GLOBAL TRAINING CENTER
DUBAI

# Effective Energy Management in New and Existing Buildings (MENA)

Hassan Younes, Member ASHRAE, BEAP, BEMP, HBDP, CPMP, HFDP, OPMP

**Based on the *Effective Energy Management in New and Existing Buildings* course by Richard J. Pearson, P.E., ASHRAE Fellow**

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# Effective Energy Management in New and Existing Buildings (MENA)

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**Course ID: 920018783**

# Presenter Biography

Hassan Younes has over 15 years of extensive experience in the fields of Energy Efficiency, Design, Sustainability, and Project Execution and Management. Prior to co-founding grfn, he was the Mechanical Manager at Meraas Holding, one of the leading developers in the region and was involved in the design of multiple large-scale developments.

He is a trainer for the ASHRAE Global Training Centre. He is an appointed Consultant for ASHRAE 62.1 Standard. He is a Certified trainer for CEM (Certified Energy Manager) course, Certified Measurement Verification Professional (CMVP) course and the trainer for the Emirates Green Building Council Building Retrofit Program. He is also the current ASHRAE Falcon Chapter president and on the technical committee and was the Vice Chair of CIBSE Regional Chapter. He holds all the ASHRAE certifications. He has been involved in many high-end projects in the MENA region.

# Today's Audience

- People responsible for facility management inside their organization
- Consulting engineers who provide energy management services to facilities
- Engineers who provide advice on energy management to facility managers and staff
- Vendors selling products to facilities

# Course Objectives

- Describe the ENERGY STAR® management cycle
- Analyze basic billing and load profile information
- Interpret weather-adjusted energy data
- Distinguish the levels I, II and III of a commercial building energy audit
- Identify opportunities for energy savings in your buildings based on course suggestions
- Develop an action plan to get started, targeting:
  - Preliminary energy analysis **or**
  - A test of discretionary facility operation.

# Guides for Today's Seminar


ENERGY STAR Guidelines for Energy Management

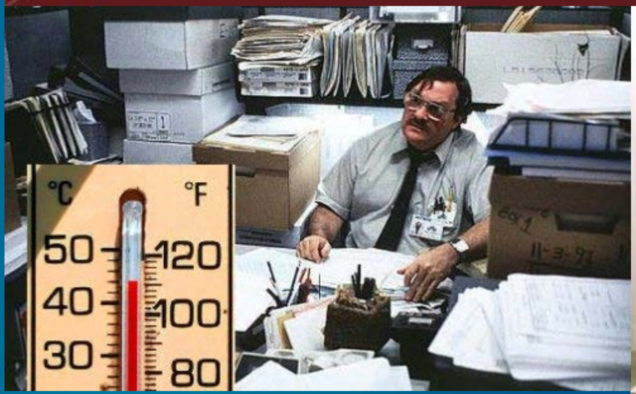
Connections:

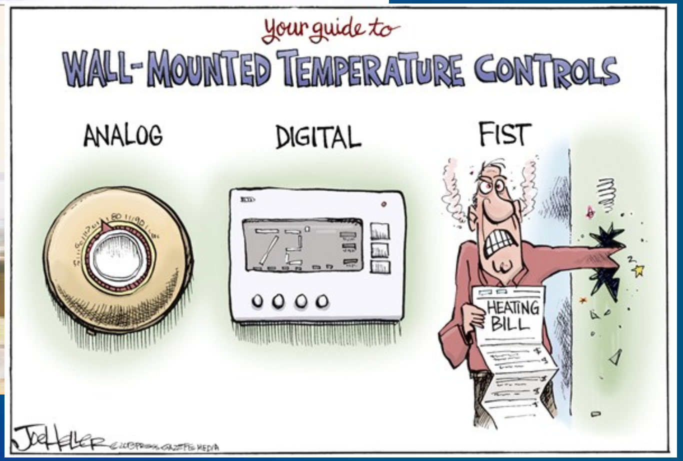
- ASHRAE Standard 100-2018, *Energy Efficiency in Existing Buildings*
- ASHRAE Standard 211-2018, *Standard for Commercial Building Energy Audits*
- *2015 ASHRAE Handbook—HVAC Applications*, Chapter 36
- Practical experience
- Opportunities in your buildings

# Today's Topics

1. Introduction to energy management
2. Why commit to energy management?
3. Assessing performance and setting goals
4. Action plans: ideas and a test method
5. Evaluating results, including adjusting for weather
6. Energy management summary
7. What can you do, starting next week?

# “Discomfort is Expensive”



# For Example…

If typical office building includes one person for every 28 $m^2$

And the annual utility cost is $21.5 per $m^2$

Then each person is “responsible” for $600 per year

---

If dramatic energy conservation reduces energy usage by 50%, or $10.76 per $m^2$

Then savings per person = $300 per year

---

If average worker salary is $50,000/yr

Then savings per person = $300/$50,000 = 0.6%

**Therefore any level of discomfort that distracts a person will clearly cost more in lost productivity than the $300 savings in energy**

# Introduction to Energy Management

# Energy Management 101—Example

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

# Energy Management 101
# **The Building**

20-story office building:

- 200,000 $ft^2$ (18,580 $m^2$)
- Five years old, no energy conservation
- Complex, energy intensive HVAC systems
- High utility bills
- No building automation system

# Energy Management 101
# How It Worked

Actions by facility manager:

- Reviewed operations ideas with building engineer and design engineer
- Reviewed daily meter data for impact, intuitively adjusting for weather
- Harassed/complimented building engineer daily on performance

# Energy Management 101
# How It Worked

Actions by building engineer:

- Aligned building schedules with occupancy times
- Raised cold deck temperature
- Lowered hot deck temperature
- Outdoor air was introduced only during occupied hours
- Reduced duct pressures

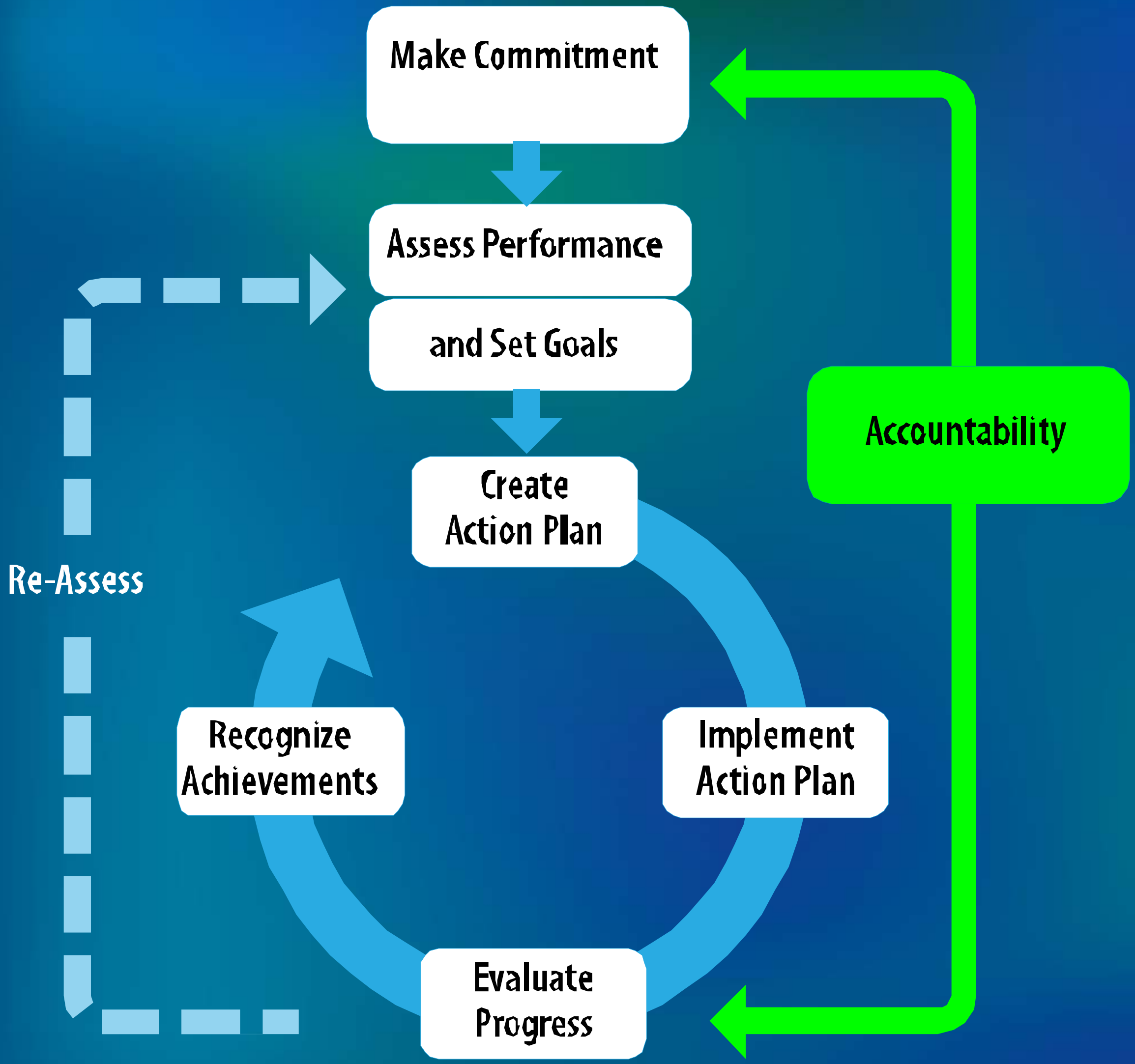
**Savings in one year: 33%!**

# Here’s a Word About Capital Projects

Energy management is the foundation for *effective* capital upgrades:

- Measure performance
- Monitor performance over time
- Deploy operations changes along with new equipment to get greatest bang for buck

# The *Management* Content of Energy Management




www.energystar.gov

ENERGY STAR guidelines describe a management cycle that helps you with execution—getting things done!

# Energy Manager Job Description

Chapter 36, 2015 *ASHRAE Handbook—HVAC Applications*

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

# Job Description—Purchasing

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

# Jerry Eaton's Story

- Headquarters in Fond du Lac, Wisconsin
- Manufacturing and sales organization
- Multiple facilities across the U.S.
- Multimillion dollar utility bill
- Jerry Eaton—energy manager
- >$1 million annual savings (>5% of bills)

# Jerry Eaton's Discoveries

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

# Jerry Eaton's Parallel Activities

Developed a corporate-wide chain of accountability:

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

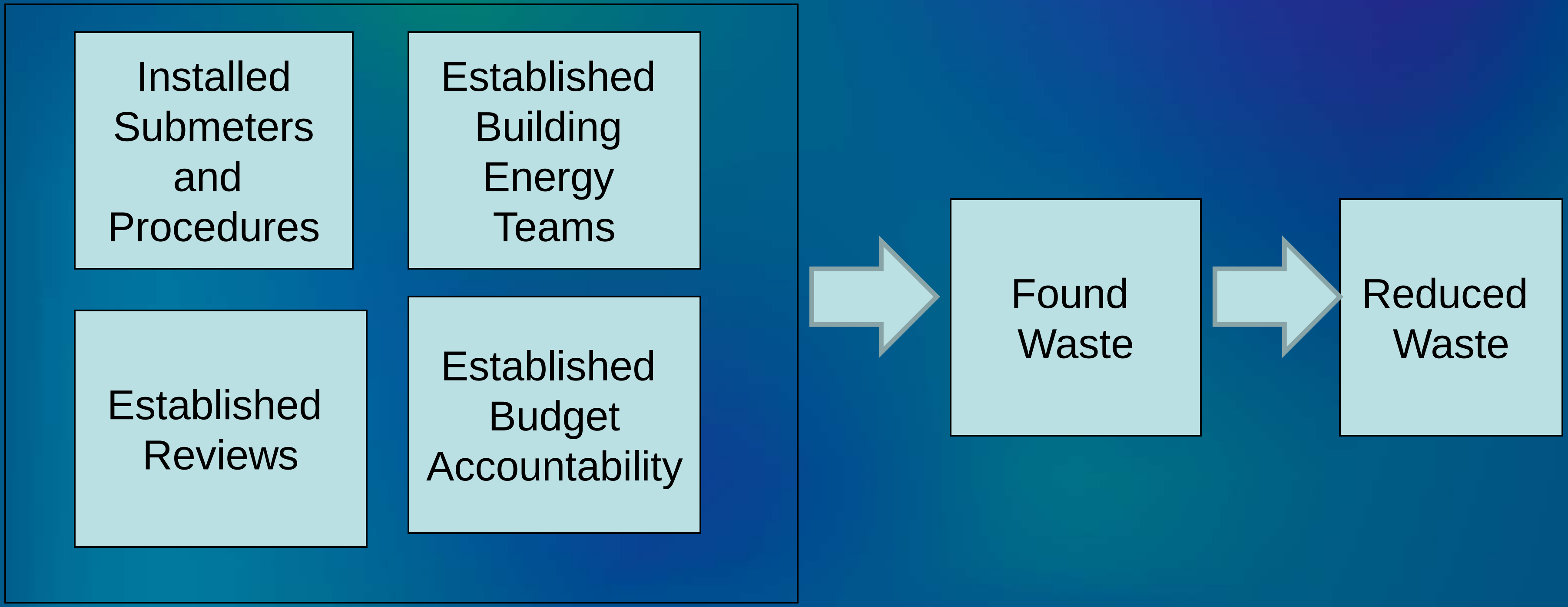
# Jerry Eaton's Parallel Activities

Developed an accountability process to review results regularly

**Typical *monthly* agenda:**

1. A look back
   - Submeter data review, check impact of last month's action ideas
2. A look forward
   - Brainstorm ideas to decrease energy
   - Commit to try ideas (who, when)

# Jerry Eaton's Parallel Activities: Summary



# Jerry Eaton's Success Story

- The cost of energy became real for each unit
- Energy teams, by building or department
- The "buck" stopped at one person in each department

➡ Annual savings: over $1 million (>5%)

# Meters and Submeters

- 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?

# Measurement Technology

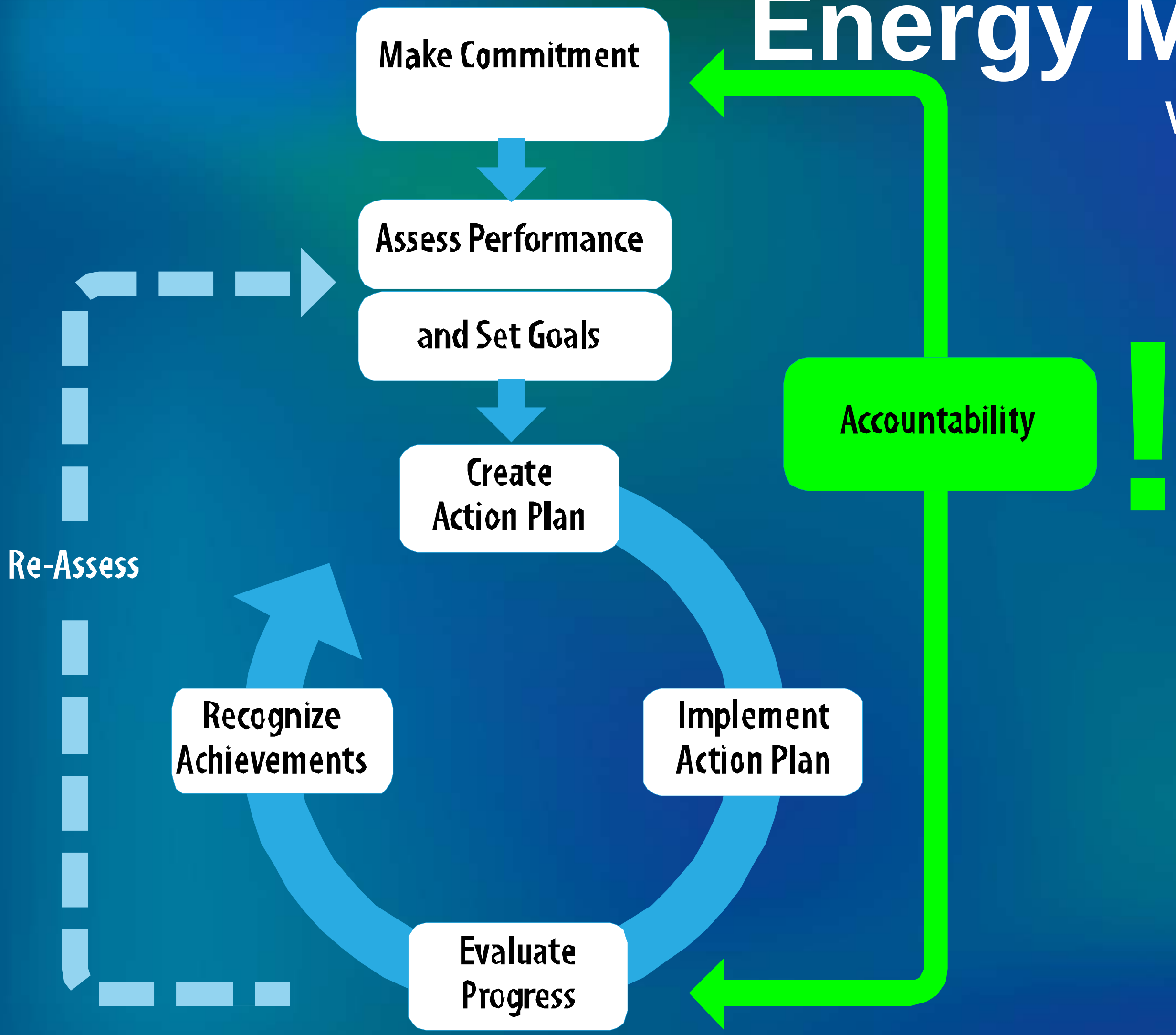
- Measurement technology is continuously improving and becoming more affordable
- More than one way to develop measurements that are useful in an energy management program
- Creative thinking and competitive bidding can produce surprising results

# Was Jerry Eaton Really an Energy Manager?

- Authority to manage energy?
- Responsibility?
- Accountability?

# ENERGY STAR Guidelines for Energy Management

www.energystar.gov



# Exercise 1: Energy Management Assessment

Page 3
in the
exercises

## Exercise 1: Energy Management Assessment

1. Name a building in your organization that might be a good candidate for energy management:______________________________.

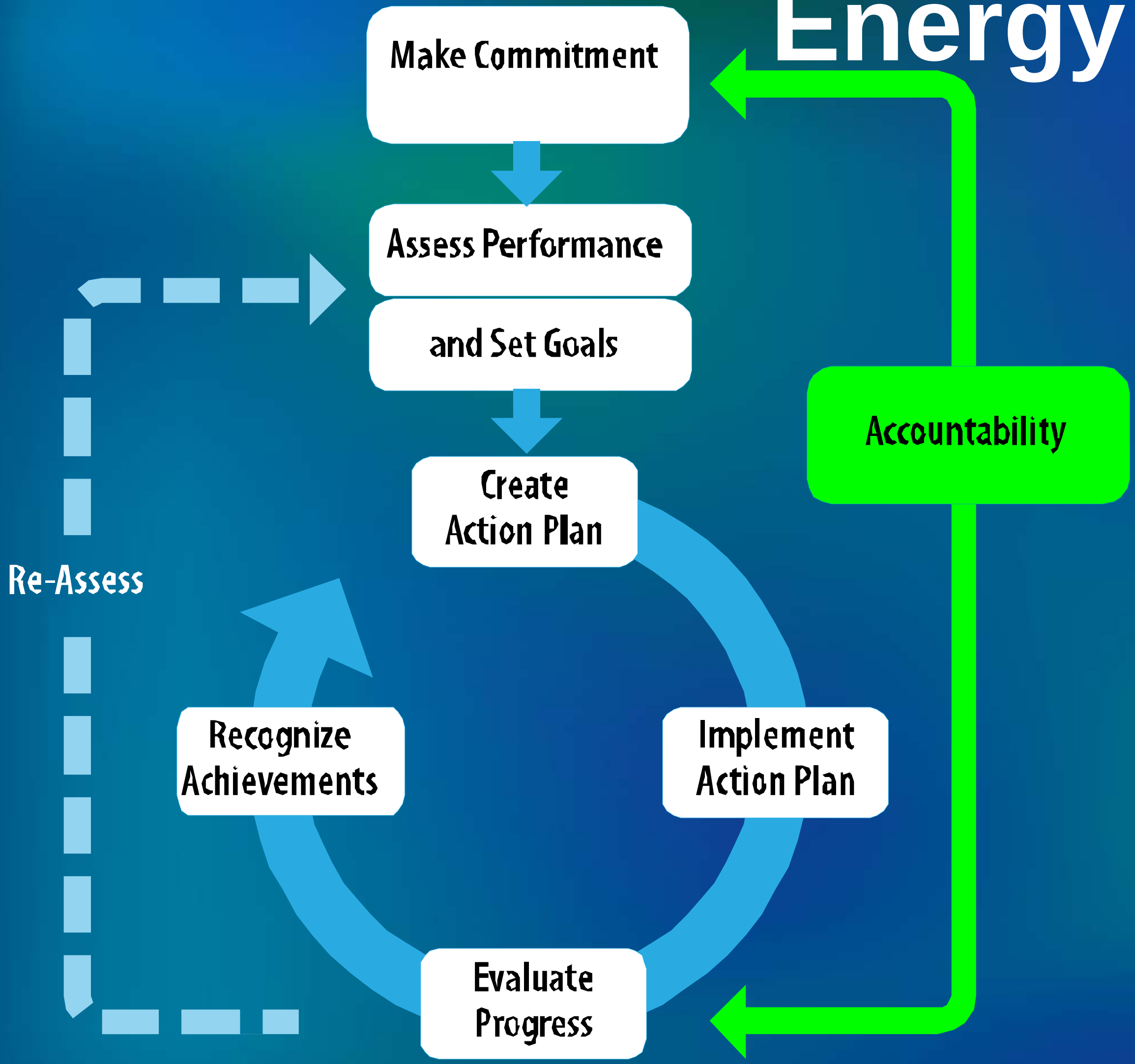
2. Use the checklist to evaluate the state of energy management for this building.

| ***Energy Management Accountability Check*** | | ***Notes*** |
|---|---|---|
| 1. Energy use is measured | | |
| a. Monthly | ☐ Yes ☐ No ☐ Not Sure | |
| b. Daily *Bonus* | ☐ Yes ☐ No ☐ Not Sure | |
| c. Hourly *Bonus* | ☐ Yes ☐ No ☐ Not Sure | |
| | | |
| 2. Somebody is responsible to know what the energy use is | | |
| a. yearly | ☐ Yes ☐ No ☐ Not Sure | |
| b. monthly | ☐ Yes ☐ No ☐ Not Sure | |
| c. daily *Bonus* | ☐ Yes ☐ No ☐ Not Sure | |
| | | |
| 3. The responsible person can show you the energy use by table or graph of | | |
| a. Yearly records | ☐ Yes ☐ No ☐ Not Sure | |
| b. Monthly records | ☐ Yes ☐ No ☐ Not Sure | |
| c. Daily records *Bonus* | ☐ Yes ☐ No ☐ Not Sure | |
| d. Hourly records *Bonus* | ☐ Yes ☐ No ☐ Not Sure | |

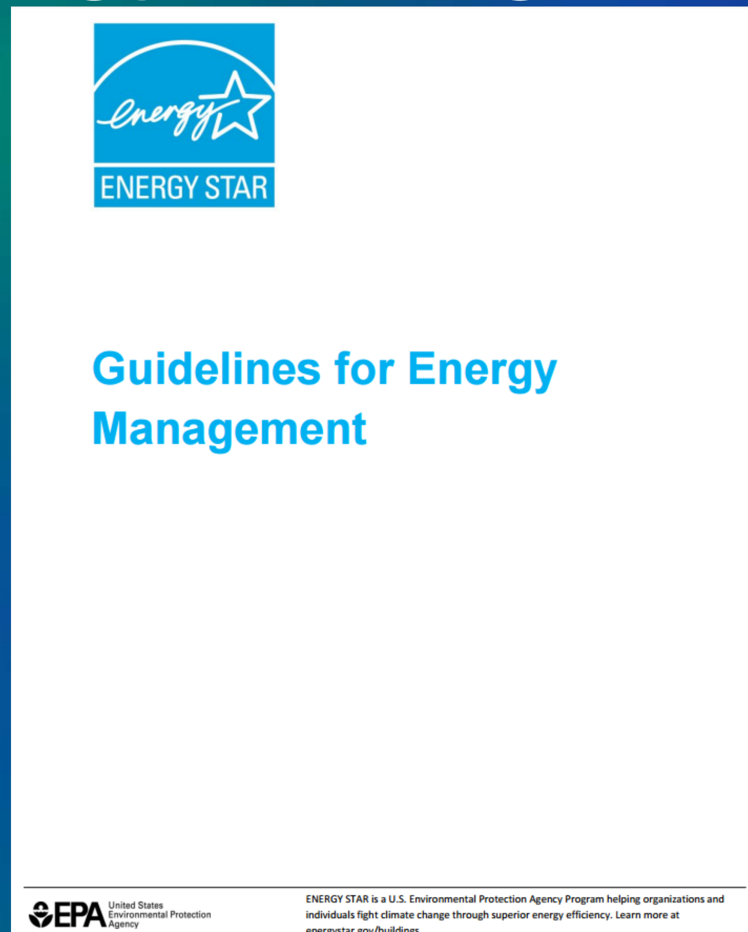
# Why Commit to Energy Management?

# ENERGY STAR Guidelines for Energy Management

www.energystar.gov



# ENERGY STAR Guidelines for Energy Management


energy
ENERGY STAR

Guidelines for Energy Management

EPA United States Environmental Protection Agency

ENERGY STAR is a U.S. Environmental Protection Agency Program helping organizations and individuals fight climate change through superior energy efficiency. Learn more at energystar.gov/buildings.

https://www.energystar.gov/sites/default/files/buildings/tools/Guidelines%20for%20Energy%20Management%206_2013.pdf.

# Dollar Savings and Margin

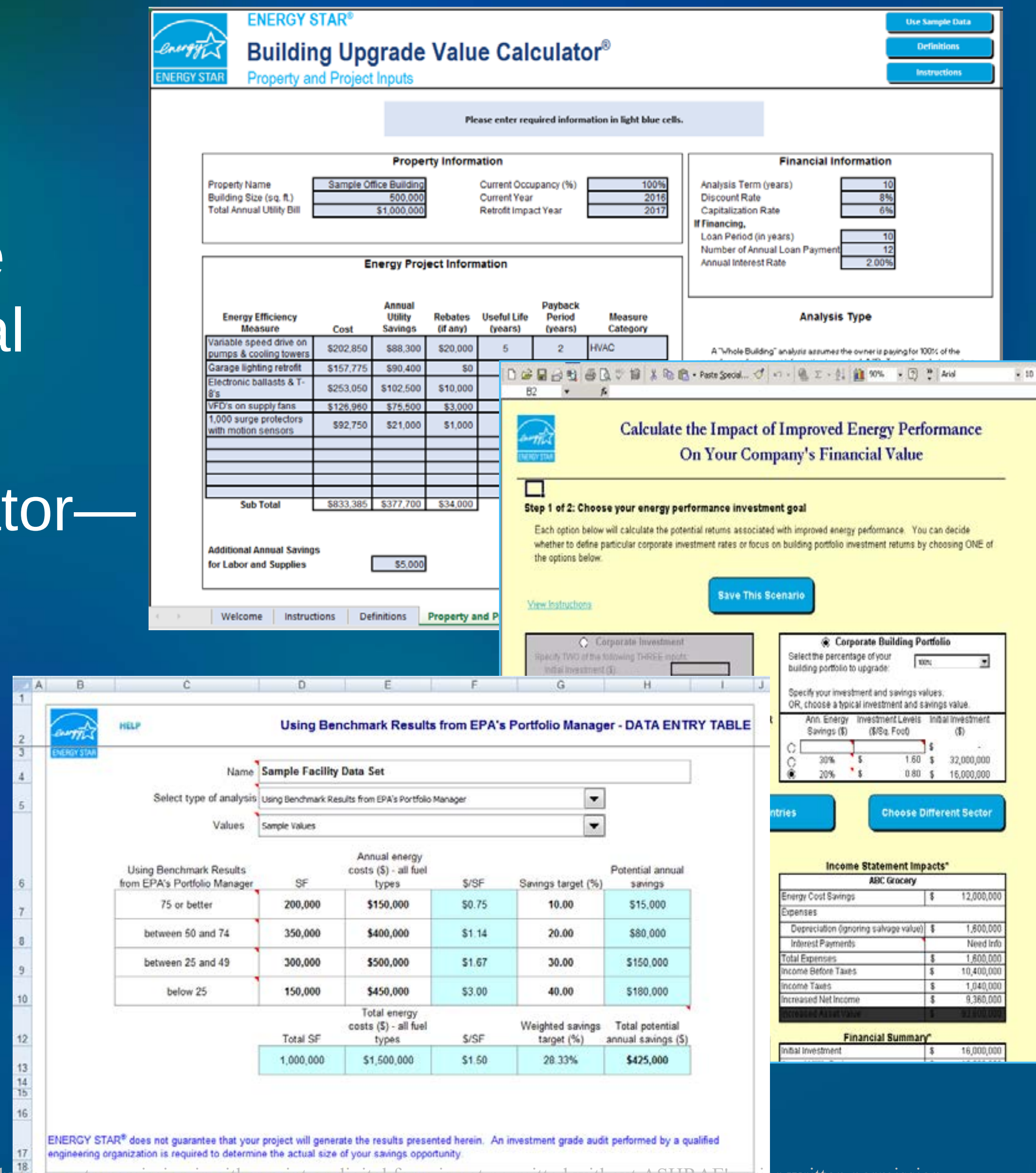
| | | |
|---|---|---|
| $ 1,000,000 | Revenue | |
| $ 950,000 | Expenses | |
| $ 50,000 | Margin | (5% of revenue) |

A cost savings of $1000 @ 5% margin

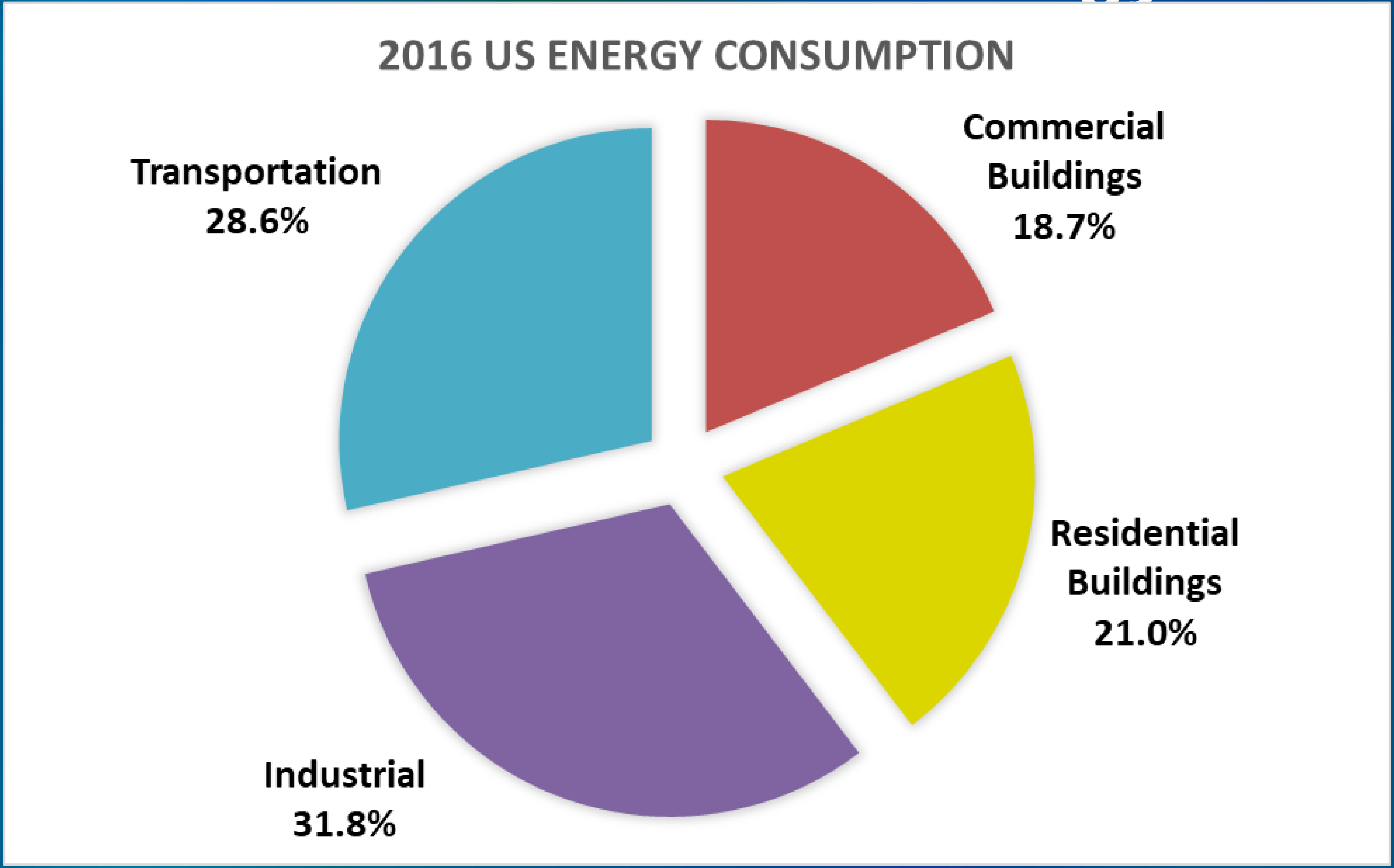
Equivalent to $20,000 in increased revenue

# Financial Value Tools from ENERGY STAR

- Building Upgrade Value Calculator—Commercial Real Estate
- Financial Value Calculator—Corporate Real Estate
- Cash Flow Opportunity Calculator

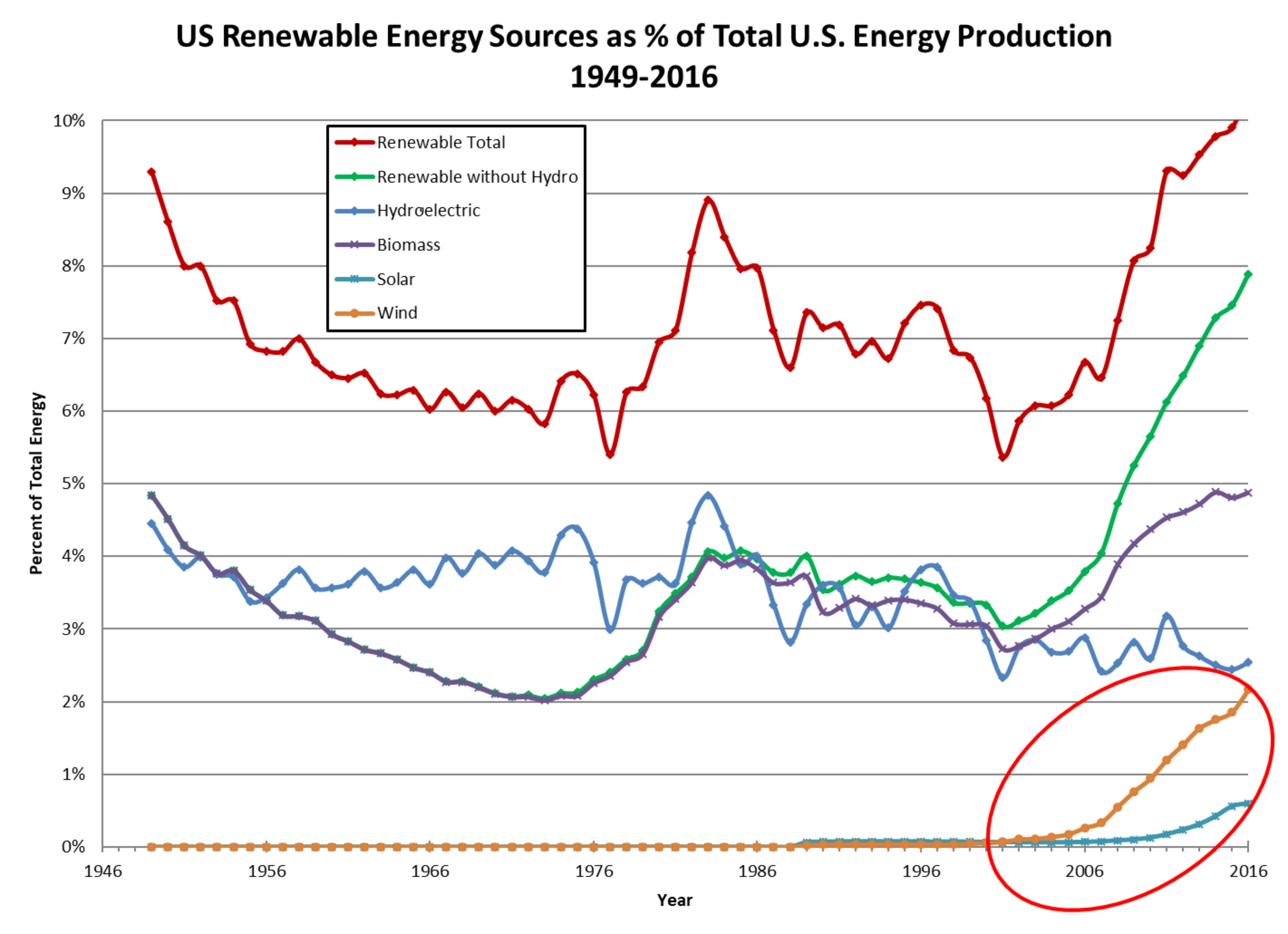


# Where Do We Use Energy?



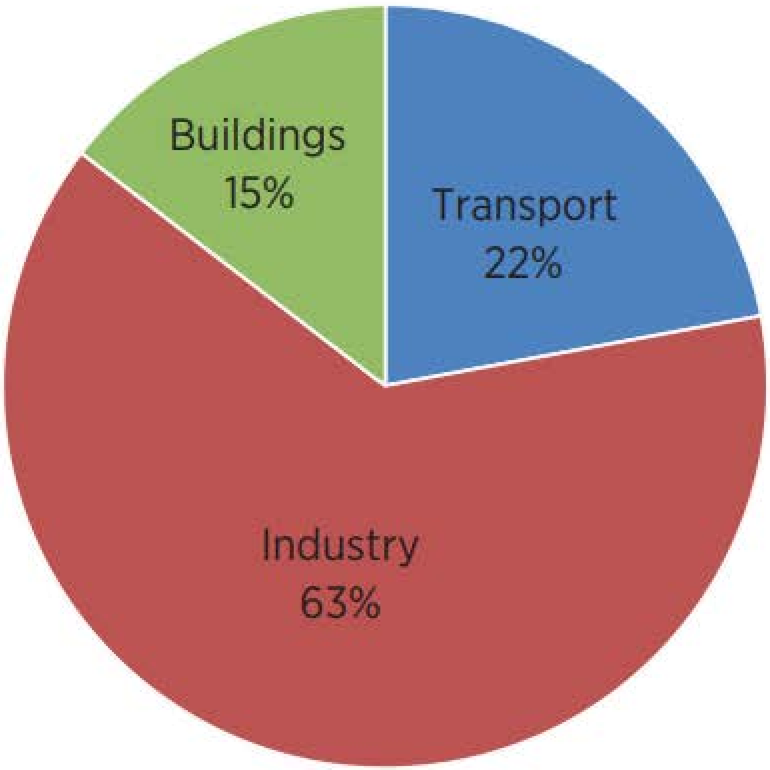

Source: U.S. EIA.

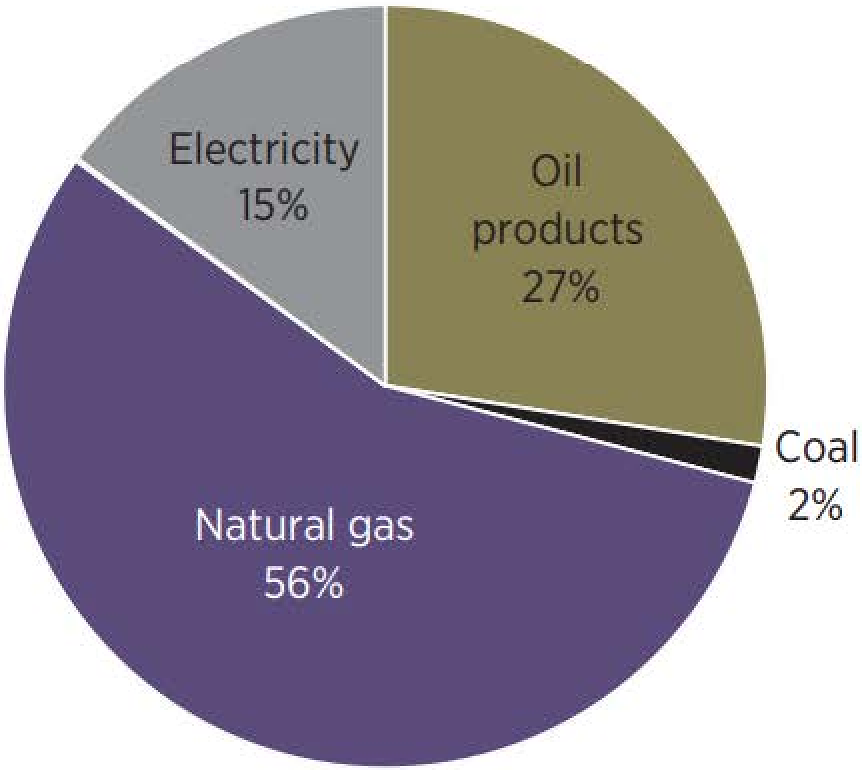
# Renewable Energy Sources




Source: U.S. EIA.

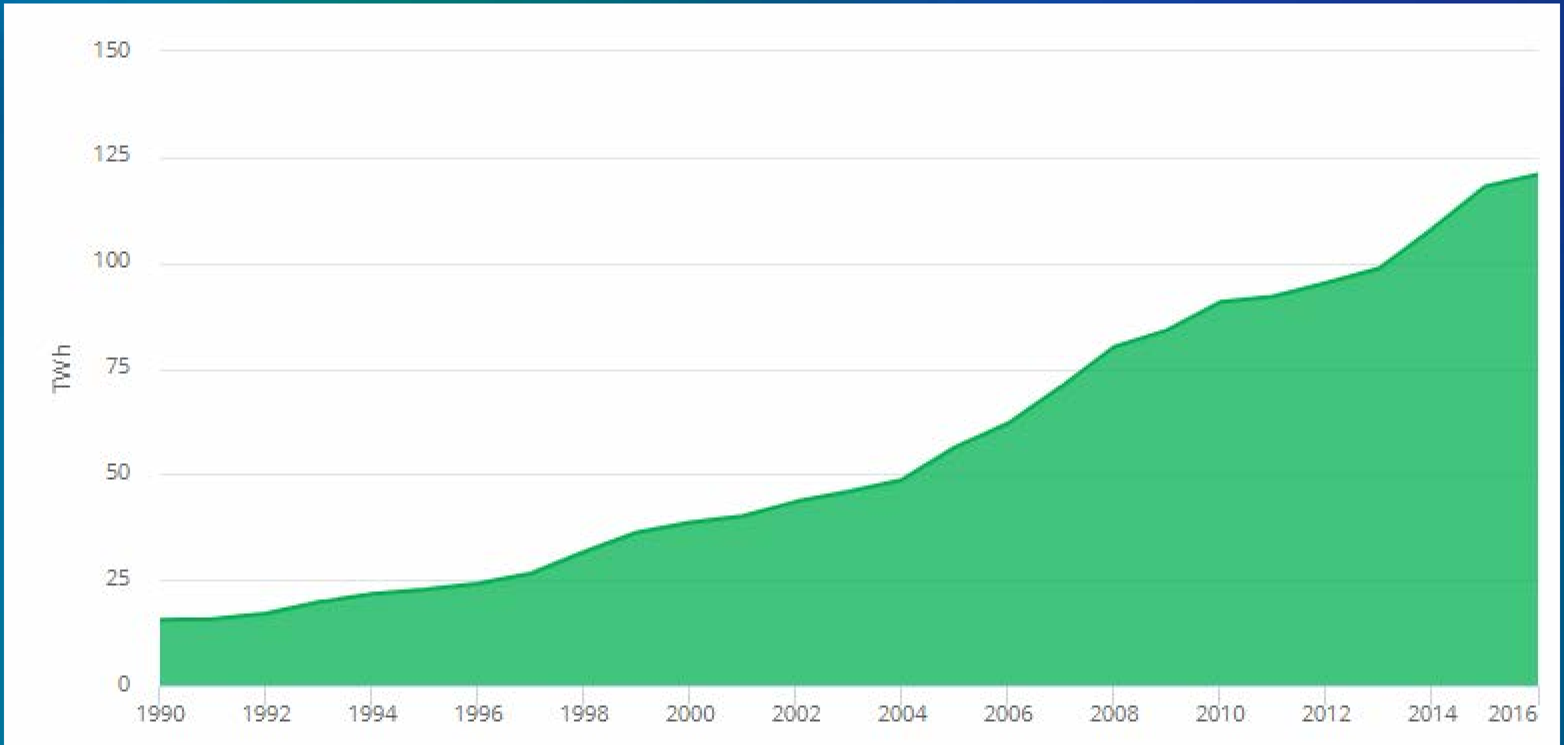
# Total Energy Consumption – UAE



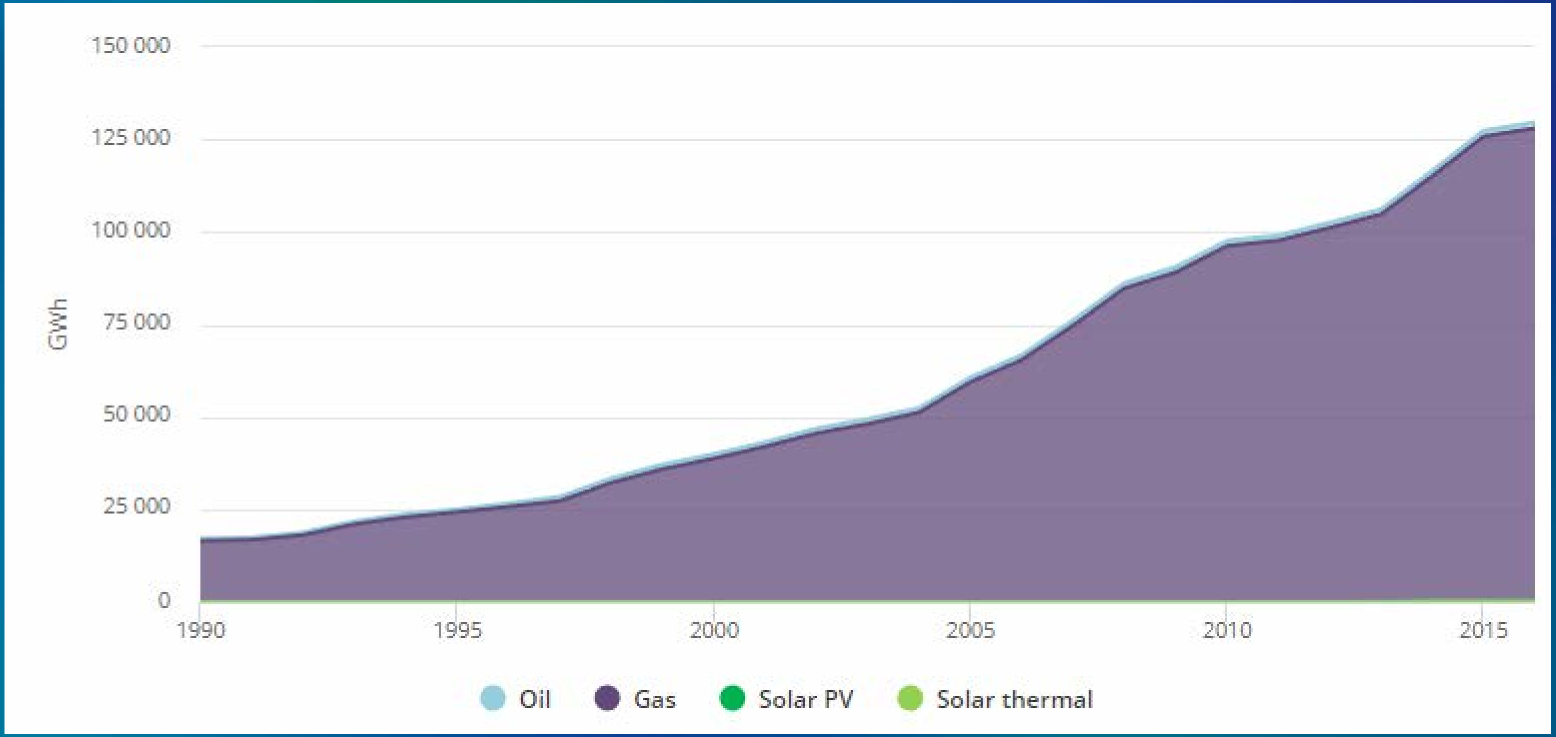

Source: REmap 2030, published April 2015.
https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA_REmap_UAE_report_2015.pdf.

# Total Energy Consumption – UAE



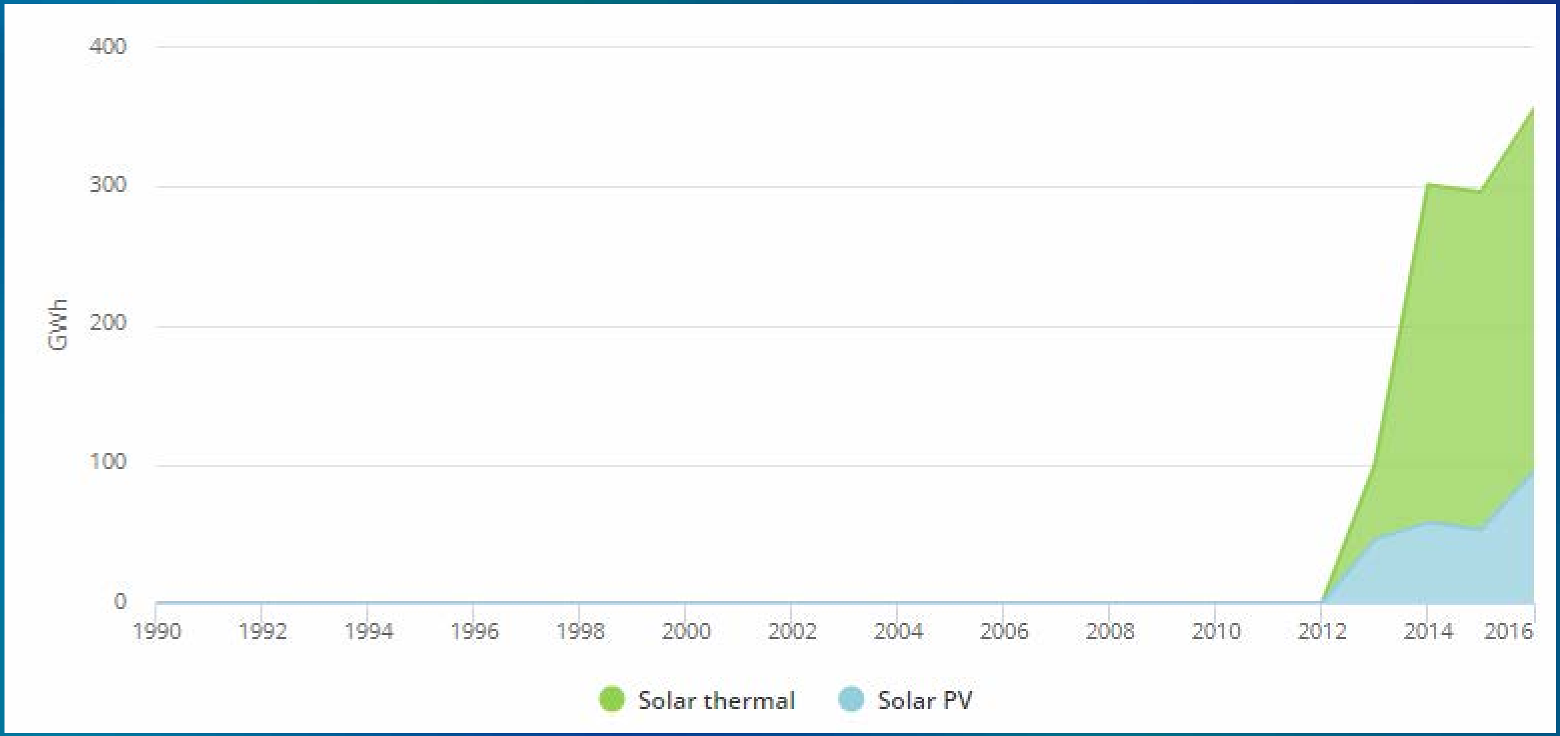

Source: IEA Electricity Information 2018.
https://webstore.iea.org/statistics/.

# Energy Generation by Fuel – UAE



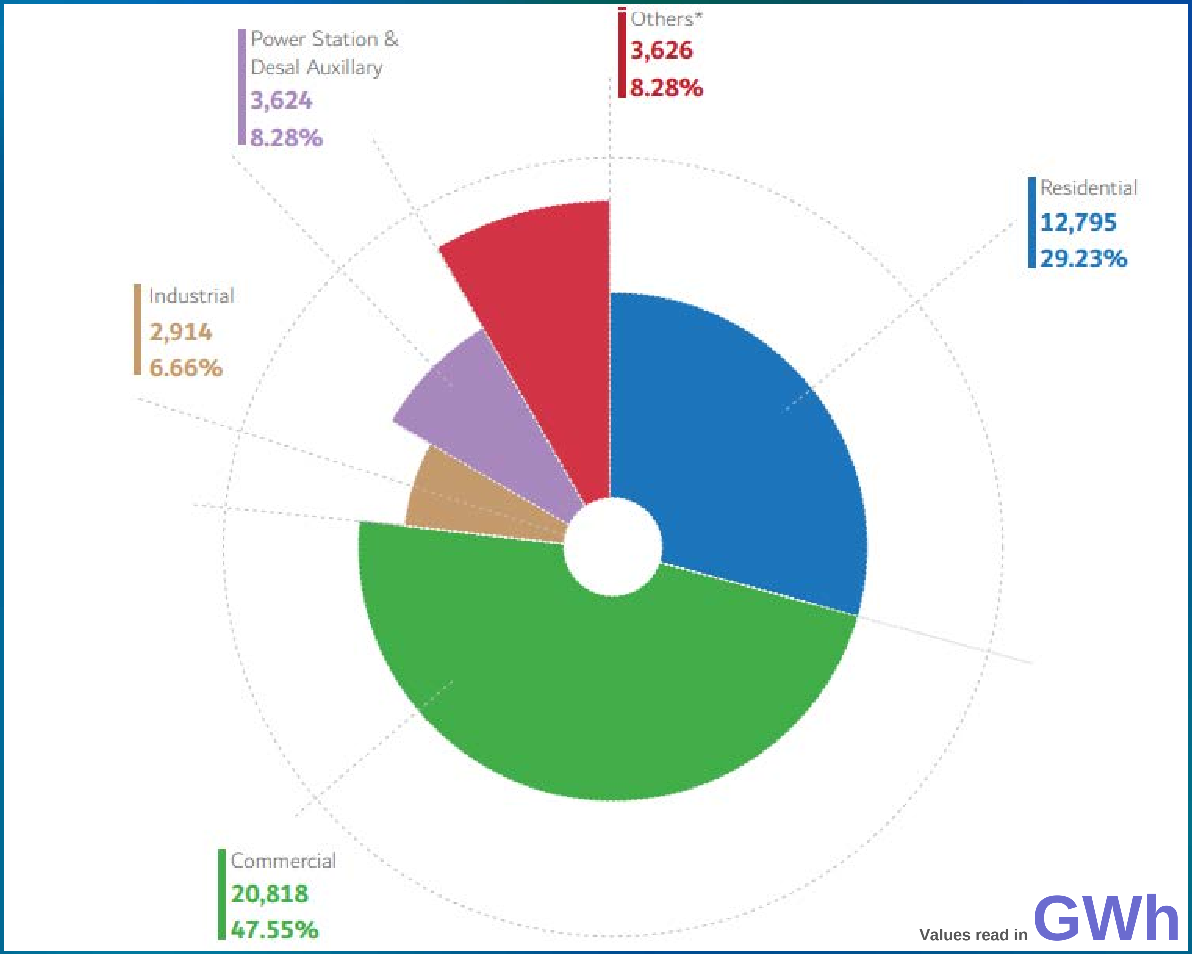

Source: IEA Electricity Information 2018.
https://webstore.iea.org/statistics/.

# RE Generation by Source – UAE




Source: IEA Electricity Information 2018.
https://webstore.iea.org/statistics/.

# Dubai Electricity Consumption, 2017

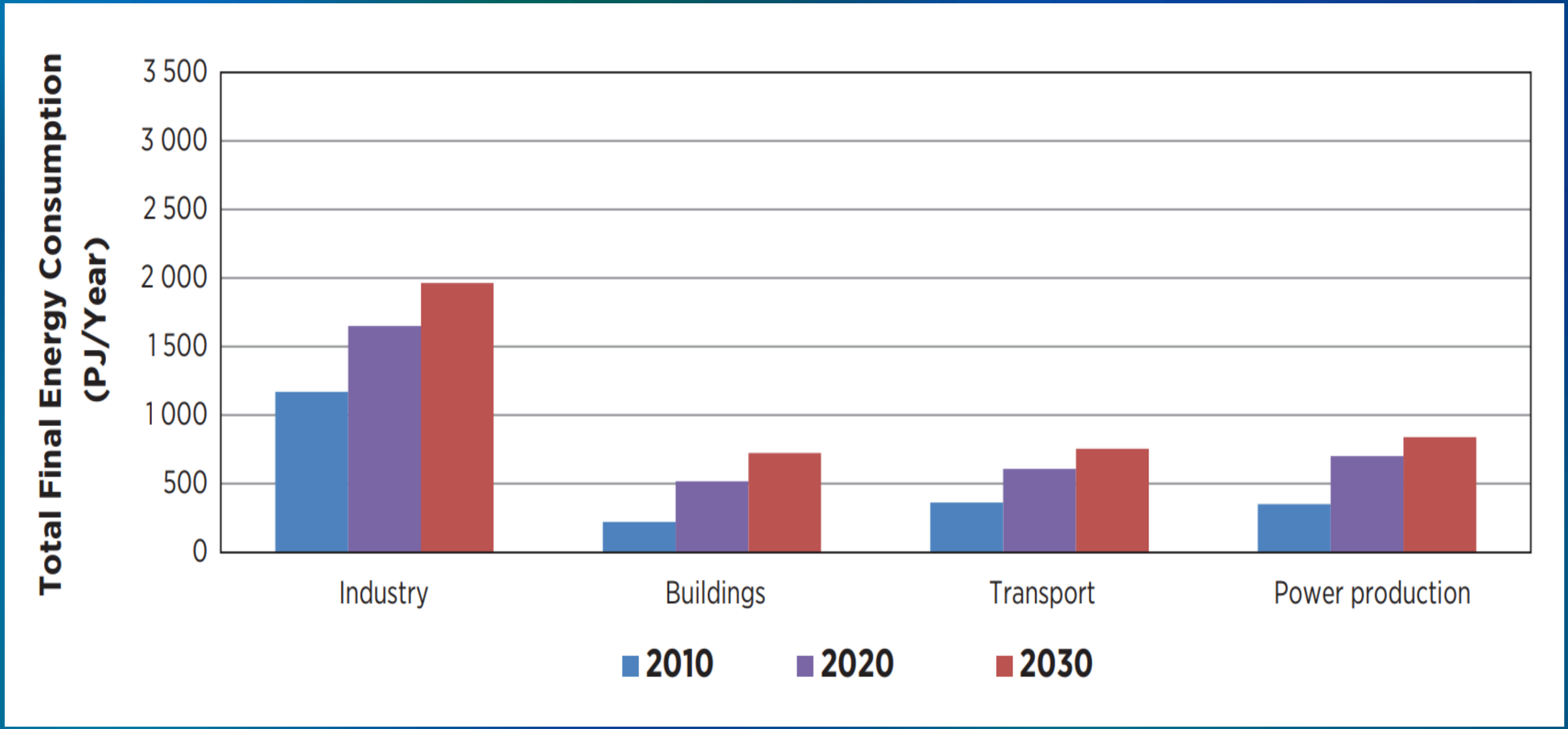



*** Others include:**

Non-commercial buildings such as mosques, police stations, government hospitals, government schools, DEWA offices, etc.

Source: DEWA annual statistics 2017.
https://www.dewa.gov.ae/~/media/Annual statistics 2017 with new cover Eng.ashx.

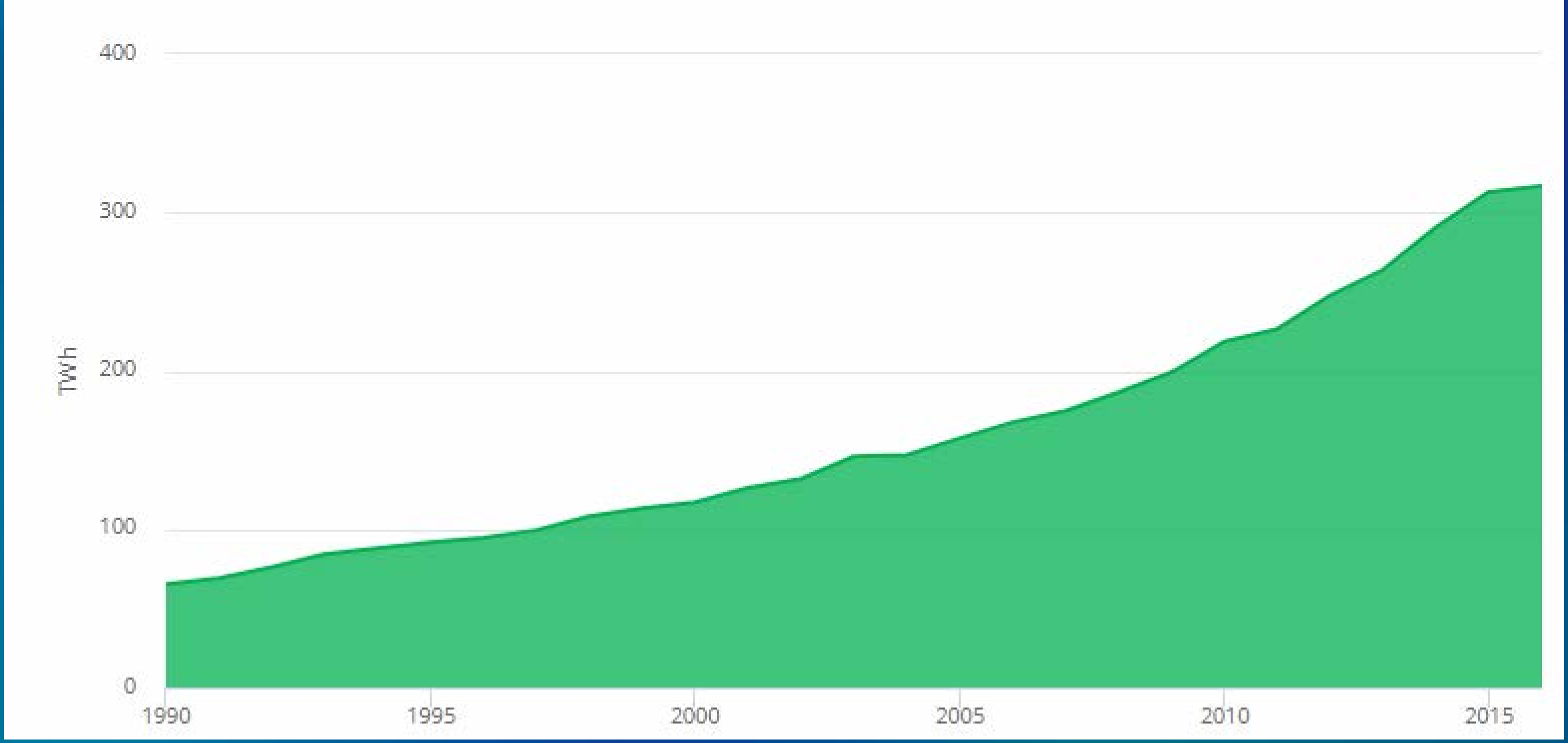
# UAE Reference Case, 2010-2030




Peta Joules (PJ) = $10^{15}$ Joules = 278 gigawatt hours

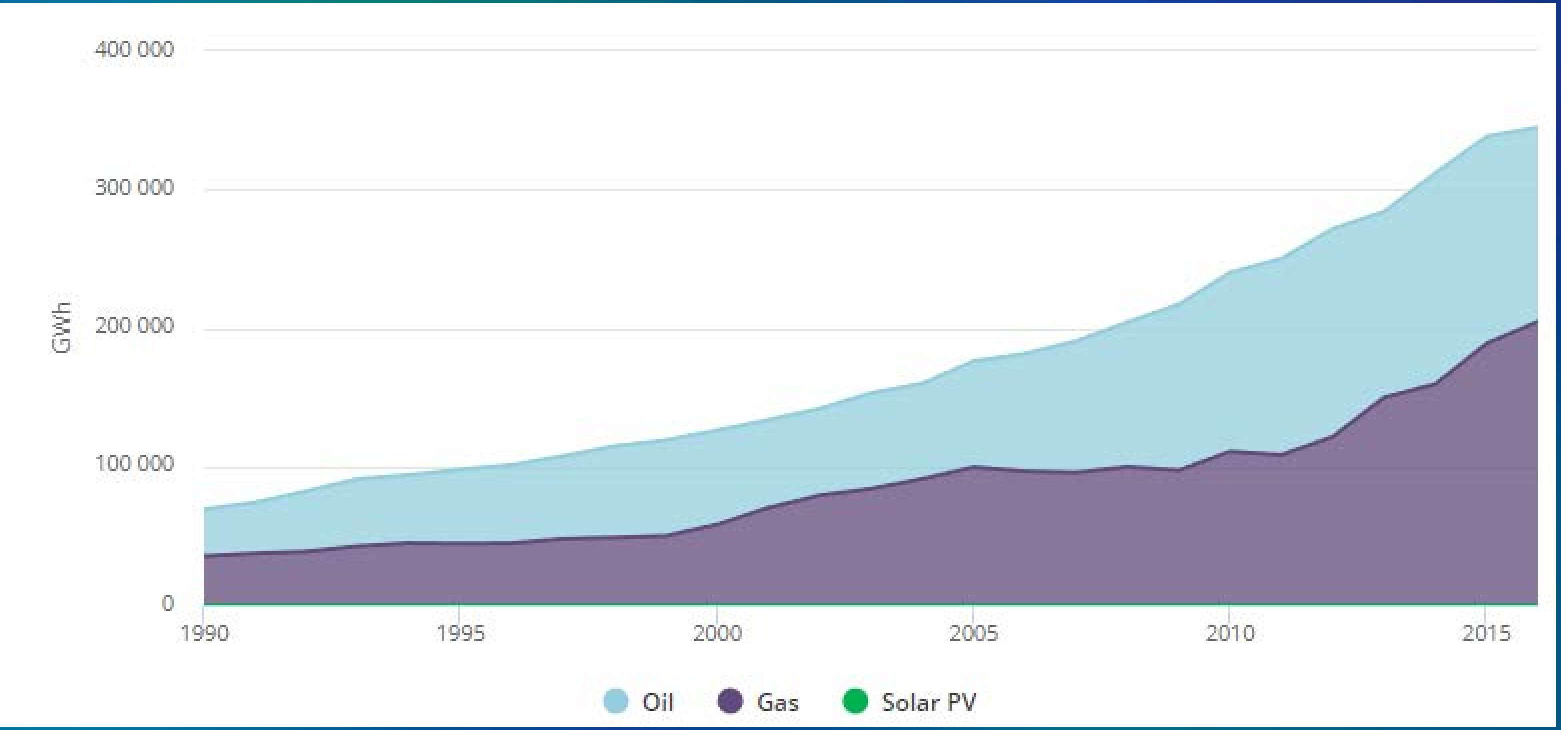
Source: REmap 2030, published April 2015.
https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA_REmap_UAE_report_2015.pdf.

# Total Energy Consumption – KSA



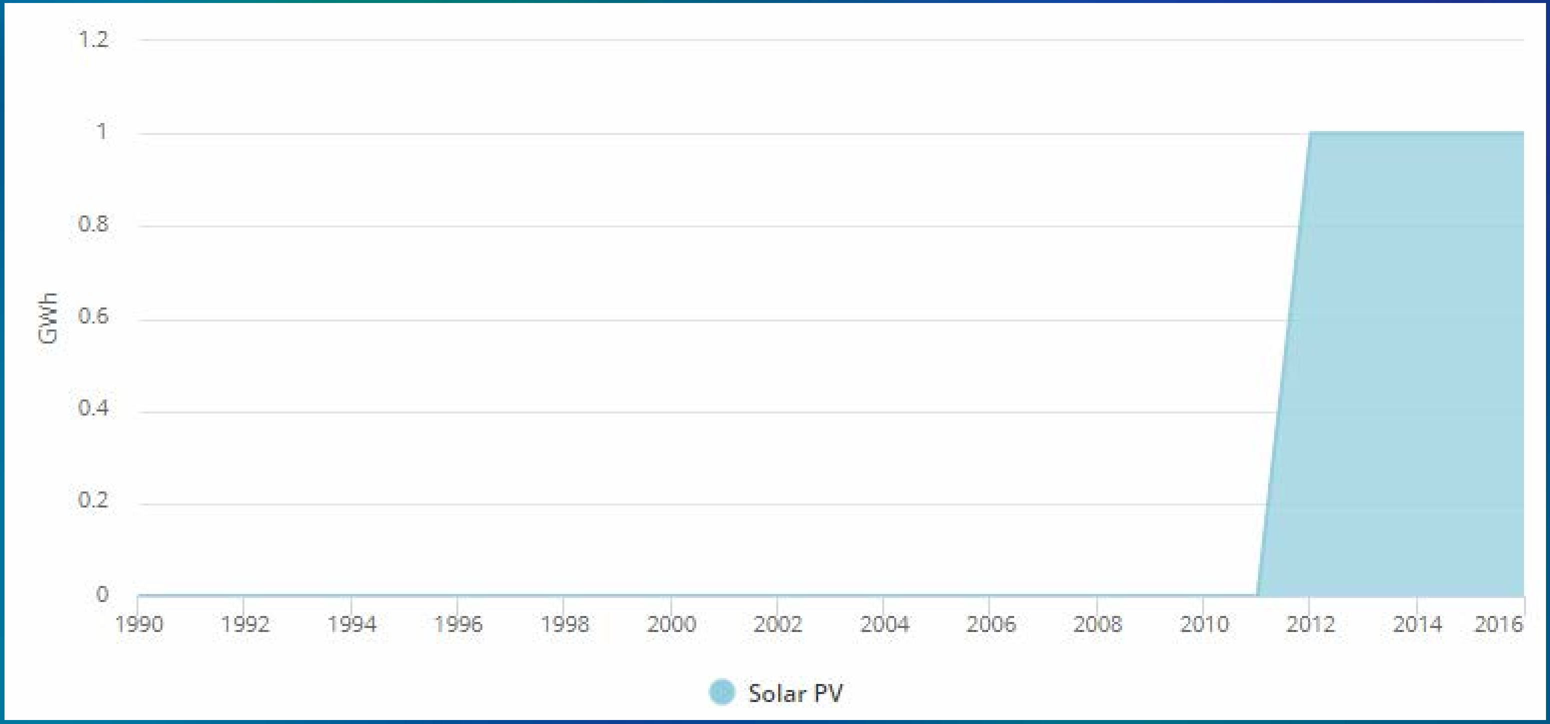

Source: IEA Electricity Information 2018.
https://webstore.iea.org/statistics/.

# Energy Generation by Fuel – KSA




Source: IEA Electricity Information 2018.
https://webstore.iea.org/statistics/.

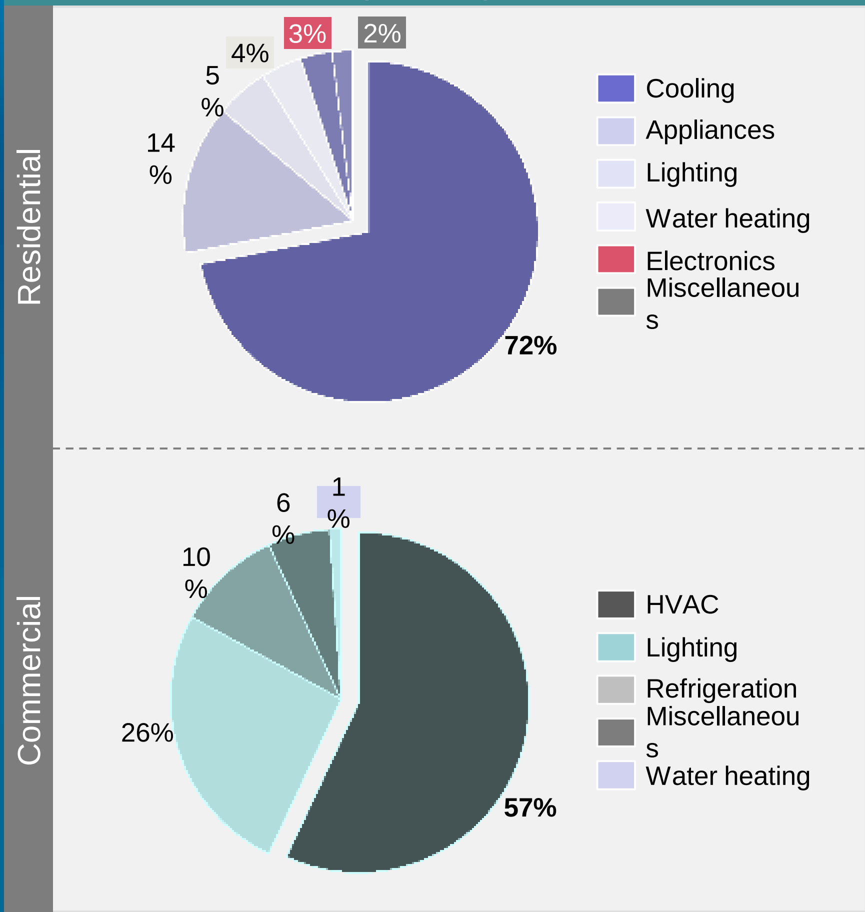
# RE Generation by Source – KSA




Source: IEA Electricity Information 2018.
https://webstore.iea.org/statistics/.

# Residential Energy Consumption – KSA

**1. KSA Final Buildings Energy Consumption, 2011**




**Key Takeaways**

- KSA's residential **cooling sector** is one of the leading electric energy consumers in the nation and can be responsible for up to **60% of the power demand in the summer season**.
- Cooling **energy consumption** is responsible for **72%** and **57%** of the total **residential** and **commercial energy** use in KSA, respectively.
- Energy management in KSA should focus on air conditioning and air-conditioning controls.

KSA's residential air conditioning sector consumes up to 60% of power demand in summer

# Energy Management Potential

- Buildings consume almost 40% of U.S. energy
  - Residential (21.0%) + Commercial (18.7%) = 39.7% (U.S.)
- Buildings consume almost 77 % of Dubai's Electricity
- Air conditioning consume almost 60% of total electrical buildings' consumption in the GCC
- 33% reduction of building energy is possible
- Great savings potential on global energy use by reducing buildings' energy consumption

# International Goals – COP21/ 23

- Agreement to limit temperature rise to 2°C with target of 1.5°C
- INDC's issued by each country forming strategy for climate change mitigation and adaptation

INDCs: http://unfccc.int/focus/indc_portal/items/8766.php

# Government Strategies

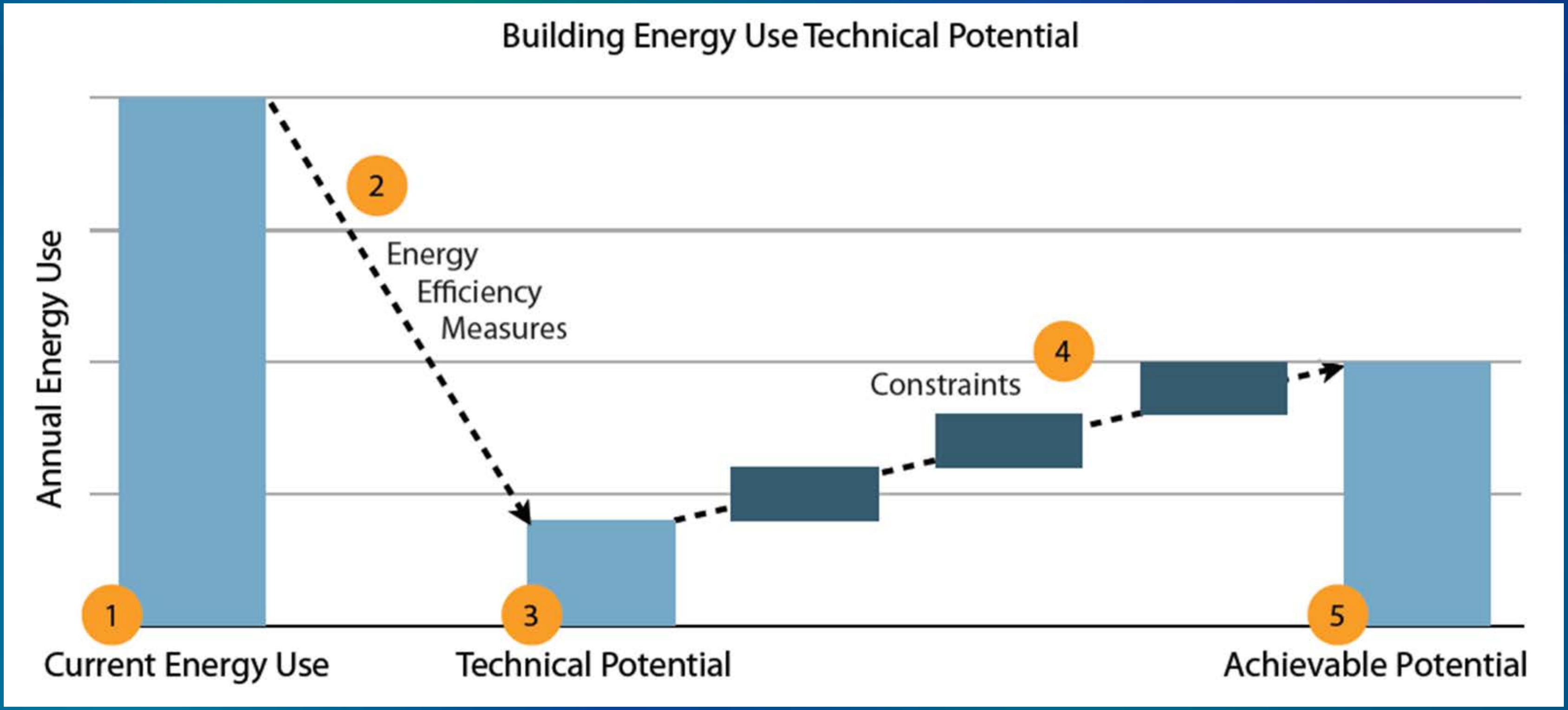
- UAE Clean Energy Strategy
  - To diversify the energy mix by 2050: 44% clean energy, 38% gas, 12% clean coal, and 6% nuclear.
- Dubai Integrated Energy Strategy
  - 30% reduction of the water and energy use by 2030
- Retrofit Strategies
  - Tarsheed Program in Saudi Arabia
  - Dubai Etihad ESCO to retrofit government buildings
  - Abu Dhabi Tarsheed Program for government buildings
  - Barjeel program in Ras Al Khaimah for government buildings

# Retrofit Potential – Financial

- Energy Efficiency Investment
  - $385 billion/year
  - $5.8 trillion by 2030
- Intergovernmental panel for Climate Change (2014)
  - Energy efficiency investments and behavioral changes most cost-effective strategy to reduce carbon emissions
- UNEP Finance Investor Briefing (2014)
  - Investment in retrofits bring “better than expected” returns
  - Most effective means to reduce GHG emission while increasing asset value
- UAE
  - 30% energy reduction target in Dubai and Abu Dhabi

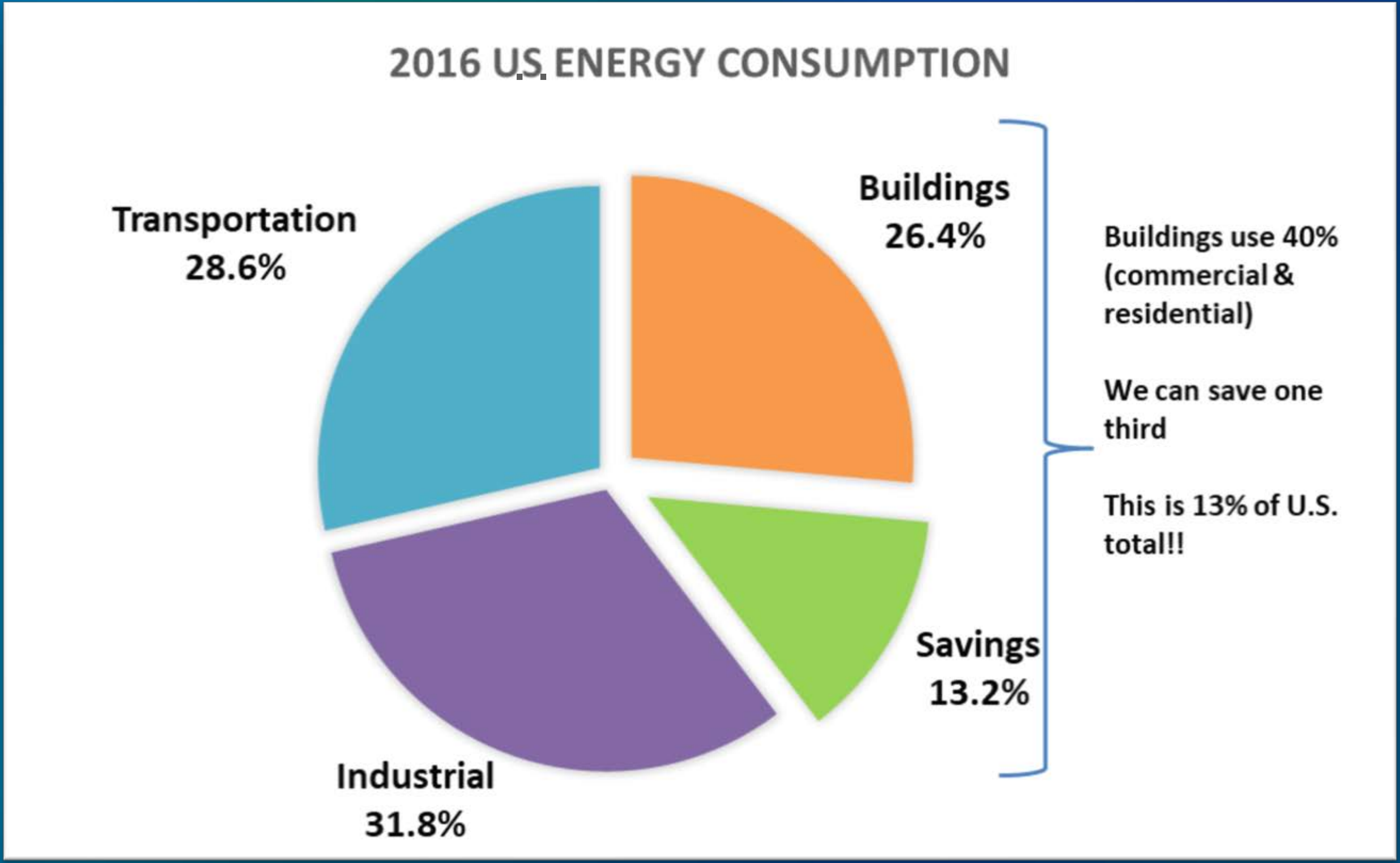
Source: Emirates Green Building Council.

# Retrofit Technical Potential



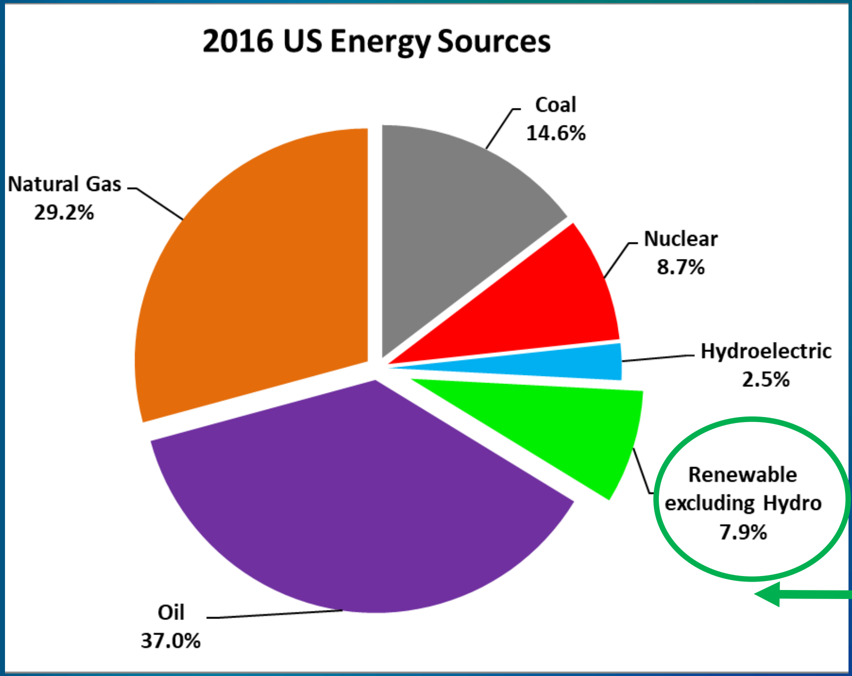

Source: RMI Retrofit Guide; Emirates Green Building Council.

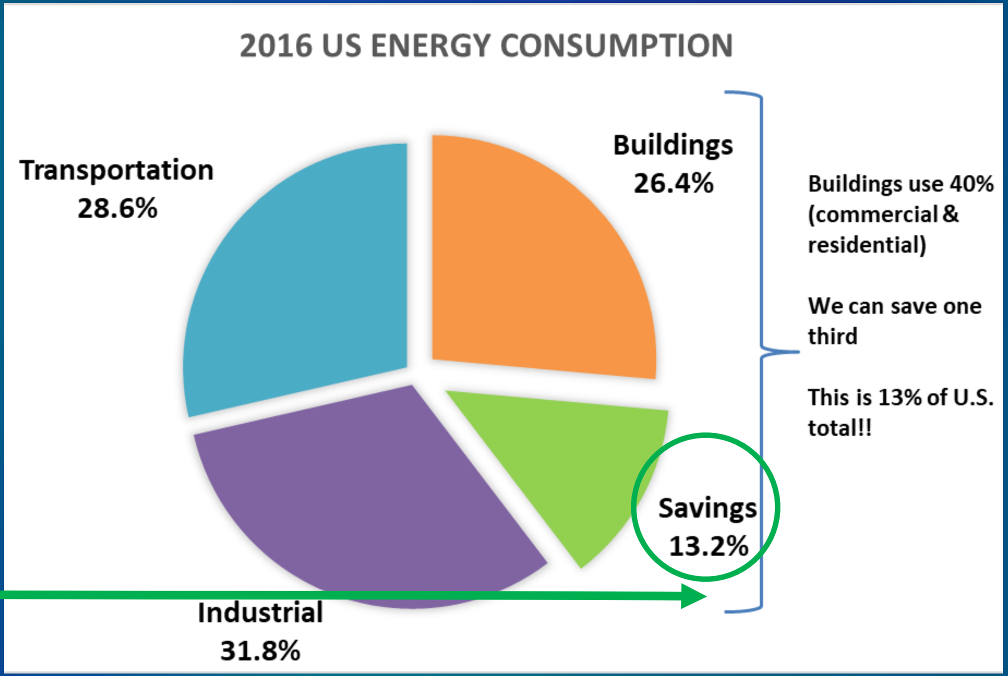
# Renewables as an Environmental Solution?




Source: U.S. EIA.

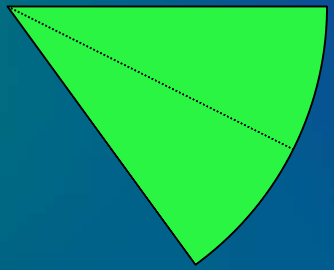
# Energy Management is the Quickest, Cheapest, Cleanest Way to Extend World Energy Supplies




Energy management can provide nearly two times the environmental impact of renewable energy!

# Where Can You Get the 33%?



- Some from smarter use of what you have right now
- Some from capital upgrades

# Greener Pastures with Energy Savings

## Emissions Reduction at Madison College

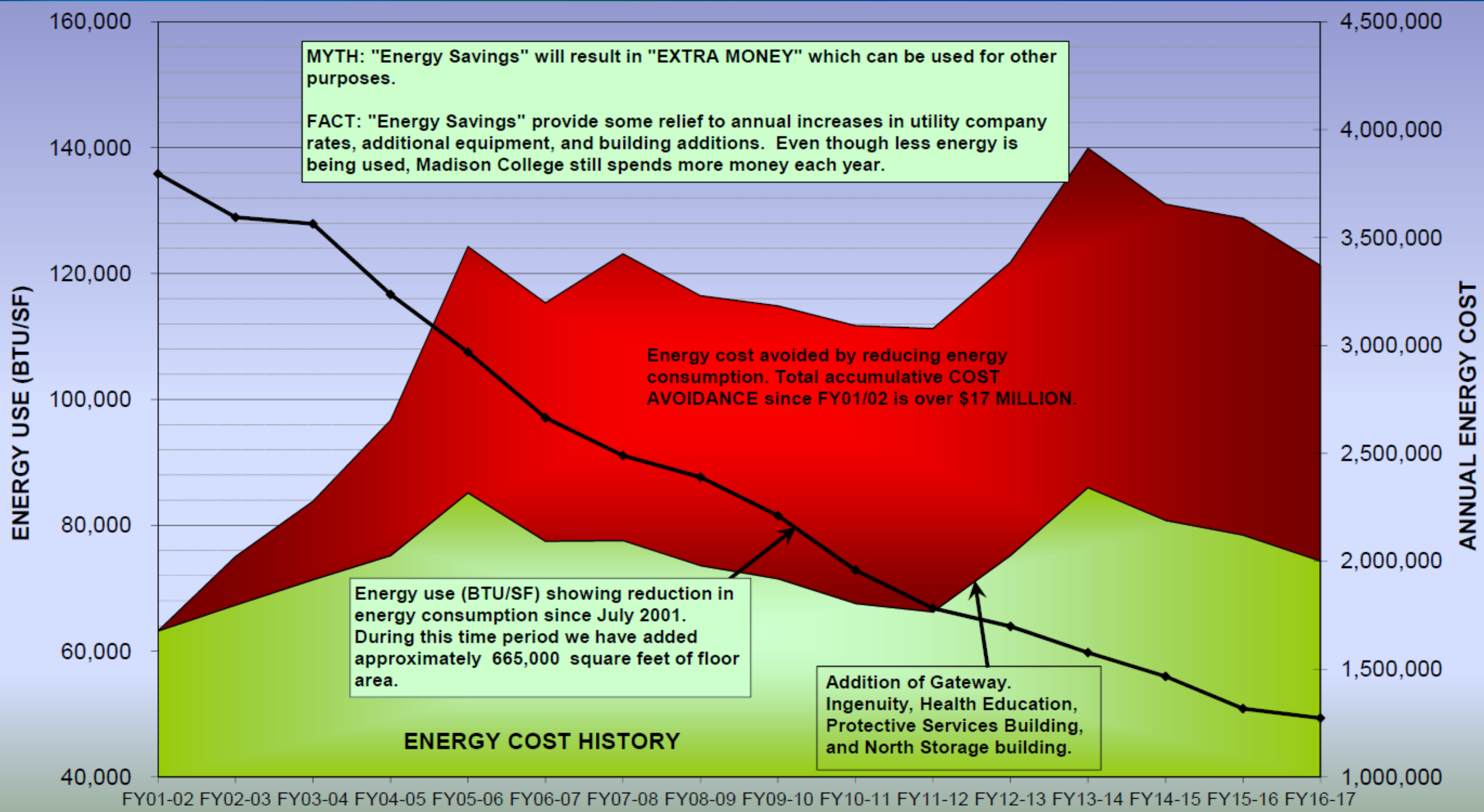
| **Energy** | **Usage FY 01/02 111,484 m²** | **Usage FY16/17 176,515 m²** | **Annual Reduction!** |
|---|---|---|---|
| Electricity | 23,000,000 kWh | 16,000,000 kWh | 7,000,000 kWh |
| Natural Gas | 94,950 GJ | 42,200 GJ | 52,750 GJ |
| **Emissions** | **Emissions FY 01/02** | **Emissions FY 16/17** | **Annual Reduction!** |
| $CO_2$ | 25,000 tons | 15,000 tons | 10,000 tons |

**The above energy savings were achieved with an <u>additional 65,030 m²</u> conditioned space!**

Source: Madison College Engineering Manager. Wesley Marquardt. wmarquardt@madisoncollege.edu.

# Greener Pastures with Energy Savings

## Energy Cost Avoidance at Madison College



# New Buildings Are a Target Too!

New buildings are often inefficient at start-up (even LEED-certified buildings).

New building performance significantly deteriorates in the first three years of operation, by as much as 30% (even those designed as energy-efficient green buildings).

# General Services Administration Energy Management Program

U.S. Courthouse

Jacksonville, Florida

- Constructed in early 2000s
- Disappointing energy use

DOE-ORNL Report

# 2000s New Building Performance

## Far less efficient than design intent

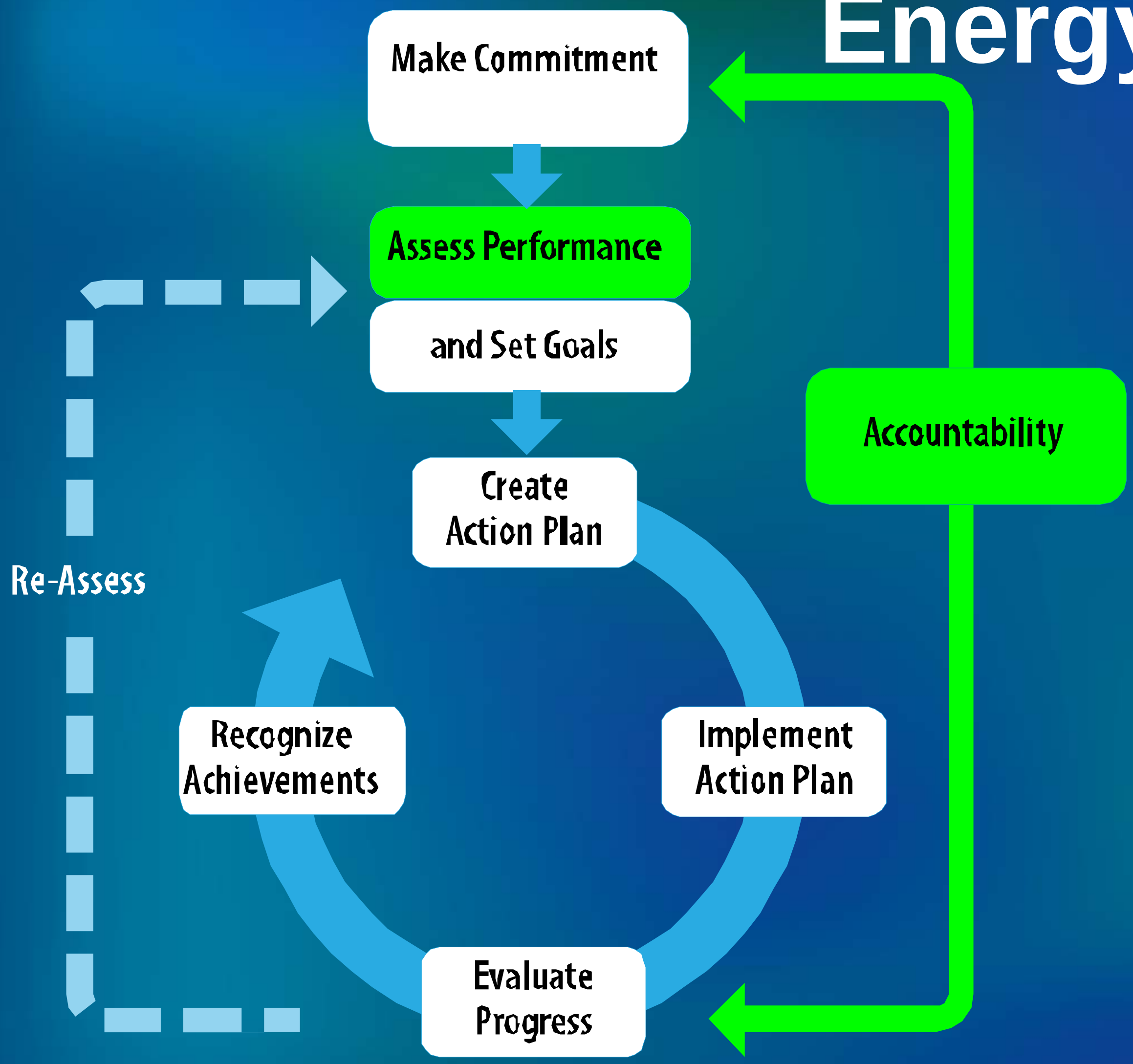
| | Actual | | Target |
|---|---|---|---|
| Floor Area $ft^2$ ($m^2$) | 492,000 (45,710) | | 492,000 (45,710) |
| EUI (kBtu/$ft^2$/year) | 81 | 😪 | 52 |
| Energy Star Rating | 41 | 😪 | 75 |
| Cost ($k/year) | 632 | 😪 | 407 |
| EUI (kWh/$m^2$/year) | 255 | | 164 |

*We'll come back to this example after we've defined a few terms…*

# Assessing Performance

# ENERGY STAR Guidelines for Energy Management

www.energystar.gov



# ENERGY STAR Advice: 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**

# What About Energy Audits?

- ENERGY STAR: audits in the analysis *and*
- We recommend other work FIRST!
- Stay tuned: audits defined and discussed later…

# ANSI/ASHRAE/IESNA Standard 100-2018

NEW!

STANDARD

**ANSI/ASHRAE/IES Standard 100-2018**
(Supersedes ANSI/ASHRAE/IES Standard 100-2015)
Includes ANSI/ASHRAE/IES addenda listed in Annex N

## Energy Efficiency in Existing Buildings

See Annex N for approval dates.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

 ISSN 1041-2336

# ANSI/ASHRAE/IESNA Standard 100-2018
## *Energy Efficiency in Existing Buildings*

- Excerpts from Table of Contents:
  - Compliance
  - Energy Management Plan
  - O&M Requirements
  - Energy Audit Requirements
  - Implementation and Verification
  - Energy Efficiency Measures
  - Payback and Life-Cycle Cost Analysis
  - Building Energy Modeling

# ASHRAE Standard 100-2018,
# *Energy Efficiency in Existing Buildings*

- Energy Targets

**Table 7-2a Building Activity Site Energy Targets ($EUI_{t1}$) (I-P Units)**

| | | EUIs by Building Type by Climate Zone (kBtu/ft²·yr) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ASHRAE Climate Zone | | | | | | | | | | | | | | | | |
| No. | Commercial Building Type | 1A | 2A | 2B | 3A | 3B Coast | 3B Other | 3C | 4A | 4B | 4C | 5A | 5B | 5C[a] | 6A | 6B | 7 | 8 |
| 1 | Admin/professional office | 39 | 40 | 39 | 42 | 33 | 39 | 33 | 46 | 40 | 40 | 48 | 42 | 39 | 54 | 47 | 58 | 81 |
| 33 | Hospital/inpatient health | 142 | 143 | 140 | 141 | 134 | 138 | 130 | 143 | 129 | 135 | 139 | 126 | 135 | 142 | 130 | 144 | 166 |
| 34 | Nursing home/assisted living | 84 | 83 | 81 | 83 | 69 | 78 | 75 | 91 | 82 | 84 | 99 | 88 | 85 | 109 | 100 | 118 | 156 |
| 35 | Dormitory/fraternity/sorority | 40 | 43 | 42 | 47 | 31 | 43 | 40 | 58 | 48 | 54 | 65 | 55 | 52 | 75 | 66 | 85 | 119 |

*Excerpts from Table 7-2a*

- Target values derived from CBECS 2003 and represent the 25th lowest percentile of energy use by each building category.

# ASHRAE Standard 100-2018,
# *Energy Efficiency in Existing Buildings*

- Energy Targets

**TABLE 7-2 Building Activity Energy Targets ($EUI_{t1}$) (SI Units)[1]**

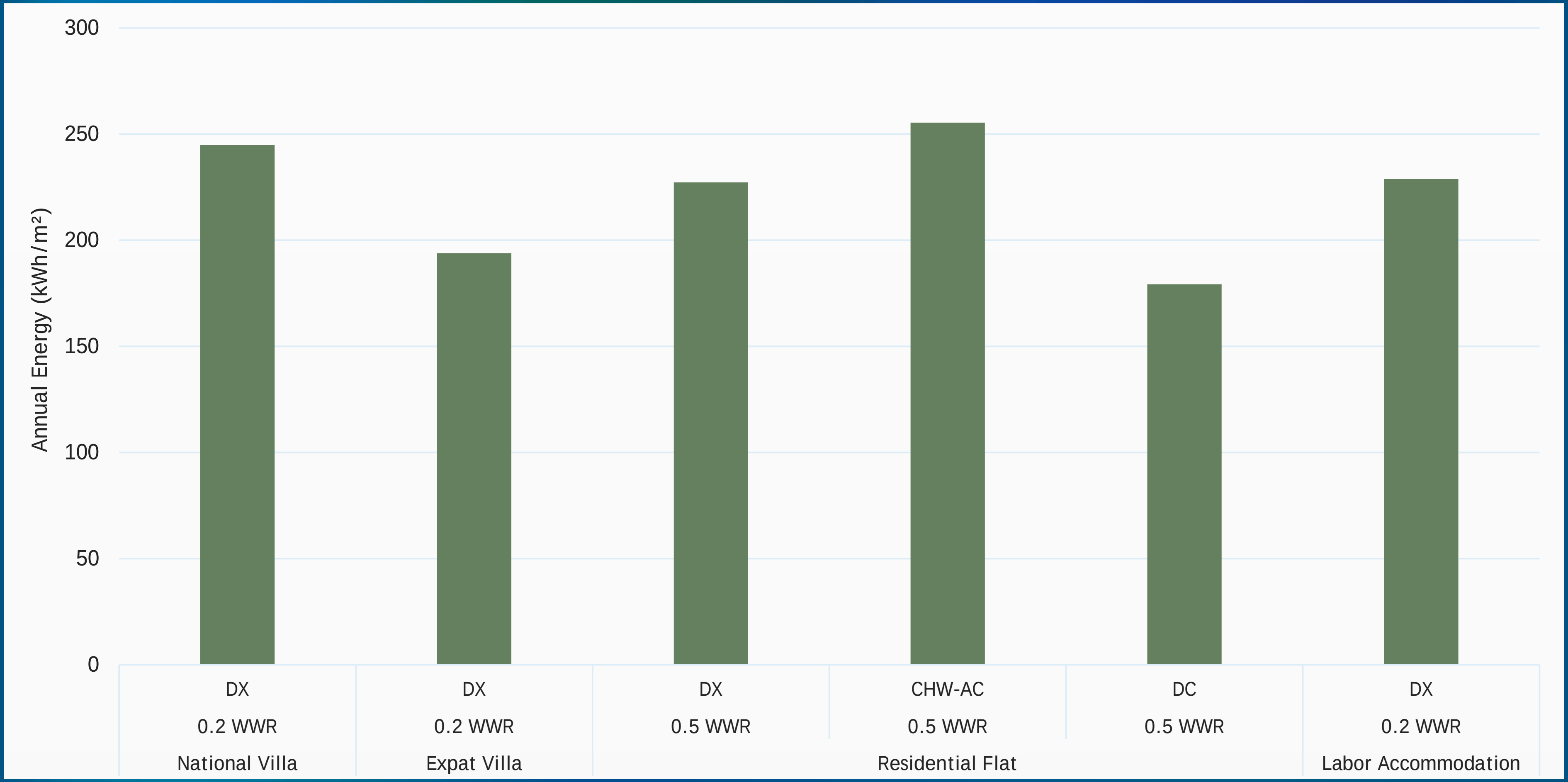
| No. | Commercial Building Type | EUIs by Building Type by Climate Zone ($MJ/m^2 \cdot yr$) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ASHRAE Climate Zone | | | | | | | | | | | | | | | | |
| | | 1A | 2A | 2B | 3A | 3B Coast | 3B Other | 3C | 4A | 4B | 4C | 5A | 5B | 5C[2] | 6A | 6B | 7 | 8 |
| 1 | Admin/professional office | 443 | 456 | 446 | 472 | 372 | 440 | 379 | 518 | 449 | 458 | 547 | 475 | 446 | 608 | 536 | 657 | 921 |
| 33 | Hospital/inpatient health | 1610 | 1624 | 1591 | 1602 | 1518 | 1570 | 1481 | 1628 | 1462 | 1533 | 1578 | 1435 | 1529 | 1615 | 1482 | 1631 | 1882 |
| 34 | Nursing home/assisted living | 955 | 944 | 915 | 938 | 787 | 884 | 852 | 1038 | 929 | 958 | 1120 | 1002 | 970 | 1243 | 1132 | 1335 | 1774 |
| 35 | Dormitory/fraternity/sorority | 457 | 483 | 480 | 538 | 357 | 493 | 456 | 656 | 549 | 613 | 744 | 626 | 586 | 852 | 753 | 968 | 1352 |

*Excerpts from Table 7-2*

- Target values derived from CBECS 2003 and represent the 25th lowest percentile of energy use by each building category.

# Summary of EUIs – UAE

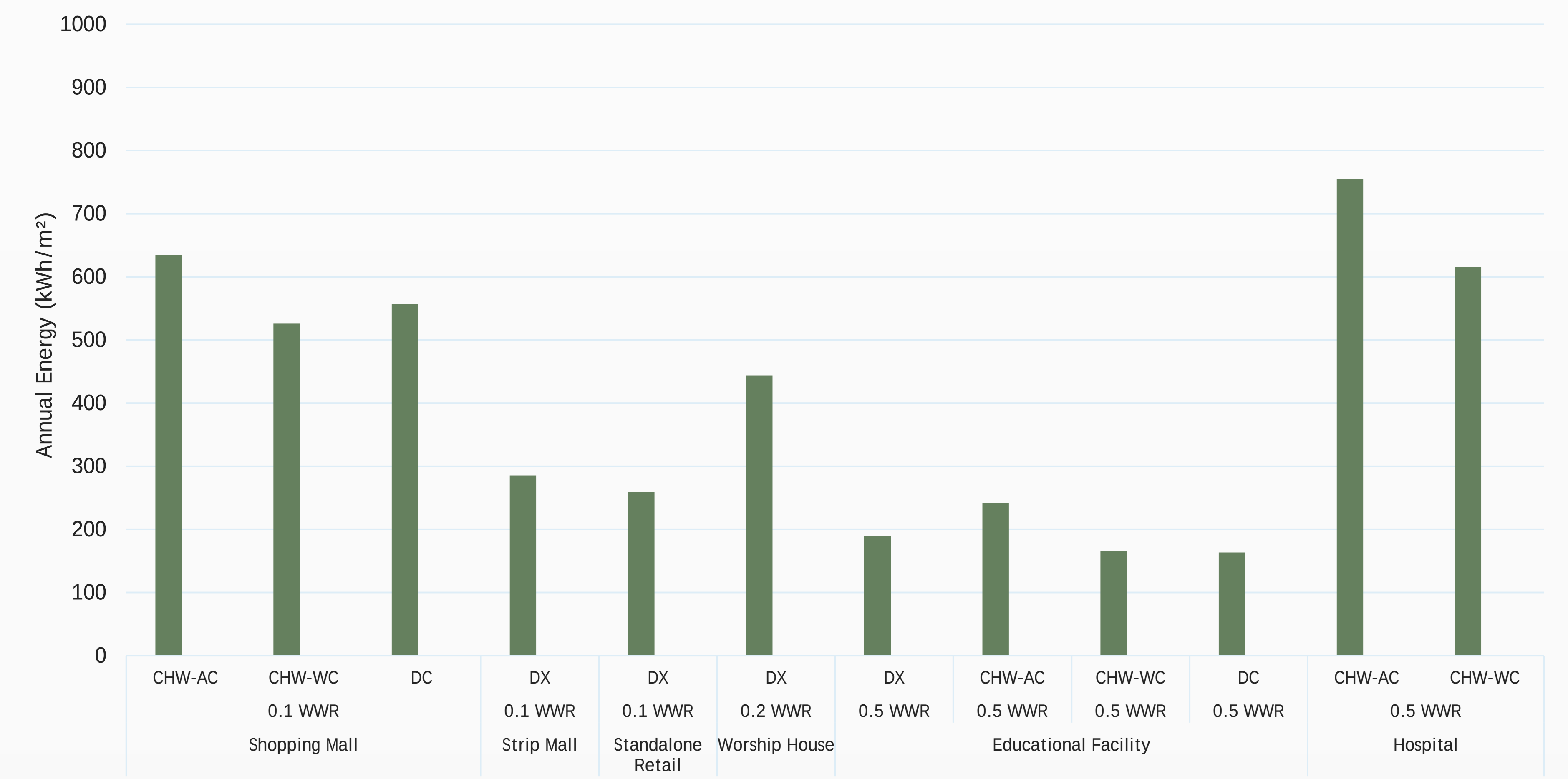
## *(Residence type building typologies)*




Source: Griffin Consultants.

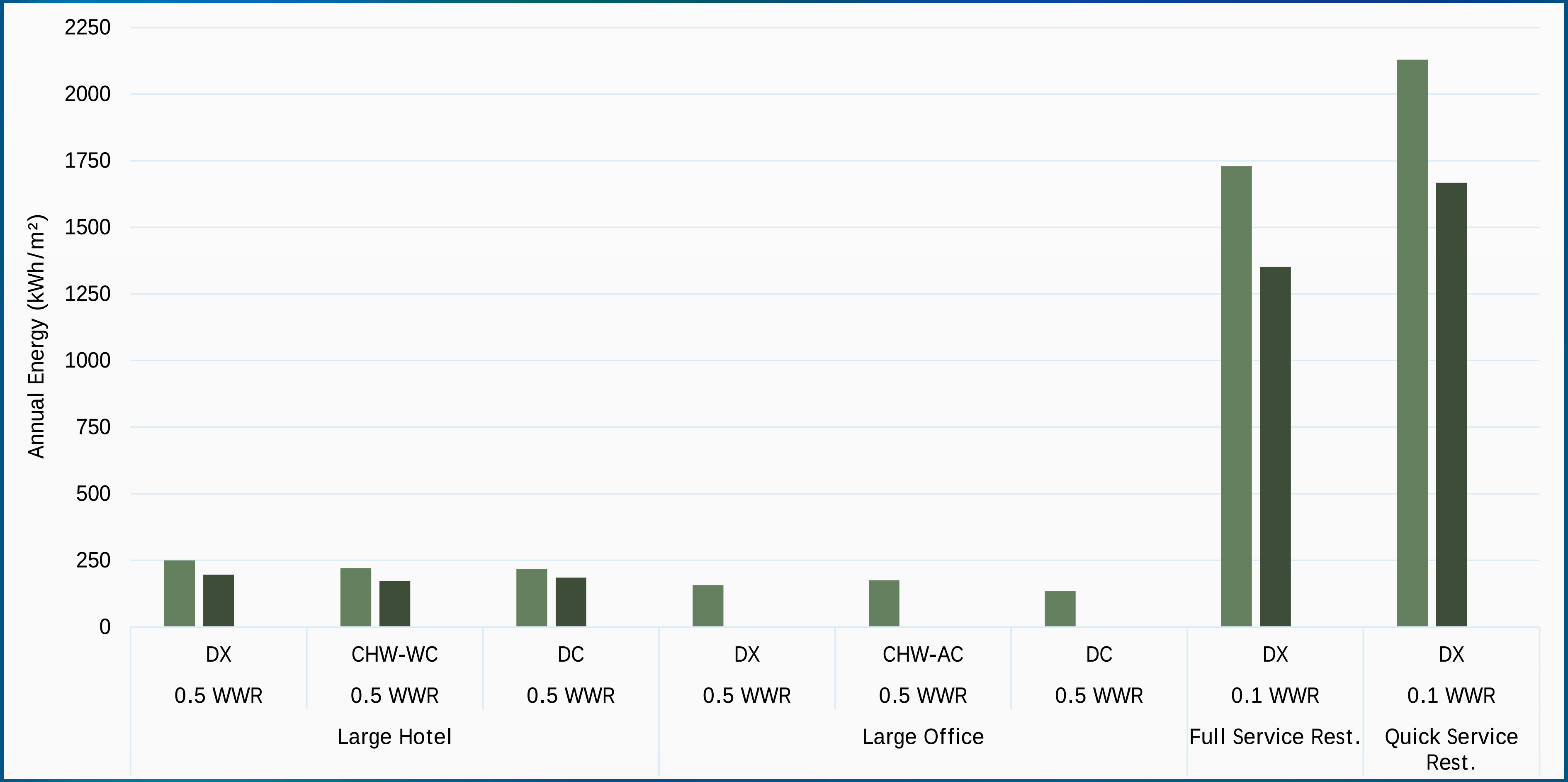
# Summary of EUIs – UAE

## *(DM public building typologies)*



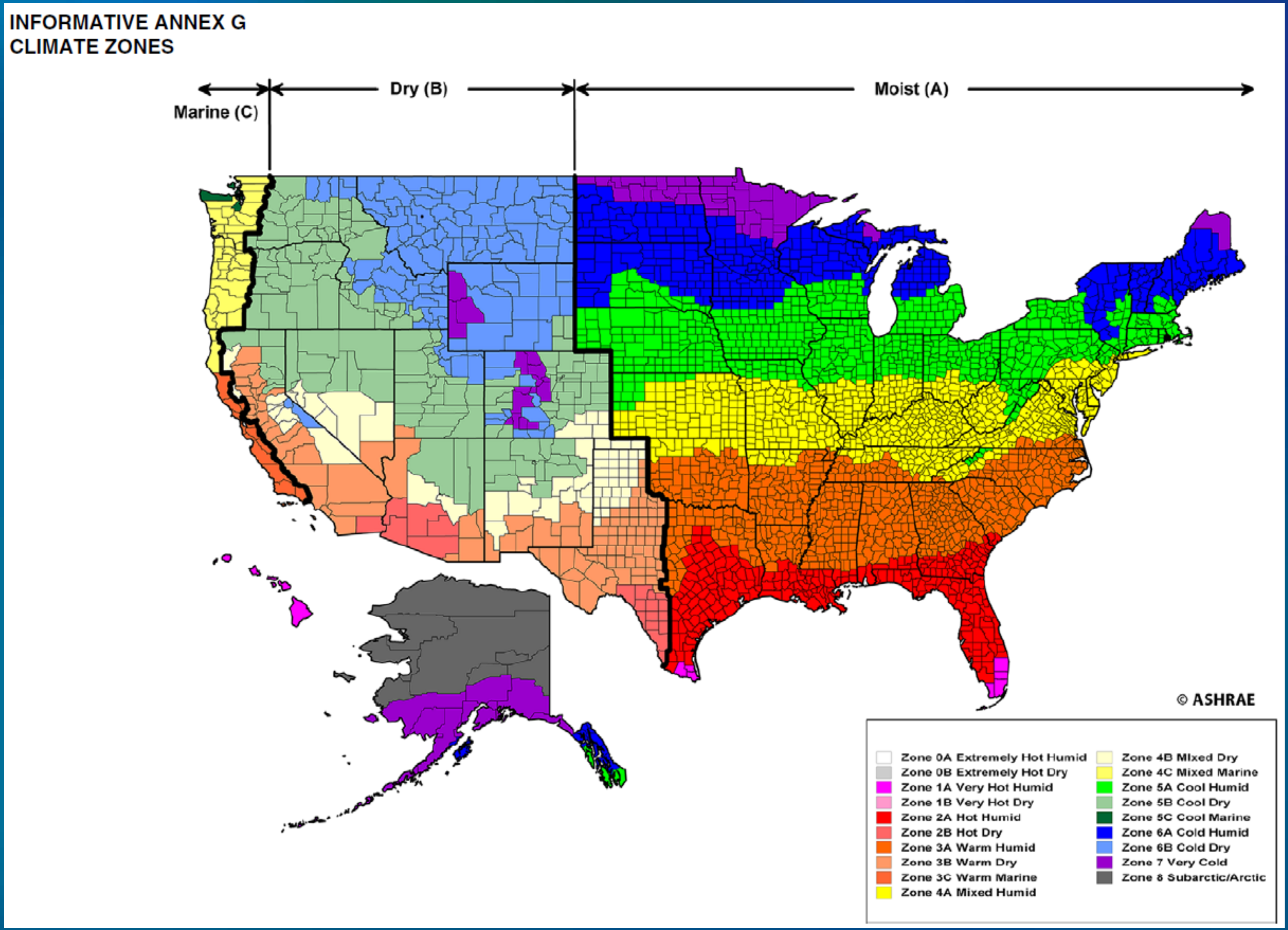

Source: Griffin Consultants.

# Summary of EUIs – UAE
## *(DM commercial building typologies)*




Source: Griffin Consultants.

# ASHRAE Standard 100-2018: Climate Zones Map



# ASHRAE Standard 100-2018, *Energy Efficiency in Existing Buildings*

- Operating Shifts

**TABLE 7-3 Building Operating Shifts Normalization Factor**

| No. | Building Activity/Type | Weekly Hours | | |
|---|---|---|---|---|
| | | 50 or less | 51 to 167 | 168 |
| 1 | Admin/professional office | 1.0 | 1.0 | 1.4 |
| 2 | Bank/other financial | 1.0 | 1.0 | 1.4 |
| 3 | Government office | 1.0 | 1.0 | 1.4 |
| 4 | Medical office (nondiagnostic) | 1.0 | 1.0 | 1.4 |
| 5 | Mixed-use office | 1.0 | 1.0 | 1.4 |

*Excerpts from Table 7-3*

# Assess Performance: Year, Month, and Daily Data

- Annual usage
  - Energy cost index (ECI)
  - Energy utilization index (EUI)
- Annual profile of monthly data
- Daily profile of 15-minute data

# Indices

ECI: Energy Cost Index = $/m²/yr

EUI: Energy Utilization Index = kWh/m²/yr

(Annual kWh) = _____kWh

\+ (Annual Therms × 29.3) = _____kWh

Total Annual Energy = _____kWh

EUI = Total Annual Energy ÷ m² = kWh/m²/yr

Example: Lowell Hall @ UW

(1,209,319 kWh) = 1,209,319 kWh

\+ (83,642 Therms × 29.3) = 2,451,175 kWh

Total Annual Energy = 3,660,494 kWh

EUI = 3,660,494 kWh ÷ 10,925 m² = 335 kWh/m²/yr

# Indices

ECI: Energy Cost Index = $/SF/yr

EUI: Energy Utilization Index = kBtu/SF/yr

(Annual kWh × 3.413) =_____kBtu

\+ (Annual Therms × 100) =_____kBtu

Total Annual Energy =_____kBtu

EUI = Total Annual Energy ÷ SF = kBtu/SF/yr

Example: Lowell Hall @ UW

(1,209,319 kWh × 3.413) = 4,127,000 kBtu

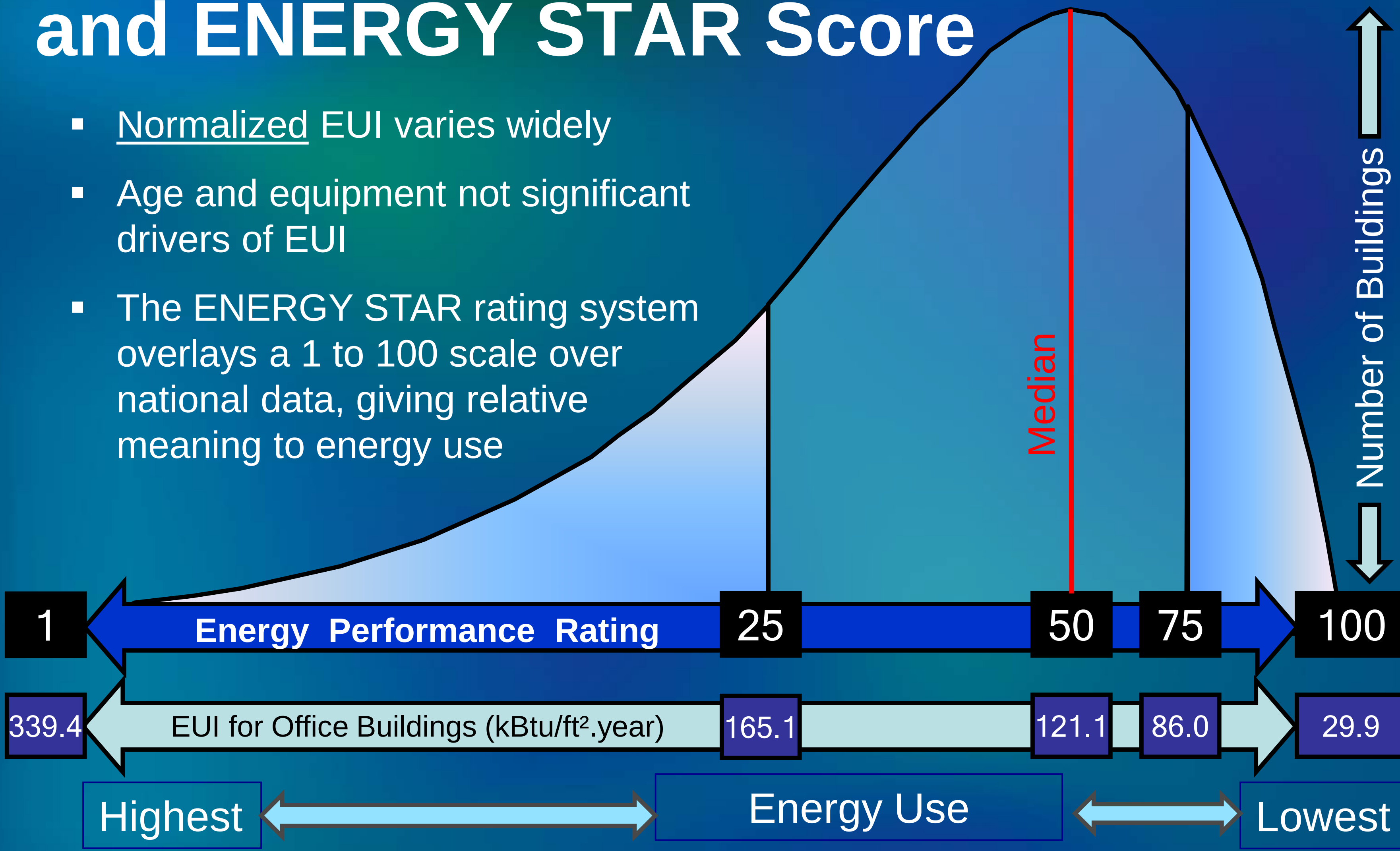
\+ (83,642 Therms × 100) = 8,364,200 kBtu *(2,451,305 kWh)*

Total Annual Energy = 12,491,200 kBtu *(3,660,810 kWh)*

EUI = 12,491,200 kBtu ÷ 117,600 SF = 106.2 kBtu/SF/yr *(334.9 kWh/m²/yr)*

# Energy Intensity of Office Buildings and ENERGY STAR Score

- Normalized EUI varies widely
- Age and equipment not significant drivers of EUI
- The ENERGY STAR rating system overlays a 1 to 100 scale over national data, giving relative meaning to energy use



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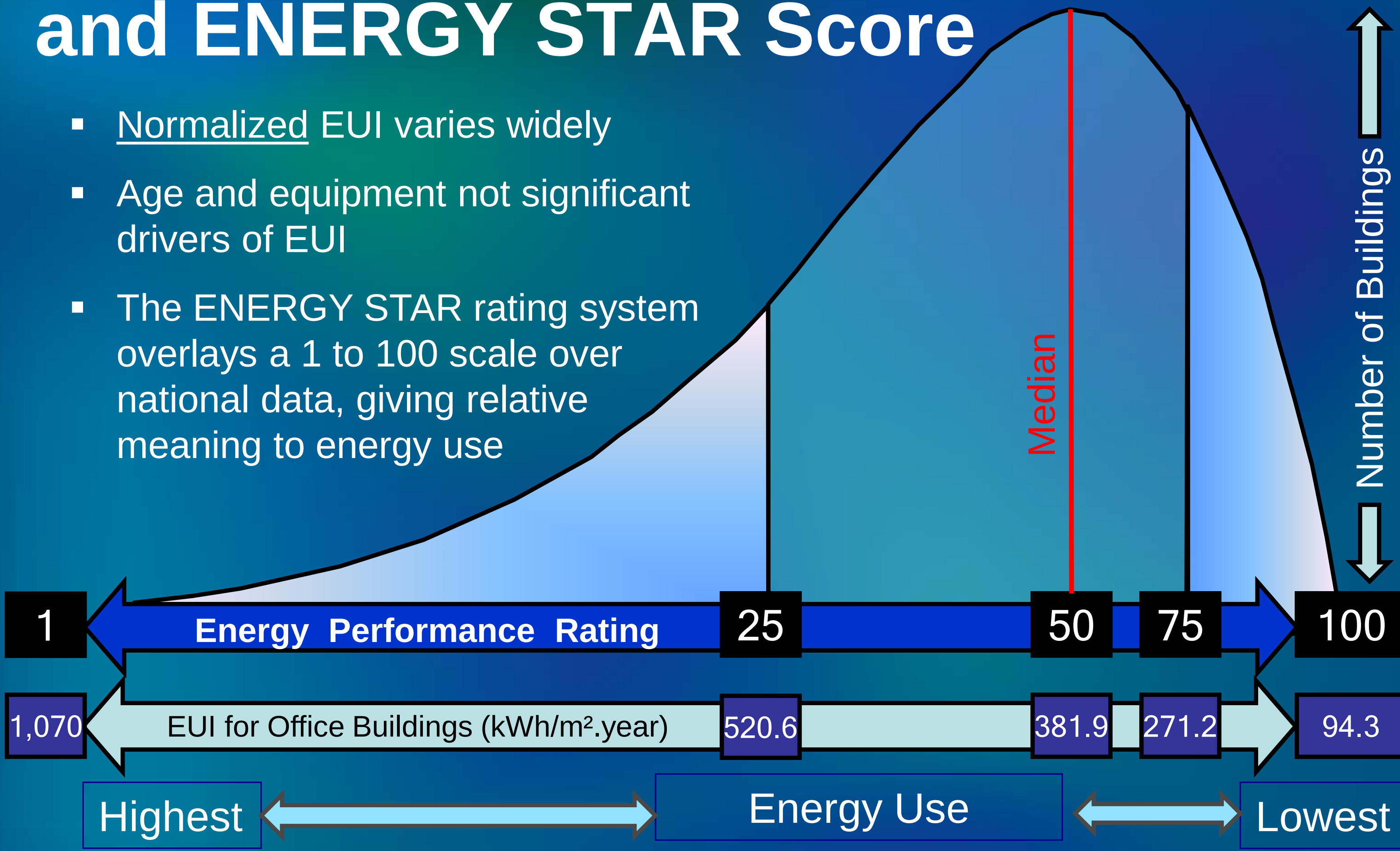


# Exercise 2:
# EUI and ECI Questions

Page 6
in the
exercises

# BREAK!

# Benchmarking Using ENERGY STAR's Portfolio Manager

www.energystar.gov/benchmark

https://www.energystar.gov/buildings/training/slide_library

# ENERGY STAR Score Eligible Building Types


Bank Branches


Barracks


Courthouses


Data Centers


Distribution Center


Financial Offices


Hospitals


Hotels

K-12 Schools


Medical Offices


Multifamily Housing


Non-refrigerated Warehouses


Office Buildings


Refrigerated Warehouses


Residence Hall

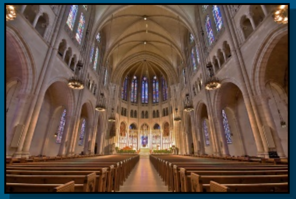

Retail Stores


Senior Care Community


Supermarkets


Wastewater Treatment Plants


Wholesale Club/ Supercenter


Worship Facilities

# Obtaining an Energy Performance Rating

- ENERGY STAR **Portfolio Manager**—Existing Commercial Buildings

  **www.energystar.gov/benchmark**.

- ENERGY STAR **Target Finder**—Commercial New Construction Projects

  **www.energystar.gov/targetfinder**.

# Why Benchmark?
# ENERGY STAR Says:

- Heighten awareness of energy use
- Assess effectiveness of current operations, policies, practices
- Set priorities for upgrade efforts and retrofits
- Track, verify, and recognize achievements
- Document role in environmental stewardship and demonstrate success

# Benchmarking with Portfolio Manager

- Compare buildings against similar buildings nationwide and against other buildings in your portfolio
- Receive an ENERGY STAR score normalized for weather
- Identify opportunities and set priorities for upgrade investments
- Track and manage:
  - Energy consumption and costs over time
  - Direct, indirect, and total greenhouse gas emissions
- Gain recognition from EPA for success!

# Getting Started with ENERGY STAR Benchmarking

www.energystar.gov/benchmark

# Assessing Performance and Setting Goals

ENERGY STAR® PortfolioManager®

"How To" Series

## Portfolio Manager® Quick Start Guide

**EPA's ENERGY STAR Portfolio Manager tool helps you measure and track energy use, water use, and greenhouse gas emissions of your buildings, all in a secure online environment.** You can use the results to identify under-performing buildings, set investment priorities, verify efficiency improvements, and receive EPA recognition for superior energy performance. Follow the steps in this guide to get started using the new Portfolio Manager to benchmark your properties, assess performance, and view results.

### *Getting Started*

Step 1: *Add a Property*

Step 2: *Enter Energy & Water Data*

Step 3: *View Results & Progress*

### 1 Add a Property

To get started, log in to Portfolio Manager at www.energystar.gov/benchmark. Then, follow these instructions to create a property and to enter property information.

1. Click **Add a Property** on the **MyPortfolio** tab.
2. Answer questions about your property and click **Get Started!**
3. Enter basic property information and select the boxes next to the statements that apply to your property. Then click **Continue**.
4. Enter use details such as gross floor area, operating hours, and number of workers for each type of use. You can use default or temporary values at this time and enter more accurate data later. **NOTE:** Mouse over the use detail to see a definition.
5. Click **Add Property**. When you have successfully added your property, you will see the property's **Summary** tab.

If you have additional types of uses on the property, you can add them at any time.

1. Click the property's **Details** tab, and then select a use type from the **Add Another Type of Use** drop-down menu. Click **Add**.
2. Enter use details for the property and then click **Save Use**.

### *Property Types*

All property types can be benchmarked. For properties with multiple buildings only hospitals, hotels, K-12 schools, multifamily, and senior care communities are eligible to receive the 1 – 100 ENERGY STAR score.

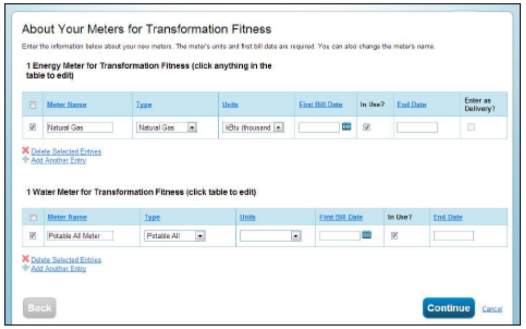
### *Properties with Multiple Use Types*

Some properties include multiple use types, such as restaurants in hotels, salons in senior care communities, and cafeterias in hospitals. As a general rule, if a certain use commonly occurs in the type of property being benchmarked, simply include it in the square footage of the building's primary use. You do not need to add another type of use.



### 2 Enter Energy & Water Data

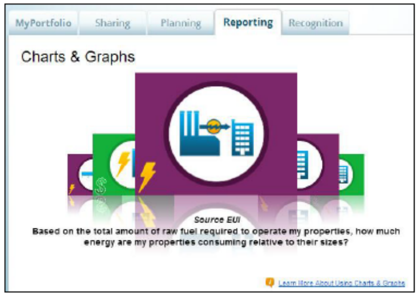
To receive an accurate picture of your building's performance, you need to tell Portfolio Manager how much and what kind of energy and water your building consumes. Follow these steps to enter energy and water data for your property.




1. Click on your property from the **MyPortfolio** tab and then select the **Meters** tab.
2. Click **Add Another Meter**.
3. Select the sources of your property's energy and your property's water usage, identify the number of meters, and then click **Get Started!**
4. Click on a meter to enter units and first bill date. If it is a bulk fuel purchase, select the **Enter as Delivery?** checkbox. Then click **Continue**.
5. Click the gray arrow next to each meter to expand the section on the **Your Meter Entries** page. Click **Add Another Entry** under the meter and enter data. Check **Estimation** if you are not including measured data for the entry.
6. Click **Finish Meter Set Up** when you have finished entering information for each meter.
7. Select the boxes of the meters that total your property's energy and water use on the **Meters to Add to Total Consumption** page. Click **Apply Selections**.

### 3 View Results & Progress

It is easy for you to see trends and to track improvement for your entire portfolio of buildings with a variety of standard graphs and reports in Portfolio Manager. Follow these steps to view reports about your properties and to assess progress.




- ✓ Click the **Reporting** tab to view graphs and reports for a property or portfolio.
- ✓ Click on the **Charts & Graphs** options to instantly see colorful graphs of how your portfolio or group of properties is performing. You can print graphs or download the images to incorporate into a presentation or document.
- ✓ View the **Templates & Reports** section to see a list of available standard reports, including Performance Highlights, Energy Performance, and Water Performance. Select **Generate New Report** from the **Action** drop-down menu to create a spreadsheet.

### *Learn More!*

To learn more about Portfolio Manager, visit www.energystar.gov/benchmark.
To get answers to your questions, visit www.energystar.gov/buildingshelp.

# 1 Add a Property

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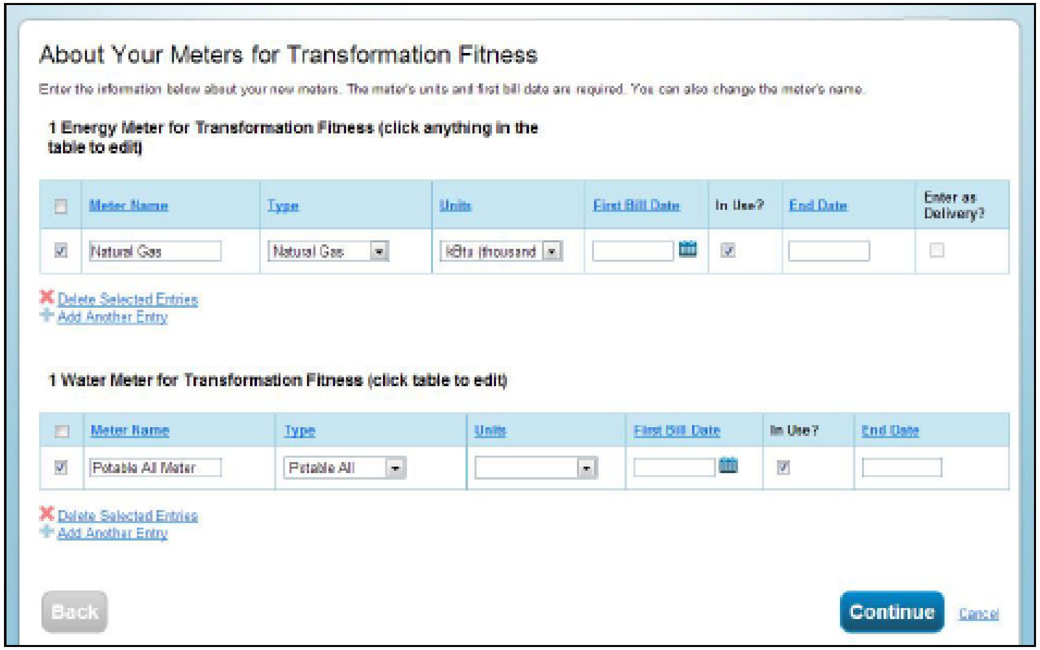


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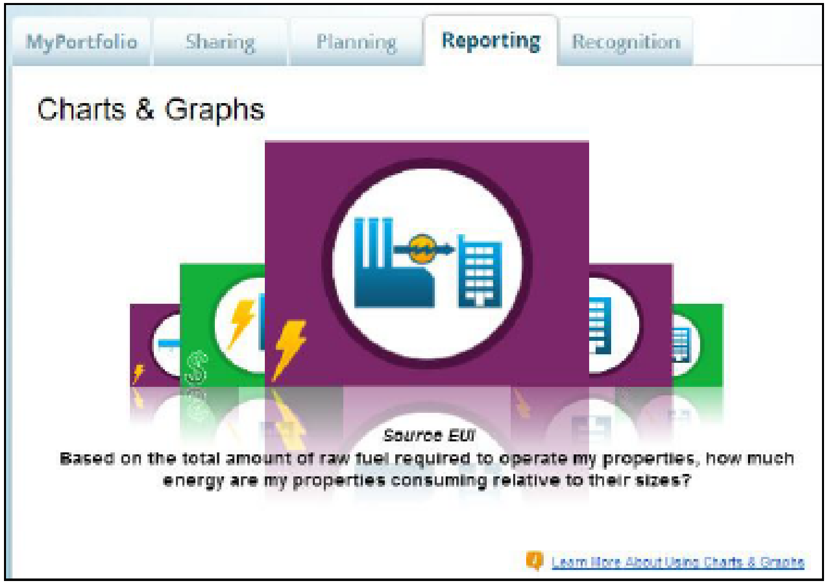


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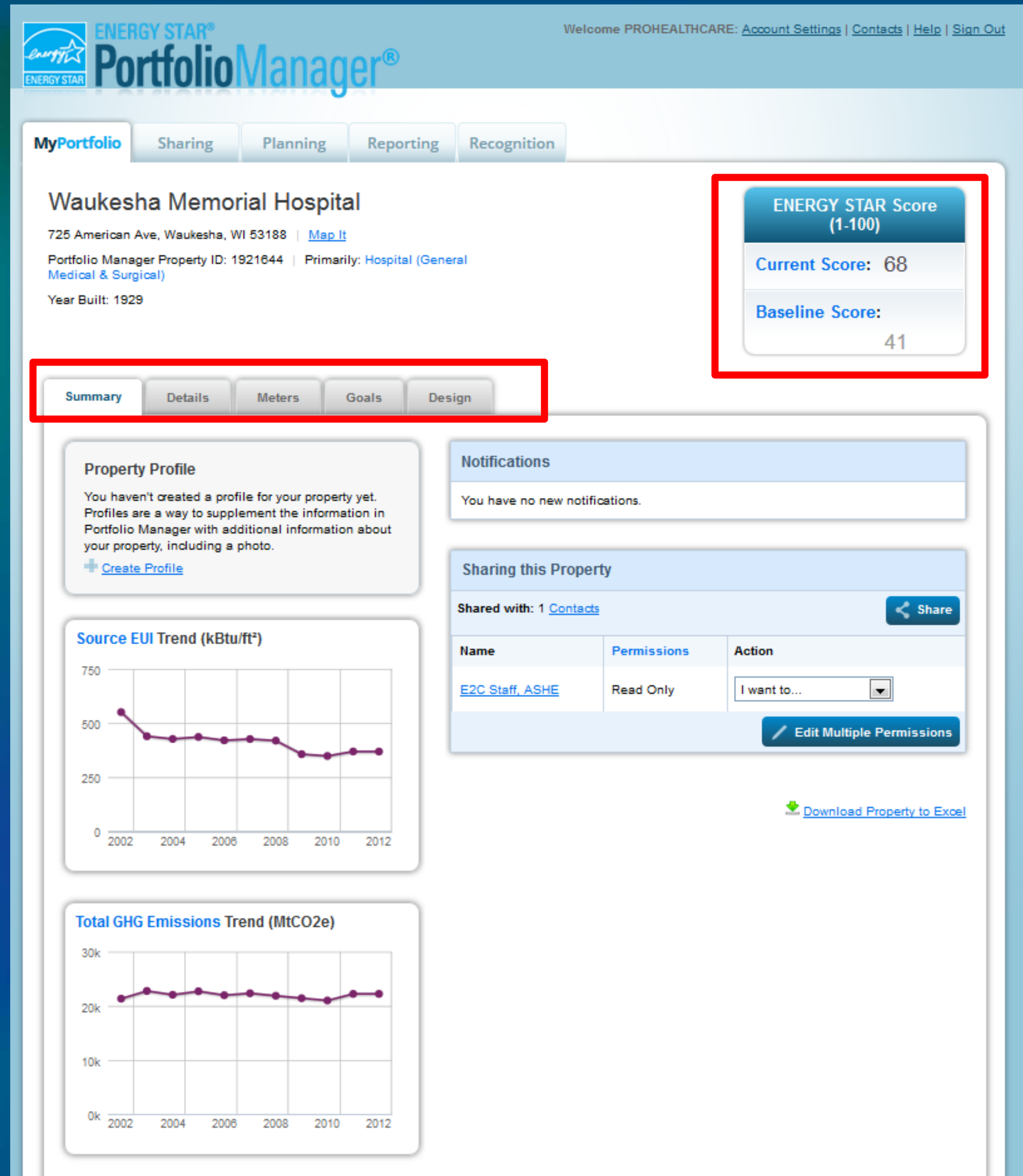
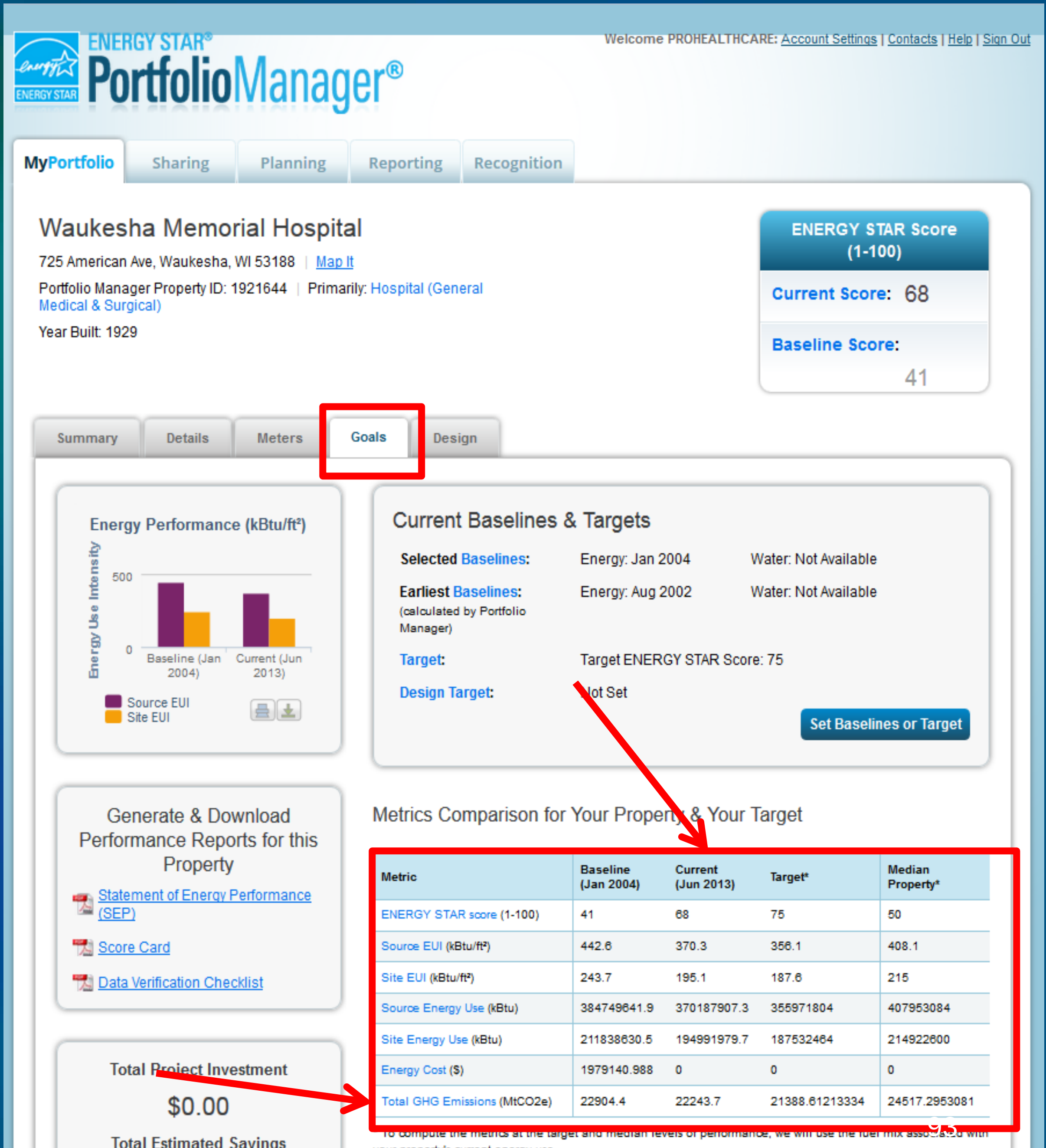
# Track Facility Energy Performance



# Greenhouse Gas Emissions




| Metric | Baseline (Jan 2004) | Current (Jun 2013) | Target* | Median Property* |
|---|---|---|---|---|
| ENERGY STAR score (1-100) | 41 | 68 | 75 | 50 |
| Source EUI (kBtu/ft²) | 442.6 | 370.3 | 356.1 | 408.1 |
| Site EUI (kBtu/ft²) | 243.7 | 195.1 | 187.6 | 215 |
| Source Energy Use (kBtu) | 384749641.9 | 370187907.3 | 355971804 | 407953084 |
| Site Energy Use (kBtu) | 211838630.5 | 194991979.7 | 187532464 | 214922600 |
| Energy Cost ($) | 1979140.988 | 0 | 0 | 0 |
| Total GHG Emissions ($MtCO_2e$) | 22904.4 | 22243.7 | 21388.61213334 | 24517.2953081 |

your property's current energy use.

# Portfolio Manager Metrics Comparison

## Metrics Comparison for Your Property & Your Target

| Metric | Baseline (Jan 2004) | Current (Jun 2013) | Target* | Median Property* |
|---|---|---|---|---|
| ENERGY STAR score (1-100) | 41 | 68 | 75 | 50 |
| Source EUI (kBtu/ft²) | 442.6 | 370.3 | 356.1 | 408.1 |
| Site EUI (kBtu/ft²) | 243.7 | 195.1 | 187.6 | 215 |
| Source Energy Use (kBtu) | 384749641.9 | 370187907.3 | 355971804 | 407953084 |
| Site Energy Use (kBtu) | 211838630.5 | 194991979.7 | 187532464 | 214922600 |
| Energy Cost ($) | 1979140.988 | 0 | 0 | 0 |
| Total GHG Emissions (MtCO2e) | 22904.4 | 22243.7 | 21388.61213334 | 24517.2953081 |

* To compute the metrics at the target and median levels of performance, we will use the fuel mix associated with your property's current energy use.

# Statement of Energy Performance

## 2013

**ENERGY STAR® Statement of Energy Performance**

LEARN MORE AT energystar.gov

**68**

ENERGY STAR® Score[1]

**Waukesha Memorial Hospital**

**Primary Property Function:** Hospital (General Medical & Surgical)
**Gross Floor Area (ft²):** 999,640
**Built:** 1929

**For Year Ending:** June 30, 2013
**Date Generated:** December 16, 2013

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

**Property & Contact Information**

| Property Address | Property Owner | Primary Contact |
|---|---|---|
| Waukesha Memorial Hospital<br>725 American Ave<br>Waukesha, Wisconsin 53188 | ________________<br>,<br>(____)____-______ | ____ ________<br>,<br>(____)____-______<br>________________ |

**Property ID:** 1921644

**Energy Consumption and Energy Use Intensity (EUI)**

**Site EUI**
195.1 kBtu/ft²

**Source EUI**
370.3 kBtu/ft²

**Annual Energy by Fuel**

| | |
|---|---|
| Natural Gas (kBtu) | 115,459,202 (59%) |
| Fuel Oil (No. 2) (kBtu) | 364,872 (0%) |
| Electric - Grid (kBtu) | 79,167,906 (41%) |

**National Median Comparison**

| | |
|---|---|
| National Median Site EUI (kBtu/ft²) | 215 |
| National Median Source EUI (kBtu/ft²) | 408.1 |
| % Diff from National Median Source EUI | -9% |

**Annual Emissions**

| | |
|---|---|
| Greenhouse Gas Emissions (MtCO2e/year) | 22,244 |

**Signature & Stamp of Verifying Professional**

I ________________ (Name) verify that the above information is true and correct to the best of my knowledge.

Signature: ____________________Date: __________

**Licensed Professional**

____ ________
,
(____)____-______
________________

Professional Engineer Stamp
(if applicable)

## 2018

**ENERGY STAR® Statement of Energy Performance**

LEARN MORE AT energystar.gov

**80**

ENERGY STAR® Score[1]

**Waukesha Memorial**

**Primary Property Type:** Hospital (General Medical & Surgical)
**Gross Floor Area (ft²):** 934,671
**Built:** 1914

**For Year Ending:** June 30, 2018
**Date Generated:** September 27, 2018

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

**Property & Contact Information**

| Property Address | Property Owner | Primary Contact |
|---|---|---|
| Waukesha Memorial<br>725 American Ave<br>Waukesha, Wisconsin 53188 | ________________<br>,<br>(____)____-______ | ____ ________<br>,<br>(____)____-______<br>________________ |

**Property ID:** 4331251

**Energy Consumption and Energy Use Intensity (EUI)**

**Site EUI**
188.1 kBtu/ft²

**Source EUI**
318.8 kBtu/ft²

**Annual Energy by Fuel**

| | |
|---|---|
| Electric - Grid (kBtu) | 64,742,341 (37%) |
| Natural Gas (kBtu) | 111,114,016 (63%) |

**National Median Comparison**

| | |
|---|---|
| National Median Site EUI (kBtu/ft²) | 220.3 |
| National Median Source EUI (kBtu/ft²) | 373.3 |
| % Diff from National Median Source EUI | -15% |

**Annual Emissions**

| | |
|---|---|
| Greenhouse Gas Emissions (Metric Tons CO2e/year) | 16,673 |

**Signature & Stamp of Verifying Professional**

I ________________ (Name) verify that the above information is true and correct to the best of my knowledge.

Signature: ____________________Date: __________

**Licensed Professional**

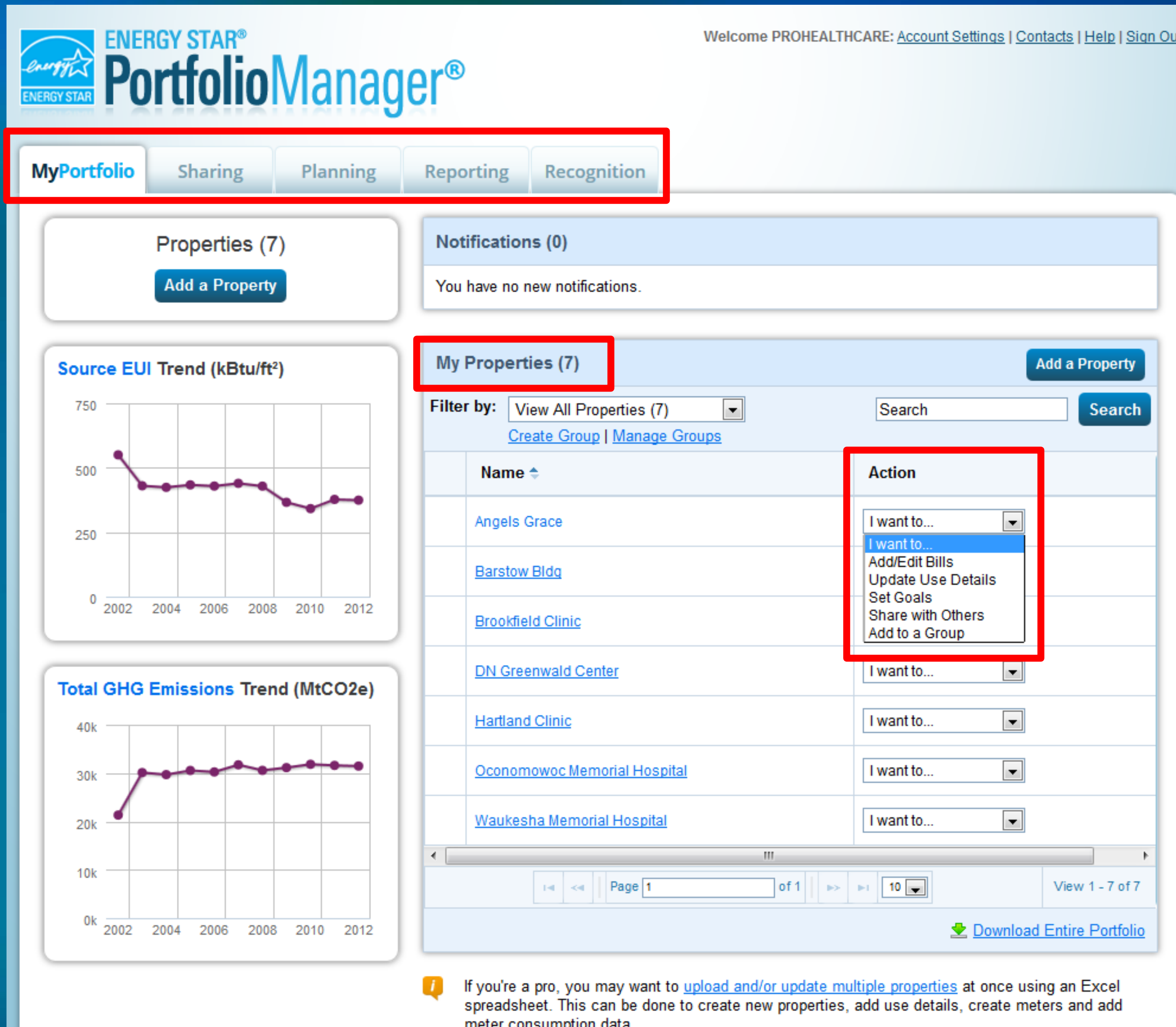
____ ________
,
(____)____-______
________________

Professional Engineer Stamp
(if applicable)

# Changes to Waukesha Memorial Hospital Since 2013

- Upgraded controls on AHUs
  - Reset duct pressure setpoint
  - Reset supply air temperature
  - Economizer at 62°F (16.6°C)
  - Optimal start
- Replace AHUs
  - New fans with VFDs
  - Hot water instead of steam heat
  - Chilled water instead of DX cooling
- New chiller plant
  - Magnetic bearing centrifugal chillers
  - Cooling towers with VFDs and indoor sump
- Replace constant-volume reheat with VAV with reheat

# Track Portfolio Energy Performance



# How Do I Enter a Facility that is Not Located in the United States?

"You may create a facility that is not located in the United States in the same way that you create other facilities: select 'Add Facility' from the My Portfolio page in Portfolio Manager and enter the required information. After you select the Country, you will be asked to select the city outside of the United States that is closest to your facility from a dropdown list."

—ENERGY STAR Website

# Can a Building Located Outside of the United States Earn the ENERGY STAR?

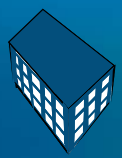
"The only buildings located outside of the U.S. that are eligible to earn the ENERGY STAR are those that are owned and occupied by the U.S. Government and that have met U.S. construction codes."

- ENERGY STAR Website

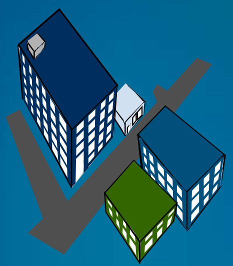
# All Buildings Can Benchmark, but Some Cannot Receive a Rating

- Benchmark your facility against itself
  - Look at trends in historical data
- Compare to other buildings in your portfolio
  - Prioritize upgrade opportunities
  - Create an internal benchmark
  - “Create a Group” to compare select buildings
- Compare to national average energy use intensity (EUI) or ASHRAE Standard 100-2018 for your building type
  - Set performance targets

# Ways to Obtain the Rating or EUI



- **Single Building Manual Entry**
  - Enter building and energy consumption information into Portfolio Manager



- **Excel Data Upload**
  - Upload building data in Portfolio Manager using an Excel template

- **Automated Benchmarking Services**
  - Use an ENERGY STAR service and product provider to have the rating automatically integrated into your energy information and bill handling system for all buildings

# Information Required for Rating

### All Space Types

- Address
- Year Built
- At least 12 months energy data

### K-12 School

- SM*
- # Walk-in refrigerator/ freezer units
- # PCs
- Open weekends: Y/N
- Cooking: Y/N
- High school: Y/N
- % heated
- % AC

### Office

- SM*
- # Workers
- Op. hrs.
- # PCs
- % heated
- % AC

### Hospitals

- SM*
- Licensed and staffed bed capacity
- # workers
- # MRI machines
- Laundry
- Tertiary care
- Laboratory
- # floors
- % heated
- % AC

Examples

***Gross square metre—deduct "upper floors" of atria**


102

# Data Collection Worksheet

LEARN MORE AT energystar.gov

## Portfolio Manager - What data is required?

In order for Portfolio Manager to calculate metrics about your property, you must provide several key pieces of information about your property's operation, in addition to your energy, water or waste data. The information required varies by the type of property and whether or not your property is eligible for an ENERGY STAR Score.

### Data Required for All Properties

Property Name ____________________

Property Address ____________________

Total Gross Floor Area of Property ____________________ Sq. Ft./Sq. M.

Irrigated Area ____________________ Sq. Ft./Sq. M./ Acres

Year Built/Planned for Construction Completion ____________________

Occupancy ____________________ %

Number of Buildings ____________________

### Helpful Hints for All Properties

- Definitions for Property Use Details are available in the Portfolio Manager Glossary (in the Help section, or https://portfoliomanager.energystar.gov/pm/glossary).
- Some properties may contain multiple Property Uses within a single building (e.g. office, data center, and parking; OR K-12 School and Swimming Pool). In most cases, EPA recommends you enter as few Property Uses as possible. More information about when to enter a separate Property Use is in this FAQ.
- For properties with multiple tenants within the same property use (e.g. Office), these tenants should be entered separately only when the number of Weekly Operating Hours differs by more than 10 hours. For example, say an Office Building has a Gross Floor Area of 100,000 square foot (SF) where 75,000 SF operates 60 hours a week and 25,000 SF operates 80 hours a week. Enter these as two separate Property Uses (one 75,000 SF property and one 25,000 SF property).

Page 1 of 5 Generated On: 03/08/2017

## Office Uses

### Data Collected for Office Uses

The following information is required to get an ENERGY STAR Score ( if eligible):

Gross Floor Area ____________________

Weekly Operating Hours ____________________

Number of Workers on Main Shift ____________________

Number of Computers ____________________

Percent That Can Be Heated ____________________

Percent That Can Be Cooled ____________________

### Definition for Office

Office refers to buildings used for the conduct of commercial or governmental business activities. This includes administrative and professional offices.

Gross Floor Area (GFA) should include all space within the building(s) including offices, conference rooms and auditoriums, break rooms, kitchens, lobbies, fitness areas, basements, storage areas, stairways, and elevator shafts.

If you have restaurants, retail, or services (dry cleaners) within the Office, you should most likely include this square footage and energy in the Office Property Use. There are 4 exceptions to this rule when you should create a separate Property Use: If it is a Property Use Type that can get an ENERGY STAR Score (note: Retail can only get a score if it is greater than 5,000 square feet) If it accounts for more than 25% of the property's GFA If it is a vacant/unoccupied Office If the Hours of Operation differ by more than 10 hours from the main Property Use More on this rule.

### Helpful Hints for Office

- If more than 10 percent of the office's gross floor area on average was vacant through the last 12 months, enter the vacant space as a separate Property Use with zero for Weekly Operating Hours, Number of Workers on Main Shift and Number of Computers.

Page 2 of 5 Generated On: 03/08/2017

Data collection worksheets available for download at:
https://portfoliomanager.energystar.gov/pm/dataCollectionWorksheet.

# ENERGY STAR Rating as a Quick Guide

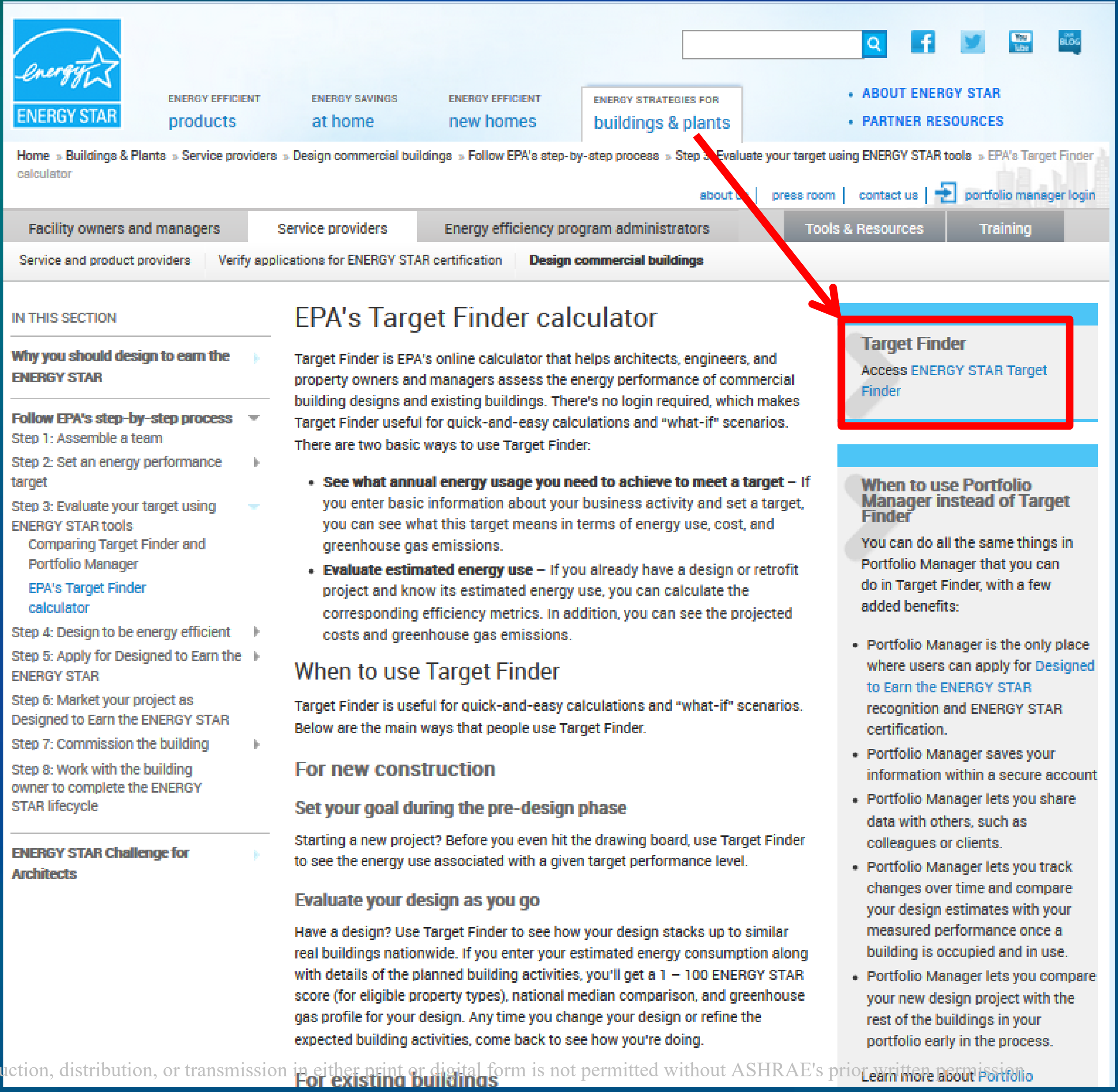
- If your building has a low score (less than 25), there are likely to be many opportunities.
- If your building has a high score (more than 75):
  - Confirm that you can monitor to keep it there
  - Go look for another building to improve

# ENERGY STAR Target Finder

## http://www.energystar.gov/targetfinder

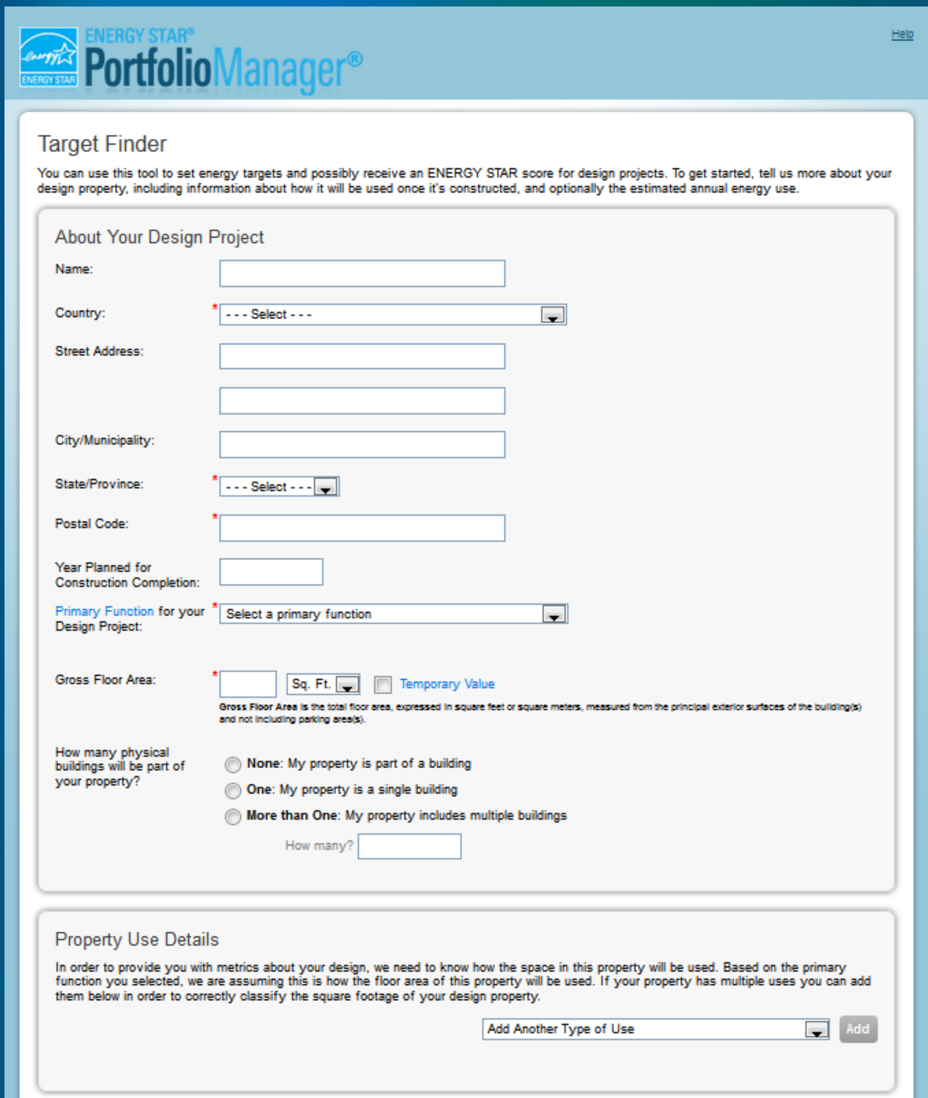
Use in design phase to

- Set energy targets
- Evaluate energy use of building models to compare design options



# ENERGY STAR Target Finder (*cont.*)

## http://www.energystar.gov/targetfinder


ENERGY STAR® PortfolioManager® Help

Target Finder

You can use this tool to set energy targets and possibly receive an ENERGY STAR score for design projects. To get started, tell us more about your design property, including information about how it will be used once it's constructed, and optionally the estimated annual energy use.

About Your Design Project

Name:

Country: * --- Select ---

Street Address:

City/Municipality:

State/Province: * --- Select ---

Postal Code: *

Year Planned for Construction Completion:

Primary Function for your Design Project: * Select a primary function

Gross Floor Area: * Sq. Ft. Temporary Value

Gross Floor Area is the total floor area, expressed in square feet or square meters, measured from the principal exterior surfaces of the building(s) and not including parking area(s).

How many physical buildings will be part of your property?

**None**: My property is part of a building

**One**: My property is a single building

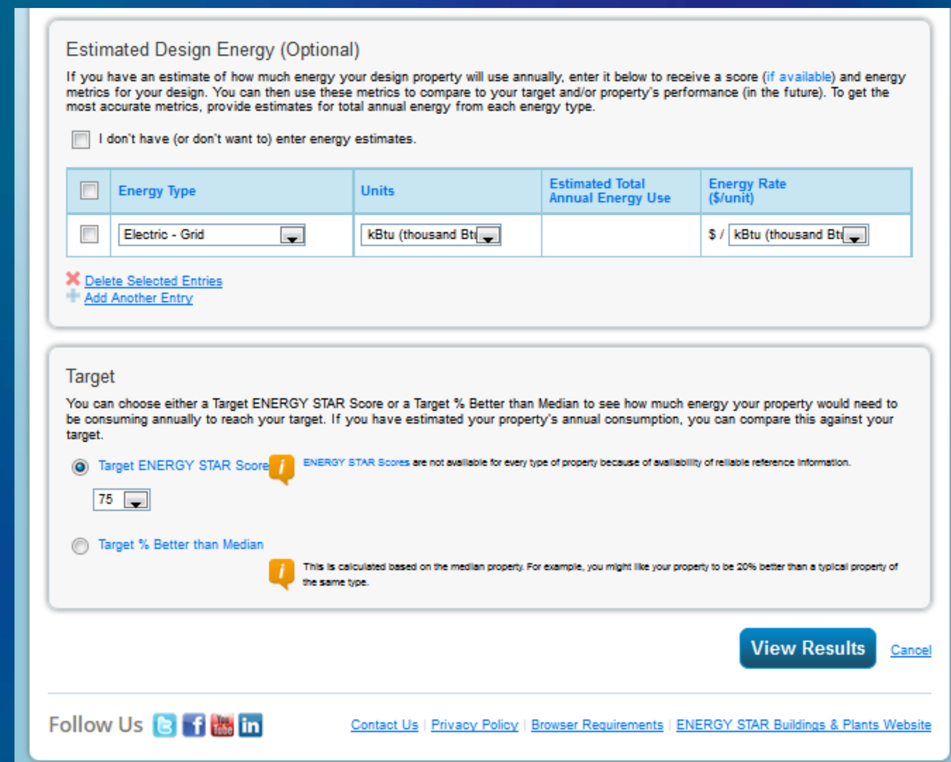
**More than One**: My property includes multiple buildings

How many?

Property Use Details

In order to provide you with metrics about your design, we need to know how the space in this property will be used. Based on the primary function you selected, we are assuming this is how the floor area of this property will be used. If your property has multiple uses you can add them below in order to correctly classify the square footage of your design property.

Add Another Type of Use | Add


Estimated Design Energy (Optional)

If you have an estimate of how much energy your design property will use annually, enter it below to receive a score (if available) and energy metrics for your design. You can then use these metrics to compare to your target and/or property's performance (in the future). To get the most accurate metrics, provide estimates for total annual energy from each energy type.

I don't have (or don't want to) enter energy estimates.

| | Energy Type | Units | Estimated Total Annual Energy Use | Energy Rate ($/unit) |
|---|---|---|---|---|
| | Electric - Grid | kBtu (thousand Btu) | | $ / kBtu (thousand Btu) |

Delete Selected Entries

Add Another Entry

Target

You can choose either a Target ENERGY STAR Score or a Target % Better than Median to see how much energy your property would need to be consuming annually to reach your target. If you have estimated your property's annual consumption, you can compare this against your target.

Target ENERGY STAR Score

ENERGY STAR Scores are not available for every type of property because of availability of reliable reference information.

75

Target % Better than Median

This is calculated based on the median property. For example, you might like your property to be 20% better than a typical property of the same type.

View Results | Cancel

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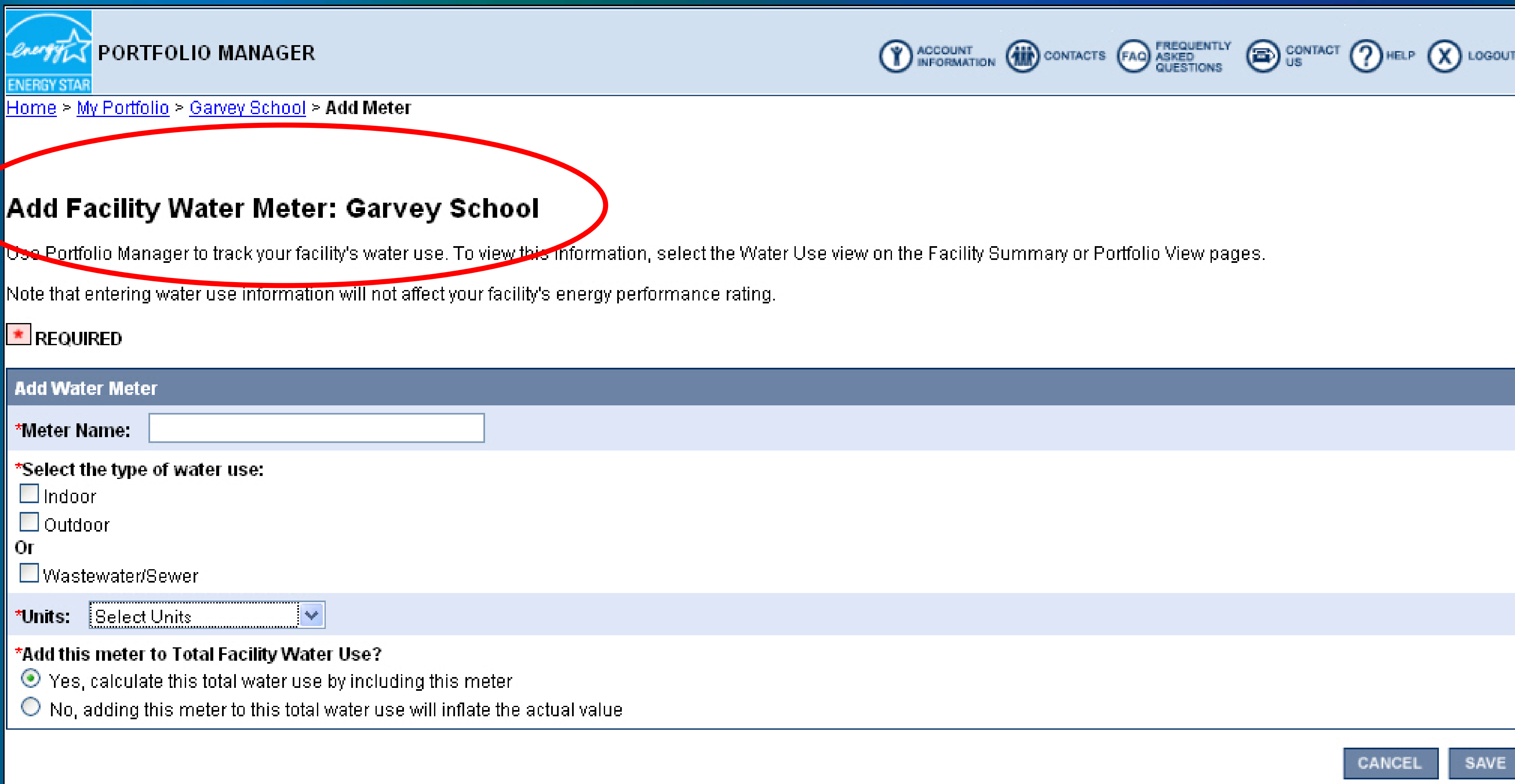
# Track Water Use Too


PORTFOLIO MANAGER

ENERGY STAR

ACCOUNT INFORMATION | CONTACTS | FREQUENTLY ASKED QUESTIONS | CONTACT US | HELP | LOGOUT

Home > My Portfolio > Garvey School > Add Meter

## Add Facility Water Meter: Garvey School

Use Portfolio Manager to track your facility's water use. To view this information, select the Water Use view on the Facility Summary or Portfolio View pages.

Note that entering water use information will not affect your facility's energy performance rating.

* REQUIRED

**Add Water Meter**

*Meter Name:

*Select the type of water use:

- Indoor
- Outdoor

Or

- Wastewater/Sewer

*Units: Select Units

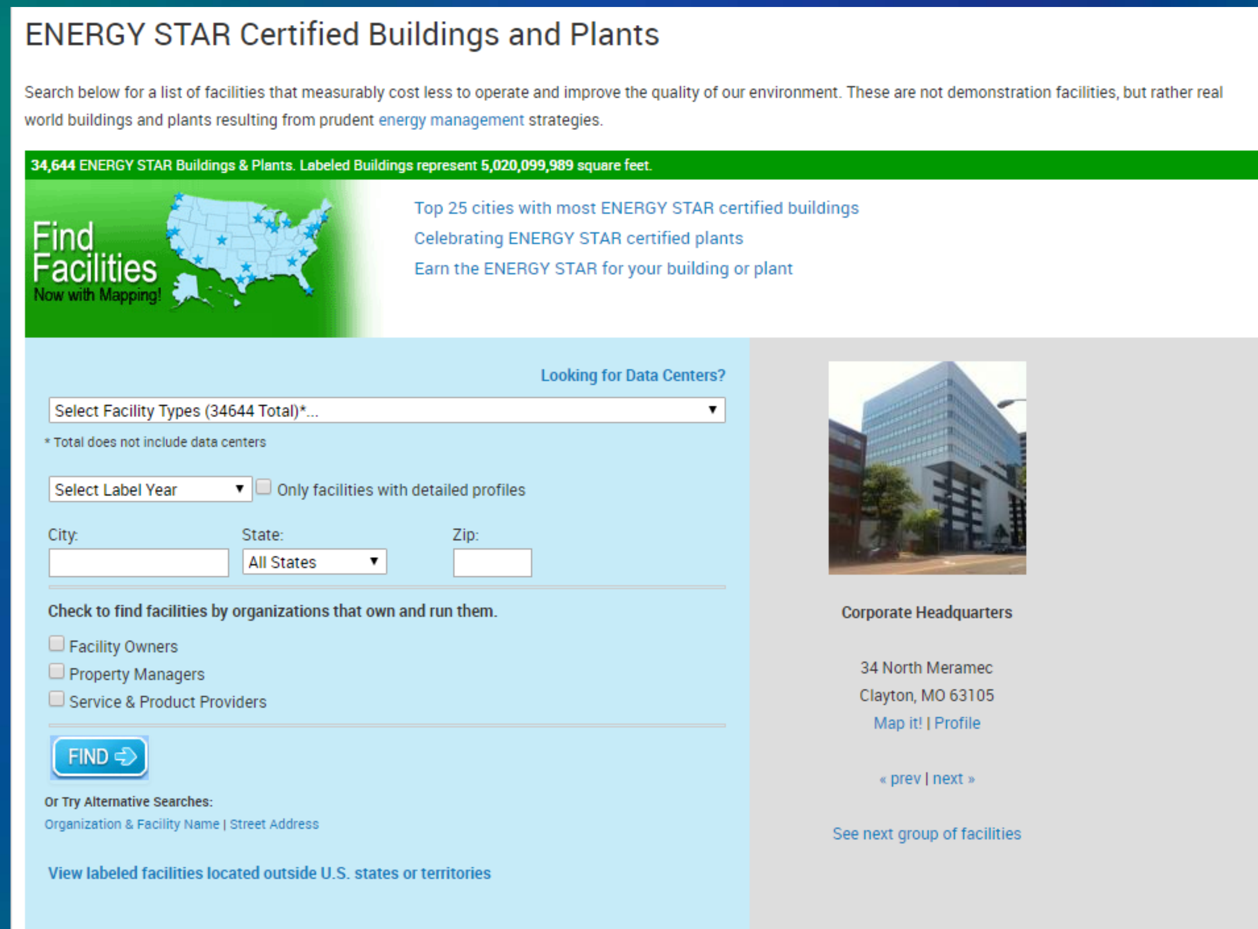
*Add this meter to Total Facility Water Use?

- Yes, calculate this total water use by including this meter
- No, adding this meter to this total water use will inflate the actual value

CANCEL SAVE

# ENERGY STAR "75+" Recognition

- Listed on the website
- Wall plaque
- Citation from EPA




# For more information on ENERGY STAR Benchmarking visit:

https://www.energystar.gov/buildings/training/slide_library

# Exercise 3:
# Portfolio Manager Facility Report

Page 8
in the
exercises

## Exercise 3:  Portfolio Manager Facility Report

The next two pages show an excerpt from a Statement of Energy Performance generated by Portfolio Manager for Garvey School.

Take a look at the document and answer the following questions.

1. *Statement of Energy Performance (page 9 of this packet):*
   Which statements are correct in interpreting the Energy Performance Rating of 13?
   A. Garvey School uses more energy than 87% of schools in the EPA database after accounting for size, equipment and climate differences.
   B. Garvey School uses more energy than 13% of schools in the EPA database after accounting for size, equipment and climate differences.
   C. Garvey School's score is too low for EPA ENERGY STAR recognition.
   D. Energy data from 2005 and 2006 were used to compute the rating.

# Site Versus Source Energy

OMB No. 2060-0347

ENERGY STAR

## STATEMENT OF ENERGY PERFORMANCE
## Garvey School

**Building ID:** 1427605
**For 12-month Period Ending:** April 30, 20
**Date SEP becomes ineligible:** N/A

**Facility**
Garvey School
10309 S Morgan St
Chicago, IL 60643

**Facility Owner**
N/A

**Year Built:** 1968
**Gross Floor Area ($ft^2$):** 57,410

**Energy Performance Rating**[2] (1-100) 13

**Site Energy Use Summary**[3]

| | |
|---|---|
| Electricity - Grid Purchase(kBtu) | 3,808,114 |
| Natural Gas - (kBtu)[4] | 0 |
| Total Energy (kBtu) | 3,808,114 |

**Energy Intensity**[5]

| | |
|---|---|
| Site ($kBtu/ft^2/yr$) | 66 |
| Source ($kBtu/ft^2/yr$) | 222 |

**Table 1**
**Source-Site Ratios for all Portfolio Manager Fuels**

| Fuel Type | Source-Site Ratio |
|---|---|
| Electricity (Grid Purchase) | 3.340 |
| Electricity (on-Site Solar or Wind Installation) | 1.0 |
| Natural Gas | 1.047 |
| Fuel Oil (1,2,4,5,6,Diesel, Kerosene) | 1.01 |
| Propane & Liquid Propane | 1.01 |
| Steam | 1.45 |
| Hot Water | 1.35 |
| Chilled Water | 1.05 |
| Wood | 1.0 |
| Coal/Coke | 1.0 |
| Other | 1.0 |

$222 = 66 \times 3.340$

# Practical Implications

- Don’t mix site and source energy values in your analysis
- Not all source energy calculations use the EPA method
- Site energy drives basic $ costs
- Source energy drives environmental costs

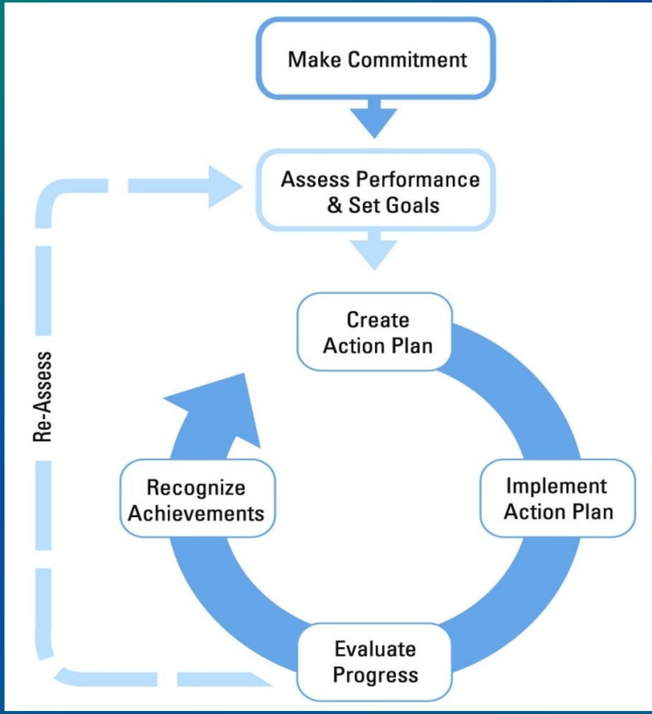
# Reference Schematic of EPA Tools on ENERGY STAR Site

## EPA Tools Support the Energy Management Process

6. Communicate results

5. Demonstrate results

4. Implement quality projects and evaluate




1. Commit to energy efficiency

2. Identify qualified projects

3. Understand financial value

# Reference Schematic of EPA Tools on ENERGY STAR Site

## EPA Tools Support the Energy Management Process

6. Communicate results

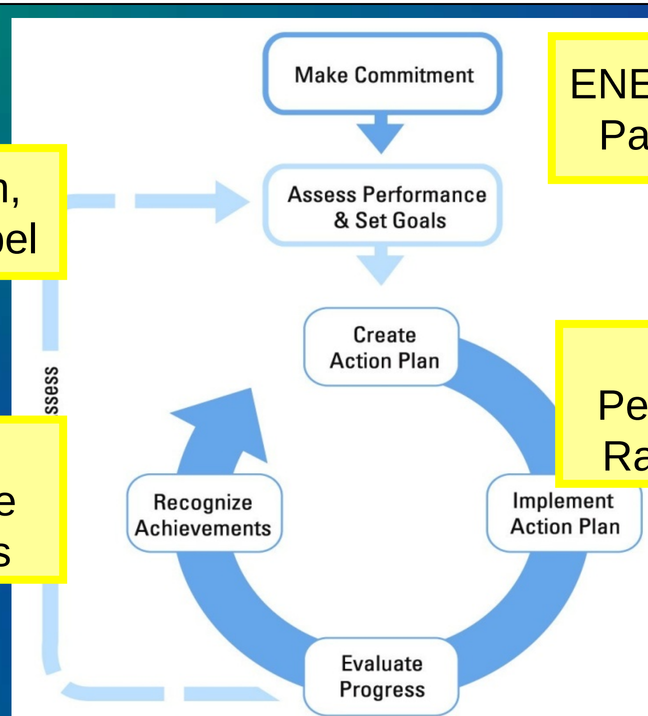
Recognition, Results, Label

5. Demonstrate results

Energy Performance Rating Tools

4. Implement quality projects and evaluate

Technical Resources




ENERGY STAR Partnership

1. Commit to energy efficiency

Energy Performance Rating Tools

2. Identify qualified projects

3. Understand financial value

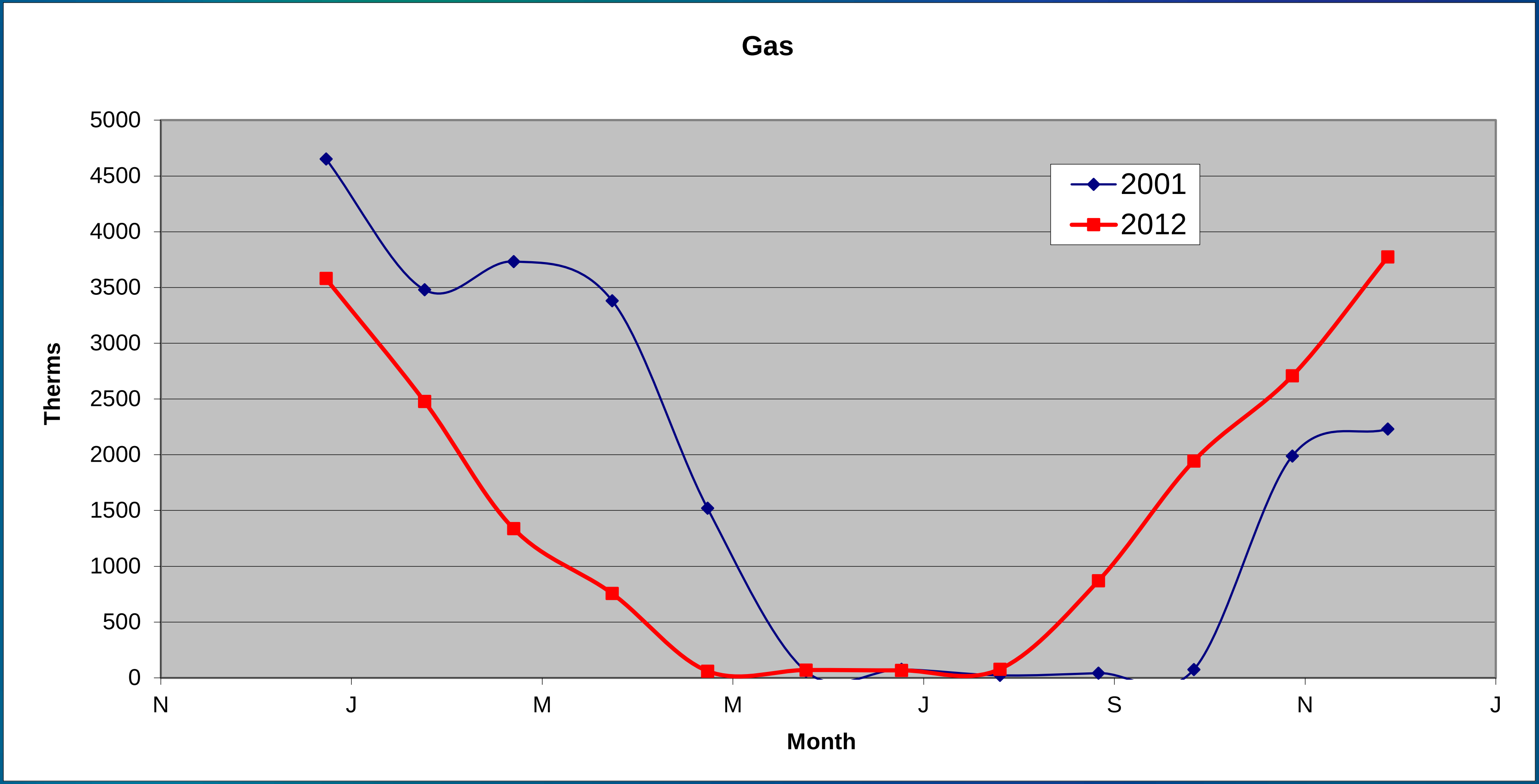
Financial Tools

# Assess Performance

- Annual usage
  - Energy cost index (ECI)
  - Energy utilization index (EUI)
- Annual profile of monthly data
- Daily profile of 15-minute data

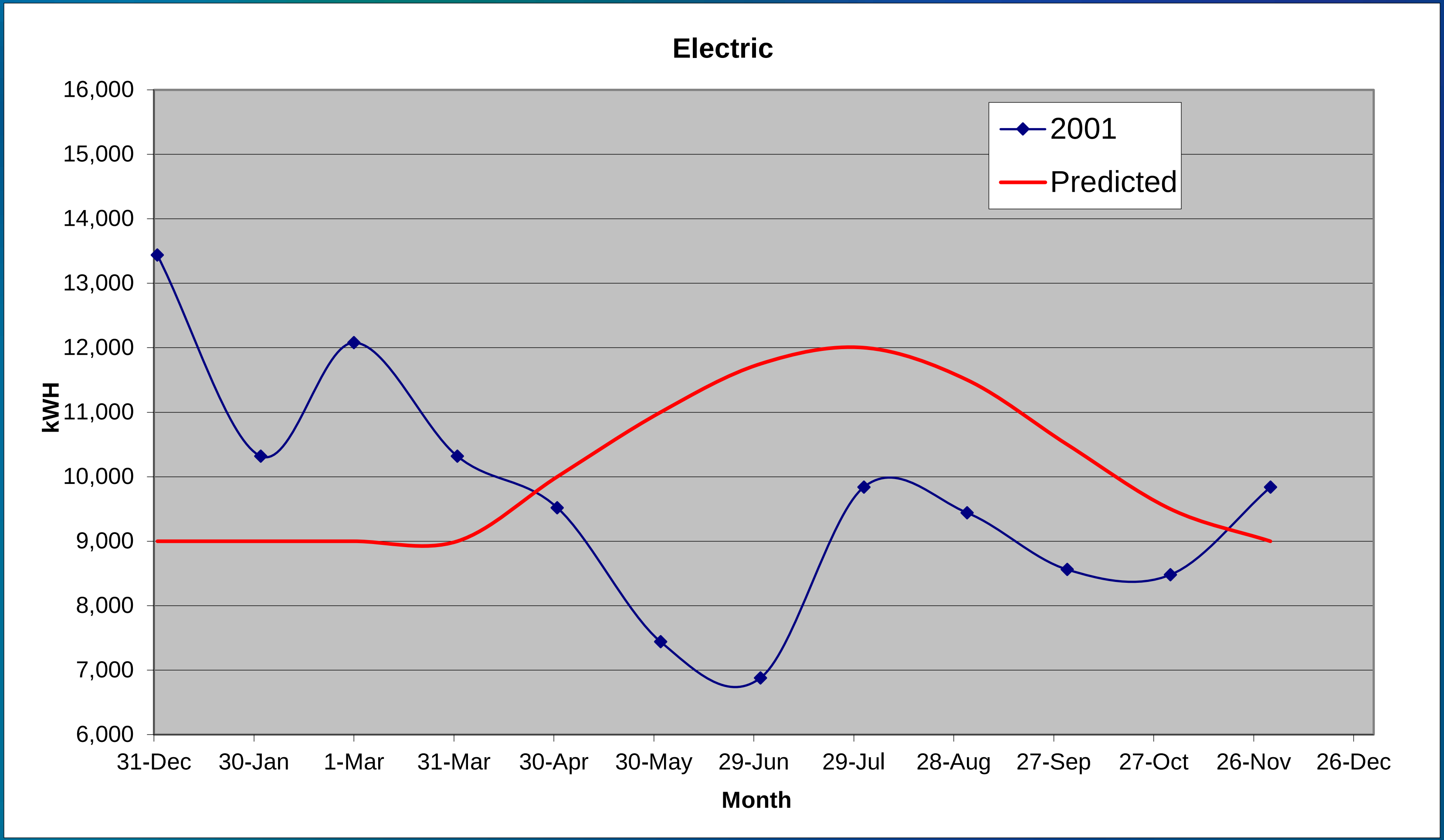
# Annual Profile of Monthly Data

## Madison Worship House



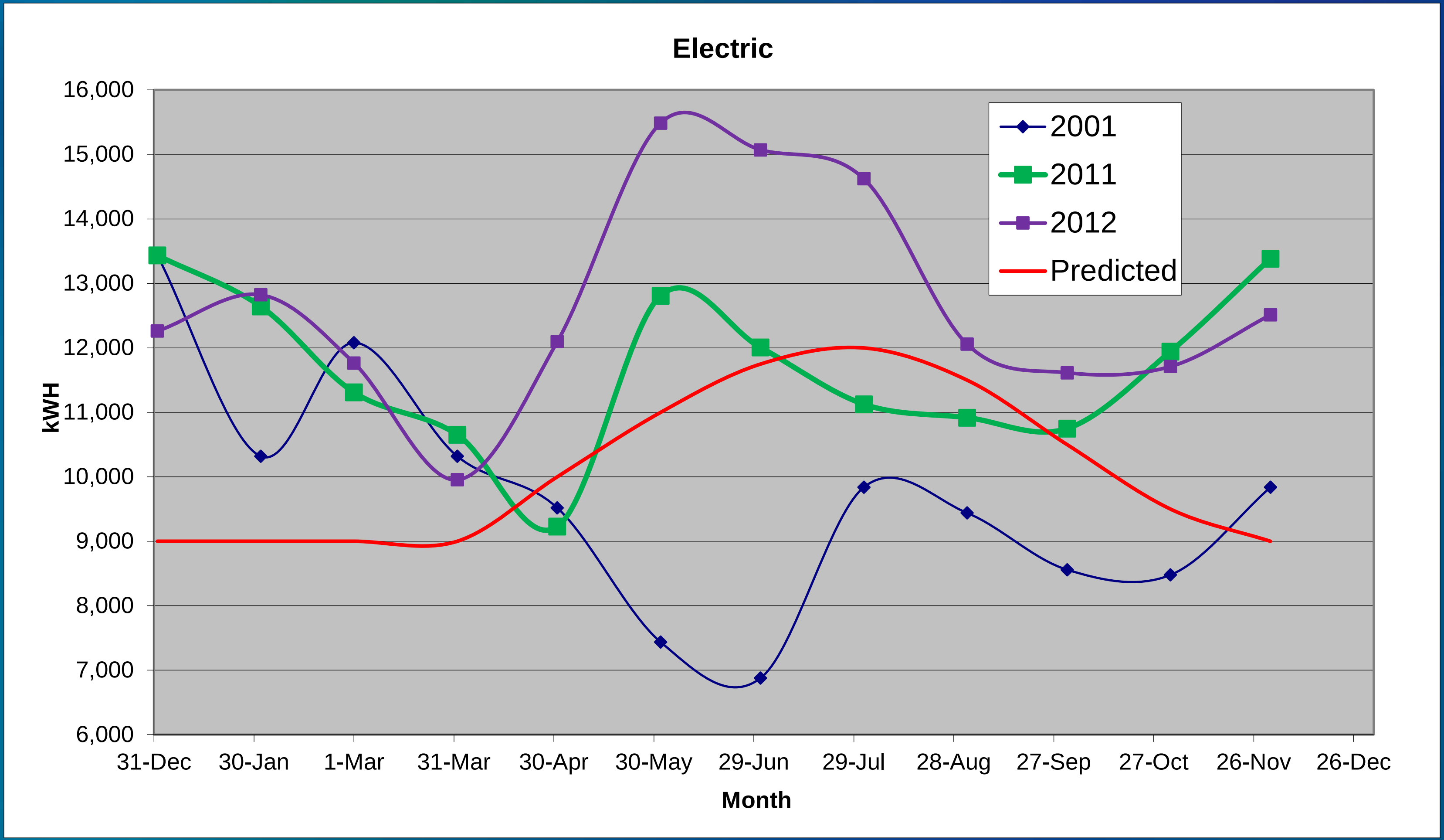
# Annual Profile of Monthly Data

## Madison Worship House



# Annual Profile of Monthly Data

## Madison Worship House



# Exercises 4A and 4B: Monthly Electric and Gas Profiles

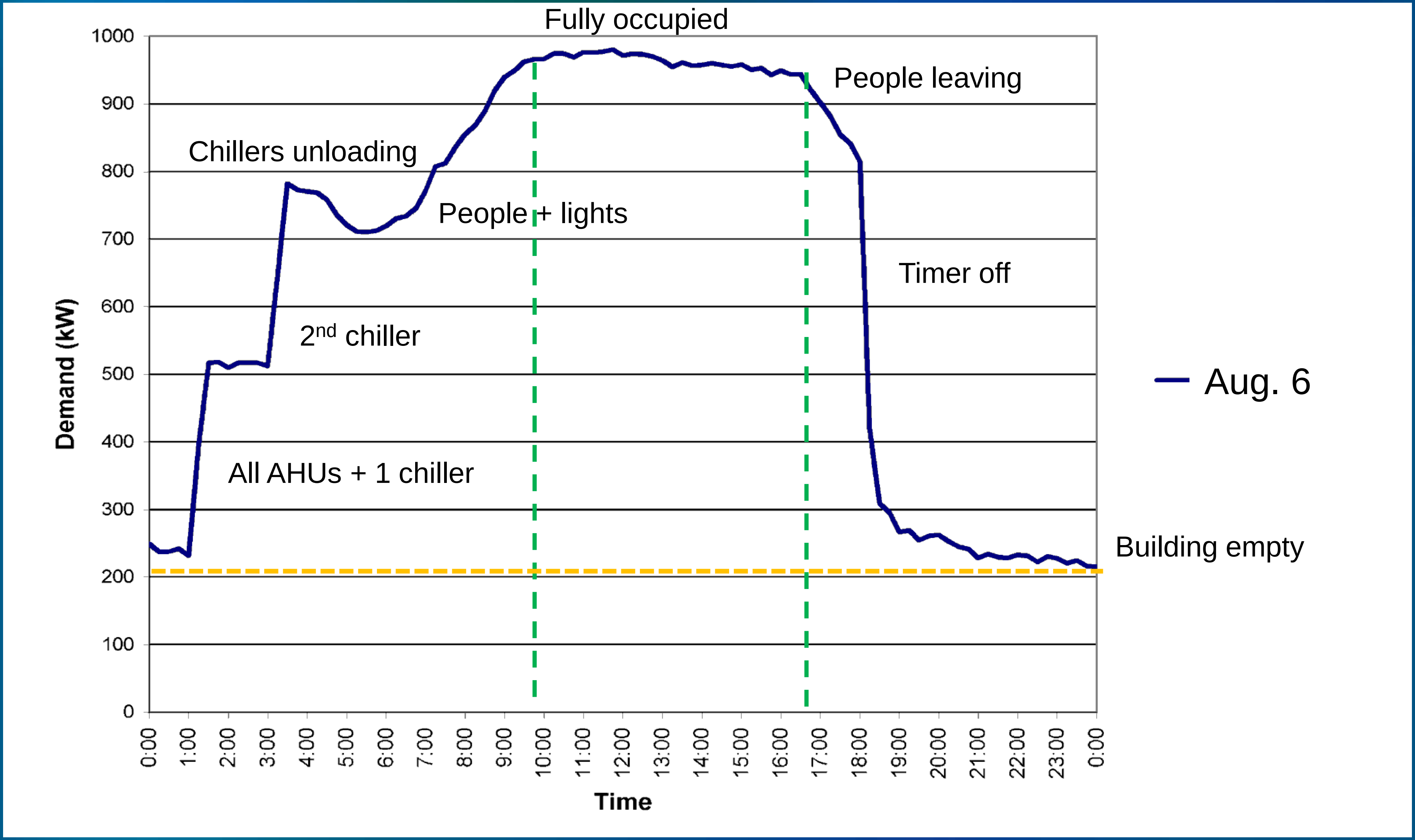
Page 11
in the
exercises

# Assess Performance

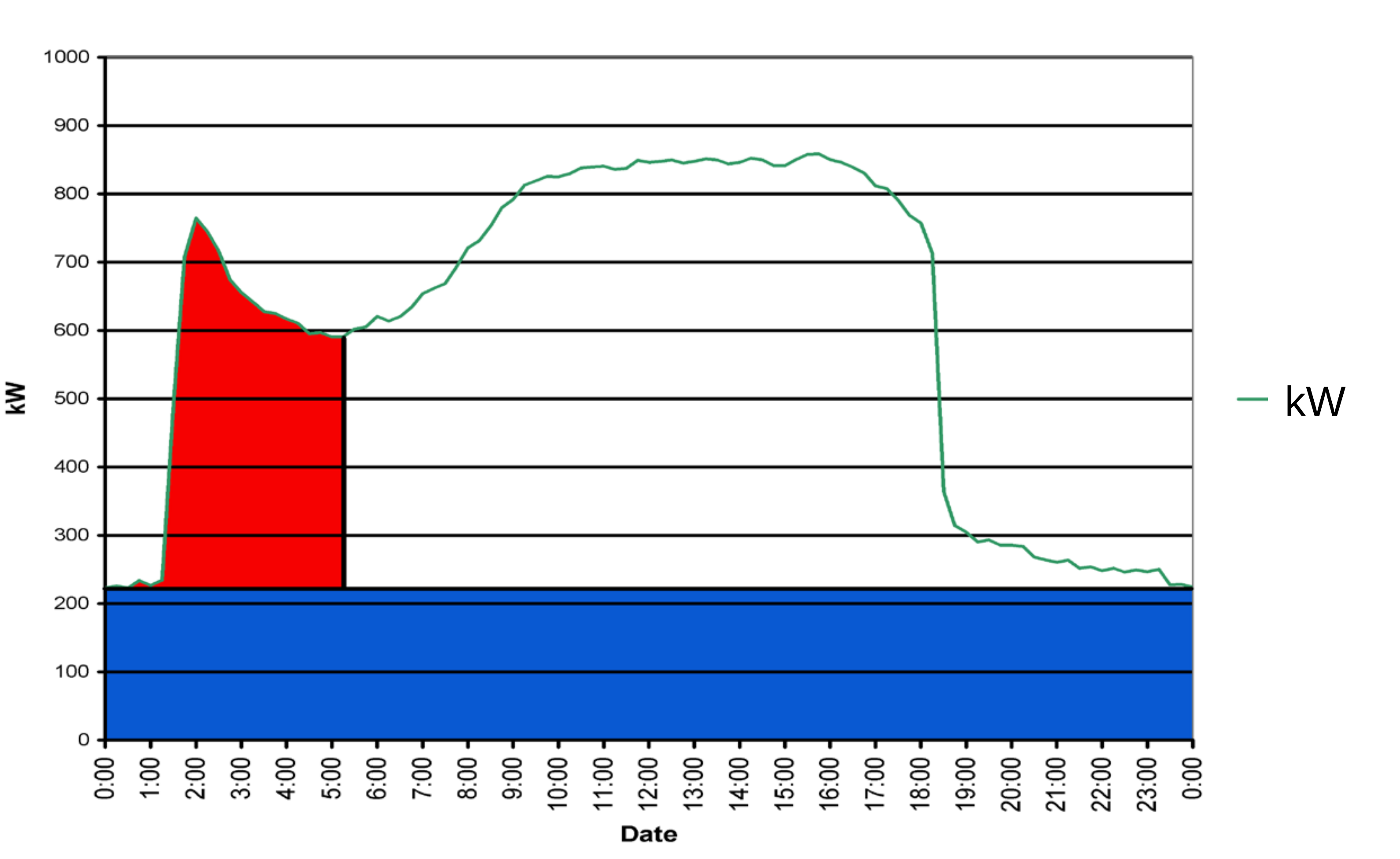
- Annual usage
  - Energy cost index (ECI)
  - Energy utilization index (EUI)
- Annual profile of monthly data
- Daily profile of 15-minute data

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

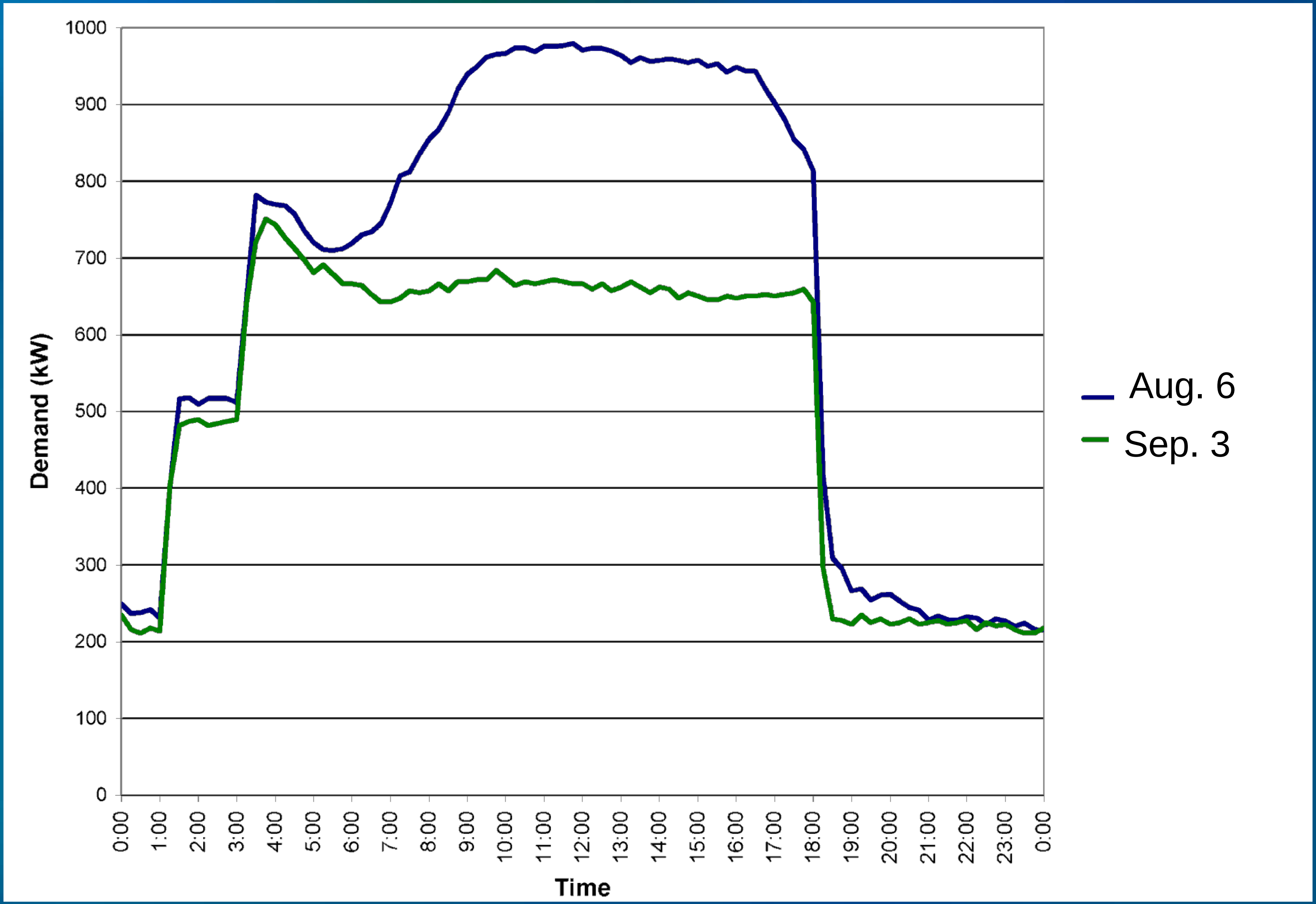
# Daily Profile of 15-Minute Data



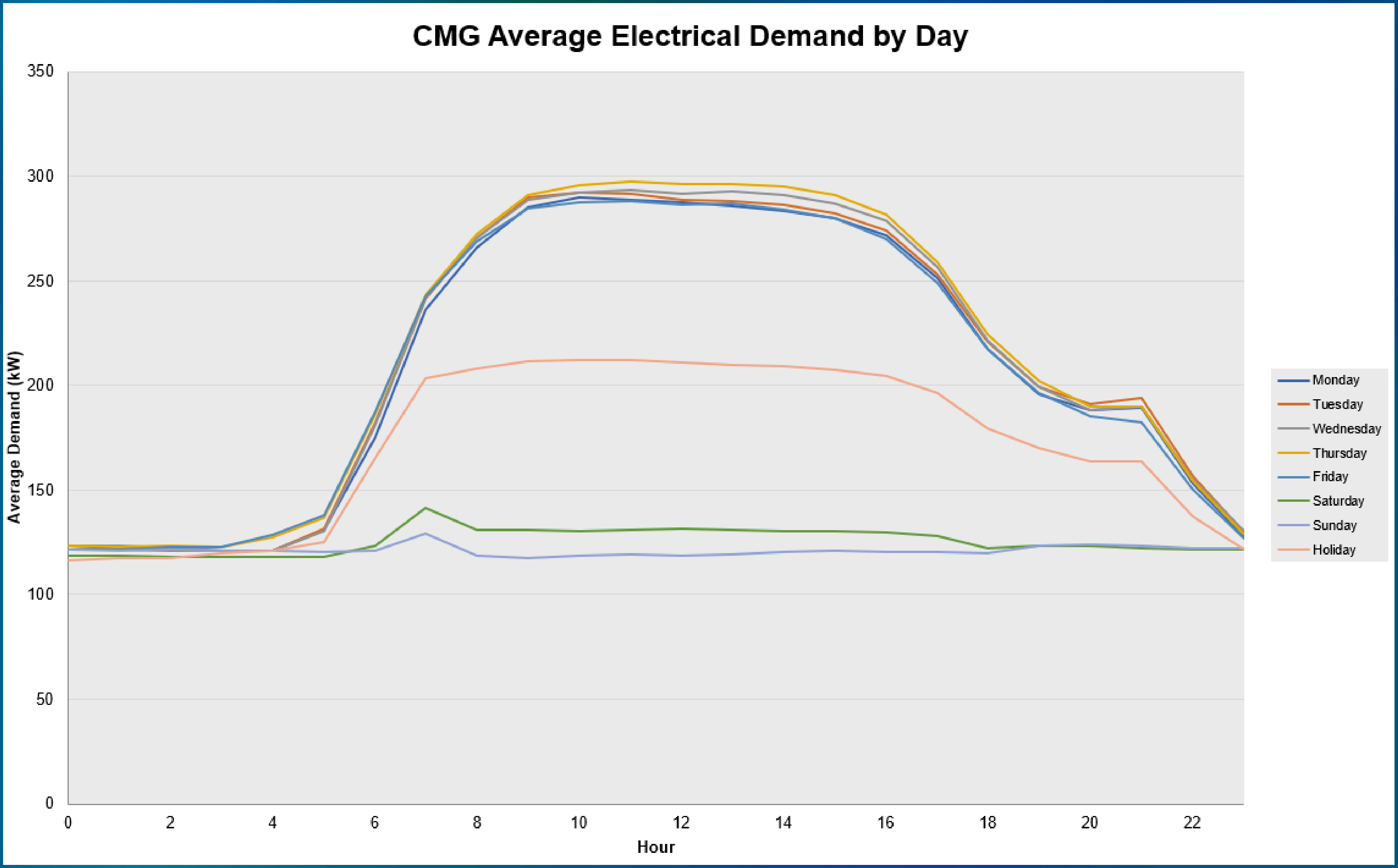
# Simplified Profile



# Monday Versus Holiday



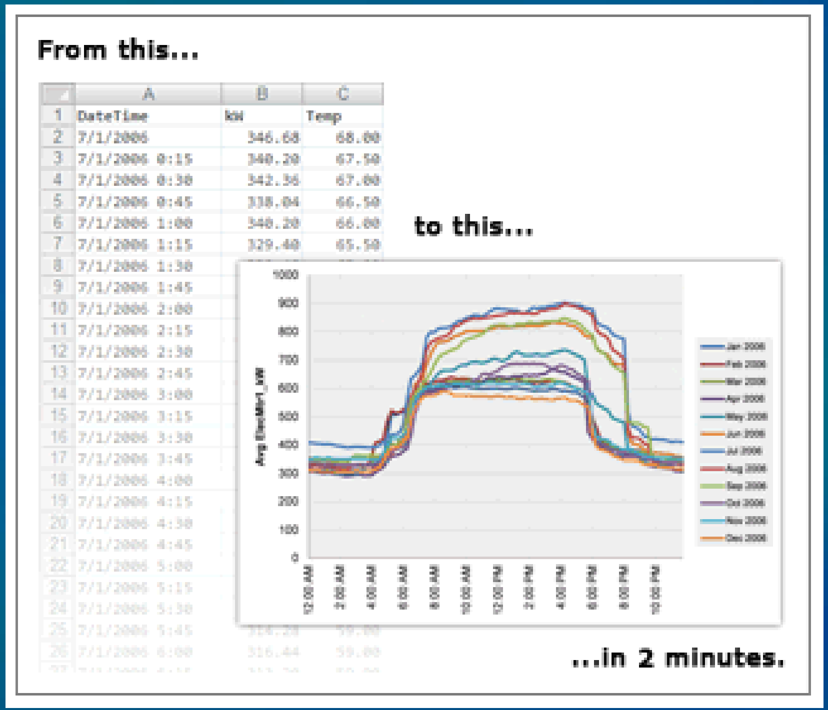
# New Software to Evaluate Interval Data



# New Software to Evaluate Interval Data

- ECAM for Excel from California Commissioning Collaborative

https://www.cacx.org/PIER/ecam/



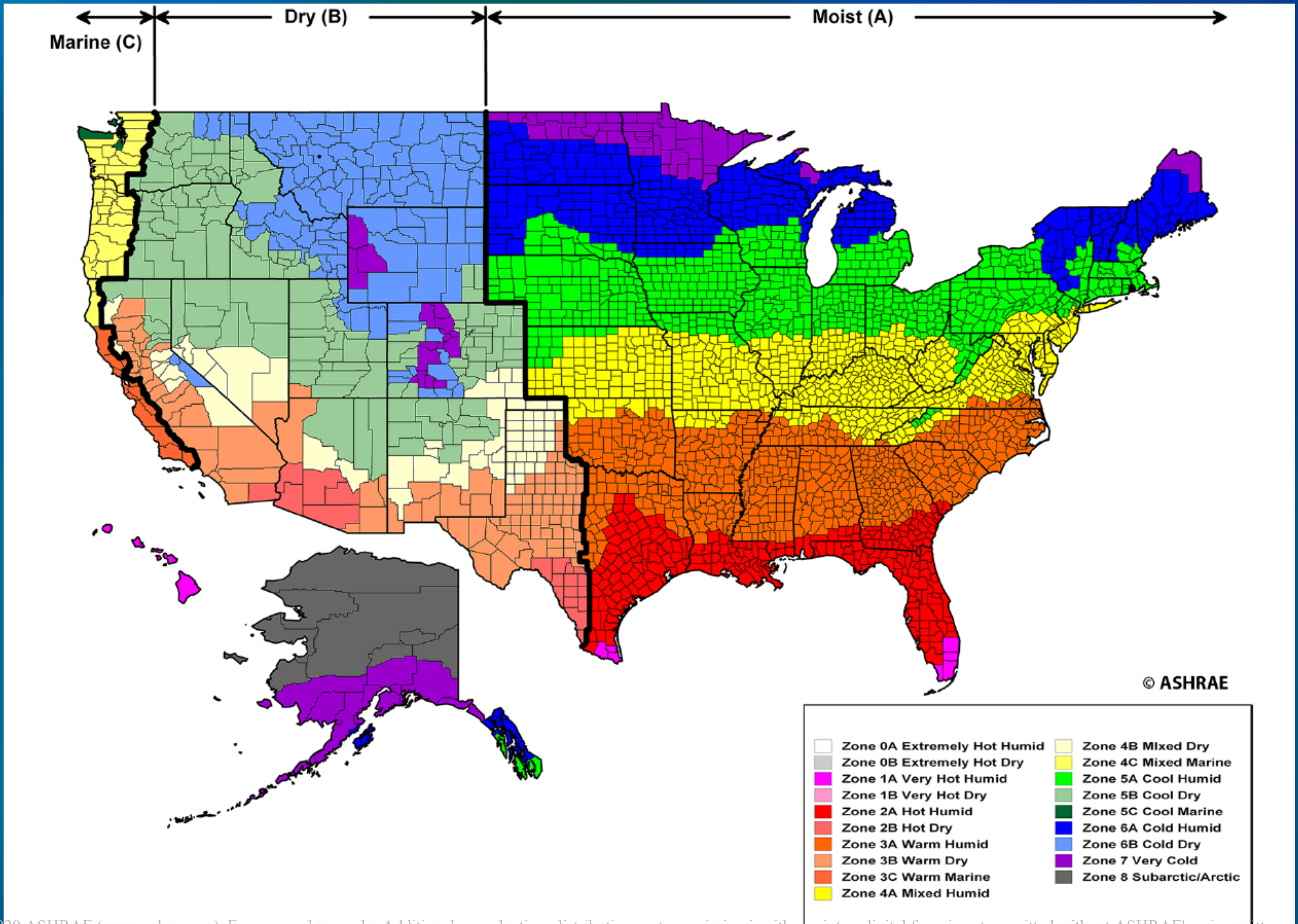
# Meters and Submeters

- Meters by themselves do not save anything
- No direct payback on the purchase of a meter
- But… how can you manage it if you can't measure it?

# Measurement Technology

- Costs decline, features improve
- More options than ever
- Creative thinking and competitive bidding can get you useful metering

# Prioritizing Multiple Buildings



# Prioritizing 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 | 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 | |

# Prioritizing Multiple Buildings (SI)

| Site | m² | Zone | Type | ECI | EUI | Current $ | |
|---|---|---|---|---|---|---|---|
| 601-Tysons Corner | 3,668 | 4 | Homestore | $32.40 | 609 | $118,823 | |
| 510-Mission Viejo | 1,198 | 4 | Houseware | $65.66 | 558 | $78,685 | |
| 503-Fashion Valley | 1,349 | 4 | Houseware | $71.62 | 558 | $96,579 | |
| 412-Roseville | 3,194 | 4 | Homestore | $44.47 | 555 | $142,059 | |
| 851-Lenox | 3,431 | 4 | Homestore | $34.49 | 552 | $118,325 | |
| 855-Alpharetta | 2,721 | 4 | Homestore | $27.07 | 492 | $73,674 | EMS |
| 511-South Coast II | 3,384 | 4 | Homestore | $64.75 | 486 | $219,158 | |
| 402-Corte Madera | 1,081 | 4 | Houseware | $67.64 | 448 | $73,119 | |
| 404 a - Santana Row | 3,533 | 4 | Homestore | $64.10 | 441 | $226,467 | EMS |
| 507-University Town Centre | 1,178 | 4 | Houseware | $57.34 | 432 | $67,561 | |
| 406-Walnut Creek | 3,490 | 4 | Homestore | $66.29 | 407 | $231,358 | |
| 505-Pasadena | 3,584 | 4 | Homestore | $45.81 | 404 | $164,175 | |
| 506-Topanga Plaza | 1,325 | 4 | Houseware | $33.48 | 382 | $44,383 | |
| 860-Crabtree Valley | 1,237 | 4 | Houseware | $20.02 | 363 | $24,761 | |
| 411-Union Square Furniture | 4,012 | 4 | Homestore | $52.80 | 359 | $211,820 | |
| 502-Century City(Closed) | 1,320 | 4 | Houseware | $22.55 | 249 | $29,763 | |
| 407-Hillsdale | 1,416 | 4 | Houseware | $34.84 | 224 | $49,341 | |
| 403-Palo Alto | 3,617 | 4 | Homestore | $9.29 | 126 | $33,588 | |

# Prioritizing Multiple Buildings

| Site | SF | Zone | Type | ECI | EUI | Current $ | |
|---|---|---|---|---|---|---|---|
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| 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 | |

# Prioritizing Multiple Buildings (SI)

| Site | m² | Zone | Type | ECI | EUI | Current $ | |
|---|---|---|---|---|---|---|---|
| 601-Tysons Corner | 3,668 | 4 | Homestore | $32.40 | 609 | $118,823 | |
| 510-Mission Viejo | 1,198 | 4 | Houseware | $65.66 | 558 | $78,685 | |
| 503-Fashion Valley | 1,349 | 4 | Houseware | $71.62 | 558 | $96,579 | |
| 412-Roseville | 3,194 | 4 | Homestore | $44.47 | 555 | $142,059 | |
| 851-Lenox | 3,431 | 4 | Homestore | $34.49 | 552 | $118,325 | |
| 855-Alpharetta | 2,721 | 4 | Homestore | $27.07 | 492 | $73,674 | EMS |
| 511-South Coast II | 3,384 | 4 | Homestore | $64.75 | 486 | $219,158 | |
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| 406-Walnut Creek | 3,490 | 4 | Homestore | $66.29 | 407 | $231,358 | |
| 505-Pasadena | 3,584 | 4 | Homestore | $45.81 | 404 | $164,175 | |
| 506-Topanga Plaza | 1,325 | 4 | Houseware | $33.48 | 382 | $44,383 | |
| 860-Crabtree Valley | 1,237 | 4 | Houseware | $20.02 | 363 | $24,761 | TARGET |
| 411-Union Square Furniture | 4,012 | 4 | Homestore | $52.80 | 359 | $211,820 | |
| 502-Century City(Closed) | 1,320 | 4 | Houseware | $22.55 | 249 | $29,763 | |
| 407-Hillsdale | 1,416 | 4 | Houseware | $34.84 | 224 | $49,341 | |
| 403-Palo Alto | 3,617 | 4 | Homestore | $9.29 | 126 | $33,588 | |

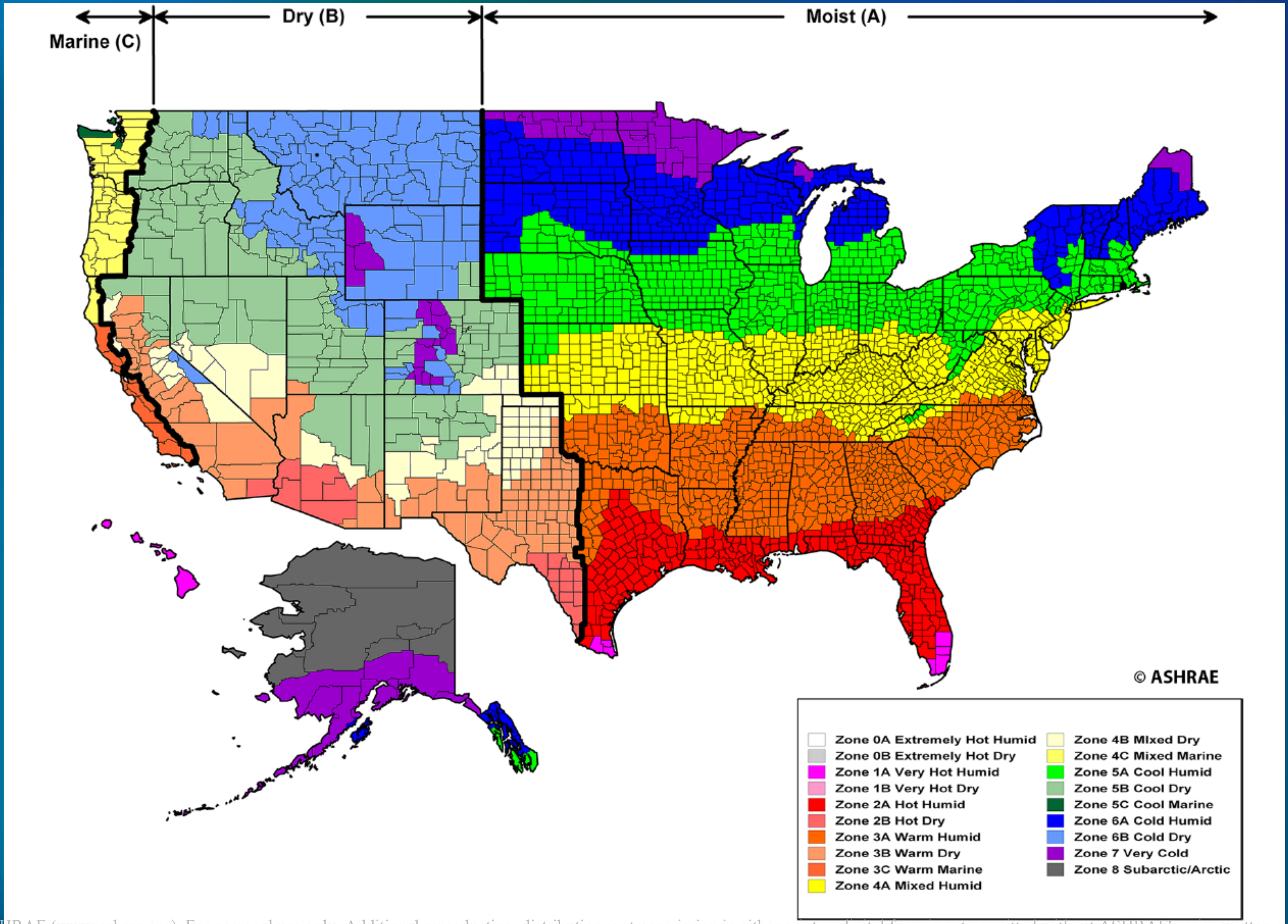
# Prioritizing Multiple Buildings

| 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** | | | |

# Prioritizing Multiple Buildings (SI)

| Site | m² | Zone | Type | ECI | EUI | Current $ | New $ | Savings | |
|---|---|---|---|---|---|---|---|---|---|
| 601-Tysons Corner | 3,668 | 4 | Homestore | $32.40 | 609 | $118,823 | $70,678 | $48,146 | |
| 510-Mission Viejo | 1,198 | 4 | Houseware | $65.66 | 558 | $78,685 | $51,093 | $27,592 | |
| 503-Fashion Valley | 1,349 | 4 | Houseware | $71.62 | 558 | $96,579 | $62,924 | $33,655 | |
| 412-Roseville | 3,194 | 4 | Homestore | $44.47 | 555 | $142,059 | $92,740 | $49,320 | |
| 851-Lenox | 3,431 | 4 | Homestore | $34.49 | 552 | $118,325 | $77,619 | $40,707 | |
| 855-Alpharetta | 2,721 | 4 | Homestore | $27.07 | 492 | $73,674 | $54,176 | $19,498 | **EMS** |
| 511-South Coast II | 3,384 | 4 | Homestore | $64.75 | 486 | $219,158 | $164,146 | $55,012 | |
| 402-Corte Madera | 1,081 | 4 | Houseware | $67.64 | 448 | $73,119 | $59,252 | $13,867 | |
| 404 a - Santana Row | 3,533 | 4 | Homestore | $64.10 | 441 | $226,467 | $185,686 | $40,781 | **EMS** |
| 507-University Town Centre | 1,178 | 4 | Houseware | $57.34 | 432 | $67,561 | $56,700 | $10,861 | |
| 406-Walnut Creek | 3,490 | 4 | Homestore | $66.29 | 407 | $231,358 | | **$339,438** | |
| 505-Pasadena | 3,584 | 4 | Homestore | $45.81 | 404 | $164,175 | | | |
| 506-Topanga Plaza | 1,325 | 4 | Houseware | $33.48 | 382 | $44,383 | | | |
| 860-Crabtree Valley | 1,237 | 4 | Houseware | $20.02 | **363** | $24,761 | **TARGET** | | |
| 411-Union Square Furniture | 4,012 | 4 | Homestore | $52.80 | 359 | $211,820 | | | |
| 502-Century City(Closed) | 1,320 | 4 | Houseware | $22.55 | 249 | $29,763 | | | |
| 407-Hillsdale | 1,416 | 4 | Houseware | $34.84 | 224 | $49,341 | | | |
| 403-Palo Alto | 3,617 | 4 | Homestore | $9.29 | 126 | $33,588 | | | |
| | | | | | | **$2,003,639** | | | |

# Climate Zone Map (2018)

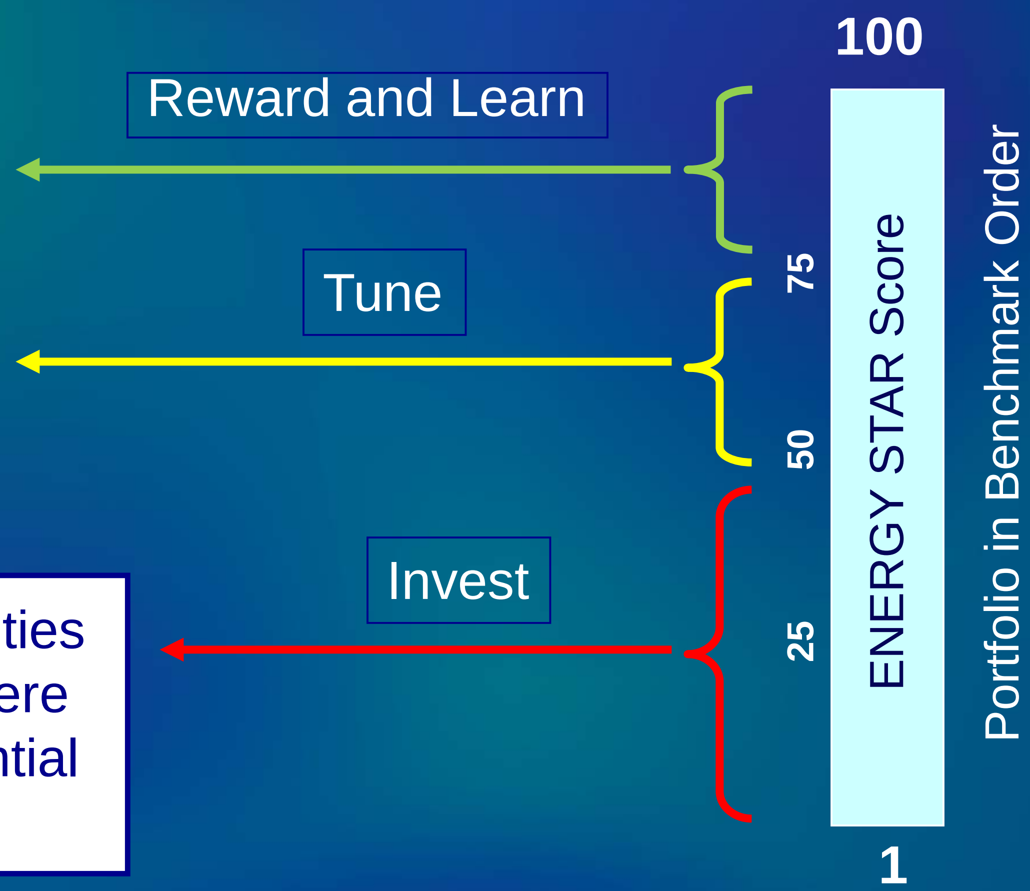


# Identify Priorities Across Portfolios

High scoring buildings provide lessons learned and may be ENERGY STAR candidates

O&M improvements will yield savings and may be ENERGY STAR candidates

Best investment opportunities are in lower quartiles, where there is the greatest potential for improvement



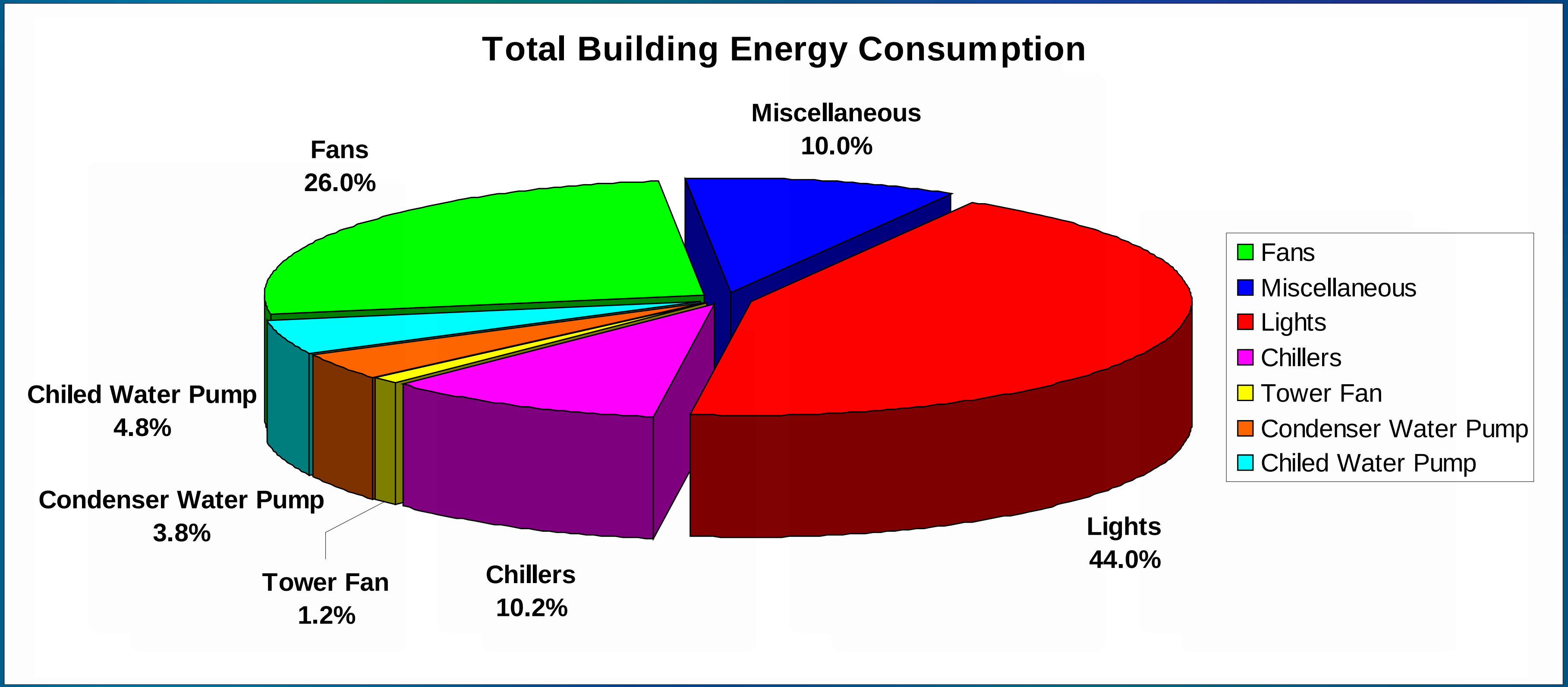
# Exercise 5: Site Targeting Case

Page 15
in the
exercises

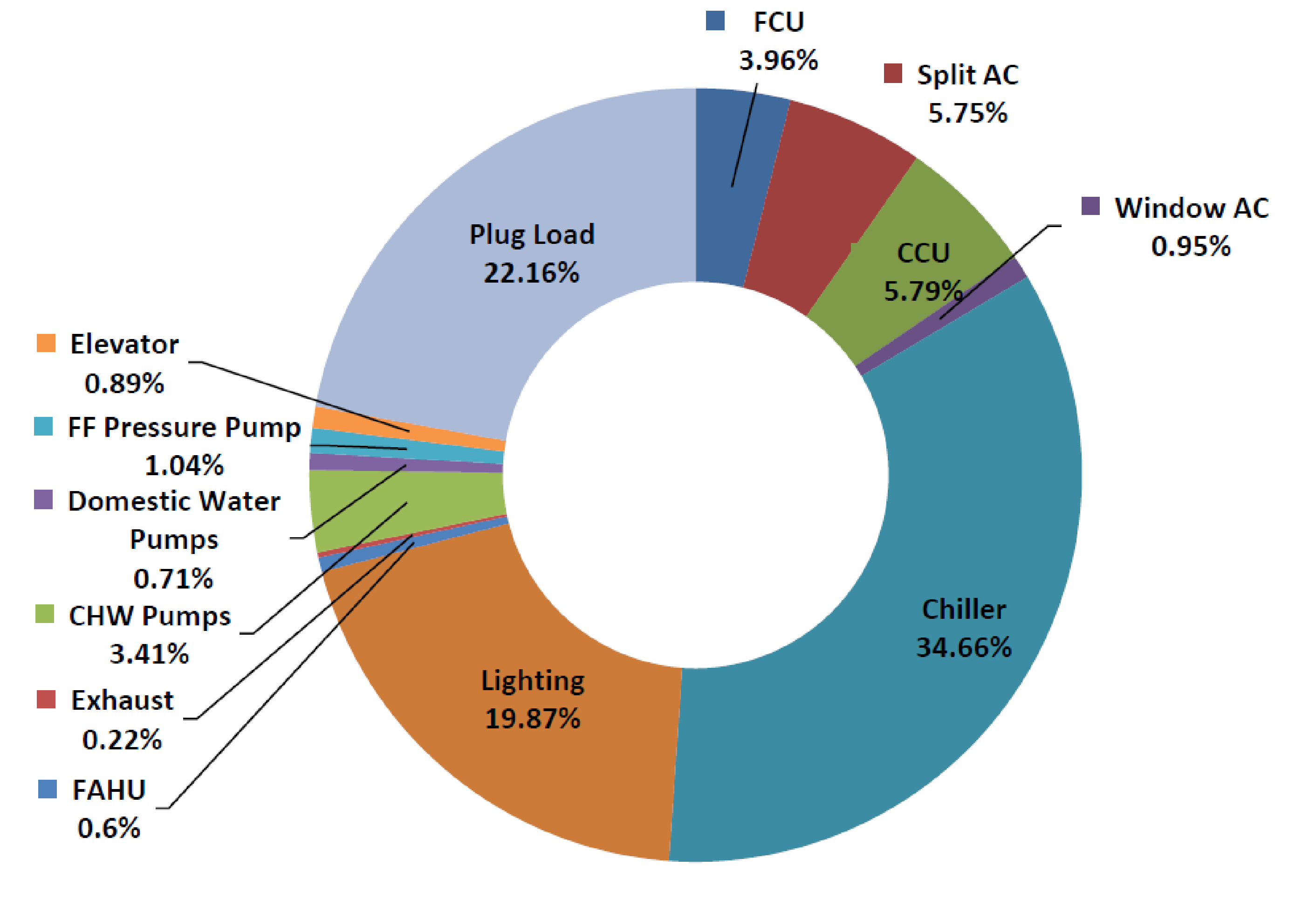
# BREAK!

# Why Look at a Breakdown of Energy Use?

# What System Should I Tackle?

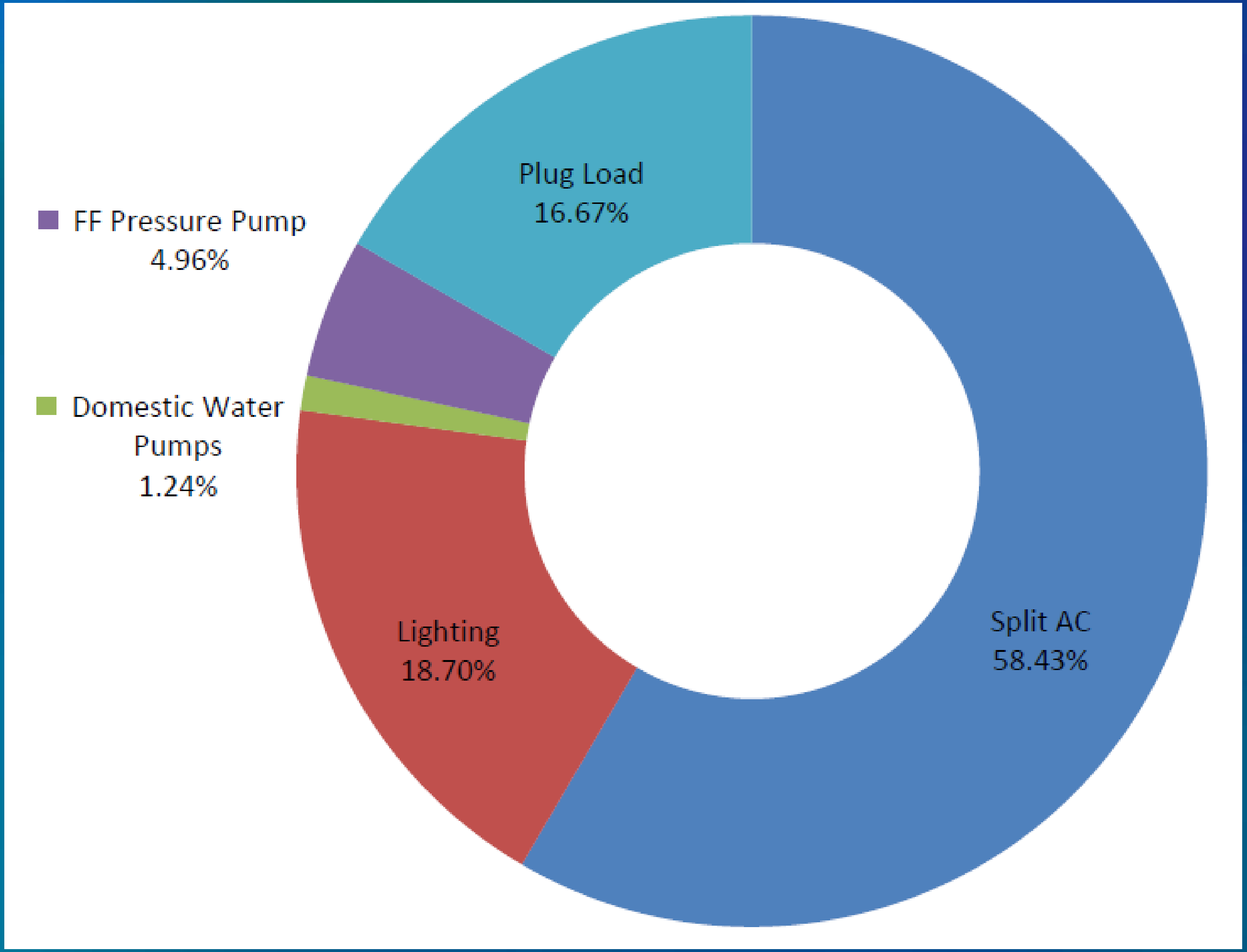


# Dubai Fire Station1 Example – Actual End Use



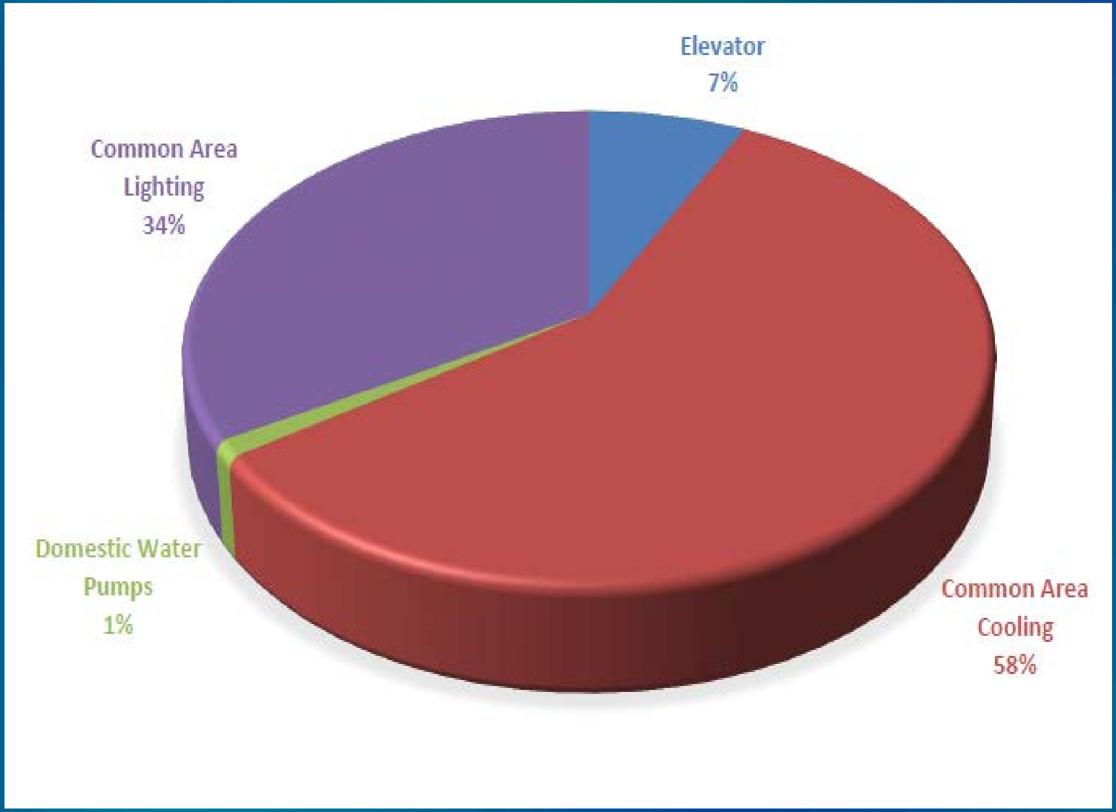

Source: Griffin Consultants.

# Dubai Fire Station2 Example – Actual End Use




Source: Griffin Consultants.

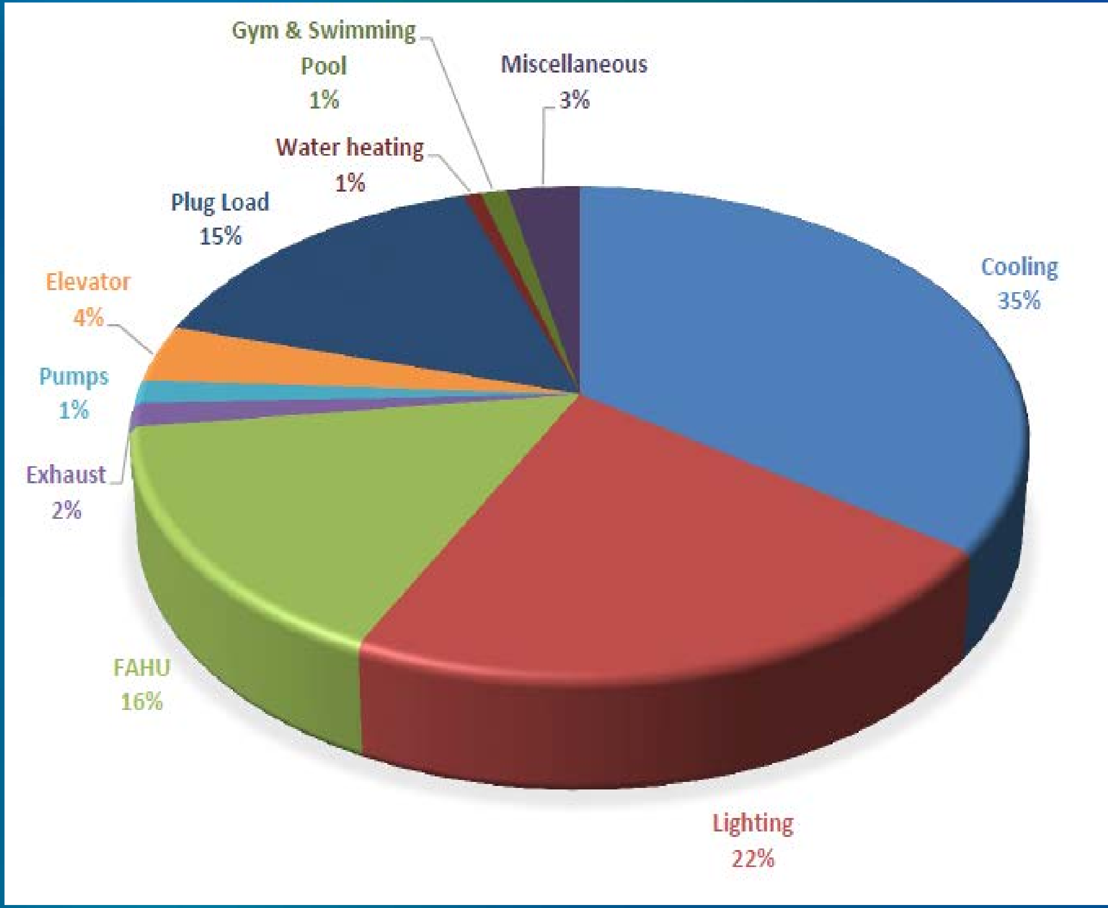
# Dubai Residential Building Example – Actual End Use




- Residential building
- Common areas in five residential floors
  - 3,020 m²
- One basement floor
  - 4,355 m²

Source: Griffin Consultants.

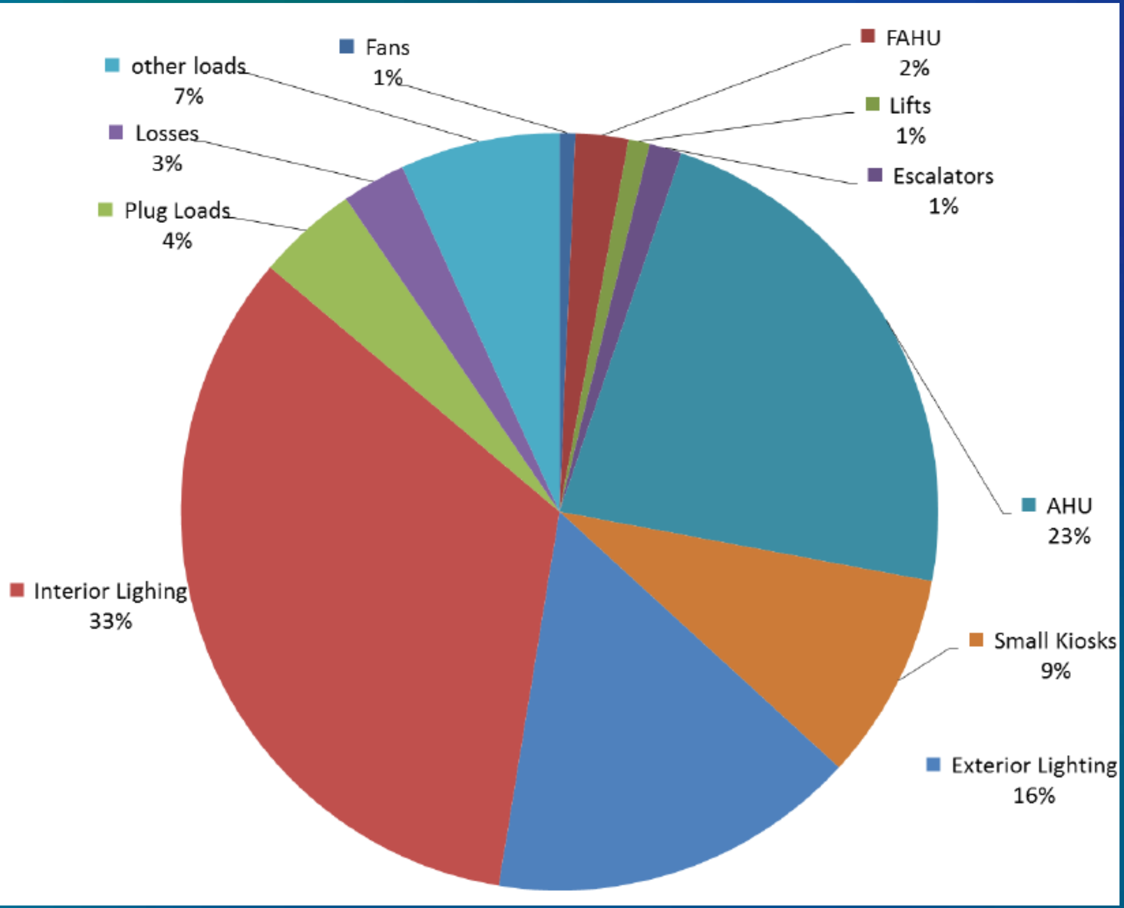
# Dubai Res/Comm. Building Example – Actual End Use




- Multi-use building
- Two office floors
  - 4,000 m²
- Common areas in thirteen residential floors
  - 2,330 m²
- Two basement floors
  - 4,980 m²

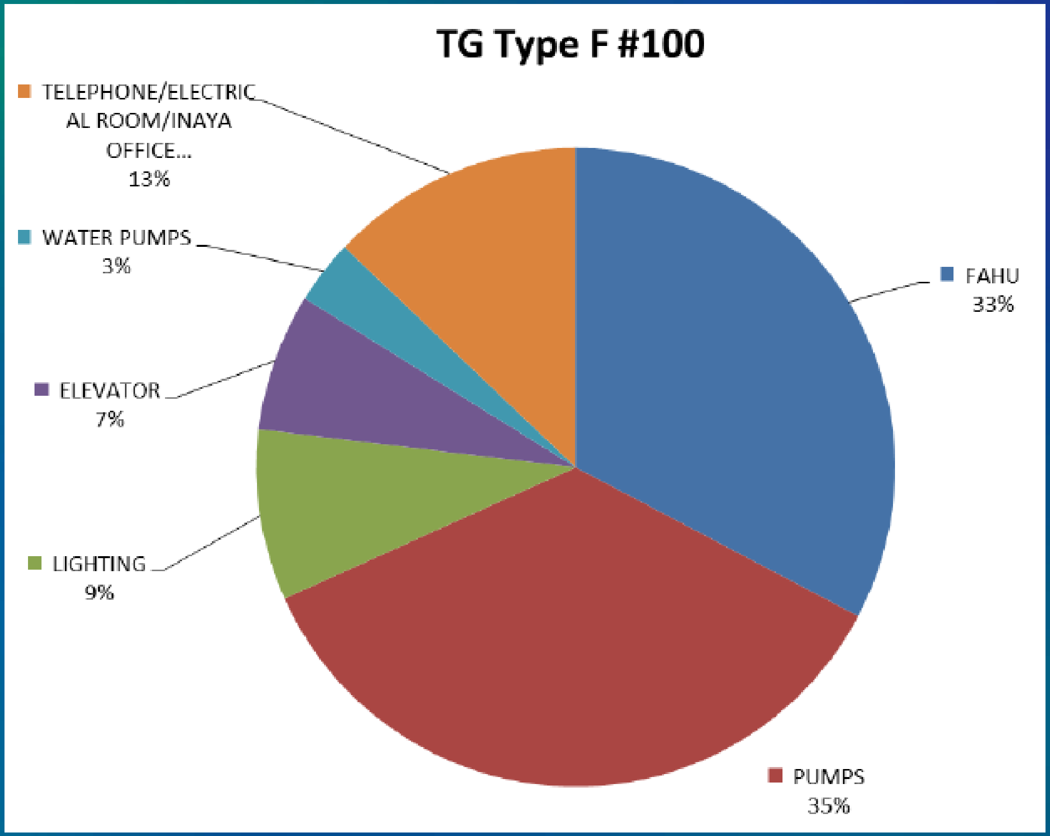
Source: Griffin Consultants.

# District Cooling Fed Mall in the UAE – Electrical Actual End Use



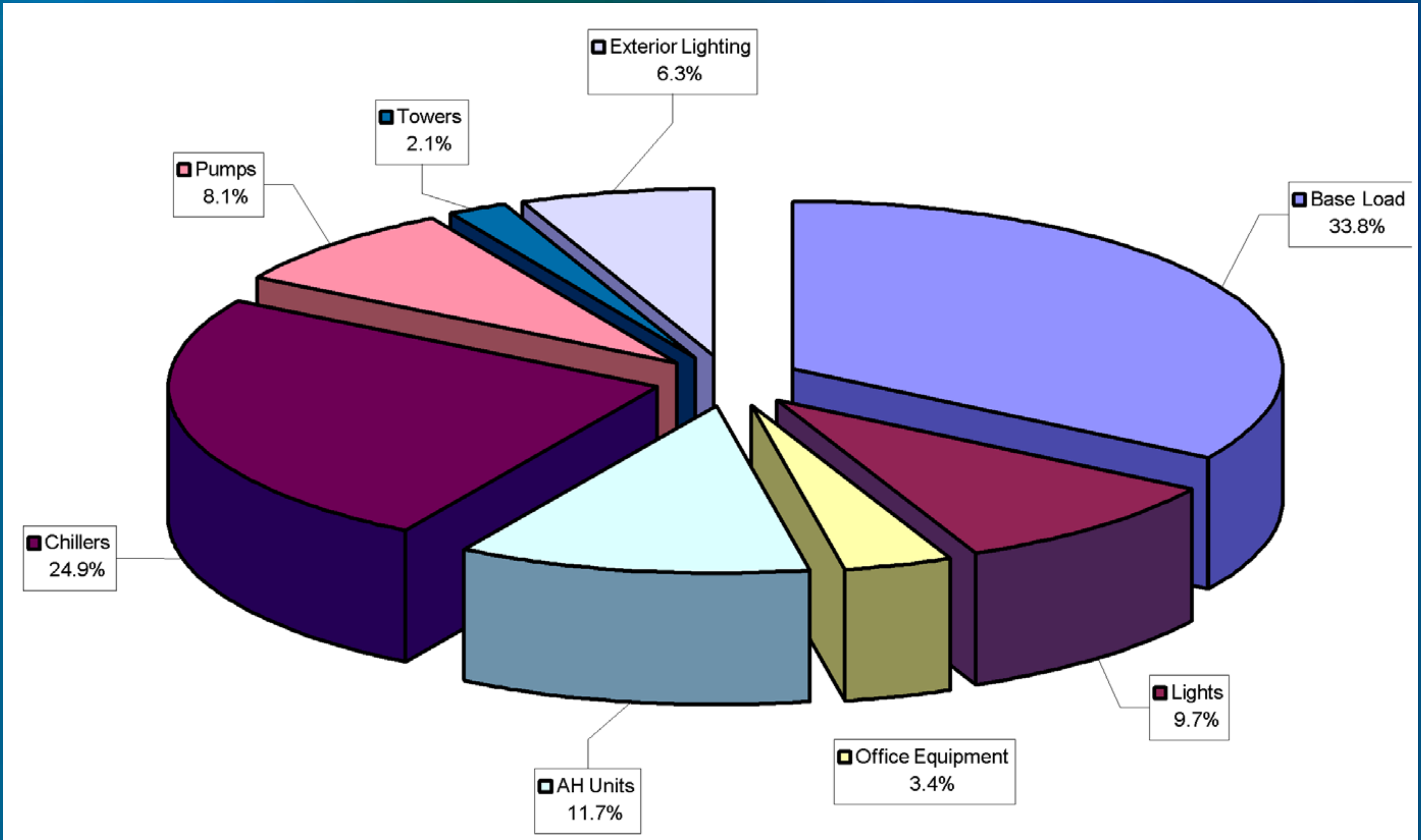

Source: Griffin Consultants.

# Res. Community Example (DC Fed) – Electrical Actual End Use

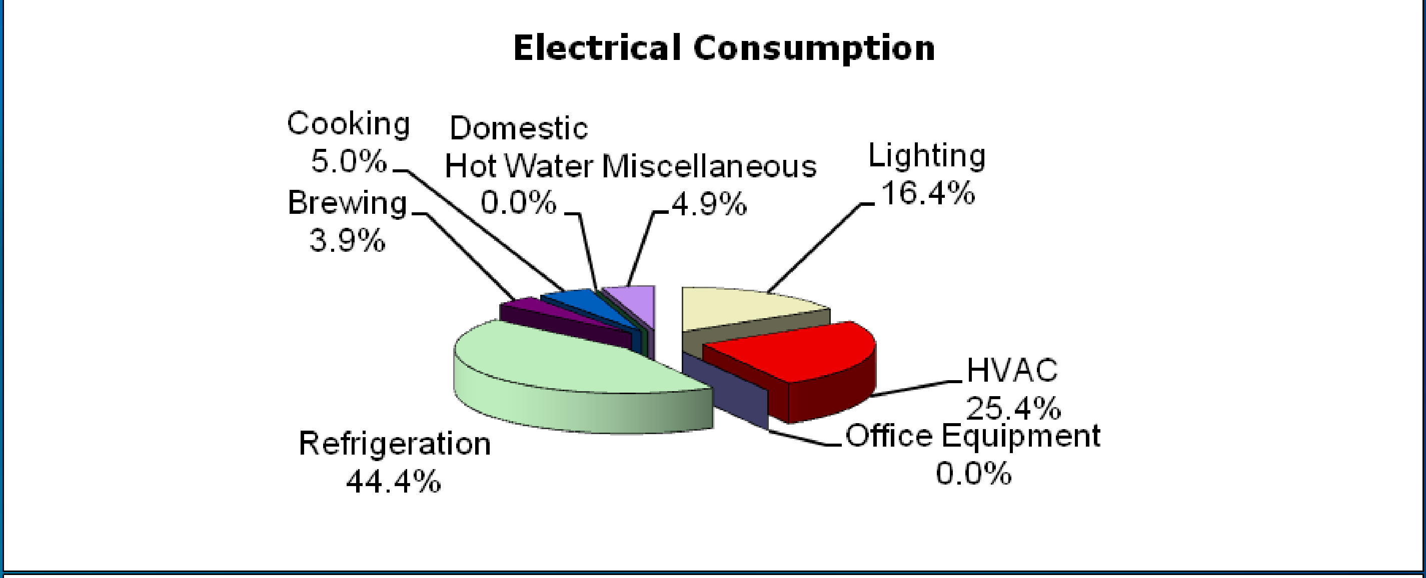


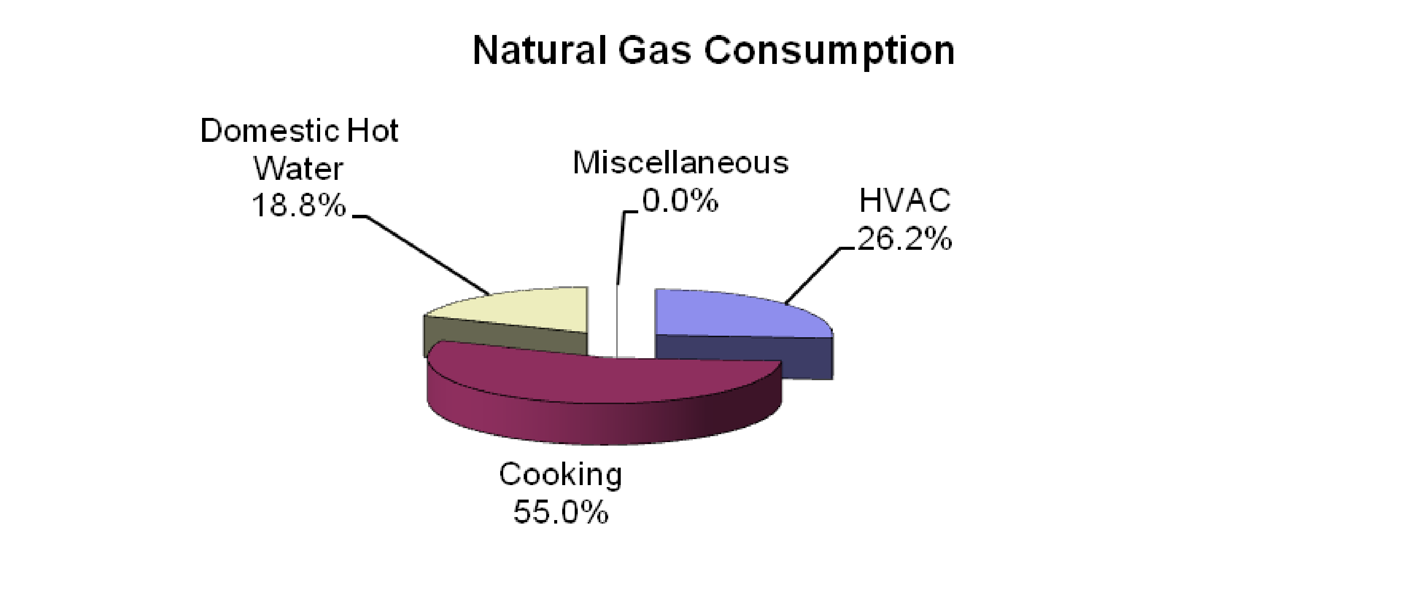

Source: Griffin Consultants.

# Honolulu Office Building Actual End Use



# Doty Street Pub—Inventory



# Examples of End-Use Energy Calculations

**Lighting example:**

46 lamps × 52 watts/lamp × 0.95 load factor × 6516 h/yr × 0.001 kW/watt

→ 14,807 kWh/yr

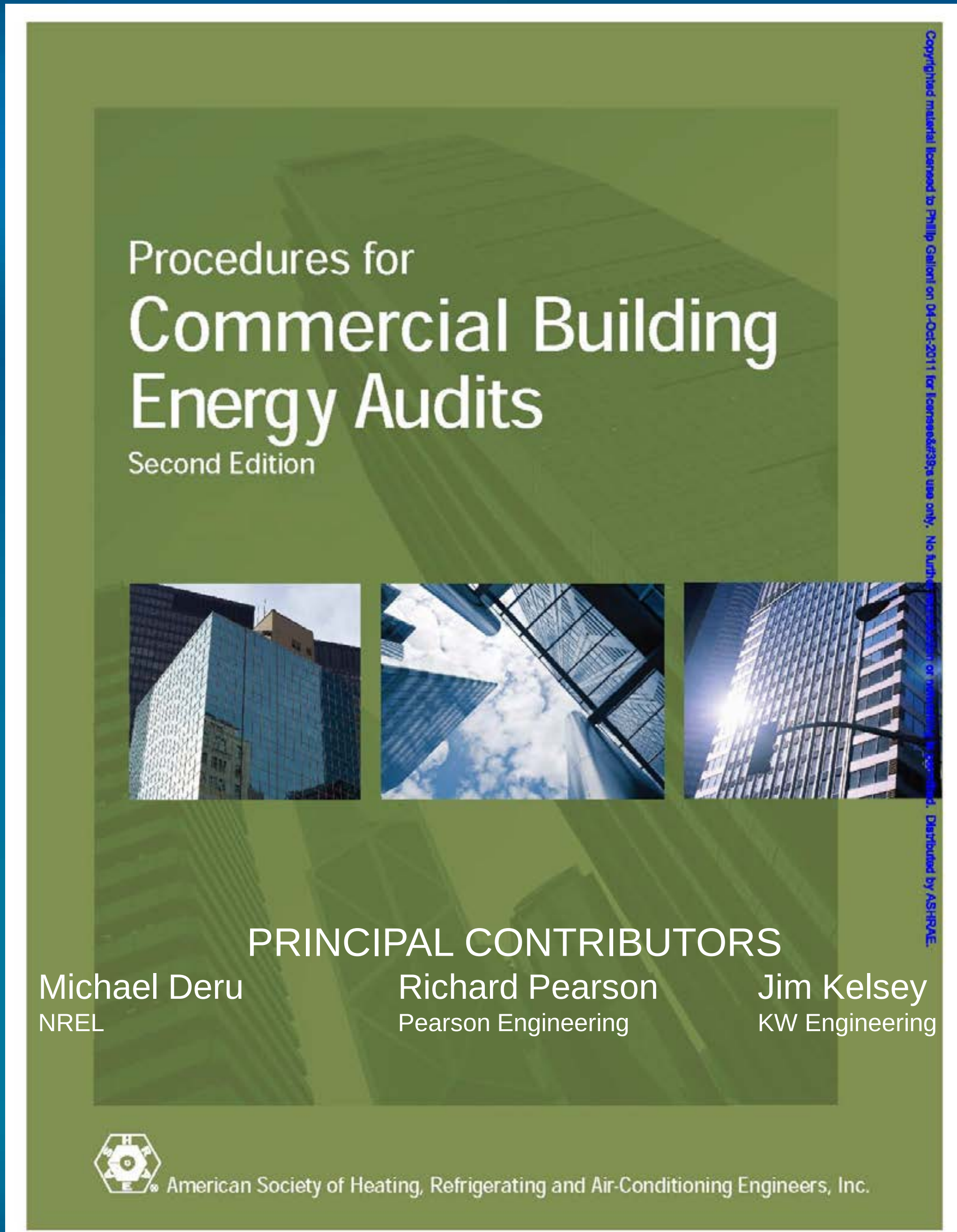
**Fan example:** 1.3 hp × 0.746 kWh/hp × 90% efficiency × 65% full load for fixed-speed motor × 1200 h/yr → 840 kWh/yr

# Exercise 6: System Target Case

Page 17
in the
exercises

# An Introduction to Energy Audits:

*The foundation for*
*smart capital investment*
**<u>and</u>**
*a source of O&M ideas*




A LEED
Existing Buildings
Reference

# What is an Energy Audit?

- An energy audit "…identifies and develops modifications that will reduce the energy use and/or cost of operating a building."*
- ASHRAE defines three levels of energy audit.
- There are tasks and deliverables at each level.

**Procedures for Commercial Building Energy Audits* (2011)

*ASHRAE Standard 211

# Objectives of an Energy Audit

- Collect and analyze historical energy usage/cost
- Study the building and its operation
- Identify potential modifications
- Perform an engineering and economic analysis
- Prepare a rank-ordered list of modifications
- Prepare a report/provide recommendations

# What You Can Get…

- Level I
  - New ideas for low cost/no cost changes
  - Ideas for capital changes
- Level II
  - All practical changes to procedures and settings
  - List of capital projects; estimated costs and benefits
- Level III
  - Detailed economic and engineering basis for capital projects

Table 1 — Energy Audit Required Tasks

| Process | Level 1 | Level 2 | Level 3 |
|---|---|---|---|
| Conduct PEA | • | • | • |
| Conduct walk-through survey | • | • | • |
| Identify low-cost/no-cost recommendations | • | • | • |
| Identify capital improvements | • | • | • |
| Review mechanical and electrical (M&E) design and condition and O&M practices | | • | • |
| Measure key parameters | | • | • |
| Analyze capital measures (savings and costs, including interactions) | | • | • |
| Meet with owner/operators to review recommendations | | • | • |
| Conduct additional testing/monitoring | | | • |
| Perform detailed system modeling | | | • |
| Provide schematic layouts for recommendations | | | • |
| **Report** | **Level 1** | **Level 2** | **Level 3** |
| Estimate savings from utility rate change | • | • | • |
| Compare EUI to EUIs of similar sites | • | • | • |
| Summarize utility data | • | • | • |
| Estimate savings if EUI were to meet target | • | • | • |
| Estimate low-cost/no-cost savings | | • | • |
| Calculate detailed end-use breakdown | | • | • |
| Estimate capital project costs and savings | | • | • |
| Complete building description and equipment inventory | | • | • |
| Document general description of considered measures | | • | • |
| Recommend measurement and verification (M&V) method | | • | • |
| Perform financial analysis of recommended EEMs | | • | • |
| Write detailed description of recommended measures | | | • |
| Compile detailed EEM cost estimates | | | • |

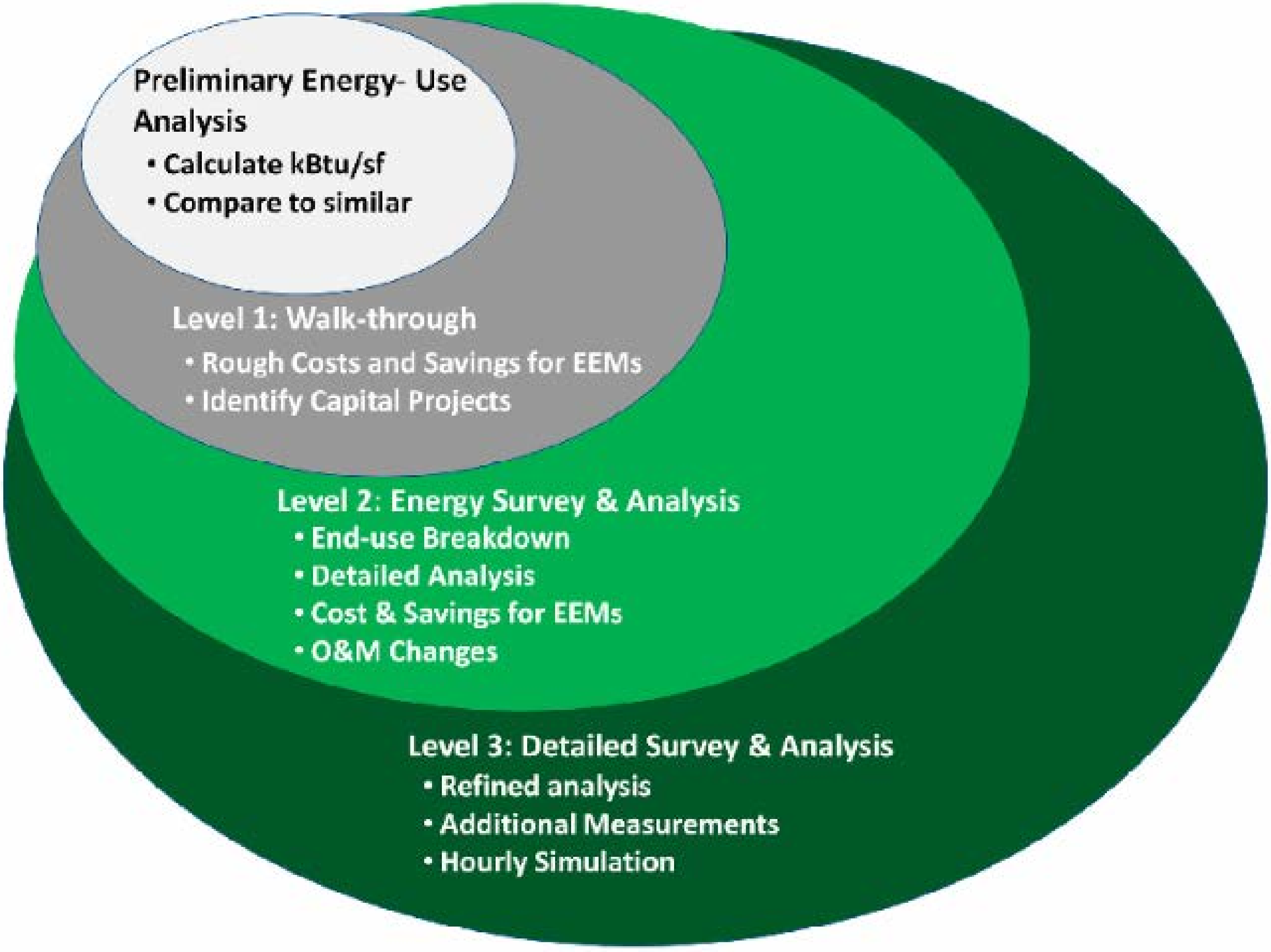



Figure 1 — Relationships of ASHRAE Energy Audit Levels 1, 2, and 3

# Energy Audits and Capital Projects

Levels II and III give the economic and engineering foundation for capital projects

- In the context of proper O&M procedures
- Understanding the organization’s capacity to incorporate the changes

Energy Audits II and III reduce the risk of unexpected results in capital projects

# How You Can Use the ASHRAE Definitions of Energy Audits I, II, III

**As a building owner:**

- Cite the definitions (cut and paste) for RFP
- Compare vendor offerings to the definitions to negotiate proposed services

**As a vendor:**

- Cite the definitions (cut and paste) in your responses to RFP
- Use the outlines to organize your reports

# Exercise 7: Audit Level Examples

## Project Information

Owner: IFA

Client: Fairmont Hotels

Contract Type: Guaranteed Savings Energy Performance Contract

Area: 90,000 m²

Source : takasolutions

## Project Summary

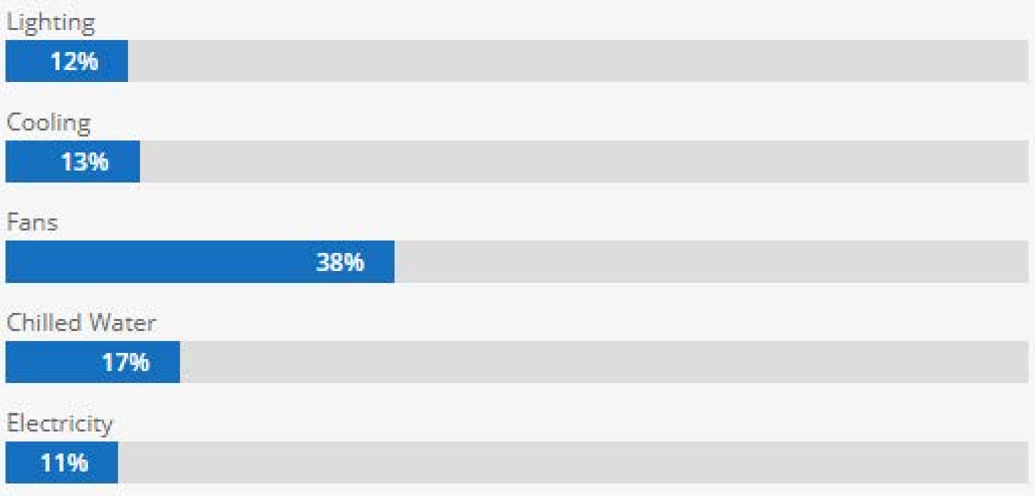
The Fairmont Palm is a world class 5-star hotel located on the trunk of the Palm Jumeirah in Dubai, UAE.  The 300 room beach resort includes a spa, conference center, penthouses and 7 food and beverage outlets.  takasolutions supports the team via a guaranteed savings energy performance contract.

## Savings

19% Savings

400,000 tons of $CO_2$ Saved

12,847 MWh / Year Saved




## Results

takasolutions works with the hotel management team to provide energy auditing, package procurement, implementation management and energy management for energy services.  Ongoing M&V and operations over the contract period will offer energy insight, reporting and a guarantee of savings.

# Energy Audit Case Studies

**Source: Griffin Consultants**

## Project Information

Contract Type: ASHRAE Level III EA Implementation (Retrofit of residential communities)

Community: Discovery Gardens residential community

## Project Summary

The project involves energy audit (EA) of a representative residential building and community-wide EA implementation in three phases.

Phase 1 – 4 buildings; Phase 2 – 28 buildings; Phase 3 – 27 buildings

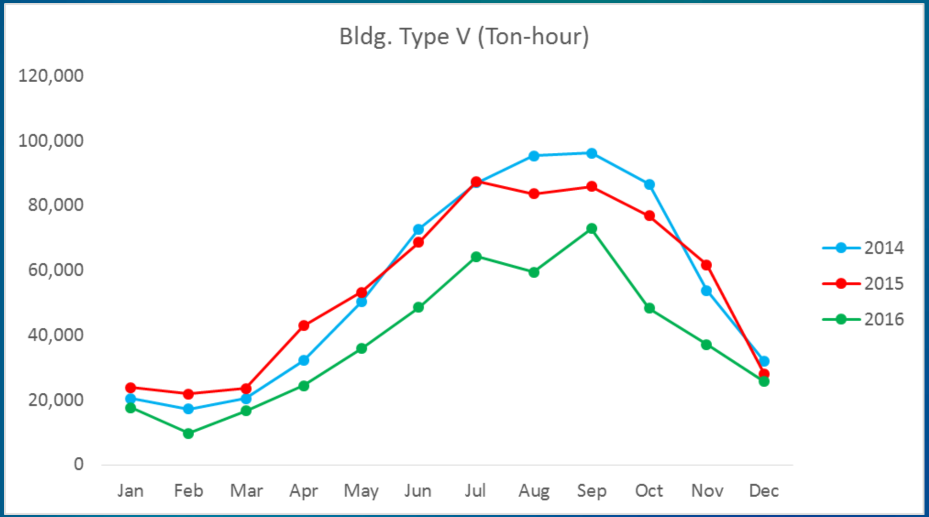
## Results

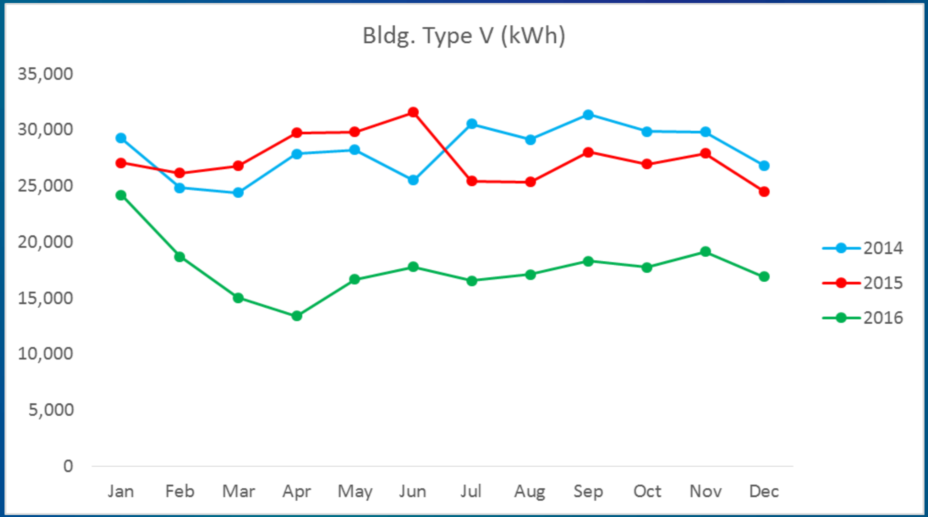
- No/ low cost ECMs:
  - Reduction in exhaust airflows to ASHRAE minimum requirements
  - Replacement of FAHU pulley to reduce fan motor power
  - Resetting of DPT points for chilled water pumps
- Total cost savings equivalent to **AED 3 million/ annum**
- Simple pay-back of **5 months**

# Energy Audit Case Studies

**Source :Griffin Consultants**

## Phase 1 Implementation – Total consumption



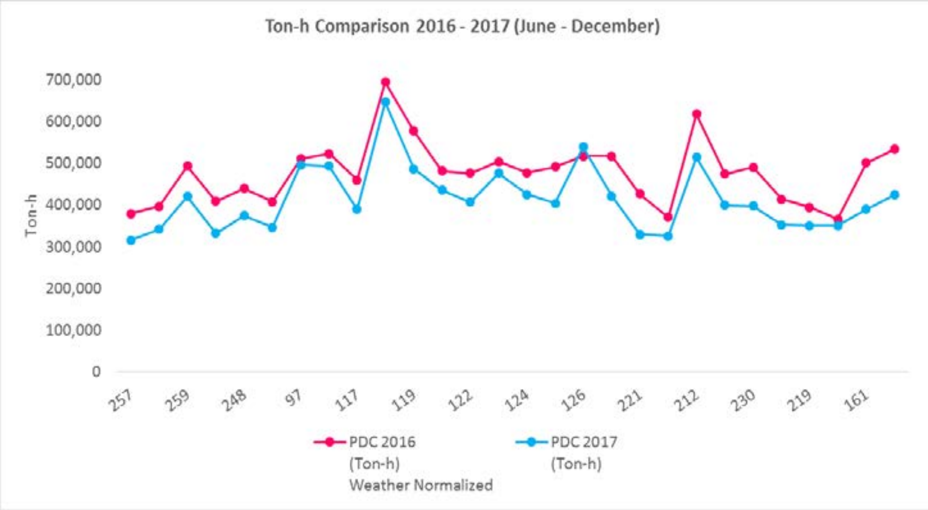

**Implementation period for ECMs – January to March 2016**

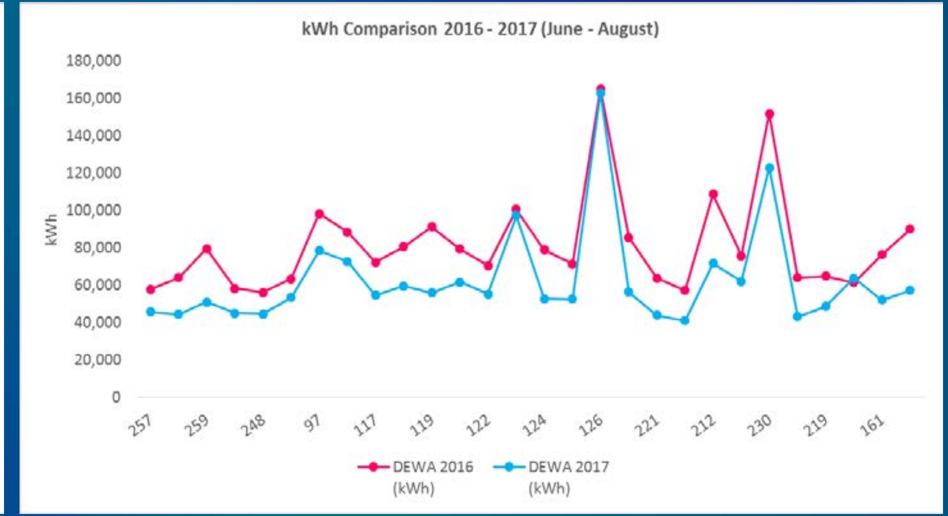
**Savings comparison – April to December 2014, 15, 16**

# Energy Audit Case Studies

**Source: Griffin Consultants**

## Phase 2 Implementation – Total consumption



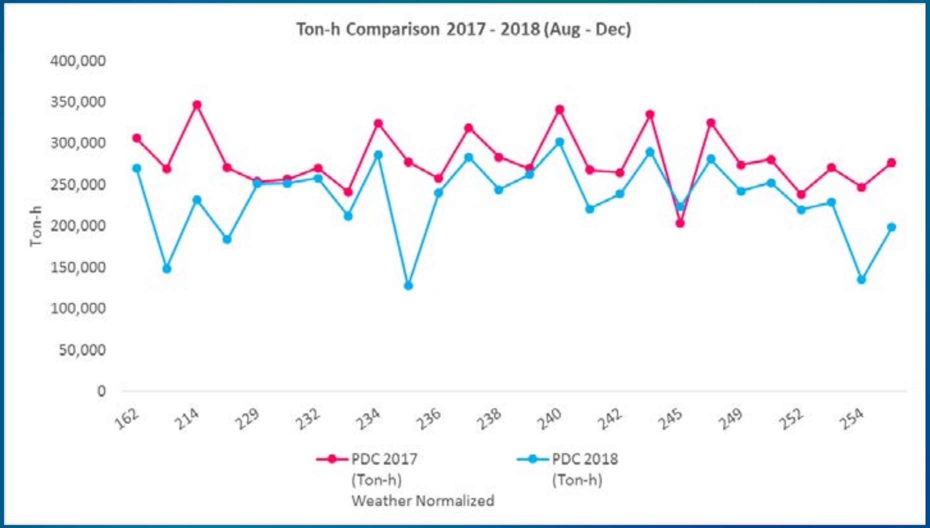

**DC savings comparison period – June to December**

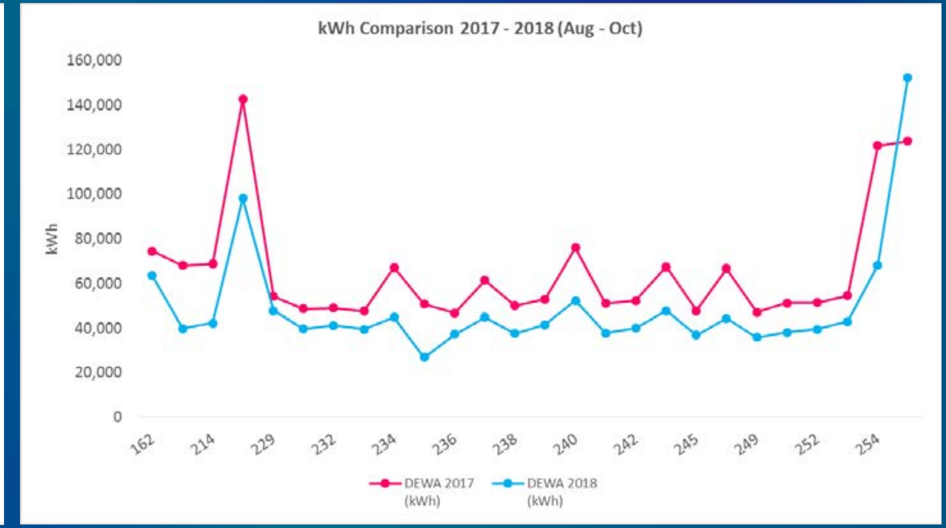
**Electricity savings comparison period – June to August**

# Energy Audit Case Studies

**Source: Griffin Consultants**

## Phase 3 Implementation – Total consumption




**DC savings comparison period – August to December**

**Electricity savings comparison period – August to October**

# Exercise 7: Audit Level Examples

Page 19 in the exercises

## Exercise 7: Audit Level Examples

**Audit of a Military Base Building, Okinawa, Japan**

Read the audit report's Executive Summary to answer the questions. Pay particular attention to the paragraph preceding Table 1. (The Table of Contents is included for reference.)

1. Here are five statements that include major elements of ASHRAE Audits II and III
   - A. The audit has an analysis of current energy use
   - B. The audit outlines the costs and savings of major energy efficiency measures (EEMs)
   - C. Specific operations and maintenance recommendations are listed in the Table of Contents
   - D. Capital project recommendations are given (with costs and savings).
   - E. The report offers detailed analysis of capital projects, including energy simulations to justify recommendations.

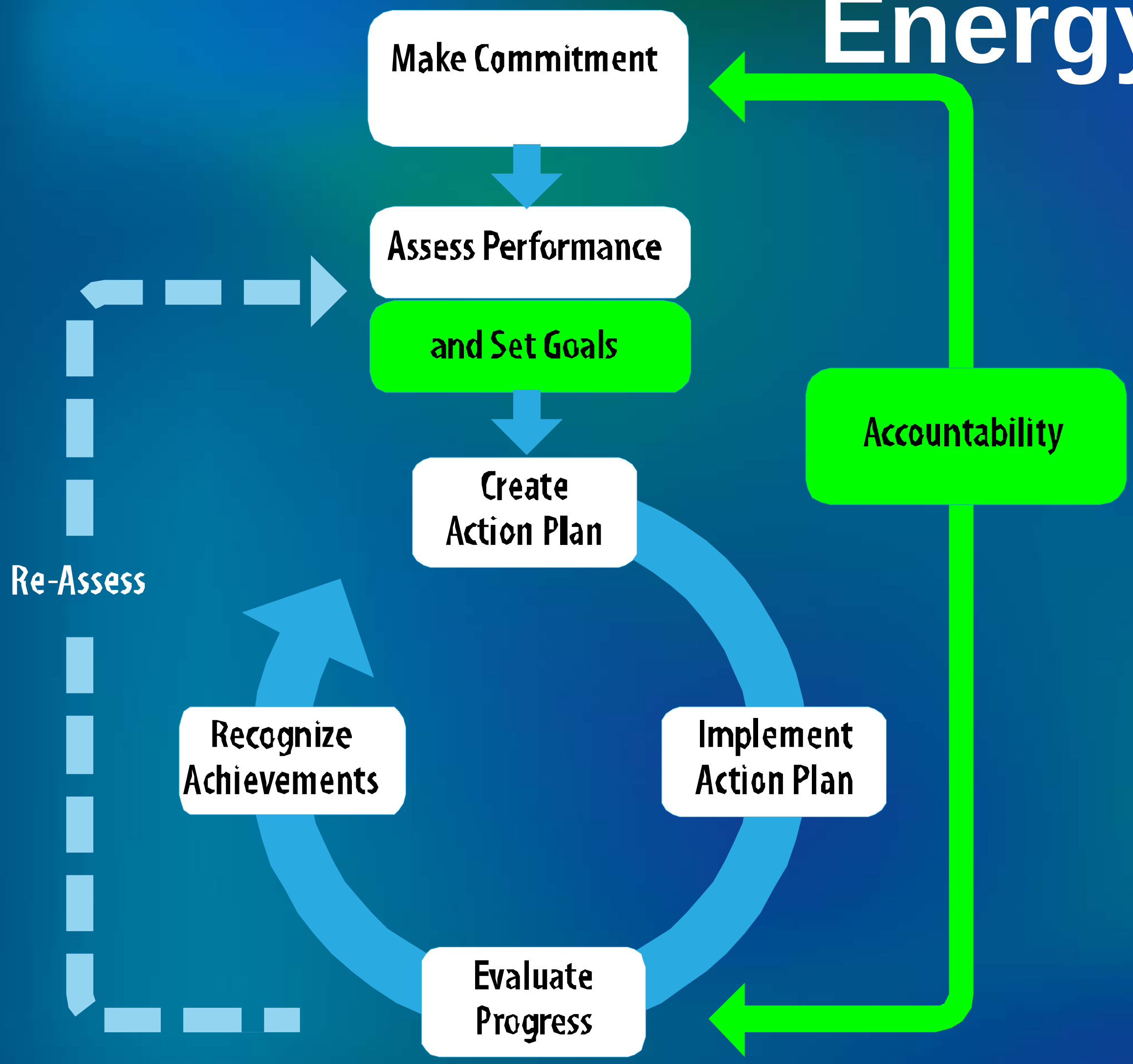
# What About Commissioning?

- Commissioning
- Recommissioning
- Retrocommissioning

2015 *ASHRAE Handbook—*
*HVAC Applications*, Chapter 43

# ENERGY STAR Guidelines for Energy Management

www.energystar.gov



# Benefits of Goal Setting

- Sets the tone for improvement
- Basis to measure success
- Helps the energy team to identify progress and setbacks
- Fosters ownership, creates purpose, and motivates
- Demonstrates commitment
- Creates schedules and milestones

# Goals: Corporate Example

ENERGY STAR Partner: 3M

Energy Efficiency Goal: Improve global energy efficiency by 20% between 2006 and 2010, with 2005 as the baseline year. Efficiency will be calculated by dividing 3M net sales by 3M total energy use.

Progress: Through 2008, energy efficiency has been improved by 19.2%.

# Level II and III Audits: Ingredients for Goals for a Building

| **Energy Efficiency Measure (EEM): AHU Variable Frequency Drives** | **Estimated Impact Calculation** |
|---|---|
| Existing System Simulation | 843,961 kWh/year |
| EEM Simulation | 705,903 kWh/year |
| EEM Energy Savings | 138,058 kWh/year |
| EEM $ Savings | $22,918/year |
| EEM construction cost (Engineering not included) | $63,100 |
| EEM Simple Payback | 2.75 years |

# SMART Goals—Reminder

- Specific
- Measurable
- Attainable
- Relevant
- Time framed

# Setting the Goal—Example

We will document 5% electrical energy savings over eight weeks at the Hilldale facility.

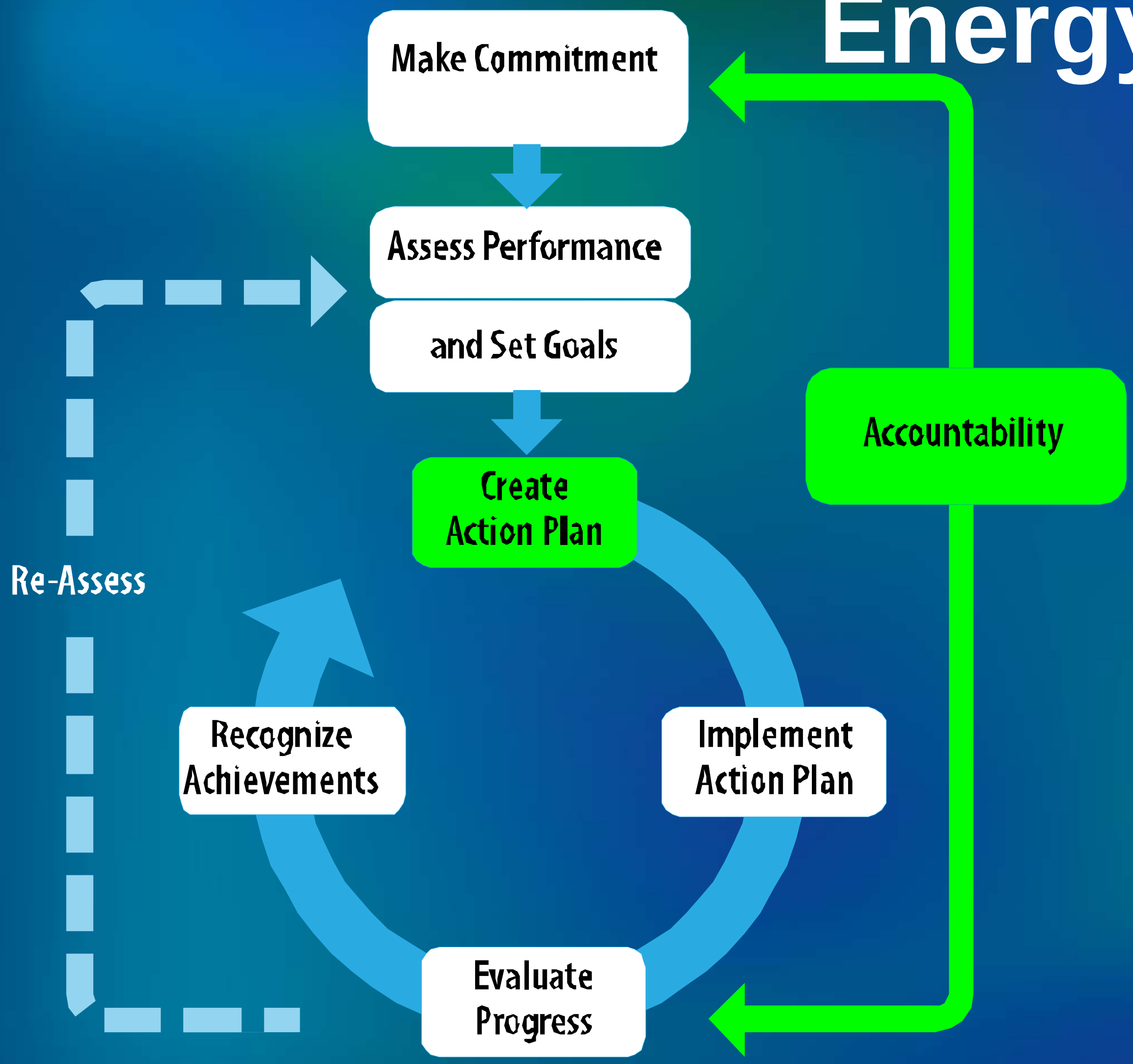
Table discussion: How SMART is the Great Dane goal?

# Action Plans: Ideas and a Test Method

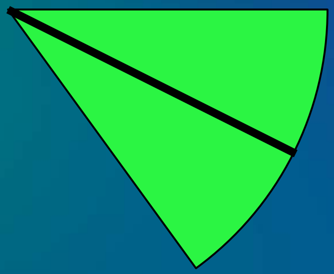
*Now that I have a target building, how do I start saving energy?*

# ENERGY STAR Guidelines for Energy Management

www.energystar.gov



# Two Types of Action



- Discretionary facility operation
- Capital improvements

# Learning by Doing: “Reverse” Energy Audit Process

- Low-cost actions decrease utility costs first
- Knowledge and skill built by facility staff
- In-depth audit and capital improvements follow, on firm foundation

"The most thorough energy conservation program begins at the end of each distribution system and works back to the Central Plant."

- John Freund, John Deere Corp.

*HPAC*, September 1980, p.58

….So, start with end uses !

# A General Sequence of Systems to Tackle

- Lighting
- Fan systems
- Pumping systems
- Boilers and chillers

Easier to harder

# Sample Discretionary Actions—Lighting

Easier to harder

- Match operating hours to activities
  - Unoccupied lighting
  - Existing custodial lighting
- Take advantage of daylight
- Check delays on occupancy sensors
- Assure appropriate foot-candles for tasks (lumens)
- Install high-Kelvin lamps

# Sample Discretionary Actions—Fan Systems

- Match running time to activities
- Lower hot-air temperatures
- Raise cold-air temperatures
- Lower fan pressure in ducts
- Adjust static pressure set points
  - o Manual reset
  - o Dynamic reset using damper positions
- Minimize outdoor air quantities
- Minimize exhaust quantities
- Match ventilation to number of occupants
- De-energize exhaust fans and close OA dampers when unoccupied

Easier to harder

# Major Tip

*To warm or cool the building ahead of occupancy, be sure that outdoor air dampers are closed until occupancy.*

# Sample Discretionary Actions—Fan Systems (*cont.*)

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

Easier to harder

# Sample Discretionary Actions—Pumping Systems

- Match running time to activities
- De-energize non-essential loads
- Verify proper flow
  - o Throttle balance valves
  - o Trim pump impellers
- Lower pressure set point to optimize variable flow
  - o Manual reset
  - o Dynamic reset
- Convert CV system to variable flow

Easier to harder

# Sample Discretionary Actions—Boilers

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

Easier to harder

# Sample Discretionary Actions—Chillers

Easier to harder

- 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 flow

# ENERGY STAR IT Tools

ABOUT ENERGY STAR PARTNER RESOURCES

ENERGY STAR

The simple choice for energy efficiency.

ENERGY EFFICIENT products | ENERGY SAVINGS at home | ENERGY EFFICIENT new homes | ENERGY STRATEGIES FOR buildings & plants

Home » Certified Products » Ways to Reduce IT Energy Costs » Activate Power Management on Your Computer

## Certified Products

Your source for energy efficient product information

All Certified Products | Appliances | Lighting | Office Equipment | Electronics | Product Specifications Search

## Activate Power Management on Your Computer

Click on your operating system below and follow the instructions to configure power management features on your computer. Note that your monitor may already enter a low-power sleep mode when the computer is inactive, but the computer itself may not. There are two separate settings: one for the monitor, and another for the computer.

- Microsoft Windows 10
- Microsoft Windows 8
- Microsoft Windows 7
- Microsoft Windows Vista

### QUICK LINKS

- Ways to Reduce IT Energy Costs
- Put your computers to sleep
  - Estimate your PC power management savings (EXCEL, 65.54 KB)
- Contact our technical experts
- Choose energy efficient IT equipment
- Save energy in the data center
- Benchmark your data center's energy efficiency
- Reduce peripheral energy consumption
- Utility Guide for Designing Incentive Programs Focused on Data Center Efficiency Measures

https://www.energystar.gov/products/low_carbon_it_campaign/power_management_computer

# Other Lists of Discretionary Opportunities

Chapter 36, “Energy Use and Management,”
2015 *ASHRAE Handbook—HVAC Applications*

ASHRAE Standard 100-2018,
*Energy Conservation in Existing Buildings*

# Exercise 8: Ranking Discretionary Actions for Discussion and Application

Page 28 in the exercises

## Exercise 8: Discretionary Facilities Operations Checklist

*Directions:* Check off actions you would like the instructor to discuss further (***More?*** column). We'll take a quick poll of participants as our guide. Use the ***Notes*** column to flag actions you want to investigate when you return to work. (See **slides 152-161** and refer to ASHRAE Standard 100 Informative Annex E for more energy efficiency measures)

| More? | Discretionary Facilities Operation Actions | Notes for your buildings |
|---|---|---|
| | **Lighting** | |
| | • Match operating hours to activities | |
| | • Replace lamps with LED or low-wattage fluorescent | |
| | • Take advantage of daylight | |
| | • Check delays on Occupancy Sensors | |
| | • Assure appropriate Foot-candles (lumens) | |

# BREAK!

# Handouts

1. Course exercises
2. Energy Management Session Supplement
3. "Focus on Energy" best practices spreadsheets
4. WA Energy Audit checklists
5. References
6. Advocate Healthcare EM operational checklists
7. Aurora walk-thru audit notes
8. Excerpts from ASHRAE Standard 100-2018
9. ENERGY STAR Guidelines for Energy Management

# Wisconsin's Focus on Energy

## Best Practices Spreadsheets

focus on energy[sm]

*The power is within you.*

# Wisconsin's Focus on Energy

## Best Practices Spreadsheets

- **Air handlers**
- **Boilers**
- **Chillers**
- **Cooking**
- **Domestic hot water**
- **HVAC**
- **Lighting**
- **Miscellaneous equipment**
- **Refrigeration**

focus on energy
*The power is within you.*

# 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 outdoor air intake
- Install night setback controls (heating season)
- Install night setup controls (cooling season)

# 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.

# Air Handlers Best Practices

## EXISTING

| | Example | System 1 |
|---|---|---|
| Motor Horsepower | 7.5 | 7.5 |
| Motor Efficiency | 85.3% | 85.3% |
| % Full Load | 65.0% | 65.0% |
| Annual Operation Hours | 2,500 | 2,500 |
| Conversion Factor | 0.746 | 0.746 |
| kW | 4.3 | 4.3 |
| kWh/yr | 10,658 | 10,658 |
| Average kWh Rate | $0.080 | $0.080 |
| Annual Energy Cost | $853 | $853 |

## PROPOSED

| | Example | System 1 |
|---|---|---|
| Motor Horsepower | 7.5 | 7.5 |
| Motor Efficiency | 85.3% | 85.3% |
| VFD Efficiency | 98.0% | 98.0% |
| Conversion Factor | 0.746 | 0.746 |
| Savings Factor | 0.59 | 0.59 |
| kW | 4.4 | 4.4 |
| kWh/yr | 4,459 | 4,459 |
| Annual Energy Cost | $357 | $357 |

## SAVINGS

| | Example | System 1 |
|---|---|---|
| kW | -0.1 | -0.1 |
| kWh/yr | 6,199 | 6,199 |
| Annual Cost Savings | $496 | $496 |
| Project cost Estimate | $1,688 | $1,688 |
| Incentive | $0 | $147 |
| Simple Payback | 3.4 | 3.1 |

.:
Annual operating hours is generally assumed as the open hours.

Sample hours per year defaults:
2000 hrs/yr - Educational (10 hr/day x 200 day/yr)
5760 hrs/yr - Food Sales (16 hr/day x 360 day/yr)
3744 hrs/yr - Food Service (12 hr/day x 6 day/wk x 52 wk/yr)
8760 hrs/yr - Health Care (24 hours per day)
2500 hrs/yr - Office (10 hr/day x 5 day/wk x 50 wk/yr)
3640 hrs/yr - Retail (10 hr/day x 7 days/week x 52 weeks/year)
-
Modify as need to match your use patterns.

INDEX

Red triangles in the upper right corner means there is a comment explaining the cell.

Index Page | Savings Summary | VFD on AHU Supply Fan | Constant Volume to VAV | Dual Duct or Multi Zor

Ready

**Install variable-speed controls on supply fan**

# 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.

**Tips**

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

# 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): | 60 | 60 |
| Heating Degree Hours: | 148,283 | 148,283 |
| Heating System Efficiency: | 80.0% | 80.0% |
| Is the facility cooled? | Yes | Yes |
| Cooling Balance Point: | 65 | 65 |
| Cooling Degree Hours: | 18,690 | 18,690 |
| EER of Cooling System: | 10.2 | 10.2 |
| Conversion Factor | 100,000 | 100,000 |
| **Avg Gas Use (th/yr)** | 1,485 | 1,485 |
| Average therm Rate | $0.710 | $0.950 |
| **kWh/yr** | 8,332 | 8,332 |
| Average kWh Rate | $0.080 | $0.080 |
| **Annual Energy Cost** | $1,721 | $2,077 |

**PROPOSED**

| | Example | System 1 |
|---|---|---|
| CFM of Outside Air | 600 | 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** | 5,573 | 5,573 |
| **Annual Energy Cost** | $622 | $681 |

**SAVINGS**

| | Example | System 1 |
|---|---|---|
| **th/yr** | 1,237 | 1,237 |
| **kWh/yr** | 2,759 | 2,759 |
| **Annual Cost Savings** | $1,099 | $1,396 |
| **Project cost Estimate** | $0 | $500 |
| **Incentive** | $0 | $19 |
| **Simple Payback** | Immediate | 0.3 |

**Reduce outdoor air intake**

# Chillers Best Practices

- **High efficiency chillers**
- **Chilled-water reset**
- **Chilled-water pump VFD**

# 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.

## Tips

1. Increase chilled-water temperature: save 1.5% power per 0.55°C
2. Decrease condenser water temperature: save 1.5% power per 0.55°C

## Extreme Example

Increase chilled-water temperature from 5.5°C to 8.9°C **and** decrease condenser water temperature from 25°C to 23.9°C:

**Save 13.5% power**

# Chillers Best Practices

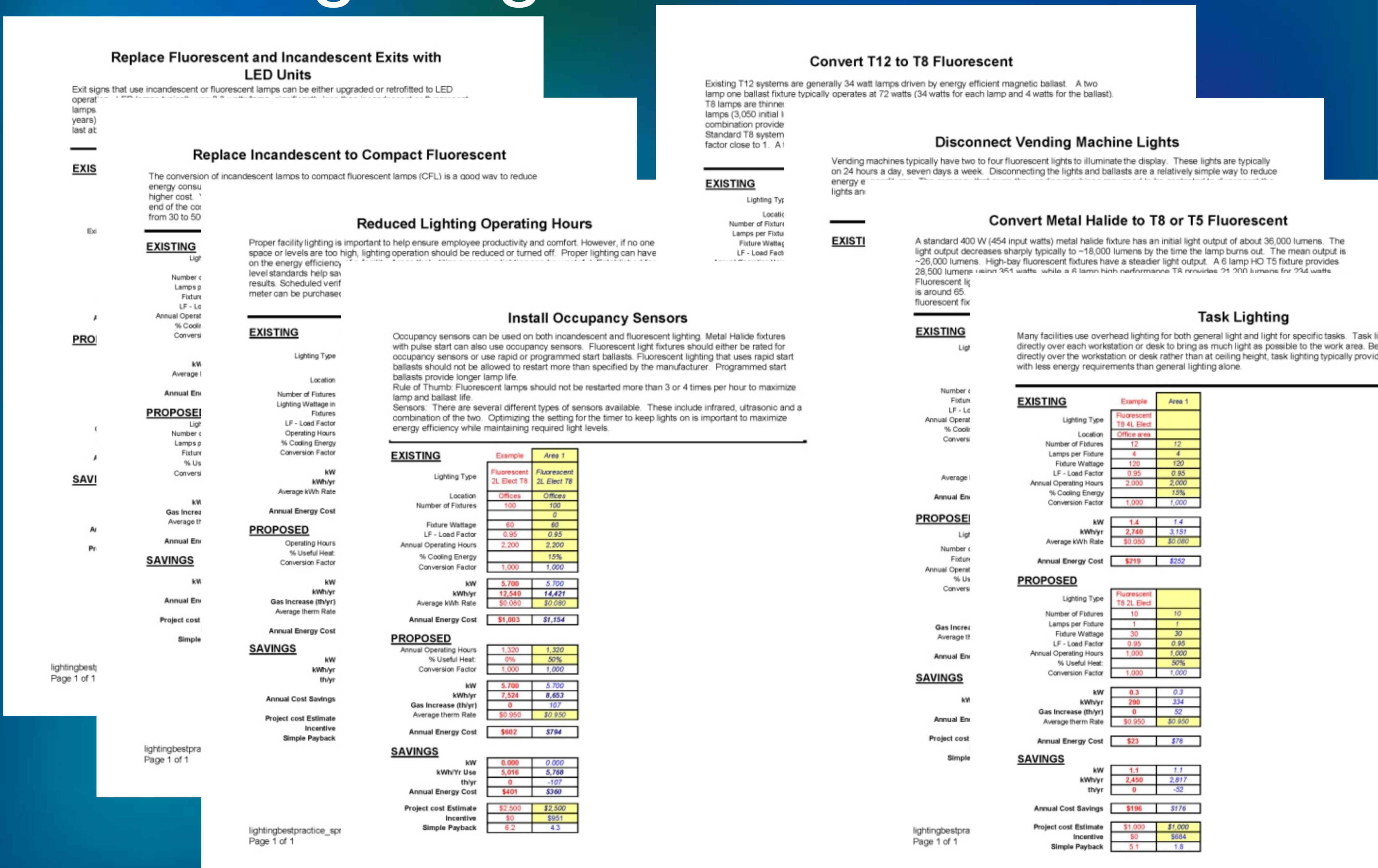
| | Example | System 1 |
|---|---|---|
| **EXISTING** | | |
| Existing Air Conditioner Size | 20 | 20 |
| Chilled Water Temperature | 45 | 45 |
| Existing Air Conditioner Efficiency (EER/SEER) | 10.2 | 10.2 |
| EqFlHrs | 900 | 900 |
| Unit Conversion (btu/tons) | 12,000 | 12,000 |
| Unit Conversion (watts/kW) | 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**

# Lighting Best Practices

- ~~Compact Fluorescents~~ ***LEDs***
- **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**

# Lighting Best Practices



### Replace Fluorescent and Incandescent Exits with LED Units

Exit signs that use incandescent or fluorescent lamps can be either upgraded or retrofitted to LED

### Replace Incandescent to Compact Fluorescent

The conversion of incandescent lamps to compact fluorescent lamps (CFL) is a good way to reduce

### Reduced Lighting Operating Hours

Proper facility lighting is important to help ensure employee productivity and comfort. However, if no one space or levels are too high, lighting operation should be reduced or turned off. Proper lighting can have

### Convert T12 to T8 Fluorescent

Existing T12 systems are generally 34 watt lamps driven by energy efficient magnetic ballast. A two lamp one ballast fixture typically operates at 72 watts (34 watts for each lamp and 4 watts for the ballast).

### Disconnect Vending Machine Lights

Vending machines typically have two to four fluorescent lights to illuminate the display. These lights are typically on 24 hours a day, seven days a week. Disconnecting the lights and ballasts are a relatively simple way to reduce

### Convert Metal Halide to T8 or T5 Fluorescent

A standard 400 W (454 input watts) metal halide fixture has an initial light output of about 36,000 lumens. The light output decreases sharply typically to ~18,000 lumens by the time the lamp burns out. The mean output is ~26,000 lumens. High-bay fluorescent fixtures have a steadier light output. A 6 lamp HO T5 fixture provides

### Install Occupancy Sensors

Occupancy sensors can be used on both incandescent and fluorescent lighting. Metal Halide fixtures with pulse start can also use occupancy sensors. Fluorescent light fixtures should either be rated for occupancy sensors or use rapid or programmed start ballasts. Fluorescent lighting that uses rapid start ballasts should not be allowed to restart more than specified by the manufacturer. Programmed start ballasts provide longer lamp life.
Rule of Thumb: Fluorescent lamps should not be restarted more than 3 or 4 times per hour to maximize lamp and ballast life.
Sensors: There are several different types of sensors available. These include infrared, ultrasonic and a combination of the two. Optimizing the setting for the timer to keep lights on is important to maximize energy efficiency while maintaining required light levels.

| EXISTING | Example | Area 1 |
|---|---|---|
| Lighting Type | Fluorescent 2L Elect T8 | Fluorescent 2L Elect T8 |
| Location | Offices | Offices |
| Number of Fixtures | 100 | 100 |
| | | 0 |
| Fixture Wattage | 60 | 60 |
| LF - Load Factor | 0.95 | 0.95 |
| Annual Operating Hours | 2,200 | 2,200 |
| % Cooling Energy | | 15% |
| Conversion Factor | 1,000 | 1,000 |
| kW | 5.700 | 5.700 |
| kWh/yr | 12,540 | 14,421 |
| Average kWh Rate | $0.080 | $0.080 |
| Annual Energy Cost | $1,003 | $1,154 |
| **PROPOSED** | | |
| Annual Operating Hours | 1,320 | 1,320 |
| % Useful Heat: | 0% | 50% |
| Conversion Factor | 1,000 | 1,000 |
| kW | 5.700 | 5.700 |
| kWh/yr | 7,524 | 8,653 |
| Gas Increase (th/yr) | 0 | 107 |
| Average therm Rate | $0.950 | $0.950 |
| Annual Energy Cost | $602 | $794 |
| **SAVINGS** | | |
| kW | 0.000 | 0.000 |
| kWh/Yr Use | 5,016 | 5,768 |
| th/yr | 0 | -107 |
| Annual Energy Cost | $401 | $360 |
| Project cost Estimate | $2,500 | $2,500 |
| Incentive | $0 | $951 |
| Simple Payback | 6.2 | 4.3 |

### Task Lighting

Many facilities use overhead lighting for both general light and light for specific tasks. Task li directly over each workstation or desk to bring as much light as possible to the work area. Be directly over the workstation or desk rather than at ceiling height, task lighting typically provid with less energy requirements than general lighting alone.

| EXISTING | Example | Area 1 |
|---|---|---|
| Lighting Type | Fluorescent T8 4L Elect | |
| Location | Office area | |
| Number of Fixtures | 12 | 12 |
| Lamps per Fixture | 4 | 4 |
| Fixture Wattage | 120 | 120 |
| LF - Load Factor | 0.95 | 0.95 |
| Annual Operating Hours | 2,000 | 2,000 |
| % Cooling Energy | | 15% |
| Conversion Factor | 1,000 | 1,000 |
| kW | 1.4 | 1.4 |
| kWh/yr | 2,740 | 3,151 |
| Average kWh Rate | $0.080 | $0.080 |
| Annual Energy Cost | $219 | $252 |
| **PROPOSED** | | |
| Lighting Type | Fluorescent T8 2L Elect | |
| Number of Fixtures | 10 | 10 |
| Lamps per Fixture | 1 | 1 |
| Fixture Wattage | 30 | 30 |
| LF - Load Factor | 0.95 | 0.95 |
| Annual Operating Hours | 1,000 | 1,000 |
| % Useful Heat: | | 50% |
| Conversion Factor | 1,000 | 1,000 |
| kW | 0.3 | 0.3 |
| kWh/yr | 290 | 334 |
| Gas Increase (th/yr) | 0 | 52 |
| Average therm Rate | $0.950 | $0.950 |
| Annual Energy Cost | $23 | $76 |
| **SAVINGS** | | |
| kW | 1.1 | 1.1 |
| kWh/yr | 2,450 | 2,817 |
| th/yr | 0 | -52 |
| Annual Cost Savings | $196 | $176 |
| Project cost Estimate | $1,000 | $1,000 |
| Incentive | $0 | $684 |
| Simple Payback | 5.1 | 1.8 |

lightingbestpractice_spr
Page 1 of 1

# Miscellaneous Best Practices

- ENERGY STAR Computers and Monitors
- Replace windows
- Vending machine occupancy sensors
- Add roof insulation
- Reduce infiltration

# Miscellaneous Best Practices *(cont.)*

## 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.

# Miscellaneous Best Practices *(cont.)*

| **EXISTING** | Example | Area 1 |
|---|---|---|
| Number of Vending Machines | 6 | 6 |
| % 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**

# Wisconsin's Focus on Energy

## Best Practices Spreadsheets

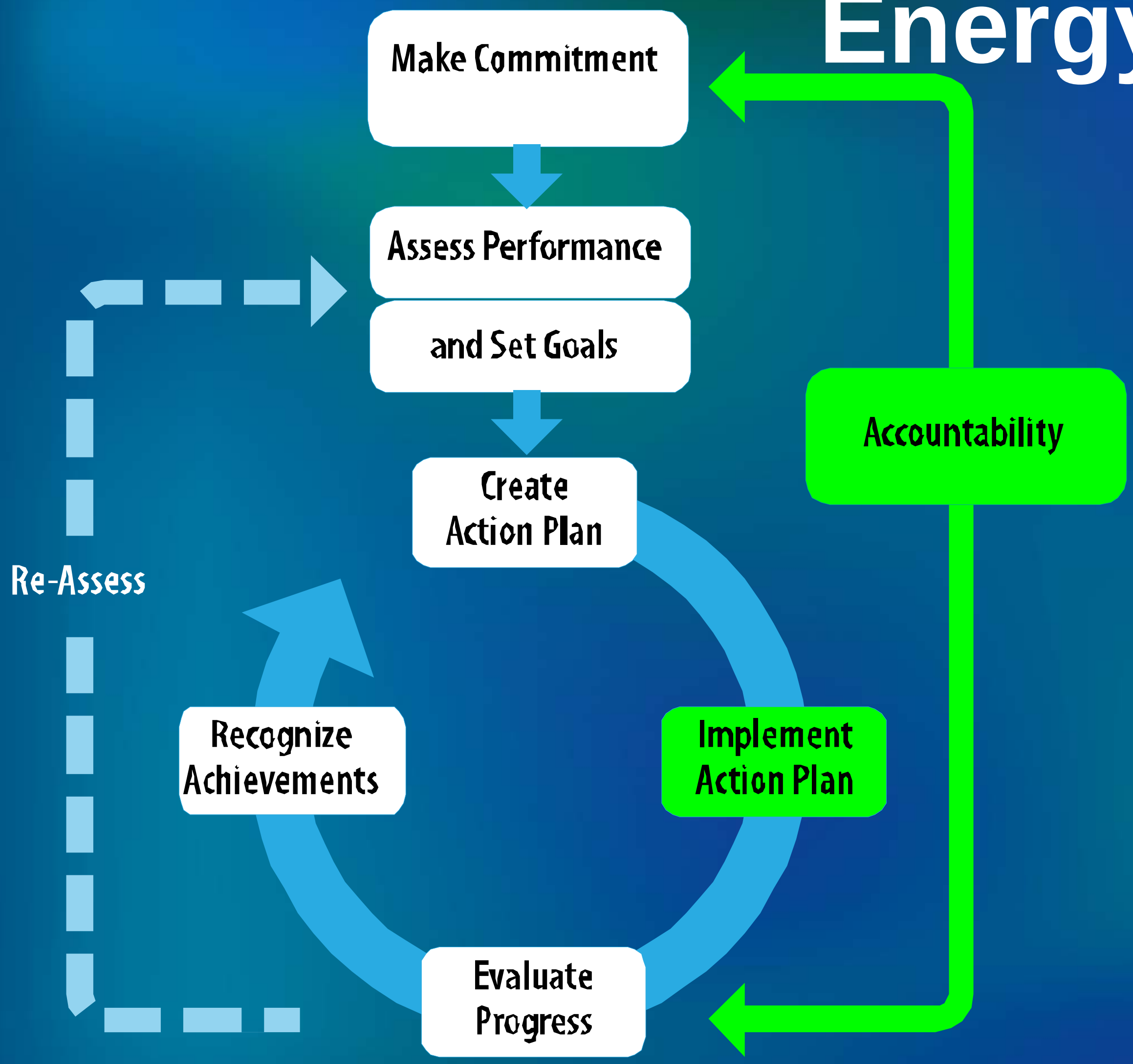
**Available in virtual handouts**

focus on energy[sm]

*The power is within you.*

# ENERGY STAR Guidelines for Energy Management

www.energystar.gov

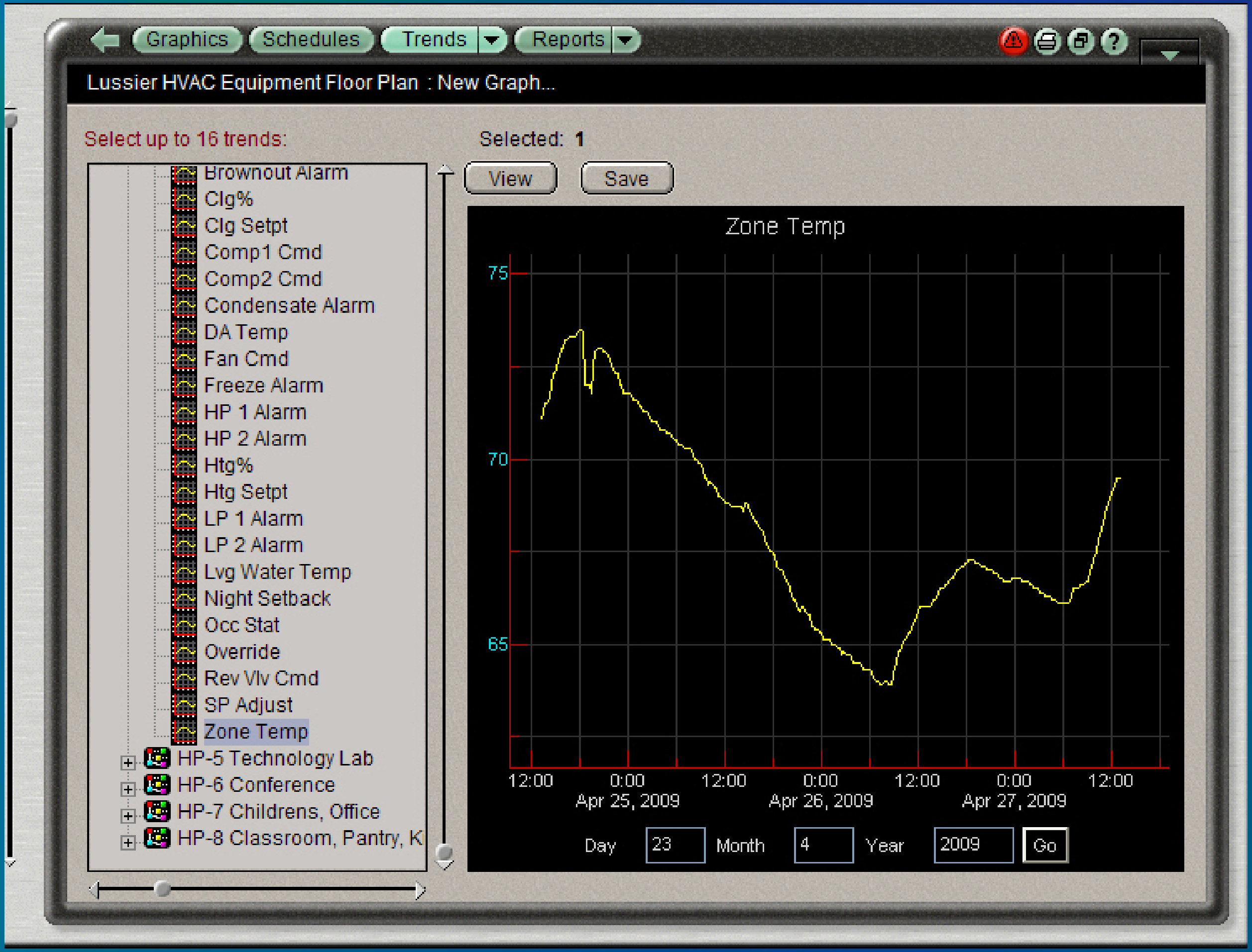


# Introducing End-Use Evaluation

Use trend logs or portable data loggers:

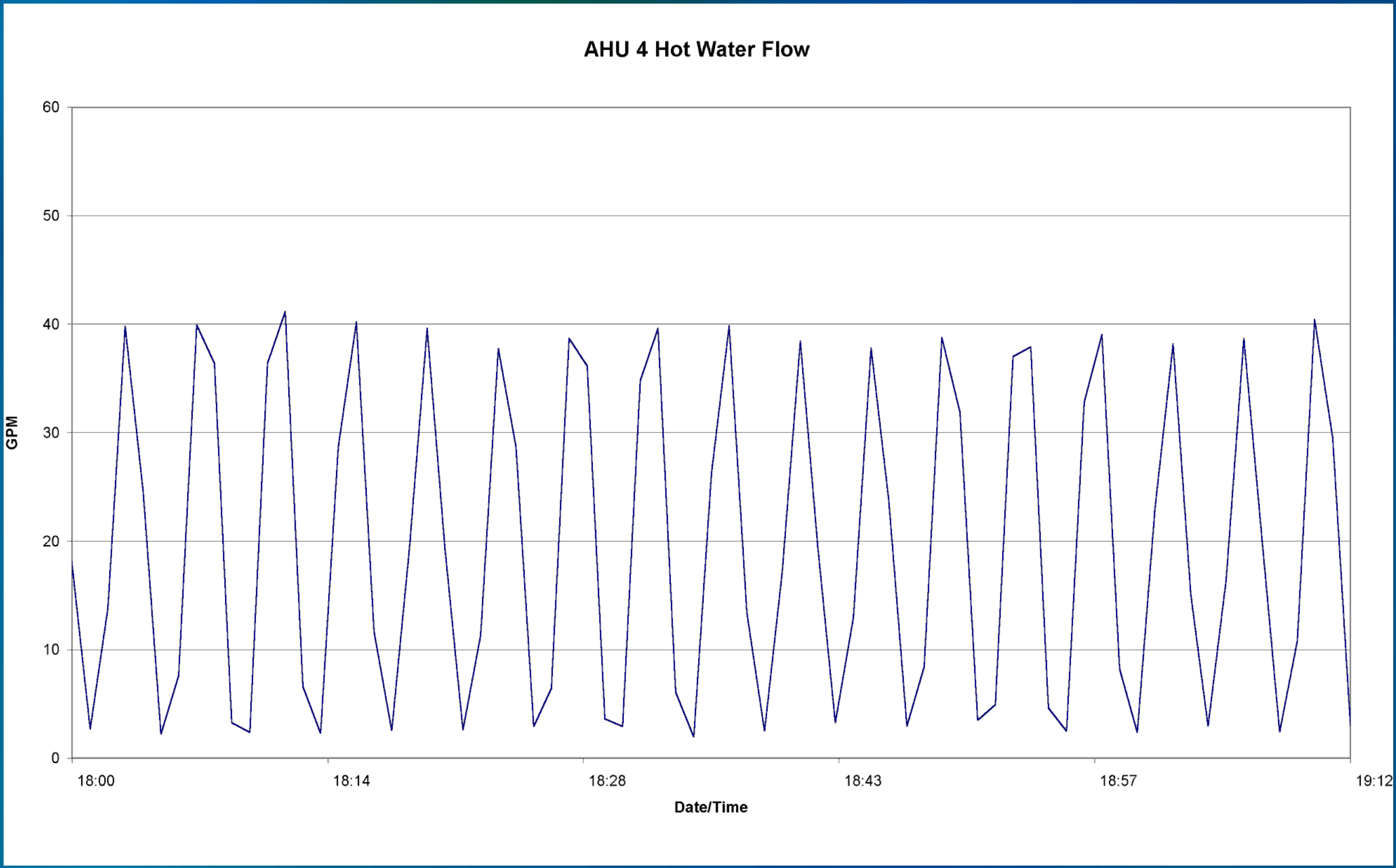
- Runtime
- Temperature and humidity fluctuations
- Electrical use
  - Amps
  - Watts
  - kWh

# Trend Logs from Control Systems



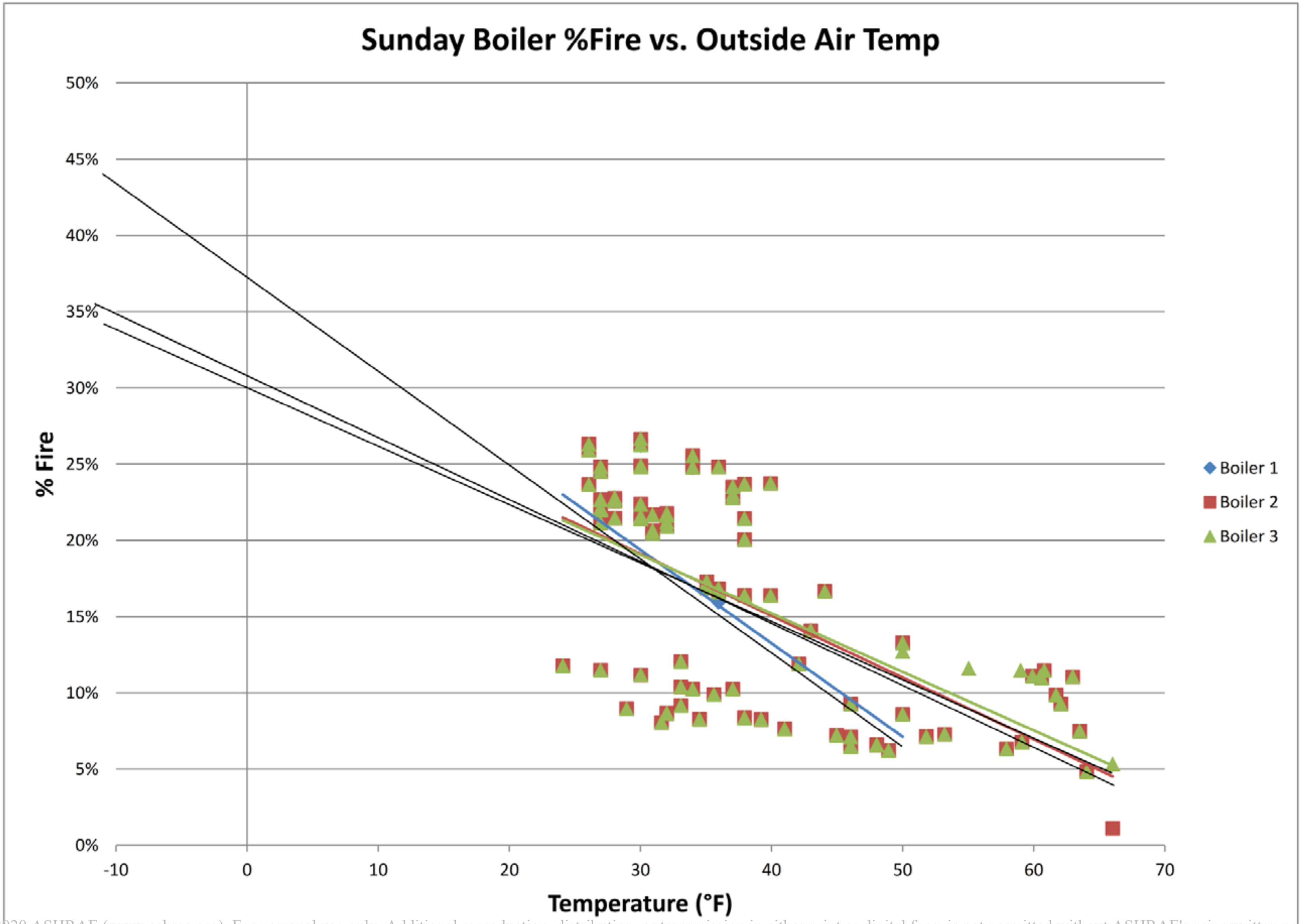
# Stand-alone Loggers (Download Data to Analyze)

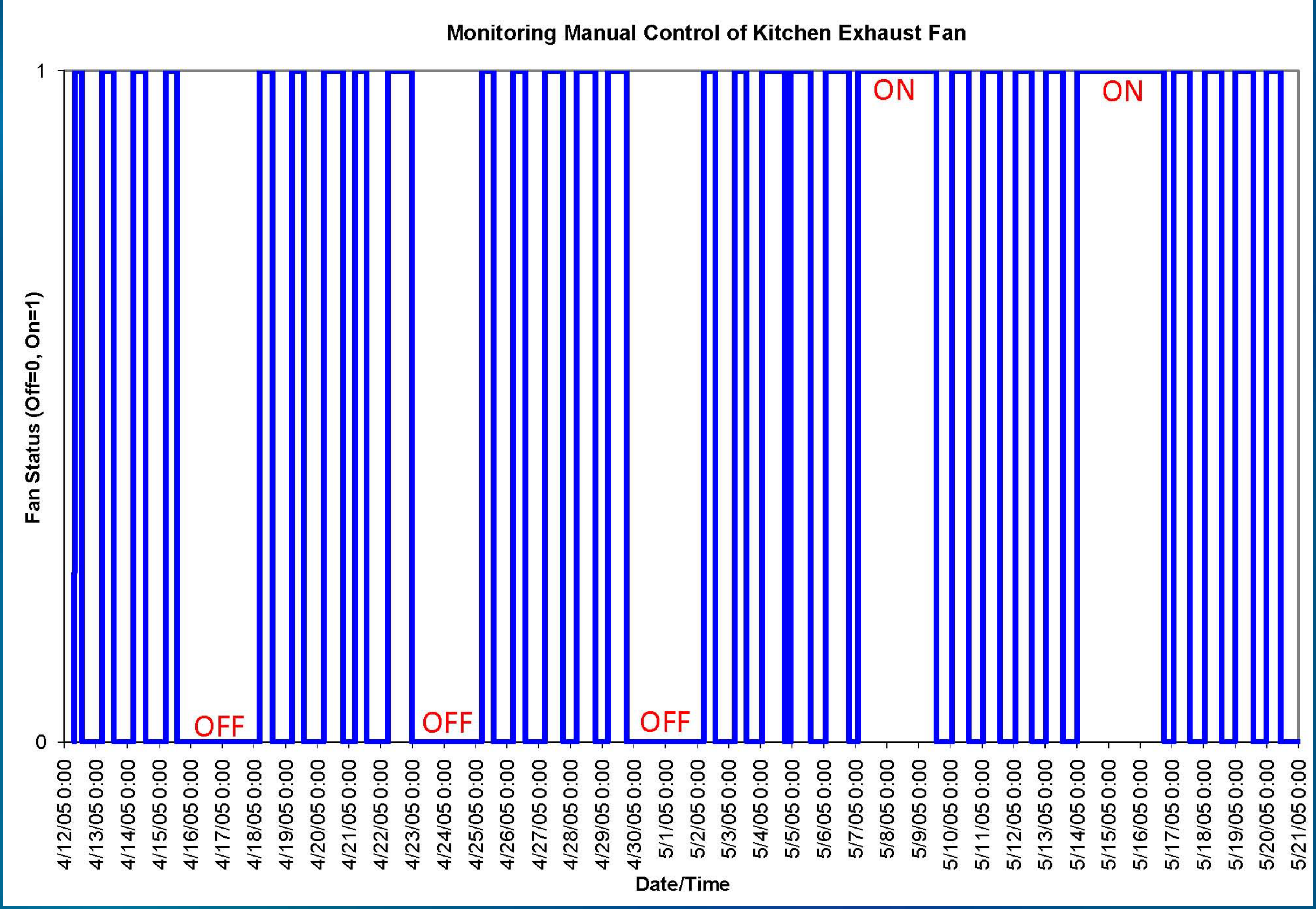

Motor On-Off Logger (R)
Temp/RH/Light Level (L)


AHU 4 Hot Water Flow
60
50
40
30
20
10
0
GPM
18:00
18:14
18:28
18:43
18:57
19:12
Date/Time

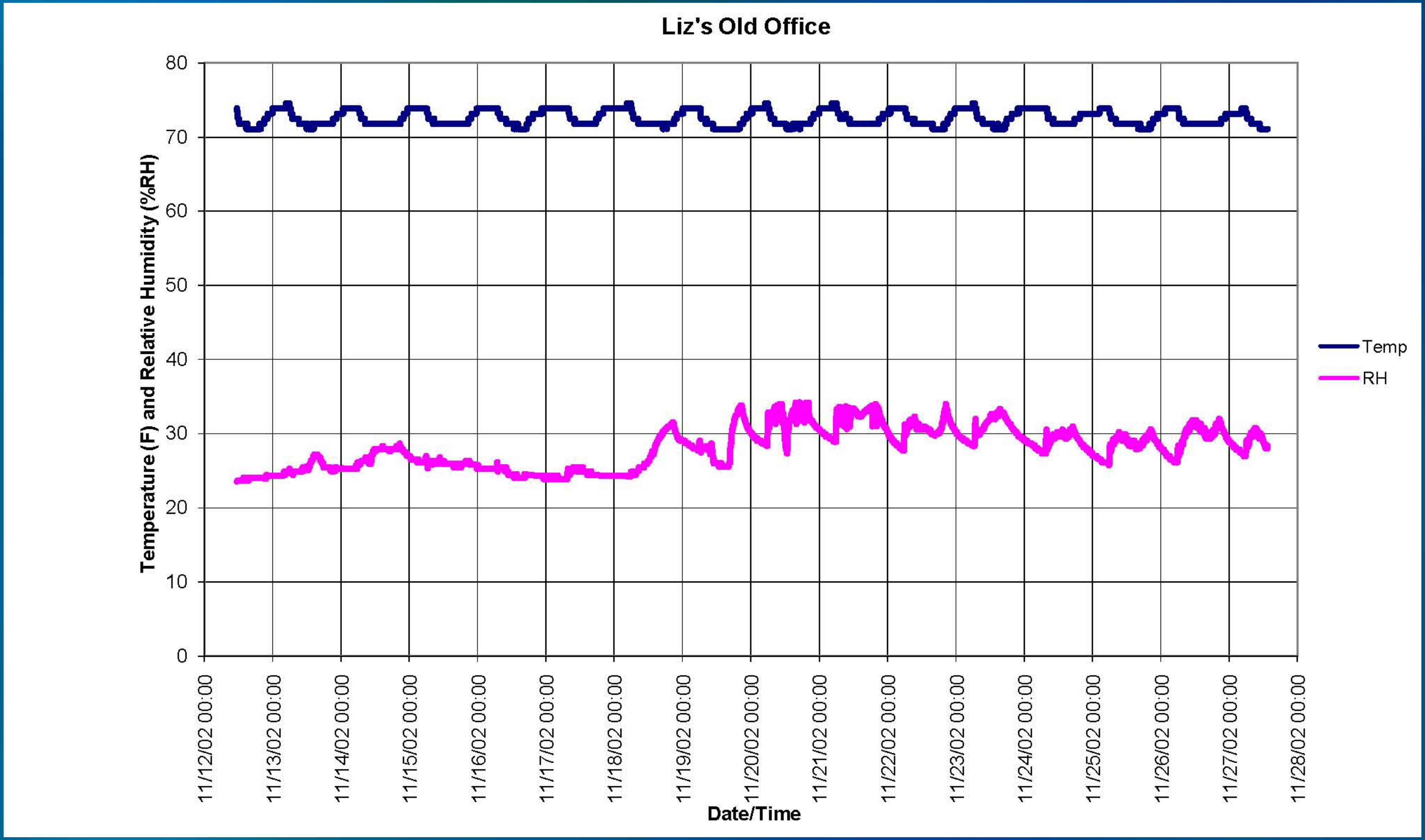
# Boiler Fire Rate Versus OA Temperature



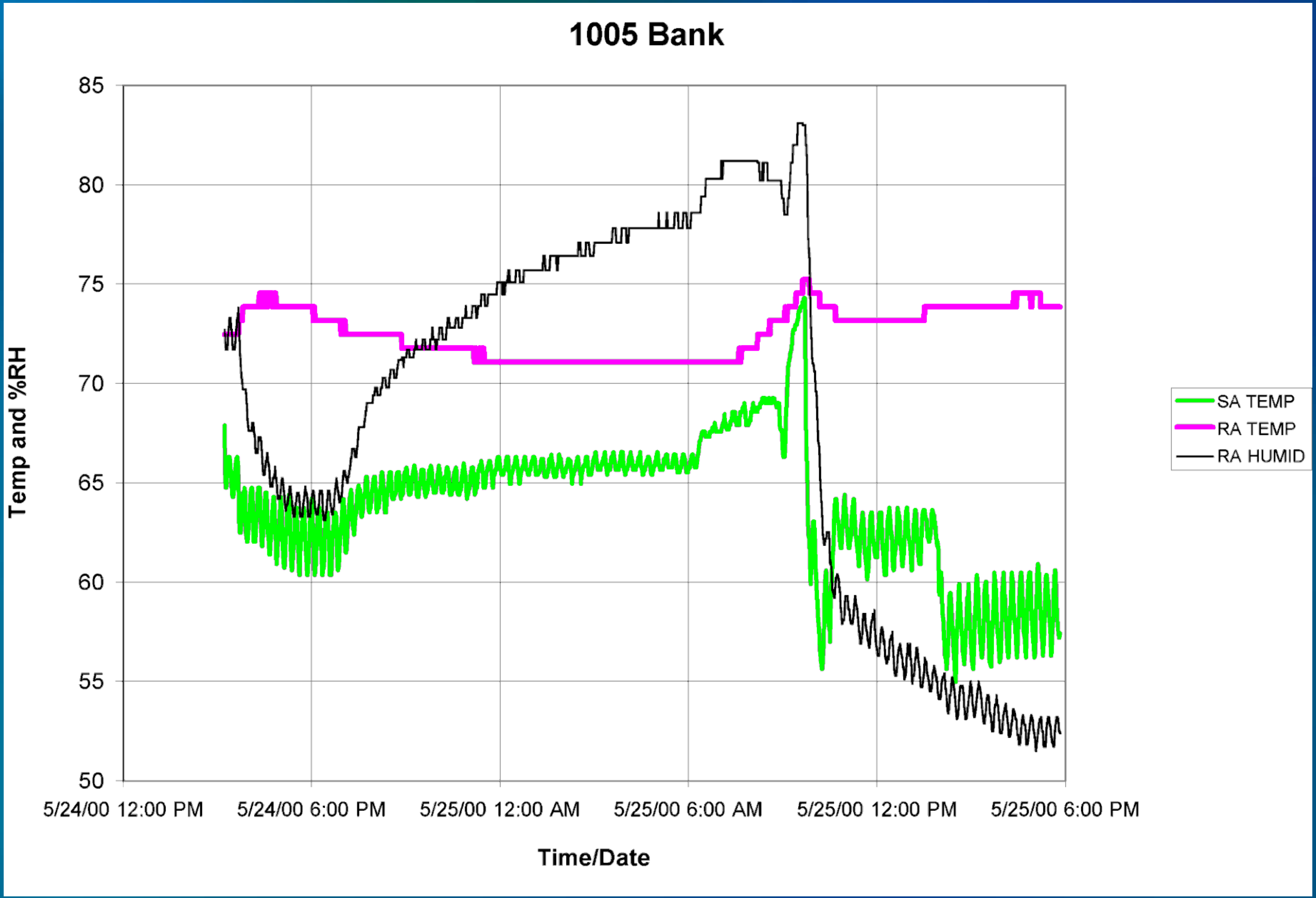



Monitoring Manual Control of Kitchen Exhaust Fan
Fan Status (Off=0, On=1)
1
0
OFF
OFF
OFF
ON
ON
4/12/05 0:00
4/13/05 0:00
4/14/05 0:00
4/15/05 0:00
4/16/05 0:00
4/17/05 0:00
4/18/05 0:00
4/19/05 0:00
4/20/05 0:00
4/21/05 0:00
4/22/05 0:00
4/23/05 0:00
4/24/05 0:00
4/25/05 0:00
4/26/05 0:00
4/27/05 0:00
4/28/05 0:00
4/29/05 0:00
4/30/05 0:00
5/1/05 0:00
5/2/05 0:00
5/3/05 0:00
5/4/05 0:00
5/5/05 0:00
5/6/05 0:00
5/7/05 0:00
5/8/05 0:00
5/9/05 0:00
5/10/05 0:00
5/11/05 0:00
5/12/05 0:00
5/13/05 0:00
5/14/05 0:00
5/15/05 0:00
5/16/05 0:00
5/17/05 0:00
5/18/05 0:00
5/19/05 0:00
5/20/05 0:00
5/21/05 0:00
Date/Time

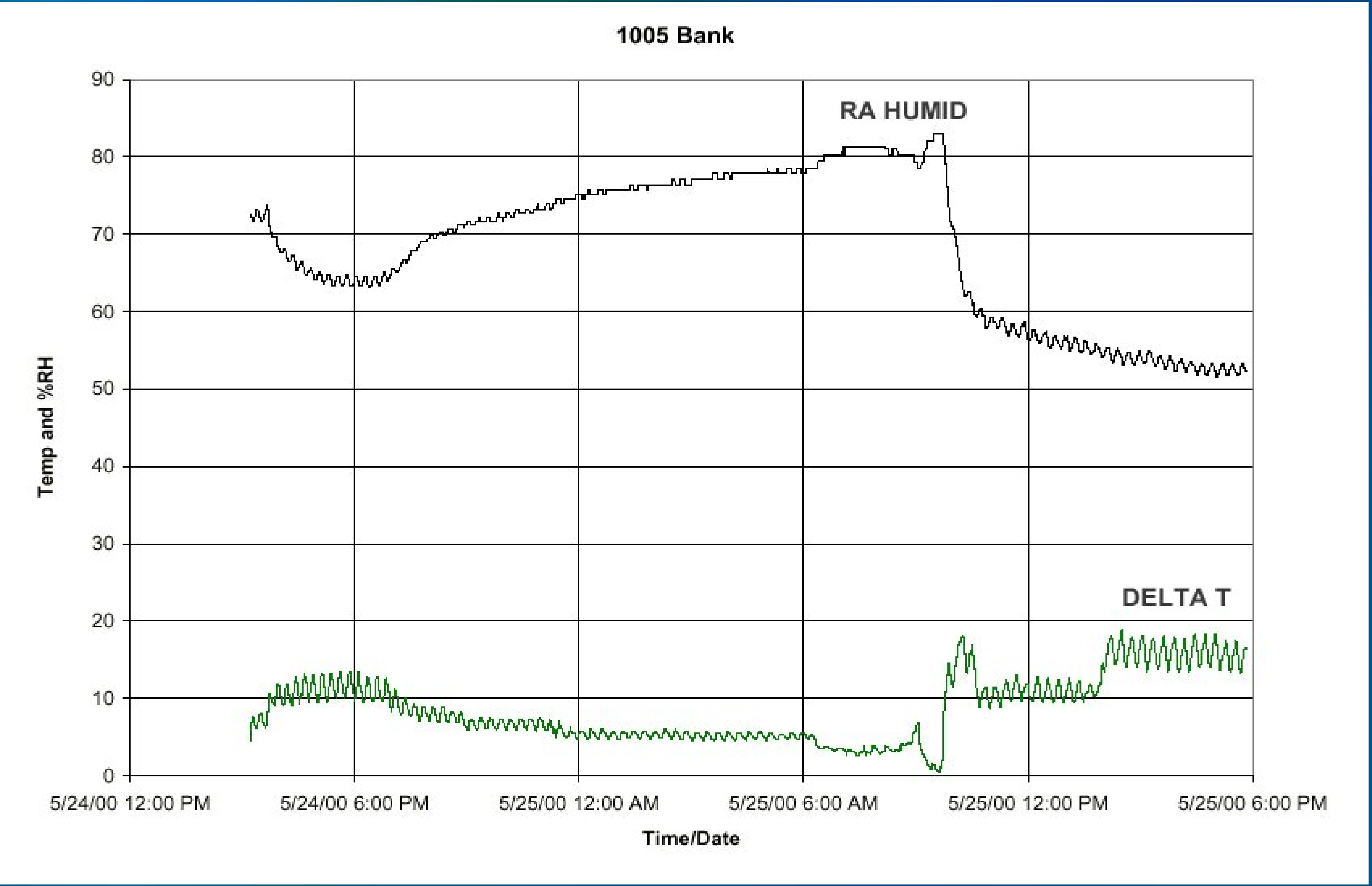
# Office Temperature/RH—Verex



# Bank Temperature/RH



# Bank ΔT Versus %RH



# Cooling Coil Rules of Thumb

| $\Delta T$ of Air | Moisture Removal |
|---|---|
| 2.8 ° to 4.4°C | zero |
| 4.4° to 6.7°C | barely measurable |
| 6.7° to 8.9°C | good |
| 8.9° to 11.1°C | excellent |

# Case Exercise 9: Using Motor Logger Data

Page 30
in the
exercises

## Exercise 9: Using Motor Logger Data

A stand-alone "Motor On/Off" logger was placed on the compressor motor controls to track when the Doty Street walk-in freezer compressor turned on and shut off.

← Compressor motor; controls and logger (below)

# Disincentives for the Building Engineer

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

# Incentives for the Building Engineer

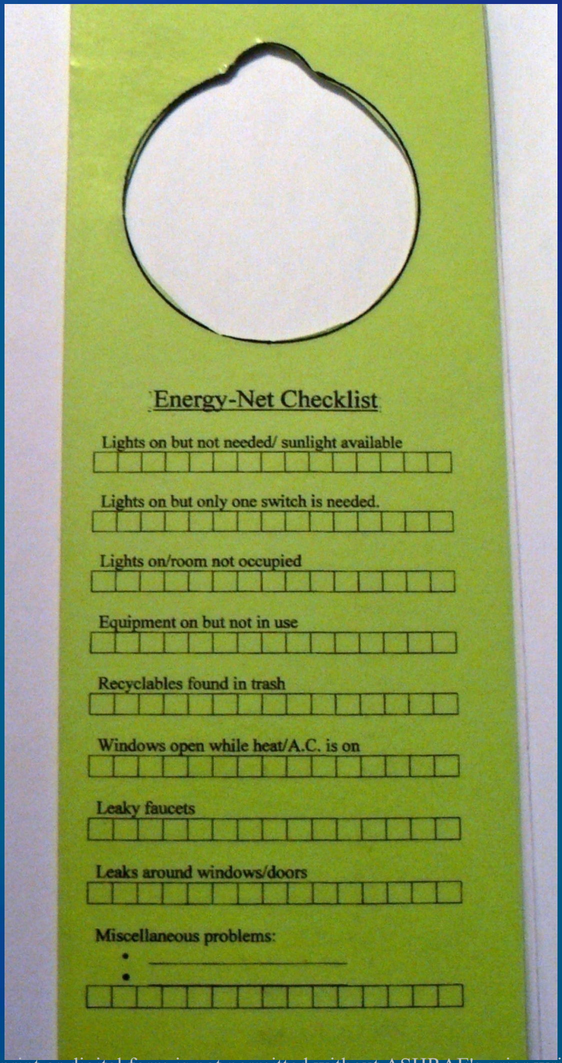
- Regular monitoring by the manager
- Managerial encouragement to experiment
  - Occasional, brief discomfort is OK
- Teamwork
- Accomplishment—getting results
- Perks paid for by savings

# So, if the Risk of Change is Worrisome…

- Take **<u>small</u>** steps that are reversible.
- Study your results, communicate, and adjust as needed.
- Engage your boss and occupants in the tests.

# Testing School Lighting Changes

Hitch Elementary School, Chicago, IL



# Ingredients for the Test

1. Aim: reduce wasted energy use
2. Measures: 30-minute electric meter use; patrol compliance
3. Change idea: Use daylight when possible in classrooms

Test Plan: Try different levels, just the week before spring vacation.

Tuesday: All lights on

Wednesday: One bank only

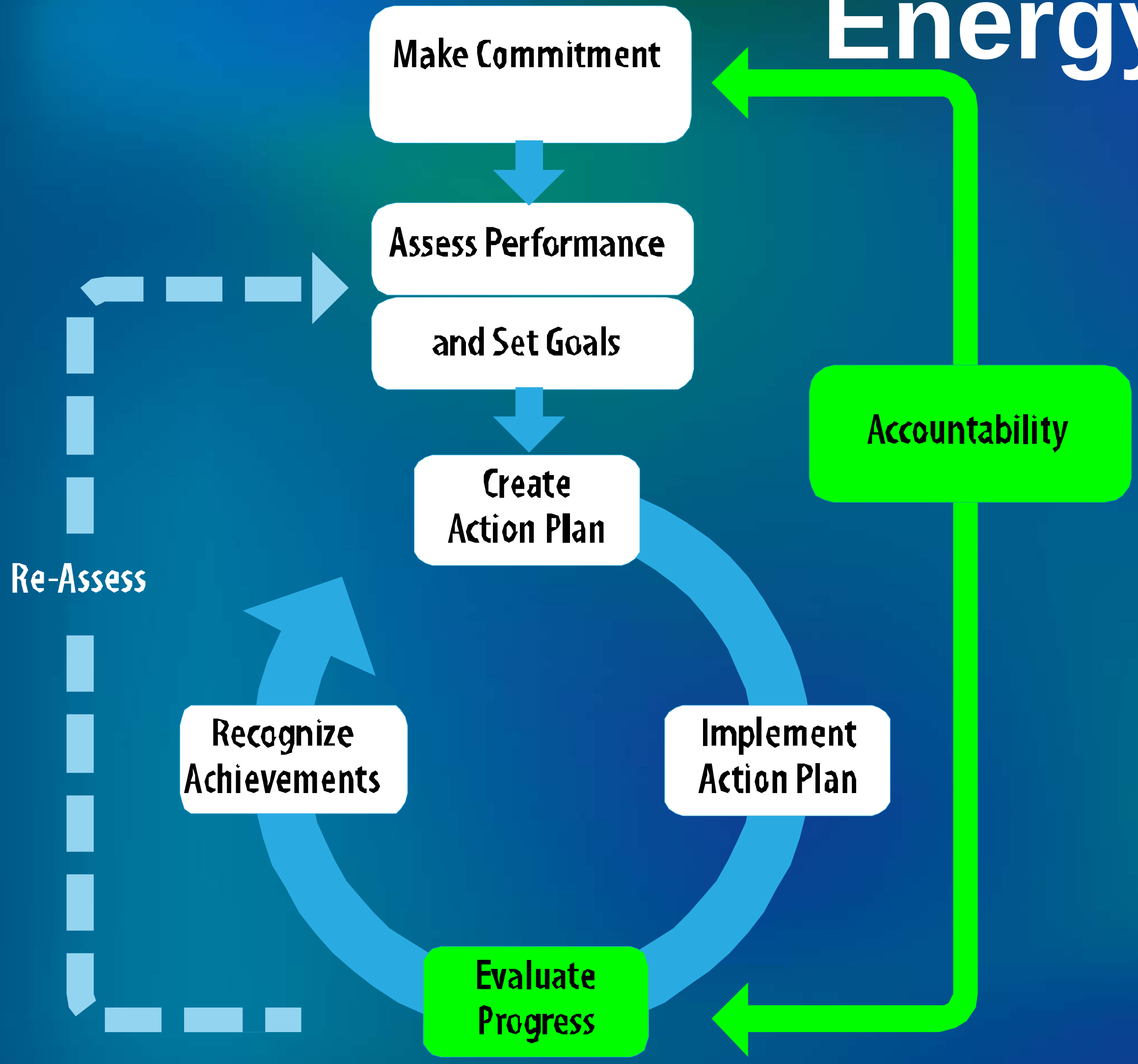
Friday: Daylight only…. Then, vacation!

# BREAK!

# Evaluating Progress

# ENERGY STAR Guidelines for Energy Management

www.energystar.gov



# Greener Pastures with Energy Savings

## Emissions Reduction at Madison College

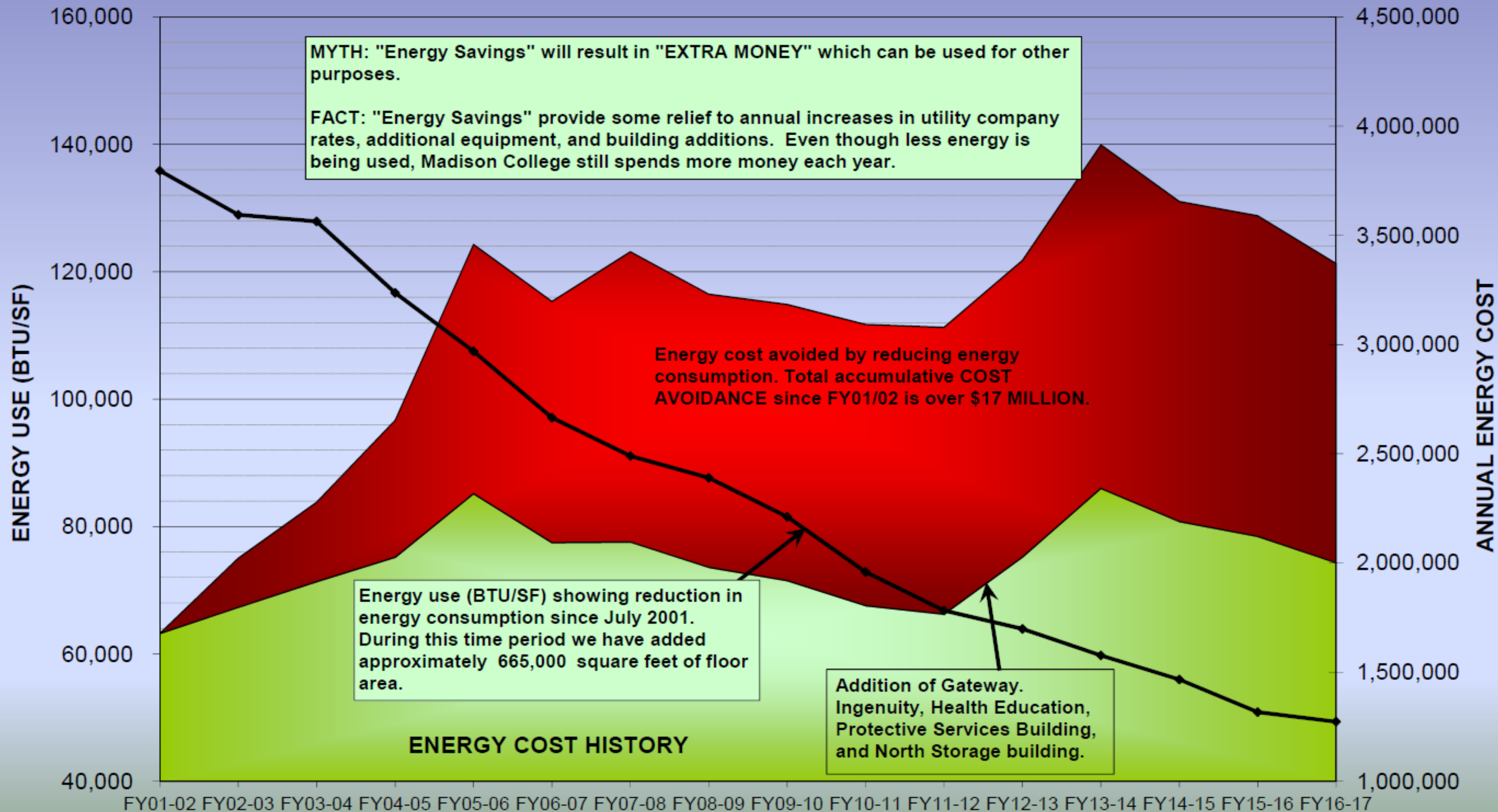
| **Energy** | **Usage FY 01/02 111,484 m²** | **Usage FY16/17 176,515 m²** | **Annual Reduction!** |
|---|---|---|---|
| Electricity | 23,000,000 kWh | 16,000,000 kWh | 7,000,000 kWh |
| Natural Gas | 94,950 GJ | 42,200 GJ | 52,750 GJ |
| **Emissions** | **Emissions FY 01/02** | **Emissions FY 16/17** | **Annual Reduction!** |
| $CO_2$ | 25,000 tons | 15,000 tons | 10,000 tons |

**The above energy savings were achieved with an additional 65,030 m² conditioned space!**

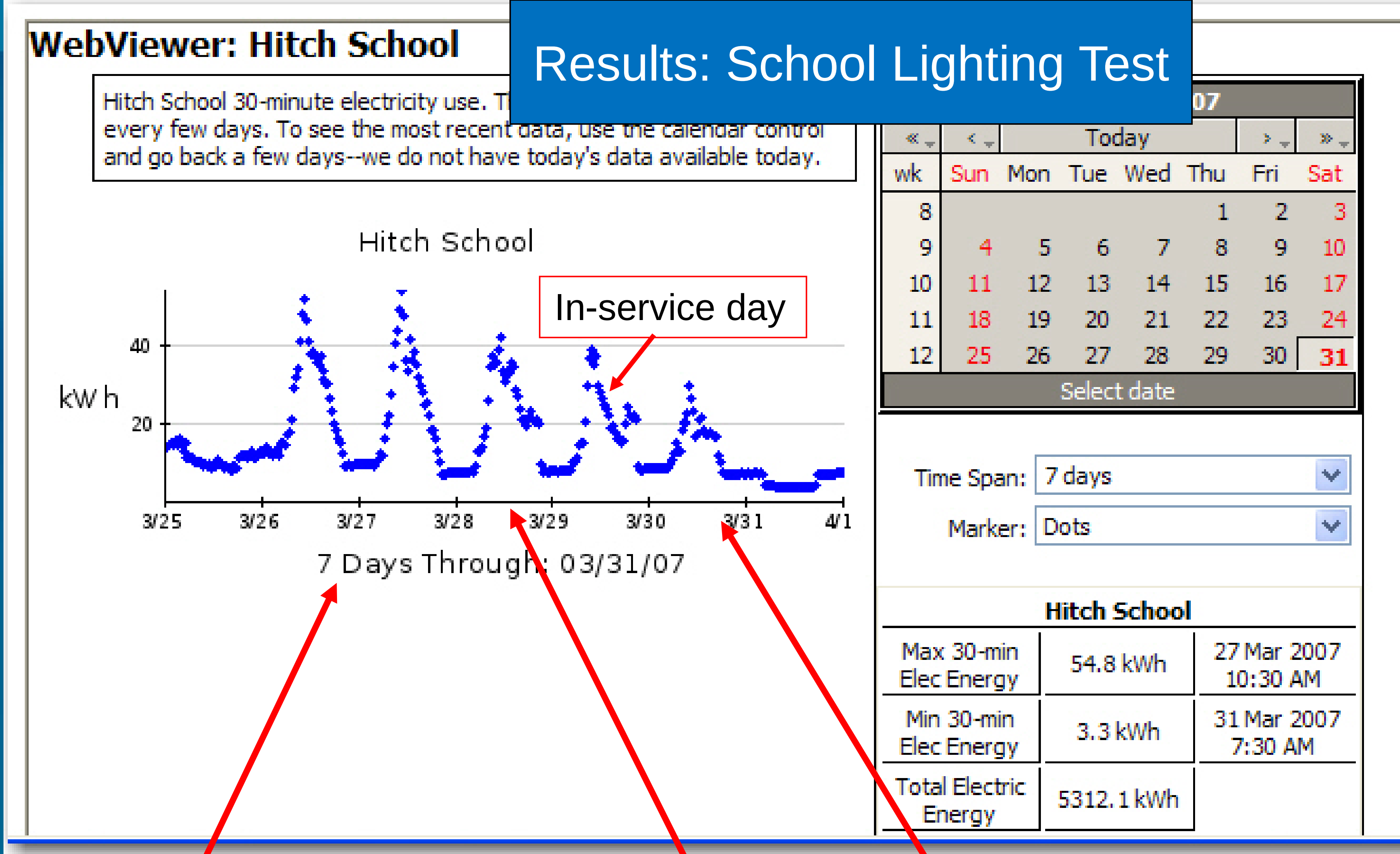
Source: Madison College Engineering Manager. Wesley Marquardt.
wmarquardt@madisoncollege.edu.

# Greener Pastures with Energy Savings

## Energy Cost Avoidance at Madison College



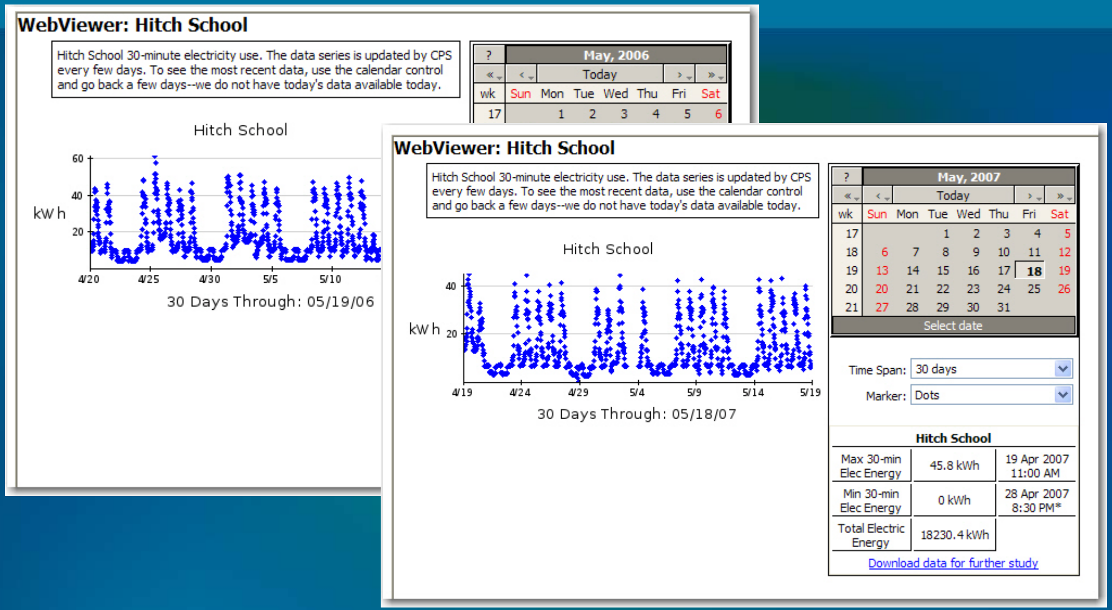
# Results: School Lighting Test




Tuesday Test: Please use both light banks

Wednesday Test: Please use only one light bank

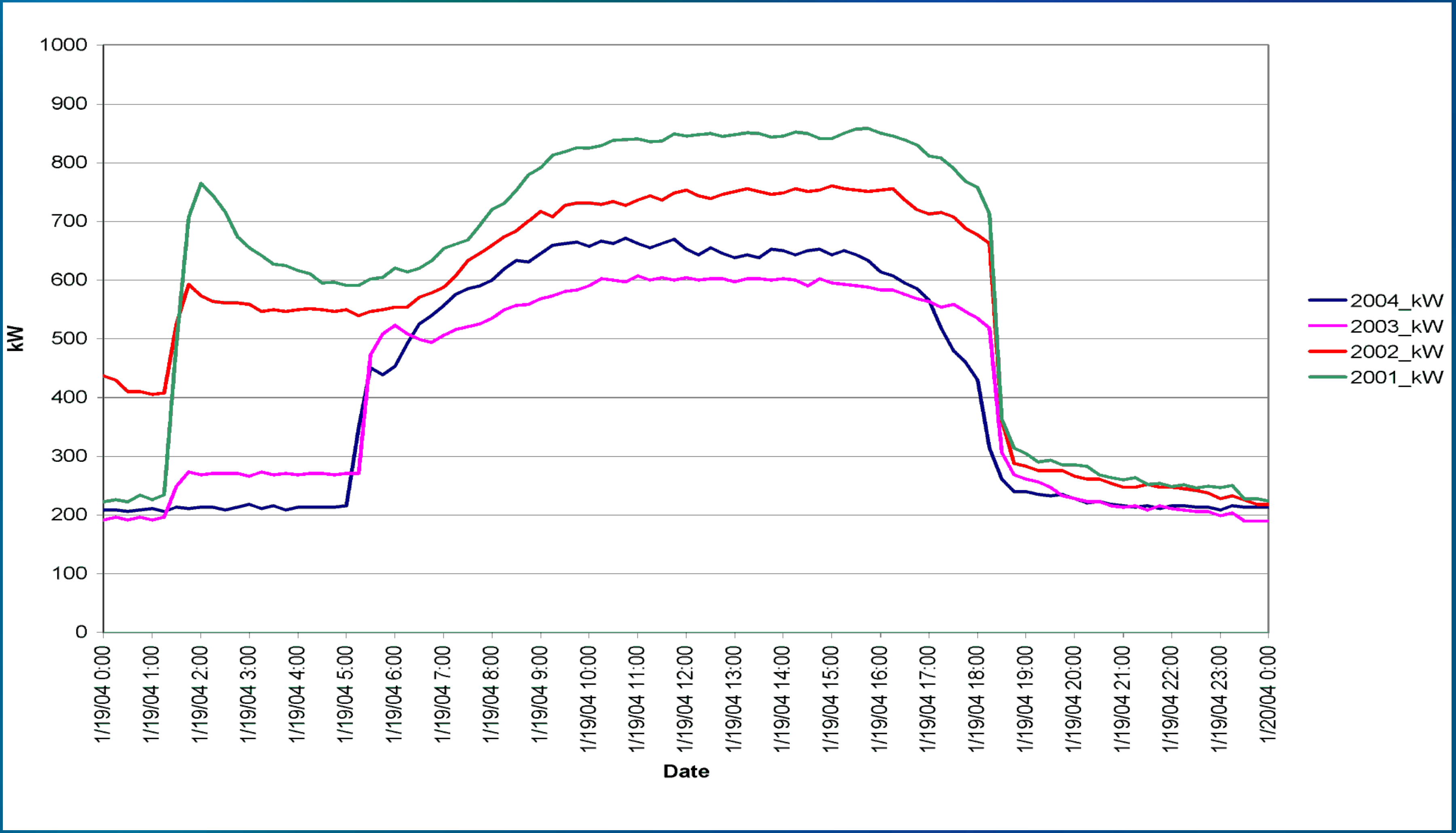
Friday Test: Please use daylight only



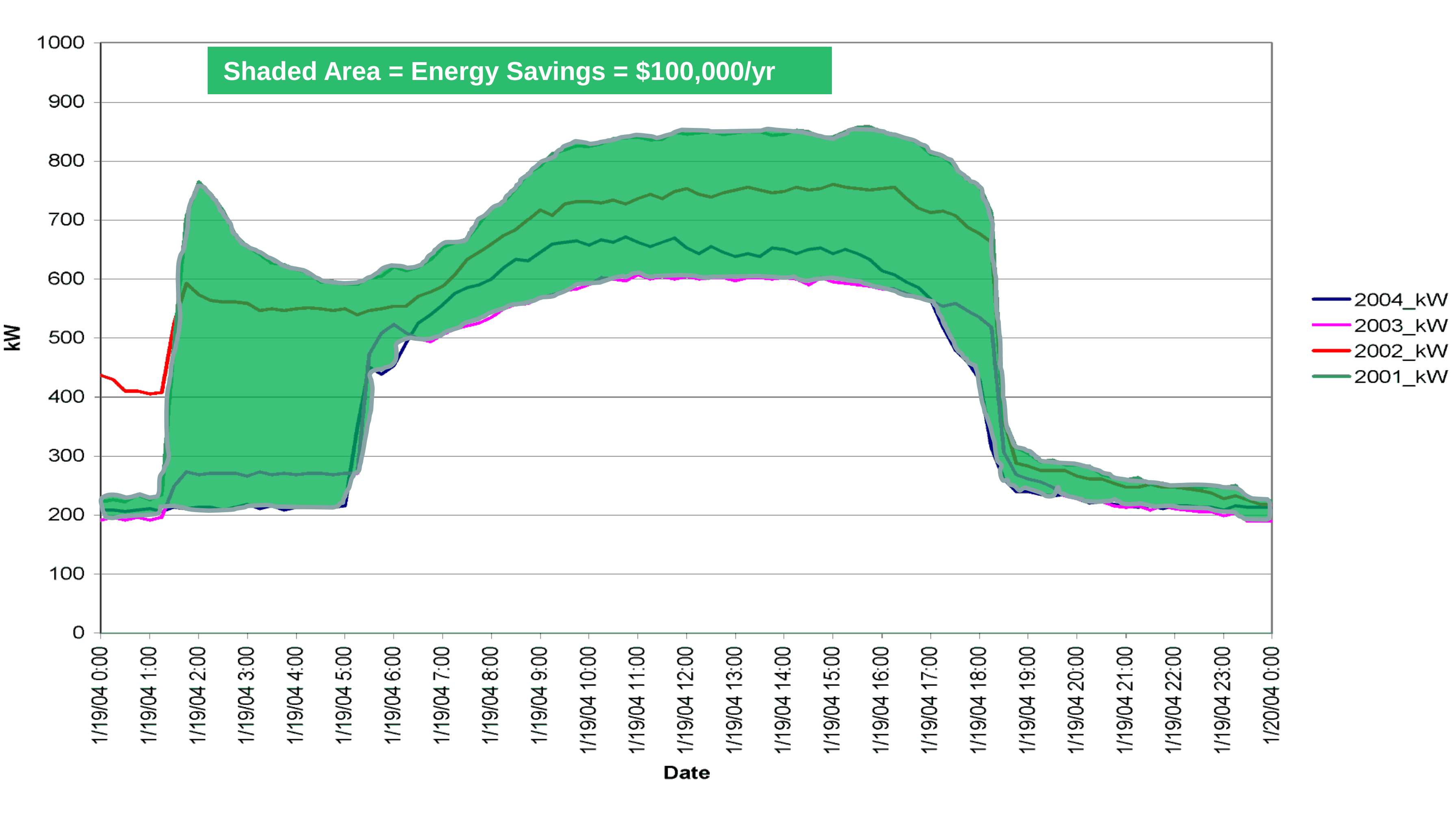

***30-day period 2007 versus 2006, more than <u>20%</u> energy savings!***

| 30 Days Time Period | Total Energy, kWh | Total energy M–F 8:30 to 3:30, kWh | Median Daily Maximum 30-Min Demand, kW |
|---|---|---|---|
| 4/20/2006–5/19/2006 | 24,690 | 11,130 | 93.5 |
| 4/19/2007–5/18/2007 | 19,000 | 9300 | 81.5 |

# Honolulu Office Building: Before and After



# Honolulu Office Building: Before and After



# What We Did

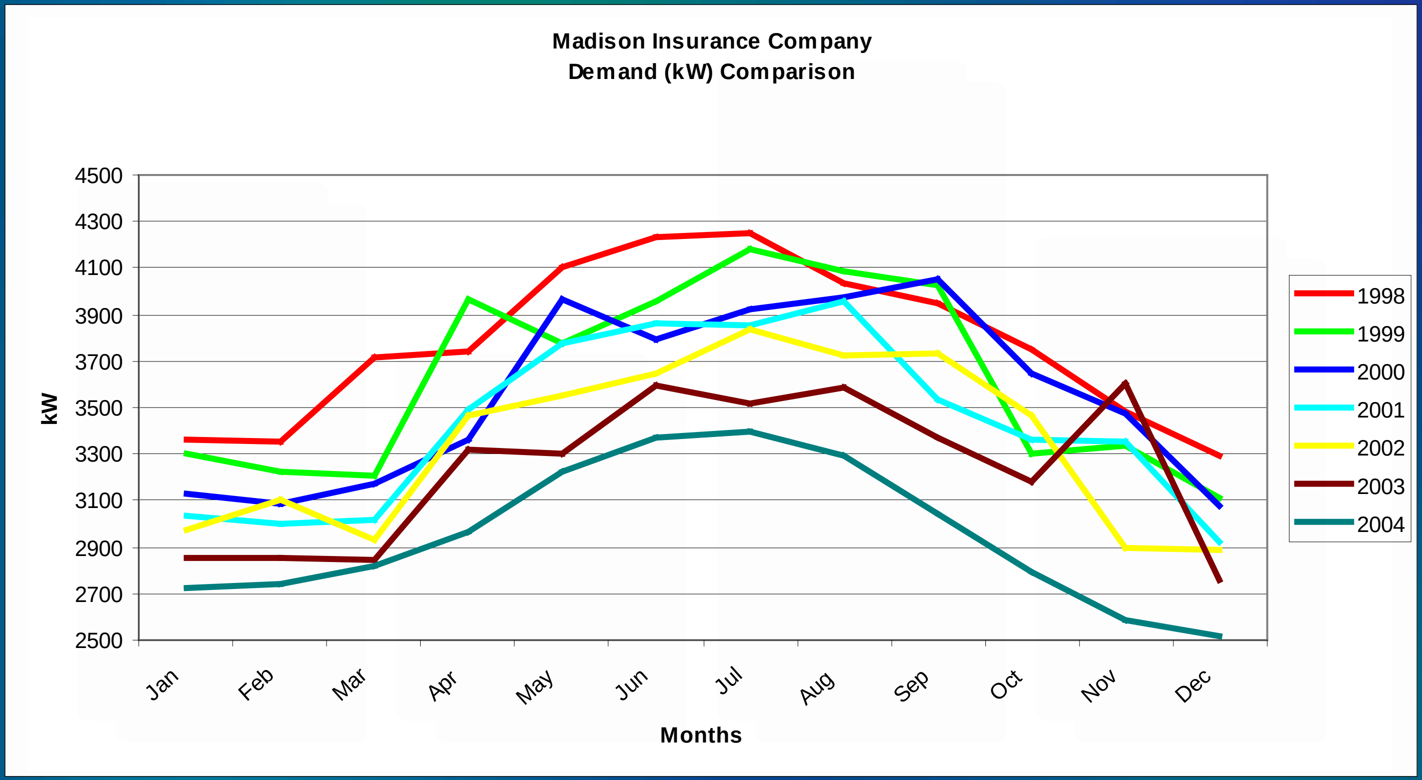
- Operational changes—matched schedules to occupancy
- Capital—more efficient chillers, pumps, towers; new building automation system to integrate equipment operation
- Cost of changes paid back in five years from savings

# Honolulu Office Building: Energy Management Results


- 20% energy savings
- Savings per year:
  - $100K
  - 750 tons carbon dioxide ($CO_2$)
  - 2.3 tons nitrogen oxide ($No_x$)
  - 2.0 tons sulfur dioxide ($SO_2$)

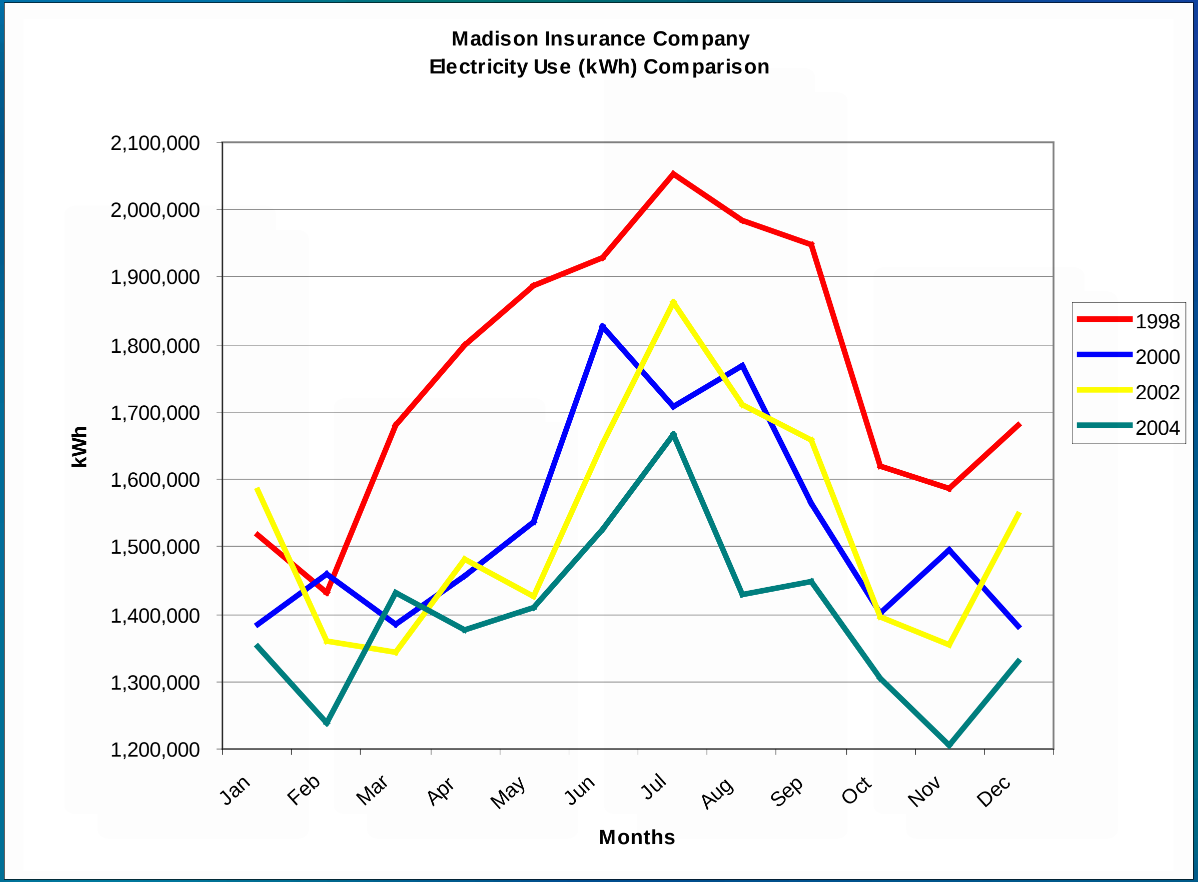
# Madison Insurance Company

# 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** |

# 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!

# Madison Insurance Company

- Operations changes: matched energy use to occupancy and needs
  - Reduced fan energy
  - Reduced pump energy
  - Reduced lighting energy
- Capital upgrade: lighting retrofit

# GSA Energy Management Program: The Rest of the Story

U.S. courthouse

Jacksonville, Florida

Energy improvements

DOE-ORNL Report

# 2000s New Building Performance

| | Actual | Target |
|---|---|---|
| Floor Area  ft² (m²) | 492,000 (45,710) | 492,000 (45,710) |
| EUI (kBTU/ft²/year) | 83 😓 | 52 |
| Energy Star Rating | 41 😓 | 75 |
| Cost ($k/year) | 632 😓 | 407 |
| EUI (kWh/m²/year) | 262 | 164 |

**Far less efficient than design intent**

# EEMs Implemented

- VAV minimum settings reduced to 10%
- Boilers turned off in summer
- AHU duct static pressure set points reduced from 375 Pa to 175 Pa

# Results of Control Modifications

| | Original | Target | New |
|---|---|---|---|
| Floor Area ft² (m²) | 492,000 | 492,000 | 492,000(45,710) |
| EUI (kBtu/ft²/year) | 83 😪 | 52 | 45 |
| Energy Star Rating | 41 😪 | 75 | 79 |
| Cost ($k/year) | 632 😪 | 407 | 377 |
| EUI (kWh/m²/year) | 262 | 164 | 142 |

- Energy Savings: 18.7 trillion Btu/year
- Energy Savings: 5,480.4 GWh
- Cost savings: Over $200,000/year

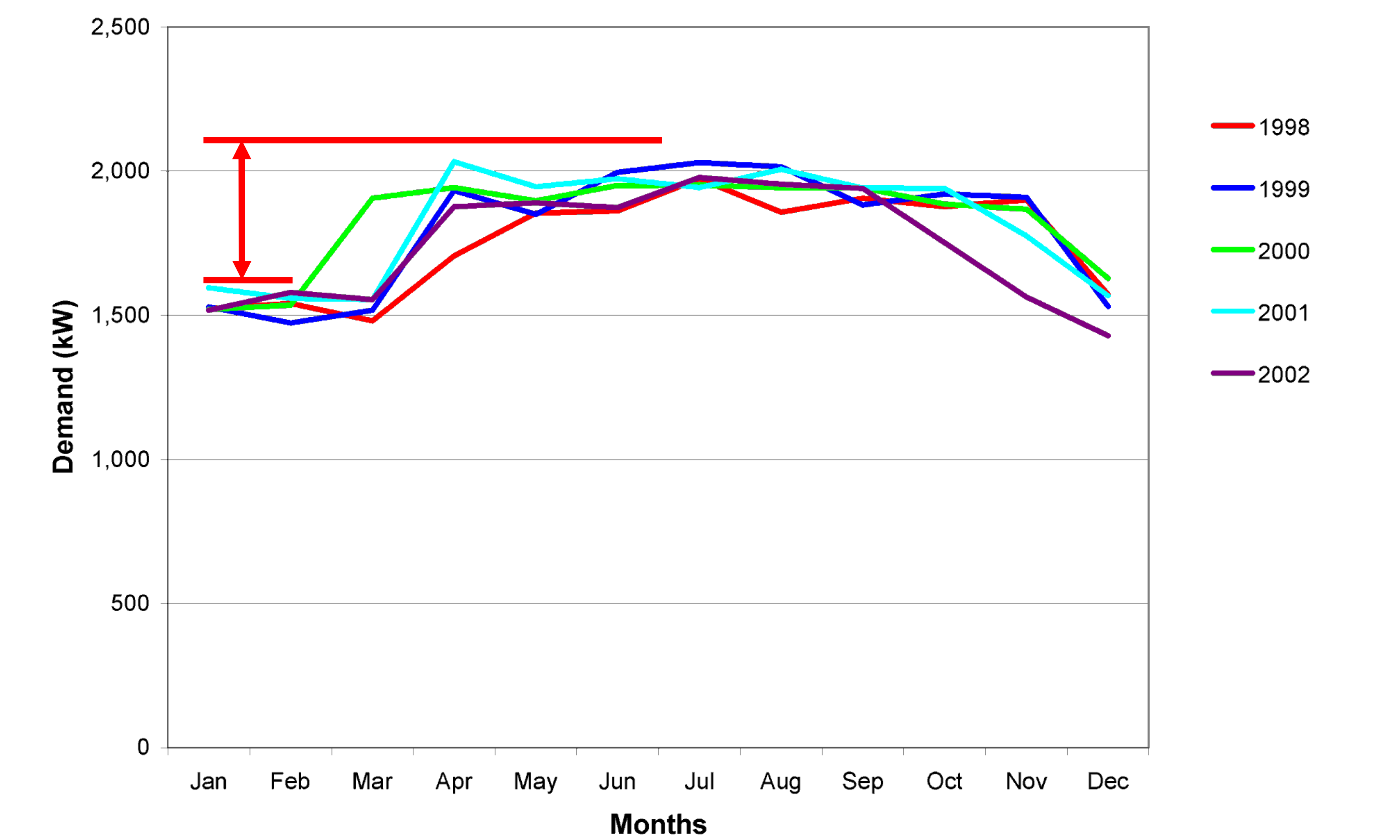
ENERGY STAR plaque is now in the lobby!

# Downtown Chicago ENERGY STAR Building

Uninsulated concrete, single-pane glass

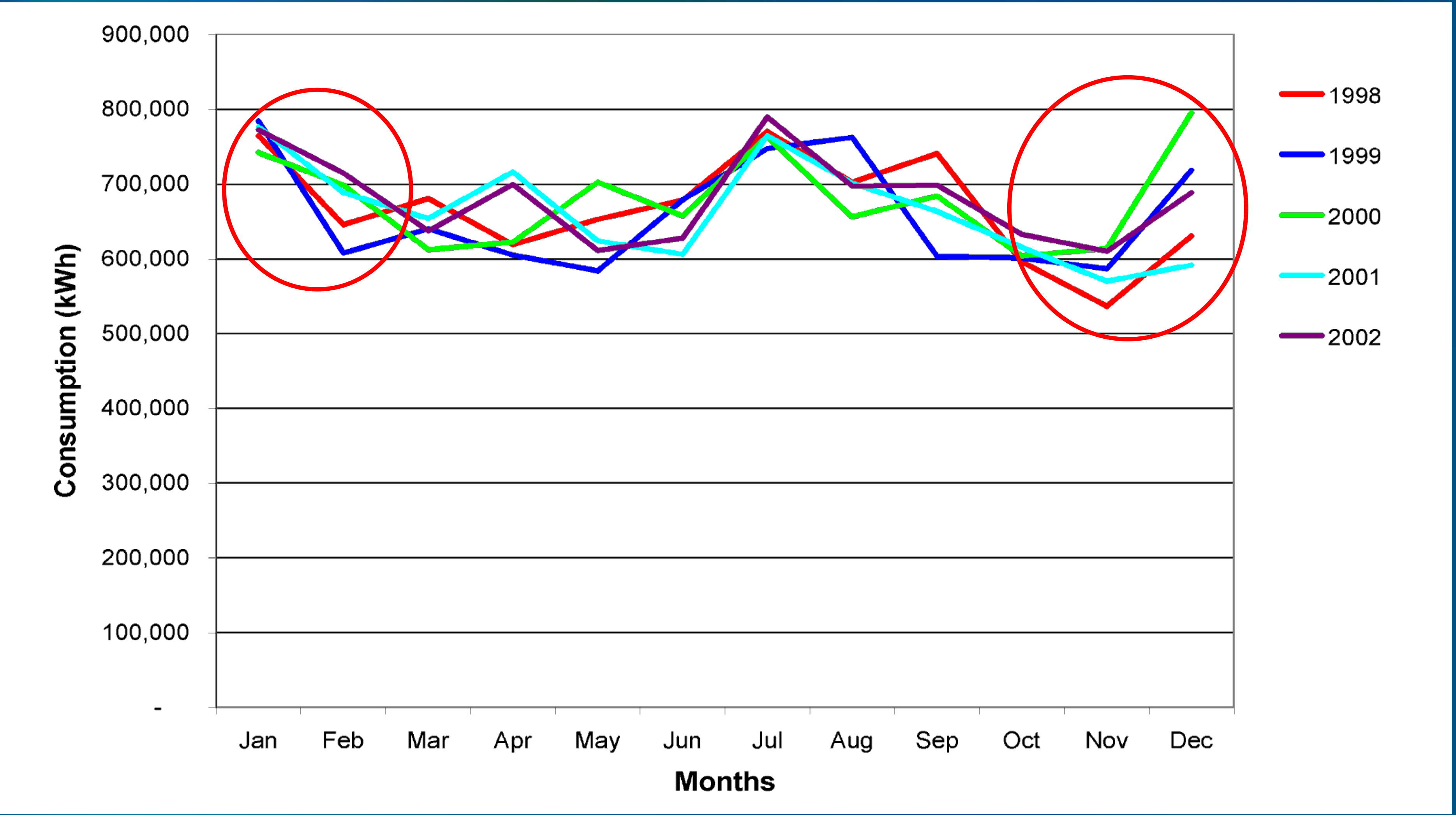
# Madison Bank

# Annual Profile of Monthly Peaks, kW



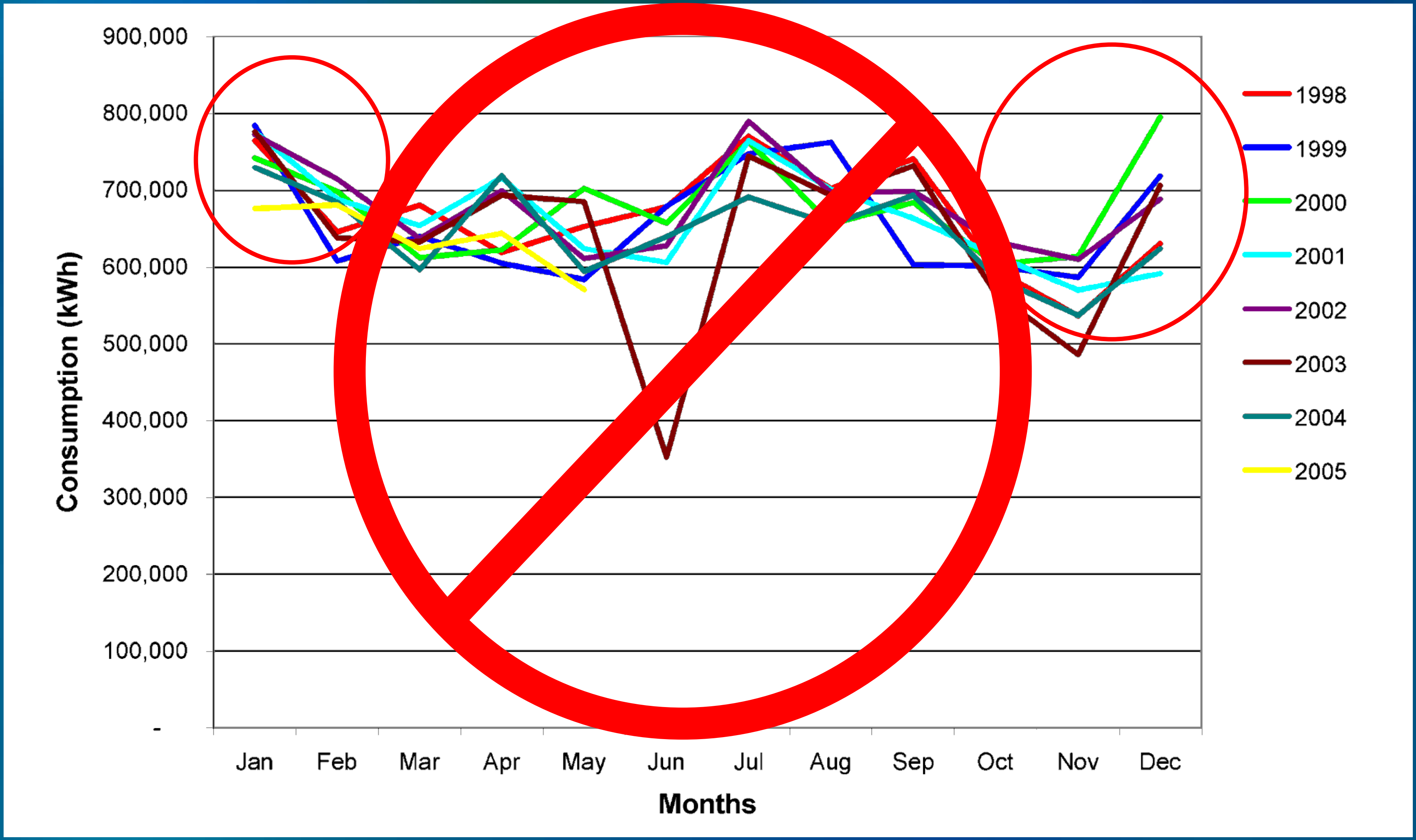

Chillers add 500 kW in summer

# Annual Profile of Monthly kWh




Fans waste energy in winter!

# Evaluate Progress Three Years Later



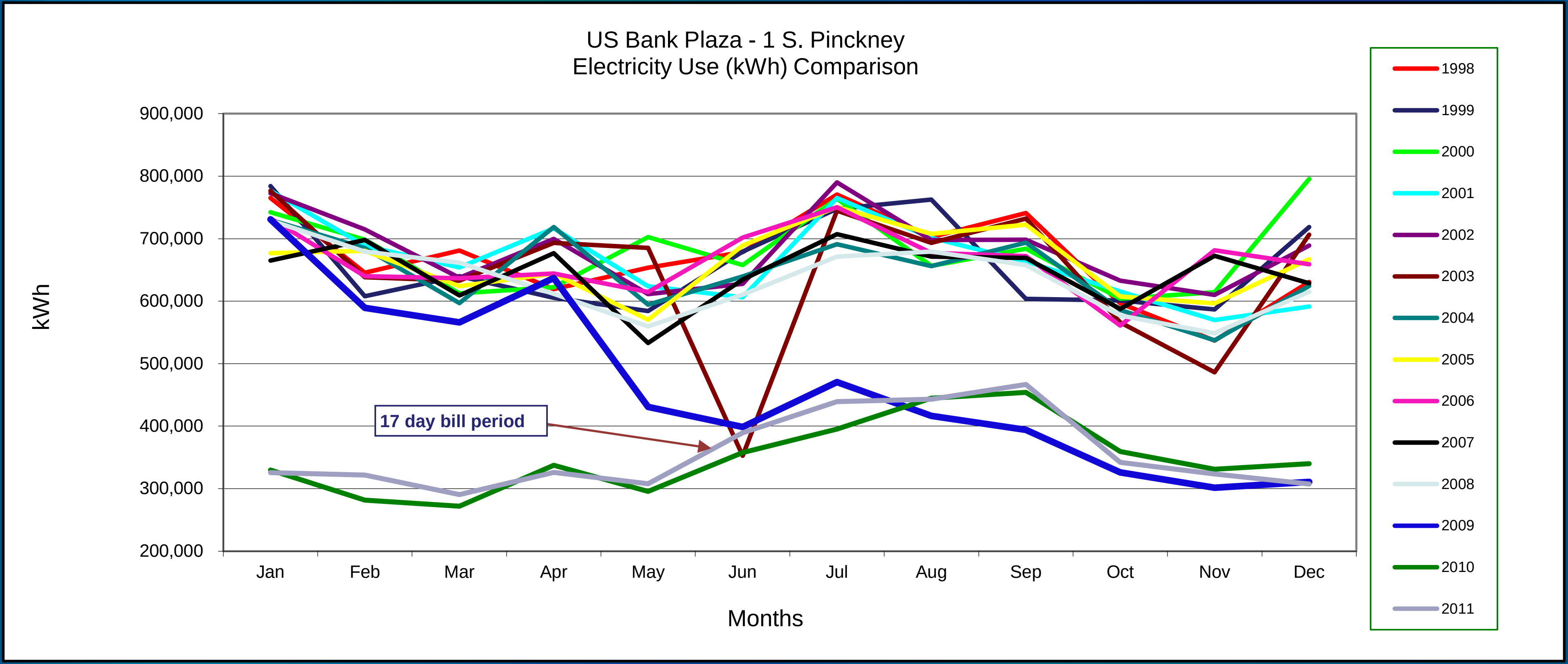

**Energy management did not work !**

# Explanation of No 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**

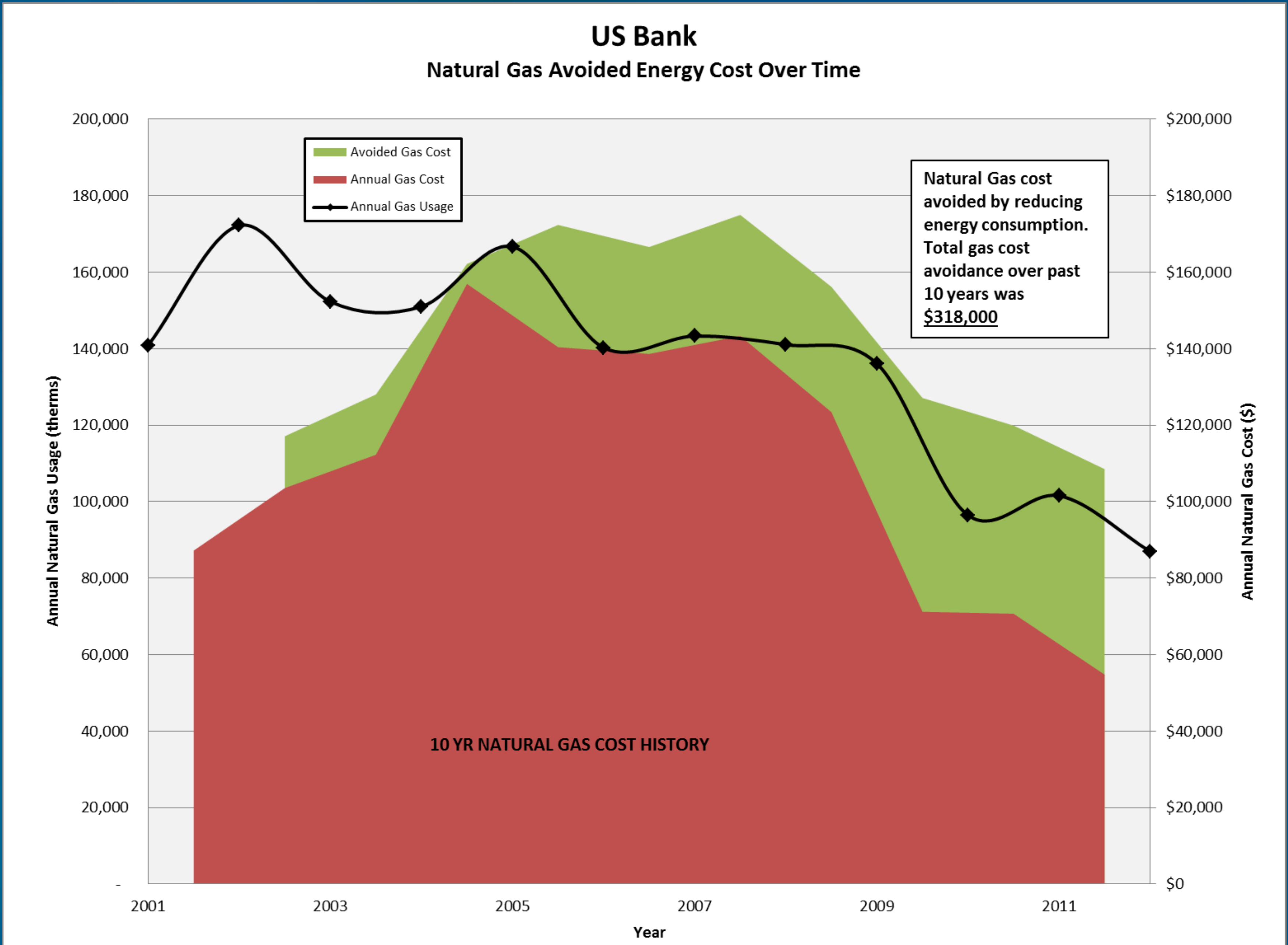
# But Things Have Changed!




August 2010: New tenants include 1,020 m$^2$ restaurant

# U.S. Bank Gas Utility Analysis

| Year | Gas Usage, therms | Gas Cost, $ | Gas Rate, $/therm |
|---|---|---|---|
| 2002 | 172,220 (18,169210 MJ) | $87,236 | $0.51 ($0.005) |
| 2011 | 101,556 (10,714,158 MJ) | $70,713 | $0.70 ($0.0065) |
| Reduction | 70,664 (41%) (7,455,052 MJ) | $16,523 (19%) | +$0.19 |

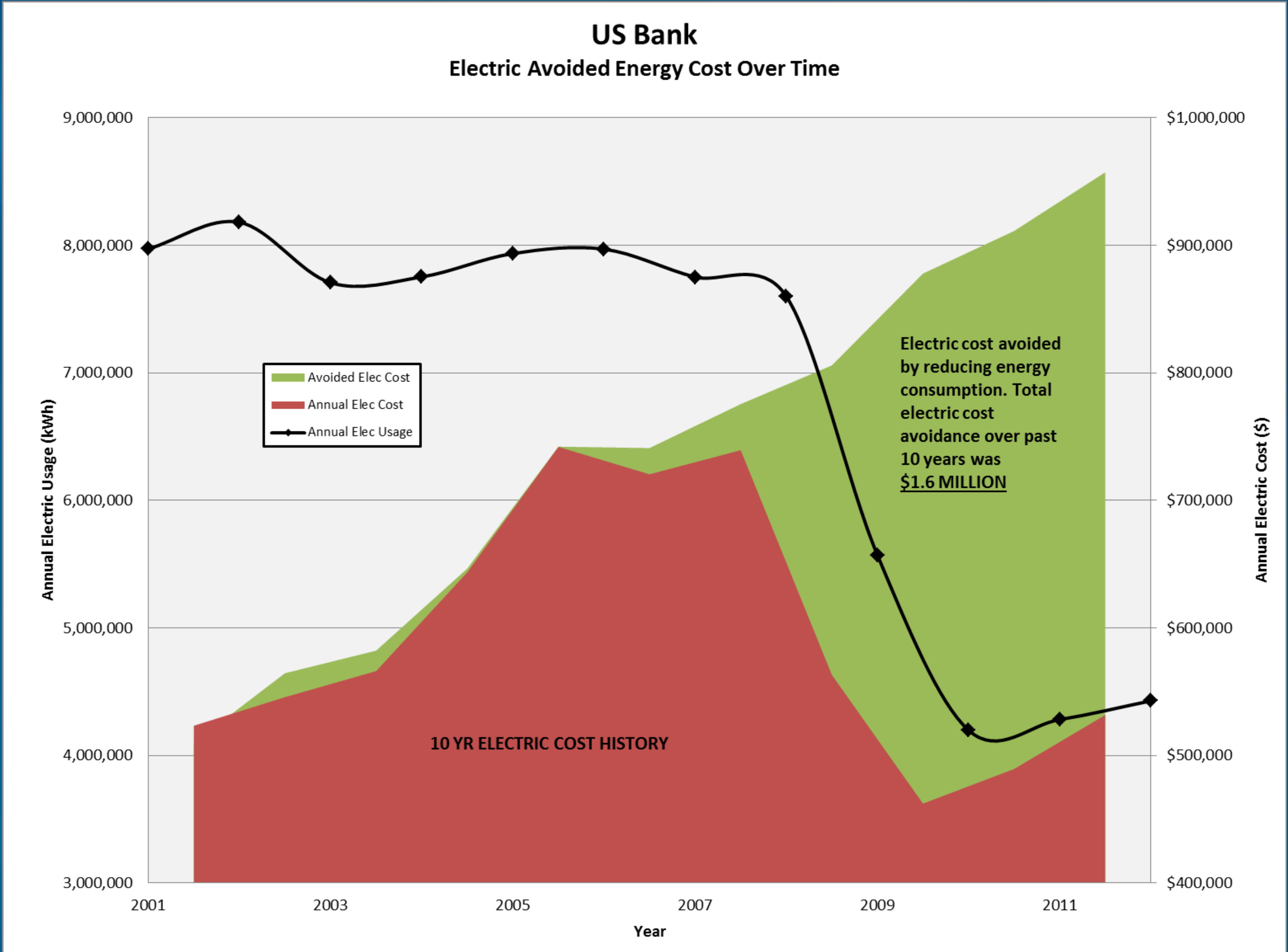

US Bank
Natural Gas Avoided Energy Cost Over Time
Avoided Gas Cost
Annual Gas Cost
Annual Gas Usage
Natural Gas cost avoided by reducing energy consumption. Total gas cost avoidance over past 10 years was $318,000
10 YR NATURAL GAS COST HISTORY
Annual Natural Gas Usage (therms)
Annual Natural Gas Cost ($)
Year
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
$200,000
$180,000
$160,000
$140,000
$120,000
$100,000
$80,000
$60,000
$40,000
$20,000
$0
2001
2003
2005
2007
2009
2011

# US Bank Electric Utility Analysis

| Year | Electric Usage, kWh | Electric Cost, $ | Electric Rate, $/kWh |
|---|---|---|---|
| 2002 | 8,181,296 | $523,405 | $0.064 |
| 2011 | 4,282,613 | $489,521 | $0.114 |
| Reduction | 3,898,683 (48%) | $33,884 (6.5%) | +$0.05 |

# US Bank Electric Demand Analysis

| Year | Max Electric Demand, kW | Min Electric Demand, kW |
|---|---|---|
| 2002 | 1979 | 1430 |
| 2011 | 1433 | 724 |
| Reduction | 546 | 706 |


US Bank
Electric Avoided Energy Cost Over Time
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
Annual Electric Usage (kWh)
$1,000,000
$900,000
$800,000
$700,000
$600,000
$500,000
$400,000
Annual Electric Cost ($)
2001
2003
2005
2007
2009
2011
Year
Avoided Elec Cost
Annual Elec Cost
Annual Elec Usage
Electric cost avoided by reducing energy consumption. Total electric cost avoidance over past 10 years was $1.6 MILLION
10 YR ELECTRIC COST HISTORY

# US Bank Asset Value Example

**Using a 7.6% cap rate**

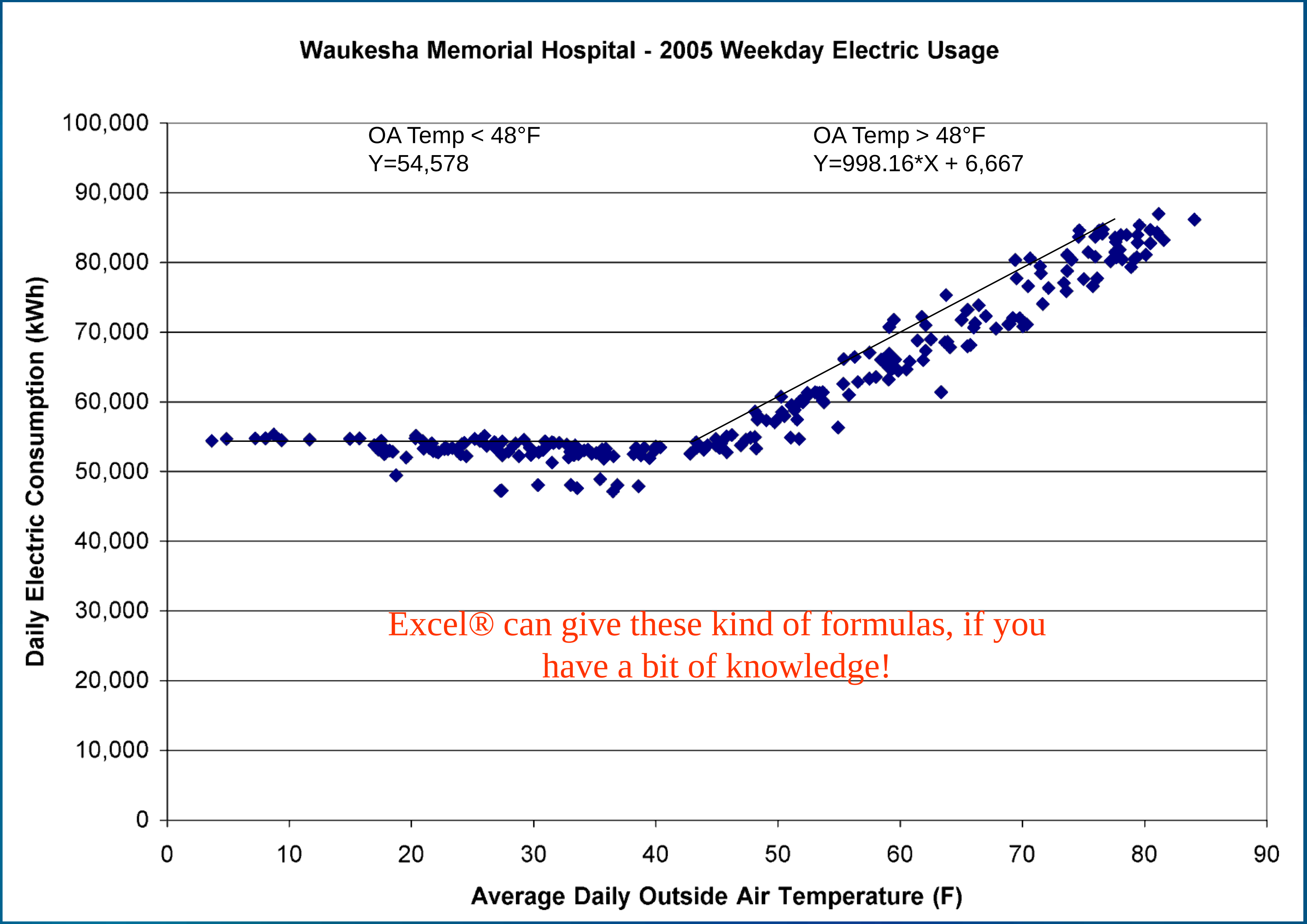
- 2002 costs minus 2011 costs
  Total Savings = $50,407
- $50,407 ÷ 0.076 (cap rate) =
  $663,250 increased asset value
- **Rates have increased in 9 years**
- Using 2011 rates for both 2002 and 2011 consumption
  Total Savings = $493,915
- $493,915 ÷ 0.076 (cap rate) =
  **$6,498,882 increased asset value**

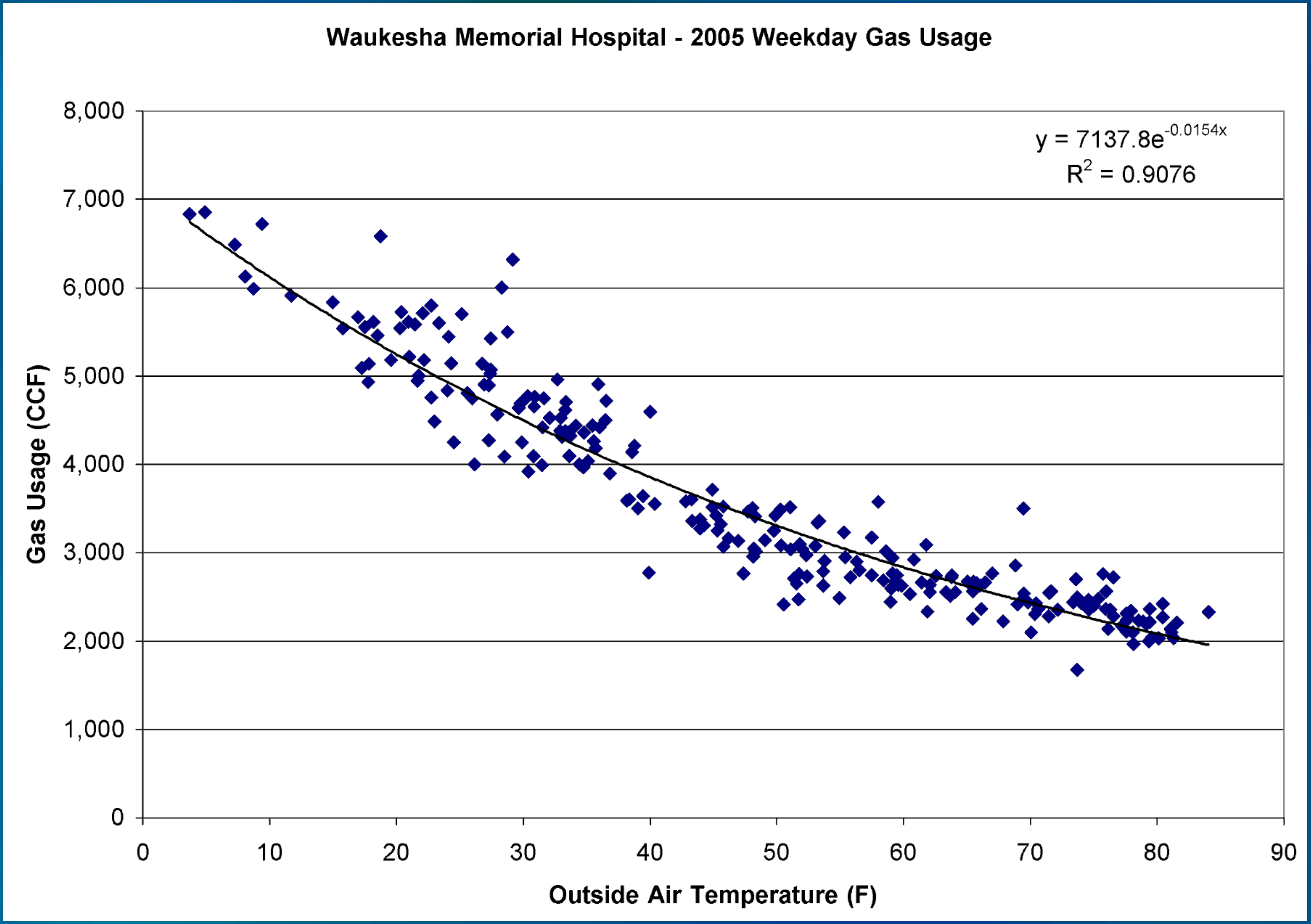
# Results of Pilot Project at Waukesha Memorial Hospital

- Collected 2005 utility information
  - 30-minute electric
  - Daily natural gas consumption
- Plotted daily consumption versus outdoor air temperature
  - Established a model of building with weather normalized
  - Weekend usage slightly different than weekday usage

# Daily Data: Results of Pilot Project at Waukesha Memorial Hospital

- $90,000 annual savings in natural gas use
- Adjustments to steam pressure and fine-tuning of burners on boilers—no capital!
- Data provided clues to changes in operations


Waukesha Memorial Hospital - 2005 Weekday Electric Usage
OA Temp < 48°F
Y=54,578
OA Temp > 48°F
Y=998.16*X + 6,667
Excel® can give these kind of formulas, if you have a bit of knowledge!
Daily Electric Consumption (kWh)
Average Daily Outside Air Temperature (F)
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
0
10
20
30
40
50
60
70
80
90


Waukesha Memorial Hospital - 2005 Weekday Gas Usage
y = 7137.8e^-0.0154x
R^2 = 0.9076
Gas Usage (CCF)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
0
10
20
30
40
50
60
70
80
90
Outside Air Temperature (F)

# Discretionary Operations Changes to Improve Gas Use

- Lowered steam pressure, in steps
  - Starting pressure was ~827 kPa
  - Tested reductions in steps of 69 kPa
  - Settled on new level: ~621 kPa
- Fine-tuned burners

# 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 | 48,960 | 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** |

# 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 | |

# Applying the Process

## Aurora Health Care—2009

- 17 facilities
- 650,320 m$^2$
- Each facility joined the Portfolio Manager® system
- President of Aurora Healthcare signed an ENERGY STAR commitment to reduce energy 12% in three years
- Each facility utilizes the spreadsheet and records energy consumption daily
- Monthly summaries distributed to all
- Monthly energy initiative meeting to share successful ideas

# Aurora Sinai Medical Center
# Daily Utility Tracking Spreadsheet

| Day | Outside Air | | Steam | | | Generators | | Electric | | | | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temp | Humidity | Calc. Usage | Actual Usage | Difference | Oil Usage | Load Shedding | Calc. Usage | Actual Usage | Total Usage | Difference | |
| | Deg F | % RH | 1000 lbs. | 1000 lbs. | % | Gals | kWh | kWh | kWh | kWh | % | |
| 11/1/2009 | 41.0 | 62.0 | 295 | 247 | 83.6 | | | 51,462 | 53,402 | 53,402 | 103.8 | |
| 11/2/2009 | 49.0 | 58.0 | 273 | 229 | 83.8 | | | 63,315 | 57,429 | 57,429 | 90.7 | |
| 11/3/2009 | 40.0 | 51.0 | 293 | 254 | 86.6 | | | 56,066 | 57,069 | 57,069 | 101.8 | |
| 11/4/2009 | 44.0 | 68.0 | 284 | 250 | 87.9 | | | 59,288 | 56,643 | 56,643 | 95.5 | |
| 11/5/2009 | 45.0 | 56.0 | 282 | 237 | 84.0 | | | 60,093 | 57,236 | 57,236 | 95.2 | |
| 11/6/2009 | 49.0 | 70.0 | 273 | 220 | 80.5 | | | 63,315 | 58,303 | 58,303 | 92.1 | |
| 11/7/2009 | 62.0 | 58.0 | 246 | 202 | 82.1 | | | 68,666 | 58,106 | 58,106 | 84.6 | |
| 11/8/2009 | 52.0 | 72.0 | 269 | 191 | 70.9 | | | 60,474 | 55,779 | 55,779 | 92.2 | |
| 11/9/2009 | 57.0 | 61.0 | 255 | 221 | 86.6 | | | 69,758 | 61,526 | 61,526 | 88.2 | |
| 11/10/2009 | 47.0 | 75.0 | 278 | 224 | 80.7 | | | 61,704 | 57,727 | 57,727 | 93.6 | |
| 11/11/2009 | 43.0 | 65.0 | 287 | 244 | 85.1 | | | 58,482 | 57,633 | 57,633 | 98.5 | |
| 11/12/2009 | 42.0 | 70.0 | 289 | 230 | 79.6 | | | 57,677 | 59,900 | 59,900 | 103.9 | |
| 11/13/2009 | 50.0 | 53.0 | 271 | 231 | 85.2 | | | 64,120 | 57,556 | 57,556 | 89.8 | |
| 11/14/2009 | 53.0 | 66.0 | 267 | 230 | 86.1 | | | 61,293 | 54,238 | 54,238 | 88.5 | |
| 11/15/2009 | 42.0 | 63.0 | 293 | 246 | 84.0 | | | 52,281 | 51,183 | 51,183 | 97.9 | |
| 11/16/2009 | 44.0 | 64.0 | 284 | 257 | 90.4 | | | 59,288 | 56,803 | 56,803 | 95.8 | |
| 11/17/2009 | 45.0 | 67.0 | 282 | 248 | 87.9 | | | 60,093 | 57,421 | 57,421 | 95.6 | |
| 11/18/2009 | 46.0 | 88.0 | 280 | 239 | 85.4 | | | 60,898 | 56,845 | 56,845 | 93.3 | |
| 11/19/2009 | 45.0 | 83.0 | 282 | 239 | 84.7 | | | 60,093 | 56,649 | 56,649 | 94.3 | |
| 11/20/2009 | 50.0 | 73.0 | 271 | 243 | 89.7 | | | 64,120 | 56,792 | 56,792 | 88.6 | |
| 11/21/2009 | 46.0 | 84.0 | 284 | 235 | 82.9 | | | 55,558 | 51,190 | 51,190 | 92.1 | |
| 11/22/2009 | 46.0 | 90.0 | 284 | 232 | 81.8 | | | 55,558 | 51,366 | 51,366 | 92.5 | |
| 11/23/2009 | 46.0 | 90.0 | 280 | 231 | 82.5 | | | 60,898 | 56,656 | 56,656 | 93.0 | |
| 11/24/2009 | 46.0 | 88.0 | 280 | 235 | 84.0 | | | 60,898 | 57,344 | 57,344 | 94.2 | |
| 11/25/2009 | 47.0 | 90.0 | 278 | 254 | 91.5 | | | 61,704 | 56,144 | 56,144 | 91.0 | |
| 11/26/2009 | 39.0 | 82.0 | 304 | 273 | 89.8 | | | 57,149 | 50,756 | 50,756 | 88.8 | |
| 11/27/2009 | 36.0 | 56.0 | 326 | 289 | 88.7 | | | 56,805 | 52,824 | 52,824 | 93.0 | |
| 11/28/2009 | 40.0 | 70.0 | 298 | 249 | 83.7 | | | 50,642 | 50,391 | 50,391 | 99.5 | |
| 11/29/2009 | 39.0 | 80.0 | 307 | 263 | 85.8 | | | 52,584 | 49,852 | 49,852 | 94.8 | |
| 11/30/2009 | 36.0 | 62.0 | 326 | 275 | 84.4 | | | 56,805 | 55,524 | 55,524 | 97.7 | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Total** | **45.6** | **70.5** | **8,521** | **7,218** | **84.7** | **0** | **0.0** | **1,781,085** | **1,670,287** | **1,670,287** | **93.8** | |

# Aurora Sinai Medical Center 2009 Utility Summary

| Day | Outside Air | | Steam | | | Generators | Electric | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Temp | Humidity | Calc. Usage | Actual Usage | Difference | Load Shedding | Calc. Usage | Actual Usage | Total Usage | Difference |
| | Deg F | % RH | 1000 lbs | 1000 lbs | % | kWh | kWh | kWh | kWh | % |
| January-09 | 16.5 | 63.3 | 14,447 | 14,436 | 99.9 | 0.0 | 1,649,628 | 1,704,820 | 1,704,820 | 103.3 |
| February-09 | 28.1 | 65.5 | 10,803 | 9,811 | 90.8 | 0.0 | 1,537,195 | 1,487,773 | 1,487,773 | 96.8 |
| March-09 | 36.4 | 63.8 | 10,357 | 10,101 | 97.5 | 0.0 | 1,756,208 | 1,628,481 | 1,628,481 | 92.7 |
| April-09 | 45.6 | 59.9 | 8,522 | 8,090 | 94.9 | 0.0 | 1,798,526 | 1,631,179 | 1,631,179 | 90.7 |
| May-09 | 57.8 | 58.2 | 7,886 | 7,246 | 91.9 | 0.0 | 2,129,761 | 1,953,022 | 1,953,022 | 91.7 |
| June-09 | 65.4 | 84.4 | 7,105 | 7,046 | 99.2 | 0.0 | 2,255,967 | 2,150,896 | 2,150,896 | 95.3 |
| July-09 | 69.0 | 62.5 | 7,093 | 6,880 | 97.0 | 0.0 | 2,421,150 | 2,261,776 | 2,261,776 | 93.4 |
| August-09 | 69.6 | 67.1 | 7,052 | 5,703 | 80.9 | 0.0 | 2,426,409 | 2,258,857 | 2,258,857 | 93.1 |
| September-09 | 64.3 | 71.9 | 7,179 | 5,103 | 71.1 | 0.0 | 2,229,347 | 2,049,718 | 2,049,718 | 91.9 |
| October-09 | 49.1 | 70.9 | 8,509 | 6,737 | 79.2 | 0.0 | 1,922,029 | 1,796,748 | 1,796,748 | 93.5 |
| November-09 | 45.6 | 70.5 | 8,521 | 7,218 | 84.7 | 0.0 | 1,781,085 | 1,670,287 | 1,670,287 | 93.8 |
| December-09 | 27.4 | 73.3 | 12,045 | 10,725 | 98.6 | 0.0 | 1,692,976 | 1,569,630 | 1,569,630 | 92.7 |
| | | | | | | | | | | |
| **Total** | **47.9** | **67.6** | **122,585** | **99,096** | **80.8** | **0.0** | **23,600,280** | **22,163,187** | **22,163,187** | **93.9** |

**Energy Savings:**

- 19% reduction in steam usage
- 6% reduction in electrical usage

# Aurora Health Care 2009–2012 Utility Summary

| Facility | Sq Ft | 2009-2012 Summary | | | | | |
|---|---|---|---|---|---|---|---|
| | | % | CO2 Reduction (lbs) | 2009 EUI (kBtu/ft²) | 2010 EUI (kBtu/ft²) | 2011 EUI (kBtu/ft²) | 2012 EUI (kBtu/ft²) |
| Sheboygan | 290,071 | 84.5% | 7,069,354 | 298.6 | 270.5 | 283.7 | 260.5 |
| Baycare Clinic | 610,716 | 94.1% | 5,205,605 | 273.6 | 258.1 | 261.7 | 246.3 |
| Hartford | 150,000 | 79.5% | 4,845,765 | 256.5 | 276.4 | 255.8 | 235.2 |
| Two Rivers | 183,500 | 83.6% | 5,565,232 | 267.2 | 265.5 | 249.3 | 221.6 |
| West Allis Memorial | 848,440 | 82.0% | 21,241,383 | 277.5 | 259.3 | 246.0 | 231.8 |
| Summit | 789,591 | 88.9% | 12,758,285 | N/A | N/A | 221.6 | 199.3 |
| St. Luke's South Shore | 360,555 | 80.9% | 11,321,748 | 242.8 | 227.6 | 216.6 | 202.1 |
| Burlington | 220,000 | 81.7% | 4,143,428 | 178.4 | 207.2 | 207.3 | 192.1 |
| Sinai Medical Center | 858,000 | 81.3% | 30,610,684 | 225.6 | 214.4 | 199.6 | 191.6 |
| St. Lukes ★ | 1,718,168 | 82.7% | 47,767,288 | 213.8 | 203.0 | 193.8 | 183.7 |
| Kenosha | 339,020 | 92.3% | 1,513,574 | N/A | N/A | 256.5 | 238.7 |
| Oshkosh ★ | 470,000 | 75.1% | 17,685,848 | 205.0 | 187.4 | 163.3 | 150.8 |
| Lakeland | 296,280 | 94.2% | (3,113,398) | 129.2 | 146.9 | 154.6 | 153.4 |
| | | | | | | | |
| Heil | 218,677 | 95.5% | 7,698,062 | 198.7 | 180.1 | 191.7 | 181.4 |
| Hospice | 31,200 | 77.5% | 745,255 | 204.0 | 193.5 | 190.9 | 162.6 |
| Corporate Building | 21,760 | 60.1% | 1,119,143 | 170.5 | 154.2 | 129.3 | 112.2 |
| Psychiatric Hospital | 206,074 | 86.8% | 155,646 | 91.8 | 85.5 | 88.9 | 76.7 |
| Forest Home ★ | 135,000 | 63.1% | 8,685,962 | 82.0 | 74.0 | 72.8 | 68.0 |
| | | | | | | | |
| **Total** | 7,747,052 | 85.2% | 185,018,863 | 227.8 | 205.6 | 196.8 | 182.4 |

★ **Achieved EnergyStar Award!**

Highlighted buildings are not acute care hospitals

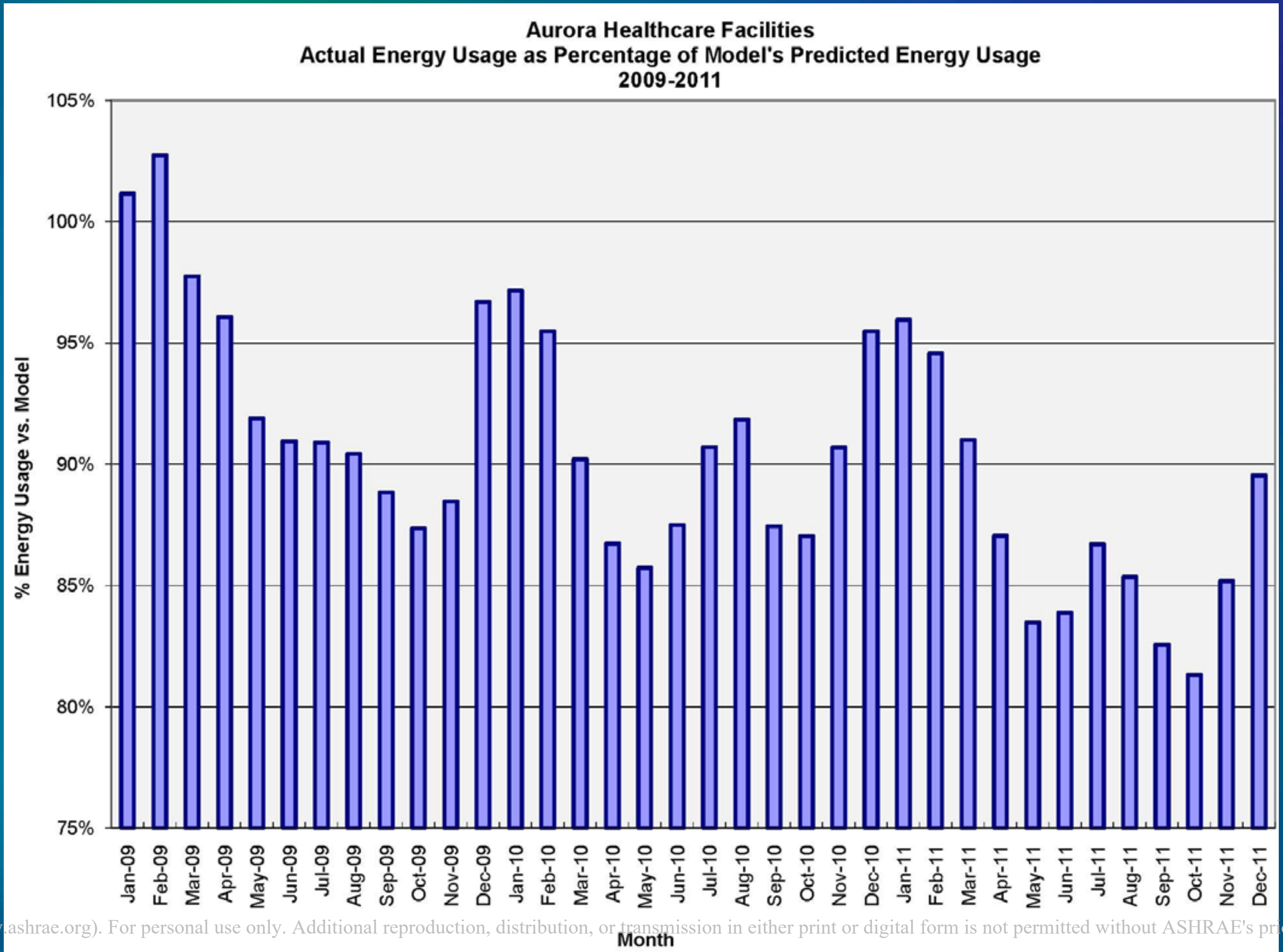
NEW

## Savings:

- 14.8% reduction in energy usage
- 92,509 tons reduction in $CO_2$ emissions

# Aurora Health Care 2009–2011

- 14.1% reduction in energy consumption
- 142.6 million pound (64,669 metric tons) reduction in $CO_2$
- Three facilities achieved ENERGY STAR



# Additional Energy Management Breakthroughs

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | 5/8/2012 | 60.0 | 65.0 | 189 | 177 | 93.8 | | | 62,486 | 61,239 | 61,239 | 98.0 | CHILLER #3 |
| 12 | 5/9/2012 | 51.0 | 79.0 | 214 | 205 | 95.9 | | | 56,625 | 57,051 | 57,051 | 100.8 | CHILLER #3 |
| 13 | 5/10/2012 | 52.0 | 64.0 | 211 | 201 | 95.5 | | | 57,276 | 58,815 | 58,815 | 102.7 | CHILLER #3 |
| 14 | 5/11/2012 | 63.0 | 42.0 | 182 | 188 | 103.2 | | | 64,439 | 63,091 | 63,091 | 97.9 | CHILLER #3 |
| 15 | 5/12/2012 | 63.0 | 64.0 | 179 | 200 | 111.7 | | | 59,474 | 58,277 | 58,277 | 98.0 | CHILLERS #1 & #3 |
| 16 | 5/13/2012 | 58.0 | 40.0 | 190 | 191 | [illegible] | | | 56,237 | 57,250 | 57,250 | 101.8 | CHILLERS #1 & #3 |
| 17 | 5/14/2012 | 66.0 | 31.0 | 176 | 189 | [illegible] | | | 66,393 | 64,286 | 64,286 | 96.8 | CHILLERS #1 & #3 |
| 18 | 5/15/2012 | 72.0 | 37.0 | 168 | 185 | [illegible] | | | 70,300 | 65,794 | 65,794 | 93.6 | CHILLERS #1 & #3 |
| 19 | 5/16/2012 | 52.0 | 55.0 | 211 | 194 | [illegible] | | | 57,276 | 59,808 | 59,808 | 104.4 | CHILLER #3 |
| 20 | 5/17/2012 | 54.0 | 60.0 | 205 | 184 | 90.0 | | | 58,579 | 59,359 | 59,359 | 101.3 | CHILLER #3 |
| 21 | 5/18/2012 | 65.0 | 52.0 | 178 | 183 | 102.6 | | | 65,741 | 63,080 | 63,080 | 96.0 | CHILLERS #1 & #3 |
| 22 | 5/19/2012 | 69.0 | 55.0 | 169 | 176 | 103.9 | | | 63,358 | 63,187 | 63,187 | 99.7 | CHILLERS #1 & #3 |
| 23 | 5/20/2012 | 78.0 | 49.0 | 161 | 178 | 110.6 | | | 69,185 | 66,113 | 66,113 | 95.6 | CHILLERS #1 & #3 |

FOUND STEAM LEAK ON CT-SF-U04 HEATING ISOLATION VALVE.

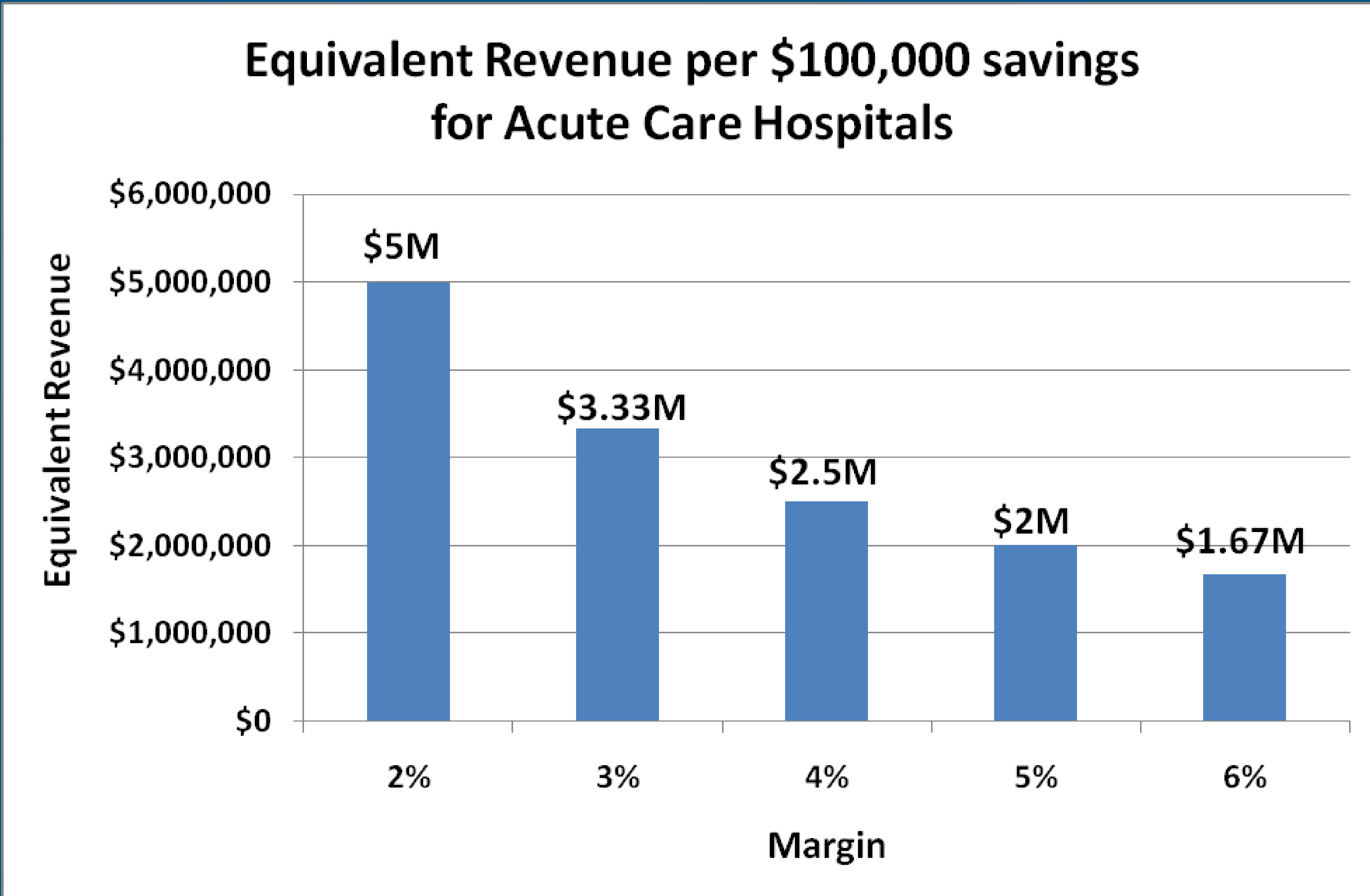
REPAIRED IN AFTERNOON.

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Day | Outside Air | | Steam | | | Generators | | Electric | | | |
| 2 | | Temp | Humidity | Calc. Usage | Actual Usage | Difference | Oil Usage | Load Shedding | Calc. Usage | Actual Usage | Total Usage | Difference |
| 3 | | Deg F | % RH | 1000 lbs | 1000 lbs | % | Gals | kWh | kWh | kWh | kWh | % |
| 4 | 2/1/2011 | 22.0 | 76.0 | 363 | 363 | 100.1 | | | 50,875 | 50,184 | 50,184 | 98.6 |
| 5 | 2/2/2011 | 21.0 | 71.0 | 368 | 366 | 99.4 | | | 50,893 | 46,611 | 46,611 | 91.6 |
| 6 | 2/3/2011 | 9.0 | 54.0 | [illegible] | [illegible] | 90.1 | | | 51,110 | 50,452 | 50,452 | 98.7 |
| 7 | 2/4/2011 | 16.0 | 60.0 | [illegible] | [illegible] | 90.8 | | | 50,984 | 50,147 | 50,147 | 98.4 |
| 8 | 2/5/2011 | 23.0 | 59.0 | [illegible] | [illegible] | 86.9 | | | 46,044 | 45,329 | 45,329 | 98.4 |
| 9 | 2/6/2011 | 28.0 | 83.0 | [illegible] | [illegible] | 88.0 | | | 45,826 | 44,917 | 44,917 | 98.0 |
| 10 | 2/7/2011 | 24.0 | 72.0 | 351 | 338 | 96.3 | | | 50,839 | 49,646 | 49,646 | 97.7 |
| 11 | 2/8/2011 | 14.0 | 61.0 | 412 | 428 | 104.0 | | | 51,020 | 50,604 | 50,604 | 99.2 |
| 12 | 2/9/2011 | 8.0 | 50.0 | 452 | 477 | 105.5 | | | 51,128 | 50,684 | 50,684 | 99.1 |
| 13 | 2/10/2011 | [illegible] | [illegible] | [illegible] | [illegible] | 93.3 | | | 51,201 | 50,883 | 50,883 | 99.4 |
| 14 | 2/11/2011 | [illegible] | [illegible] | [illegible] | [illegible] | 90.9 | | | 51,038 | 50,955 | 50,955 | 99.8 |
| 15 | 2/12/2011 | [illegible] | [illegible] | [illegible] | [illegible] | 89.8 | | | 45,783 | 46,469 | 46,469 | 101.5 |
| 16 | 2/13/2011 | [illegible] | [illegible] | [illegible] | [illegible] | 89.5 | | | 47,342 | 45,448 | 45,448 | 96.0 |
| 17 | 2/14/2011 | 38.0 | 58.0 | 282 | 281 | 99.7 | | | 52,554 | 50,387 | 50,387 | 95.9 |
| 18 | 2/15/2011 | 31.0 | 72.0 | 314 | 266 | 84.7 | | | 50,712 | 51,350 | 51,350 | 101.3 |

FOUND F/B DAMPER ISSUES ON CT-SF-U01 THRU CT-SF-U05

FOUND STEAM LEAKS ON CT-SF-U02 HTG COIL & ON CT-SF-U05 VACUUM BREAKER (VACUUM BREAKER WAS REPLACED 02/10/2011)

# BREAK!




Source: Corporate Realty, Design & Management Institute.

# Aurora Health Care Equivalent Revenue (Using a 4% Margin)

- 2009–2012 Total Energy Savings (weather-normalized)

  Total Savings = $8,665,000

- $8,665,000 ÷ 0.04 (margin) =

  $216,625,000 equivalent revenue

- **$216,625,000** ÷ 4 years =

  **$54,156,250 Equivalent Revenue per Year**

# Energy Management Strategies Taken

- Chiller operations
- HW reset schedules
- Run schedules (occupied/unoccupied, day/night, summer/winter)
- DA temperature reset schedules
- Steam pressures
- Installation of variable-speed drives
- Steam trap survey
- Shutting off air handling units in unoccupied areas
- Maintaining modified space temperatures
- Promoting the energy message at department meetings

# Outdoor Air Temperature Data Sources

| Sources | Barriers to Use |
| --- | --- |
| Outdoor air sensors—BAS | Extracting data; maintenance of sensors; data quality |
| Stand-alone temperature sensors | Extracting data; maintenance of sensors; data quality |
| NOAA data (public domain)<br><br>https://gis.ncdc.noaa.gov/maps/ncei#app=cdo | No cost for simple searches; cumbersome to access multiple locations |
| Weather data services | Fee for access to comprehensive database |
| Weather Underground<br>https://www.wunderground.com/history/ | No cost for searches; long time periods require multiple searches |

# Exercise 10: Weather Normalization

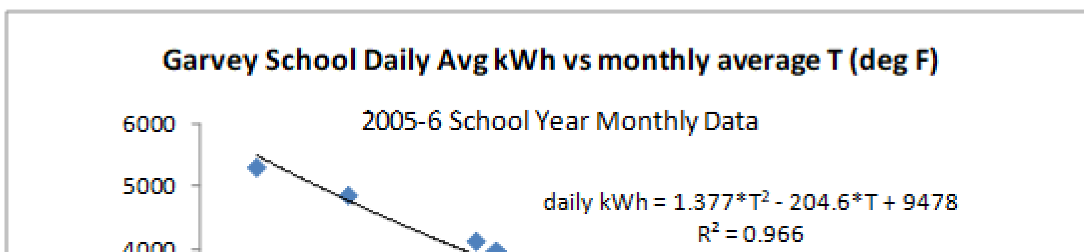
Page 31 in the exercises

### Exercise 10A: Weather Normalization

**Part 1:** We introduced Garvey School, an elementary school in Chicago, earlier in the seminar when we discussed Portfolio Manager. It is an “all-electric” school, built in 1968.

The graph shows the relationship between average monthly temperature and average daily electricity use, based on 12 monthly utility bills for the school year 2005-6 (baseline year). Daily temperature data were obtained from the O'Hare Airport weather station.

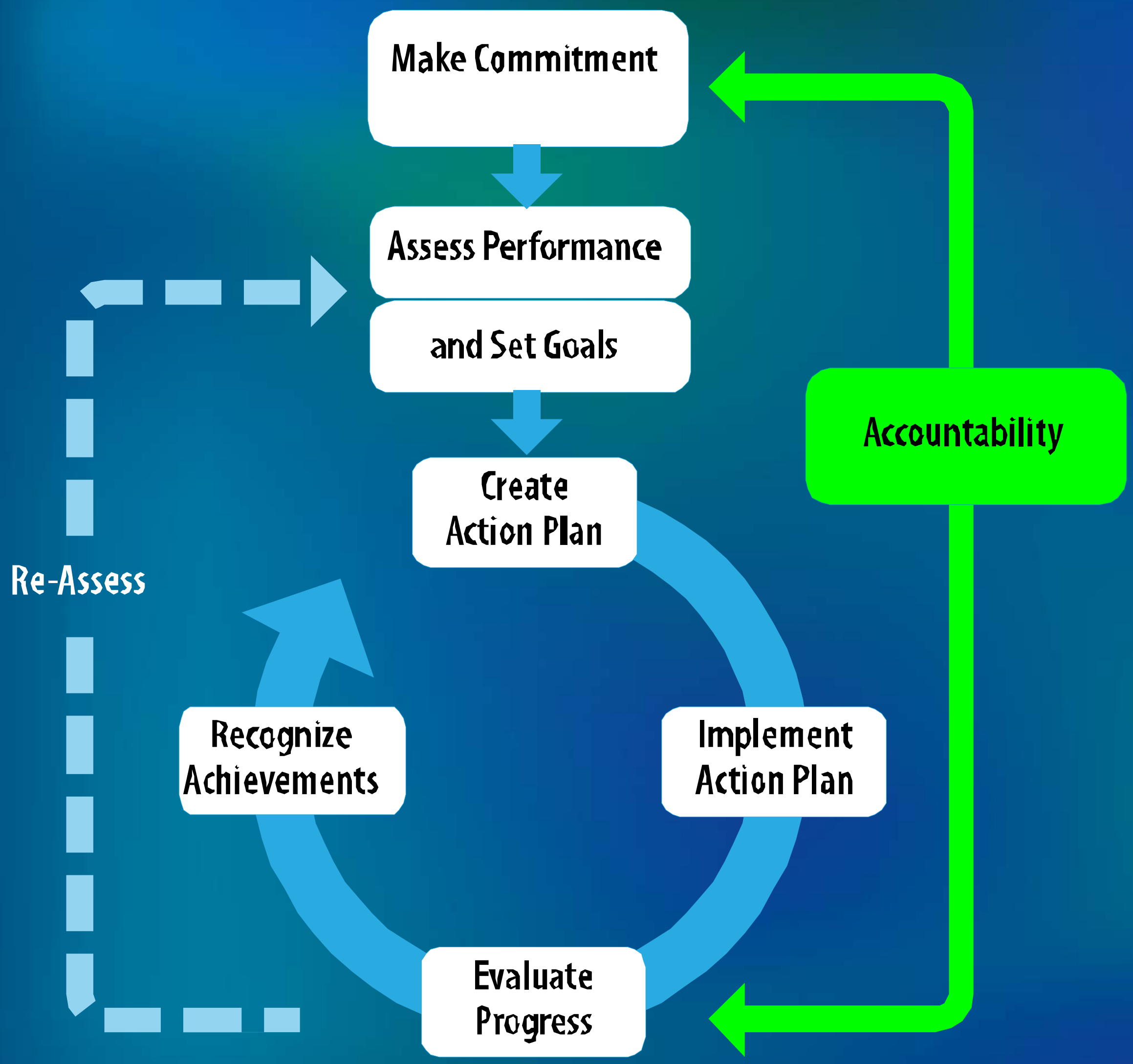
Excel® generated the equation relating daily kWh to average monthly temperature. (See notes below on the Excel command details).




Exercise includes short tutorial on generating graph and equation using Excel®

# Energy Management: Accountability Revisited

# Accountability




**A person is accountable; a department or building can't be!**

# Lowell Hall Facility—What's Missing?

**Space Use** Add Space

| Space Name | Space Type | Floor Area (Sq. Ft.) | % Floor Area | Alerts | |
|---|---|---|---|---|---|
| Lodging | Hotel | 88,949 | 76 | | Delete Space |
| Staff Offices | Office | 28,634 | 24 | | Delete Space |
| Total | | 117,583 | 100 | | |

Because more than 50% of your building is Hotel, your building is designated as Hotel within Portfolio Manager. This building may be eligible for a rating (Click to learn more). If you can see a rating for this building, please note that the rating takes into account all of the space types you have listed. If you cannot see a rating for this building, you can be compared to the national average for Hotel (Click to learn more).

Due to rounding, the % Floor Area Total may not always equal 100%.

**Energy Meters** Add Meter | Update Multiple Meters | View All Meter Data in Excel

| Meter Name | Energy Type | Space(s) | Last Meter Entry (End Date) | Alerts | Read/Write Access | |
|---|---|---|---|---|---|---|
| Electricity | Electricity - Grid Purchase (kWh (thousand Watt-hours)) | Entire Facility | 05/15/2012 | Data > 120 days old. more | | Delete Meter |
| Gas | Natural Gas (therms) | Entire Facility | 05/14/2012 | Data > 120 days old. more | | Delete Meter |

The energy meters for this facility quantify whole facility energy consumption. This consumption total includes all common and tenant spaces in the facility. (Change Metering Configuration)

**General Facility Administration**

Track Energy Performance Improvements
Delete this Facility from Portfolio Manager
Contact us

**Sharing Data**

Add user to share this Facility
Modify list of users
Transfer Facility to another user
View entire Access List for this Facility

**Applying for the ENERGY STAR**

Apply for the ENERGY STAR
View status of ENERGY STAR Applications

**Building Profiles**

A building Profile can be created when an ENERGY STAR label application is submitted

# Facility Upgrades

| Change | When |
|---|---|
| Efficient central water chiller | Summer 1995 |
| Lighting upgrade (T8, elec ballasts) | Spring 1996 |
| Cooling tower replacement | Spring 2000 |
| Building automation controls | Spring 2000 |
| Heating water pumps modification to AHU | Summer 2003 |
| Remodel of lobby, HVAC upgrade | Summer 2006 |

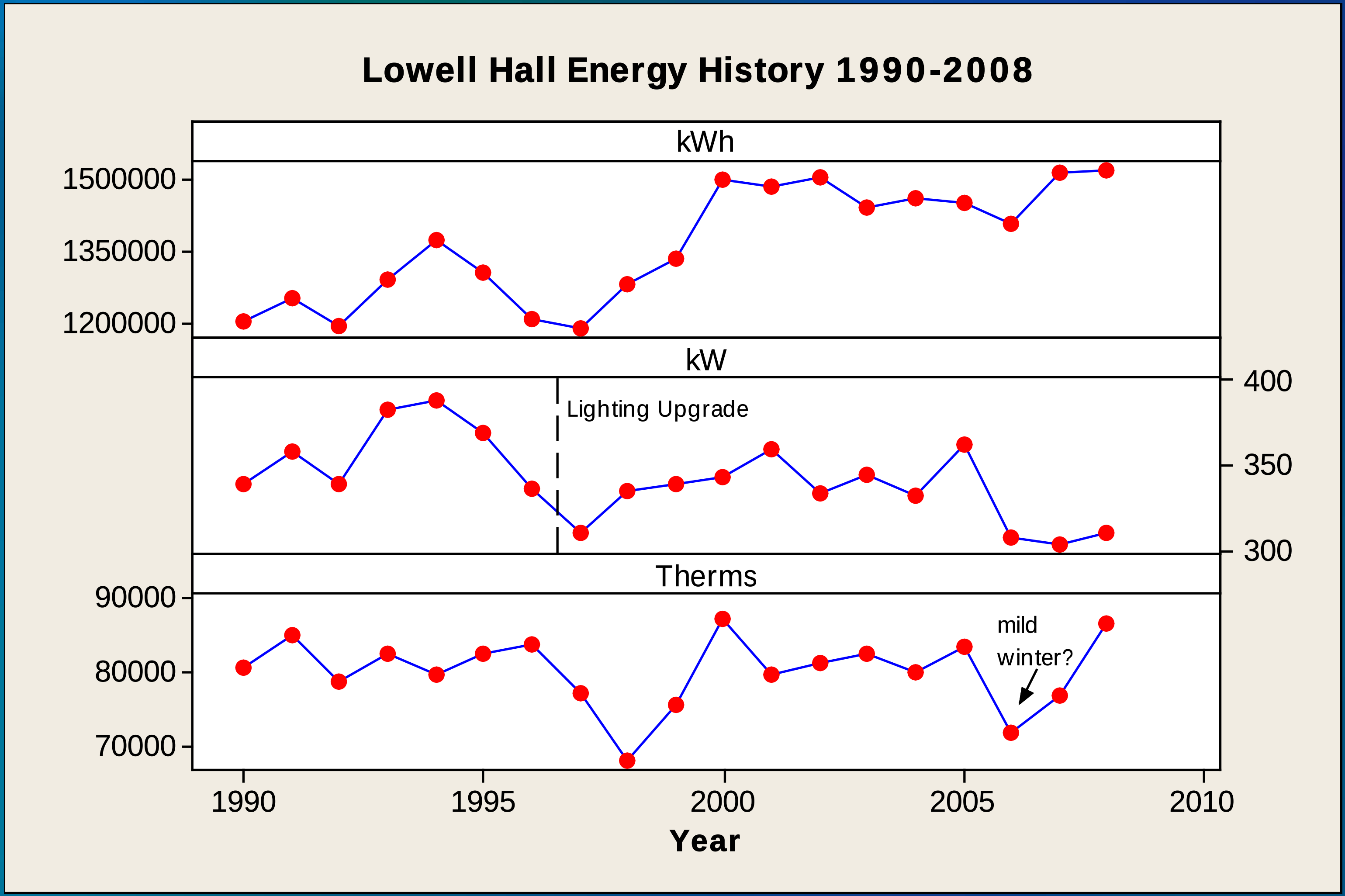
# Lowell Hall Energy Performance

**Facility Performance** Set Baseline Periods | Set Energy Performance Target

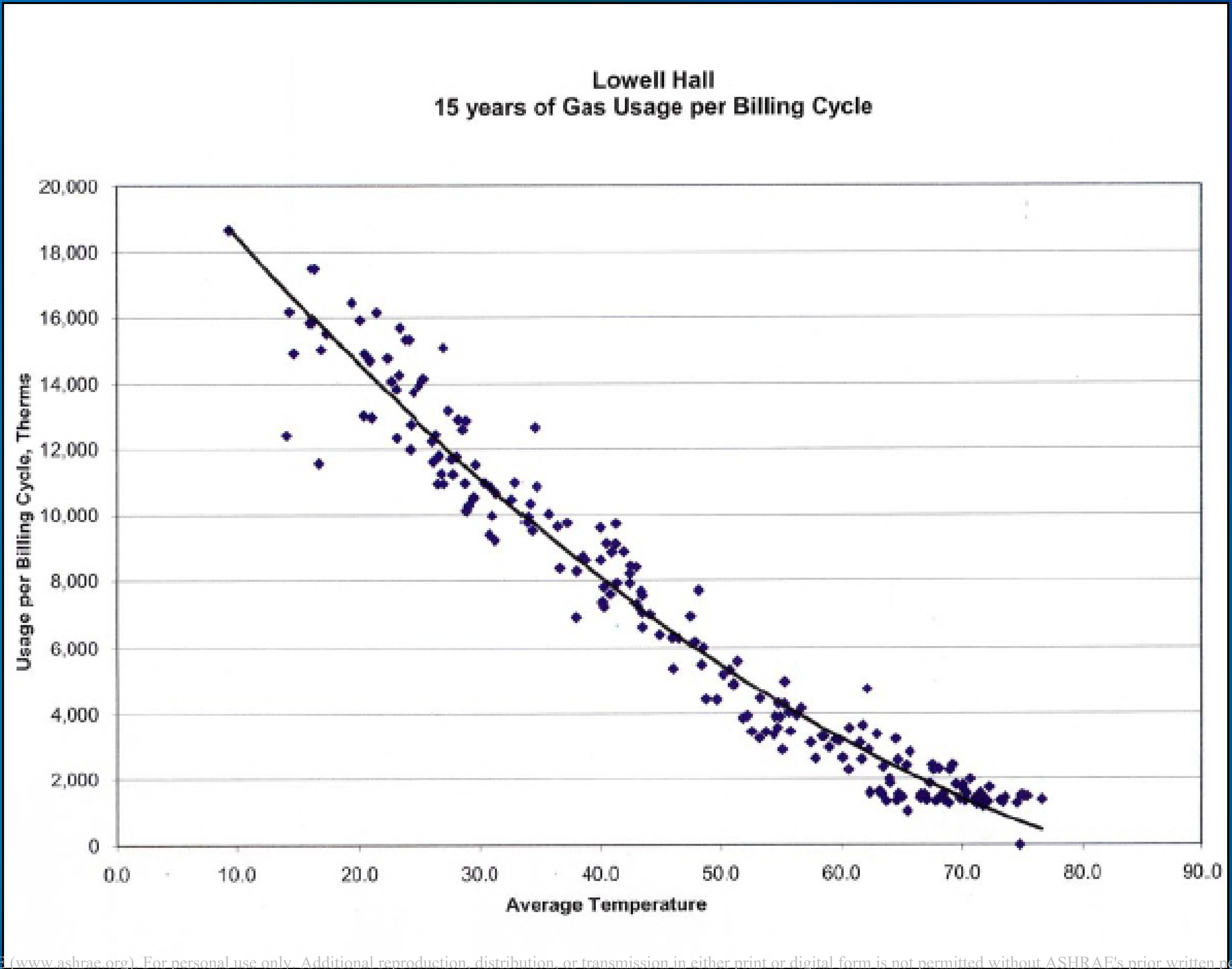
**Select View:** Summary: Energy Use — Create View | Edit View

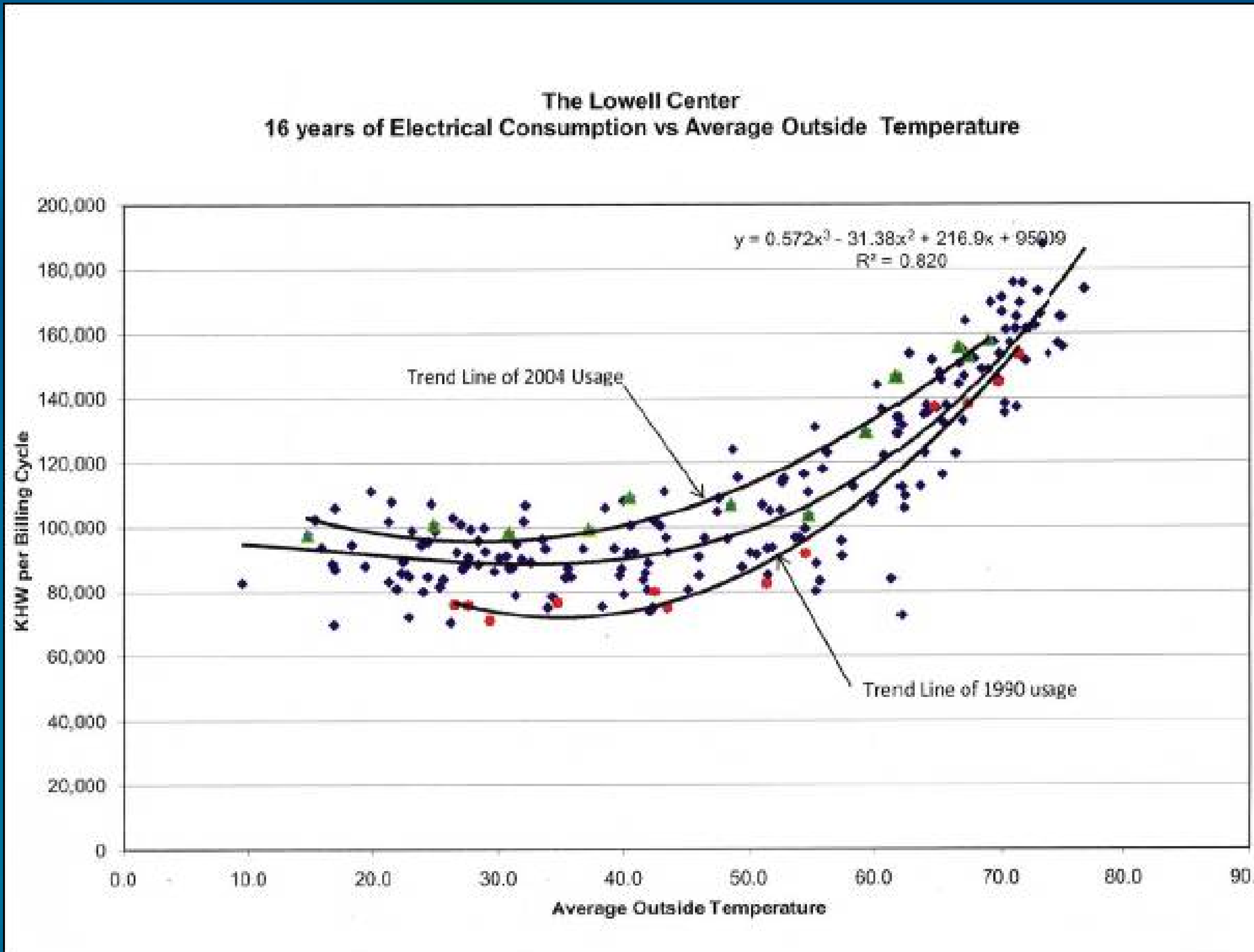
| 12 Months Ending | Current Rating (1-100) | Current Site Energy Intensity (kBtu/Sq. Ft.) | Current Source Energy Intensity (kBtu/Sq. Ft.) | Change from Baseline: Energy Use Intensity (kBtu/Sq. Ft.) | Change from Baseline: Adjusted Energy Use Intensity (kBtu/Sq. Ft.) |
|---|---|---|---|---|---|
| May 2000 | 42 | 109.7 | 208.7 | -18.7 | -19.5 |
| April 2012 | 20 | 117.8 | 225.1 | -10.6 | 36.8 |
| **Change** | -22 | 8.1 | 16.4 | N/A | N/A |

# History Matches Portfolio Manager



# Lowell Hall—Gas Usage




The Lowell Center
16 years of Electrical Consumption vs Average Outside Temperature
y = 0.572x³ - 31.38x² + 216.9x + 95909
R² = 0.820
Trend Line of 2004 Usage
Trend Line of 1990 usage
KHW per Billing Cycle
Average Outside Temperature
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0

# Lowell Hall Evaluation

**Score on our Energy Management checklist:**

1 YES    14 NO

No Bonus Points

| *Energy Management Accountability Check* | |
|---|---|
| 1. Energy use is measured | |
| a. Monthly | ☒ Yes ☐ No |
| b. Daily *Bonus* | ☐ Yes ☒ No |
| c. Hourly *Bonus* | ☐ Yes ☒ No |
| | |
| 2. Somebody is responsible to know what the energy use is | |
| a. yearly | ☐ Yes ☒ No |
| b. monthly | ☐ Yes ☒ No |
| c. daily *Bonus* | ☐ Yes ☒ No |
| | |
| 3. The responsible person can show you the energy use by table or graph of | |
| a. Yearly records | ☐ Yes ☒ No |

# Energy Management at Monona Terrace Convention Center

Jeff Griffith
Building Maintenance Supervisor

- Action plan
- Monitoring
- Benchmarking
- Accountability

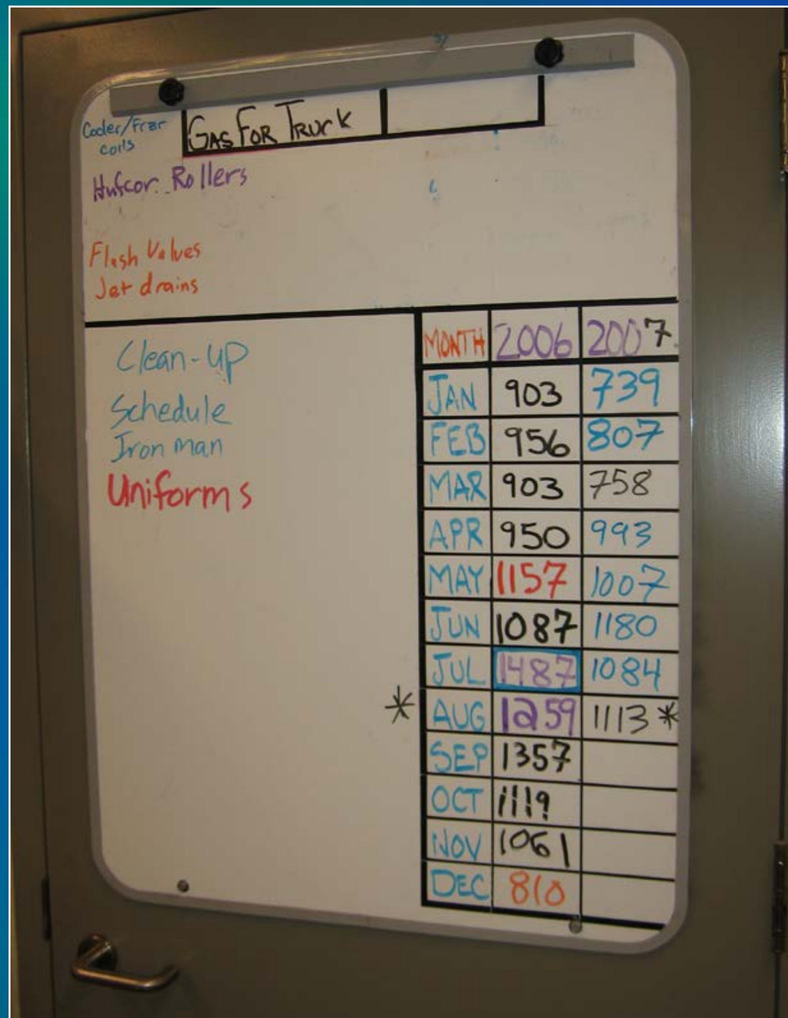
# Action Plan

- 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

# Regular Monitoring

- Weekly energy review by engineering staff
- BAS alarms to pagers
  - Demand exceeds 1100 kW
  - Chilled water exceeds 50°F
- Personal attention by one engineer on peak days

# Monitoring—Low Tech Display!



# 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—personally accountable to the facility manager for facility energy use
- Engineering staff—accountable to Jeff for components of energy use
- Entire staff maintains an energy-conscious culture
- Weekly staff review of energy use

# Monona Terrace Evaluation

| *Energy Management Accountability Check* | | *Notes* |
|---|---|---|
| 1. Energy use is measured | | |
| a. Monthly | ☒ Yes ☐ No ☐ Not Sure | |
| b. Daily *Bonus* | ☒ Yes ☐ No ☐ Not Sure | |
| c. Hourly *Bonus* | ☒ Yes ☐ No ☐ Not Sure | Real time w/trending & totalization |
| 2. Somebody is responsible to know what the energy use is | | |
| a. yearly | ☒ Yes ☐ No ☐ Not Sure | |
| b. monthly | ☒ Yes ☐ No ☐ Not Sure | |
| c. daily *Bonus* | ☒ Yes ☐ No ☐ Not Sure | Maint Super |
| 3. The responsible person can show you the energy use by table or graph of | | |
| a. Yearly records | ☒ Yes ☐ No ☐ Not Sure | |
| b. Monthly records | ☒ Yes ☐ No ☐ Not Sure | |
| c. Daily records *Bonus* | ☒ Yes ☐ No ☐ Not Sure | Steam & Electric |
| d. Hourly records *Bonus* | ☒ Yes ☐ No ☐ Not Sure | Real time w/trending & totalization |
| 4. Somebody is accountable to actually make changes to improve energy use. | ☒ Yes ☐ No ☐ Not Sure | |
| 5. Somebody has planned, tested or deployed a change in procedures or operating practices to improve energy use | | lighting controls upgrade. |
| a. in the last 90 days | ☒ Yes ☐ No ☐ Not Sure | |
| b. in the last 30 days | ☒ Yes ☐ No ☐ Not Sure | |

| | | |
|---|---|---|
| 6. Somebody has checked performance of clocks, set-points, or other parameters using suitable probes and loggers | | Bi-annual Inspection/Calibration of all HVAC Controllers & equipment |
| a. In the last 90 days | ☒ Yes ☐ No ☐ Not Sure | |
| b. In the last 30 days | ☒ Yes ☐ No ☐ Not Sure | |
| 7. For the last major upgrade of equipment or controls, somebody did a numerical "before and after" analysis to judge actual energy impact of the change. | ☒ Yes ☐ No ☐ Not Sure | lighting controls/daylight harvestors. Measured before & after but didn't have accurate way to "predict" impact. |
| *Bonus* The "before and after" analysis compared predicted energy impact to actual energy impact | ☐ Yes ☒ No ☐ Not Sure | |
| 8. The responsible person can get technical assistance when s/he is not sure of the next energy management step, test or change (assistance can be internal or external). | ☒ Yes ☐ No ☐ Not Sure | Johnson Controls MG&E. Focus on Energy |
| 9. A regular forum (meeting) is held at least monthly to review energy performance and actions taken to use energy more intelligently—the responsible person has to give explanations based on numbers, in tables and graphs, not anecdotes. | ☒ Yes ☐ No ☐ Not Sure | Weekly Maintenance Staff meeting. |
| 10. A manager of the responsible person (the "boss") attends the review meeting described in 9. | ☐ Yes ☒ No ☐ Not Sure | |
| **Total** | 18 **Yes** 2 **No** __ **Not Sure** | |

18 YES (including 5 Bonus items on monitoring)

2 NO

# Monona Terrace

# LEED EB Gold Certification

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

# Dubai Chamber Example LEED EB Recertification

**Project Information**

Building: Dubai Chamber

Contract Type: LEED v4 recertification EBOM

Total Area: 20,000 m²

Conditioned Area: 16,457 m²

**Project Summary**

Dubai Chamber, 1st LEED EBOM in the region, is a leading example for CSR focusing its efforts on green building and sustainability. The Dubai Chamber reduced potable water use by 69%, energy use of HVAC by further more than 25%, the need for a cooling tower by using outdoor water fountain as a Hx to cool server room, etc.

**Results**

ENERGY STAR label rating of 91

Consumes less energy than 91% of similar buildings in the US (with normalization)

LEED Platinum certification

# Exercise 11: Plans for Next Week

Page 37
in the
exercises

**Exercise 11: Planning Exercises**

Now is the time to reflect on our seminar and begin to plan how to improve Energy Management in your organization.

Options to develop your intentions for ***action*** after the ASHRAE Meeting

Exercise 11A helps you identify beginning actions to organize and review energy performance data.

Exercise 11B helps you begin to plan a test of a discretionary facility operations change.

Exercise 11C applies the ENERGY STAR® facility assessment matrix, using all the steps of the Energy Management Cycle (requires internet connection).

Everyone needs to summarize and prepare a short report out to the session:

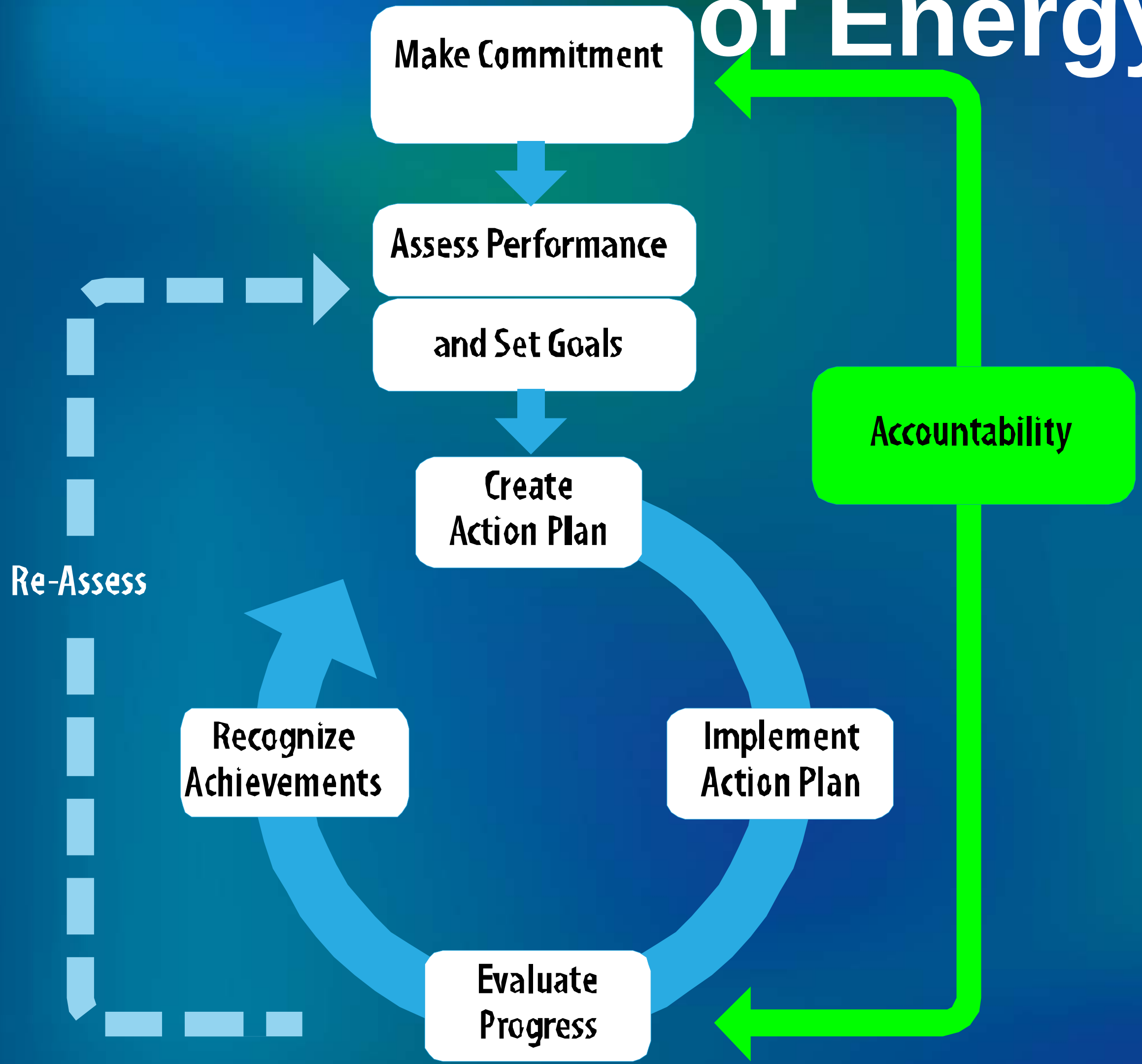
Exercise 11D is a simple summary of your intentions when you return to work after the ASHRAE Meeting.

# Poll: What Will You Do Next Week?

- Collect 24 months of utility bills?
- Use Portfolio Manager?
  - Review EUI and rating
- Test one discretionary action?
- Go through energy management checklists?
- Or something else?

# Recap and Send-off

# Recap: The *Management* Content of Energy Management




www.energystar.gov

This is the cycle we have used to guide our discussion.
It’s time to summarize.

# Recap: Assess Performance

*Don’t start with audits!*

# Recap: Assess Performance

## Monitor

- Know what performance actually is
- Different time scales
  - Year
  - Month
  - Day
  - Hour or shorter

## Benchmark

- Know how performance compares
- Relevant references
  - Self reference (history)
  - Similar buildings
  - Local utility examples
  - ENERGY STAR, etc.

# Recap: Why Assess Performance?

To see striking patterns and big differences

- Time-based performance
  - Winter versus summer
  - Weekday versus weekend
  - Day versus night
- One building versus other buildings' performance
- Predicted versus actual performance

# Recap: Create Action Plan

**Questions to guide you:**

- Where are there big differences?
- What could cause the differences?
- What can you adjust?

**Ingredients of your plan:**

- Choose something to adjust
- Monitor performance before and after
- Identify limits and barriers
- Repeat

# Recap: Evaluate Progress

## How?

- Look at energy use over time
- Do adjustments sync with improved energy use?

## Why?

- Prove that adjustments improve energy use
- To guide your next actions

# Recap: Accountability

Who is accountable to

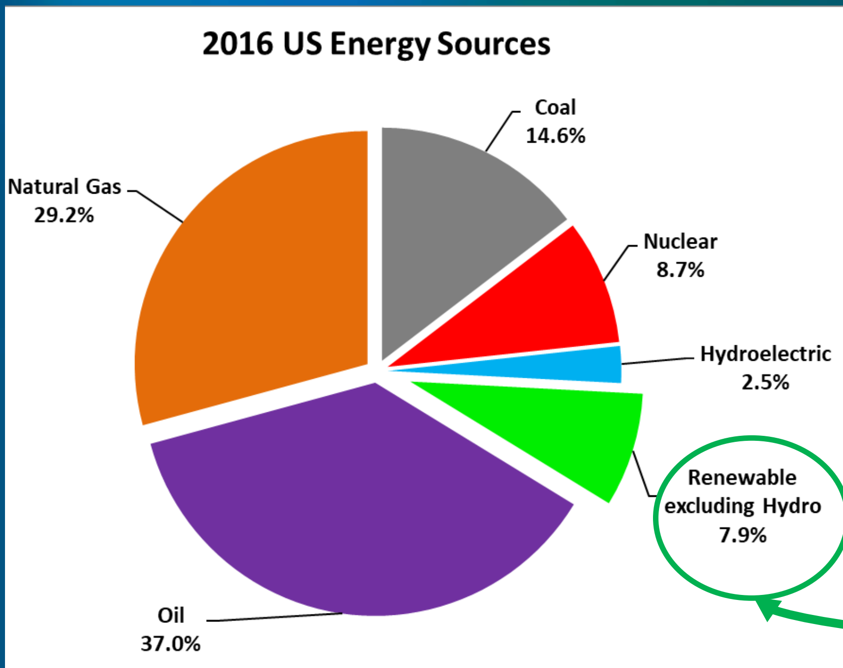
- Assess energy performance?
- Create and carry out action plans to improve performance?
- Evaluate progress?

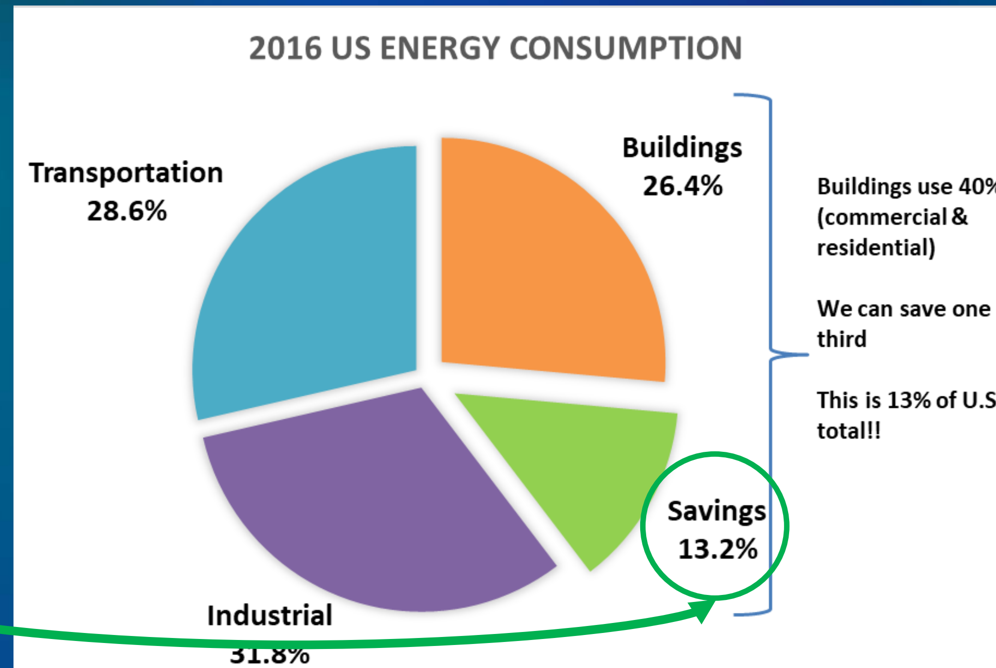
# Recap: When are You Really Ready for Audits and Retrocommissioning?

- When you have a monitoring and benchmarking system in place
- When you have adjusted everything you can think of to improve energy performance

# And Now the Send-Off…

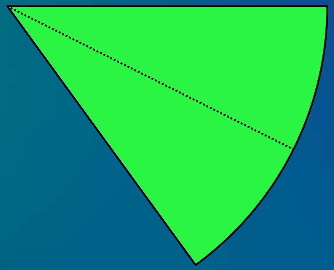
# Energy Management is the Quickest, Cheapest, Cleanest Way to Extend World Energy Supplies




Energy management can provide nearly two times the environmental impact of renewable energy!

# 33% Energy Savings Are Possible in Existing Buildings



- Some from smarter use of what you have right now
- Some from capital upgrades

# Sustained Energy Savings Require Management Actions

- An individual must be accountable
- Team-oriented atmosphere
- Use of data to guide actions

# Remember to Monitor!

Resources for Your Energy Management Work

# Supplementary Information

# References

Text and online references are listed in the References supplement

# Link to ASHRAE Bookstore

http://www.techstreet.com/ashrae

Check out the resources mentioned in this seminar and more at the online ASHRAE Bookstore!

# Evaluation and Certificate

- ASHRAE values your comments about this course. You will receive a separate email from ALI-Education (edu@ashrae.org) allowing access to the course evaluation. Once you complete the survey, you will be directed to download/print the Certificate of Attendance. Please be sure to check your spam/junk folder if it appears that you have not received the ALI-Education email. Please direct any questions concerning certificates or the survey to: **globaltrainingcenter@ashrae.org**.
- A copy of the presentation and access to supplemental files are available at the following URL: **www.ashrae.org/2020GTCenergymanagement9nov**
- If you have any questions about ASHRAE courses, please contact Ayah Said at **asaid@ashrae.org**.

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