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Achieve Your Building's Optimal Efficiency

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UNDERSTANDING WHAT AN ENERGY MODEL CAN AND CAN'T DO IS CRITICAL TO ITS SUCCESS

By Clark Denson

Find this article in the June issue of Building Operating Management

WITH FUEL PRICES RISING, ENERGY EFFICIENCY HAS BEEN TOP-OF-MIND FOR FACILITY MANAGERS. And, state and nationwide energy-saving programs, mandates and incentives have increased dramatically. These include increasingly stringent energy codes and standards, green building rating systems, federal tax deductions, numerous state- or utility-specific rebates and incentives, building labeling programs, and more.

All of these highlight the importance of doing quality energy modeling early in the design phase, as a part of an integrated design process. An energy model is primarily a decision-making tool for comparing various scenarios in a building design to help achieve energy and cost savings.

The term "integrated design process" is thrown about frequently in the design and construction industry, with supporters touting the benefits of early stage collaboration among various stakeholders including facility managers, owners, architects, engineers and contractors. During these conversations, proponents will likely bring up energy modeling as a key ingredient in the integrated design process, but may not be able to fully articulate the benefits energy modeling can provide. Or, they may over-promise what energy models can actually do for the owner.

Initial Analysis

Although architects have the primary ability and skills to visually represent multiple building designs at an early stage of design or conceptualization, an energy analyst is best suited to illustrate multiple paths to achieving the owner's energy-saving goals. Therefore, an effective integrated design process should include the input of the energy analyst during this conceptual design phase. Just as an architect can provide a visual comparison of a brick veneer vs. a curtain-wall assembly, an energy analyst can provide a "high-altitude" view of design strategies that affect energy consumption. Ideally, this effort analyzes strategies that are difficult to change later in the design process, such as building orientation, shape, programming, shading and window-to-wall ratio. The purpose is to help drive decisions towards the owner's goals for the building.

The process is dependent on the owner's energy-saving goals for the building. So, goal-setting should be a topic of discussion early in the design process, ideally, during the project kick-off meeting or an eco-charrette. Energy goals could include one or more of the following:

- **Comparative, such as achieving a design that consumes 30 percent less energy than an ASHRAE 90.1 baseline building**
- **Absolute, such as achieving a design with an energy use intensity (EUI) of 40 kBtu per square foot per year**
- **Certification-based, such as achieving an Energy Star Label or LEED® certification**
- **End-use specific, such as designing a building where all domestic hot water is provided by solar thermal water heaters.**

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GREENBUILD 2011 Booth #4841S

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Date and time: **Wednesday**
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Booth #: **4841S**

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Visit the Greenbuild website to redeem your free pass to the exhibit hall (use the registration code shown above).

We look forward to seeing you at Greenbuild 2011!

Compare and Contrast

As the design progresses and key decisions have to be made, the energy model can be used to identify synergies in the design that can help reduce projected energy costs.

1. **Identifying synergies to reduce equipment sizes.** To reduce energy consumption, it is necessary to invest in energy modeling at an early stage, and it may also be necessary to invest more money in particular building components like high-efficiency, ground-source heat pumps or variable refrigerant flow systems. However, that doesn't mean the overall building costs have to be appreciably higher. Modeling various building shapes and exterior shading devices can result in an optimized passive solar design that reduces the solar heat gain on the building in the summer, and allows the sun to heat the building in the winter when the sun is lower in the sky.

   Additionally, modeling various window-to-wall ratios and glazing selections can identify an optimized design for daylight harvesting that minimizes solar heat gain while allowing enough visible light into the occupied spaces to maintain acceptable light levels. This in turn allows the electric lights to dim or turn off completely. Employing passive solar design and reducing lighting loads during peak times of day, means HVAC equipment capacities can be reduced, saving first costs.

   This is a perfect example of the integrated-design process, where the synergy of architectural design, lighting design, and mechanical systems design produce a solution that reduces operating costs and yet may not increase first costs compared to a typical, non-integrated design approach. While general principles toward passive design and daylighting may provide a "good" solution, energy modeling is the best tool for getting a "great" solution.

2. **Find areas of highest potential impact.** Comparisons of various "what-if" scenarios in a building show that some energy conservation measures eventually have diminishing returns. As a result, an energy model can be used to show how a project's budget can be allocated most cost effectively to meet the project's energy goals.

   For example, a process called "load elimination" can be used to demonstrate the impact different building components have on energy consumption. A first step may be incrementally increasing wall insulation from code-minimum values to some maximum value where wall heat transfer is essentially eliminated.

   It's also possible to do a similar analysis for interior lighting power, process loads, window U-value and ventilation. This analysis may show that adding insulation may not decrease energy consumption as much as reducing lighting power by 25 percent. While optimizing passive elements of the building like the building envelope and shading are important and should be the first areas to be examined, there is a point of diminishing returns in making improvements to some elements. It may be more cost-effective to look elsewhere to meet the owner's energy goals.

   Energy modeling also can show which building design areas hold the biggest opportunities for improvement. For example, a preliminary energy model may indicate 90 percent of the building energy consumption is electricity and only 10 percent is natural gas. This suggests the first place for energy-saving opportunities might be in the electricity-using end-uses. Investigating the individual electrical end-uses in the model may show that 50 percent of the electricity is currently modeled as being used by lighting, while the rest is evenly used by plug loads, fans and cooling equipment. Previous experience indicates lighting typically doesn't consume such a high portion of the electricity and that may be best place to look for energy saving opportunities.

3. **Identifying counter-intuitive building performance relationships.** As the need for increased energy efficiency may require more complex and integrated relationships among buildings and their mechanical and electrical systems, conventional wisdom may not hold as true. For example, energy standards have been incrementally increasing the minimum requirements for insulation in the building envelope, so design teams might be tempted to conclude, "If a little is good, a lot must be better."

   Some buildings, like hospitals and heavy manufacturing facilities, do not always benefit from exceeding the minimum insulation requirements. An analysis of the energy model output sometimes indicates the building's internal loads (people, lighting and process loads) tend to dominate the external loads exerted by outside air temperature and solar heat gain. As a result, these process-intensive buildings are penalized by a highly insulated envelope that does not allow internal loads to radiate out of the building.

> ***Just as an architect can provide a visual comparison of a brick veneer vs. a curtain-wall assembly, an energy analyst can provide a "high-altitude" view of design strategies that affect energy consumption.***

Realistic Expectations Needed to get Most out of Energy Modeling

When a building owner knows that an energy model has been used in the design of a building, he or she may ask, "How much will my utility bills be?" This is a legitimate concern for all building owners, since they need to know how to set up billing arrangements for their tenants or are interested in negotiating long-term contracts with utility providers based on future use. Unfortunately, energy models can't predict the building's actual energy use with a high level of accuracy, especially models constructed during the design phase of new construction projects.

Even the ASHRAE Standard 90.1 User's Manual cautions that energy model results will be misconstrued. The manual states that the modeling guidelines presented in the standard are intended to provide a baseline for comparison of the estimated annual energy cost of the proposed building and the baseline building for the purposes of a rating. They are not intended to provide an accurate prediction of actual energy consumption or costs for the building as it is actually built. Although the energy analyst is expected to model energy use as closely as possible, there are many reasons why the actual building performance rating may differ from the predictions of the building performance rating method.

Those reasons include variations in occupancy, control, maintenance, weather, energy rates and the precision of the simulation program. When creating an energy model, these assumptions must be agreed upon in order to get a result, but they can't be 100 percent accurate in predicting future energy consumption.

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Even when the owner is consulted during the integrated design process, predictions about the building's real operating hours, estimated occupancy and utility rates may be inaccurate.

For example, a newly constructed library got a lot of attention from its successful public relations campaign which touted LEED® certification and energy-efficient design. The campaign was so successful the library had to extend its operating hours to accommodate patrons. As a result, its first-year energy consumption was noticeably higher than predicted.

Even the best energy modeling tools make approximations and assumptions for how systems actually behave. For example, modeling programs typically assume that controls work perfectly and typically don't model operational inefficiencies. Theoretically, you could possibly de-rate your boiler's efficiency to try to estimate leaky steam traps, but do you really want to expect your building to operate in a less than ideal fashion? Instead, the as-designed energy model should represent the potential of the building's energy performance, and facility managers should strive to maintain the building's systems in peak condition to stay as close to the predicted performance as possible.

Driving Off the Lot

Bill Worthen, resource architect for sustainability at the American Institute of Architects, emphasizes: "Today's modeling tools are not intended to provide any higher degree of predictive certainty for actual utility bills than the miles-per-gallon ratings displayed on the window sticker of your last new car will predict real life mileage. Hopefully, that number influenced your selection of the car. But when you drive off the dealer's lot, most people don't drive their cars exactly the same way the mileage testing was designed."

An energy model is one of the best tools to make educated decisions in designing high-performance buildings. Energy models are essential to achieving rebates, incentives, green building ratings and more. In the future, energy models will be relied upon even more in the integrated design process to help meet increasingly stringent energy codes and net-zero energy targets in new construction. ■

Clark Denson is an energy engineer with the Sustainable Solutions Group of SSRCx.

Sustainable Buildings and Climate Initiative

By James D. Qualk, LEED AP BD+C

Original blog post for ED+C

Today there are a great many organizations including nonprofits, non-governmental organizations (NGOs), for-profit corporations, and government institutions promoting and seeking to provide leadership in the area of sustainability and, more specifically, green buildings. As a result, a good deal of progress has been made in recent years with the "mainstreaming" of green building best practices and the adoption of LEED® in the U.S. and elsewhere. This leadership also includes the much needed modernization of energy and other codes across the country, especially in California where at least a minimum amount of green practice now makes it into pretty much every project.

But, don't forget that sustainability and green building are a global priority. Especially now as the realization is finally starting to settle in that buildings can have the largest impact on reducing green house gas emissions (GHGs) and mitigating climate change on one end of the spectrum, and a huge impact on human health, well-being and productivity of occupants at the other. Since this is a global priority and opportunity, how do we even communicate what constitutes a green building across borders and economies, some developed and some developing? How do we prioritize actions and measure the effects of our efforts when the situation on the ground can vary so widely from one region of the world to another?

The United Nations Environment Programme Sustainable Buildings and Climate Initiative (SBCI) seeks specifically to address these questions and more. By engaging leaders from around the globe SBCI "provides a common platform to all buildings and construction stakeholders for addressing sustainability issues of global significance, especially climate change. " Additionally, SBCI is establishing baselines based on a life-cycle approach focusing on energy efficiency and CO2 emissions. Other goals include developing tools and strategies for wide-ranging sustainability practices to be applied throughout the world and establishing pilot projects to further refine and enhance these tools for wider use. And not just at the building level but also at the city and country level.

The language of sustainability, especially in the built environment, can be broad and complex with regional issues and norms dictating the approach in any one country or economic sphere of influence. While a tool like LEED® works very well in many countries including the U.S., some parts of the world may prefer another program with varying goals and priorities. At the end of the day, though, all of us are searching for the best way to reduce the impacts that buildings have on the planet and all of us. Many of the details regarding a best or preferred approach are still being refined and improved in this pursuit. And though this is a global issue and priority, focusing on what we can control in our own daily work and lives can contribute a great deal. In the United States, utilizing tools like LEED and ENERGY STAR have the potential to reduce a building's impacts significantly. But without a doubt, much more can be done, including the pursuits of net zero, life-cycle cost analysis and carbon measurement. So, don't stop with the tools that may be preferred in your neck of the woods, seek to do more and maximize the potential of your next project or existing building in relation to mitigating the negative effects that can potentially come about from design, construction and day-to-day building operations. If we are all doing the very best we can, there is no limit to what we can accomplish. ■

The U.S. Green Building Council (USGBC) introduced the LEED® for Healthcare green building rating system, on April 8, 2011. Rockingham Memorial Hospital (RMH), in Harrisonburg, VA, is highlighted in the introduction of the LEED for Healthcare reference guide for its commitment to energy efficiency and innovative strategies. SSRCx was the LEED and sustainability consultant on the RMH project team. Additionally, SSR provided MEP engineering and medical communication design.

Health care facilities, particularly hospitals, are complex and require a number of unique considerations in their design, construction and operation policies. As part of the innovative solutions at this facility, RMH partnered with a county landfill to supply landfill gas to the facility boilers as both a renewable and cost-effective energy source. As a result of this and numerous other strategies, RMH is also a Grand Prize Recipient in the 2011 Project Innovations Awards program and will be featured in the October issue of *Buildings*. ■

Project HIGHLIGHTS

Spectrum Properties / Emery recently achieved LEED®-EB (Existing Building) Gold certification for the Corporate Center campus and LEED-EB Silver for the Carothers Building in Franklin, Tenn. These 1.4 million-square-foot buildings are the largest multi-tenant LEED-EB campus in Tennessee.

Located in the Cool Springs area just south of Nashville, these seven Class A office buildings house numerous tenants from several industries including finance, insurance, and medical, many of them Fortune 500.

Read more in Tabitha Goodman's project profile on FMLink™.

Naval Facilities Engineering Command (NAVFAC) Southeast

This 5-year IDIQ contract geographically covers and will be used for Navy, Air Force and Marine Corps bases along the Gulf coast. It also may be used at other DOD or non-DOD facilities in the geographic area for which NAVFAC SE performs work.

NAVFAC now requires all new general building construction projects to receive LEED Silver certification from the U. S. Green Building Council, as well as meet other command-specific energy efficiency standards.

The Government Department of Defense (DOD) team for SSRCx is working under Indefinite Delivery Indefinite Quantity (IDIQ) contracts with the United States Army Corps of Engineers Whole Facility Commissioning for two government healthcare facilities and bases along the Gulf coast.

Fort Riley Replacement Hospital,

Kansas City, Mo.

Under this five-year, $6 million contract, SSRCx is commissioning a $334 million new facility to replace the existing Irwin Army Community Hospital. The replacement hospital will include a 263,000-square-foot hospital, a 289,000-square-foot clinic, a central energy plant, an ambulance garage and supporting facilities.

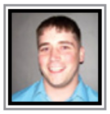
SF Kaiserslautern Military Community Medical Center,

Kaiserslautern, Germany

Working with the United States Army Corps of Engineers, Europe District on a five-year, $12 million contract, SSRCx will provide commissioning, energy support, measurement and verification services, and the energy model for the 1.3-million-square-foot facility.

This center will provide direct medical services to patients throughout Europe Command and emergency casualty evacuation support for Europe, Central and Africa Commands. ■

SPOTLIGHT *on our* PEOPLE



SSRCx welcomes **ERIC KEES** as an engineer-in-training to work with energy modeling. Eric has four years of experience as a mechanical designer and holds a Bachelor of Science degree with a specialty in mechanical engineering from the University of Wisconsin-Platteville.

TABITHA GOODMAN has been promoted to project manager with responsibility for developing new business opportunities and cultivating relationships with potential clients; managing projects from conception to completion; and serving as an educational and technical resource on green buildings to aid clients in achieving LEED® certification.

STEVE HARRELL recently passed the AABC Commissioning Group (ACG) Certified Commissioning Authority (CxA) exam.

Upcoming CONFERENCES

Visit Us At **Greenbuild** in Toronto – Booth 4841S
Oct. 4-7, 2011
Metro Toronto Convention Center
Toronto, Canada
Website: www.greenbuildexpo.org/Home.aspx
SSRCx contact: Jamie Qualk jqualk@ssr-inc.com

Design-Build Conference & Expo – Booth 122
October 19-21, 2011
Marriott World Center
Orlando, Florida
Website: www.dbia.org/conferences/expo/2011/
SSRCx contact: Ted Foster, tfoster@ssr-inc.com

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