COMPARING ENERGY MODEL USE TO ACTUAL ENERGY USE

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Reality is often different from assumptions made in energy modeling. In general, energy modeling has limitations, and comparing energy model results to actual energy recorded at the utility meter presents several obstacles. Assumptions were made for Sweetwater Creek State Park Visitor Center's energy model regarding improved energy efficiency of demand based ventilation with CO_2 concentrations to regulate the volume of outside air delivered over a given period. Variables include:

- Daily population in the visitor center and time in a building;
- Number of days represented by utility consumption for a given year (typically does not equal 365 days); and
- Weather elements such as dry and wet bulb temperatures, enthalpy, clear sky percentages, precipitation, wind speed and direction.

Typically, energy modeling programs use a variety of long-term average weather data files to estimate average energy consumption. Even with verified plug and equipment loads and schedules, weather files can create obstacles to accurate comparisons of calculated versus actual. For the visitor center, we used the original energy input file and actual weather data from the area. The closest weather station with the most complete data was Atlanta Hartsfield-Jackson International Airport, located 25 miles away. What we imagined as a relatively easy task was complicated by:

- A plethora of weather file formats, each containing its own set of observational measurements, format and availability of reliable actual weather year data, expected data format versus indicated weather data format, and missing data;
- Proximity of weather station to project site; and
- A general lack of information or sparse and outdated information on alternative ways to accomplish actual weather year modeling.

Sweetwater Creek State Park Visitor Center's estimated annual energy consumption is 81,660 kWh. Using the actual dry and wet bulb temperatures in lieu of the historic averages raised the estimated energy consumption to 85,200 kWh. However, the actual energy use for 2006 was 94,680 kWh, 11% higher than estimated. Without measurements of actual occupancy, actual plug loads or contribution from the solar photovoltaic system for the same time period, it is difficult to determine the causes of the variance.

Twin interior lightshelves below clerestory windows bounce daylight into the main exhibition space.

that would be durable and easy to maintain; and materials that had minimal VOC off-gassing. Twelve percent of materials by cost, including photovoltaic solar panels recovered and reused from a gas station canopy, were salvaged. Additionally, 29% of the project's materials by cost were manufactured within 500 miles of the project site. In response to the criteria listed earlier, primary exterior materials consist of masonry stucco, galvanized steel siding, prefinished steel roofs, vegetated roofs, and aluminum storefront and window systems. The provisions diverted 125 tons or 80% of the construction waste from landfills.

Financial Contributions

Several financial partnerships contributed to the success of this project. State funds represented less than 75% of the total project costs. The Friends of Sweetwater Creek State Park raised more than

LESSONS LEARNED

Monitor Building Performance Implementing a measurement and verification plan helps confirm that the high performance building is operating within anticipated parameters. Without monitoring the main building systems, the owner of the best designed and best constructed building in the world may not be aware that the building is not performing as intended. In the case of Sweetwater, a 77% reduction in potable water use was anticipated while over 90% was achieved. In contrast, achieved energy savings were lower than anticipated. Comparing actual meter readings to the energy model baseline and the design case is unrealistic without matching actual conditions. Nevertheless, adjustments are being made to the building energy use, particularly lighting, to achieve readings closer to the anticipated savings.

Nutrient Recycling Three times during the design process, owner, architect, LEED consultant, structural engineer, mechanical engineer, electrical engineer, landscape architect, civil engineer, construction cost consultant, commissioning agent and a representative from Friends of Sweetwater Creek State Park gathered to consider cross-disciplinary strategies and make decisions based on team consensus. On several occasions, the integrated design process yielded ideas and solutions that developed the project design into a more intelligent and elegant expression. A good example is the nutrient recycling aspect of the project, where excess liquid from the composting toilet system is combined with the building's gray water before being pumped to the exterior landscaping as liquid plant food, thereby eliminating the waste stream to a treatment plant or conventional septic system. No single discipline was responsible for the solution; rather, it required input and expertise from the owner (a civil engineer by training with a willingness to explore an unconventional solution), the mechanical engineer (the portion of the system inside the building), the civil engineer (the portion of the system outside the building), the landscape architect (the plant material), and the architect (integrating the system into the building).

Display Lighting Efforts to optimize building performance can continue even after building operation begins. To further improve the building's performance, the design team encouraged the owner to implement newer technologies for the display lighting when available. The interpretative exhibits' track lighting is a significant power consumer in the building. Because this lighting is associated with the displays, it was not included in the energy modeling of the base building. When the building opened, reliable dimmable compact fluorescent lighting lamps were not available; thus, dimmable incandescent lighting lamps were used. The owner plans to swap out these lamps with dimmable compact fluorescents when feasible.

$500,000 for this project, including $250,000 from a major corporate donor and varying amounts from other businesses. Grants were received for some of the renewable energy features including a large donation of salvaged photovoltaic panels valued at approximately $85,000 and a grant from the Georgia Environmental Facilities Authority for new photovoltaic panels valued at approximately $20,000.

If the value of the donated recycled photovoltaic panels (about $85,000) was included in the cost of the building (excluding exhibits and site work), the final cost of the building would be approximately $185/ft^2. However, the actual cost of the building, not including the value of the donated panels, was $175/ft^2.

The majority of the contributions were made because the project was going to be an exemplary sustainable building. The sustainability of the project made the fundraising significantly easier and brought in many partners and donors interested in promoting green buildings.

Teaching Tool

Recognizing its place within a conservation park, the facility preserves and interprets the cultural history of the area; conserves and protects the local natural ecosystem; and educates the public in environmental stewardship, using the site and building design as a teaching tool. The interactive facility allows visitors to experience areas inside, beside and on top of the building. Sustainable systems, incorporated into exhibits inside the building, teach visitors about conservationism. With the exhibits and site design, Sweetwater Creek State Park Visitor Center has become a destination for those interested in learning more about resource conservation and high performance, green buildings.

Acknowledgments

This article contains data from an energy analysis and modeling report prepared by Commissioning & Green Building Solutions, Inc. One World Sustainable Energy Corporation provided the estimated solar photovoltaic production for the visitor center in *Figure 1*. The emissions information was derived from the U.S. Environmental Protection Agency's (EPA) Emissions & Generation Resource Integrated Database (eGRID) for the calendar year 2000. ●

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