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FEATURE

The Art of Life-Cycle Cost Analysis

Making a case for an energy system upgrade to a chief financial officer (CFO) requires an economic analysis. The different metrics and methods that may be used to make a compelling business case range from simple to sophisticated.

Evaluating the Economics of Energy System Options

Relatively simplistic and familiar approaches used for making a business case include simple payback—how long it takes to recover the initial investment in a cost-saving measure—and return on investment (ROI), which expresses the percentage of the investment cost that will be returned annually by savings. Such methods are useful when comparing an energy upgrade with other demands for capital (such as expanding the core business). They are too simplistic, however, to accurately assess the relative costs of different options aimed at the same result (for example, lighting a workspace).

Life-cycle cost (LCC) analysis totals the expense of options over the components' expected lifetimes. The option with the lowest LCC is the most economical choice. The National Institute of Standards and Technology (NIST) defines LCC as "the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or a building system over a period [of time]." It's worth noting that this concept may also be referred to in some circles as total cost of ownership (TCO). TCO expands an evaluation to include costs for research to develop the analysis and the cost of the analyst. Because of the conceptual similarities between a TCO and an LCC, chief financial officers may ask for a TCO without realizing that they are asking for much more than may be needed when comparing energy upgrade options. If a TCO is requested, check with your financial department as to whether a standard LCC is acceptable instead.

Inside EMQ

Corporate Energy Managers' Consortium

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LCC Components

Life-cycle costs include both investment-related costs and operations, maintenance, and repair (OM&R) costs, as follows:

Investment-related costs

- Planning
- Design
- Purchase
- Construction
- Resale
- Salvage
- Disposal
- Capital replacement (such as overhauls requiring allocation of capital beyond a typical maintenance budget)

OM&R costs

- Energy (including any generated on-site)
- Water
- Operator labor
- Replacement components (both recurring and one-time)
- Repairs (including preventative maintenance and overhauls)
- Routine commissioning

Once costs have been restated to their present values (see discussion below) and all such costs have been summed over the lifetime of the new system, an LCC has been determined. When two LCCs are compared, the differential value is called the net savings.

Performing an LCC Analysis

One approach to LCC analysis is thoroughly explained in a free, 224-page manual entitled "Life-Cycle Costing Manual for the Federal Energy Management Program (FEMP)" (Handbook 135), which is produced by NIST and available at www.eere.energy.gov/femp/program/lifecycle.cfm.

The NIST manual covers LCC analysis in 10 basic steps:

1. Define the problem and state the objective.
2. Identify feasible alternatives.
3. Establish common assumptions and parameters.
4. Estimate costs and times of occurrence for each alternative.
5. Discount future costs to present value.
6. Compute and compare LCC for each alternative.
7. Compute supplementary measures (for example, determine net savings), if required for project prioritization.
8. Assess uncertainty of input data.
9. Take into account effects for which dollar costs or benefits cannot be estimated.
10. Advise [management] on the decision.

The first four steps are taken with any form of economic analysis and should be familiar to all energy management personnel. Step 5 involves choosing discount and price escalation rates, which are discussed in the next section. Steps 5 through 7 are most efficiently performed using LCC software, examples of which are discussed below under "LCC Software Tools."

Step 8 requires, at a minimum, qualitatively assessing one's confidence in the various inputs to the LCC calculation. An additional step would involve sensitivity analysis, in which inputs are varied in order to determine how a change in assumptions affects the results. The potential value of emissions or renewable energy credits could also be included. Step 9 may involve subjective discussion of such intangibles as cleaner air, better national security, improved corporate image, hedging against price volatility, and fulfilling a mission statement.

When completed, an LCC should make a clear case for a proposed alternative, accompanied by an unbiased assessment of the economic uncertainties (both positive and negative) that could occur during the proposed system's lifetime.

Discount and Escalation Rates

Because the LCC process involves an examination of costs across the entire lifetime of a piece of equipment, two important effects must be taken into account. One is the "time value of money": Simply stated, a dollar received today is worth more than a dollar that will be received in the future, because today's dollar can either be invested or spent on something that provides immediate value.

The "discount rate," expressed as a percentage, is the measure of the time value of money. The LCC procedure applies the discount rate to future costs and benefits, converting them to present-value equivalents. Determining what discount rate to use is a lengthy topic in itself, beyond the scope of this article, but corporations and government agencies typically have set discount rates, which are revised from time to time.

Another important effect to consider is price escalation. Future costs will likely differ from today's costs, due both to economy-wide price escalation (inflation) and relative changes in the costs of such things as fuel and capital equipment. Most of the costs for an initial investment may be established with reasonable certainty, based on bids and quotes for equipment and installation work. OM&R costs (especially those for energy) may vary considerably over time, requiring application of an escalation rate and/or specific pricing at defined points in time. Although some costs may be fixed for the first few years of operation via energy purchasing and maintenance contracts, such contracts rarely span the 15- to 30-year lifetimes of most energy-related systems.

LCC calculations can be based on either "nominal-dollar" or "real-dollar" cost estimates. When nominal dollars are used, all future costs must reflect projected inflation. If the LCC analysis is based on real dollars, economy-wide inflation can be ignored, but costs that are expected to rise faster than inflation—as might be the case for energy costs—should be adjusted accordingly. The choice between nominal- and real-dollar calculations is linked to the discount rate, which is itself either nominal or real. Either estimation approach is valid; what's important is to be consistent and to follow organizational policy.

For federal facilities, NIST annually updates discount, inflation, and fuel cost escalation rates via its "Annual Supplement to Handbook #135" document, which is available at www.eere.energy.gov/femp/program/lifecycle.cfm. To efficiently handle LCC analysis, however, use of computer-based LCC software is suggested.

Those performing LCC calculations should utilize whatever discount rates and price escalation assumptions are employed by their firms for other corporate investments. The NIST rates are based on models developed by the federal Office of Management and Budget (OMB) and are

mentioned here only as a guideline; no endorsement is implied.

LCC Software Tools

Microsoft Excel is an excellent tool for performing LCC calculations, but building a model (or template) is time-consuming and no longer necessary: at least two such tools are available at no cost. The Federal Energy Management Program offers multiple Building Life-Cycle Cost (BLCC) programs, including BLCC 5.3, which is supported by NIST and is available at www.eere.energy.gov/femp/information/download_blcc.cfm. And the Cost Analysis Strategy Assessment (CASA) model, version 8.0, is an LCC/TCO decision-support tool that is offered by the U.S. Army at https://www.logsa.army.mil/alc/casa. In addition, professional LCC software from commercial providers (ranging in cost from $2,500 to $5,000) may be obtained from Relex Software (www.relexsoftware.com) and Isograph Software (www.isograph-software.com).

Some LCC software is targeted at types of upgrades such as HVAC or lighting. Trane offers its System Analyzer for HVAC cost analysis for $1,000. Find it at www.trane.com/commercial/software/analyzer. A free lighting LCC tool from the Small Commercial Lighting Program can be found at http://sclp.lightingresearch.org/allyPortal.asp?AllyType=Multi-Site. And a listing of various LCC-related software is available from the Reliability Analysis Center at http://rac.alionscience.com.

NIST also offers LCC training workshops; you can obtain a schedule from the Office of Applied Economics, NIST, Building 226, Room B226, Gaithersburg, Maryland, 20899, 301-975-6132. And three training videos may be purchased from Video Transfer Inc., 5709-B Arundel Ave., Rockville, Maryland, 10852, 301-881-0270.

A Few Ground Rules

Apply these rules to all options to be reviewed:

- Each must meet your minimum performance requirements.
- Use the same system start-up date, time frame, and discount/escalation rates for all options. The life-cycle time frame should match the lifetime of the longest-lived option being analyzed.
- If an option makes money (for example, through energy grants or operating incentives), the revenues must be subtracted from the costs for that system.

Avoid assumptions that are lacking foundation. Many oft-mentioned claims—for example, that upgraded lighting should result in at least a 1 percent improvement in employee productivity—are unproven and could seriously corrupt the LCC process.

Doing nothing or outsourcing the service (instead of purchasing a system) must either be evaluated on an equal footing with other options or dropped for stated reasons.

Limits on upgrade expenditures must be known in advance to eliminate choices that, despite their potential value, are beyond the firm's financial capabilities.

If the facility may be sold or otherwise change ownership, that uncertainty should be discussed in Step 8.

Realistic lifetimes should be used instead of manufacturers' recommended service lives—for example, a window air conditioner's life may be rated by the manufacturer at 10 years, but it is common to find 20-year-old units still running at many facilities.

Advice from the Real World

When presenting upgrade options to financial officers, use terminology they understand. Stick to the dollars; avoid trying to persuade with technical arguments. If a technical issue has value (such as greater reliability), it can be translated into dollars to be spent (or avoided) at some point in a system's lifetime.

Summarize your results in simple tables or graphics accompanied by supporting spreadsheets that show all of your assumptions. A CFO who wants to determine the impact of changing an assumption can then do so.

IN BRIEF

Database of State Incentives for Renewable Energy

Did you ever wonder if there was a one-stop shop for information on available incentives to promote renewable energy? The DSIRE (Database of State Incentives for Renewable Energy) web site (www.dsireusa.org) contains a point-and-click map that allows you to drill down by state and view any potential incentives—local, utility, state, and even some federal—that promote renewable energy. A wealth of information can be viewed by state, including financial incentives, tax credits, regulatory issues, and utility rebate programs.

The site also has summary tables of financial incentives and state policies and regulations for a quick national overview, and it has links to incentive summaries. Summary maps are downloadable in Microsoft PowerPoint format and give you the ability to get a quick geographical idea of the availability of selected financial and regulatory incentives across the U.S. The summary maps include information on issues such as equipment certification requirements, generation disclosure rules, grant programs, income tax incentives, loan programs, net metering rules, property tax exemptions, public benefits funds, rebate programs, and renewable portfolio standards.

Energy Star Portfolio Manager

The Energy Star Portfolio Manager software from the U.S. Environmental Protection Agency can be used to analyze the Office Buildings, Grocery, Education (primary and secondary schools), Hotel, and Hospital sectors. Ranking systems for additional building types are being developed, including convenience stores, warehouses, and healthcare buildings. This free tool can show you where you stand relative to the demonstrated energy performance of existing buildings during the past several years. By entering your building information, you can compare performance with similar buildings in areas with similar weather.

The output is a score from 0 to 100, with scores above 75 indicating that the building is in the top quartile in terms of energy performance (the lowest energy-intensive buildings earn the highest points). Buildings that score 75 and above are eligible to apply for an Energy Star building label. For procedures on verifying the building and energy data entered into Portfolio Manager and evaluating the acceptability of a building's indoor environment, you can download the "Professional Engineer's Guide to the Energy Star Label for Buildings" (www.energystar.gov/ia/business/evaluate_performance/pm_pe_guide.pdf).

The New Energy Bill in a Nutshell

Although the United States' 2005 Energy Policy Act is an impressive piece of legislation, it's also over 1,700 pages long. The $14.5 billion legislation, signed into law on August 8, 2005, contains multiple Titles that each have hundreds of provisions, ranging from tax incentives and climate-change issues to new standards for technologies and grid reliability.

Two energy industry organizations have been kind enough to slice, dice, and summarize the new energy bill into digestible pieces. The American Council for an Energy Efficient Economy (ACEEE) has highlighted the key provisions from the Efficiency and Tax Titles on its web site; the Edison Electric Institute (EEI) site contains a summary of the Efficiency Title as well as separate downloadable Titles for Climate Change, Electricity, Tax Incentives, and Incentives for Innovative Technologies.

To view summaries, analysis, and commentary regarding the new energy bill, please visit the ACEEE at www.aceee.org/energy/05finalnrg.htm or the EEI at www.eei.org/industry_issues/electricity_policy/federal_legislation/index.htm.