Energy Evaluations: a Practical Approach

Identification of truly justifiable energy-based projects involves careful consideration of various difficult-to-quantify "soft" issues

By **DONALD NEWELL, PE, CEM**
EMCOR Services/Trimech Corp.
Pompton Plains, N.J.

At first glance, energy evaluations for existing HVAC systems seem to be a nebulous and sometimes confusing service. On one extreme, one could argue an appropriate work scope should include only an informal phone conversation or a day's worth of time provided at no charge. On the other end of the spectrum, it could require weeks of detailed conceptual development and investment-grade computer modeling. There is no upper limit to the expense of the latter scenario. Which is the right choice for your facility? The answer is somewhere in between these two extremes.

The intent of this article is to present concepts behind a more practical approach to the completion of an energy evaluation. In this context, practical does not mean exclusion of theory. Rather, it means efficiently arriving at the objective, which in this case is the identification of truly justifiable energy-based projects. Practical also means consideration of important factors other than first and operating costs. Practical must exclude the submission of a seemingly photocopied list of energy-saving measures that *may* be feasible. It also must exclude the presentation of projects that have no real chance of succeeding, despite what the computer says. Finally, and most importantly, practical always will mean that you treat your client's time and money as if it were your own.

This article will begin with discussion of very important "soft" issues. These are items that are either difficult or impossible to quantify through calculations or software. As such, engineers have a natural inclination to dismiss their worth. However, consideration of productivity, system complexity, and maintenance during completion of an energy evaluation is crucial to its success. Then, starting with facility benchmarking and ending with detailed modeling, this article will conclude with the description of a very simplified and practical procedure for developing and assessing energy-based projects.

PRODUCTIVITY VS. ENERGY SAVINGS

Can large energy savings justify a small degree of occupant discomfort? Consider a "typical" 100,000-sq-ft Class A office building. From building code, we can expect the occupancy to be approximately 665 people. While salary costs vary significantly by geographical region, company, and position, it would be reasonable to assume that, on average, each employee costs the company $50,000 (including salary, benefits, etc.). Simple math reveals a total "burdened cost per employee" of just over $33 million per year, or just over $330 per square foot. Depending on your perspective, that may seem high or low, but when compared with typical operating costs between $1.50 to $3.50 per square foot for lighting, HVAC systems, and utilities, $330 per square foot is astronomical. In other words, the employees cost approximately

*A senior project engineer with EMCOR Services/Trimech Corp., Donald Newell, PE, (*dnewell@trimechcorp.com*) is an Association of Energy Engineers-certified energy manager and a National Environmental Balancing Bureau-certified testing-and-balancing supervisor and building-systems-commissioning administrator.*

100 times the cost of building utilities.

Assume that this facility is at the upper end of the operational-cost range at $3.50 per square foot and that new management wants to fix the problem. The facility energy director and a world-class team of energy consultants develop a foolproof, justifiable plan that cuts operating costs in half over three years. At the end of Year 3, the facility is operating at $1.75 per square foot. However, management is noticing an increase in comfort complaints. Was it worth it?

Is it conceivable that discomfort could produce 10 min of hand-warming in a day? Perhaps 10 min to get some fresh air or to complain to a co-worker? Despite the new energy savings of $1.75 per square foot, which resulted in an annual windfall of $175,000, 10 min a day in lost productivity would cost the company almost $700,000.

SYSTEM COMPLEXITY

In general, the more complex a system is, the less likely it will work as predicted on paper. Clearly, proper commissioning and attention to detail can avoid this issue, but has that additional time and cost been allowed for in the estimate used during the payback analysis? Does the contractor understand the critical importance of having this system or isolated feature work exactly as planned on paper, or might he or she believe that a standard installation is sufficient? Is the required control tolerance of the new measure beyond the ability of the control system or mechanical components and, therefore, unrealistic?

Some real-world examples are:

• Four set-back/up temperatures instead of two.

• A summer/fall/winter/spring mode instead of the standard summer/winter.

• Control of space temperature on a variable-air-volume (VAV) system to less than 1 F deadband.

The list continues. Inevitably, systems with schemes similar to the above get "dumbed down." A good rule of thumb is that if a project includes "cool" or "unique" energy-saving strategies, it may be too complex. As such, before proceeding, make sure that the potential downsides have been properly considered.

MAINTENANCE

There are two maintenance issues to consider when evaluating a project's feasibility. The first is the cost of proper maintenance. The second is the likelihood of proper maintenance.

The cost of proper maintenance is not really a soft issue as much as it is an issue that can be overlooked easily, sometimes undercutting the benefits of a project. For example, a fume-hood VAV retrofit project that manifolds 50 exhaust fans into a single header and uses a single exhaust fan would significantly reduce the ongoing maintenance costs of a system. Quantitatively, if each of the smaller fans warrants 1 hr per quarter for miscellaneous preventive-maintenance tasks, such as checking the belts, lubricating the bearings, and visual inspection, and the larger fan requires 4 hr per quarter, this could lead to a manpower reduction of 184 hr per year. Using an outside-contractor rate of $75 per hour, this leads to a reduction in maintenance fees of almost $14,000 a year. To be conservative, reduce this number by 50 percent—it still is significant enough to warrant consideration. This would be in addition to a reduction in energy from the use of VAV and the system turndown. Although the above example incorrectly reduces the apparent viability of a project, experience says the opposite scenario is common—that is, necessary maintenance costs being omitted, which makes a project seem more attractive than it should be.

The second issue (the likelihood of maintenance) pertains only to more complicated control-system strategies that tend to change over time because of "tweaks." These typically happen for valid reasons, such as simplification of control, perceived improvement of performance, or the elimination of a problem in a related system. Unfortunately, these changes often are made without full knowledge of important background information. As such, original features and benefits may be removed. The point is, it does not take long to forget specific reasons why something was designed and installed the way it was. This needs to be considered during the evaluation of potential projects.

A PRACTICAL PROCESS

When you embark on the journey to improve your facility's energy performance, start with a specific building, rather than tackling the entire campus. The lessons you learn (through trial and error) will be very useful for completion of the other building evaluations.

Step 1: Organize (two hours). The key to success on this type of project is to establish a single spot for the data that you will be collecting during the project. Depending on the facility in question, this information may be limited to internal documents or may include proposals, reports, and cutsheets from various vendors and consultants. Consider starting with a 3-in., three-ringed binder with tabbed sections labeled "benchmarking," "company goals," "brainstorming," "screening," and "detailed analysis."

At this point, the only item that should be included in each section is a pocket folder for loose documents. This will be the home of all documents pertaining to each phase until you have an opportunity to hole-punch them and place them in the binder.

Step 2: Benchmark (four to eight hours). The purpose of this phase is threefold:

• To begin the process with an easy-to-accomplish step.

• To compare the current energy performance of the facility with others of a similar occupancy/usage (external comparison).

• To establish baseline energy performance of the facility for tracking of progress (internal comparison).

The first step is to assemble all utility bills (electric, natural gas, water, fuel oil) from every month for the past two years.

Using a spreadsheet program, input the data from the bills to show the cost of each utility per month. Then total the cost per month and the cost per year. When you divide by the building square footage, you have the most useful metric in energy analysis: dollars per square foot. While this value will be used for progress tracking on a long-term basis, it first can be used to determine how your facility compares with others in your industry. Most commercial office buildings range from $1.50 to $3.50 per square foot. If your energy usage is comparable to the lower end, then your work may be over. If you are on the higher range, then you may decide to dedicate more resources to the effort.

For more information on building-performance data, obtain the most recent version of "Experience Exchange Report" from the Building Owners and Managers Association (BOMA).

Step 3: Establish your company's goals (four to eight hours). Start with this plan and modify it during the project:

- Mission statement: Decrease operating costs while maintaining proper levels of comfort within the facility.
- Energy director (internal): Who is ultimately responsible for the success of this effort? Who is responsible for allocating resources, etc.?
- Energy team (internal): Should include the energy director and a representative from the maintenance team.
- Quantifiable goals: Reduce operating costs by 10 percent over the next three years. Proceed with energy-based projects that provide a three-year simple payback. When age and operation warrant, replace electrically powered devices with ones powered by their fossil-fired counterparts.
- Starting point: Begin with an evaluation of Building A.
- Check-in: The energy director will meet with the energy team once a month to determine progress, required support, lessons learned, etc.

Step 4: Brainstorming (eight to 16 hours). Brainstorming will involve an informal discussion with competent advisors about potential energy-saving measures in your facility. Ideally, this team should be comprised of a representative from management and personnel with a mixture of engineering, construction, and maintenance backgrounds. If you have a buildingwide DDC system, a representative familiar with the facility's system should be included. Have a representative from the utility company present. Finally, someone from the administrative staff who is able to capture the major discussion points should be involved. Depending on your location, this service may be provided at cost.

With this diversified team, many of

the "standard" measures can be discarded based solely on experience. Based on their knowledge of the facility, the team may be able to develop more subtle measures that could not have been developed independently from an outside consultant. The end product of this phase will be two lists. The first is a "not practical" list, which would include a list of potential energy-saving measures that were discussed, but believed not to be feasible to implement. The second list of items would contain measures that may turn out to be feasible after further investigation. Back-up sheets should summarize key points as to why the classification was made for each measure. It is amazing how useful the back-up information for the not-practical list turns out to be when someone later asks, "Why wasn't this done or looked into?"

The most common mistake in this phase is the utter fear of excluding a potentially viable project. Accept that this may happen. However, if you consider all factors (including soft costs) during brainstorming, this is unlikely.

Step 5: Screening (eight hours). The purpose of this phase is to discard any projects from the potentially viable list that are not believed to meet the required payback or return on investment. This should be done with as little effort as possible. One should use very rough installation budgets (twice the installation cost, dollars per square foot, dollars per ton) and operational-savings estimates based on rules of thumb and past experience. Utility rebates should be considered during this phase. However, because rough information is being used, the results should be viewed accordingly. Therefore, if payback is only a couple of years beyond the target payback, the team should consider passing this on to the final phase.

Step 6: Detailed evaluation and energy simulation (time requirements depend on time specifics). The working list has been paired down to items that warrant detailed analysis. To determine which will be developed into projects, the team must prepare a detailed construction estimate and a prediction of energy savings—often including a computer-based simulation.

SUMMARY

It is crucial to remember that the goal of an energy evaluation is not to provide a comprehensive list of potential projects or pounds of paper to justify a fee—especially if the same list can be obtained from any one of numerous textbooks. The goal, as always, needs to be value, which is the efficient development and presentation of projects that are truly justifiable for the specific application. Judged very simply, would you buy this project if it were your money at stake?