EIGHT WAYS IN WHICH A POOR QUALITY ENERGY AUDIT CAN PROVE COSTLY TO THE BUILDING OWNER

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ABSTRACT
It is short-sighted to hire a low cost energy auditor. In the long run, a poor quality energy audit can end up costing a building owner many times the cost of the audit. This paper details eight ways in which a poor quality energy audit can result in decreased energy savings, higher installation costs, and squandered opportunities. Some of the ways in which energy audits lead to less than desirable results include: missing the most beneficial energy efficiency measures, suggesting measures that do not save energy, and not including a scope of work. Examples of problems we have encountered in poor quality energy audits are provided in this paper. Ultimately, it is up to the building owner to ensure that energy audit quality does not hinder energy efficiency goals.

INTRODUCTION
If you needed representation in a serious lawsuit filed against yourself, would you use an unemployed neighbor to represent you in court for a pittance? Or would you hire a seasoned but expensive expert lawyer? You likely would have opted for the seasoned professional to perform the job because you wanted to ensure that your outcome was favorable. So why would building owners consider using an inexpensive amateur to perform an energy audit on their building?

Perhaps the reason why many choose a less qualified energy auditor may be because they are uninformed about the effects that a good or bad energy audit can have on their energy efficiency efforts. Because they do not know, and are trying to conserve company resources, they then may pick the least cost auditor, who ends up delivering a poor quality energy audit.

There is a human tendency to think in a short-sighted manner—we look for short-term benefit, and tend to ignore the long term risks. In selecting an energy auditor, this is often the case. Even though money could be saved on a low bid energy audit, in the long term, the poor quality of the resulting audit can end up costing the building owner many times what they spent on it.

This paper will detail eight ways in which a poor quality energy audit can cost the building owner money.

THE PROBLEM: GOOD ENERGY AUDITS CAN BE EXPENSIVE
To some, energy audits are perceived as expensive. It is difficult for some building owners to spend thousands of dollars only to receive a stack of paper, which in itself does not reduce energy costs. Additional money must then be spent installing the actual technologies in order to reduce the energy spend. A traditional ASHRAE Level II audit could cost between $6000 and $25,000 for a 100,000 square foot office building, depending on the level of detail required, complexity of the building's heating, ventilation, and air conditioning (HVAC) systems, and other factors. Some building owners, in response to the high costs, prefer to find a low bid contractor to provide the energy. A problem with low bid contractors is that they may be new to the business, have little experience, and produce a poor quality energy audit.

THE OTHER PROBLEM: POOR QUALITY ENERGY AUDITS CAN BE MORE COSTLY IN THE LONG RUN
There is a significant difference between a good and a bad energy audit, as well as how these audits can affect a building owner's cash flow. A good energy audit will provide the building owner with a specific plan that can be used to reduce energy in their building. A poor audit will miss energy conservation opportunities, and will not provide a clear description of what needs to be done, which may ultimately lead to squandered energy cost savings opportunities. Good and poor quality audits may all have the same format and sections, but what matters is the quality within the content, and how this content can lead or mislead the reader.

HOW DO ENERGY EFFICIENCY PROJECTS FAIL?
There are two ways an energy efficiency project can fail to deliver a good return on investment (ROI). Either poor energy efficiency projects were selected to implement in the first place, or the contractor did not implement the energy efficiency measure correctly. Both of these problems can be averted by a sound energy audit that

accurately advises the building owner which are the best measures to implement and that gives a clear and complete description of the measure recommended so that the contractor is more likely to install it correctly.

WHY DO BAD AUDITS OCCUR?

There are many possible causes of poor work. The most likely causes are: 1) either the auditor does not have the proper experience to conduct a rigorous energy audit and 2) that in order to compete and win the audit job in the first place, the auditor had to bid a low price, and therefore the auditor was not able to budget enough time to perform good work. The first cause is due to shortcomings of the auditing staff. The second cause is due to a poor decision by the building owner to select a low bid auditor, who may have had the experience and skill to produce a good audit, but just could not budget the time based on the low audit cost. The ultimate responsibility for a bad audit, unfortunately, lies with the building owner who selected the auditor in the first place.[1]

EIGHT WAYS IN WHICH A POOR QUALITY AUDIT CAN PROVE COSTLY

Energy audits are supposed to provide expert direction to building owners so that they can reduce their energy costs with the least investment necessary. However, poor quality audits may not provide the best direction to this effect, and can result in hundreds of thousands of dollars in energy savings not realized. Below is a list of eight ways in which a poor quality energy audit can end up compromising an energy efficiency program.

1. Audit Only Applies Simple Measures and Misses the Most Beneficial Measures

Finding lighting, plug load, and envelope measures is easy, and even beginning auditors find these types of conservation measures. HVAC and controls measures are much more complicated and are typically the weak point for most amateur and less experienced auditors. HVAC controls measures are often the most financially attractive measures, offering the best ROIs and lowest simple paybacks. Unfortunately, the least experienced auditors are not well versed enough in these technologies to identify these measures in the buildings they audit. Instead, they will pack their audits with more easily identifiable measures, overlooking many prime opportunities for energy savings. .

The unfortunate consequence for the auditing client is that after implementing these simple measures, the client may think that they are running their building in an efficient manner, but they are not. There may be many measures that they have not implemented that they do not know anything about, because they were not mentioned in the audit report. By not implementing these undiscovered measures, the building owner is wasting money by overpaying the utility for energy that need not be consumed.

2. Audit Overestimates Savings

Overestimating energy cost savings is a common problem in poor-quality energy audits. This is often the result of poor assumptions, faulty calculations, not matching energy calculations to utility usage, or not accounting for interactive effects between measures. Occasionally an auditor can nudge assumptions in order to make an improvement appear economically feasible.[2] This often occurs when equipment vendors are providing audits.

When I worked for an energy service company (ESCO), we used to contract out our energy audits to energy consultants. Twice while I worked for the ESCO, we received energy audits from consultants in which the energy savings reported by the audit was more than the actual energy usage of the building. A building cannot save more energy than it uses![3]

In a prior job, some engineers from a major ESCO wanted me to examine their building model for mistakes. They had experienced a $40,000 annual savings shortfall on a performance contract that centered on a variable air volume (VAV) conversion. It turns out that they had indeed made a modeling error, and the post-retrofit model was not accounting for any reheat energy usage at all when it should have been. What the engineers had assumed to be gas savings was actually a modeling error—a $40,000 overstatement of energy savings. This costly error could have been avoided by applying a "believability test" to the results, which they did too late in the process. This type of "believability test" is something only a senior level energy professional can do. Experienced engineers know to check their models for "believability" before presenting results, and quality companies have their calculations double-checked by another engineer.

[1] How do you select a good auditor in the first place? See the white paper: "A Guide to Picking a Quality Energy Auditor: How to Avoid Energy Audit Disasters", by John Avina, which is available at http://abraxasenergy.com/articles/choosing-the-best-energy-auditor/

[2] See Ian Shapiro's paper, "10 Common Problems in Energy Audits", ASHRAE Journal, February 2011

[3] I suppose this is now possible with the advent of renewables, but renewables were not part of either study mentioned.

The problem with overestimated savings is that the building owner, believing the audit is accurate, may implement an energy efficiency measure, only to be disappointed when the expected savings do not materialize. The building owner may spend tens or hundreds of thousands of dollars on a measure that does not produce the expected amount of savings, when they could have spent the money on measures which would have been more financially compelling. Unfortunately, a poor quality energy audit may not accurately present which measures the building owner should invest the energy efficiency budget on.

3. Audit Does Not Suggest Best Energy Efficiency Measure for a Given Situation

Oftentimes there may be several different approaches to an energy-wasting situation. An experienced auditor will consider all of them and pick the best measure after accounting for ROI, persistence of savings, likelihood for a successful project and other factors. An inexperienced auditor may not recognize the many possibilities and may instead select the only one that comes to mind.

We have seen an audit by a vendor where the auditor suggested replacing older steam boilers with like-sized steam boilers without assessing the heating requirements of the building. During our site visit, we learned that steam was only required for sterilizers which ran about 16 hours a week, while the remainder of the steam passed through a heat exchanger to produce 180°F heating hot water for reheat coils. The boilers ran all hours of the year. Unfortunately, these steam boilers were installed about six months before we were on-site, and the facility had paid about $300,000 for the new system.

A better solution would have been to install a modular hot water boiler system for heating hot water, and a small, dedicated steam boiler for the sterilizers. Hot water boilers are more efficient for producing heating hot water than steam boilers, because steam boilers have to produce steam at about 300°F at 80 psig (which is then reduced via heat exchangers to about 180°F hot water for the air handlers), while hot water boilers only need to heat water to about 180°F. Had our recommendations been heeded, the steam boiler would have run only when needed for the sterilizers, while the hot water boilers would still have run all hours, but would have used much less energy.

In another example, we audited a hospital recently that had a failing water-cooled screw chiller. A previous energy audit suggested that it be replaced with another screw chiller. We thought this would have been a squandered opportunity to save energy when much more efficient options were available. We suggested replacing the failing chiller compressor with magnetic bearing compressors, which would have saved over 40% of chiller energy usage, but would have cost more than a new chiller. A comparison of life-cycle costs of the two options clearly favored the magnetic compressor retrofit over the new screw chiller. This is another example where an auditor did not suggest the best available option. Had the building owner heeded the prior audit's recommendations, the building owner would have lost a substantial amount of money in the end.

By not presenting the best measure, an energy audit can cost the building owner money because:

1. the building owner installs the more costly option (which was detailed in the poor quality audit) and wastes money due to the more expensive installation, or
2. the building owner installs a less than optimal measure (which was detailed in the poor quality audit) and is unable to gain the energy savings that a better measure would have returned, or
3. the ROI associated with the less attractive measure presented by the poor quality audit was disqualified from consideration, while a more attractive measure was not even considered by the audit. As no action was taken, an energy savings opportunity was squandered, and the building owner would not even be aware of it.

4. Audit Focuses on Only Some Building Systems

Every auditor has their strong and weak areas. Some auditors are familiar with building envelopes and lighting, but not HVAC and controls. As a result, they may only look for those measures in which they are proficient. Some auditors may be controls-centered and miss all of the building envelope measures. Experienced energy auditors have had the years of experience to develop a mastery of all of the building systems. Inexperienced auditors have not reached that point, and their audits will be focused on just some building components. Once again, the drawback for the owner is that significant savings opportunities can be lost.

Recently when we audited a large fish laboratory, we were given an audit that was completed a few years before. The audit included only measures for changing thermostat setpoints, exit signs, high-efficiency motors, and T8 lighting. This audit completely missed HVAC, and almost all of HVAC control. Our audit found many measures that were missed including: variable water flow, heat recovery on boilers, reprogramming HVAC controls, fume hood occupancy control, exhaust fan control, AHU scheduling, and twist timers to control shop radiant heating.

Often the best measures in terms of ROI are controls-related measures, and these control measures are precisely the measures that the more inexperienced auditors will usually miss.

5. Audit Provides Inaccurate Measure Costs
Energy auditing does not just require proficiency in building systems, but also requires some knowledge of project costing and project management. It takes years of experience for a senior engineer to understand how contractors price jobs, all the items that are involved in pricing, and the difficulties that contractors may run into.

Often the most important metric that determines whether an energy efficiency project should go forward is financial criteria such as the ROI, simple payback, or life-cycle cost. Determining expected energy savings based on sound engineering calculations and assumptions is only half of the financial picture. The other half is costing. If the energy calculations are perfect and the costing is amateurish, then the financial criteria will be flawed.

A measure with an underestimated cost may be selected by the building owner for implementation instead of what is truly a more cost effective measure. The result for the building owner is that the most financially beneficial measures may not be selected for implementation. By selecting less than optimal measures, the building owner may not maximize the energy savings delivered for each energy efficiency dollar spent.

6. Audit Suggests Measures that Will Not Save Energy
One problem with poor quality energy audits is that they may suggest measures that are inappropriate and which may not save energy. These suggestions are typically made because the energy auditors are not sufficiently experienced to understand the applicability and limitations of certain technologies. Of course, the result for the building owner is that an investment that was supposed to save energy could save little to nothing.

One common example is the recommendation of a high efficiency (95% or more) condensing boiler to replace a standard efficiency (85% or less) conventional boiler. This seems like a simple measure, and it is unfortunately too often simply applied with the result that clients may be misled by their audits into paying for and installing expensive condensing boilers that end up saving very little energy. In order for a condensing boiler to achieve above 90% efficiency, it must operate with a return water temperature below 130°F, which allows for condensation to occur in the boiler flue gases and extra energy to be captured, which is where the extra efficiency comes from. Unfortunately, most air handling unit (AHU) hot water coils are designed for entering hot water temperatures between 160°F and 180°F and return hot water temperatures between 140°F and 160°F. In these types of applications, the temperature of water returning to the hot water boiler is typically above 130°F, which prevents the boiler from condensing and achieving high efficiencies. In other words, condensing boilers are being recommended for applications in which they cannot deliver the high efficiencies.[4] Condensing boiler applications are complicated in many ways, and the auditor should understand that the measure can only work if certain conditions are met in the heating system.

7. Audit Does Not Include a Scope of Work
A scope of work (SOW) is a description of exactly what needs to be done to implement an energy efficiency measure. Ideally, when a client wants to implement a measure, the client should be able to print out the section of the audit report devoted to the measure in question, and to hand it to contractors to obtain quotes. A SOW details exactly what the contractor should do, including which items are to be replaced, how many, which items (make and model) are to be installed, and detailed instructions on how the equipment is to be controlled. With a clear SOW, there will be fewer or no unknowns, and thus the measure installation costs should be lower.[5]

One of the banes of energy efficiency is that contractors often do not install measures correctly, and as a result, the savings do not occur as expected. A SOW goes a long way towards preventing this problem. Poor quality audits often do not have scopes of work, usually because the auditor was not asked to provide one.[6]

8. Audit is Incomprehensible
Unfortunately, many engineers, however skilled they might be, cannot communicate their ideas. We have encountered audits by our own subcontractors that we had to completely rewrite. In some cases, our audit team wasted hours to decipher them and to ensure that they were correct and complete. Whether the poor writing stems from the auditor being a non-native English speakers, confused thinking, or lack of time and attention, a poorly written audit is of no value to anyone if the recommendations are

[4] For more examples of poor energy efficiency recommendations, read the paper by Kleinheinz, Seryak, Sever and Raffio, "How the Culture of Inefficiency is Out-Foxing LEED, ASHRAE, and Efficiency Programs in the Midwest", *2012 ACEEE Summer Study on Energy Efficiency in Buildings Proceedings.*

[5] When there are unknowns for contractors, contractors may bid high to cover themselves so that they will not lose money. Without a scope of work, contractors may also misunderstand what the measure entails and may end up billing for unnecessary additional work.

[6] ASHRAE Level I and ASHRAE Level II audits do not require a scope of work. Not having a scope of work does not mean the audit is insufficient, it only opens up the possibility that implementation of measures will not be completed correctly, and at the right cost.

not understood. If it is unclear what the recommendation is, how can one expect a contractor to implement the retrofit correctly? It is vital that clear and detailed information be given to contractors; if not the retrofits may not save energy as expected.

SUMMARY

If you are serious about energy efficiency, it is shortsighted to select inexperienced energy audit providers. Often the low cost providers charge very little because they have little experience and need to build their resume (often at your expense) and they may provide a poor quality audit. In the long run, a poor quality energy audit can hinder the building owner's energy efficiency success, and end up costing the building owner many times more than cost of the audit. This paper details eight ways a poor quality energy audit can prevent the building owner from achieving the highest level of energy cost savings with the lowest investment. It is important when selecting an auditor that a building owner selects a seasoned professional to do the job. Ultimately, the responsibility for the quality of the energy audit belongs to the building owner.

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