
Existing Boiler Efficiency	80%	80%
Average Current therm/Yr Use	67,000	67,000
Average therm Rate	$0.950	$0.950
Annual Energy Cost	$63,650	$63,650
PROPOSED		
Est. % Increase in Efficiency	2.0%	2.0%
Proposed Efficiency	82.0%	82.0%
Proposed Therm Use:	65,366	65,366
Annual Energy Cost	$62,098	$62,098
SAVINGS		
th/yr	1,634	1,634
Annual Cost Savings	$1,552	$1,552
Project cost Estimate	$750	$750
Incentive	$0	$110
Simple Payback	0.5	0.4

Test & Adjust Boiler Burners

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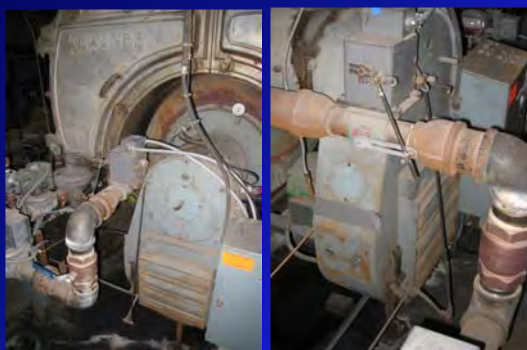
Existing Burner showing linkages for gas and combustion air.



89

Linkageless Burner Characteristics

- Measures O_2 in flue gas
- Separately modulates gas valve to control load and matches speed of combustion air fan to maintain optimum efficiency at all loads.
- Estimated original turndown is 3:1
- Realistic new turndown is 6:1 (can be 8:1)
- Original peak efficiency is 78% to 80%
- New efficiency at all loads is 83% to 85%

90

Analysis of Linkageless Savings

- Apparent efficiency improvement: 78%/80% to 83%/85%. This is a 6% improvement at peak load.
- O_2 trim and separate modulation maintain peak efficiency at ALL LOADS.
- Burner turns down to lower loads without cycling off, this minimizes purging.
- An apparent 6% improvement results in an actual improvement of 20% or better.

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Linkageless Economics

- Installed Cost ≅ $30,000
- Gas saved (15,600 therms @ $1) ≅ $15,600

  - Simple Payback ≅ 1.9 years

92

Boilers Best Practices

Reduce Steam Pressure

Steam plants for heating and process needs can often operate at a range of pressures. It is often most efficient to operate these systems at the lowest possible pressures. When a system is operated at lower pressures, the temperature of the steam is lower. This leads to decreased heat loss from steam pipes. It also leads to more efficient operation of the boiler or steam generator, because the difference in temperature between the flame and the steam / hot water temperature is greater at lower pressures, resulting in greater heat transfer. In this analysis, only the savings due to increased boiler efficiency is estimated.

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Boilers Best Practices

	Example	Plant 1
EXISTING		
Boiler Plant Size (MBTUH) input:	1,000	1,000
Average Boiler Load Factor :	25%	25%
Steam Temperature (F)	274	274
Boiler Efficiency at 215F Steam	80.0%	80.0%
Boiler Efficiency at Steam Temp:	76.9%	76.9%
Hrs/yr Boiler System is Enabled:	8,760	8,760
Conversion Factor (Mbtuh/Th)	100	100
Average Existing th/yr	21,900	21,900
Average therm Rate	$0.950	$0.950
Annual Energy Cost	$20,805	$20,805
PROPOSED		
Steam Temperature	250	250
Boiler Efficiency at New Steam T:	78.2%	78.2%
Average Proposed th/yr	21,550	21,550
Annual Energy Cost	$20,473	$20,473
SAVINGS		
th/yr	350	350
Annual Cost Savings	$332	$332
Project cost Estimate		$1,235
Incentive	$0	$22
Simple Payback	immediate	3.7

Reduce Steam Pressure

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Boilers Best Practices

Steam Trap Maintenance

The primary function of steam traps is to keep steam within the steam-using coils and appliances until the steam has condensed. The resulting condensate (water) flows out of the steam trap and into a condensate return. Steam traps are notorious for mechanical failure. Traps can either fail "closed" where no water or steam passes into the condensate system, or can fail "open" when both steam and water are allowed to pass into the condensate system. The steam that passes into the condensate system eventually travels out the vent of the condensate tank. This wastes energy and increases the amount of makeup water and chemical treatment needed. Routine checks and maintenance, and replacement of steam traps can reduce malfunctions and save energy.

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Boilers Best Practices

	Example	Trap type/size 1
EXISTING		
# Traps in System	30	30
Steam Loss Rate	12.0	12.0
BTU/lb	945	945
Boiler Efficiency	80.0%	80.0%
% of Traps Failed Open:	10%	10%
# Traps Failed	3	3
Boiler Operating Hours	5,110	5,110
Conversion Factor	100,000	100,000
Average Existing steam loss, th/yr	2,173	2,173
$/th	$0.950	$0.950
Annual Energy Cost	$2,064	$2,064
PROPOSED		
Adjustment Factor: the amount of steam loss that is actually wasted	75%	75%
Average Proposed th/yr	543	543
Annual Energy Cost	$516	$516
SAVINGS		
Savings th/yr	1,630	1,630
Annual Cost Savings	$1,548	$1,549
Project cost Estimate	$1,300	$1,200
Incentive	$0	$354
Simple Payback	0.8	0.5

Steam Trap Maintenance

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Boilers Best Practices

Isolate Boilers

Most facilities that use boilers for space heat have at least two units to provide redundancy, and efficient operation during milder weather. Often these boilers are not easily isolated from one another when only one unit is operating. The result is that the standby unit has hot water or steam circulating through it. Because of this, the standby unit is effectively heated to the same temperature as the active unit, and therefore has significant shell heat loss. Automatic valves can be put in to isolate boilers, when only one unit is firing. Or, one boiler can be manually isolated during the mild periods of the heating season to reduce shell losses.

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Boilers Best Practices

EXISTING	Example	System 1
Ave. Boiler Rating (MBtuh)	1,670	1,670
% Shell Losses at Ave. Boiler Rating	2.2%	2.2%
Boiler Steam or Water Temperature	221	221
Ave Temperature in the Boiler Room	70	70
Number of Boilers in the Plant	2	2
Hrs/yr Boiler Plant Operates	5,840	5,840
Average Existing th/yr	4,469	4,469
Average therm Rate	$0.950	$0.950
Annual Energy Cost	$4,246	$4,246
PROPOSED		
# of Boilers to be Isolated	1	1
Hrs/yr/yr Boilers will be Isolated	3,650	3,650
Proposed Therm Use:	3,072	3,072
Annual Energy Cost	$2,918	$2,918
SAVINGS		
th/yr	1,397	1,397
Annual Cost Savings	$1,329	$1,328
Project cost Estimate	$0	$1,200
Incentive	$0	$150
Simple Payback	Immediate	0.8

Isolate Unused Boilers

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Boilers Best Practices

Variable Speed Drive Pump on Chilled or Hot Water Pumps

Many existing systems water pumping systems are constant speed. By going to a variable speed drive system, pumping energy can be saved. Often this will involve a constant temperature water supply, possibly some valving changes, and control changes.

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Boilers Best Practices

EXISTING	Example	System 1
Motor Horsepower	20	20
Motor Efficiency	88.4%	88.4%
% Full Load	85.0%	65.0%
Control Factor	100%	100%
Annual Operation Hours	8,760	8,760
Conversion Factor	0.746	0.746
kW	15.0	11.0
kWh/yr	96,108	96,108
Average kWh Rate	$0.080	$0.080
Annual Energy Cost	$7,688	$7,688
PROPOSED		
Motor Horsepower	20	20
Motor Efficiency	88.4%	88.4%
% Full Load	85%	55%
Conversion Factor	0.746	0.746
Control Factor	39%	39%
kW	11.0	11.0
kWh/yr	37,481	37,481
Annual Energy Cost	$2,998	$2,998
SAVINGS		
kW	0.0	0.0
kWh/yr	58,625	58,625
Annual Cost Savings	$4,690	$4,690
Project cost Estimate	$4,500	$4,500
Incentive	$0	$544
Simple Payback	1.0	0.8

Install Variable Speed Pumping

100

Boilers Best Practices

Hot Water Reset

Hot water heating systems are generally controlled to maintain a constant hot water temperature throughout the year. Therefore, the hot water temperature is set to the highest temperature required by the building. While the building may need very hot water in the winter to satisfy heating demand, during milder conditions lower water temperatures can often be used. Controls can be installed on most boiler systems to reduce the hot water set point based on the outside air temperature - the warmer the outside air temperature, the cooler the hot water temperature. Depending on the type of boiler being used, minor plumbing changes may need to be made to prevent the boiler from being shocked by cooler return water. The main energy savings associated with this best practice, is a reduced uncontrolled heat loss from the hot water pipes. In the winter months, the heat loss from the system may actually help to heat the building. However, during milder times of year, the heat loss can contribute to building overheating. This can be an especially significant problem for buildings that employ summer reheat, and therefore must circulate hot water in the summer time.

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Boilers Best Practices

EXISTING	Sample	System 1
Ft. of HW Pipe	400	400
Average Pipe Diameter (inches)	2	2
Hot Water Temperature (F)	180	180
Heat loss rate	31	31
Hrs/Yr	8,760	8,760
Boiler Efficiency	80%	80%
% of Losses that Provide Useful Heat	67%	67%
Is a cooling system used when the boiler is operating ?	Yes	Yes
EER of Cooling System	10.2	10.2
Conversion Factor	100,000	100,000
Average Existing th/yr	448	448
Average therm Rate	$0.710	[illegible]
kWh/yr	3,514	3,514
Average kWh Rate	$0.080	$0.080
Annual Energy Cost	$599	[illegible]
PROPOSED		
Hot Water Temperature	150	150
Heat loss rate	22	22
Average Proposed th/yr	318	318
kWh/yr	2,494	2,494
Annual Energy Cost	$425	[illegible]
SAVINGS		
th/yr	130	130
kWh/yr	1,020	1,020
Annual Cost Savings	$174	[illegible]
Project cost Estimate	$1,500	$1,500
Incentive	$0	[illegible]
Simple Payback	8.6	8.7

Hot Water Reset

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Chillers Best Practices

- High Efficiency Chillers
- Chilled Water Reset
- Chilled Water Pump VFD

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Chillers Best Practices

Chilled Water Reset

Chilled water temperature is often kept at a fixed set point. However, chillers tend to operate more efficiently, and have more cooling capacity if they are operated at higher chilled water temperatures. To increase chiller efficiency, chilled water temperature can be adjusted automatically based on the outside air temperature.

Dick's Tips

1. Increase chilled water temp: save 1.5% power per 1°F
2. Decrease condenser water temp: save 1.5% power per 1°F

Extreme Example

Increase chilled water temp from 42°F to 48°F AND decrease condenser water temp from 78°F to 75°F:

SAVE 13.5% POWER

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Chillers Best Practices

EXISTING	Example	System 1
Existing Air Conditioner Size	20	20
Chilled Water Temperature	45	45
Existing Air Conditioner Efficiency (EER/SEER)	10.2	10.2
EqFlHrs	900	900
Unit Conversion (btu/tons)	12,000	12,000
Unit Conversion (watts/kW)	1,000	1,000
kW	23.5	23.5
kWh/yr	21,176	21,176
Average kWh Rate	$0.080	$0.080
Annual Energy Cost	$1,694	$1,694
PROPOSED		
Ave. Chilled Water Temp.	50	50
Proposed Air Conditioner Efficiency (EER/SEER)	10.7	10.7
Unit Conversion (btu/tons)	12,000	12,000
Unit Conversion (watts/kW)	1,000	1,000
kW	22.4	22.4
kWh/yr	20,187	20,187
Annual Energy Cost	$1,615	$1,615
SAVINGS		
kW	1.1	1.1
kWh/yr	989	989
Annual Cost Savings	$79	$79
Project cost Estimate	$1,000	$1,000
Incentive	$0	$124
Simple Payback	12.6	11.1

Chilled Water Reset

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Chillers Best Practices

Variable Speed Drive Pump on Chilled Water Pumps

Many existing systems water pumping systems are constant speed. By going to a variable speed drive system, pumping energy can be saved. Often this will involve a constant temperature water supply, possibly some valving changes, and control changes.

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Chillers Best Practices

EXISTING	Example	System 1
Motor Horsepower	20	20
Motor Efficiency	88.4%	88.4%
% Full Load	85.0%	85.0%
Control Factor	100%	100%
Annual Operation Hours	8,760	8,760
Conversion Factor	0.746	0.746
kW	11.0	11.0
kWh/yr	96,106	96,106
Average kWh Rate	$0.080	$0.080
Annual Energy Cost	$7,688	$7,688
PROPOSED		
Motor Horsepower	20	20
Motor Efficiency	88.4%	88.4%
% Full Load	85%	85%
Conversion Factor	0.746	0.746
Control Factor	39%	39%
kW	11.0	11.0
kWh/yr	37,481	37,481
Annual Energy Cost	$2,998	$2,998
SAVINGS		
kW	0.0	0.0
kWh/yr	58,625	58,625
Annual Cost Savings	$4,690	$4,690
Project cost Estimate	$4,500	$4,500
Incentive	$0	$2,124
Simple Payback	1.0	0.5

Chilled Water Pump VFD

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Lighting Best Practices

- Compact Fluorescents
- LED Exit Lights
- Reduced Hours of Operation
- Occupancy Sensors
- Vending Machines
- T12 to High Performance T8s
- Metal Halide to High Performance T8s or T5s
- Task Lighting

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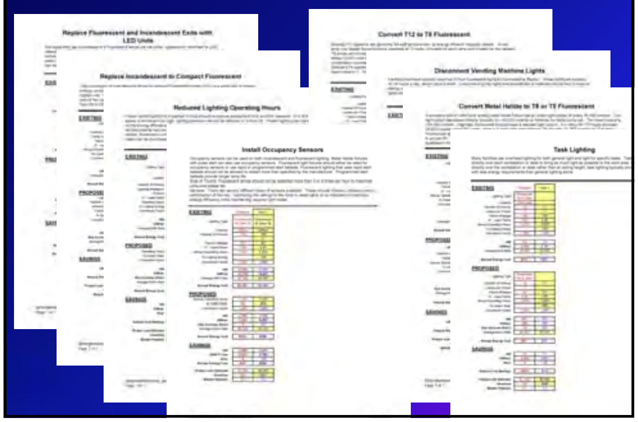
Lighting Best Practices



Miscellaneous Equipment Best Practices

- EnergyStar Computers & Monitors
- Replace Windows
- Vending Machine Occupancy Sensors
- Add Roof Insulation
- Reduce Infiltration

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Miscellaneous Equipment Best Practices

Computers and Monitors

Many computers and monitors today are "Energy Star Compliant". This means that the units have the ability to operate in a low power mode after a certain amount of inactivity. The computer and or monitor will power up to its normal operational power at the press of a key or movement of the mouse. Many computers, especially those produced after July of 2000, can sleep "intelligently" on networks, such that they can be awaken by a command placed over the network. Often the energy star features of computers and monitors are not enabled leading to no savings. The process to enable the features is simple, and can lead to substantial savings for facilities with a large number of computers.

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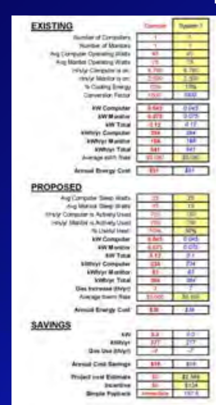
Miscellaneous Equipment Best Practices



[EnergyStar Computers & Monitors]

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Miscellaneous Equipment Best Practices

Install Occupancy Sensors on Vending Machines

Vending machines typically operate 24 hours a day, seven days a week. There are a number of products available that turn off the vending machine using an occupancy sensor. When no one is near the machine for a preset amount of time, the unit turns off. When someone walks by, the unit turns on. These devices are also set up to make sure the that the machine maintains beverages at a low temperature. Occupancy sensor units for vending machines typically cost ~$180 per unit.
Rule of Thumb: Installing a occupancy sensor device on a vending machine can typically save $50-$120/machine/year depending on the type of unit and amount of people traffic by the unit. Simple payback range, 1.5 - 4 years.

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Miscellaneous Equipment Best Practices

EXISTING	Example	Area 1
Number of Vending Machines	8	8
% Useful Heat	50%	50%
% AC Savings	15%	15%
kWh/yr saved per machine	1,800	1,800
kW	None	None
kWh/yr	12,420	12,420
Average kWh Rate	$0.080	$0.080
Gas Increase (th/yr)	230	230
Average therm Rate	$0.950	$0.950
Annual Energy Cost	$775	$775
PROPOSED		
kW	None	None
kWh/yr	0	0
Gas Use (th/yr)	0	0
Annual Energy Cost	$0	$0
SAVINGS		
kW	None	None
kWh/yr	12,420	12,420
Gas Use (th/yr)	-230	-230
Annual Cost Savings	$775	$775
Project cost Estimate	$1,080	$1,080
Incentive	$0	$215
Simple Payback	1.4	1.1

Vending Machine Occupancy Sensors

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Wisconsin's Focus on Energy
Best Practices Spreadsheets

Available for download at:
http://www.focusonenergy.com/business/commercial-business/cpem/sixsteps.aspx

focus on energy
The power is within you.

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Sample Discretionary Action Plan - Lighting

- Match operating hours to activities
  - Unoccupied Lighting
  - Existing Custodial Lighting
- Add Occupancy Sensors
- Assure Footcandles Appropriate for Tasks
- Install Efficient Light Sources
- Use lamps with higher Kelvin temperature ratings (recommended: 4100°K- 6500°K)

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Sample Discretionary Action Plan – Air Systems

- Match running time to activities
- Lower hot air temperatures
- Raise cold air temperatures
- Lower fan pressure in ducts
- Adjust static pressure setpoints
  - o Manual reset
  - o 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

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Sample Discretionary Action Plan – Air Systems

- Make best use of economizer operation
- Eliminate simultaneous heating and cooling
- Reduce airflow in constant volume (CV) systems
- De-energize nonessential loads
- Seal leaky ducts
- Convert CV systems to VAV

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Sample Discretionary Action Plan – Pumping Systems

- Convert CV system to variable flow
- Install variable frequency drives
- Match running time to activities
- Verify proper flow
  - o Throttle balance valves
  - o Trim pump impellers
- Lower pressure setpoint to optimize variable flow
  - o Manual reset
  - o Dynamic reset
- De-energize nonessential loads

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Sample Discretionary Action Plan – Boilers

- Lower hot water temperatures
- If steam, lower steam pressure
- Install modulating burners (linkage-less)
- Optimize boiler sequencing
- Minimize losses in de-energized boilers

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Sample Discretionary Action Plan – Chillers

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

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Available at:
http://www.energy.wsu.edu/ftp-ep/pubs/rem/energyaudit/OMchecklists.pdf

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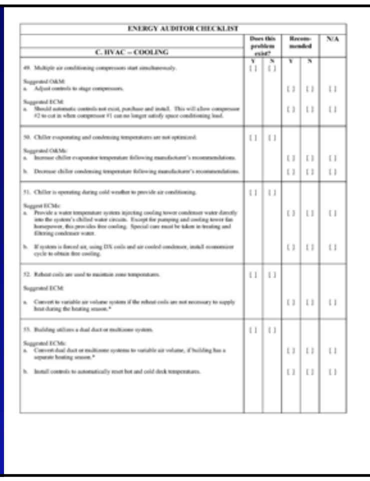

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Additional Discretionary Opportunities

- Chapter 36, ASHRAE 2011 Handbook "Energy Use and Management"
- Washington State University Checklist
http://www.energy.wsu.edu/ftp-ep/pubs/rem/energyaudit/OMchecklists.pdf
- Advocate EM Operational Checklist (handout)

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BREAK!

Exercise #9 Discussion

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Energy Star Guidelines for Energy Management

www.energystar.gov

Accountability

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Disincentives for the Building Engineer

- Risk of occupant discomfort
- Risk of equipment failure
- Experimentation can be terrifying

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Incentives for the Building Engineer

- Regular monitoring by the manager
- Managerial encouragement to experiment
  - Occasional, brief discomfort is OK
- Teamwork

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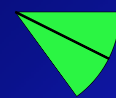
Two Types of Action



- Discretionary Facility Operation
- Energy Audits and Capital Improvements

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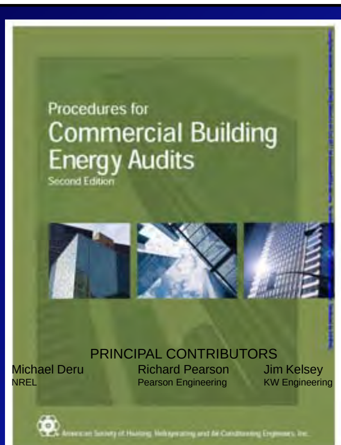

A LEED EB Reference

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Levels of Effort

- Preliminary Energy Use Analysis
- Level I – Walk-Through Analysis
- Level II – Energy Survey and Analysis
- Level III – Detailed Analysis of Capital-Intensive Modifications

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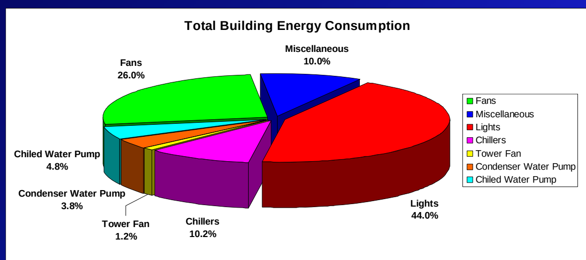
"Typical" Office Building End-Use



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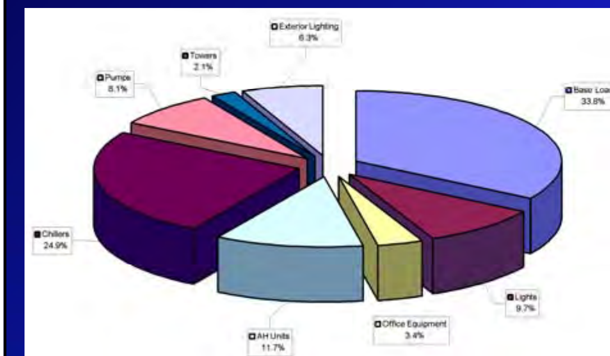
Honolulu Office Building Actual End-Use



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Energy Star Guidelines for Energy Management

www.energystar.gov

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Evaluate Progress

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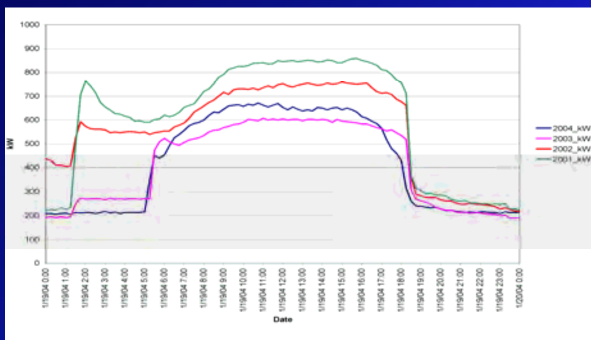
Honolulu Office Building After



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What We Did

- Capital – more efficient chillers, pumps, towers; new building automation system to integrate equipment operation
- Operational changes – matched schedules to occupancy
- Simple Payback: 5 years

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Honolulu Office Building: Energy Management Results

- 20% energy savings
- Savings per year
  - $100K
  - 750 tons CO_2
  - 2.3 tons NO_x
  - 2.0 tons SO_2

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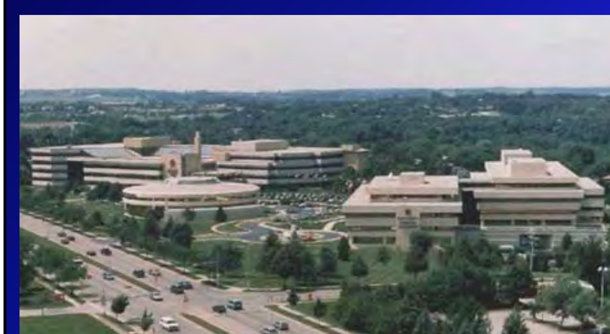
Madison Insurance Company



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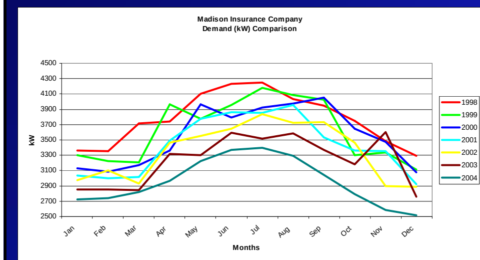
Madison Insurance Company
Evaluate Progress



	Peak kW
1998	4,250
1999	4,184
2000	4,054
2001	3,956
2002	3,833
2003	3,597
2004	3,394
Seven Year Reduction	**856**

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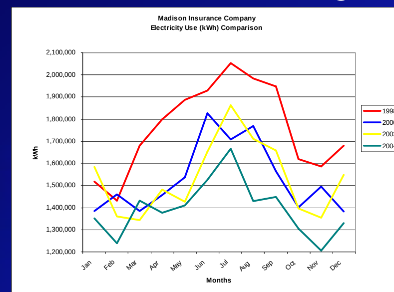
Madison Insurance Company
Evaluate Progress



	TOTAL kWh
1998	20,786,867
1999	19,071,735
2000	18,374,900
2001	18,190,269
2002	18,425,789
2003	17,763,746
2004	16,716,580
Seven Year Reduction	4,070,287
20% Reduction	

4.1 Million kWh per year
provides electricity for 586 new homes!

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GSA Energy Management Program: The Rest of the Story

US Courthouse
Jacksonville, Florida
Energy Improvements

DOE-ORNL Report

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2005 New Building Performance

- Floor area: 492,000 ft^2
- EUI: 83 kBtu/SF – predicted to be 45 kBtu/SF
- Energy Star rating: 41 – predicted to be 79
- Utility costs: $664,000/year – predicted to be $220,000/yr
- **Far less efficient than design intent**

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ECMs Implemented

- VAV minimum settings reduced to 10%
- Boilers turned off in summer
- Duct static pressure setpoints reduced from 1.5 in. to 0.7 in.

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Results of Control Modifications

- EUI: 45 kBtu/SF – Reduced from 83
- Energy Star rating: 79 – Improved from 41
- Energy Savings: 11.7 trillion Btu/year
- Cost savings: $220,000/year

Energy Star Plaque is now in the lobby!

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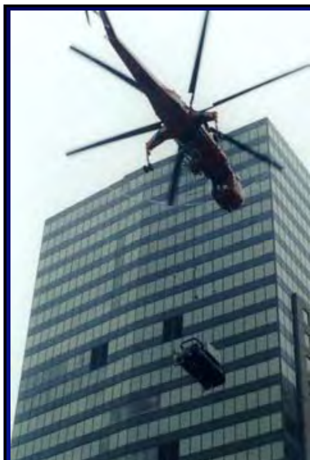

Downtown Chicago Energy Star Building

Uninsulated concrete
Single pane glass

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Madison Bank

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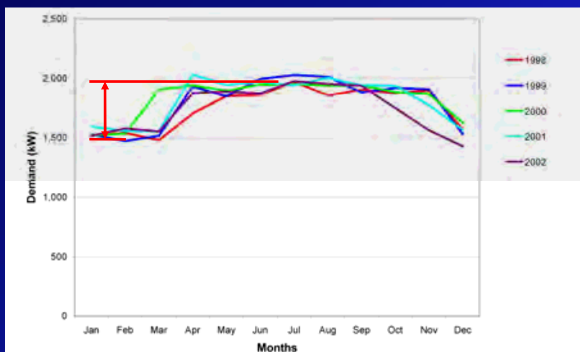
Annual Profile of Monthly Peaks (kW)



Chillers add 500 kW in summer

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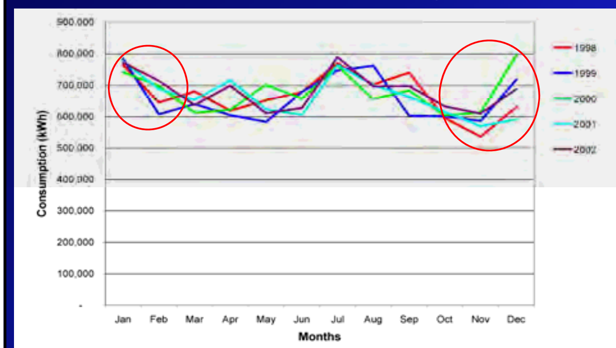
Annual Profile of Monthly kWh



Fans waste energy in winter!

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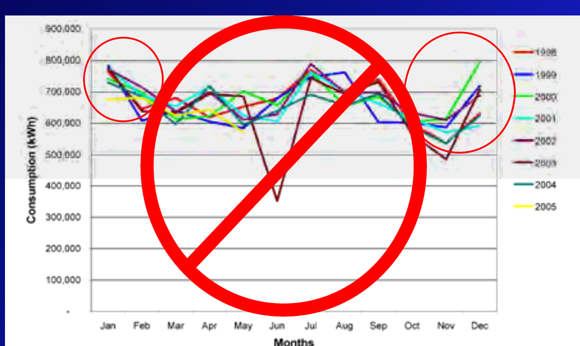
Evaluate Progress 3 Years Later



Energy Management Did Not Work!

164

Explanation of the failure to see progress at Madison Bank

- The high electrical energy use in colder months results from decision to maintain fans “on 24/7:
- No commitment to improve energy use
- No accountability

Therefore, NO CHANGE.

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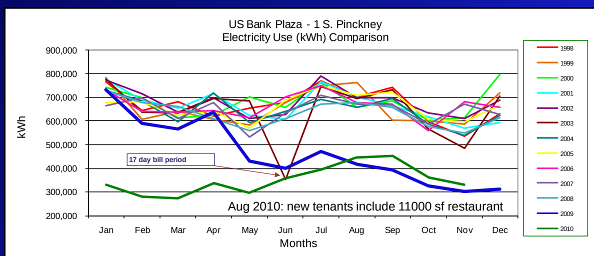
But Things Have Changed!



BREAK!

Unique Process using daily energy data

- Collect one year's utility data
  - o Electric interval data (15 min or 30 min)
  - o Daily natural gas (or steam) consumption
- Plot daily consumption versus Outside Air Temperature
  - o Establish a model of each building normalized for weather
  - o Weekend usage slightly different than weekday usage

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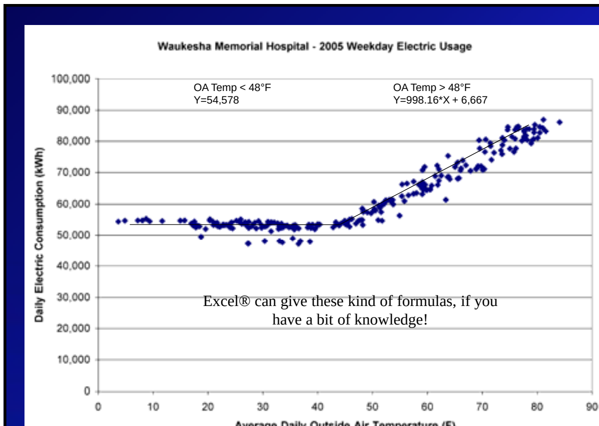

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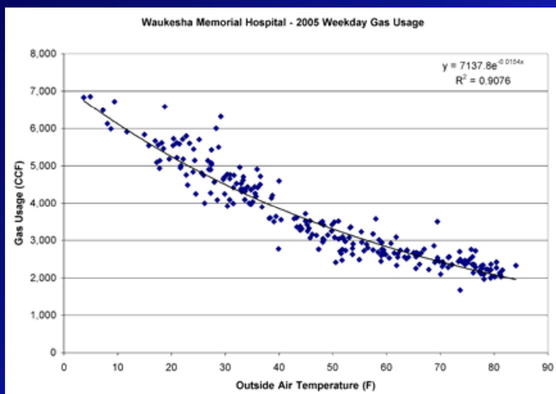

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7% savings in 12 months: $89K and 530 Tons CO_2

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	48,980	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	1,258,1[illegible]7	92.9%	89,214	21,[illegible]25,821	21,602,617	101.5%	-323,204

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Extra Benefit: An Energy Management Breakthrough

		Gas			Electric			
	Outside Air Temp	Calculated Usage	Actual Usage	Difference	Calculated Usage	Actual Usage	Difference	Comment
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	[illegible]	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	78.9	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	

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Applying the Process

Aurora Health Care – 2009

- 17 facilities
- 7 million sq. ft.
- Each facility joined the Portfolio Manager© system
- President of Aurora Healthcare signed an EnergyStar© commitment to reduce energy 12% in 3 years
- Each facility utilizes the spreadsheet and records energy consumption daily
- Monthly summaries distributed to all
- Monthly energy initiative meeting to share successful ideas

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Aurora Health Care 2009-2010 Utility Summary

Facility	Sq Ft	2009-2010 Total			
		%	CO2 Diff (lbs)	2009 EUI (kBtu/ft²)	2010 EUI (kBtu/ft²)
Sheboygan	276,000	69.6%	2,998,873	358.6	284.2
Hartford	150,000	90.7%	1,447,970	258.5	278.1
Two Rivers	183,500	97.0%	1,587,641	367.2	265.4
West Allis Memorial	848,440	92.6%	6,662,596	277.5	259.2
Baycare Clinic	610,716	98.2%	1,578,580	273.8	258.1
St Luke's South Shore	360,555	90.5%	4,189,934	242.8	227.6
Sinai Medical Center	858,000	89.9%	11,218,115	225.6	214.3
Burlington	220,000	97.0%	1,188,255	176.4	203.5
St Luke's ★	1,718,166	91.1%	18,192,528	229.6	203.0
Kenosha	339,020	99.9%	1,614,300	201.4	194.7
Oshkosh	470,000	94.0%	4,580,028	205.0	187.4
Summit	789,591	98.7%	2,273,173	N/A	150.8
Lakeland	296,280	87.3%	(432,713)	129.2	146.9
Hall (Removed Laundry)	173,000	84.4%	5,558,891	251.2	226.8
Hospice	31,200	90.5%	279,033	204.0	193.3
Corporate Building	21,780	81.3%	334,388	170.5	154.2
Psychiatric Hospital	208,074	90.4%	60,265	91.8	85.4
Forest Home ★	135,000	69.2%	4,098,775	82.0	74.0
Total	7,687,304	92.4%	67,567,601	227.8	207.6

★ Achieved EnergyStar Award!

Highlighted buildings are not acute care hospitals

Savings:
- 7.6% reduction in energy usage
- 67,567,601 lbs. reduction in CO_2 emissions

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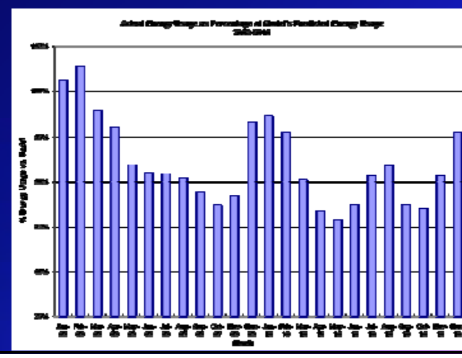
Aurora Health Care 2009-2010

- 7.6% reduction in energy consumption
- 67.6 million pound reduction in CO_2
- Two facilities achieved ENERGY STAR



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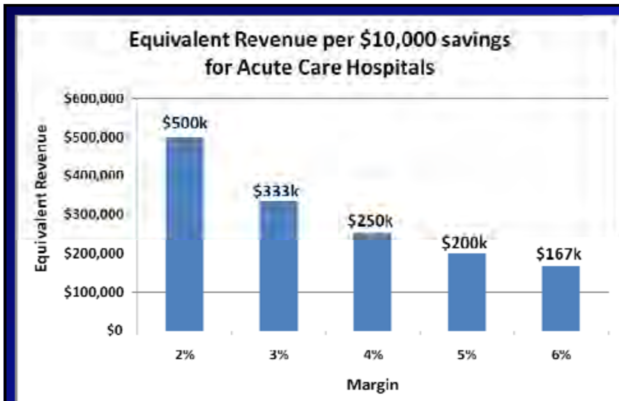

Source: Corporate Realty, Design, & Management Institute

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Energy Management Strategies Taken

- Chiller operations
- H.W. reset schedules
- Run schedules (occ./unocc., day/night, summer/winter)
- D.A. temperature reset schedules
- Steam pressures
- Installation of variable speed drives
- Isolation dampers for unoccupied areas
- Steam trap survey
- Shutting off air handling units in unoccupied areas.
- Maintaining modified space temperatures
- Promoting the energy message at department meetings

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Reverse Energy Audit Process

- Low cost actions decrease utility costs first
- First steps reveal specific needs for future capital improvements
- In-depth audit and capital improvements follow

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Energy Management at Monona Terrace Convention Center

Jeff Griffith
Building Maintenance Supervisor

- Action Plan
- Monitoring
- Benchmarking
- Accountability

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Action Plan

- Initial commissioning by staff
- No compromise in customer comfort
- Eliminate simultaneous heating and cooling
- Adapt operation to daily schedule
- Eliminate energy use in unoccupied spaces
- Regular reminders to entire staff

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Regular Monitoring

- Weekly energy review by engineering staff
- BAS alarms to pagers
  - Demand exceeds 1,100 kW
  - Chilled water exceeds 50°F
- Personal attention by one engineer on peak days

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Monitoring and Benchmarking

Benchmarking

	Square Footage	Electricity (kbtu/sqft)	Nat Gas (kbtu/sqft)	Steam (kbtu/sqft)	Chilled Water (kbtu/sqft)	Total Energy (kbtu/sqft)
Rochester, NY	200,000	55.76	0.00	0.00	0.00	55.76
Pittsburg. PA	1,500,000	24.05	0.00	32.25	106.46	162.75
Collinsville, IL	72,500	102.42	69.39	0.00	0.00	171.81
Rochester, MN	191,531	79.90	4.77	89.98	0.00	174.65
Milwaukee, WI	667,475	65.23	2.16	80.06	0.00	147.46
Madison, WI	303,000	51.08	9.51	4.91	0.00	65.50
Sarasota Springs, NY	52,500	66.23	89.81	0.00	0.00	156.04
Toledo, OH	325,000	39.72	73.74	0.00	0.00	113.46
Davenport, IA	154,215	45.26	81.37	0.00	0.00	126.62
Totals	3,466,221					

Accountability

- Jeff is personally accountable to the facility manager
- Engineering staff is accountable to Jeff and to each other
- Entire staff maintains an energy conscious culture
- Weekly staff review of energy use

Monona Terrace

LEED EB Silver Certification

- Significant energy savings
- Non-toxic cleaning products
- Use of clean energy
- High recycling rates

Accountability: A Management Challenge

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Defining Accountability

- Is a person answerable for the results?
- A building or a department can't be!

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MERCURY MARINE

- Headquarters in Fond du Lac, Wisconsin
- Manufacturing and sales organization
- Multiple facilities across the US
- Multi-million dollar utility bill
- Jerry Eaton – Energy Manager
- >$1 million annual savings

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Jerry Eaton's Discoveries

- Utility cost was an overhead item – not a manageable expense
- Stickers on light switches – no impact on expense or consumption

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Jerry Eaton's Parallel Activities

Developed a corporate-wide chain of accountability:

- ✓ Begin with buildings (each with a meter)
- ✓ Then departments within buildings (each with a meter)
- ✓ Appoint a person in each location to be responsible for proven results

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Jerry Eaton's Parallel Activities

Developed 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.
- ✓ Some type of weekly review has proven to be very effective.

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Jerry Eaton's Parallel Activities

Found waste and inefficiencies

Found ways to be more efficient

Developed a significant sub-metering program

Developed procedures to monitor the meters on a regular basis

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Jerry Eaton's Success Story

- 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.
- Annual savings of over $1 million.

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Meters and Sub-Meters

- Meters by themselves do not save anything
- No direct payback on the purchase of a meter
- That is not the basis for their justification as an energy conservation investment
- Question: How can you manage it if you can't measure it?

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Measurement Technology

- Measurement technology is continuously improving, and becoming more affordable
- More than one way to develop measurements which are useful in an Energy Management program
- Creative thinking and competitive bidding can produce surprising results

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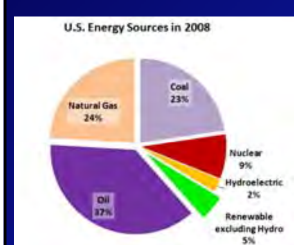
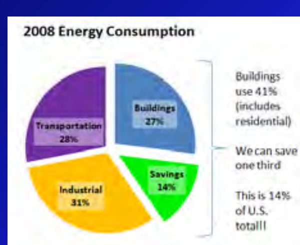
Energy Management is the Quickest, Cheapest, Cleanest Way to Extend World Energy Supplies





Energy management can provide three times the environmental impact of renewable energy

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Successful Energy Savings Are Within Your Reach!

- Personal, regular attention of a single person
- Team-oriented atmosphere tends to ensure conservation
- Consider tying success to department perks or bonuses

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Prepare for Culture Change — What You Can Do…

- Collect 24 months of utility bills
- Enter utility information into Energy Star Portfolio Manager and get your score as a baseline
- Review the Discretionary Action Plans (slides 116-124)
- Try one change — save some energy, reduce climate impact and build your confidence to deploy on-going Energy Management

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Remember to Monitor!!

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References

Text and on-line references are listed in the References supplement

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About the Speaker

Richard J. Pearson, P.E.
ASHRAE Fellow and Distinguished Lecturer

Principal of Pearson Forensic Engineering, Madison, Wisconsin
dick@pearsonfe.net

Principal Contributor – ASHRAE Publications
Procedures for Commercial Building Energy Audits, Second Edition (2011)
Energy Use and Management Chapter (36), ASHRAE Handbook (2011)

Lead Instructor – University of Wisconsin College of Engineering
Department of Engineering Professional Development – Fundamentals of Energy Auditing Course

Member of the National Register of Peer Professionals
Conducts Peer Reviews of GSA design projects for US courthouses, etc.

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Questions?

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