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Does your building measure up, energy wise?

- *The amount of energy a building uses depends on its envelope, energy systems and the end users.*

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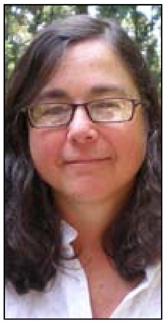

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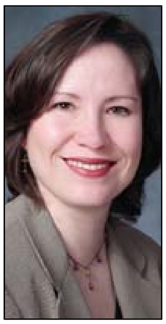

Henderson

With cars, we have gas mileage. And that singular metric is suitable for a system with one energy source, one driver and one energy system. When you operate your car, you experience the direct relationship of speed and equipment efficiency to gasoline consumption. But in the case of your average commercial or residential building, a utility bill offers little insight into the factors that contribute to a building's energy use.

In a building, energy use is a function of three things: the envelope, the energy systems and the end users. Any successful approach to reducing a building's demand for energy will need to evaluate and balance these complex elements.

Envelope

The envelope is literally the skin of your building. It is composed of your floors, walls, windows and roof. The envelope is the first line of defense in reducing energy use, by reducing demand for that energy in the first place. Thermal windows and well-insulated exterior walls and roof cavities help hold in heat when it's cold outside. During summer months, a low-e coating on those thermal windows and a light-colored roof can mitigate solar heat gain to help keep things cool inside.

Obviously, a well-insulated envelope is an important part of the building's energy-use profile. However, adding insulation beyond a certain point offers only diminishing return on the initial investment. How do you measure the relative value of envelope improvements when it comes to energy cost savings?

Energy systems

Energy systems — such as HVAC, lighting and domestic hot water — play the most obvious role in a building's energy consumption and are what most people think of. But there's more to this story than simple equipment specifications. Lighting generates a significant amount of heat, and lighting fixtures vary greatly in their energy efficiency. That means that lighting itself can contribute to the need for cooling and/or reduce the need for heating.

HVAC and domestic hot water systems often use either gas or electric power sources, which offer different environmental, maintenance and cost benefits depending on your building and your region. Whether you are debating a central gas boiler versus electric hot water or electric baseboard heat versus under-floor hydronics, you need to know what kind of system upgrade will yield the best outcome.

Photo courtesy of ArchEcology

The Seattle Housing Authority was awarded $10 million in green retrofit funds for its Denny Terrace apartment building. The improvements are expected to reduce energy usage by more than 35 percent.

End users

Then there are the end users. The characteristics and behavior of the people that inhabit your building shape its performance. Their schedules and personal habits dictate energy use and demand in your building. Education and awareness are essential to optimum energy performance. Many owners turn to automation and demand-control strategies such as occupancy sensors and daylight controls, on-demand hot water and automated solar shades to address behavioral issues.

Whole building simulation

When LEED certification came along, it brought an enormous focus on energy use reduction. Among the many requirements and suggested measures was a mandatory 14 percent reduction over the American Society of Heating and Refrigeration Engineers' national standards used by building codes. Even greater percentage reductions over that standard are encouraged and commensurately rewarded.

Traditionally, the envelope, mechanical and lighting systems are designed separately, based on code standards and industry rule-of-thumb. The architect develops his envelope and selects his materials. The mechanical engineer designs his HVAC systems to fit appropriately into the box provided by the architect. The electrical engineer provides appropriate lighting fixtures to suit program, cost and aesthetics.

No matter how well executed, each system remains an individual component. This inability to integrate the performance expectations of these systems until physically combined together in the final structure is a huge barrier to cost-effective decision-making.

3-D energy model

To facilitate energy-saving outcomes, LEED adopted a previously under-used design tool — the Whole Building Energy Simulation or Energy Model. This 3-D energy model approach, while not unknown in the industry, is still only rarely used to its full capacity by an experienced practitioner to offer a holistic assessment of complex inter-related envelope, energy and end-user strategies.

With a 3-D energy model to use as a design tool, envelope decisions, equipment selections, material choices and end-user behavior can be integrated together to evaluate building performance. Options and alternative configurations can be explored and analyzed on a cost-benefit basis long before construction starts.

For the purposes of LEED certification, the modeling task starts by constructing a baseline representation of a similar building, built to conventional code standards, and then compares that theoretical baseline to a second version constructed to represent your building's sustainable design. The difference between these two representations predicts the anticipated reduction in energy use for the new building versus a similar one built conventionally. It is important to understand that this LEED energy model outcome is entirely theoretical — a conceptual conventional building as compared to a conceptual building design.

So it’s really no surprise when a LEED-certified building, which claimed an expected 30 percent reduction in energy use, doesn’t really achieve those savings in actual utility bills. Owners should, however, realize significant savings over the results of the buildings they would have constructed otherwise.

That’s great for those designing a new building. But where does that leave an owner of an existing building, hoping to undertake energy upgrades and realize energy cost savings? Do not despair. The energy model process and its benefits need not apply solely to new construction and LEED certification.

Saving at Denny Terrace

To turn a conceptual energy model design tool into an existing building performance measurement tool requires only calibration. When the Seattle Housing Authority needed a way to pursue a federal stimulus grant by evaluating potential energy improvements at one of its oldest and largest apartment buildings, Denny Terrace, that’s exactly what we did.

First, we performed an on-site investigation, studied available plans, and gathered information about tenant schedules and behavior. From that information, we created an energy model of Denny Terrace. We then carefully calibrated the model using several years’ worth of actual meter readings. Once calibrated, we modeled numerous potential energy conservation measures to determine which options would be most cost-effective, while yielding the best possible reduction in energy use.

Proposed infrastructure improvements were carefully evaluated against not only initial cost, potential energy reduction and utility savings, but also against durability and low maintenance requirements. The resulting recommendations were used as a tool to apply for green retrofit financing and to further refine capital needs assessments. Recommended improvements are projected to reduce energy use by more than 35 percent over current annual use.

A building’s performance is more than the just the sum of its individual systems. An energy model approach allows potential upgrades to envelope systems, lighting and HVAC to be evaluated holistically. The cost to implement each measure can be weighed against its effectiveness, when used in conjunction with the other proposed measures, to provide a true cost-benefit analysis on a whole-building basis.

And the beauty of this process is that it can be iterative, allowing you to prioritize improvements, phase upgrades, and then evaluate their success before undertaking the next round. A calibrated energy model is the first step toward an ongoing measurement and verification process that can reduce your annual operating expenses, inform your capital needs assessments, help secure retrofit funding, and provide a mechanism for continuing improvement as times and technologies change.

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