# Energy Management Package for Small Commercial Buildings

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Package Contents:

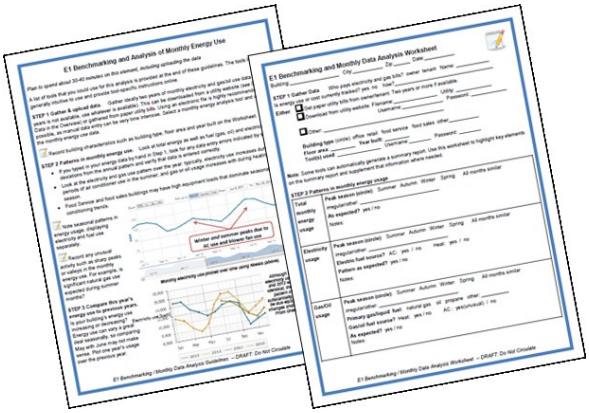
# Overview

**Objectives:**

- Provide best practices guide for HVAC contractors to deliver energy management services to small commercial buildings
- Identify low- or no-cost action items to reduce energy usage (primarily operational changes)
- Inform owners of building's performance and strategies for improvement

**Target buildings:** The Energy Management Package is designed for use with commercial buildings of less than 50,000 sf, and focuses on office, retail, food service and food sales building types. Because of the difficulties in benchmarking multi-use buildings, we focus here on single use spaces. The package is expected to be easiest to execute in owner-occupied buildings (see Appendix 4 for further discussion of ownership structure).

**Structure:** The package is designed to be completed over a 6-12 month cycle. The objective is that it will take about 4 hours total to complete the package elements, once familiar with the process and the analysis.



***Guidelines (left) and worksheet (right) for Element 1***

The package contains 5 elements, each containing guidelines and a worksheet. The guidelines are intended to serve as a reference, and the user may only need the worksheets, once the user becomes familiar with the package.

Analysis is intended to be done using free or inexpensive, already available software tools. For each relevant element (1, 2 & 5), there is a list of currently available tools that can be used for the analysis in that element. Tool-specific training for several publicly available tools is provided in the form of short video clips on the YouTube channel 'SmallComEnMS' http://www.youtube.com/user/SmallComEnMS/videos/. Additional information is readily available online at the individual sites. Inclusion in the tool list or training videos is not an endorsement by LBNL: the list is merely provided as a starting point, as additional tools may become available.

When you see this icon, make sure to record the requested information in the relevant worksheet

When you see this icon, look for tips for actions to reduce energy consumption.

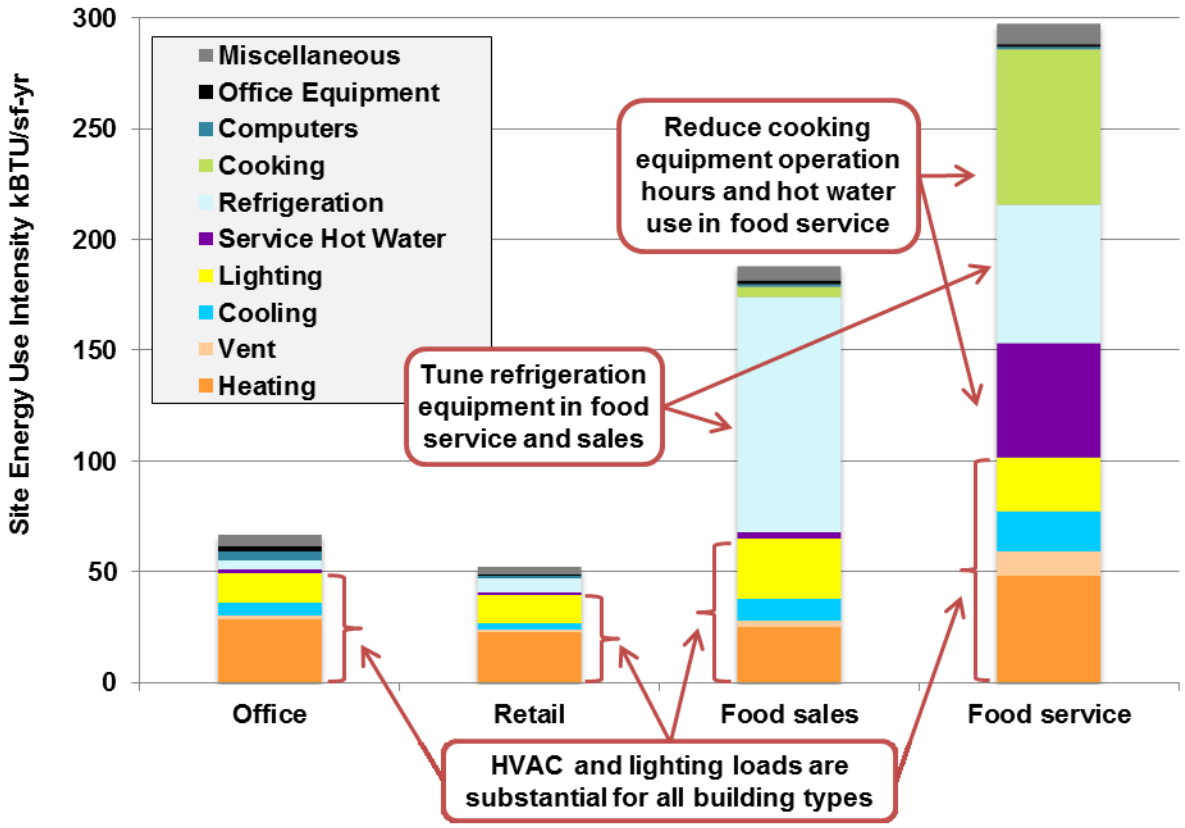
When you see this icon, there may rebates available for this item. Incentive identification is covered in Element 4.

**Business model:**

Based on conversations with stakeholders, the Energy Management Package is designed to be integrated into an annual maintenance contract. The cost to administer the package (labor costs for analysis and walkthrough) can be covered in part by  with a small premium on the contract fee. Additionally, energy management can add value to an annual maintenance contract and distinguish the contract other HVAC companies.

In addition to improving customer retention and recruitment, energy management can also help to identify additional HVAC service opportunities and help illustrate the value of preventative maintenance. A separate business model document describes in detail how an HVAC company might integrate this package into their offerings.

***How is energy used in small commercial buildings?***




Before digging into a specific building's energy usage, in can be helpful to have an idea of what to expect, in terms of different end uses of energy. The small buildings sector contains a wide variety of building types, but many energy uses are common across building types. For example, there are opportunities for savings in HVAC and lighting in almost all building types. Some opportunities are building type specific--focusing on hot water usage in an office when offices tend to use very little hot water is not likely to be the best place to start. For food sales and food service, a significant fraction of energy is typically spent on refrigeration, so making sure this equipment is maintained appropriately can lead to substantial savings. In Food service buildings, hot water and cooking equipment use are large energy loads: making sure equipment is efficiently is key here. The elements of the package contain specific instructions on how to interpret energy use history and make recommendations.

**Obtaining Data**

**Monthly Data:** You can either download monthly billing data by logging into the utility account through the web portal, or you can enter data from paper monthly bills. It is highly recommended to download the electronic file if possible, because manual data collection and entry can be quite time consuming. After logging into the utility account, you may need to select 'my usage' and then select monthly bill totals.

- Ideally, collect at least 2 years of monthly billing information
- While you are downloading monthly billing data, also download interval data, if available (see below).

**Interval Data:** To analyze your interval data, you need to obtain a data file containing hourly (or sub-hourly) values of timestamp and electricity usage. The easiest way to obtain this data file is to login directly to the utility account through the web portal and download the data. Typically, this is under a link marked 'my usage', and you may need to select, 'download my green button data'.

- Download at least one year of interval data (if available)
- If a full year is not available, download whatever is available
- Generally, you want to select the .xml file format (unless the tool you are using specifies .csv)

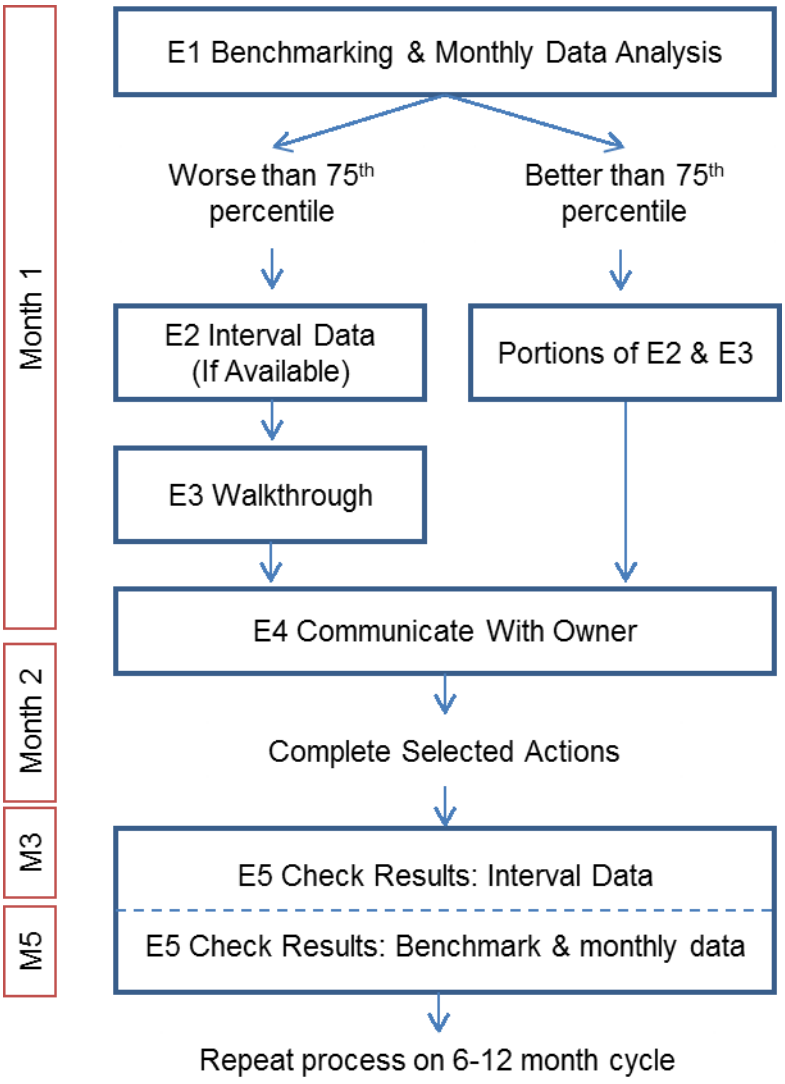
The Energy AI tool has a great overview of the specific process required to obtain interval energy data from different utility companies: http://energyai.com/EAIWeb/LoadDataSourceList.php

**Selecting Package Elements**

Depending on the performance of your building and the data available, you may want to complete only selected elements for an individual building. The outline below provides guidance on how to navigate the package, starting with Element 1 Benchmarking and Monthly Data Analysis.

To assess how much energy you should expect your building to use, we use two benchmarking metrics in the package. The first is energy use per square foot, also called energy use intensity (EUI). The second is the percentile ranking of a building's EUI relative to other peer buildings, which is equivalent to the Energy Star Rating. Benchmarking is sometimes required for compliance with building energy use disclosure laws. Unless the percentile ranking is already quite high, the package will likely highlight many opportunities to reduce energy use.

Within E5, there is interval data analysis that can be done as few as 2 weeks after adjustments to load scheduling & setpoints. However you need to wait 2-3 months after adjustments to do the Benchmarking and monthly data analysis in E5, in order to see changes in the building performance.



# E1 Benchmarking and Analysis of Monthly Energy Use

*Plan to spend about 30-40 minutes on this element, including uploading the data*

A list of tools that you could use for this analysis is provided at the end of these guidelines. The tools listed are generally intuitive to use and provide tool-specific instructions online.

**STEP 1 Gather & upload data.** Gather ideally two years of monthly electricity and gas/oil use data (if two years is not available, use whatever is available). This can be downloaded from a utility website (see Obtaining Data in the Overview) or gathered from paper utility bills. Using an electronic file is highly recommended if possible, as manual data entry can be very time intensive. Select a monthly energy analysis tool and upload the monthly energy use data.

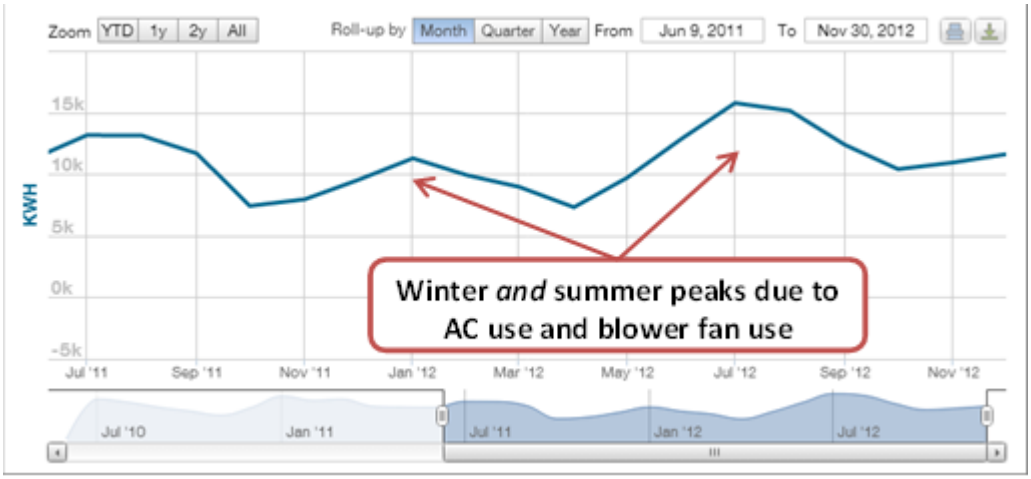
Record building characteristics such as building type, floor area and year built on the Worksheet.

**STEP 2 Patterns in monthly energy use.** Look at total energy as well as fuel (gas, oil) and electricity.

- If you typed in your energy data by hand in Step 1, look for any data entry errors indicated by significant deviations from the annual pattern and verify that data is entered correctly.
- Look at the electricity and gas use pattern over the year: typically, electricity use increases during periods of air conditioner use in the summer, and gas or oil usage increases with during heating season.
- Food Service and food sales buildings may have high equipment loads that dominate seasonal conditioning trends.

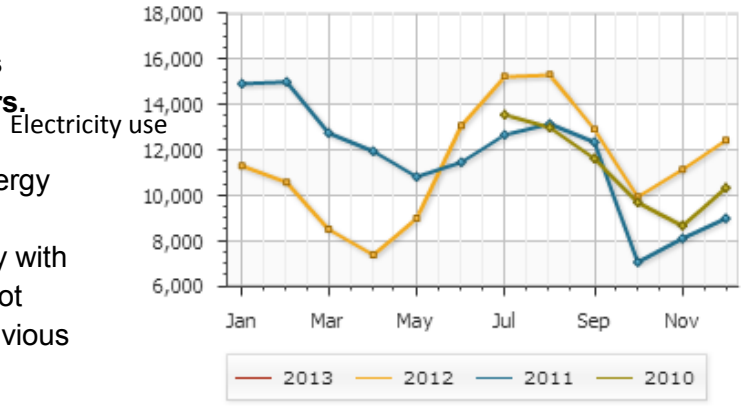
Note seasonal patterns in energy usage, displaying electricity and fuel use separately.

Record any unusual activity such as sharp peaks or valleys in the monthly energy use. For example, is significant natural gas use expected during summer months?




***Monthly electricity use plotted over time using Noesis (above).***

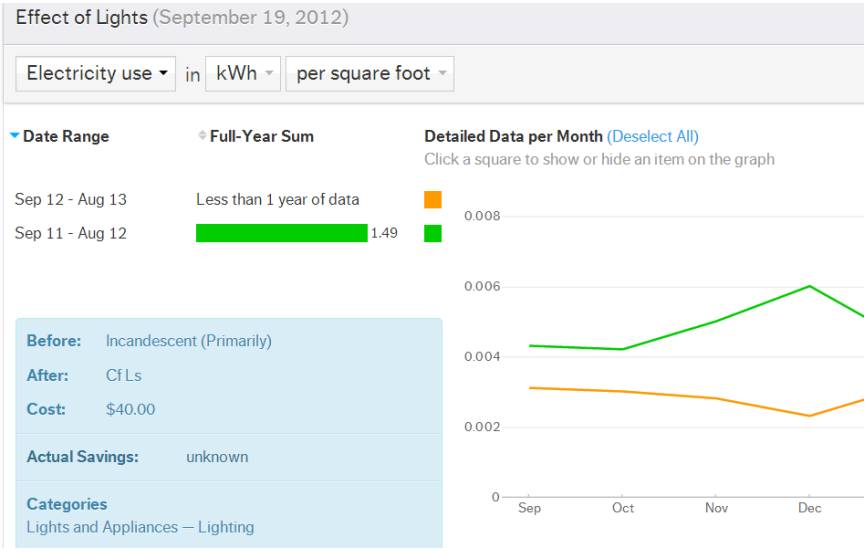
**STEP 3 Compare this year's energy use to previous years.** Is your building's energy use increasing or decreasing? Energy use can vary a great deal seasonally, so comparing May with June may not make sense. Plot one year's usage over the previous year.




***Although the total electricity used in 2011 and 2012 was nearly identical, the seasonal pattern changed substantially: this could be due equipment use changes and/or weather. From GreenQuest.***

Record how this year's energy use compares with previous years.

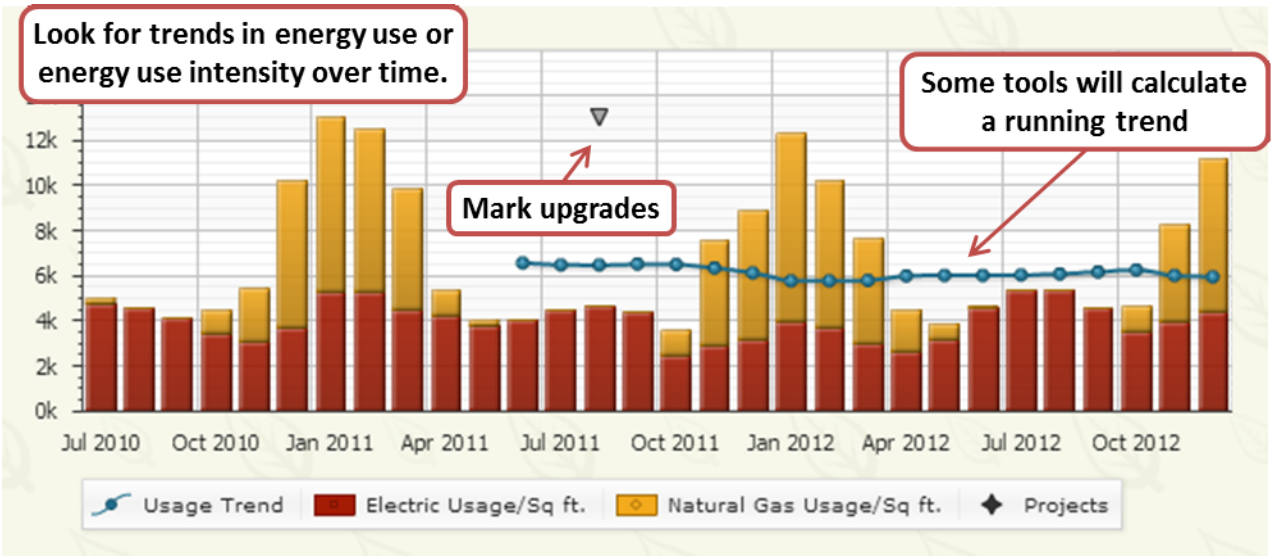
Make sure to look at energy use over time, **not** cost over time: changes in energy prices can complicate the interpretation of cost over time. With little influence over rates, the best objective from an operational standpoint is to focus on reducing energy consumption rather than cost.




Some tools include the capability to note when specific energy efficiency upgrades were made, so that you can compare the impact of the upgrade on the overall energy use, or on the use of a specific fuel.

***The impact of changing from incandescent to CFL light bulbs is illustrated using WegoWise to compare electricity use before and after the measure.***

Some tools provide 'weather normalized' results to control for the impact of extreme weather in a given year. Take note of whether or not the results you record are normalized for weather.




***Energy use history (monthly total BTU/square foot) plotted over two years in GreenQuest.***

- Increasing energy use can reflect changes in equipment condition or type, thermostat or lighting controls, increasing plug loads or occupancy (number of workers or hours).
- Decreasing energy use can reflect effective energy efficiency measures or changes in occupancy or scheduling.

Take note of any specific changes in energy use trends and record possible explanations.

**STEP 4 Cross-sectional Benchmarking: Compare your building with similar buildings.**

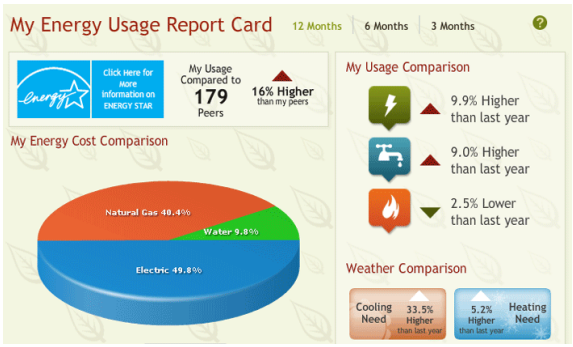
You want your building to be efficient, but how much energy should you expect your building to use? Comparing your building with similar buildings gives you a measure of how well your building is performing. The most common metric for comparison is the Energy Use Intensity (EUI), where total energy use is divided by floor area to give the annual energy use per square foot. Benchmarking can be required by building energy use disclosure laws, and can be useful to identify where to focus efforts in a building owner's portfolio.

| Rank | Name | Location | Climate Zone | Area (ft²) | Utility Types | Energy Intensity (Actual) (kBtu/ft²) | Energy Star Rating (Period End Date) |
|---|---|---|---|---|---|---|---|
| 1 | Tulsa Demo | Tulsa, OK | Warm | 46,800 | | 3.164 | 93 (11/2012) |
| 2 | Austin Demo | Austin, Texas | Hot | 46,800 | | 23.653 | 75 (11/2012) |
| 3 | Atlanta Demo | Atlanta, GA | Warm | 46,800 | | 25.216 | 80 (11/2012) |

***The online tool Noesis displays Energy Use Intensity as well as Energy Star Rating for buildings in a sample portfolio.***

Record the Energy Use Intensity (EUI) for your building including the units: if possible, select kBTU/sf-yr. Take note if this is site energy (energy used onsite) or source energy (also includes losses in electricity generation and transmission).

Most tools provide some measure of how your building compares with others--this may be the percentile of buildings that are less (or more) efficient than your building. The Energy Star Rating metric between 1 and 100 indicates what percentage of peer buildings have *higher* energy use per square foot. For example, an Energy Star Rating of 55 indicates that your building is more efficient than 55% of peer buildings. Other tools might provide a metric like: "your building uses 16% more energy than similar buildings". Portfolio Manager does not issue an Energy Star Score for **restaurants/food service**, but you can use Energy IQ to find the percentile ranking from the restaurant's EUI.




***Energy Use Report Card from the GreenQuest tool, which submits your most recent energy use data to Portfolio Manager to retrieve your Energy Star Rating.***

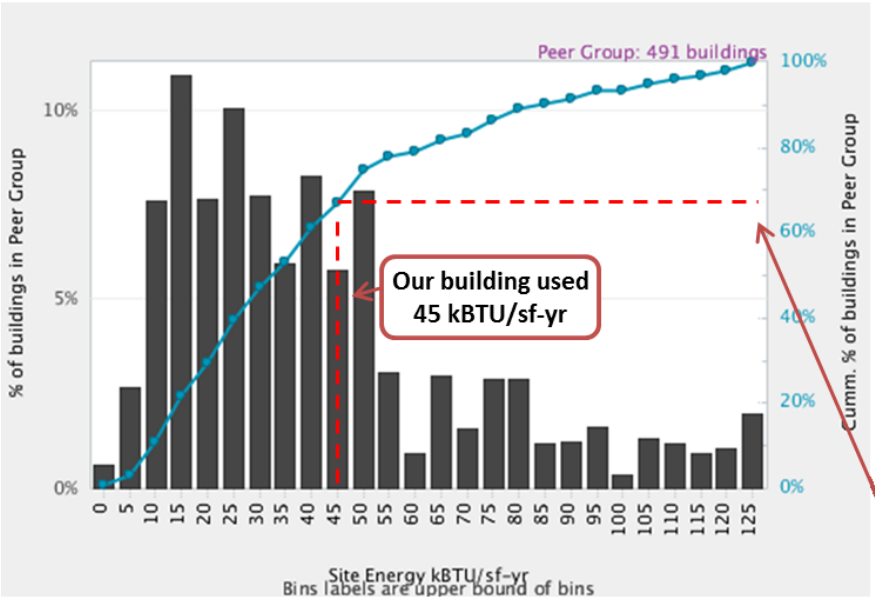
Record how your building compares with peers. Ideally, record the percentage of peer buildings that use *more* energy per square foot than your building (the Energy Star Rating).

When you define your peer group, think about how your specific building might differ from this peer group:

- Is your building mixed use? For example, an office building that has a portion devoted to manufacturing or a restaurant will tend to have higher energy use intensity than single use office buildings.
- Does your building have unusual occupancy loads or hours? Some tools adjust for scheduling and occupancy rates but others do not. For example, a restaurant in a seasonal destination may have lower annual energy use than one in a year-round destination.

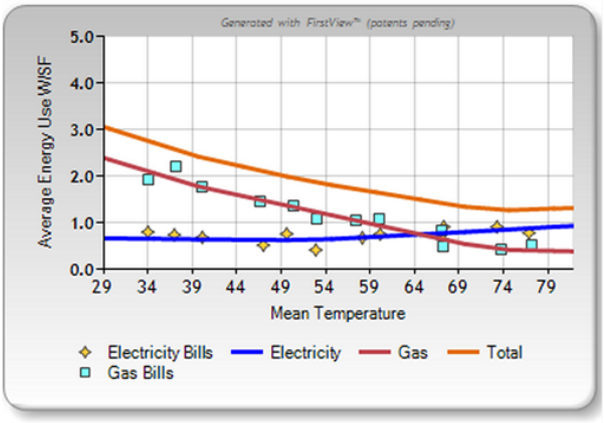
**To receive an Energy Star Rating**, enter data directly at the Portfolio Manager website, or use another online tool that submits information to Portfolio Manager on your behalf. Typically, it will take 1-2 days for an Energy Star Rating to be displayed.

If the tool you are using does not provide the percentile ranking to compare your building with other buildings of the same type, you can use Energy IQ to estimate this ranking for your building using the EUI. If the number of buildings in the defined peer group is small, you may want to broaden the peer group definition.




***Energy IQ can be used to benchmark buildings by size, location, age, and building type using EUI.***

**Optional STEP 5: Other analyses.** Energy management tools are regularly developing new analyses to provide insight from your monthly utility data--have a look around and see what else might be useful!




| Category | Status |
|---|---|
| **Occupant Load:** | Low |
| **Heating Impact of Shell and Ventilation:** | Good |
| **Cooling Efficiency:** | Good |
| **Controls:** | Large Inefficiencies |
| **Reheat:** | Unlikely |
| **Gas Baseload:** | High |
| **Data Consistency:** | Orderly |

***Energy signature and highlighted inefficiencies generated by the FirstView tool.***

For example, FirstView uses monthly electricity and gas use to highlight possible inefficiencies by relating energy use to outdoor temperature. The tool is limited to office buildings with gas heating and electric cooling.

**STEP 6 Look forward.** Benchmarking results and energy use trends can give an indication of how much effort it will take to reduce energy use:

- If your building is in the 90th percentile of peer buildings, this is great! It may be best to focus energy efficiency efforts elsewhere, as it may be difficult to improve this building further. Make sure to update benchmarking of this building on an ongoing basis to ensure high performance is maintained.
- If your building is in 75-90%, there may be some opportunities for improvement, but detailed investigation may not pay off.
  → Complete **Element 2 Steps 2 & 4** and **Element 3**, as seems appropriate for the building
- If your building is below the 75th percentile, low-cost opportunities to lower your building's energy use are likely to exist. → Continue to **Element 2 Interval Data Analysis**

# Benchmarking & Monthly Data Tool List

Portfolio Manager Free online tool calculates Energy Star Rating and energy use tracking for commercial and industrial buildings and portfolios. Portfolio Manager will be updated in June 2013.

Noesis Set of online energy management and benchmarking tools for commercial buildings and portfolios. Basic account is free, upgrade to pull data directly from the utility ($5/month) or to get advanced features. Tutorial video at http://www.youtube.com/user/smallcomenms/videos/.

GreenQuest Free online tool for tracking energy and water use for a single building (one building per login account). For a portfolio, EnergyCap offers tracking of 25 meters starting from $49/month.

PG&E Business Energy Checkup Online account portal displays daily, weekly and monthly energy use and benchmarks against peer buildings. Business Energy Checkup also estimates usage/cost based on end use.

Energy IQ Free online tool for benchmarking against a customizable group of peer buildings using various metrics. This tool allows you to view the range of values of energy use metrics for different building types, including normalizing energy use by factors such as floor area, employees or restaurant seating. Limited energy use tracking of buildings or portfolios is available. Energy IQ can retrieve data from Portfolio Manager.

Wegowise Online energy and water management and benchmarking tool focused on cross-portfolio comparison for multifamily and small commercial buildings and portfolios. Wegowise connects directly to utility accounts and interfaces with Portfolio Manager to retrieve Energy Star Ratings. Membership is $6/building/month for commercial buildings.

FirstView Free online tool benchmarks buildings against peers and provides automated analysis of monthly data to identify potential areas of inefficiency based on the building's energy signature. Limited to office buildings with gas heat and electric cooling.

Energy Lens by BizEE Software Ltd Tool can plot trends in daily weekly or monthly energy use over time, as well as interval data, but this is not a benchmarking tool. Software add-in for Excel available for download for a one-time fee of $495.

| | Step 1 | Step 1 | Step 2 | Step 3 | Step 3 | Step 4 | Step 4 | Step 4 | Step 4 |
|---|---|---|---|---|---|---|---|---|---|
| | Retrieve data from utility | Retrieve data from Portfolio Manager | Plot monthly energy use | Plot trend over time | Track EE upgrades | Calculate EUI | Compare w/ peers | Calculate Percentile benchmark | Retrieve ES rating |
| Portfolio Manager | | NA | | | | X | X | X | X |
| Energy IQ | | X | limited | limited | | X | X | X | |
| FirstView | | | | | | X | X | | |
| GreenQuest | | | X | X | X | X | X | X | X |
| Wegowise ($) | X | X | X | X | X | X | X | X | X |
| Noesis | ($) | X | X | X | X | X | X | X | X |
| PG&E BEC | NA | | X | X | X | | X | | |
| EnergyLens($) | | | X | X | | | | | |

# E1 Benchmarking and Monthly Data Analysis Worksheet

Building:_____ City:_____ Zip:_____ Date:_____

**STEP 1 Gather Data** Who pays electricity and gas bills? owner tenant Name: _____
Is energy use or cost currently tracked? yes no how?_____

**Either**: ☐ Get paper utility bills from owner/tenant. Two years or more if available.

☐ Download from utility website. Filename:_____ Utility: _____
Username:_____ Password: _____

☐ Other: _____

**Building type** (circle): office retail food service food sales other_____
**Floor area**: _____ **Year built:** _____
**Tool(s) used**: _____ Username:_____ Password: _____

**Note**: Some tools can automatically generate a summary report. Use this worksheet to highlight key elements on the summary report and supplement that information where needed.

**STEP 2 Patterns in monthly energy usage**

| | |
|---|---|
| **Total monthly energy usage** | **Peak season (circle)**: Summer Autumn Winter Spring All months similar<br>irregular/other: _____<br>**As expected?** yes / no<br>Notes: |
| **Electricity usage** | **Peak season (circle)**: Summer Autumn Winter Spring All months similar<br>irregular/other: _____<br>**Electric fuel source?** AC: yes / no Heat: yes / no<br>**Pattern as expected?** yes / no<br>Notes: |
| **Gas/Oil usage** | **Peak season (circle)**: Summer Autumn Winter Spring All months similar<br>irregular/other: _____<br>**Primary gas/liquid fuel**: natural gas oil propane other: _____<br>**Gas/oil fuel source?** Heat: yes / no AC : yes(unusual) / no<br>**As expected?** yes / no<br>Notes: |

**STEP 3 Performance Over Time**

☐ Printed a plot comparing this year's energy use with the previous year's or rolling annual average.

How does this year's monthly energy use compare with the previous year? increase decrease same
In all months/seasons?

By fuel type?

Is the baseline for comparison 'weather normalized' to adjust for that year's weather? yes no not sure

**Specific changes in energy use over time**. Consult with owner about changes in schedule, building usage and equipment may explain observations. Include changes in building occupancy, usage or equipment that you expect might have an impact on energy use.

| **Dates** | **Description of change** *(ex: abrupt increase by 10,000 kBTU/month in 2/12 that continues over the next year)* | **Explanation** *(check daily load schedule, consult with owner/occupants, recent efficiency upgrades)* | **Plan to address?** (check if yes) |
|---|---|---|---|
| | | | |
| | | | |

**STEP 4 Cross-sectional Benchmarking**

**Energy Use Intensity** (EUI):_____ (include units, ideally kBTU/sf-yr)

*EUI is total annual energy use per unit floor area.*

**Comparison % ranking**: _____ (% of buildings with higher EUI (worse performance) than yours)

*Note that in some tools, percentile is defined in the opposite way.*

**Is this an Energy Star Rating**? yes no **Peer group used** (if available):

*If Energy Star Rating is 75 or higher, the building may be eligible for an Energy Star Label.*

**Other peer comparison**: *Example: Your building's EUI is 40 kBTU/sf-yr and the average for similar buildings is 55 kBTU/sf-yr.*

Are there special considerations that might cause your building to differ from the defined peer group?

**Optional STEP 5: Other analyses.** Record notes here from any other monthly data analyses performed.

Notes:

**STEP 6 Look forward**

If Energy Star Score is **75 or less**, continue to Element 2 Interval Data Analysis.

If Energy Star Score is **better than 75** , continue to Element 2 Steps 2 & 4 , and Element 3 as seems appropriate for the specific building.

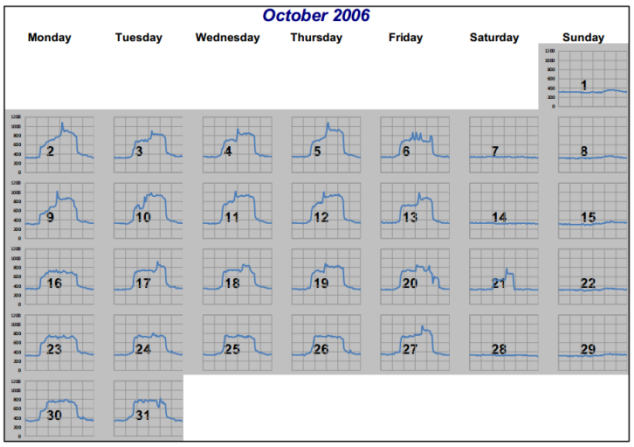
# E2 Interval Data Analysis Guidelines

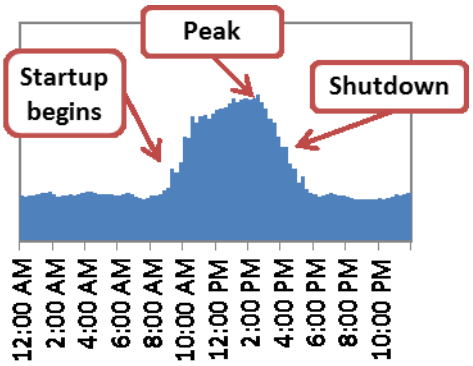
*Plan to spend about 20-30 minutes reviewing a building's interval energy use data.*

**STEP 1 Upload data** Load interval data into the program. You need at least one month (as much as 6-13 months for some tools) of electricity use data reported every hour (or every 30, 20, 15 minutes). See the Overview for more information on obtaining data. At the end of this document, there is a list of tools that can be used for this element.

**STEP 2 Daily and weekly load schedule** Display electricity use data vs. time for a few weeks of interval energy use data.

***Right: Energy use for each day in the month of October 2006 using ECAM (from ECAM instruction manual). Note weekday vs. weekend schedule is typical, with abnormal activity on Saturday October 21.***



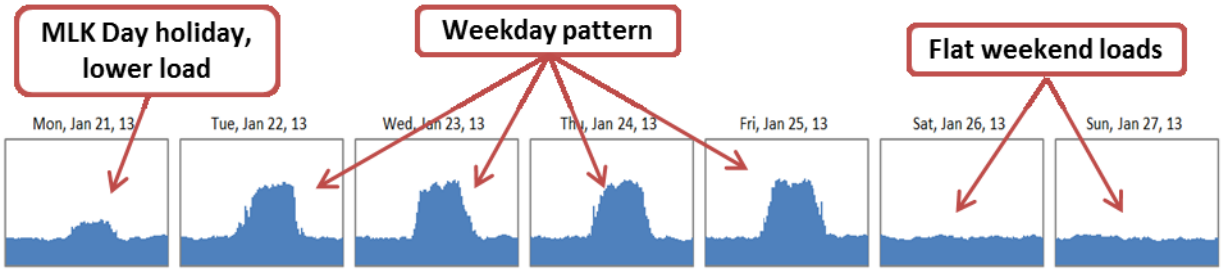




*Does the daily load profile have the same shape as you would expect?*

*Do morning startup and evening shutdown happen at appropriate times?*

*Does the load follow a different shape on weekends? Just Sunday?*

*Does the load decrease on holidays or during vacation periods?*



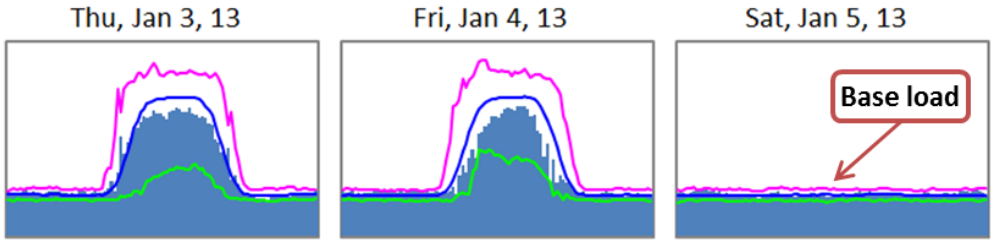

Some tools will also calculate an average profile for weekday, weekend, or by day of the week which can be useful to compare these load profiles. Examine this data for each month (at least one month in each season).

Make note of the weekly pattern and times when equipment may be running unnecessarily.

Discuss this figure with the building owner or building operator to verify whether equipment and schedules are operating appropriately.

Program thermostat and lighting controls to include holiday, weekend, and nighttime setbacks during the *Walkthrough*.

**STEP 3 Base load** From the view of a month or a week of data, you will see that there is a level below which the energy use does not drop. This is usually called the 'base load' or '24-7 load'. This is the electricity load that the facility consumes all of the time, even when the facility is closed.



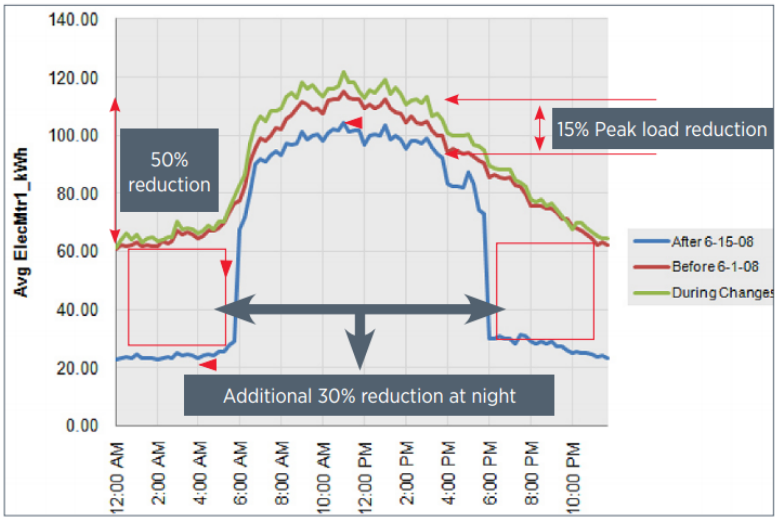

***Load profiles for three days in January, illustrating the base load level across all days in the month. Lines show the maximum, average, and minimum energy use in each interval for each day of the week. From BizEE EnergyLens.***

*What is the base load level? Is the base load higher than 50% of the typical daily peak load?*

The base load will vary depending on the building type (i.e., a 24-hour supermarket will have a higher base load than one that is only open from 8am-8pm due to lighting and other equipment that is switched off at night). Reducing off hour loads can lead to significant energy savings, given that commercial buildings that may be unoccupied more than half of the time:

Turn off unnecessary equipment during off-hours (computers, lighting). Standby power for electronic equipment can be significant even if equipment is switched off. Smart power strips can be used to reduce standby loads.

Deepen programmed setbacks during off-hours during *Walkthrough*. This includes both increasing cooling setpoints and decreasing heating setpoints.

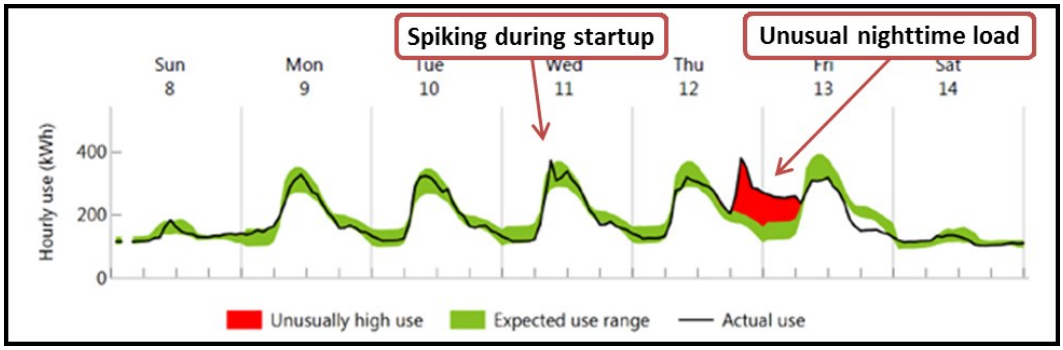



***Comparison between before and after retro-commissioning in an office building showing 30% reduction in nighttime load. From ECAM instruction manual.***

**STEP 4 Load spikes and unusual activity** Look at the load time series over a day, week or month.

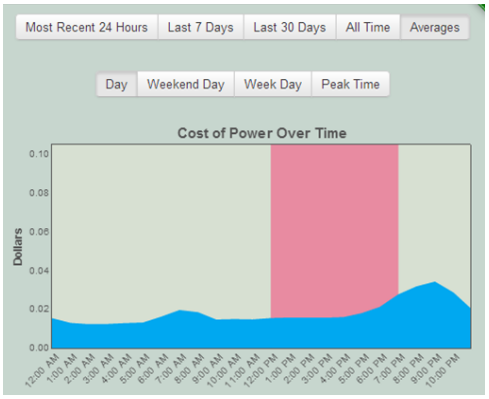
*Are there spikes in the energy use?* Note the times of spiking or unusual activity.

Spiking in the time series can indicate equipment malfunctioning, cycling, or scheduling issues. Staggering equipment startup times can reduce load spikes, which can reduce demand charges.




***Comparing the measured energy use to the average profile, an anomaly is identified on Thursday evening in this figure of energy use at a high school. From Energy Ai website.***

**STEP 5 Peak loads** Display the average weekday load. If averaging is not available, display a month of daily load profiles. Many utilities charge higher rates at times when electricity demand is highest, typically between 2 and 6pm.




***Daily load for an average weekday, with the peak period shown by the pink bar, using the Green Button Grapher application.***

Note when peak load occurs, and the level of the peak.

Some businesses may be able to save on electricity costs by reducing peak loads or shifting power-intensive activities to occur before or after the peak-rate period. For example, a restaurant might program a thermostat setback between lunch and dinner services, or a supermarket might change when chickens are roasted.

If demand charges are in effect (a utility charge based on the peak level used at any time during the month), staggering startup or altering scheduling to reduce the peak may save the customer money, regardless of what time the peak occurs. For California buildings less than 25,000 sf, the average peak load is 5 W/sf for office and retail, 6 W/sf for food sales and 8.5 W/sf for food service. If the peak load is greater, look for opportunities to reduce the peak load.

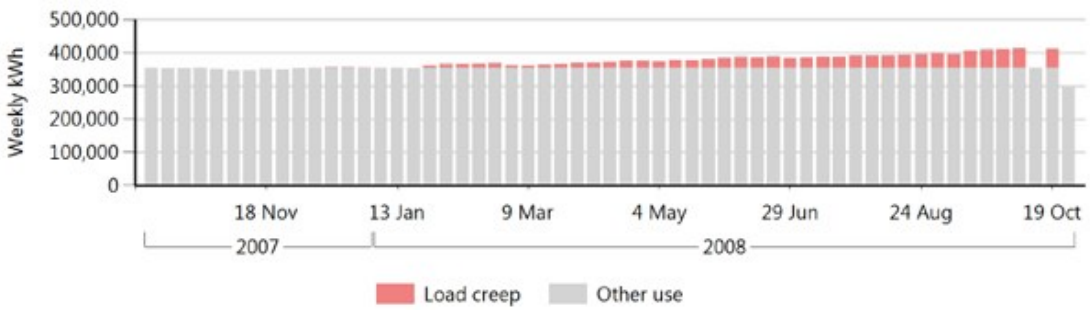
**STEP 6 Changes over time**

Plot total daily load (or weekly load) over several months or a year. With some tools you can choose which days of the week to include.

*Is seasonal variation as expected?* Seasonal variation is also addressed in E1.

*Are there any gradual or abrupt changes in the daily load?*

***Load creep is apparent in this figure showing weekly energy use on a college campus. From Energy Ai.***




Looking at electricity use by day or week can help identify what events might have occurred that led to changes in usage. Thermostat settings or scheduling changes might lead to a noticeable change from one week to the next, and also lead to changes in the base load relative to the peak (Step 3). Whereas equipment in need of service or changes in occupancy may occur over longer periods of time. Some tools have a feature to mark the timing of energy efficiency upgrades, so that before and after usage can be compared.

Make note of drift in usage over time or periods of abrupt change. The building owner or manager may have insight on what led to these changes.

Consider any energy efficiency upgrades over this time period that might impact trends.

If seasonal variation is very high, the building may benefit from air-sealing, improved insulation or increased solar shading.

## Interval data analysis tools

Green Charts Very simple, free online tool to display monthly, daily and hourly energy use data, that allows the user to move easily between different months and days. This tool requires data in an .xml file no larger than 2.6MB.
Tutorial video at http://www.youtube.com/user/smallcomenms/videos.

Leafully Simple, free, online tool to display interval data on different timescales. Can connect with a number of utilities through Green Button Connect for automatic updating, or you can upload a .xml file.

Building Energy Fingerprint Simple, free online tool to analyze Green Button data (.xml file). This tool generates a custom report with several graphs that may help identify trends in interval electricity data.

Green Button Grapher Very simple, free, online tool to display interval energy use data. This tool can also display the average weekend and weekday load profile. This tool requires data in an .xml file and may have trouble loading very large files (larger than about 8MB).

Energy Ai Analysis of 6-13 months of interval electricity data for a single meter (load), for $20 per pdf report. The report highlights use patterns and irregularities.

Energy Lens by BizEE Software Ltd Software add-in for Excel available for download for a one-time fee of $495. Tool can display daily load profiles over a month compared with average profiles, or plot trends in daily weekly or monthly energy use over time. This tool is easiest to use with data in a .csv file, but .xml files can also be imported into Excel.

Plotwatt The free, residential online tool can be used to visualize interval energy data over time. The restaurant tool attributes real-time energy use to specific devices and provides monitoring and scheduling advice. The restaurant tool requires an installed device and has a monthly service fee. This tool requires either a login to your utility account or upload of an .xml file.

*More complex tools:*

ECAM While designed to analyze interval data from multiple system points, this free add-in to Excel for Windows can be used to visualize building level interval data by month or by day type (day of week, weekend, holiday). This tool is easiest to use with data in a .csv file, but .xml files can also be imported into Excel.

FirstFuel FirstFuel offers 'virtual audits' examining interval energy use data for a building or portfolio.

*Tools that may add interval data visualization / analysis in future:*

PG&E's Business Energy Checkup
Online portal offers analysis of daily, weekly and monthly energy use, with plans to add hourly (or sub-hourly) data visualization.

Wegowise Energy management and benchmarking tool for multifamily and small commercial buildings, has plans to add interval data display. Membership is $30/meter/year for commercial buildings.

## E2 Interval Data Analysis Worksheet

Building:_____
Date:_____

**STEP 1**: Obtain & upload interval energy use data

**Either**: ☐ Get file from owner. File name: _____

☐ Download file from utility website (recommended)

Filename: _____ Utility: _____

Username:_____ Password: _____

**Building floor area**: _____ **Operating hours**:_____

**Building type**:(circle): office retail food service food sales other_____

Tool used to display interval data: _____

**STEP 2 Daily and Weekly Scheduling**:

☐Printed a plot of a week or several weeks of daily loads

| | |
|---|---|
| Weekly pattern (circle):<br><br>Weekend load compared w/ typical:<br>As owner expected? | all days similar weekday/weekend weekday/Sat/Sun<br>irregular/other: _____<br>same slightly lower much lower base load level<br>yes / no |
| Holiday loads compared w/ typical:<br>Which holidays (circle):<br><br>As owner expected? | same slightly lower much lower base load level<br>1/1 MLK Pres. Mem. July4 Labor Colum. Vet. ThnksGiv 12/24<br>12/25 other:_____<br>yes / no |
| Typical day scheduling:<br><br>As owner expected? | Startup begins: _____ Startup ends: _____<br>Shutdown begins:_____ Shutdown ends:_____<br>yes / no |
| Notes on irregular activity:<br>*Include times where equipment may be running unnecessarily.* | |

**STEP 3 Base Load**:

| |
|---|
| Base load level: _____ Typical daily maximum level _____ |
| Base load to daily maximum ratio: _____<br>*Divide base load by typical daily max* |
| • *If ratio above is greater than 0.50, look for opportunities to deepen setbacks.* |

**STEP 4 Load Spikes and Unusual Activity**

| **Date & Time** | **Description**<br>*(ex: 100kWh spike above typical load)* | **Explanation**<br>*(consult with owner/occupants)* | **Plan to address?**<br>(check if yes) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

**STEP 5 Peak Loads**

Time of day pricing? yes / no Demand charges? yes / no
*Utility bill should include this information.*

Time of peak: _____ Size of peak (kW):_____ Peak load per floor area: _____W/sf

- *If time of peak is between 2 and 6 pm and time of day pricing is applied, consider shifting scheduling to off-peak hours.*
- *If demand charges are applied, consider shifting equipment scheduling to reduce peak level.*
- *If peak load per floor area is greater than 6 W/sf for office, retail or food sales or 9 W/sf for food service, look for opportunities to reduce peak level.*

**STEP 6 Changes Over Time (any changes not already addressed in E1 Step 3)**

| **Dates** | **Description of increase**<br>*(ex: increase from 50,000 kWh/week to 60,000 kWh/week over two years)* | **Explanation**<br>*(check changes in base load, consult with owner/occupants, recent efficiency upgrades)* | **Plan to address?**<br>(check if yes) |
|---|---|---|---|
| | | | |
| | | | |

# E3 Walkthrough Guidelines

*Plan to spend about 60 minutes at the site on this element.*

**Small commercial buildings are all so different--how do I even know where to start looking for energy savings opportunities?** The Energy Management Package focuses on operational improvements rather than capital improvements. Operational improvements can often deliver significant savings at low implementation cost. Almost all building types have potential savings opportunities in:

- HVAC operation and scheduling
- Lighting operation and type
- General equipment use

These main topics should be addressed in all buildings types. For ease of completion, the walkthrough is divided into four steps:

1. Quick overview of the building
2. Items to look for throughout the building,
3. Items to discuss with the manager and/or occupants
4. Specific equipment to check

## STEP 1: Overview of energy using equipment

List the major energy-using equipment in the building (include HVAC equipment, office equipment, cooking, refrigeration and other kitchen equipment, lighting, and other major installed equipment) so that you make sure to consider operation of the main equipment.

During the walkthrough, for each major energy user pay special attention to consider:

- When does this equipment need to be running? on standby?
- How is this equipment controlled? (programmed schedule, setpoint, manual operation, etc)
- How could the schedule be modified to minimize energy waste?

Before starting the walkthrough, read through the worksheet items quickly so that you know what to look for. You will not need to access rooftop units or the mechanical room during this walkthrough.

## STEP 2 Look for these items throughout the building

**Q1** ***Are occupancy sensors installed and working?*** Occupancy sensors can significantly reduce lighting energy usage, particularly in spaces that have intermittent occupancy such as meeting rooms or storage spaces.

***Ceiling and wall-mounted occupancy sensors. From flickr.com.***

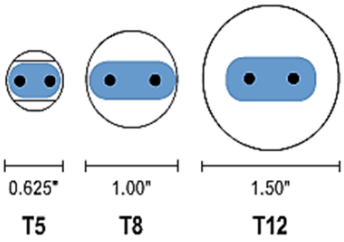
If occupancy sensors are present, verify with the manager or occupants that they are configured appropriately. For most occupancy sensors, you can adjust the timeout (delay until light switches off), 'sensor mode', and motion sensitivity. Reconfiguring the device may require looking up manual information for the particular model and removing the cover plate for the sensor.

Check for available rebates for lighting control devices.

***Are occupancy sensors placed appropriately?*** Sensors should be placed so that they can see the entrance to the space and so that they are not obstructed by doors or furniture.

**Q2** ***Are incandescent or T12 fixtures present?*** If individual incandescent bulbs are present, switching to fluorescent light bulbs is an easy and cost-effective switch. LED bulbs offer higher performance but somewhat longer payback than fluorescent bulbs.

**Switching out T12 lamps is necessary** as T12 lamps are currently being phased out of production and it will become increasingly difficult to find T12 bulbs. See Appendix 3 for information on retrofitting T12 fixtures.




Switching from T12 to T8 lamps can reduce lighting energy by 40%, and often utility incentives are available to lower the installation cost. ***At right, different fluorescent tube options from most efficient (T5) to least (T12) (from www.ballastshop.com).***

**Q3** ***Are fans or portable space heaters being used?*** Space heaters in particular are typically much less efficient than the building's central heating system. Regular complaints or space heater use indicates the setpoints for the zone of interest may need to be adjusted.

**Q4** ***Are radiators and air vents clear and unobstructed?*** If possible, resolve this issue during the walkthrough.

### STEP 3 Consult with manager and/ or occupants about these items

**Q5** ***Are employees trained in energy conservation measures?*** Including energy conservation in employee training and documenting procedures may increase the likelihood that equipment schedules and setpoints will be properly executed.

**Q6** ***Are doors / windows kept closed during heating and cooling season?*** Keeping the door closed is likely to be the number one opportunity for savings in small retail stores and restaurants. ***Image at right from www.closethedoor.com.uk***

close the door
against energy waste

**Q7** ***Are computers and monitors switched off at night?*** Institute a practice to shut down computers at the end of occupied hours. Use conservation power strips to shut down peripherals or other office equipment automatically when computer is switched off. For increased savings, set computers to auto-sleep after 15 minutes of inactivity.

**Q8** ***Are lights scheduled (time-based on/off control)?*** Time clocks can be more expensive than occupancy sensors per device but can offer a more straightforward solution in spaces that need continuous lighting over a specified time period. If occupancy sensors or time clocks are not installed, owners/occupants should institute a plan to minimize lights left on. Emergency and egress lighting requirements may need to be met.

**Q9** ***What is the most common HVAC complaint?*** If summer temperatures are too cold, this is a ripe opportunity for energy savings!

### STEP 4 Check specific equipment


**Q10** ***Are vending machines turned off or set to sleep at night?*** Vending machines with non-perishables can be switched off at the end of the day or alternatively, occupancy sensors ('vending misers') can be installed to control the machine while keeping drinks cold. To check if a vending miser is installed, look if the machine is plugged into a control unit (*see image on right*). Energy efficient lighting and models are also available.

Look for rebates for vending misers and energy efficient models.

**Q11** ***Are thermostats programmed?*** It is unlikely that the thermostat is programmed in an ideal fashion, and savings from instituting setpoints and schedules can be significant.

Using the following guidelines, you want to specify setpoint temperatures for occupied and unoccupied conditions, as well as the schedule for occupied hours. You may need to look up the manual for the specific device installed because each device is different and few are intuitive. Make sure the thermostat is in schedule mode, not override or manual mode.

If programmable thermostats are present and programmed:

**Q11a** ***Does the setback schedule match occupancy schedule?*** Verify whether the schedule programmed in the thermostat agrees with the occupancy schedule reported by the owner/tenant.

**Q11b** ***Is the heating setpoint for occupied hours 70°F or lower?*** A heating setpoint as low as 68°F may be acceptable, but below this temperature occupant comfort typically drops off quickly.

**Q11c** ***Is the heating setpoint for off-hours 62°F or lower?*** The acceptable off-hours setpoint temperature may depend on the level of activity in the building during off-hours.

**Q11d** ***Is the cooling setpoint for occupied hours 75°F or higher?*** Occupants will tolerate warmer temperatures indoors when it is warmer outdoors, so cooling setpoints up to 78°F may be acceptable.

**Q11e** ***Is the cooling setpoint for off-hours 80°F or higher?*** The off-hours cooling setback temperature may be between 75-85°F.

If thermostat is **not** programmable or is in manual mode, ask manager or business owner how thermostat is operated. In small businesses with non-programmable thermostats, two thirds of occupants manually setback the temperature during off hours. Discuss deepening manual setbacks according to the guidelines above.

**Office: Q12** ***Are copy machines, printers & fax machines shut off at the end of the day***. Sleep and standby modes on conventional equipment typically use significant energy, so the devices should be fully switched off during off hours. Power strips with integrated timers or that power off multiple devices when one lead device is switched off can be an inexpensive control option for clusters of office equipment.

**Kitchen: Q13** ***Do you have a start-up/shutdown schedule for all equipment? Is equipment idling unnecessarily?*** Most cooking equipment can preheat in only 20 minutes. Hoods, ranges, and fans should be run only when needed. Integrate this schedule into employee training. All non-essential machines should be turned off after business hours.

**Kitchen: Q14** ***Is equipment properly maintained and calibrated?*** Make sure a planned maintenance schedule is in place for equipment. Key elements for energy savings include: hood filter changes, checking door gaskets, temperature calibration, and refrigeration unit servicing.

**Kitchen: Q15** ***Are dishwashers only run when full?*** Integrate this practice into employee training.

# E3 Walkthrough Worksheet

Building:_____ Date:_____
Facility contact name: _____
Phone: _____

Building operating hours:
Weekdays _____ to _____
Saturday: _____ to _____
Sunday: _____ to _____

## STEP 1 Overview

List major energy consuming equipment in this building:_____
_____

| ✓ | If issues were highlighted in: | Pay special attention to question number: |
|---|---|---|
| | E2 Step 3: High evening / weekend / base load | 1, 5, 6, 7, 8, 11c, 11e, 12 (office), 13 (kitchen) |
| | E2 Step 2: Load schedule does not match occupancy schedule | 8, 11a, 13 (kitchen) |
| | E2 Step 5: High peak, daytime loads | 11b, 11d, 9 |
| | E1 Step 5: High seasonal variability | 10 |

Questions in **bold** below are the typically the most important to assess.

## STEP 2 Look for these items throughout the building

| # | Description | Yes | No | NA | Corrective Action / Comments | Solved? |
|---|---|---|---|---|---|---|
| 1 | **Are occupancy sensors installed and working? Are they placed appropriately?** Consult manager / occupant about functioning. | | | | | |
| 2 | **Are incandescent or T12 fixtures present?** | | | | | |
| 3 | Are fans or portable space heaters being used? | | | | | |
| 4 | Are radiators and air vents unobstructed? | | | | | |

## STEP 3 Consult with manager and/or occupants about these items

| # | Description | Yes | No | NA | Corrective Action / Comments | Solved? |
|---|---|---|---|---|---|---|
| 5 | **Are employees trained in energy conservation measures?** Consult manager. | | | | | |
| 6 | **Are doors/windows kept closed during heating and cooling season?** Consult manager / occupant. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | Are computers and monitors set to sleep or off at night? Consult manager / occupant. | | | | | |
| 8 | Are lights scheduled? (time-based on/off control)? Consult manager. | | | | | |
| 9 | What is the most common HVAC complaint? Consult manager. | | | | | |

## STEP 4 Check specific equipment

| # | Description | Yes | No | NA | Corrective Action / Comments | Solved? |
|---|---|---|---|---|---|---|
| 10 | Are vending machines set to turn off/sleep at off hours? | | | | | |
| 11 | **Are thermostats programmed? (see 8a-8e)**<br>**Are thermostats manually setback during off-hours?** | | | | | |
| 11a | Does the setback schedule match occupancy schedule? | | | | | |
| 11b | Is heating setpoint for occupied hours 70°F or lower? | | | | | |
| 11c | Is heating setpoint for off-hours 62°F or lower? | | | | | |
| 11d | Is AC setpoint for occupied hours 75°F or higher? | | | | | |
| 11e | Is AC setpoint for off-hours 78°F or higher? | | | | | |
| 12 | **Office: Are copy machines, printers & fax machines shut off at the end of the day?** Consult manager or occupant**.** | | | | | |
| 13 | **Kitchen: Do you have a start-up/shutdown schedule for all equipment?**<br><br>**Is equipment running or idling longer than necessary?** Consult manager or occupant. | | | | | |
| 14 | **Kitchen: Is there a service maintenance schedule?** Consult manager. | | | | | |
| 15 | Kitchen: Are dishwashers only run when full? Consult occupant. | | | | | |

# E4 Communicate with Owner Guidelines

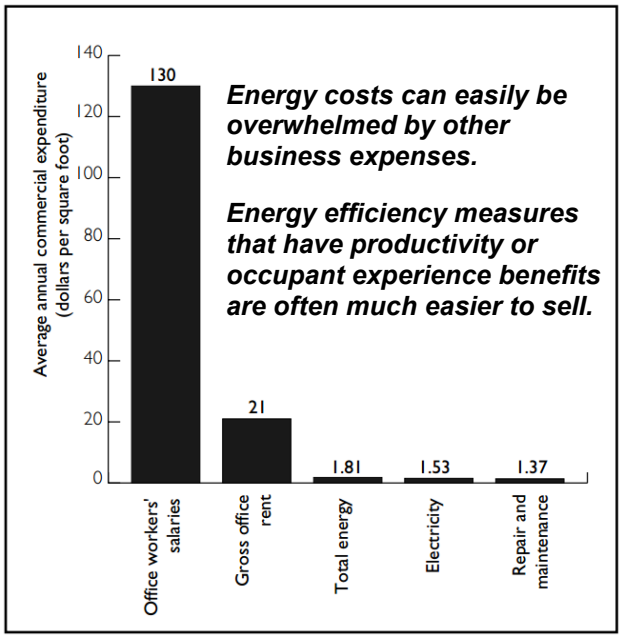
This element focuses on pitching energy efficiency upgrades to a customer, conveying the results from E1, E2, and E3 and recommending actions, identifying incentives, and setting an energy savings goal. A summary document is designed to provide straightforward, action-oriented information to the owner.

**STEP 1 Pitching energy efficiency upgrades**

Convincing an owner to pursue energy efficiency upgrades can be challenging, particularly in small buildings where the anticipated energy savings may be only hundreds of dollars per year. Business owners have a lot to deal with, so come prepared to explain why the measures you suggest are worthwhile *for them*.

***It is very likely that reducing energy use or cost will not be the most important factor. Key considerations can include:***

- Reducing risk, both financial and safety
- Reducing hassle or maintenance
- Improving occupant experience (thermal or acoustical comfort, lighting quality, odor, etc)
- Improving productivity: increasing productivity by 6 minutes a day can have 100 times the cost savings of energy efficiency measures
- Increasing property value




***Reproduced from Romm & Browning 1998, data from Building Owners and managers Association; Electric Power Research Institute; Statistical Abstract of the US 1991.***

***Identify the owner's needs and help them meet those needs efficiently***

- Owners may care more about **why** make an upgrade than **what** the upgrade is. For example, "this upgrade will provide you better lighting quality with lower maintenance and operating costs", rather than "this upgrade will be to a model XX-X lamp with a YY ballast which will provide ZZ lumens per watt and meet IESNA recommendations".
- Hone your approach for each owner: different businesses will have different priorities, decision making authority, risk attitudes as well as appetite or ability to make capital investments
- Ownership structure will impose some constraints: owner-occupied or single tenant buildings will have more flexibility than multi-tenant spaces. See Appendix 4 for further discussion of ownership structure.
- Tell the owner about a success story in a similar building in the neighborhood to drive home your point
  - Include how energy savings was only a piece of the total benefit for the owner
  - Collect these stories to use in future marketing efforts.
- Describe cost in terms of the return on the investment. A 33% annual return on investment often sounds much more attractive than a three year payback.
- Frame savings in terms relevant to the business
  - For example, "the savings would be equivalent to increasing food sales by 5%", or translate savings to hamburgers sold, staff members employed, etc.

***For non-energy benefits and energy savings estimates for each specific action, see APPENDIX 4.***

**STEP 2 Complete the Summary of Results.** From the analysis of energy data and the walkthrough, you want to provide the building owner with a brief summary information about the energy performance of the building, as well as recommendations for action.

The *easiest* way to complete the Summary of Results is to use the Automated Summary Generator, an Excel Spreadsheet document in which you fill in the blanks and use the embedded checklist to recommended action items. You will need the worksheets for E1, E2 & E3.The Summary Generator will then generate a 1-2 page summary including a table of recommendations for the building owner to consider.

If *not* using the automatic summary generator, there are a number of recommended items to include the summary. See Appendix 4 for recommendations on what to include in a custom document.

**STEP 3 Incentives Identification.** Incentives or rebates are most likely to be available for lighting replacement or control, power control of office equipment or vending machines or window tinting/films. The most frequently, a utility provides a rebate to the customer for a portion of the cost after installation is complete, but grants, on-bill financing, incentives requiring pre-approval, and incentives paid to contractor are sometimes available. If rebates or incentives are available for any of the recommended actions listed in the Summary Report, include rebate type & amount in the Summary Table under 'Incentive?'.

There are several options to identify incentives:

- Visit your customer's local utility website or call the utility and ask about rebates for small buildings
- Some tools used in E1 will identify relevant incentives, ex: PG&E Business Energy Checkup & Noesis
- Search the DSIRE Database by State for relevant incentives http://www.dsireusa.org/

If owners want to go beyond the scope of the package or are looking to purchase new equipment, higher cost energy upgrades often have incentives available. In this case, alert the owner to incentives available for energy efficient / Energy Star-rated equipment at www.energystar.gov.

**STEP 4 Setting goals with a customer.** By working with your client to set a realistic energy management goal, you have a way to assess your success. **Print this page** to bring with you to the meeting.

**What do you want to accomplish?**

- Reduce energy usage or cost by a certain % below your baseline or previous year's level
- Increase the % ranking / Energy Star score a certain number of points or to a certain level. Sometimes a special designation can be motivational, for example, buildings with an Energy Star score of 75 or higher may be eligible for the 'Energy Star Rating', which comes with a plaque.

**When do you aim to accomplish this?**

- Given seasonal energy trends, it is most straightforward to set annual goals. For example, "Reduce annual energy usage 3% compared with the baseline year".

**What is a realistic goal?** This will depend on the current status of the building, the building type, and the commitment of the owner. The package aims to achieve 3-5% reduction in energy use, but higher savings may be possible for motivated owners. In general, the worse the initial performance, the less effort it takes to achieve a 1% reduction in energy use. Below is a rough guide of feasible goals based on initial % ranking (Energy Star Score). The Energy Star Score provides a simple metric that is straightforward to obtain and can be compared across climate, building size or type.

**Potential reduction in annual energy use or cost**

*These estimates are provided to aid goal-setting and individual results may vary in specific buildings.*

| Initial % ranking or Energy Star Score | Energy Management Package with 3-10 actions taken | Energy Management Package with 10+ actions taken | Energy Management Package plus minor retrofits and equipment upgrades |
|---|---|---|---|
| 1 to 50 | 3 to 7% savings | 5 to 25% | 10 to 35% |
| 50 to 75 | 3 to 5% savings | 4 to 15% | 8 to 25% |
| 75 to 100 | 2 to 4% savings | 3 to 12% | 5 to 20% |

**Potential improvement in % ranking**

| Initial % ranking or Energy Star Score | Energy Management Package with 3-10 actions taken | Energy Management Package with 10+ actions taken | Energy Management Package with additional minor retrofits and equipment upgrades |
|---|---|---|---|
| 1 to 50 | + 1 to 3 | + 2 to 10 | + 4 to 14 |
| 50 to 75 | + 1 to 2 | + 2 to 6 | + 3 to 10 |
| 75 to 100 | + 1 to 2 | + 1 to 5 | + 2 to 8 |

## Sample Summary of Results from the Automated Summary Generator

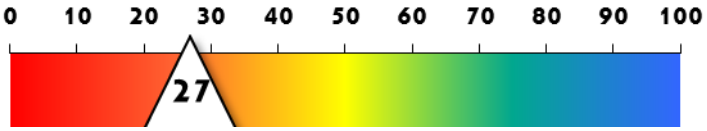
# How is your building performing?

*Prepared for Delightful Dentistry, 52 Main St. by Got your back HVAC*

Your building uses 500 kBTU/sf per year, which is more efficient than 27% of food service buildings. Your building's energy use has decreased by 5%, compared with the previous year.

Based on your percentile ranking, there are likely many low-cost opportunities to improve the energy efficiency of this facility.

By reducing your building's energy use by 5%, you could save $820 annually, based on national average energy costs. This is equivalent to selling 164 more dental cleanings per year! This program aims to use low-cost measures to reduce energy use by 3-5%, but higher savings can be achieved by completing many recommendations or additional measures with higher upfront costs.




Knowing is half the battle. But what's the other half? The following table includes low-cost opportunities to reduce your building's energy costs. The more items you choose to implement, the more energy you are likely to save. Additionally, regular energy monitoring is recommended to maintain the energy savings that you achieve.

| **Recommendations** | How easy is this? | Who? | Cost | Incentive? | Date Completed |
|---|---|---|---|---|---|
| **Train employees in energy conservation** | **Easy** | **Owner** | **$** | | |
| **Keep doors/windows closed during cooling and heating season** | **Easy** | **Owner** | **$** | | |
| **Switch off computers and monitors at night** | **Easy** | **Owner** | **$** | | |
| **Replace T12 lamps with efficient T8 lamps** | **Medium** | **Lighting Contractor** | **$$** | | |
| **Install occupancy sensors or time clocks for lighting control** | **Difficult** | **Lighting Contractor** | **$$$** | | |
| **Adjust thermostat setpoints** | **Medium** | **Owner or Contractor** | **$** | | |
| **Investigate increasing energy usage over time** | **Medium** | **Contractor and owner** | **$$** | | |

*See separate document SummaryGenerator.xlsx to make this report*

# E5 Check Results Guidelines

You've analyzed monthly data, benchmarked, looked at daily load profiles, done a walkthrough, and worked with the owner to implement improvements. After all that hard work, let's see how much you're saving!

*Plan to spend about 20-30 minutes on this element, once you have uploaded the data.*

**STEP 1 Update actions completed.** Make sure the Recommendations table on the summary of results is updated with the completion date for each action taken.

**STEP 2 Savings assessment.** Revisit the energy use tool used in Element 1, adding monthly data from recent utility bills. A list of tools that may be helpful for this element is provided at the end of the guidelines.

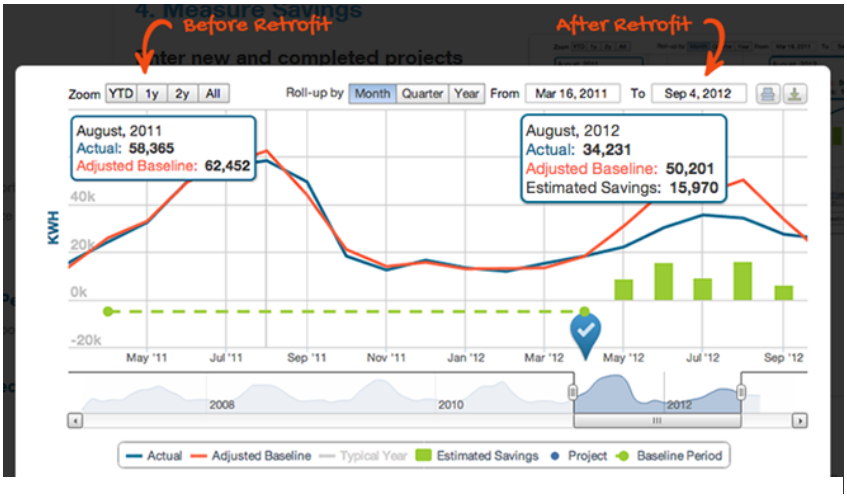
Use the tool to assess energy savings since implementing the package:

- If possible, calculate cost savings since the measures were implementated by comparing energy cost in this period to a baseline period. Some tools have this capability to estimate savings to-date.
- Alternatively plot the current year's monthly energy cost overlaid with the previous year. Note when measures were implemented and compare with the baseline (previous year). If there is a reduction in energy cost from the previous year, the line for the current year should fall consistently below the line for the previous year. The further apart the lines, the greater the difference in energy cost. The total savings is equal to the sum of the differences between the lines for each of the 12 months (the difference can be negative if more energy was used in the current year than in the previous).
- Here, plot cost in $ rather than energy use (kBTU, kWh) to show the owner savings impact.


Record how current energy use & cost compares with the year period before implementation of the Energy Mangement Package.

The expected energy savings may be relatively small (3-5%), compared with typical variability in building energy use from year to year, which can be as much as 10%. If it is difficult to see a difference between the current and baseline energy use, you may want to plot electricity and fuel use separately, comparing energy use in the current year to that in the previous year (see Element 1, Step 2).

Still not seeing savings? See Step 4 and Appendix 5.




***Energy savings compared to weather adjusted baseline from Noesis.***

**STEP 3 Update your energy use metrics**.

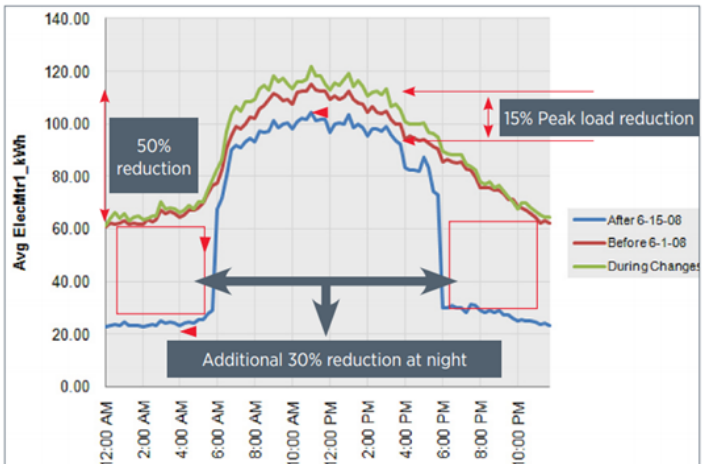
The energy use intensity (EUI) or performance percentile (Energy Star Rating) also provides you with a way to compare your building's most recent 12 months of performance with prior performance. If you have reduced energy use, you should see your EUI drop and your performance percentile/ ES Rating increase!


Recalculate your EUI or Energy Star Rating for the most recent 12 months--most tools will update these metrics automatically when you enter new bills. Record the updated metrics.

**STEP 4 Compare daily load profiles**

If you are not seeing any savings in the previous steps, you should check to make sure that scheduling changes have been implemented properly by looking at changes in the daily load profile. Following instructions in Element 2,

- Upload **current** interval data and plot daily load profiles for the most recent week.
- Compare current load profiles with load profiles before package implementation to check changes in timing and depth of nighttime and weekend setbacks.
- If the new profile is not as expected, look over the time since the implementation to see if settings may have been altered by occupants.




***Comparison between before and after retro-commissioning in an office building. From ECAM manual.***

If scheduling changes are not as intended, you may need to reprogram setbacks. Use daily load profile plots to illustrate the importance of maintaining the programmed schedule.

**STEP 5 Go further**. You've finished this period's cycle of the package, but you and the building owner are anxious to pursue even greater energy savings. What can you do?

- Revisit thermostat controls and setbacks. Can you increase the cooling setpoint another degree or two? Or lower the heating setpoint? Generally occupants are more willing to accept warmer indoor temperatures in the summer(>72°) rather than colder indoor temperatures in the winter(<68°). You may also be able to adjust setpoints for off-hours even further.
- For buildings with high seasonal conditioning loads, consider air sealing to reduce infiltration or shading or cool roof paint to reduce solar gains.
- When replacing equipment, target energy efficient options. The Energy Star site www.energystar.gov has details and savings calculators for food service & sales, office, and HVAC equipment.
- For more information on tuning buildings for optimal performance, visit www.pnl.gov/buildingretuning/

**STEP 6 Leveraging success**

While following up with customers after energy efficiency measures have been implemented, make sure to ask if there were any unanticipated benefits of the upgrade. Collect these stories and use them in your future marketing efforts. If results are exemplary, ask the owner if you can use their results in a case study. A case study flier can be particularly helpful in illustrating the value of energy management to other clients.

## Check Results tools

Tools with capabilities particularly helpful for verification and savings assessment are listed below.

Noesis Tool calculates weather-adjusted baseline behavior for a designated period, and then calculates savings to-date relative to this baseline.

GreenQuest Tool automatically submits the most recent 12 months of utility data to Portfolio Manager to retrieve an Energy Star Rating. Tool can overlay plots of cost or energy usage to compare subsequent years.

Wegowise Tool tracks your performance over time relative to a benchmark, and you can plot data before and after a designated upgrade date to show impact.

# E5 Check Results Worksheet

Building:_____ Date:_____

**STEP 1 Update Data**

Tool(s) used: _____ Username:_____ Password: _____

**Note**: Some tools can automatically generate a summary report. Use this worksheet to highlight key elements on the summary report and supplement that information where needed.

**STEP 2 Savings assessment**

List the measures completed:

| Energy efficiency measure | Date begun | Date completed | Estimated cost |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

If the tool used automatically calculates savings relative to a baseline period:

Current period start date: _____ end date: _____ savings($): _____ savings(%):_____

If no automated savings calculation:

Have energy costs decreased since implementing the Energy Management Package?
decreased greatly(>15%) decreased slightly(0-15%) same increased slightly(15%) increased greatly(>15%)
Approximate % change:
Other factors that might be affecting energy cost since package implementation:

☐ Printed a plot comparing energy use before and after the actions were implemented

**STEP 3 Update your energy use metrics**

For most recent 12 months of billing data:

EUI (w/ units): _____ for billing period: _____ to _____
Performance percentile / Energy Star Score _____ (% of homes with worse performance)
*Compare with results in Benchmarking / Monthly Data Analysis Worksheet*

**STEP 4 Compare daily load profiles**

| |
|---|
| Has the daily load profile changed?<br>Yes & setbacks are as expected  Yes but behavior is not as expected  No clear change |
| Describe any issues: |
| Describe plan to resolve, if needed: |

**STEP 5 Compare daily load profiles**

| |
|---|
| Has the daily load profile changed?<br>Yes & setbacks are as expected  Yes but behavior is not as expected  No clear change<br>Describe plan to resolve, if needed: |

**STEP 6 Leveraging success**

| |
|---|
| For each measure, did the owner / occupant notice any benefits beyond what you had discussed prior to implementation?<br><br>Is it ok to use this building as an example in our materials?  yes  no |

# Appendices

**APPENDIX 3 Walkthrough**

**How to switch from T12.** To switch from T12 to T8, you do not need to replace the entire fixture: kits are available for roughly $40 per fixture to replace the magnetic ballast with an electronic ballast so that T8 bulbs can be used. The energy savings of T8 over T12 is substantial, but T5 typically offers only slightly more savings than T8. If new fixtures are being installed, you may want to consider the smaller T5 fixtures rather than T8. This work most likely needs to be completed by an electrician.

**Additional actions to consider**

***Are there areas where there is too much lighting?*** Lamps can be removed from fixtures to improving lighting levels and reduce lighting energy consumption.

***Does Supply Air Temperature reset based on Outdoor Air Temperature (advanced reset)?*** If advanced reset is not programmed, this can lead to excessive reheating. Modification of reset schedules for HVAC processes may be needed.

***Are RTU economizers working properly?*** Energy savings from economizer operation requires regular maintenance and an appropriate control algorithm. Economizer savings can be significant in climates with high daily temperature range and summer nighttime temperatures below 70°F.

**Retrofit upgrades**

The Energy Management Package, including the Walkthrough Worksheet, focuses on energy management and operational changes rather than retrofit upgrades, which tend to require a larger capital investment. There may be cases when a retrofit measure makes economic sense for a small commercial building owner, particularly in the case of equipment replacement or if a significant incentive is available. Below is a list of energy efficiency retrofit upgrades by building type.

Office:

- Is office equipment Energy Star certified?

Kitchen:

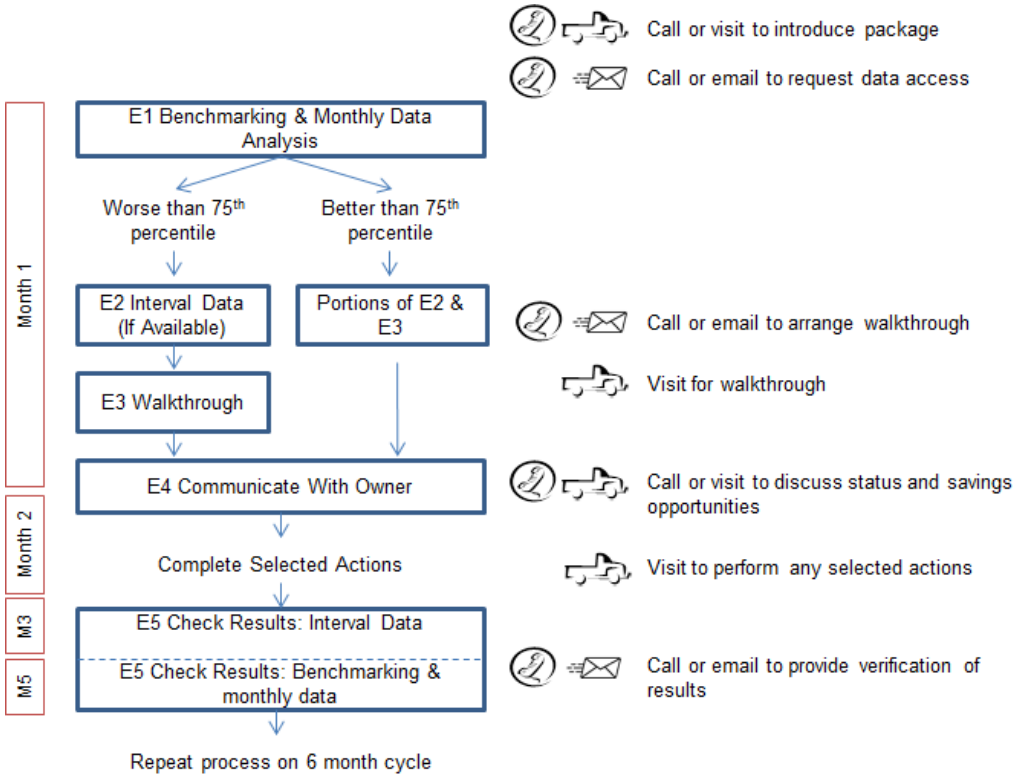
- Are doors to refrigerator, freezer, steamer properly sealed? Do gaskets on refrigerator doors need to be replaced? If you can slip a dollar bill out easily when the door is closed then replacement is needed.
- Are dishwasher sprayers equipped with low flow nozzles?
- Are exhaust ventilation systems and hoods energy efficient or have variable volume controls?
- Are appliances Energy Star certified?
- Can refrigerated display units be retrofitted with glass or curtain doors?

Food Sales:

- Do gaskets on refrigerator/freezer doors need to be replaced?
- Do walk-in refrigerators have strip curtains and install automatic door closers?
- Have shaded pole fan motors been replaced with electrically commutated motors (ECM) to reduce fan motor electrical consumption in refrigerated cases?
- Do cases and walk-in units have evaporator fan controllers, and efficient evaporator fan motors?
- Do display cases have efficient, LED lighting

## APPENDIX 4 Communicate with Owner

While E4 focusses on the communication of results and getting an owner to commit to taking action, communication is important throughout the execution of the package, as illustrated by the graphic below:




**Timeline for E4** Because E4 has a number of different types of pieces to complete, a timeline is included below. An agenda and list of documents for the meeting with the owner are also listed.

**Prior to meeting with building owner**

- Read tips on selling energy efficiency (Step 1)
- Complete the Summary of Results in (Step 2)
- Identify relevant incentives (Step 3)
- Read through goal setting (Step 4)

**Meet with building owner**

- Discuss Summary of Results & Recommendations
- Discuss how specific upgrades meet their needs
- Discuss how actions would be completed (by owner, by HVAC contractor, by lighting sub-contractor)
- Set an energy savings goal (Step 4) and action plan
- Mention that you will check results with data (E5)

**Documents to bring to meeting**

- Summary of results including table of recommendations
- Any key plots generated in E1 & E2
- Copy of worksheets from E1, E2, E3
- Goal setting guidelines

**Non-energy benefits for specific recommended actions**:

| **Recommendation** | **Energy benefit** (maybe this is obvious and we should exclude or be more specific?) | **Non-energy benefits** |
|---|---|---|
| **Train employees in energy conservation** | - Reduce energy usage | - improve buy-in to company from sustainability-oriented employees, clients |
| **Keep doors/windows closed during cooling and heating season** | - Reduce HVAC energy: Space conditioning costs can be as much as doubled when the door is kept open.<br>- Reduce space heater and air curtain energy use | - reduce rates of shoplifting<br>- less drafty / improved thermal comfort |
| **Switch off computers, monitors & office equipment at night.** Conservation powerstrips available for $20-40 can operate on a timer or shut down computer peripherals or clustered office equipment automatically when the lead computer is manually switched off. Network software can also shut on and off computers. | - Reduce electricity usage. Save $50-90 per computer per year, and $200/year per copier or printer by switching off devices at night | - less wear on equipment due to reduced operating hours<br>- potentially improved cyber security |
| **Switch off vending machines or set to sleep during off-times.** Switch off vending machines at the end of the day or alternatively, occupancy sensors ('vending misers') can be installed for under $200 to control the machine while keeping drinks cold. | - Reduce vending machine energy to save $300 per machine per year.<br>-Reduce conditioning energy required to remove excess heat (if in conditioned space)<br>  Look for rebates for vending misers and energy efficient models. | -less wear on equipment (fewer operating hours) |
| **Replace incandescent lamps with fluorescents** | - Reduce lighting energy: individual fluorescent bulbs offer estimated energy savings of $16/yr per bulb and require fewer changes. | -fewer bulb changes, purchases (savings on maintenance & disruption expenses) |

| | | |
|---|---|---|
| **Replace T12 lamps with T8, T5 or LED lamps** | - Reduce lighting energy: Switching from T12 to T8 lamps can reduce lighting energy by 40% (roughly $10-15 savings per fixture per year), and often utility incentives are available to lower the installation cost.<br>  Check for available rebates | - avoid risk and hassle associated with discontinued products<br>- fewer bulb changes & purchases reduces maintenance and disruption<br>- higher lighting quality can improve productivity and safety<br>- smaller fixtures take up less space<br>- full brightness instantly<br>- eliminates hum & flicker |
| **Install occupancy sensors or time clocks for lighting control.** Sensors cost $15-50 and are most beneficial in spaces with intermittent occupancy (meeting rooms or storage spaces) | - Reduce lighting energy: Controlling lighting using occupancy sensors or time clocks can save 24% on lighting costs.<br>  Check for available rebates for lighting control devices. | -reduces nighttime light pollution (for astronomers, bird migration)<br>- save time turning off and on lights |
| **Configure lighting control devices** | - Reduce lighting energy | - reduce frustration from poorly configured/placed occupancy sensors |
| **Program thermostats or use manual setbacks** | - Reduce HVAC energy. For example, each 1°F increase in the AC setpoint saves 1-3% on cooling costs. Reducing the 'occupied' time period by one hour per day can have an even greater impact. | - improved seasonal thermal comfort<br>- improved convenience (vs. manual nighttime or weekend setbacks) |
| **Minimize space heater usage by adjusting zone setpoints** | - Reduce electricity usage | -reduce fire hazard risk<br>-reduce workplace trip hazards and clutter |
| **Clear radiators and air vents from obstructions** | -Reduce HVAC operation | - reduce fire hazards<br>- reduce wear on ventilation fans |
| **Implement a startup/shutdown schedule for kitchen equipment** | - Reduce cooking equipment loads, as well as ventilation and space conditioning loads. Reducing idle broiler operation time by only 1 hour per day can save $300 per year.<br>- Manage peak loads | - reduce training time by standardizing procedures<br>- reduce time and hassle associated with the loss of institutional knowledge by having procedures documented |
| **Implement a maintenance schedule for kitchen equipment** | - Reduce equipment loads | - reduce critical service calls, equipment downtime<br>- reduce risk for hazardous equipment failures<br>- improve capability to plan over time for equipment replacement |

| | | |
|---|---|---|
| **Run dishwashers only when full** | - Reduce power & water heating loads | - reduce water usage<br>- minimize time to clean dishes |
| **Air seal or insulate to reduce high seasonal space conditioning loads** | - Reduce HVAC usage | - improve thermal comfort by reducing drafts<br>- improve sound insulation<br>- increase habitable square footage<br>- improve resale value<br>- increase % of hours HVAC system can meet demand/reach setpoint,<br>- reduce response time<br>- enhance fire safety |
| **Implement advanced reset to reduce simultaneous heating and cooling** | - Reduce conditioning energy | - reduce wear on equipment |
| **Repair or tune RTU economizer** | - Reduce cooling energy use | - improve thermal comfort by increasing system cooling capacity<br>- reduce wear on air-conditioning unit |

**Building occupation structures**

Small commercial buildings can be either owner-occupied or tenant-occupied. Buildings containing multiple businesses may have a mix of tenant and owner-occupied spaces. The package is expected to be easiest to implement in owner-occupied buildings where the building owner is also paying utility bills and has a strong interest in environmental quality issues such as thermal comfort.

**Owner-occupied**:

- Likely to be the best buildings to target with the Energy Management Package
- Owner can realize payback in energy savings for capital investments
- May be easier to get permission to make adjustments

**Tenant-occupied**:

- If utilities are paid directly, may be motivated to lower costs, but may be hesitant or unable to make capital or long-term investments
- If utilities are incorporated into the rent, tenants may be less motivated
- May be multiple tenants in one building which can be harder to coordinate
- It may be possible to use non-energy benefits to motivate tenants

**Summary guidelines, if not using the automatic summary generator**

E4 contains an automatic summary generator. If you would rather generate the summary of building performance that you will share with the owner on your own, it is recommended that you include the information in the following statements:

*"Your building uses **[insert EUI]** kBTU/sf, which is better than **[insert percentile ranking or Energy Star score]** % of peer **[insert building type]** buildings."*

Consult E1 Step 4 for the EUI and percentile ranking. Make sure the units of the number you are using for the EUI are correct. Comparison percentile ranking is equivalent to the Energy Star Rating.

*"Your building's energy use has **[increased/decreased/stayed constant]** by **[insert percent change]** % over the last **[insert number of years]** years"*

Consult E1 Step 3. If you only have 1 year or less of data, you will probably not be able to estimate a percentage change. To make this calculation take:

$$\%\ change = \frac{total\ energy\ use\ in\ most\ recent\ year - total\ energy\ in\ baseline\ year}{total\ energy\ in\ baseline\ year} \times 100$$

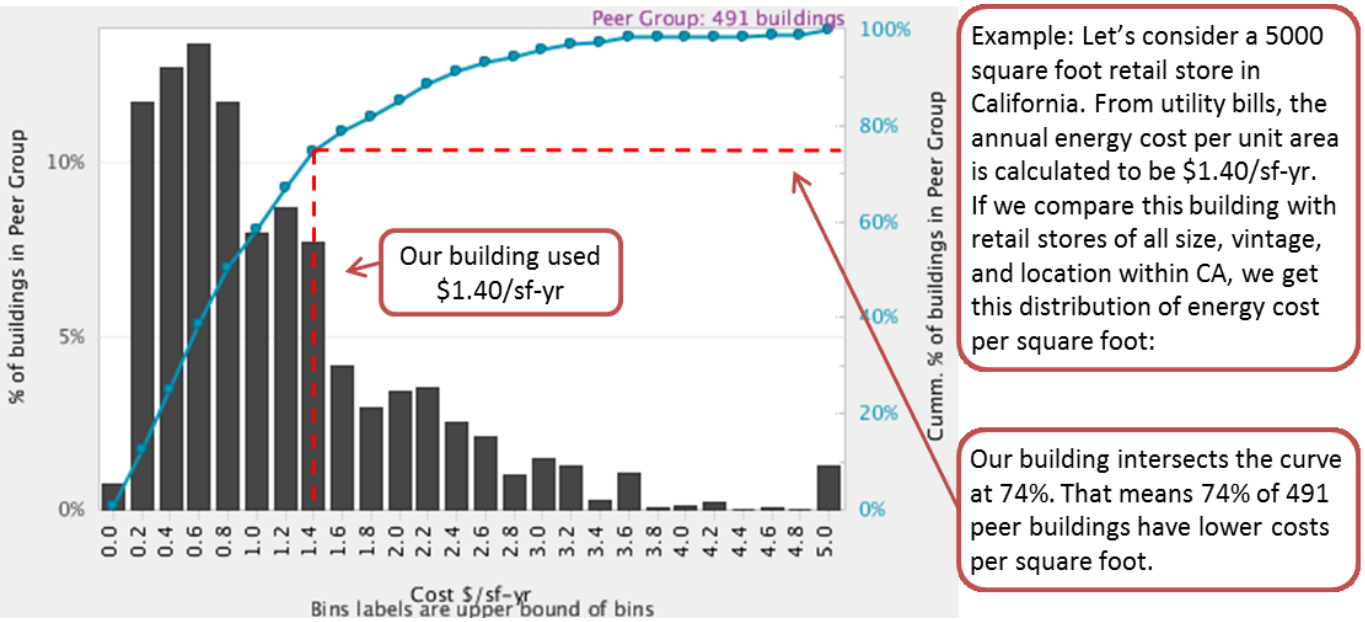
If this number is positive then energy use has increased; if negative then energy use has decreased.

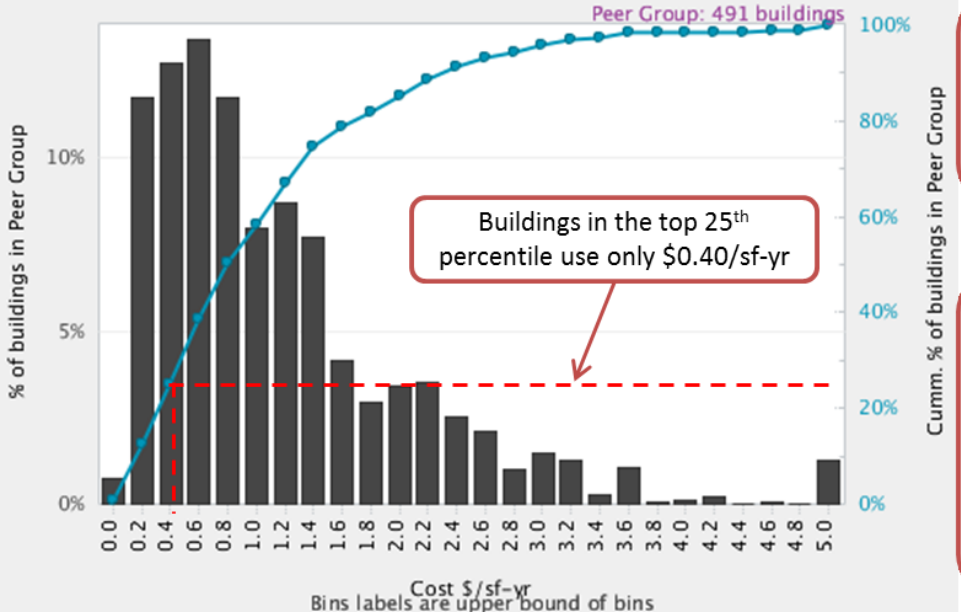
"Improving your building's performance to the 75th percentile could save you $***[insert projected annual savings]"***

First calculate the total annual energy consumption cost for your building in the last 12 months. Some tools will calculate this for you. Divide by the floor area to find the annual $/sf for your building. Then follow the example below to use EnergyIQ to determine the savings possible by improving to the 75th percentile (Note: Energy IQ refers to this as the 25th cumulative percentile).

$$projected\ annual\ savings\ [\ in\ \$/yr] = \left(annual\ \frac{\$}{sf}\ for\ your\ building - annual\ \frac{\$}{sf}\ for\ building\ at\ 25th\ cumm\ \%\right) \times floor\ area$$

***Calculate projected annual savings using Energy IQ:***






But if we could improve our building to the 25th percentile through energy management and upgrades, how much could we save?

If we could improve our building to this level, we could save:
($1.40 – $0.40 /sf-yr)*5000 sf = $5000/yr in energy costs!
The annual cost would be 71% less than the current energy cost.

**APPENDIX 5: E5 Check Results**

***Why don't I see any effect of the changes we made?*** There can be significant variability in a given building's energy use from year to year. Because a wide range of factors influence the total energy usage, total energy use varies significantly from year to year--perhaps 10%. For example, you may have additional occupants or computers in an office, or your restaurant's number of daily customers may increase or decrease slightly. The expected energy savings due to changing light bulbs or adjusting the thermostat settings are well documented and will save energy compared to if you had not made these changes, but this might be a small change compared to other changes that may have occurred in the building that year. The package is expected to lead to savings of 3-5% of annual energy usage. However, the larger the changes you make, the more likely you will be able to see the effect in your bills.

***How can I improve the energy savings estimate?*** Normalizing for the effects of weather can control for some of this variability--tools use historical local weather records to adjust for unusual weather trends. Beyond this, one might expect that using multiple years of data to calculate the baseline energy use would give you a more accurate baseline level. However, longer term changes might alter the the energy use in the building: has occupancy or equipment changed significantly over this baseline period? Typically the previous year is the best comparison for the current year (i.e., for a retrofit in March 2013, use Feb 2012 - Feb 2013 data for the baseline time period).