Optimizing Energy Use in a HealthCare Setting

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Session Learning Objectives

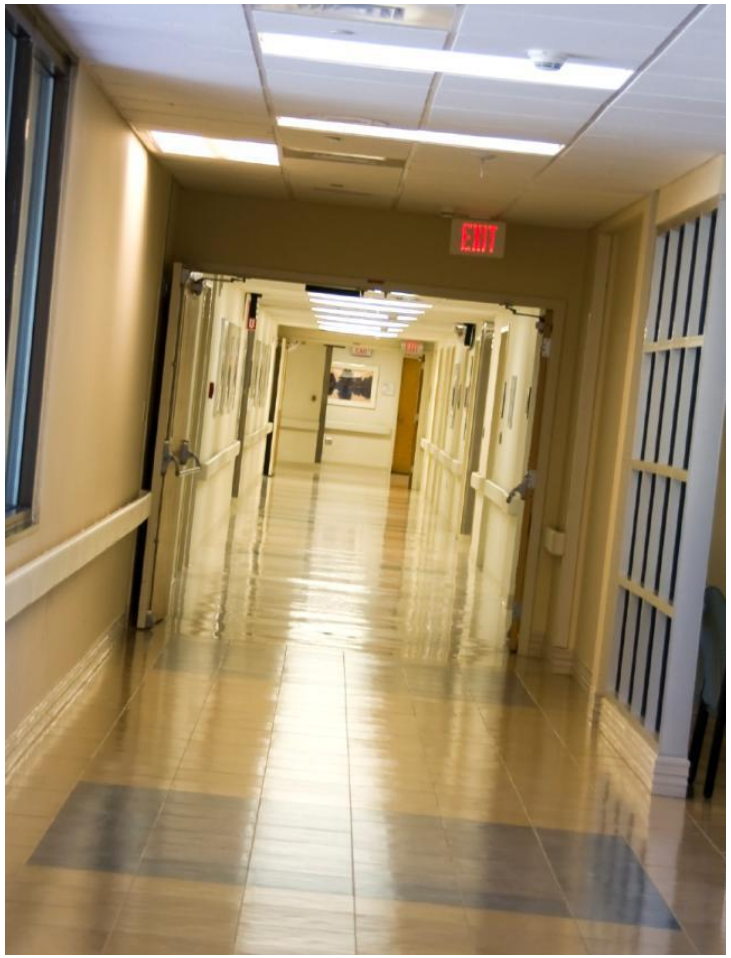
At the end of this session participants will be able to:

1. Identify and use unique systems approaches when undertaking an energy optimization project
2. Leverage energy savings approaches specific to in healthcare EBCx
3. Apply the latest OR pressurization codes and standards for occupied and unoccupied modes
4. Test, commission and optimize pressure dependent spaces

Today's Objectives

- Healthcare Today
- Define Energy Optimization
- Outline the Optimization Process
- Applying the Process
- Expected Results

EH&E's Healthcare Experience



- Hands-on experience managing Joint Commission and EH&S programs
- Currently staffs the Department of Environmental Affairs at Brigham and Women's Hospital
- Longstanding EH&S partnering with numerous teaching and community hospitals
- Consulting relationship with 100+ hospitals nationwide
- Commissioning

Exemplary Healthcare Projects

Children's Hospital Boston

PCRA Support

Brigham and Women's Hospital

EHS/PCRA Support

Dana-Farber Cancer Institute

Construction Support

St. Jude Children's Research Hospital

OSHA Gap Analysis

Beth Israel Deaconess Medical Center

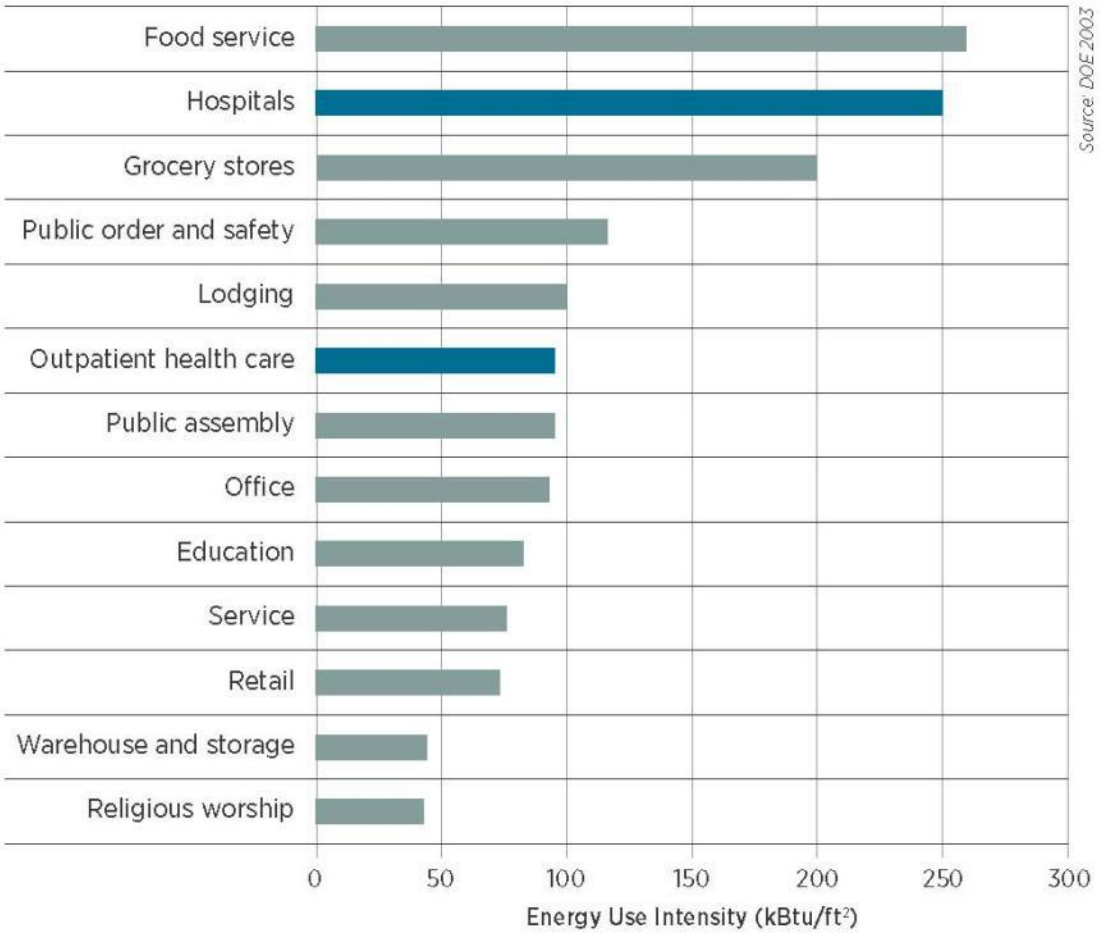
Construction and EH&S

Children's Medical Center of Dallas

Construction

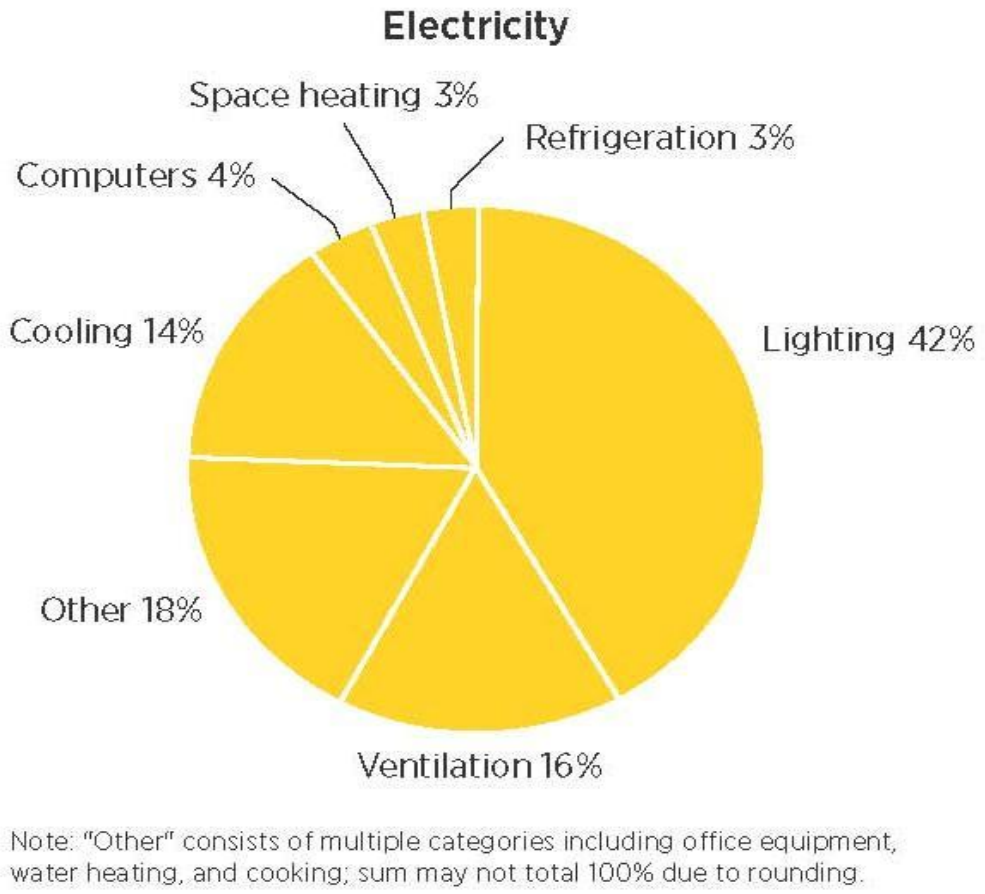
Energy Consumption Comparison

Energy Consumption
kBTU / ft²



Source(s):EIA, 2003 Commercial Buildings Energy Consumption and Expenditures: Consumption and Expenditures Tables, Oct. 2006 Table C1a

Average Electricity end use profile for HealthCare Facilities



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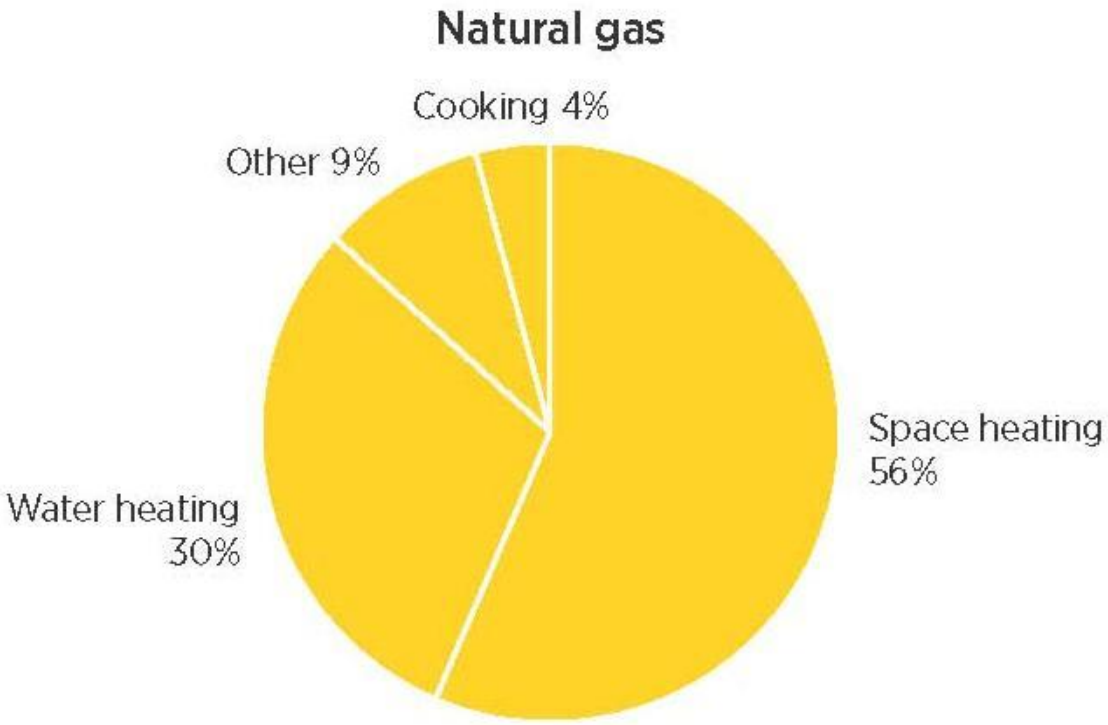
Average Natural Gas end use profile for HealthCare Facilities



Source(s):EIA, 2003 Commercial Buildings Energy Consumption and Expenditures: Consumption and Expenditures Tables, Oct. 2006 Table C1a

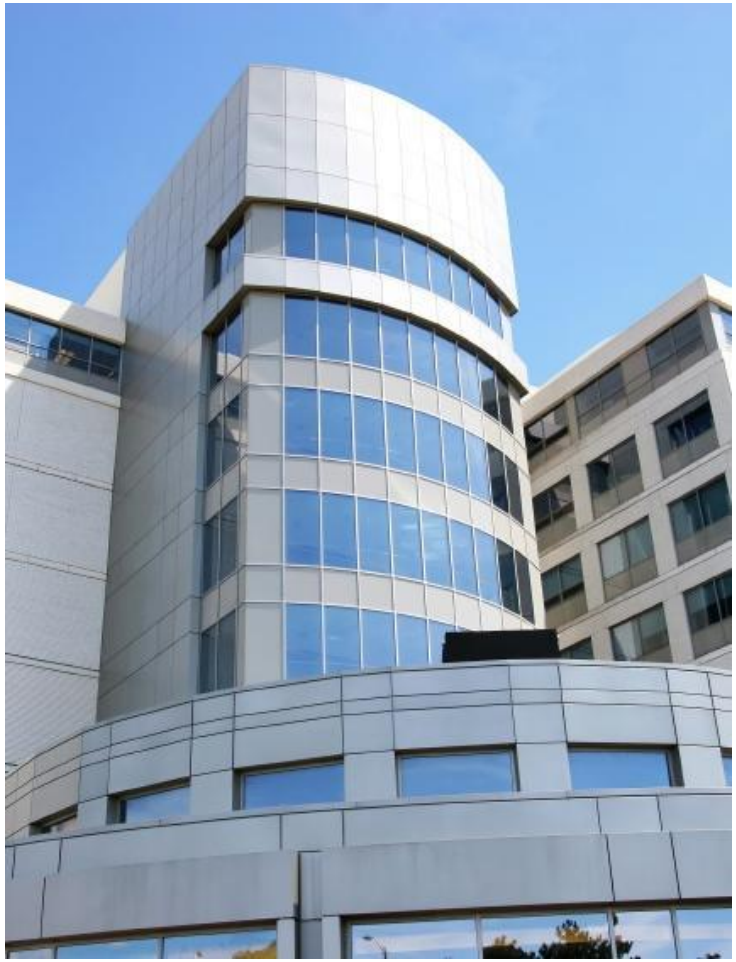
Energy Consumption - Healthcare

- Energy use intensity (EUI) for Hospitals is approximately 250 kBtu/ft2
- The EUI of Hospitals is nearly 3x that of typical commercial buildings
- US HealthCare facilities spend $8.8 billion/year on Energy
- Hospitals use an average of 600,000 MMBtu

Definitions

Re-commissioning (Re-Cx)

- Extensive systemic review of previously commissioned building.
- Maintains the value that Cx originally provided.



Definitions

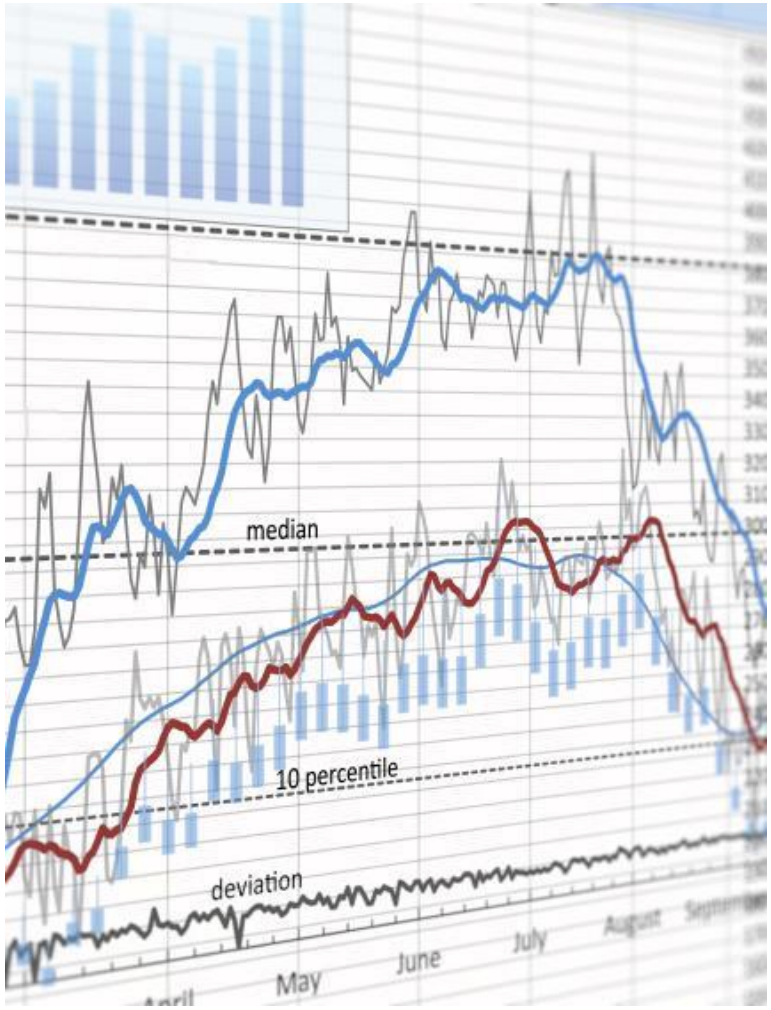
Energy audit

Equipment/system review focused on identifying capital equipment upgrades.

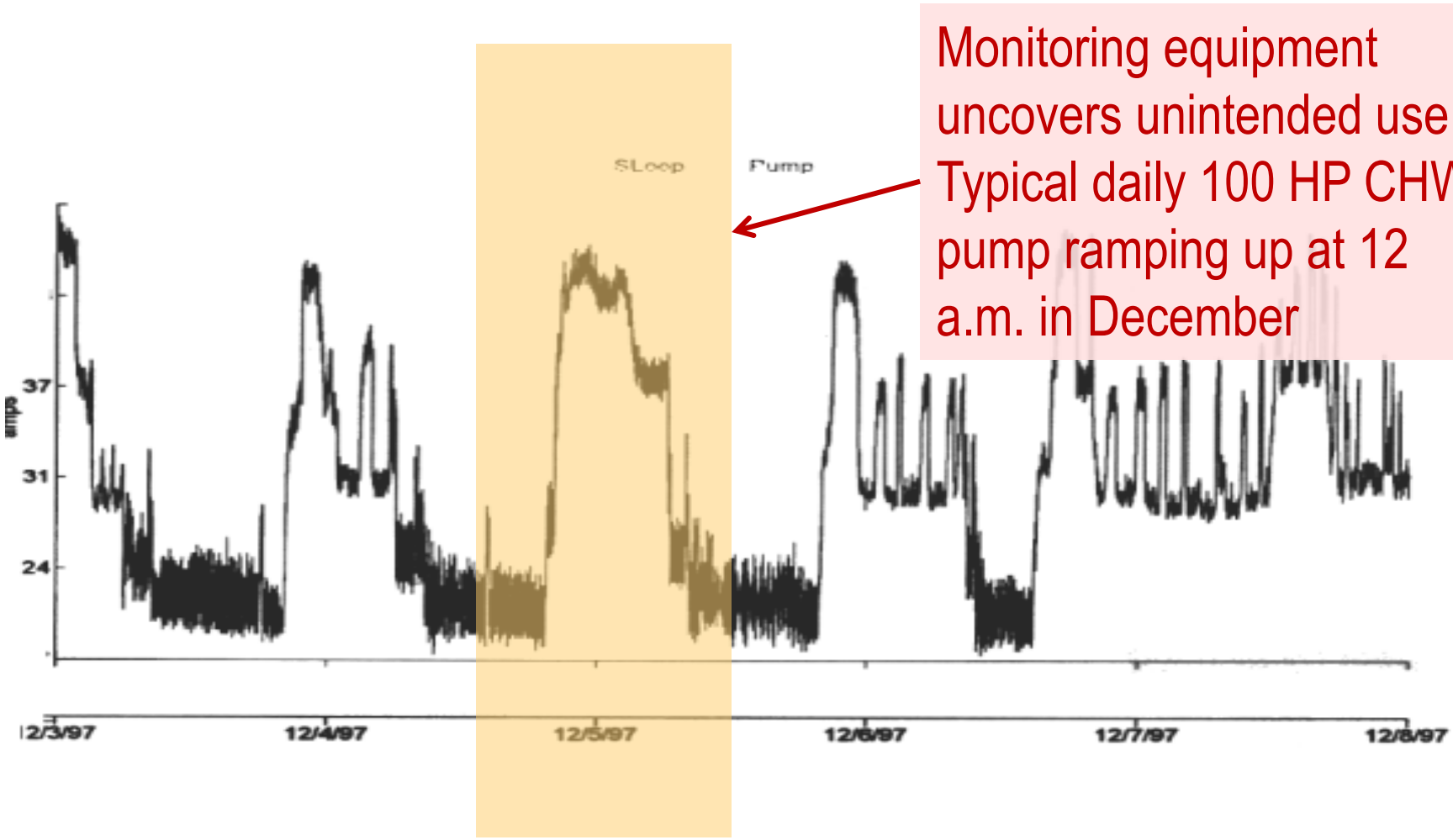
Definitions

Performance optimization

Measurement & verification to ensure mechanical system performance matched to demand



Audit vs. Optimization

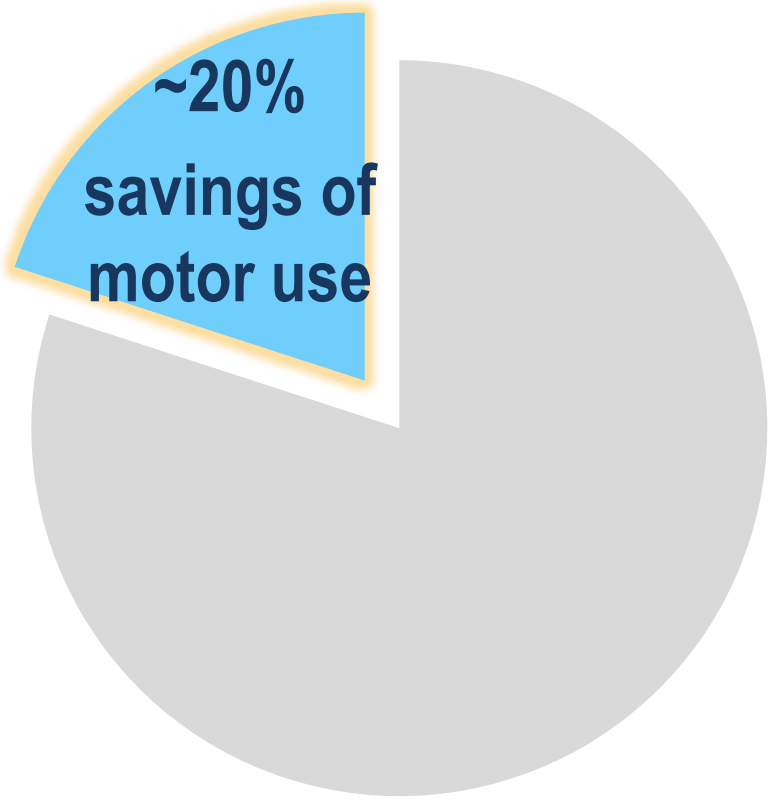


Monitoring equipment uncovers unintended use: Typical daily 100 HP CHW pump ramping up at 12 a.m. in December

Audit vs. Optimization

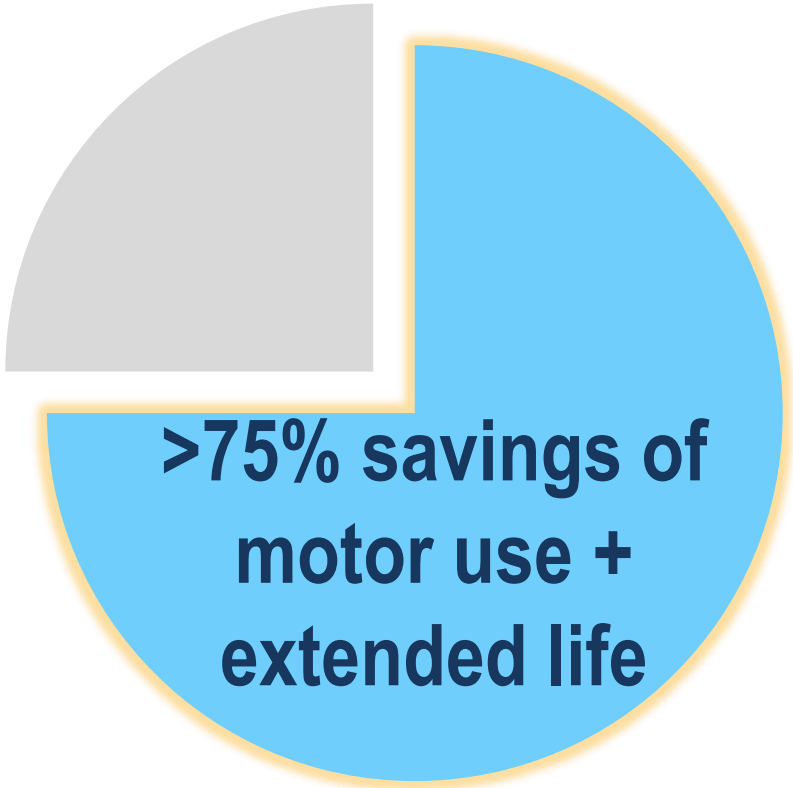
Optimization Recommendation Example:

Eliminate unintended motor use



Audit Recommendation Example:

Replace high-use motor with more efficient model



Healthcare Today – Optimization

Potential energy
to be used

Energy **needed** to **meet performance requirements**

– Understand the real building/system load –

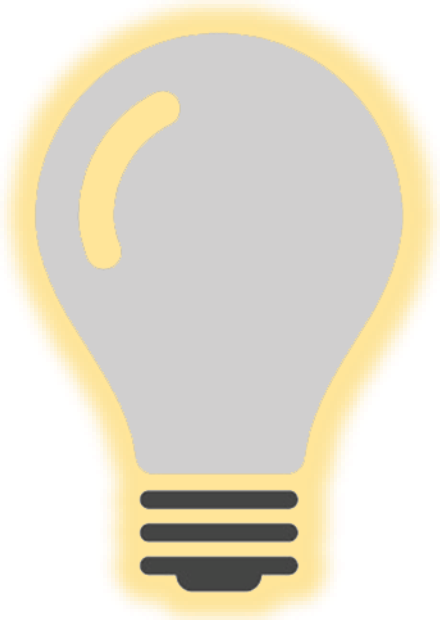
Optimization Summary

Focus on verified performance

Optimize system performance

Strategic data measurement and analysis

Focus on ROI (typically < 12 months)

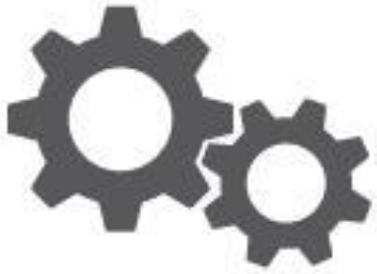


Optimum energy consumption is natural by-product

Why Optimization Works

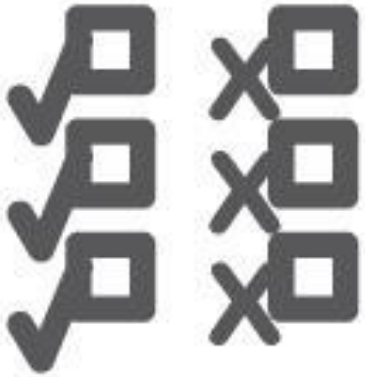
Typical New Building Commissioning Project (200K SF)

150 – 200 components reviewed



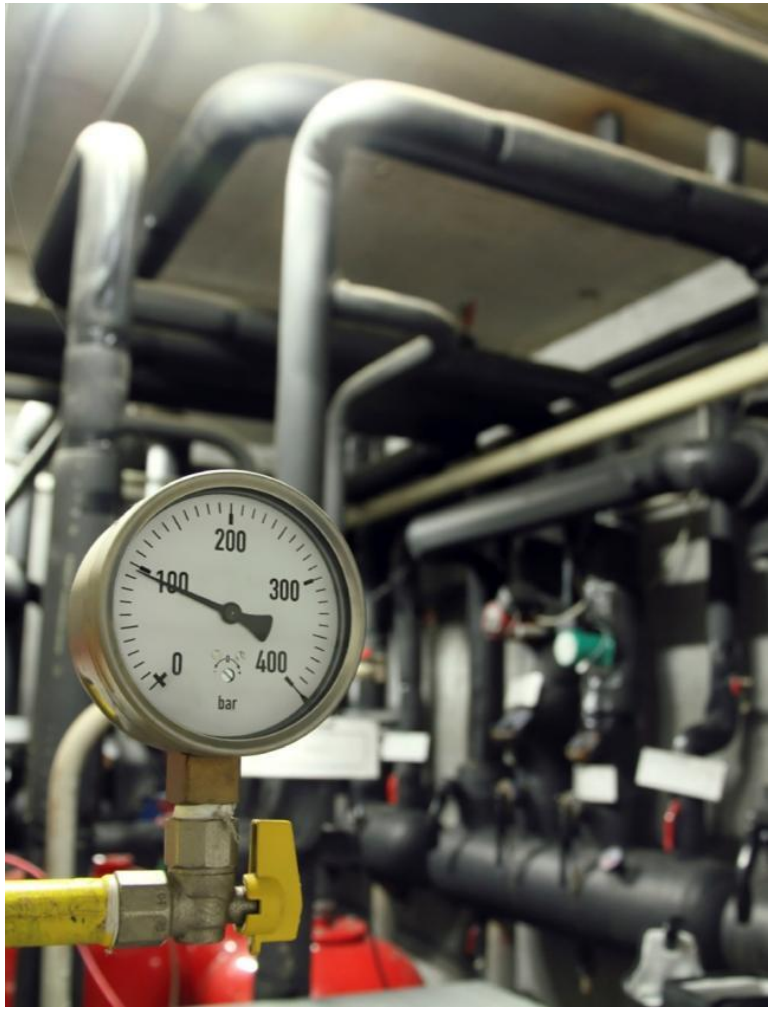
~ 200 – 300 deviations discovered

50% fail functional testing



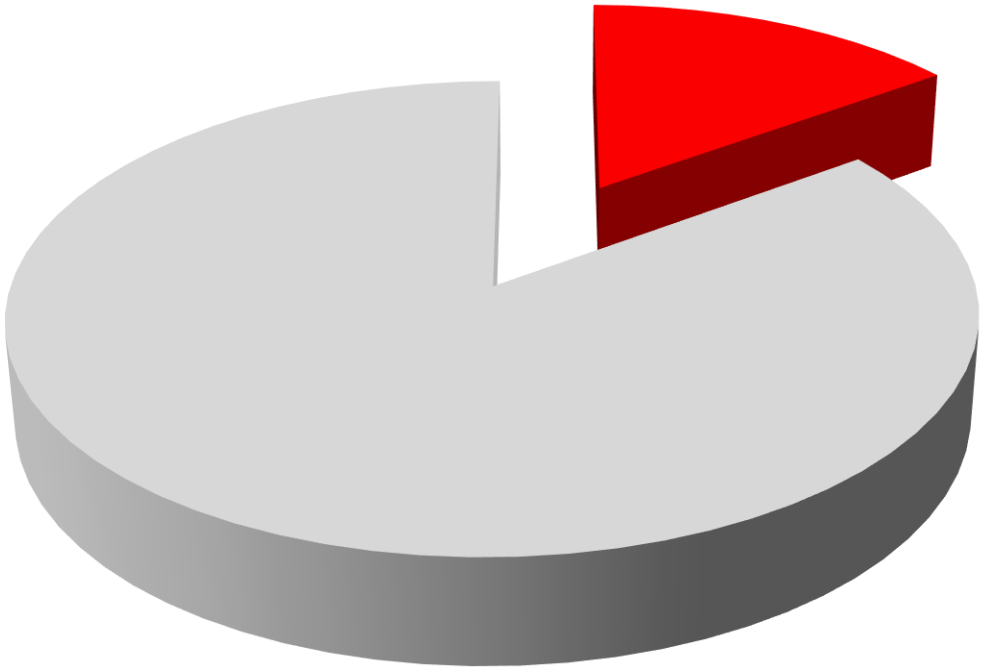
If your building is not commissioned…

- Systems are under performing
- Operational problems exist
- Energy is being wasted



Underlying Principle

Strategic measurements & analysis determines optimal equipment use.



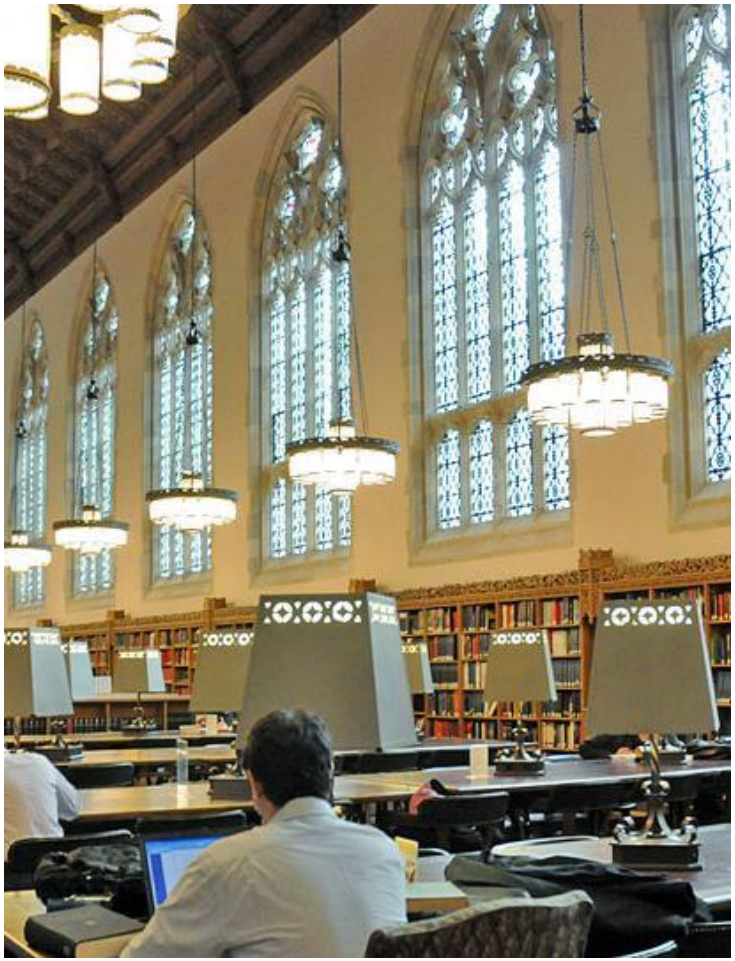
10% - 15% inefficiency is hidden in assumptions.

Optimization Process

- Benchmark Building Parameters (Load)
  - Type/Use/Occupancy
  - Systems
  - Control strategy
  - Utility Data
- Collect and analyze performance data from key building systems
- Compare actual to intended performance
- Identify Energy Efficiency Measures with cost/savings analysis

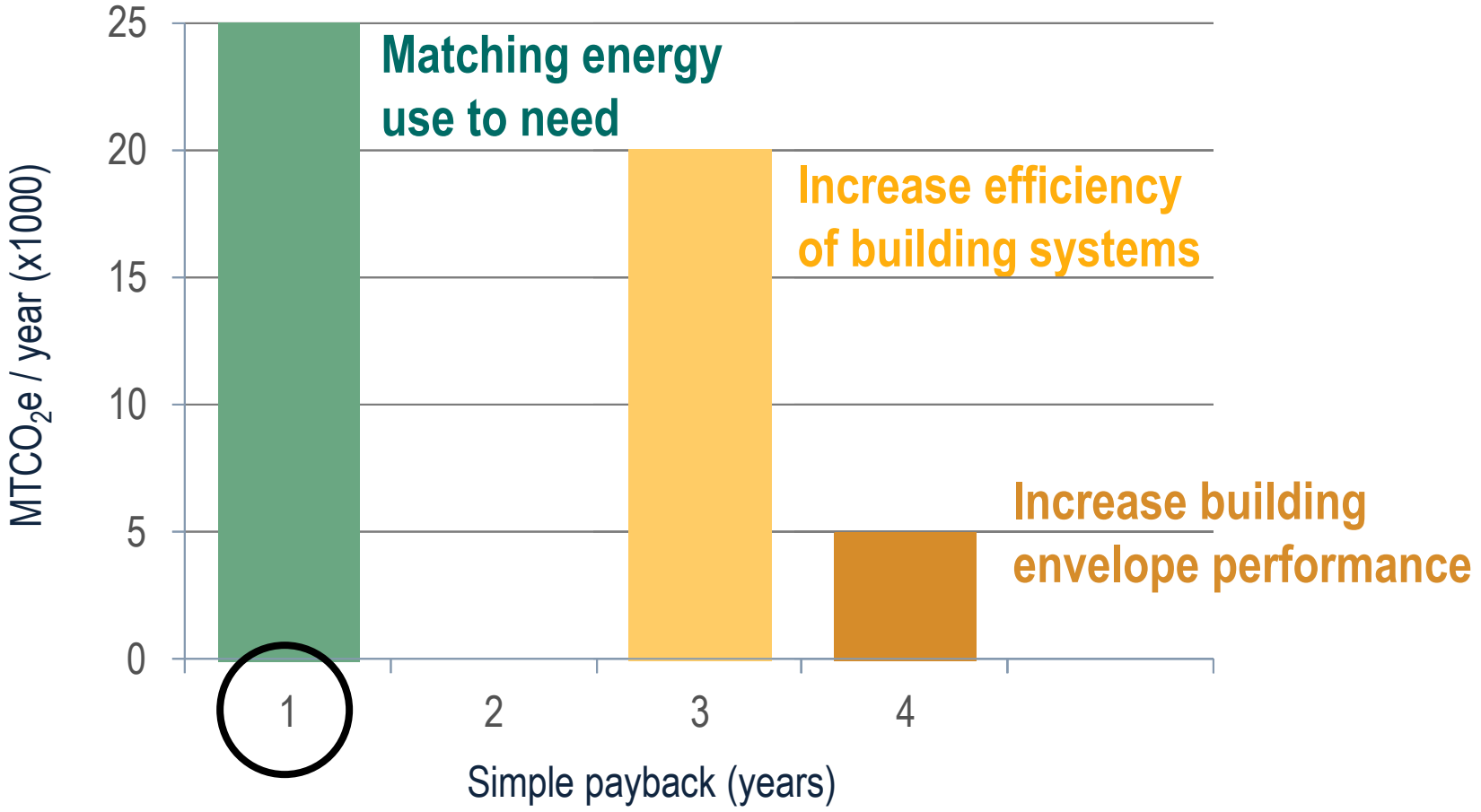
Yale University: Energy

"Yale's power plants provide utility services to over 11 million square feet of facilities, which include research laboratories, academic buildings, administrative buildings, residential buildings, dining facilities and athletic facilities."



Yale University: Building Efficiency

Energy initiative summary for 90 pre-2005 buildings



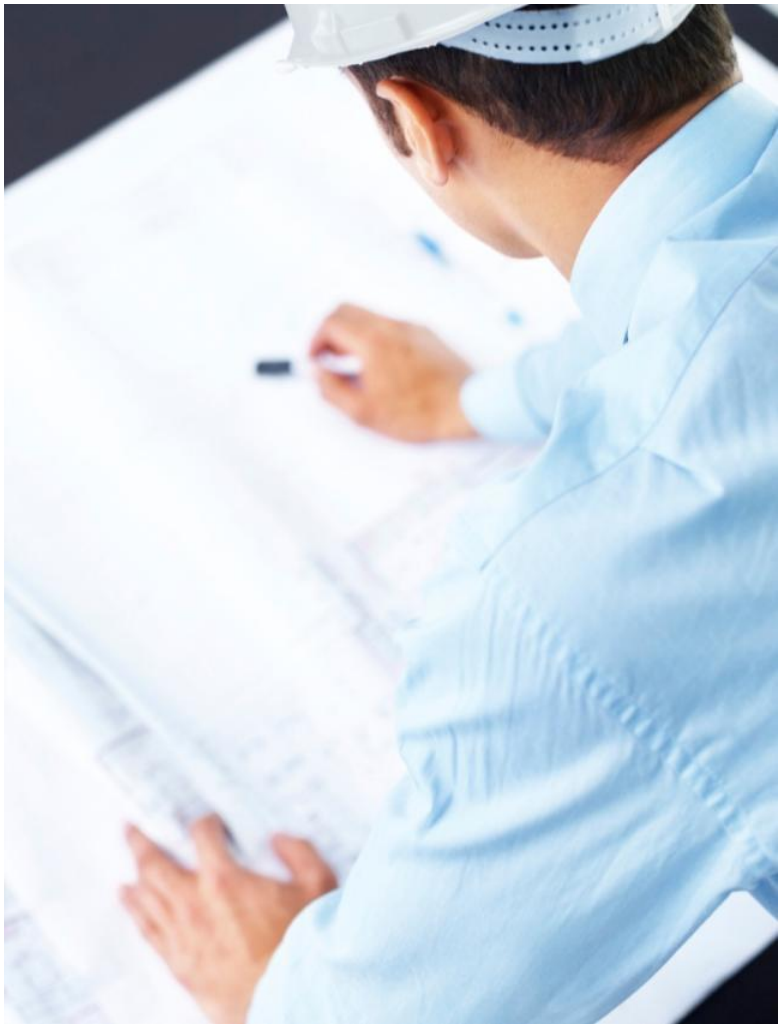
2009 Article: “Before Adding, Try Reducing”

“Efficiency improvements, these sources add, are often an easy, cheap fix in the struggle to reduce CO_2 emissions.”

Taking the Initiative

Optimizing building performance is fundamental to your business

a) Why do most buildings sub-perform?
b) Where do you start?
c) How can you estimate your ROI?



Where Do You Start?

** EH&E offers building benchmarking as a free service.*

Next: Performance Profile

Review **Verify** **Document**

- **What** systems?
- **How** are these systems operating?
- **When** are these systems operating?

Performance Profile

1. Review of Building Systems & Operating Strategy
2. Utility Data Analysis
3. Operating Data Acquisition
4. Data Analysis and Deviations List
5. Report & Savings Estimate

Review of Building Systems

1. Identify Building Systems & Operating Strategy

- Review & Document
  - Building drawings & As-built documentation
  - Control system “sequence of operation”
  - Control “points list”
  - Interview facility operations staff
- Goal
  - Create an operational & performance benchmark

Utility Data Analysis

Account #	ID	Location	Sq.Ft.		Total kWh	kWh/ Sq.Ft.
2637-015-1008	Meter 1	Pods D,E	160,545		3,681,080	**22.93**
2637-034-1005	Meter 2	Pods A, B, C	183,455		6,573,960	**35.83**
		Total	**344,000**	**3** **9**	**10,255,040**	**29.81**

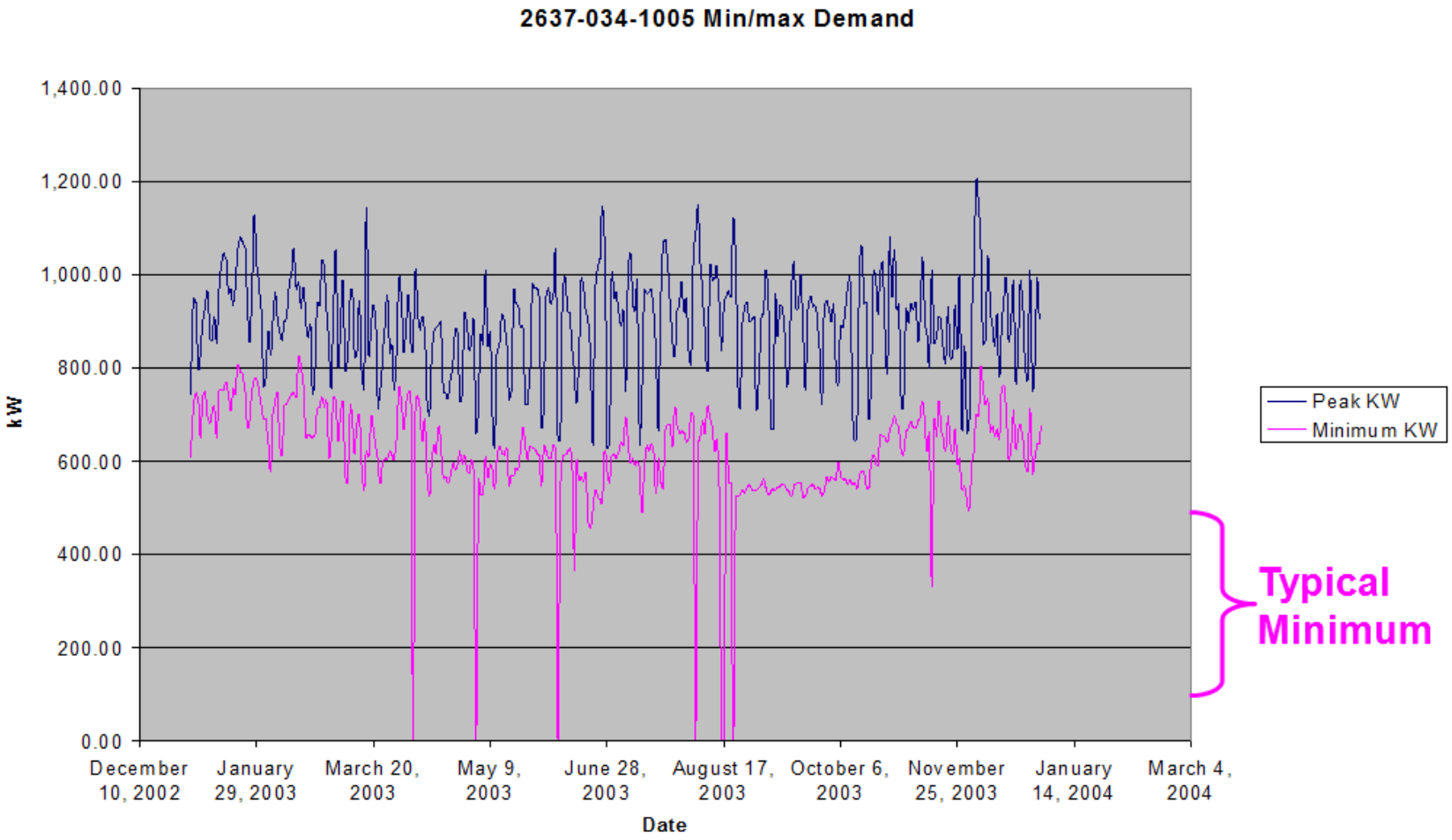
kWh/ Sq.Ft.
22.93
35.83
29.81

Utility Data Analysis

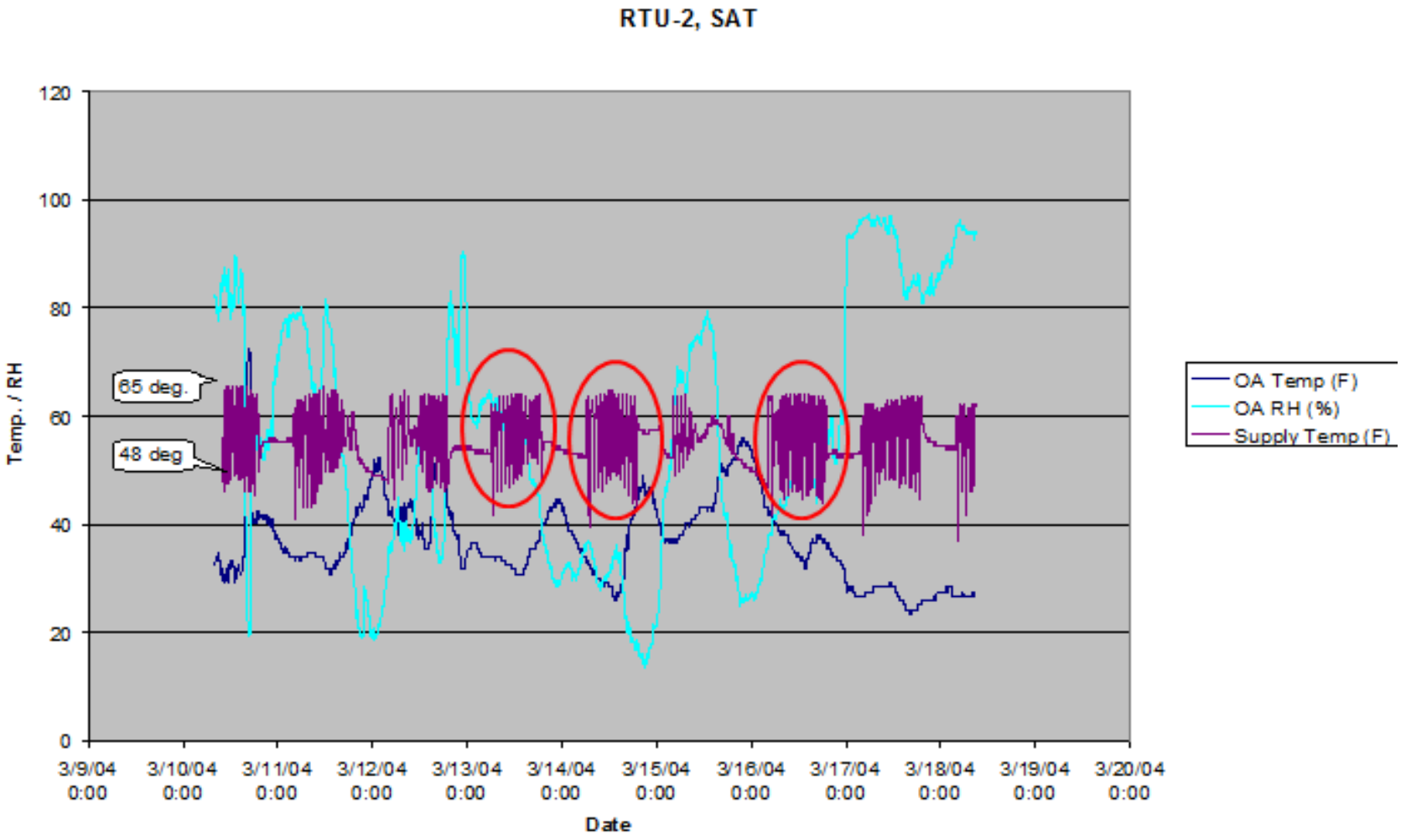
Location	Sq.Ft.	Avg	ar	Total	kWh / Sq.Ft.
Data Center	4,200		760	1,215,888	**289.50**
Mail Center	3,200		760	78,796	**24.62**
Call Center*	7,500		760	613,200	**81.76**
Gas Skada*	3,200		760	700,800	**219.00**
Cafeteria	15,000		760	184,486	**12.30**
Total	**33,100**			**2,793,170**	**84.39**

kWh / Sq.Ft.
289.50
24.62
81.76
219.00
12.30
84.39

Electrical Demand Data Analysis



Operating Data Acquisition



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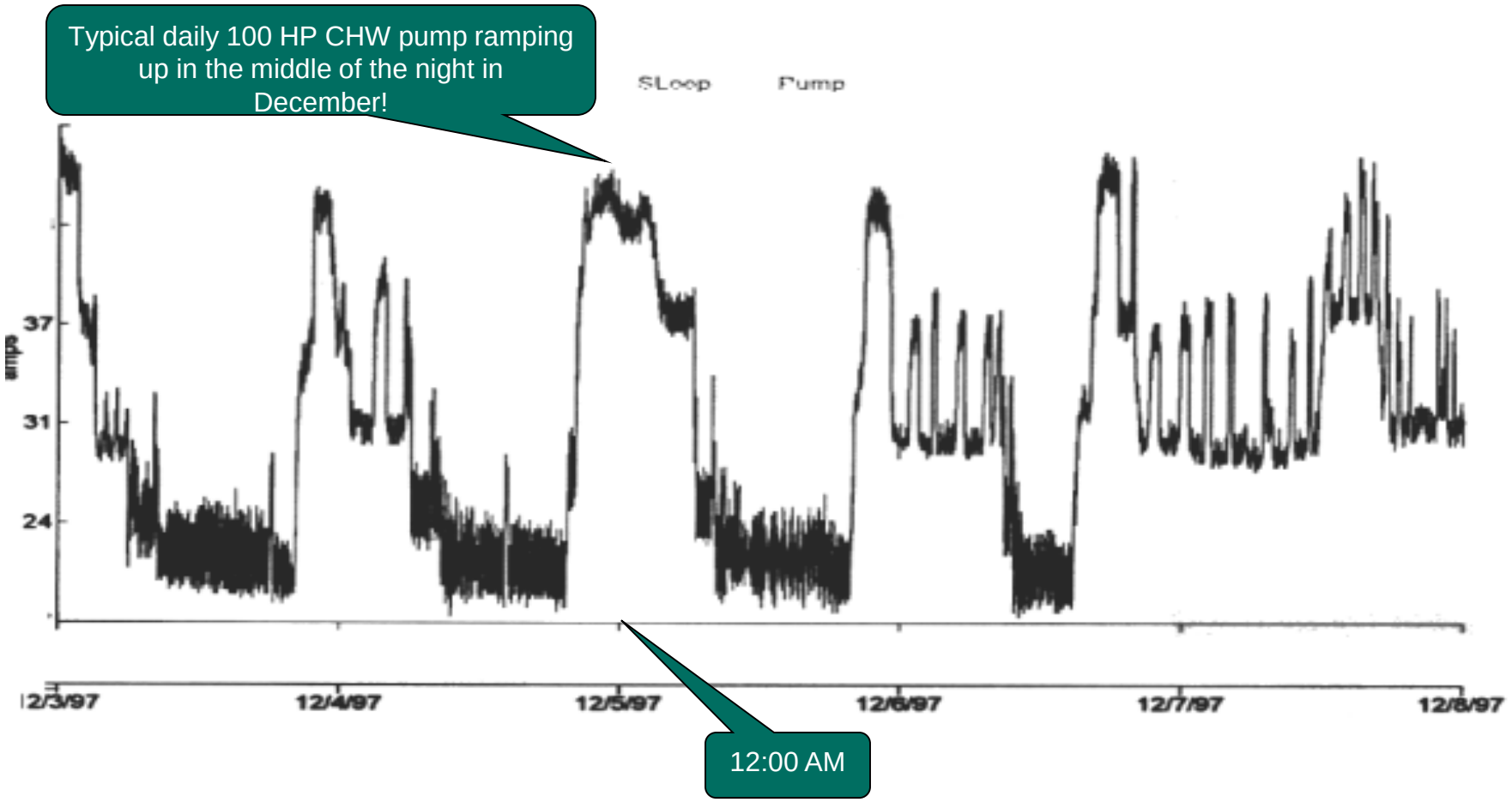

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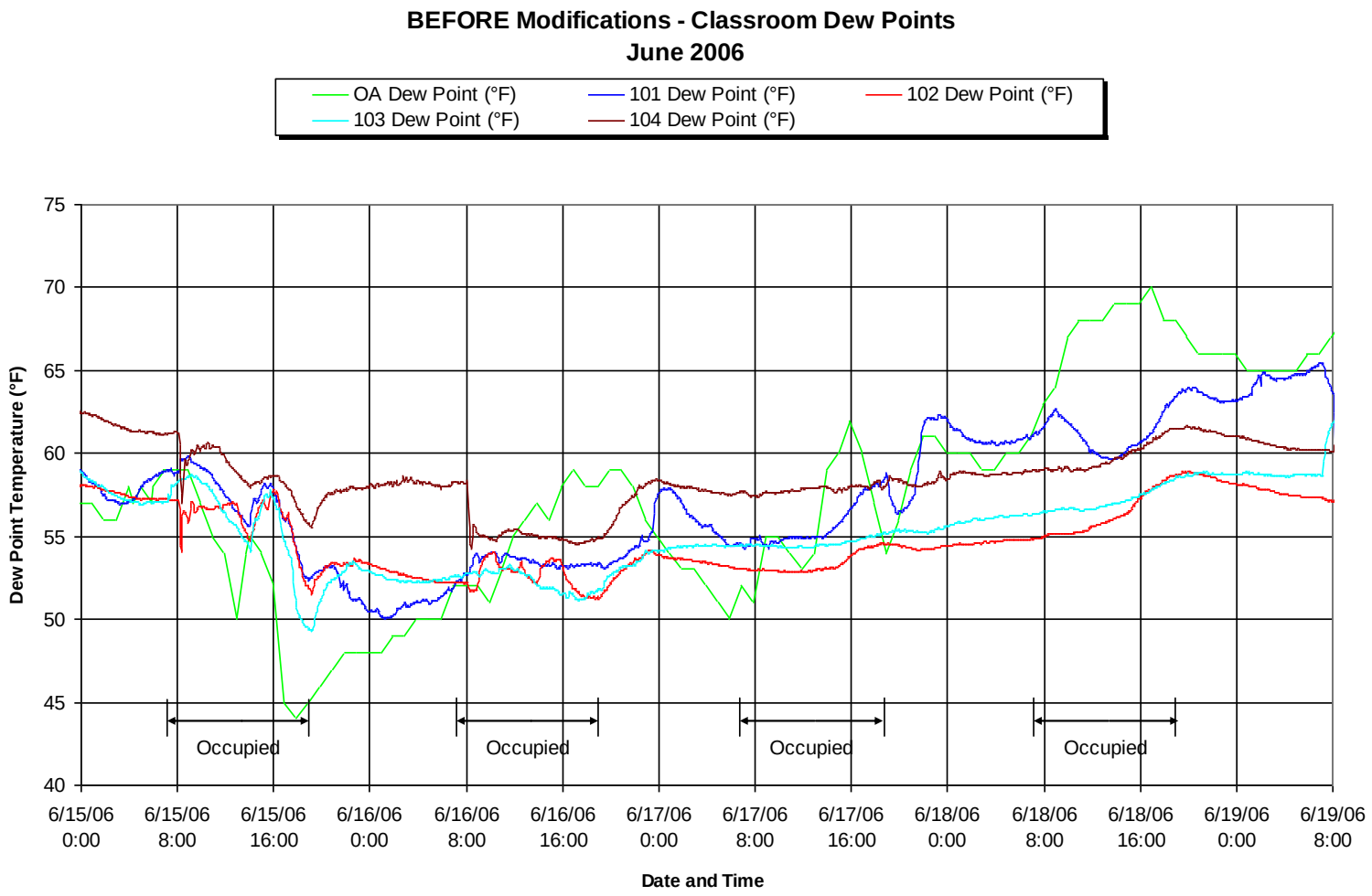

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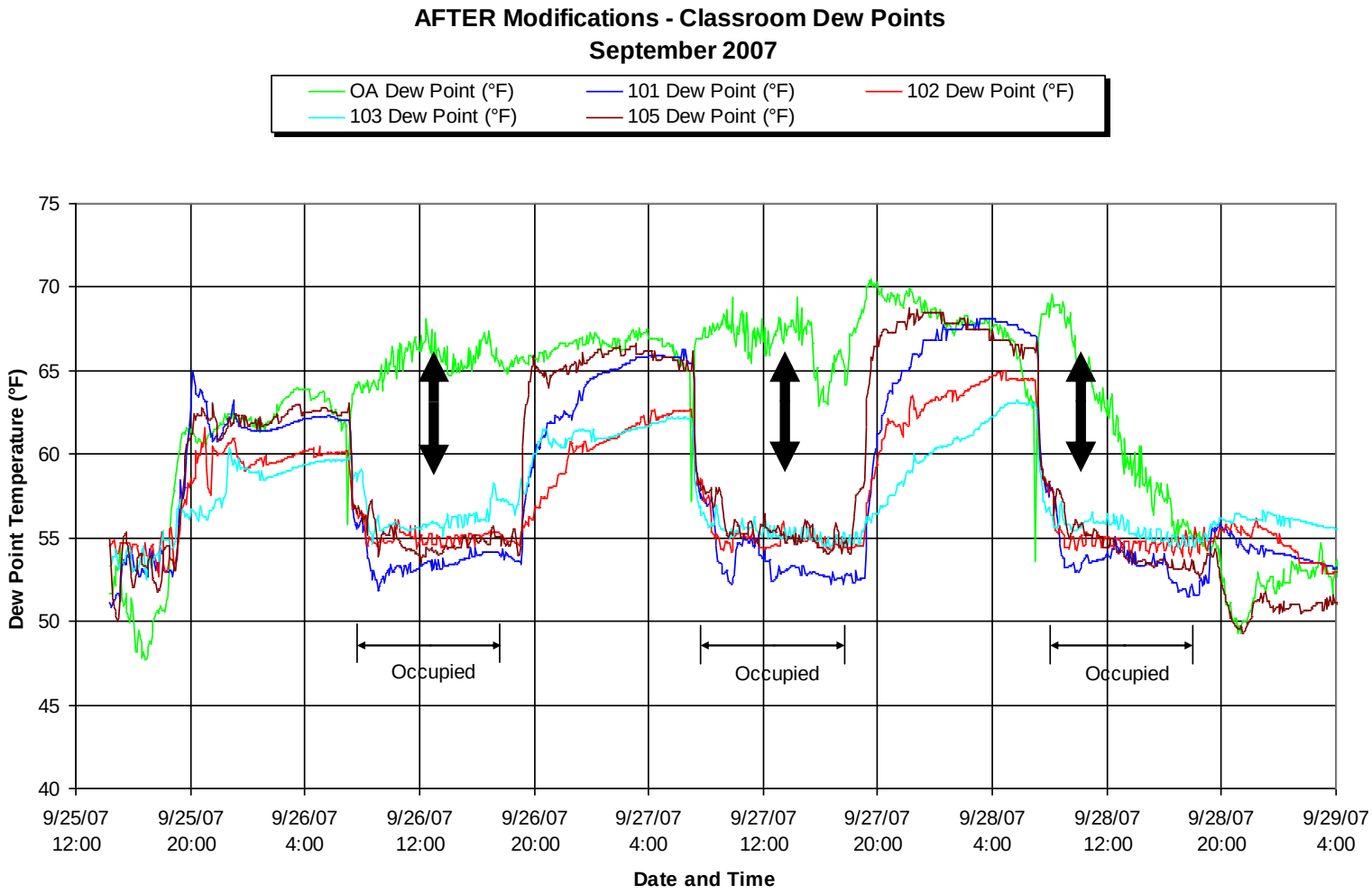


Night Setback Example

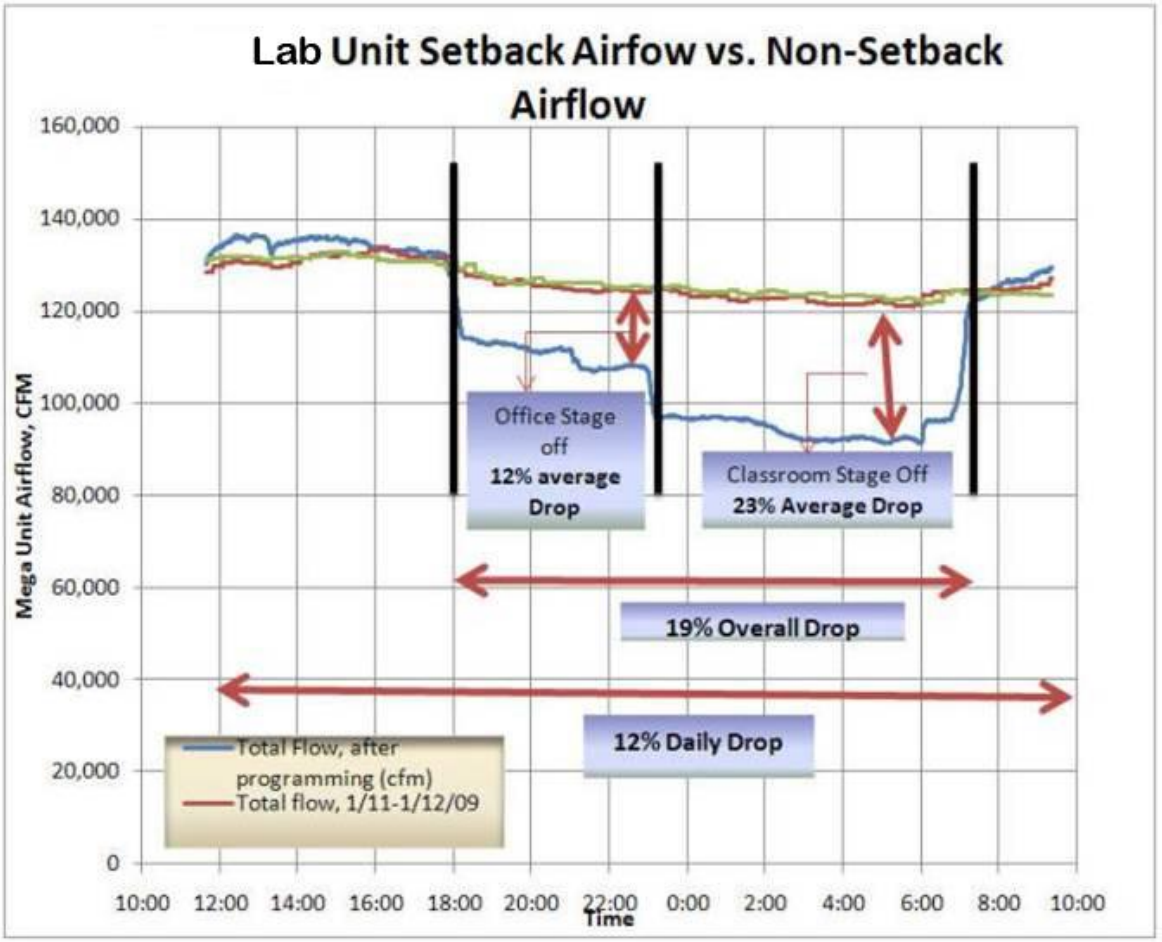


Figure 1 - Airflow versus time after implementing a flow reset strategy.

- ~15,000 cfm reduction
- **@ $5.00 per cfm savings = $75K/yr.**

Case Study: Hospital

Acute care hospital with labs + medical office building

- 337,550 square feet

Energy consumption:

- 9,818,200 kWh (main building)
- 1,456,200 kWh (medical office building)
- 453,638 Therms (central plant)

Energy costs: ~$1,900,000 / year

Target = 10% Total Energy Savings

What makes optimization rise to the top compared to other energy-saving measures?

Client testimonial

- Targets “low cost”
- No client capital investment
- High ROI
- “Right thing to do”

Annual Electrical Use

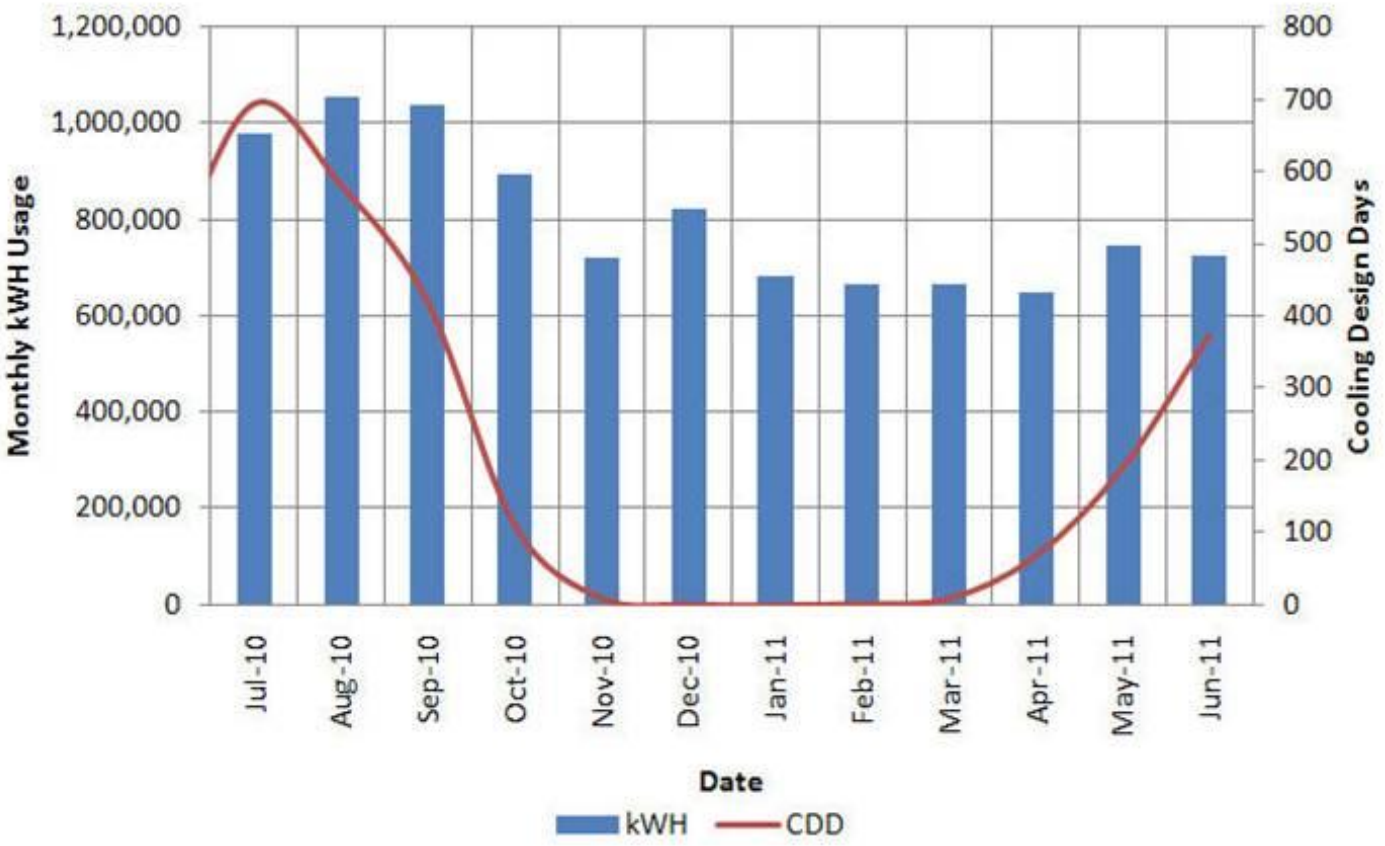


Figure 5.2 Electricity (kWh) Usage from July 2010 to Jun 2011

Peak/Off Peak Data

% Off-Peak kWh
60%
60%
63%
58%
57%
58%
62%
59%
60%
60%
60%
62%
60%

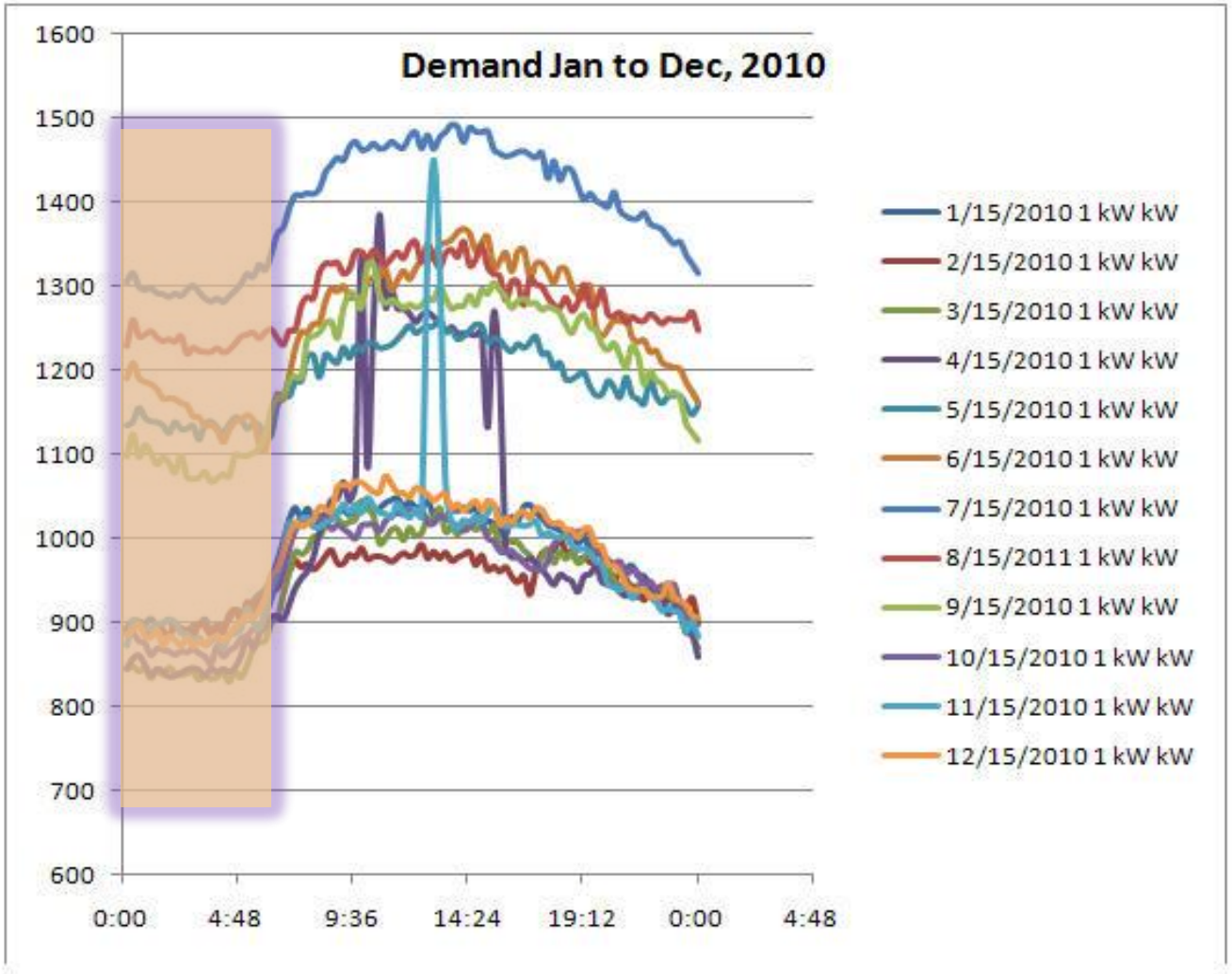
Table 5.1 Case Study Hospital Consumption

Month	Peak kW	Peak	Total kWh	% Off-Peak kWh
Jan-10	1,260	281,400	698,600	60%
Feb-10	1,092	278,600	695,800	60%
Mar-10	1,064	261,800	707,000	63%
Apr-10	1,372	287,000	683,200	58%
May-10	1,456	313,600	733,600	57%
Jun-10	1,792	330,400	791,000	58%
Jul-10	1,778	369,600	978,600	62%
Aug-10	1,834	431,200	1,054,200	59%
Sep-10	1,876	415,800	1,038,800	60%
Oct-10	1,820	357,000	896,000	60%
Nov-10	1,806	287,000	721,000	60%
Dec-10	1,484	315,000	820,400	62%
Annual Totals	**18,634**	**3,928,400**	**9,818,200**	**60%**

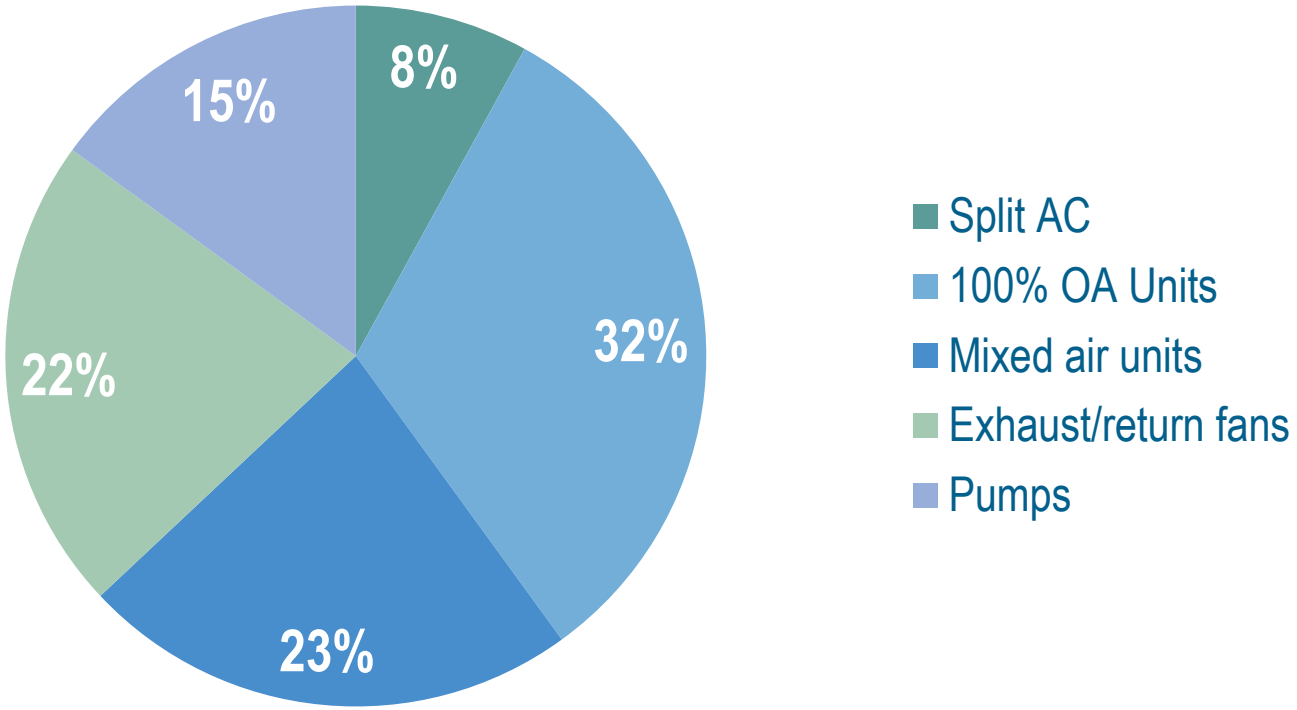
kW kilowatt

kWh kilowatt Hour

24 Hour Demand Profile



Electrical Use / Equipment



kWh Breakdown of Equipment Monitored

Natural Gas Usage

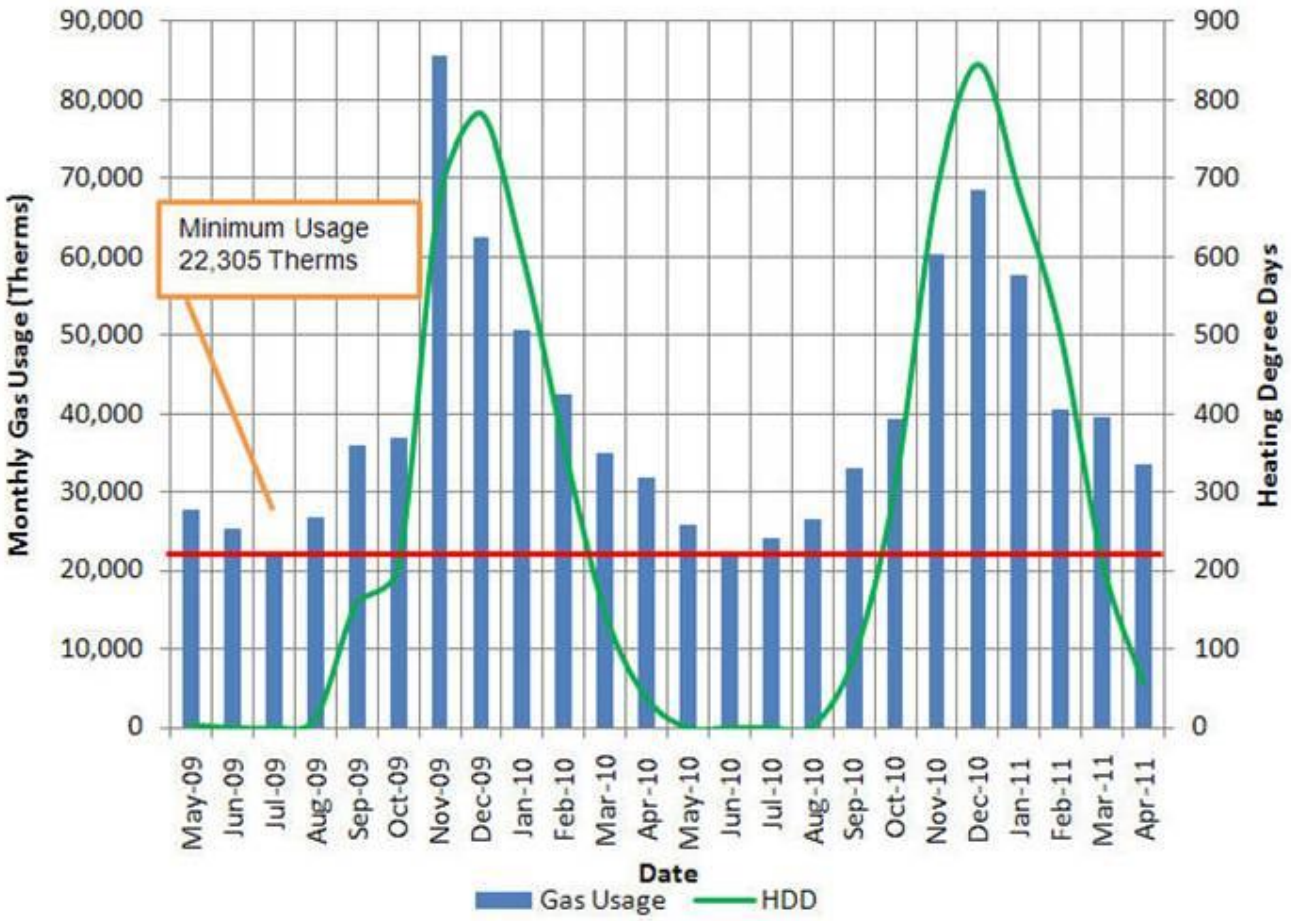
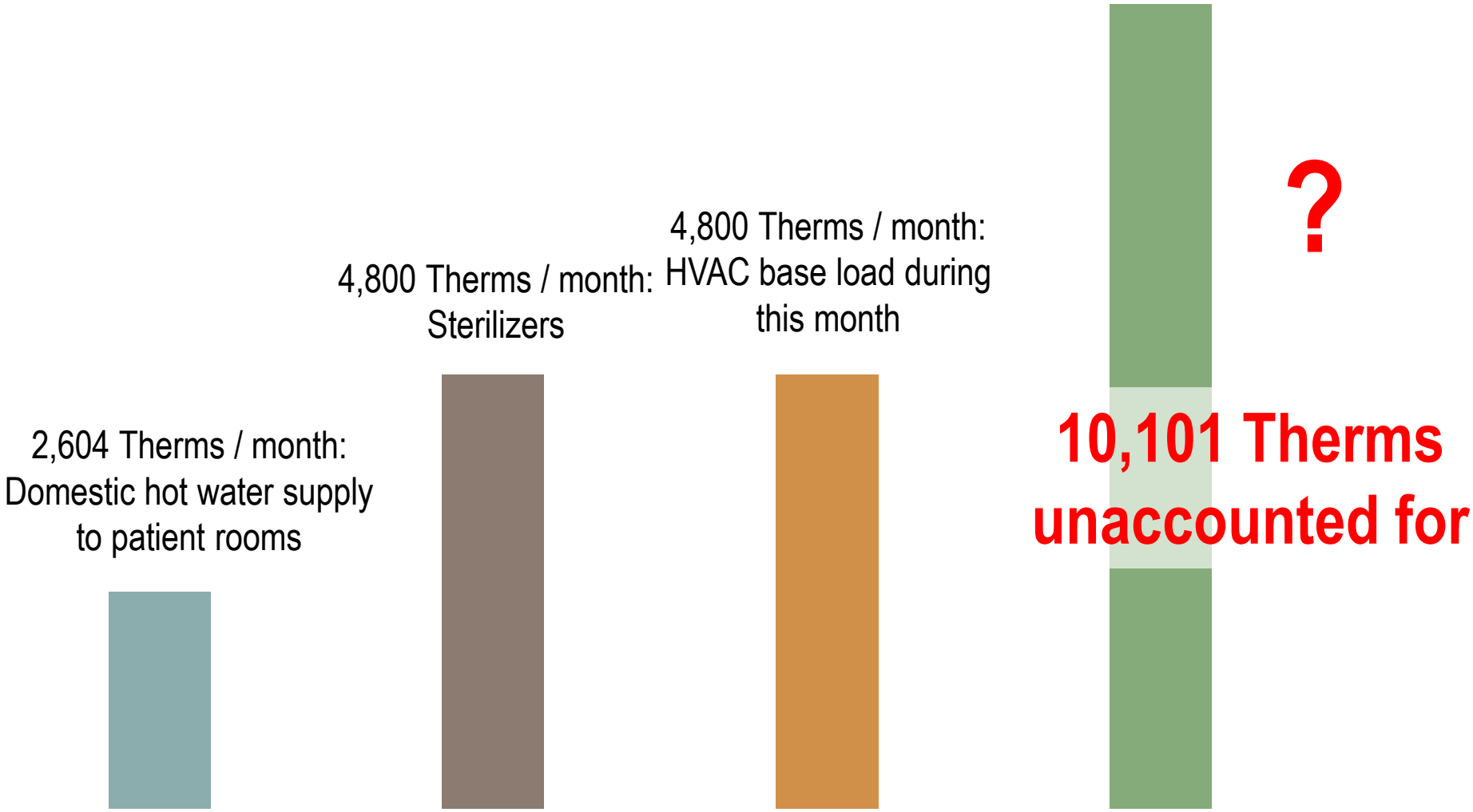


Figure 5.4 Natural Gas Usage, Heating Degree Days

Gas Usage Breakdown



Data Acquisition

6 rounds of 1 week data acquisition

- Air handling units
- Chilled water system
- Steam/hot water system
- Compressors
- Patient rooms
- Non-patient rooms

Space Use / Hours of Operation

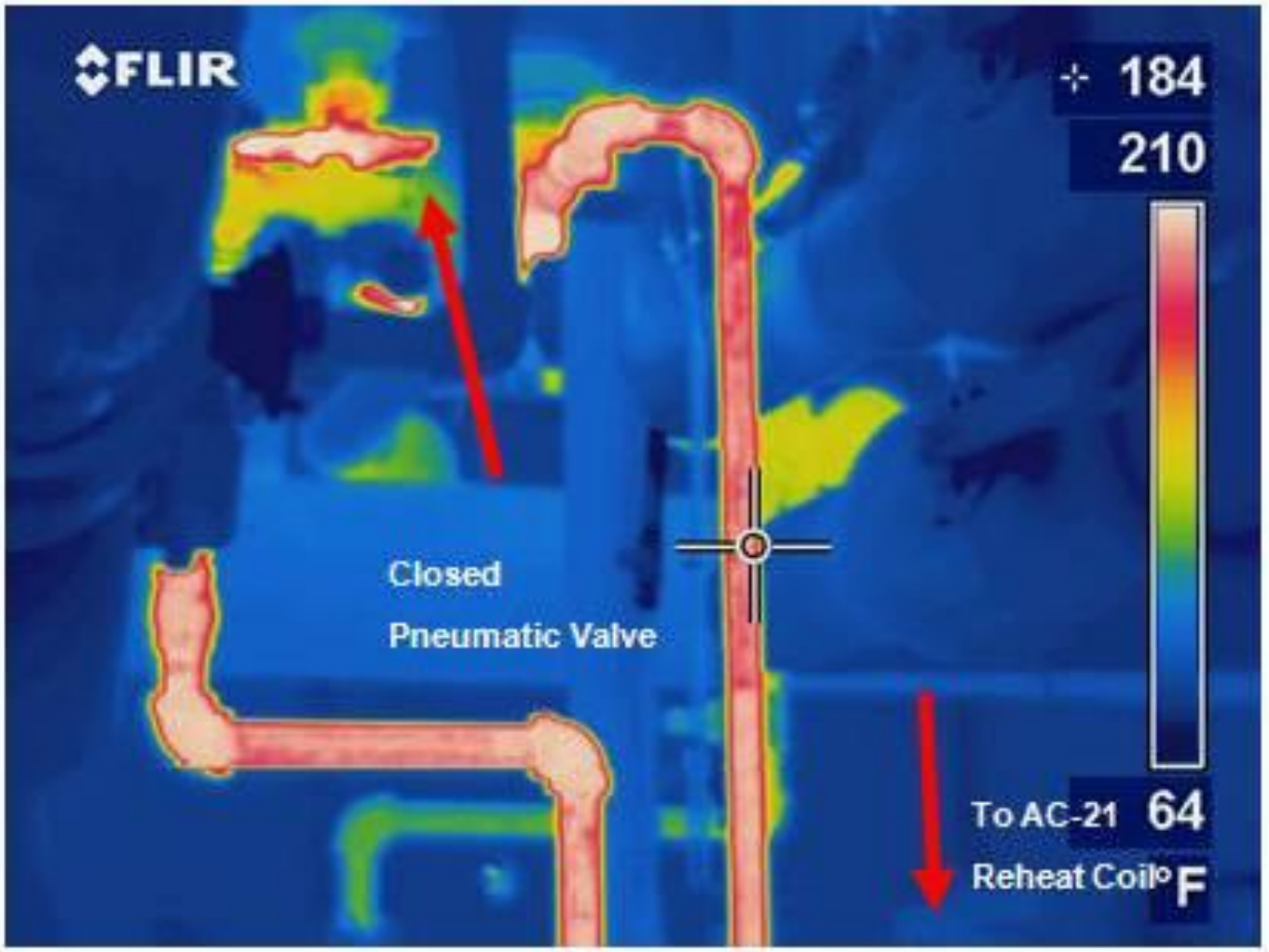
Patient rooms/direct patient support: ~30%

Indirect patient support / office / other

Key Finding / Opportunities

- Building schedule
  - Air handling unit schedule
  - Exhaust fan schedule
  - Fan coil unit setback
- Air handling unit (AHU, AC, RTU) discharge air temperature control and simultaneous heating and cooling
- Hot water pump sequencing
- Equipment maintenance

Steam Valve Leakage



Constant VFD Operation

Figure 4.7 Supply and Return Fan Amperages for AHU-2

Fan Coil Unit Maintenance

Photograph 4.4 Fan Coil Unit with Dirty Coils/Housing

Estimated Savings

Equipment	Recommended Change	kWh Savings	Annual Electric Savings($)	Gas Unit Savings (Therms)	Annual Gas Savings($)	Total Annual Savings($)	Cost to Fix ($)	Simple Payback (years)
AC-4,5,14,15, 33 AHU-2	Set the air handling units on an occupancy schedule (Fan Savings)	213,693	$21,797	–	–	$21,797	$3,800	.17
	Set the air handling unit on an occupancy schedule (Heating/Cooling Savings)	62,649	$6,390	10,810	$10,810	$17,200	$3,800	.22
Air Handling Units	Fix steam leak-by on air handling unit reheat valves. Savings assume 15% leak-by on 75% of units.	232,996	$23,766	27,976	$27,976	$51,741	$23,000	.44
Hot Water Pumps 1,2,3	Adjust operating schedule to run fewer pumps during the cooling season (Pump Savings)	14,298	$1,458	–	–	$1,458	$1,000	.69
Fan Coil Units	Set approximately 40% of fan coil units on a temperature setback plan	142,798	$14,565	3,682	$3,682	$18,248	$52,500	2.88
Total	–	666,433	$67,976	42,468	$42,468	**$110,444**	$84,100	.76

Updated Savings

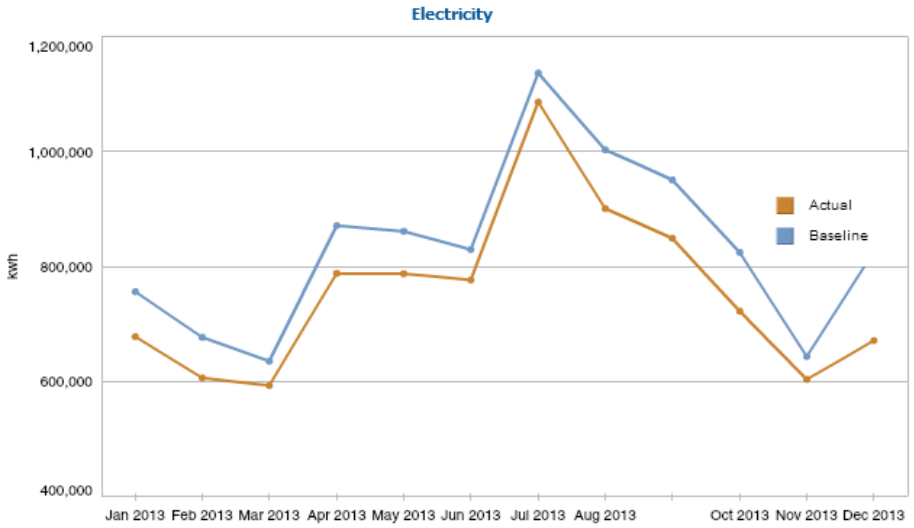
Equipment	Recommended Change	kWh Savings	Annual Electric Savings($)	Gas Unit Savings (Therms)	Annual Gas Savings($)	Total Annual Savings($)	Cost to Fix ($)	Simple Payback
AC-4, 5,10, 12, 13/16,14,15, Moakley, Cancer Center, 30, 31	Set the air handling units on an occupancy schedule (Fan Savings)	506,251	$ 60,750	-	$ -	$ 60,750	$ 7,600	0.13
	Set the air handling unit on an occupancy schedule (Heating/Cooling Savings)	120,327	$ 14,439	124,969	$ 124,969	$ 139,408	$ 7,600	0.05
Air Handling Unit Steam Valves	Fix steam leakby on air handling unit reheat valves. Savings assume 15% leakby on AC-6, 8, 9, 10, 12, 14, 15, 13/16, 18, 19, 20, 21, 30, 31	189,624	$ 22,755	40,598	$ 40,598	$ 63,353	$ 23,000	0.36
Hot Water Pumps 1,2,3	Adjust operating schedule to run fewer pumps during the cooling season (Pump Savings)							
Fan Coil Units	Set approximately 40% of fan coil units on a temperature setback plan							
Total		816,202	97,944	165,567	165,567	$ 263,511	38,200	0.14

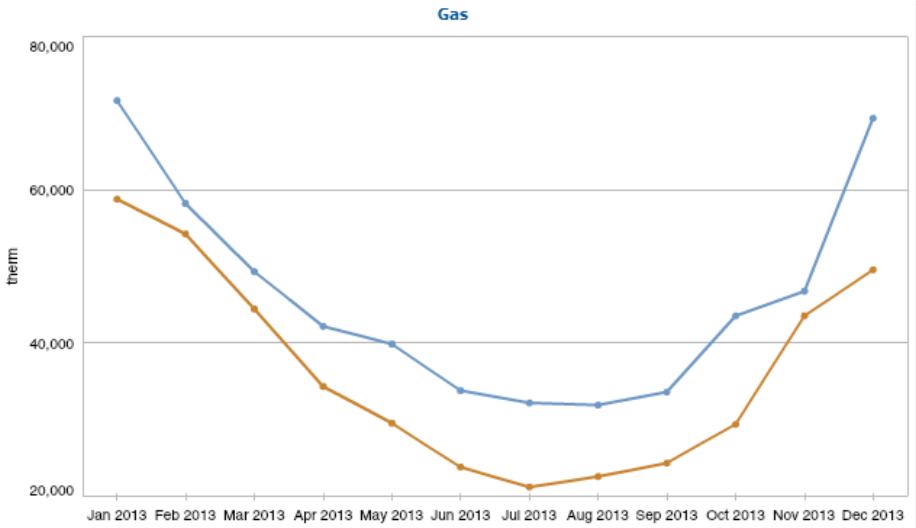
< 2 month payback

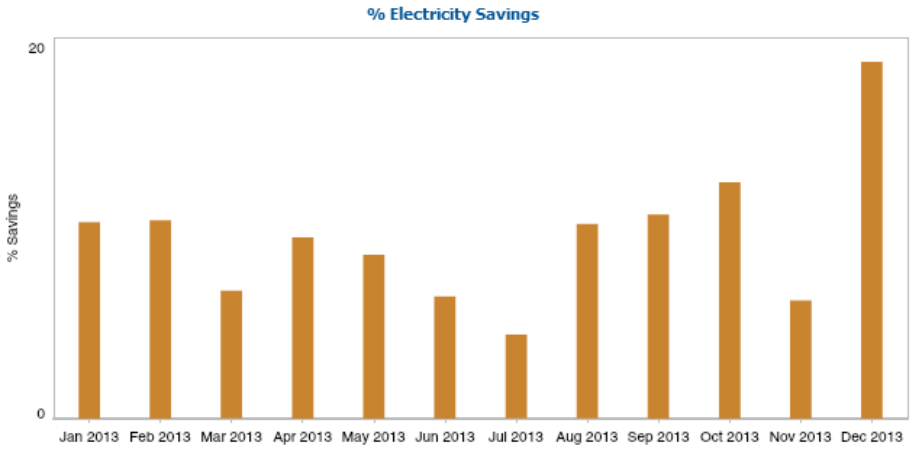
Additional Opportunities

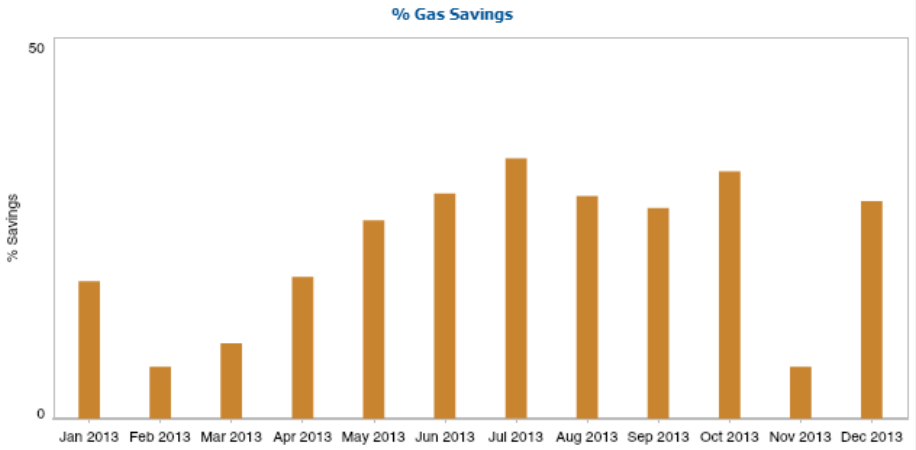
- Patient room FCU improvements
- Economizer mode optimization
- Chilled water distribution control
- Compressor improvements
- Process equipment scheduling
- Optimized schedule for ORs, radiology, labs, etc.

Health Care Campus Dashboard
Hospital One









Results

Hospital One

	Electric Savings		Gas Savings		Total Savings		Total Energy
	KwH	($)	therms	($)	kBtu	($)	Savings (%)
Performance Year	614,992	$73,799	105,779	$97,316	12,675,229	$171,115	14%
Maintenance Year 1	908,653	$109,038	112,796	$103,772	14,378,313	$212,810	16%
Maintenance Year 2	464,347	$55,721	33,739	$31,039	4,957,226	$86,761	13%

Hospital Two

	Electric Savings		Gas Savings		Total Savings		Total Energy
	KwH	($)	therms	($)	kBtu	($)	Savings (%)
Performance Year	493,900	$59,268	75,095	$69,087	9,193,699	$128,355	12%
Maintenance Year 2	464,347	$55,721	33,739	$31,039	4,957,226	$86,761	13%

Hospital Three

	Electric Savings		Gas Savings		Total Savings		Total Energy
	KwH	($)	therms	($)	kBtu	($)	Savings (%)
Performance Year	972,757	$116,730	52,622	$48,412	8,579,301	$165,143	11%

Hospital Four

	Electric Savings		Gas Savings		Total Savings		Total Energy
	KwH	($)	therms	($)	kBtu	($)	Savings (%)
Performance Year	675,849	$81,101	220,578	$202,931	24,362,445	$284,033	19%

Total Savings

74,146,213kBtu

$1,048,217

Analysis To Insights

PROFIT

$102,000 per month → **1,500** inpatient days per month *(profit)*

$1 MILLION to date → **2** MRI machines *(purchase)*

$1.8 MILLION projected savings → increase in **$45M** revenue (top-line)

PLANET

4,130,000 kwh of electricity → **599** cars

600,000 therms of natural gas → **81,569** trees

6,028 tons of carbon dioxide → **550** homes' energy

PEOPLE

Supporting organization of Boston Green Ribbon Commission

Better than 60% of all U.S. hospitals in Energy Intensity

Candidate for Energy Star Battle of the Buildings

Steward Health Care Energy Optimization Program in partnership with EH&E, Needham, MA | www.eheinc.com | as of April 2014

What have the results been from optimization across the organization?

Client testimonial

- "Extraordinary"
- Exceeded savings targets (14% vs. 10%)
- Total system wide savings should be ~ $2 Million
- Facility Staff "buy-in"

Summary

- Improving performance is high-ROI
- Requires strategic monitoring and inspection
- Focus is on using existing equipment efficiently (as intended)
- Improvement is predictable (>10%)

Summary

Improving building performance can significantly improve business performance.

- Lower energy costs
- Reduce complaints/maintenance tickets
- Reduce premature equipment failures
- Better (funded) capital improvement plans
- Lower occupancy costs
- Higher employee productivity
- Successful facilities managers!

Questions

2014 NCBC

ENVIRONMENTAL HEALTH & ENGINEERING, INC.

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