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Making the most of your energy model

- ***An effective model can help building owners boost their energy efficiency and save money.***

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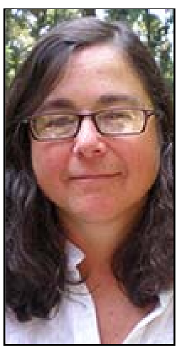
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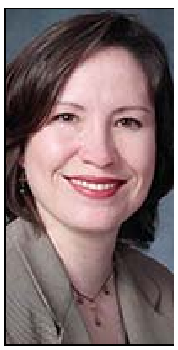
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A building's energy performance is a function of the interplay between the envelope and the mechanical and electrical systems. Climate and occupant behavior also affect the performance.

Tools to predict energy performance exist because each of these primary systems — the building envelope, HVAC and lighting — are designed by different consultants that may or may not understand the other two disciplines as well as their own or how they will ultimately interact in your building.

The first step in maximizing the energy performance of your building's design is understanding the predictive tools at your disposal. On a typical project, tools for understanding relative energy use come in three possible flavors: energy code compliance calculations, a life-cycle cost analysis, or a whole-building energy simulation, commonly referred to as an energy model.

A project might have only one or all three of these permutations, but each of them is very different. Each of them has a particular purpose with benefits and limitations.

Energy code compliance

Obtaining a building permit for a commercial building usually requires a set of complex calculations specific to the building envelope to demonstrate compliance with the energy code.

These calculations are a series of spreadsheets that approximate the heat loss of the roof, floors, walls, windows and doors — components that make up the proposed building envelope. The spreadsheets list each building assembly and its associated R-values, U-values or F-factor, and calculate the weighted average heat loss of those materials compared with the code-allowed heat loss.

And that's all. These calculations do not incorporate HVAC and lighting systems, and as a result do not represent the anticipated energy performance of the building as a whole. There are lighting and mechanical energy code requirements, but those are often handled separately by the electrical and mechanical engineers.

Photo courtesy of Weber Thompson [enlarge]

Holland Partner Group saved $200,000 using an energy model to help choose the windows for this project in South Lake Union.

Life-cycle cost analysis

In our region, owners often elect to have the general contractor provide design-build mechanical and electrical instead of having an engineering firm do a full design. This often means mechanical and electrical decisions are made much later in the design process. And, of course, they have their own permits to pull.

As project teams come to grips with decisions about what kind of HVAC and lighting systems to use and what kind of energy performance to expect, they often wish to take energy code calculations one step further. A life-cycle cost analysis can help make choices about specific energy systems the building might select.

Unlike a life-cycle assessment, which analyzes materials from cradle to grave, a life-cycle cost analysis is geared for rough order-of-magnitude projections. This tool allows project teams to arrive at the type of HVAC system (electric baseboard vs. heat pump) that best captures the needs of building occupants while meeting budget constraints.

A life-cycle cost analysis will look at an individual system and calculate the rate of return for investing in a more expensive system. This analysis will take into account financing and energy cost savings, but may not be able to fully capture the interactive effect that system will have with other systems.

For instance, a reduction in lighting power also reduces heat — increasing heating energy and reducing cooling energy. So while this calculation will tell you how much you will save on lighting, it will not tell you how much your heating energy will go up or how much your cooling will go down as a result.

This type of calculation is best with standalone systems. For instance, domestic hot water-system efficiency is a very simple calculation and has little impact on any other system.

This tool should not be confused with an energy model. A life-cycle cost analysis can offer guidance with respect to the big decisions and general expectations, but it lacks any ability to refine results as the progress of design continues. It is useful in schematic design for rough order-of-magnitude decision making.

To truly understand all the energy uses in your building and how the systems interact, you either have to build the building or do a whole building energy simulation.

Whole building simulation

Energy models take things to a whole new level. With this three-dimensional computer model of the future building, you can simulate the interaction of nearly any combination of envelope, mechanical, electrical and renewable energy strategies that you wish to explore.

Energy models are slowly beginning to gain some traction in the industry. Like building-information models, they can be a very powerful tool for those project teams comfortable with the technology and the upfront investment in their development. Often used on projects seeking LEED certification, the requirement of the U.S. Green Building Council for buildings to optimize energy performance leads most project teams to develop an energy model.

A good energy model takes all of the energy code calculations from the envelope and uses the architect's CAD plans to create a 3-D model. HVAC systems are created, and the building is zoned according to the mechanical design.

Please note that energy models are developed in stages like construction documents. A schematic level of development is often called a shoe box model and bears as much resemblance to an energy model as schematic drawings do to construction documents.

Light fixtures, which have a significant impact on energy use, are also identified and can be paired with daylight controls and occupancy sensors to play a strong role in minimizing energy demand. Also added are appliances, elevators and miscellaneous equipment, etc.

The 2012 local energy codes have a very high bar for energy reduction and offer a revised energy model path to compliance (total building performance path). This allows buildings more flexibility in how they trade off energy-using features. The Seattle Energy Code also now requires onsite renewable energy systems for most commercial buildings, unless one of the exceptions is met.

An energy model pulls all of these building systems together into one dynamic model with local climate data and occupancy schedules. There are numerous reports that can tell building owners what impact various energy efficiency measures have. Energy models can also find the most effective combination of measures — that offer the best energy efficiency for the least cost.

A useful tool

Unfortunately, most owners don’t get the biggest bang for the buck when they invest in an energy model. There are lots of ways this can happen. Not all energy models are good ones. As with any computer-driven simulation, it’s only as good as the information that went in.

Energy models are often created by individuals from mechanical engineering disciplines and tend to focus on that part of the model’s parameters, rather than envelope or lighting considerations. The best models are provided by those who can do justice to all three primary systems.

Even with a great energy model, many owners don’t know how to take the best advantage of this complex and powerful tool. And, of course, they have to rely on a knowledgeable energy modeler to employ it.

Energy models have several primary uses. They can be used to evaluate energy reduction and cost benefit during design or to obtain building permits. They can assist with LEED certification. They can also be used for measurement and verification.

The biggest benefit of an energy model is that once built you can use it over and over again. For discerning owners that pursue measurement and verification strategies, the energy model is an invaluable tool.

Design-level energy models are built on assumptions. But once the building is constructed and occupied, those assumptions can be replaced with real data.

Using utility bills and actual weather conditions, an energy model can be calibrated to represent actual energy usage on an annual basis. With this tool, operational issues such as equipment malfunctions and leaks can be identified. Power demand can be shifted from peak times. Equipment performance can be monitored.

When the time comes to consider capital improvements, owners will again be faced with choices about energy systems and cost benefit. This time their energy model stands ready to replicate a whole new set of assumptions.

Energy reduction is everyone’s concern in the construction industry. The cost of energy is volatile. It’s a significant percentage of construction and operating costs for the building.

Supply and demand issues for energy are also uncertain over the long term. A building design oriented toward reducing energy demand, and constant vigilance with respect to maintenance and operation is essential to optimizing energy use and controlling costs.

The use of energy also contributes to global warming and climate change, so energy reduction will continue to be a regulatory priority for the foreseeable future. Buildings that can offer efficient energy use will have a competitive advantage in the marketplace.

A good energy model can be a useful tool before, during and after construction.

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