

Energy Audits

BENEFIT CUSTOMERS, HVAC PROFESSIONALS ALIKE

Can be a great addition to existing portfolio of technical services.

BY SCOTT GORDON, NEBB CP, CEM, CM

Images courtesy of the author.

Energy auditing is a technical service that brings tremendous value to HVAC contractors, technicians and their customers. Performing energy audits is a service that contractors can add into their existing portfolio of technical services.

Three energy audit facts

→ They are often called energy surveys, assessments or studies. These are essentially all the same. The objective of an energy audit is to identify opportunities to reduce energy waste in a building or facility; with the goal of building a compelling business case based around sound financial justification.

→ Alone they do not reduce energy costs for a customer. Only the implementation of opportunities discovered through the effort of an energy audit reduces energy costs. The opportunities discovered through the effort of energy audits are typically called Energy Conservation Measures (ECM) or Energy Efficiency Measures (EEM).

→ If it ends up as a report that sits on a shelf, then it is a waste of time, effort and money. Only the implementation of ECMs will drive energy savings for customers, while generating energy-related project work for the HVAC professional. An energy audit is a win/win for everyone involved.

Benefits of energy audits

HVAC contractors and technicians are perfectly positioned to provide energy audits as a valuable service to their customers. Benefits of energy audits include:

Contractors

- Differentiates contractor's company from the competition.
- Converts existing service agreements to Energy Saving Service Agreement (ESSA).
- Secures new service agreements as ESSAs.
- Builds retrofit opportunities and increases sales revenue.
- Strengthens customer relationships.

Technicians

- Adds a valuable skill to current toolbox of services.
- Expands knowledge base of other building systems.
- Provides a service that can be performed during slower times of the season.
- Enhances value to the company.
- Increases income.



⌘ Measuring combustion efficiency on a boiler is one of many transferable skills that can be used when performing energy audits.

Customers

- Reduces energy waste and associated costs.
- Provides the ability to upgrade equipment and have energy savings pay for it.
- Reduces repair costs associated with maintaining older inefficient systems.
- Improves comfort and general indoor environmental quality.
- Improves reliability of equipment operation.

Transferable skills

HVAC contractors and technicians already possess many skills that transfer directly into energy auditing. Many energy auditors struggle with HVAC systems; this area is home base for HVAC contractors and technicians. Many of the skills used to test HVAC equipment transfers directly into lighting and electrical systems.

Skills that HVAC professionals already possess, such as problem solving, understanding systems, controls and general building construction, transfer directly into developing energy auditing as a new skill.

HVAC professionals have a solid background of electrical theory, heat transfer, air and hydronic distribution systems and combustion burning systems; all which transfer directly towards the field of energy auditing.

The efficient implementation of energy audits is a team effort for contractors, leveraging the strengths of technicians to obtain the field data and identify opportunities that have the potential to drive energy savings. Developing the financial cost justification portion of the energy audit requires energy calculations to be performed, which is a skill that can be learned by HVAC professionals that are familiar with spreadsheets.

An excellent resource to aid in performing energy calculations is NEBB's *Handbook for Energy & Water Calculations*, First Edition, 2015. The handbook includes an Excel spreadsheet (on CD) that has more than 20 energy calculations developed, including weather data for 76 cities across North America. The handbook and calculator are available at: www.nebb.org.

Instrumentation

In addition to transferable skills, most of the instrumentation that HVAC professionals use is also transferable when performing energy audits. Some instruments that may need to be added to the toolbox include:

- Light meter
- kW/power factor meter
- Data loggers (temperature, R/H, lighting level)
- CO₂ meter
- Thermal infrared imaging camera

Audit process: levels of effort

ASHRAE has established procedures for the levels of effort in performing energy audits. Energy audits are classified as:

- Level 1—Walk-through analysis
- Level 2—Energy survey analysis
- Level 3—Detailed analysis of capital intensive modifications

Prior to any level of energy audit, a Preliminary Energy-use Analysis (PEA) is performed to determine a building's current energy consumption and cost efficiencies relative to other similar buildings.

Energy Star Portfolio Manager (www.energystar.gov) is a free online tool that provides a common benchmark comparison for peer building types, with a score between 1-100. One being the least efficient, and 100 indicating the highest energy-efficient building.

All comparisons are made using a database of similar building types (office buildings, hospitals, schools, hotels, etc.) in similar geographical regions.

ASHRAE's publication *Procedures for Commercial Building Energy Audits*, Second Edition, is an excellent reference for detailed information on the process of performing the various levels of energy audits.

Below is a brief description of each level, remembering that the first step is to perform a PEA:

→**Level 1**—Perform a brief walk through of the building to identify low-cost changes with estimated energy savings. Potential capital improvement projects with an initial rough estimate of potential costs and savings is provided.

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→**Level 2**—Building upon the Level-1 effort, a Level-2 energy audit is the most common level, and identifies specific ECMs with associated costs and energy savings. Level 2 analysis will provide adequate information for the owner to act upon recommendations for most buildings and for most measures.

In order to identify and develop specific ECMs, a deeper study of the facility is performed (over the Level-1 audit) by reviewing available as-built mechanical and electrical drawings to understand what equipment and systems serve the facility.

Review the Building Automation System (BAS) to identify opportunities such as: improve schedules, set-points, and control sequences, including temperature and pressure resets. The BAS is an area that has significant opportunity to reduce energy waste and drive savings.

Tuning the BAS is one of the most cost-effective areas that has the potential to generate significant energy savings at a low cost to implement. The savings from control system retuning helps pay for longer payback measures, such as equipment replacement or major control system upgrades.

It is important to mention the act of “bundling” energy savings to blend the longer payback measures in with faster payback measures. When a customer has major capital intensive needs such as replacing old inefficient HVAC equipment, it is helpful to bundle low-cost measures that provide high energy savings (such as control system retuning) in with the longer payback measures.

Bundling helps build a compelling business case based around financial cost justification. If a customer chooses to implement only the low hanging fruit (low cost/high savings measures), then the added savings is gone and the longer payback measures stand alone. Building a compelling business case for the stand-alone high capital intensive measures is more difficult when they are not bundled in with the faster payback measures.

Testing is performed as required to establish how the equipment and systems are operating. KW should be measured on all motors 5 hp and larger, and is used in energy calculations. Motor tag hp should not be used, as variables including: voltage, amperage, load factor, power factor and motor efficiency all impact the actual brake horsepower that is less than the hp on the motor tag.

The energy consumption is disaggregated by building system in order to determine where the energy is being used throughout the building or facility. Another reason to disaggregate the energy use is to establish the current energy costs that each system has towards the total utility bill, so that estimated energy savings is compared against the appropriate portion of the bill.

Examples of disaggregated energy use:

The primary building systems that are typically disaggregated are:

- HVAC
- Lighting
- Plug loads
- Domestic hot water
- Laundry
- Refrigeration
- Process loads
- Others

Identify ECMs, estimate implementation costs and associated savings (including energy and maintenance/repair). Prepare



⚡ There are three levels of effort for performing energy audits.

a financial evaluation showing each ECM financial impact including: Return on Investment (ROI), Net Present Value (NPV) and Simple Payback (SPB).

Investigate available incentives, rebates and grants in the contractor's area. Add the proposed incentive into the financial summary to show the customer the financial advantage and positive impact that the incentive has. Look at incentives, rebates and grants as “energy coupons” that help to buy down the project cost.

→**Level 3**—The third level focuses on potential capital-intensive projects identified during a Level-2 analysis. It requires more detailed field data gathering as well as more rigorous engineering and economic analyses. In the Performance Contracting world, a Level-3 audit is called an Investment Grade Audit (IGA). Often a Level-3 audit uses a comprehensive life-cycle cost analysis (LCCA) as a decision making tool.

Targeted energy audit

A targeted energy audit focuses on a particular system or group of systems in a facility. The Level 1, 2, 3 energy audit provides a comprehensive approach to energy savings, while the targeted audit hones in on particular building systems such as:

- The feasibility of a specific technology, such as Thermal Energy Storage (TES) systems.
- Central chiller plants.
- RTU replacements.
- Control system upgrades.
- Lighting system upgrades.
- Building envelope.

It is important to keep in mind that there is a logical order when implementing energy projects. If the customer has deep energy retrofit needs that extend beyond the HVAC system (such as building envelope, lighting or roof replacement), it is critically important to understand the interaction and impact that these retrofits will have on the HVAC system.

For example, if HVAC systems are replaced in a building that has an old roof and inefficient windows, then two years later when a new roof with higher R-value insulation is installed with high efficiency glass the HVAC system will be oversized for the building. Another example is installing an LED lighting system that generates less internal heat, which reduces the cooling load, while increasing the heating requirements. Depending on the climate zone that the building is located, the impact of this scenario will vary.

In the HVAC world, it is tempting to replace equipment first, then the customer may implement a lighting or building

envelope upgrade at a later date. Keeping the customer's best interest in mind, it is important to think through how different ECMs impact and interact with other measures. If building envelope improvements are needed, it is important to complete them prior to upgrading major HVAC systems. Once the building envelope upgrades are decided on, and as the work is being performed, the HVAC upgrades can start.

Energy conservation measures (ECM)

When surveying a building during an energy audit, it is best to discover the problems, then develop the most appropriate solutions. Saying it another way, do not go in with a solution in mind looking for a problem that fits a solution. Look first to understand and discover the problems, then develop a specific solution set to solve the problem(s).

There are literally hundreds, if not thousands of potential ECMs. ECMs are broken down by system type, such as chillers, boilers, pumps, air handlers, controls, etc. The goal is to apply the most appropriate ECM to address the opportunities discovered during the energy audit. Think of ECMs as a tool; there is a right tool for every job, just as there is a correct ECM for every energy reduction opportunity. ECMs are just another tool in the tool box. Below are some common ones:

Control system retuning

- Optimize schedules
- Implement optimal start/stop
- Keep outdoor air dampers closed during morning warmup/cooldown
- Implement discharge air temperature reset
- Implement discharge duct static pressure reset
- Implement Demand Controlled Ventilation (DCV)
- Implement pump pressure reset
- Reduce minimum airflow set-points on VAV systems
- Optimize economizer operation
- Calibrate sensors

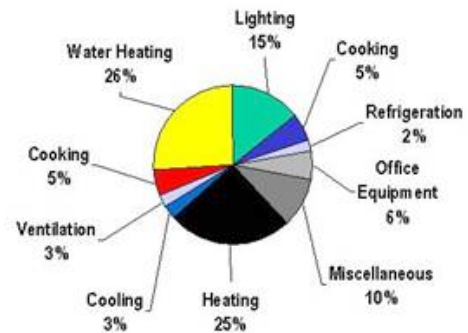
Air Handling Units (AHU)

- Clean coils
- Set correct airflows to match the load
- Add VFDs
- Install high or premium efficiency motors
- Repair, enable or install economizers
- Reduce duct static pressure
- Add energy recovery
- Calibrate airflow measuring stations
- Adjust outdoor air to maintain slightly positive building pressure

Chillers

- Clean condensing coils (air or water cooled machines)
- Check and maintain correct refrigerant charge
- Minimize oil migration
- Add VFD
- Implement chilled water temperature reset
- Implement condenser water reset
- Replace chiller with higher efficiency machine
- Add Thermal Energy Storage (TES) to an existing chiller plant (reduce demand charges)

Energy Use in Hospitals (averaged across climate zones)



Source: *Managing Energy Costs in Hospitals*

⚡ Disaggregated energy use in the average hospital.

Boilers

- Implement hot-water reset
- Reduce steam pressure
- Preheat combustion air
- Install oxygen trim controls
- Provide dual fuel burners
- Install stack heat recovery
- Install blow-down heat recovery

Pumps

- Trim impeller or install VFD when over pumping
- Right size the pump for the load

In addition to HVAC specific ECMs, there are many other categories of measures for lighting and the building envelope. ECMs need to be well thought out, as there are interactions of different measures that can cause unintended consequences. One measure is resetting discharge air temperature and duct static pressure together on a VAV system. As the discharge air temperature resets up, warmer air can cause VAV boxes to open up more, thus increasing fan speed and fan bhp.

Energy audits are a win/win scenario for both the HVAC professional and their customer. There are many transferable skills that the HVAC professionals have that dovetail into energy auditing. Energy auditing is a valuable service that adds tremendous benefit to contractors, technicians and their customers. 📞

Scott Gordon owns EBCx Services, and has over 40 years of HVAC industry experience. Gordon learned the trade from his father, Cal Gordon, founder of Tropic Air Conditioning in Miami, FL. He obtained his Journeyman license at the age of 19, and earned his Class-A Certified Air Conditioning Contractor License (FL) at age 21. His career includes decades of real world experience, coupled with continuous training. He holds certifications with NEBB for TAB, Cx, RCx and Building Enclosure Testing. Additionally, he holds multiple certifications with the Association of Energy Engineers (AEE), and is a LEED AP Operations & Maintenance. Gordon can be reached at scott@ebcxservices.com or 423-737-5085.