Stanley ENERGY

Making Buildings Better for 60 Years

Energy Analysis Handbook

www.stanleyenergy.com

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Introduction

Business owners and property managers are under constant business pressure to improve tenant services, make their buildings more “Energy Efficient” and accomplish all of this while reducing operating expenses year-over-year.

These “opposing” objectives bring to light the business challenges faced by business owners each and every day. They are too busy to focus on energy efficiency with so many other things interrupting their daily activities. When the Utility bills arrive, they just pay them and move on, as they are keenly aware of the impact on operating costs.

Business owners have a general understanding of how much the utilities cost each month but they are not necessarily aware of how those costs convert into consumption of kilo-watts, kilo-watt hours, Therms, gallons or cubic feet.

The path to reducing energy expenses is best served by using energy management software as a service to establish a baseline energy consumption profile. This easily tracks and monitors the costs of energy and the volume of kwHours and natural gas therms consumed by buildings, and begins to analyze why certain things are happening.

For example, this baseline tracking brings to light why the electricity usage might be high on a weekend when:

- The factory is closed but the heat and air conditioning are BOTH running with no-one in the building!
- An air compressor is running when no machines are operating.
- The lights are on in the building at midnight when there is no second shift.
- Every desktop computer monitor is left on when the entire staff goes home for the evening.

- Common area lighting remains on all weekend. A potential for additional savings exists with the installation of motion sensors and conversion to compact florescent lighting.

Understanding Your Electricity Bills

You may not realize it, but your monthly electric bill is a valuable tool. It tells you what, when and how you spend your energy dollars every month. By knowing how to "translate" these dollars and cents into energy use information, you can identify energy and cost-saving opportunities. Then, after you've taken steps to reduce energy use, your bill can act as a "score card" and give you monthly feedback on your progress.

Most electric bills are complex and can be difficult to read or understand. As a property or facility manager, you might not even see them on a monthly basis.

However, the operating decisions you make each day directly affect your bill's bottom line. Also, by understanding how energy is measured and billed, you can discover ways to reduce energy cost by controlling when and how energy is consumed.

Typical PSNH energy bills are broken down into three major categories of costs:[i]

Delivery Services

Customer charge: The customer charge recovers costs associated with making service available to a customer, such as installing and maintaining meters, utility poles, power lines and equipment, as well as meter reading and PSNH's 24-hour customer service center.

Distribution Charge: This charge recovers costs related to the maintenance and operation of PSNH's distribution system, and PSNH's power restoration and service operations. The KWH charge is based on the number of kilowatt-hours (KWH) of electricity used during a billing period. The KW charge, or "demand" charge, is based on the greatest amount of electricity used in any half-hour period during a billing period.

Transmission Charge: This charge recovers costs related to the delivery of electricity over the high-voltage or transmission system power lines. The KWH charge is based on the number of kilowatt-hours (KWH) of electricity used during a billing period. The KW charge, or "demand" charge, is based on the greatest amount of electricity used in any half-hour period during a billing period.

Stranded Cost Recovery Charge: This charge helps fund the recovery of PSNH's past investment costs, including expenses incurred through mandated power contracts and other long-term investments and obligations. The KWH charge is based on the amount of kilowatt-hours (KWH) of electricity a customer has used during a billing period. The KW charge, or "demand" charge, is based on the greatest amount of electricity used in any half-hour period during a billing period. A portion of this charge is owned by PSNH Funding LLC and is being collected on its behalf.

System Benefits Charge: This charge funds energy efficiency programs for all customers as well as assistance programs for residential customers within certain income guidelines.

Deregulated Supply

Energy Charge: This charge is based on the amount of kilowatt-hours (KWH) of electricity a customer has used during a billing period. It includes a supplier's costs to generate and/or buy power.

Taxes

Electricity Consumption Tax: This is a state-mandated tax on electricity consumption.

Get Going [ii]

Once you understand how your facility's electricity use is metered and billed, you can better manage your energy consumption. Next, taking the steps necessary to make operational changes to reduce these costs becomes a lot easier. For example, energy and cost-saving steps can include:

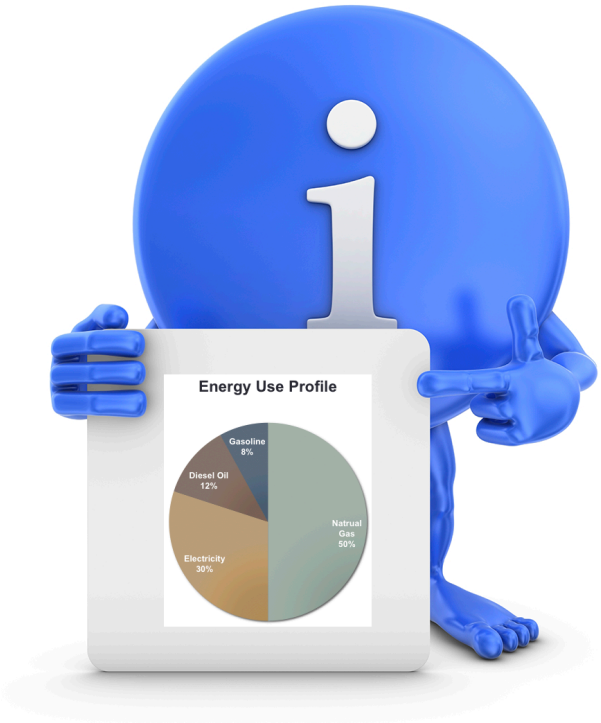
- Comparing the present bill with the bill for the same billing period in the previous year, not the previous month. There can be various usage differences in a month-to-month comparison, such as warmer or cool weather conditions or holidays.
- Developing a comprehensive energy and cost reduction plan and sharing it with your employees, and submitting the application for your building's "Energy Star" rating.
- Making utility costs known to employees.

- Getting copies of your electric bills and keeping track of monthly expenses and usage with an energy management software solution.
- Setting goals and targets for both energy consumption reduction and demand reduction.
- Looking for periods of unusually high or abnormal energy use and determining the cause.
- Identifying the time of your peak demand, determining causes of this peak, and finding ways to reduce it. Consider possible strategies for shifting equipment operations into utility off-peak periods.
- Identifying equipment that runs excessively and using automatic controls to shut it down when not needed.
- Setting controls so that operation is staggered (for instance two pumps that need to operate only one hour per day should be controlled so as not to operate at the same time).
- Understanding that utilities have different rates for different types of customers. Talk with your utility representative, and make sure you are being charged the correct rate for your facility. Inquire if there are programs offered that will allow lower rates.
- Implementing energy conservation and efficiency measures.

Image courtesy of US Navy on Flickr.

Energy Use Index and Energy Profiles

There are many ways to look at how energy is consumed in a building and but it is best to understand how much energy is used in total for the entire building for all fuels. Next, it is absolutely critical that the building owner is able to drill down into all of the details by fuel type, cost, usage by building service and usage by equipment type. Using energy profiles[iii] is a good way to gain a better understanding how energy is consumed while being able to compare and contrast charts, graphs and consumption data for each building.



Energy Use Index (EUI)

Energy Use Index (EUI) is a unit of measurement that describes the total energy consumption for each building. EUI represents the energy consumed by a building relative to its size, and is expressed in BTUs per square foot per year. It can also be used to compare energy consumption relative to the number of building types or to track consumption from year to year in the same building.

This is a measure of total energy use normalized for floor area, and is used to compare the energy consumption for different buildings. For example, whole-building energy use is measured in kBtu (1000 British thermal units) per square foot, per year, to standardize units between fuels, while electricity use is often expressed as annual KWH per square foot per year.

How is EUI Calculated?

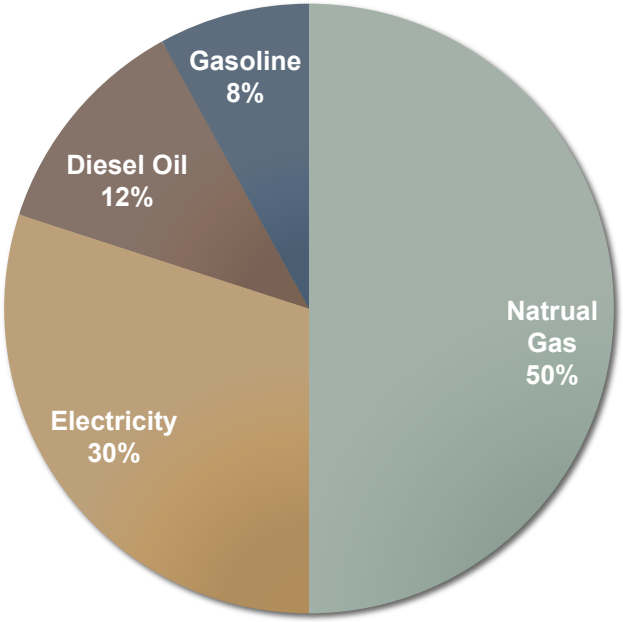
A building's EUI is calculated by converting annual consumption of all fuels consumed in one year (measured in kBtu) and dividing it by the total square footage of the building. For example, if a 50,000-square-foot school consumed 7,500,000 kBtu of energy last year, its EUI would be 150. A similarly sized school that consumed 9,000,000 kBtu of energy last year would have a higher EUI (180) to reflect its higher energy use. Generally, a low EUI signifies good energy performance.

Building owners and property managers are extremely busy and just want to understand the big picture and understand what it is going to take for them to start saving money. Energy Consumption charts for each calendar day along with energy profile graphs are the best way to summarize where and how energy is being used.

The following examples are energy "Profile" charts that can easily be provided by an energy management software solution.

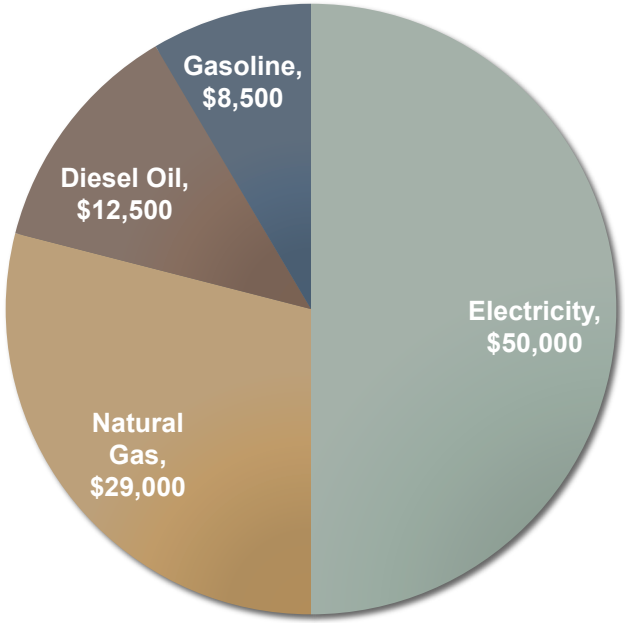
Energy Use Profiles calculate the overall amount and percentage of energy used by the fuel type.

Energy Use Profile



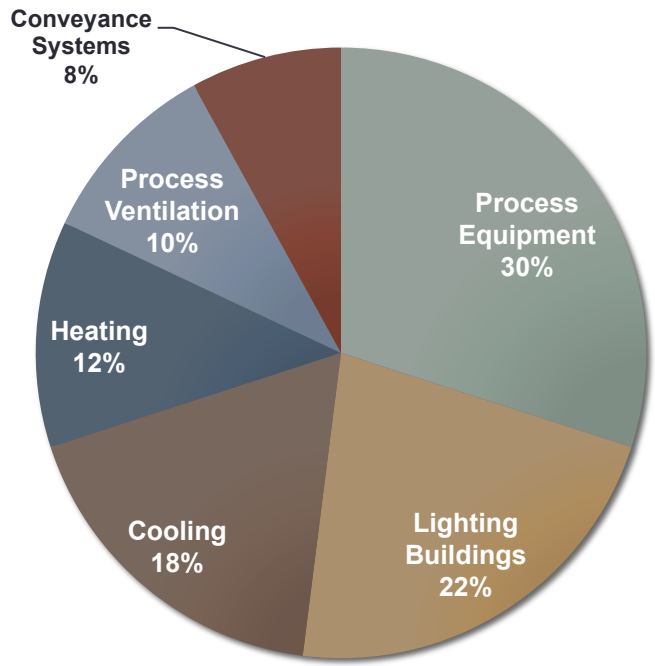
Energy Cost Profiles calculate the overall cost and percentage of energy used by fuel type.

Energy Cost Profile



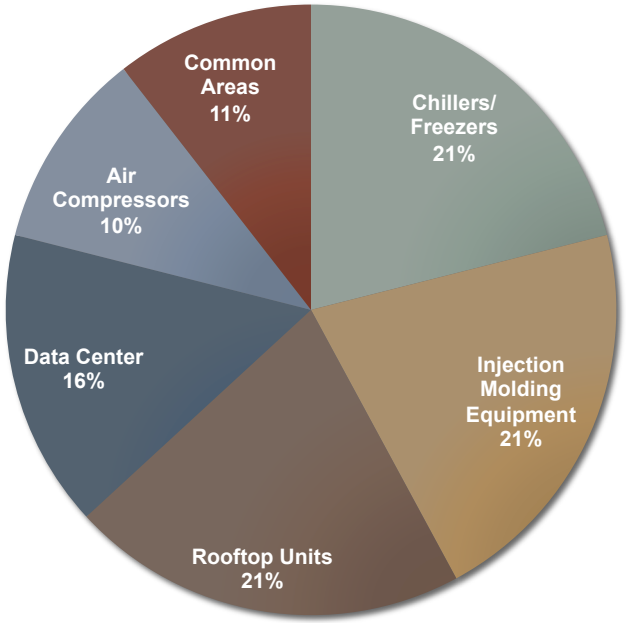
Energy Distribution Profiles calculate how much energy is being consumed by each building service and highlights major areas of energy consumption.

Energy Distribution Profile



Energy Equipment Profiles calculate how much energy is being consumed by each individual piece of equipment used in the building.

Energy Equipment Profile



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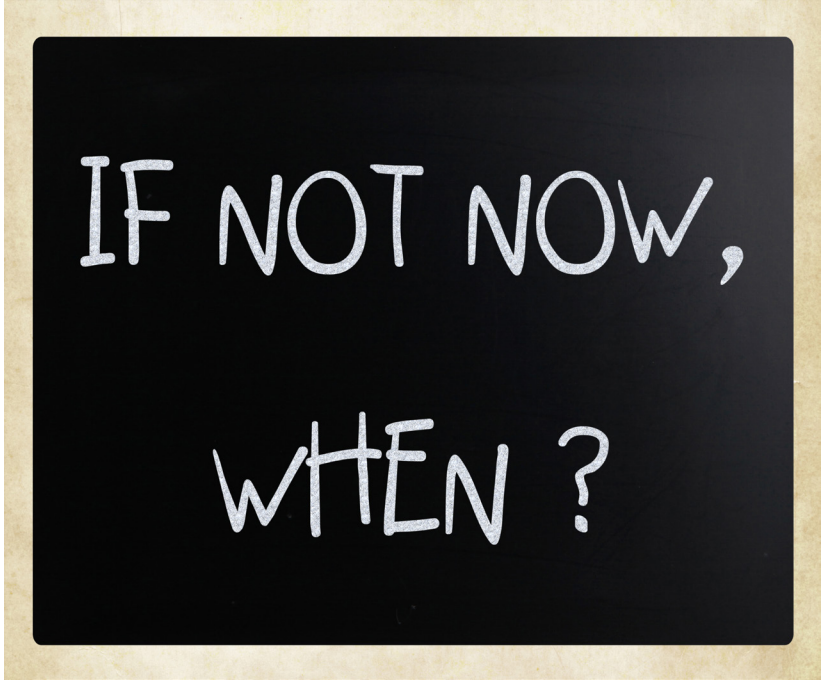
Get Going

Once you understand how your facility's electricity use is metered and billed, a good next step is to subscribe to a SaaS (Software as a Service) **Energy Management System** which would allow you to inquire into a variety of energy consumption graphs and energy use profiles. Being able to visualize operating inefficiencies highlights the areas where you can begin to attack potential savings.

Options for energy conservation and energy efficiency measures can be assessed and prioritized to deliver maximum benefit, ROI and cash flow improvements. Once the projects have been evaluated and prioritized, project tasks can be assigned to your facilities team.

- Implement a “software as a Service” Energy Management Solution that enables online web access to your utility bills, your energy consumption by fuel type and specific operational processes.
- Evaluate and implement energy conservation measures.
- Evaluate and implement energy efficiency measures.



Energy Conservation Measures (ECMs)

Managing total energy costs over time requires an energy strategy focused on quantity as well as price. Energy conservation measures can go a long way toward lowering consumption and associated costs while achieving sustainability goals and meeting regulatory compliance.

These top four high-impact measures should be included in most energy conservation projects:

- Lighting Retrofits - Almost always the quickest payback and most profitable energy conservation measure
- Building Automation Controls - Comparable to lighting in quick payback and cost-effective savings
- Water Conservation - Among the most aggressive ROI measures to provide big dollar savings and fast paybacks
- HVAC Upgrades - Can improve efficiency on a large scale

Also reference the DOE – Office Building Energy Checklist

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Energy Efficiency Measures (EEMs)

Recommended list of energy energy efficiency measures:

- **Building envelope improvement**
    - Weather/infiltration sealing
    - Increased insulation
    - High performance window replacement
    - Low emissivity reflective window film (to reduce unwanted solar gain in the summer and increase the R-value of windows in the winter)
- **Lighting**
    - "Delamping," i.e. permanently turning off/disconnecting unneeded light fixtures
    - "Relamping," i.e. replacing inefficient light fixtures or lamps with high efficiency fixtures/lamps
        - Convert T-12 fixtures/lamps to T-8 or T-5
        - Relamp 32 watt T-8 lamps with 28 watt T-8
        - Eliminate incandescent bulbs
        - Convert all exit lighting to LEDs or switch to photoluminescent signs that require no electricity
        - Beware of retrofitting with indirect lighting – while classy looking it may require more fixtures and more wattage
    - Increase reliance on task lighting in order to decrease general illumination without adversely affecting productivity
    - Improve lighting controls
        - Occupancy sensors
        - Timers (stand alone or energy management system or EMS-interfaced)
        - Daylight harvesting sensors and controls including simple photocells
    - Convert outdoor lighting to high pressure sodium

- Eliminate/reduce outdoor decorative lighting
- Consider LEDs for general indoor and outdoor illumination (the technology is almost there)
- Consider outdoor solar powered-LED light fixtures (this technology is also almost there)
- Require white or off-white wall paints for maximum light reflectivity so adequate lighting levels can be achieved with minimum lighting wattage
- When renovating spaces, design new lighting for less than 1.0 watts per square foot

- **Boilers**
  - Replace old boilers with new high efficiency boilers
  - Do not oversize replacement boilers
  - Retrofit boilers with variable flame burners
  - Consider multiple high efficiency modular boilers to improve efficiency by better matching hot water heating loads
  - Consider replacing boilers with cogenerators (which also produce electricity)
  - Control boiler output water temperature with outside air temp reset so boiler does not need to heat water hotter than necessary
  - Retrofit boilers with flue gas/stack heat recovery
- **Chillers**
  - Replace old chillers with new high efficiency chillers whose efficiency curve best matches your load profile
  - Do not oversize replacement chillers
  - Operate at peak efficiency (by adjusting water flow, load, condenser/evaporator water temps, etc.)
  - Replace old cooling towers with new high efficiency towers
- **Air conditioning**
  - Replace older AC equipment with maximum efficiency models

- Discontinue use of inefficient window units
- Reduce AC operating hours
- Turn off reheats and stop controlling humidity levels during the cooling season
- Clean cooling coils on a regular basis
- Maximize use of “free cooling” with economizer cycle
- Use open windows and passive cooling when mechanical air conditioning is not needed
- Close windows when air conditioning is in operation
- In dry climates consider evaporative cooling
- In humid areas consider desiccant cooling

- **Temperature control**
  - Reduce temperature settings in winter
  - Increase temperature settings in summer
  - Maximize night, weekend and holiday temperature setbacks
  - Install tamper proof or remote thermostats
  - Control space temp remotely by EMS
  - If occupant controlled thermostats are required, then limit range of adjustment to ensure campus temperature policy compliance

- **Motors, fans and pumps**
  - Adjust operating schedule to minimize run hours (review and update periodically)
  - Replace old motors, pumps, and air handling units with high efficiency
  - Control motors serving fans and pumps with variable speed drives (VSDs)
  - Operate VSDs at maximum acceptable turn-down; vary by time of day and occupancy; also vary by season
  - Convert constant volume fan system to variable air volume
  - Reduce outside air volume during morning warm-up cycle and where/whenever possible through damper settings and demand control ventilation

- Reduce needless pumping by eliminating three-way by-pass valves

- **Laboratory Ventilation and Fume Hoods**
  - Switch to a “green chemistry” teaching program that doesn’t require fume hoods
  - Turn off 100% outside air ventilating systems whenever possible, e.g. in teaching labs whenever classes are not in session; shut down or slow down related supply fans
  - Decommission/remove unneeded fume hoods and reduce fan system outside air volume
  - Eliminate unneeded fume hoods by using ventilated storage cabinets instead of hoods for chemical storage
  - Retrofit constant volume fume hood ventilation systems to variable air volume
  - Retrofit conventional fume hoods with low-flow hoods and reduce outside air volumes
  - Retrofit these systems with heat recovery

- **Heat recovery**
  - Run around loops
  - Heat wheels
  - Heat pipes
  - Desiccant wheels
  - Air-to-air heat exchangers
  - Install heat recovery

- **Energy Management Systems (EMS)**
  - Switch to direct digital control (DDC) systems
  - Purchase EMS systems which are easy to program (so programming capabilities will be fully utilized by facilities staff)

- Utilize and optimize use of EMS energy conservation programs, e.g.
    - Optimal start/stop
    - Night setback
    - Demand shedding
    - Remote programmed lighting control
- **Fuel Switching**
    - Consider converting electric space and water heating to natural gas
- **Energy Intelligence & feedback systems**
    - Accessible display units that show energy use and savings can have dramatic results in energy use behaviors

Get Going

The list of measures and projects listed above is a great place to start in determining which activity will have the greatest impact on your building, with your tenants and on your operational cash flow.

- Take advantage of DOE's Energy Star – energy benchmarking software to easily get started and help you establish priorities.
- Review, Prioritize and assign energy conservation measures.

Energy Star - Portfolio Manager Overview

- Portfolio Manager helps you track and assess energy and water consumption within individual buildings as well as across your entire building portfolio. Enter energy consumption and cost data into your Portfolio Manager account to benchmark building energy performance, assess energy management goals over time, and identify strategic opportunities for savings and recognition opportunities.

- Portfolio Manager is an interactive energy management tool that allows you to track and assess energy and water consumption across your entire portfolio of buildings in a secure online environment. Whether you own, manage, or hold properties for investment, Portfolio Manager can help you set investment priorities, identify under-performing buildings, verify efficiency improvements, and receive EPA recognition for superior energy performance.

- Manage Energy and Water Consumption for All Buildings

- Set Investment Priorities

- Portfolio Manager provides a platform to track energy and water use trends as compared with the costs of these resources. This is a valuable tool for understanding the relative costs associated with a given level of performance, helping you evaluate investment opportunities for a given building and identify the best opportunities across your portfolio.

- In order to take advantage of Energy Star software, your energy management solution should provide an automatic feed (or API – Automatic Programming Interface) directly into Energy Star. This feed eliminates the need for manually entering all of the data each and every month, and allows the building owners to focus on energy conservation and energy efficiency programs.

Building Energy Audit: Building Envelope, Lighting, HVAC

Energy audits can be performed on commercial and industrial buildings to assess the amount of energy currently being used and assist in prioritizing and implementing energy-efficiency projects. Energy audits use a variety of techniques to evaluate energy efficiency and identify potential efficiency improvements to lower utility bills and increase comfort. Energy Star rating is just one method of establishing a comparative baseline of the energy usage of a building. Energy audits will assist building owners and property managers in identifying ways to help lower operating costs and create a more competitive position for their building in the real estate market.

Energy audits can be obtained at no cost to the building owner and at a minimum should include a review of the building envelope and building operations.

Typical energy audit reports will include similar recommendations in the following areas:

- Building Envelope and Building Operations
- Lighting Systems
    - Occupancy sensors for lighting in amenity areas
- Heating and Cooling
    - Scheduled start and stop of HVAC equipment and lighting
- Water Heating
    - Reset boiler hot water temperatures based upon outside air temp
    - Lower domestic hot water temp to 120 degrees
- Energy Management Systems and Controls
    - Repair/ Replace defective zone control valves

    - Controls to lock out central cooling below 50 degrees
    - Controls to lock out central heating above 65 degrees
- Set space temperatures during unoccupied times up to 85 degrees/ set back to 65 degrees at night
- Annual Maintenance
    - Changing filters, cleaning coils and cleaning tubes/duct-work
- Heat Recovery Operations

Sample Energy Audit Recommendations for Low Cost/ No-Cost Energy Conservation Measures

- Install Programmable thermostats
- Insulate interior hot water pipes
- Install photocell control of parking lot and exterior lighting
- Global Control for computer monitors “off” after 15 minutes of inactivity or at night

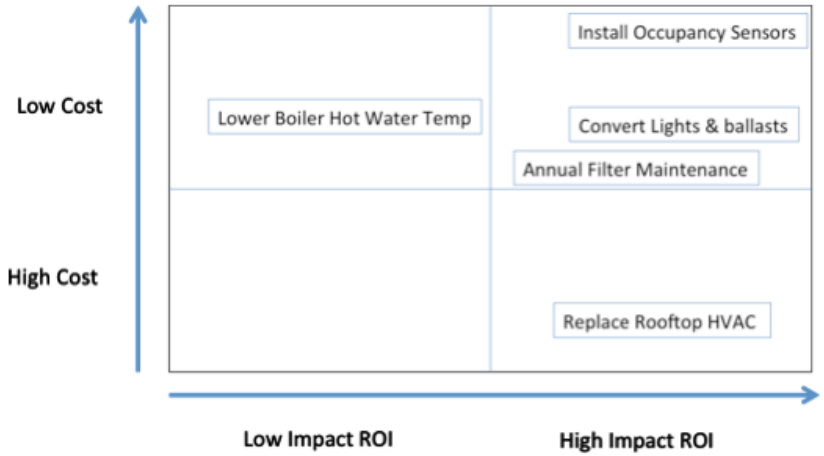
Sample Energy Audit Recommendations for Retrofit or Upgrade at next replacement cycle

- Evaluate potential savings for alternate Power Systems – Variable Frequency Drives
- Install low flow faucets, and toilets
- Install higher efficiency heating or cooling systems
- Increase roof insulation
- Evaluate window replacement
- Replace higher efficiency lighting in common areas, exit lighting and stairwell lighting

Higher efficiency lighting in room areas, especially to replace incandescent bulbs

Get Going

- Take advantage of DOE's Energy Star – energy benchmarking software to easily get started and help you establish priorities.
- Contact a deregulated energy broker in your area and request a free energy audit
- Contact your local utility company and request a free energy audit
- Review, prioritize and assign energy conservation measures and energy efficiency measures to ensure all high impact ROI and Low Cost projects are assigned and implemented first.
- Contact your local energy broker to provide a list of all available energy rebates and tax incentives.



Energy Savings Project ROI – Key Performance Indicators in Functional Business Terms

There are many options for evaluating the financial impact of recommended energy improvements. "Payback" is still the most widely used measure of value and describes the number of years it takes for the cost of an investment to be recovered through the annual savings that it provides.

Many industry corporate managers are often not impressed by proposed energy savings. Yet the same results may be enthusiastically received when impacts are related to **Key Performance Indicators (**KPIs) of the client's business operations. This means expressing a reduction in energy use (or cost) per unit that the business uses to measure output and productivity on a daily basis: tons of product, barrels of product, gallons per revenue passenger mile, energy costs per square foot, energy cost per meal served in a restaurant, BTUs per employee, or the total annual energy spent as a percentage of net income.

Defining your energy costs of production is an essential step to understanding how energy affects your productivity and profit margin. Businesses are best served by making the additional effort to carry the efficiency project ROI, Payback and Savings calculations out one step further and applying the energy costs/ savings to the functional business KPIs that represent the strategic purpose of the business.

Once the energy efficiency projects are brought back full circle and get measured in day-to-day operational terms the company will achieve true synergistic reductions in energy use.

Get Going

Armed with total energy usage data, meter data, Energy Star rankings and a prioritized list of Key Performance Indicators (KPIs), a Facilities Manager is prepared to establish a list of operational units of output that can be directly tied to energy consumed. Conversely, all energy conservation measures and energy efficiency measures can now be expressed in operational business terms

- Define your organizational business metrics or production measurements.
- Redefine your current energy efficiency project in terms of Business KPIs.
- Create company, employee and/or tenant awareness with lobby and cafeteria based energy reporting kiosks.

Establish an on-going measurement, monitoring and tracking program for these newly established KPIs.

Best of luck with launching your energy analysis!

Endnotes

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[i] Public Service Company of New Hampshire - http://www.psnh.com/Templates/WideContent.aspx?id=4294967623&terms=psnh bills

[ii] State of Wisconsin Business Programs – Understanding your Electric Bill - Technical Data Sheet, Page 2, (2007), (Taking Action, Next Steps)

[iii] Al Thuman, William Younger, Terry Niehaus, Handbook of Energy Audits, Fairmont Press, pages 33 & 34, 8th Edition, 2010