

White Paper #2

April 28, 2009

Energy Audit Basics

Considering an audit? Here are some of the things you can expect.



Note: These are the high spots only. Depth of data gathering, analysis, and detail will vary depending on customer and fee. Free audits are much less rigorous than paid-for audits.

Preliminary

- Identify the industry segment, and understand basic common drivers of energy use
- Know the top 3-5 items that probably constitute the bulk of energy use

Utility Tariff Review

- Identify unit cost of energy for gas and electric.
- Identify unit cost of demand kW.

Utility History Review

- Identify patterns and anomalies
- Establish the energy use index and compare to benchmark data if available
- Benchmark data will gauge whether the customer's use seems normal or abnormal
- Benchmark data will also provide early indication of relative potential savings
- For buildings with multiple 'segment' use, determine proportions and create an "adjusted" benchmark. This will provide insight as to where the energy use should be
- Use kBtu/SF-yr as the unit, not \$/SF-yr since this is more stable (utility rates change)
- Determine load profile by month for insight into end use patterns
- If available obtain load profile by hour for even better insight. Not all customers have time of use meters, but they may so ask
- Determine load factor and fraction of bill that is demand. Poor load factors are sometimes an opportunity to spread out load
- Review energy use with respect to weather to understand the extent to which energy use is weather dependent

Questionnaire

- Inquire about usage habits, hours of occupancy, number of people, when equipment is turned on and off, etc
- Inquire about basic energy using systems including lights, HVAC, process equipment

- Inquire about computer rooms, size, and cooling load. Cooling load is a good indicator of computer equipment actual load, since they balance.
- Ask questions that lead to the understand of the primary energy use points
- Determine if process equipment dominates the usage
- Prepare the customer to have a person to escort you through the facility for 4-8 hours Large facilities will take more time

Field Work And Some “Look-For” Items

General

- Visit major equipment and large points of energy use
- Walk the interior spaces and spot-measure temperatures and lighting levels
- If utility graphs show usage is temperature dependent, look hard at HVAC system
- Look for large exhaust flow points that are adjacent to coincident large make-up air points
- Look for negative pressure building

“Look For” Items – Maintenance

- Systems well understood?
- Mechanical areas kept clean?
- Heat exchangers kept clean?
- Chiller and boiler heads been off lately?
- How does the cooling tower basin water look? That’s what the condenser tubes see
- Look at the filters and also the coils inside – often the filters are changed just before the audit starts

“Look For” Items – Point Of Use Conservation

- Over-lit areas
- Areas kept too warm or too cold. ASHRAE Comfort Envelope says 74/50 percent rH in summer and 70 winter will satisfy most of the occupants most of the time, if appropriately dressed
- Lights on in unoccupied areas, and also outdoor lights on during the day
- Heat/cool overlap
- Control valves and dampers that don’t fully close (leaking hot water control valves can account for up to 20 percent of summer cooling load if the boilers are on!)
- Kitchen hoods left on all the time
- For process equipment, determine the relationship between production and energy use. E.g. when equipment is idle, is it still consuming energy?
- Large transformers located indoors (heat load)
- Small 24-7 cooling loads served by large house systems, forcing them to run continuously for this small area
- Computer rooms. These are very large energy users per SF. Energy Use Index can be 10x that of other areas, per SF.
- High flow plumbing fixtures, esp. where hot water is used. Restricted flow fixtures, low volume basins or tubs, etc. can be effective to nip this energy and water use in the bud.

“Look For” Items – Automatic Temperature Control

- Continuous operation of equipment
- Duct static pressure set too high – try 1 inch w.c. and see if it works OK
- Supply air reset on VAV air handlers
- Space temperature adjustments allowed from local tenant
- Chiller condenser water temperature settings too high
- Control overlap in air handlers for sequenced items
- Chillers left on in winter
- Boilers left on in summer
- If trends and logs are available, obtain run hours and pct load for large equipment. This will establish load profiles.

“Look For” Items – Demand Charges

- Equipment run concurrently that could be spread out
- Electric space heating that could be staged through the control system
- Over-sized equipment

“Look For” items – Envelope

- Single Pane Glass
- No wall insulation
- Minimal (0-2 inch) roof insulation. A good place to view this is the cut-out at a roof scuttle.
- Leaks around doors, window frames, and openable windows
- Large East and West glass exposures that aren't shaded or Low-E coated.

“Look For” items – Equipment Efficiency

- Electric resistance heat. Rates vary, but electric heat usually costs 70% more than natural gas for simple heating tasks.
- Types of lighting that could be changed to a more efficient type. (incandescent, T-12 fluorescent, high intensity/metal halide, etc.)
- HVAC air economizer and compressor should lock out below 55-60 degF
- Old equipment that may be inefficient. Some equipment more than 10 years old can consume 50 percent more power than new equipment.
- HVAC fan horsepower in relation to cooling horsepower. Common (but not great) practice ends up with fan HP being half of the cooling HP, or 1/3 of the total. This is usually indicative of ductwork downsized to save initial dollars, but this builds-in excess utility costs for the life of the building.
- Central cooling plant auxiliary pump horsepower and cooling tower fan Hp in relation to chiller horsepower. Good designs keep the auxiliaries in proportion; pumps combine to not more than 0.1 kW/ton and cooling tower fans limited to 0.05 kW/ton.
- Equipment in poor condition – esp. dirty or fouled heat exchange surfaces, or loose fins on air-cooled equipment. Measurements of “approach temperatures” are used to verify. For example, if a boiler produces 180 degF water, a 280 degF flue may be normal but a 380 degF flue temperature may indicate fouling – the blocked heat exchanger means the excess heat goes right out the roof. Each type of equipment has a characteristic “new, clean condition” approach which is the best way to gage fouling.
- Boilers with excess air (combustion test required).
- Standby losses from idling equipment that could be turned off.
- Domestic water heater “side arm” from the boiler, requiring the boiler to be active year-round

- Short cycling of primary equipment during part load demand creates standby losses for gas fired equipment

Analysis And Report

- Estimate energy use from various sources. Compare sum total of expected energy use to actual utility bills and typical end-use break down where applicable benchmarks and “pie charts” exist. This step is a vital sanity check.
- Take care not to over-estimate savings. Not only would owner confidence be lost, but their budget may depend upon the accuracy of the estimates
- Estimate demand savings, but only if the demand savings will occur during a peak time
- Look hard at control routines being used. Automatic control systems are an excellent facility management tool and usually underutilized.
- Look at ventilation. Often ventilation is LESS than it is supposed to be and correcting this will ADD energy costs. In cases where ventilation is too much (say, when operating unoccupied but the damper is still open), savings can be found.
- For equipment side, larger and less efficiency equipment should be targeted
- Recommendations should begin with points of use and work back
- Group the recommendations.
 - Low-Cost – relatively easy, quick items
 - Capital – investment required, cost identified, payback or ROI. Sometimes this category is sub-divided into medium and high capital expense.
 - Strategic – smart choices to make for long term energy frugality
- If costs are estimated, include design fees, escalation, contingency, and general conditions. Remember that retrofit costs are higher than new construction costs.
- For equipment that is in need of replacing anyway, the “cost” should not be normal replacement, it should be only for high efficiency upgrade. Energy Conservation payback should not be saddled with normal replacement costs. These should be budgeted anyway for normal expected life spans
- Identify system issues noted, safety issues noted, etc. observed during the survey.
- Non-energy benefits, such as labor savings and pollution avoidance, may or may not be included.