New Energy Design Software

by Rick Clyne

Predicting the energy performance of a new building is a complicated project. Computer-based energy simulations are carried out routinely for large institutional-scale projects, but they require expertise with complex software and days (or weeks) of data input. Such an effort has generally been too expensive and time-consuming for homes or small commercial buildings.

But not anymore. A new software package for personal computers, Energy-10, puts detailed building energy analysis within the reach of any residential designer. With Energy-10 software, the analyses that used to take weeks now take a few hours.

Equipped with an extensive database of climate data for hundreds of North American locations, Energy-10 enables builders anywhere on the continent to easily design homes that use 30% to 70% less energy than a standard house — without sacrificing comfort or appearance. Because the software allows the designer to quickly evaluate and compare the effect of various design changes, a new home or remodeling project can now incorporate the best mix of energy-efficient strategies with little or no increase in design costs.

User Friendly

In creating Energy-10, the program's developers placed a premium on ease of use. The secret to Energy-10's simplicity is its automatic use of hundreds of initial default values to describe a building in the computer. To get started, the user need only input five basic parameters: the total square footage, the number of stories, the geographic location, the type of hvac system, and the building's intended use (for a home, the choice is "residential"). Other details — wall construction, insulation levels, window types, and so on — are governed by the computer's starting assumptions until the user specifies something different.

Initial comparison. After the user inputs the five starting parameters, Energy-10 automatically creates two generic "shoe box" building descriptions. The first is a reference case that assumes the builder will follow standard building practices, and the second is a low-energy case that incorporates some or all of ten energy-saving strategies, including high-performance window glazing, shading, daylighting, energy-efficient lighting, improved insulation, thermal mass, and high-efficiency hvac.

After these two building descriptions are created, Energy-10 runs an energy-use simulation routine, subjecting both buildings to a full year of weather simulations to evaluate how energy will be consumed in heating, cooling, and lighting. The program then compares the performance of the two hypothetical buildings and produces bar charts that show how the standard house design stacks up against the energy-efficient design.

Generating this base comparison takes about 20 minutes. Then, using the energy-efficient shoe-box case as a target, the designer can introduce changes one by one and quickly gauge their effect on the home's performance.

Worked Example

Let's say, for example, a client wants you to build a 2,400-square-foot, two-story colonial in the suburbs of Philadelphia, Pennsylvania. You need only select an appropriate hvac system to have enough information to begin the Energy-10 analysis.

The results of the initial simulation for our Philadelphia home are shown on page 62. The reference-case data reflect how this home would use energy if it were built using standard construction practices. The low-energy-case data show how the home would use energy if all the energy-efficient strategies were incorporated. With the proper balance of energy-efficient strategies, the design of the actual home should approach the performance of the low-energy case. For our Philadelphia home, the initial results show that energy-efficient heating strategies will have a significant impact on energy use.

Within a half-hour of starting the design, then, you have valuable information on how the home will use energy. You can now make subsequent design decisions with a functional understanding of the home's basic energy-use characteristics.

Refining the design. The original shoe-box building description created within Energy-10 evolves as the design process progresses. As details become known, you can input wall construction details, foundation characteristics, window areas and locations, insulation levels, and hundreds of other values that will accurately reflect the maturing building design. With each value input, the description in Energy-10 performs more like the actual home and less like the generic shoe box.

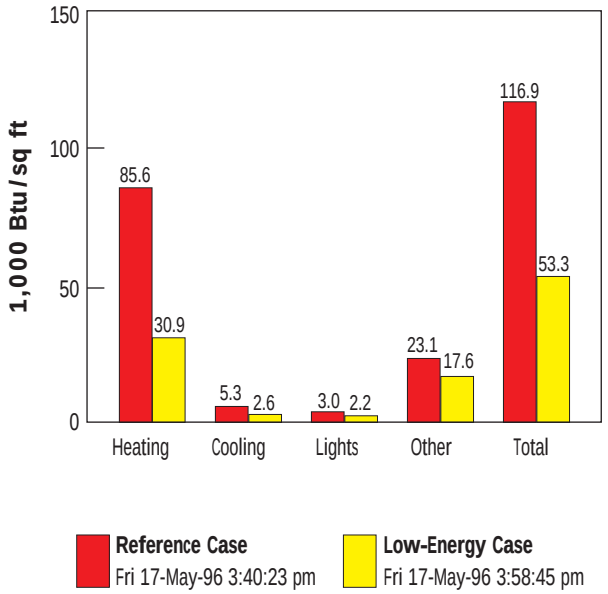
Ranking Priorities

One of the program's strongest features is its ability to rank the energy-efficient strategies according to their effectiveness. By running this ranking routine early on, you know which strategies will provide the most bang for the buck. Note the output from this ranking feature as applied to our Philadelphia home (righthand chart, page 62). Based on these data, you would at a minimum want to ensure that inside ducting, infiltration tightening, and a high-efficiency hvac system are incorporated into the design, because the chart shows clearly that these offer substantial energy savings.

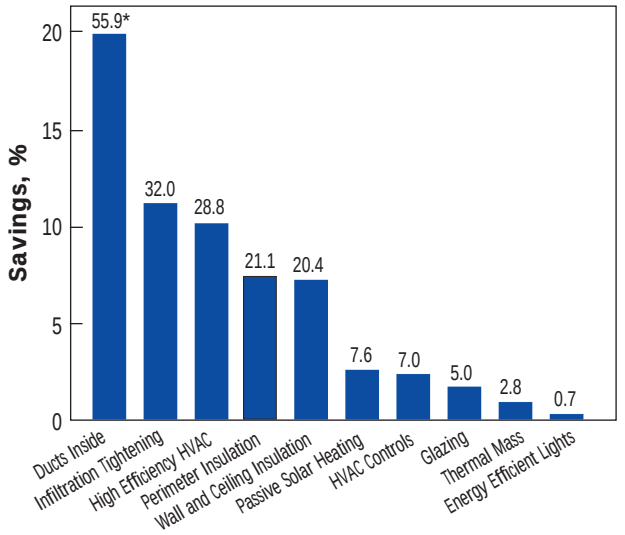
Energy-10 also lets you isolate the effect of a single energy-efficient strategy. At any time in the design process, you can select the strategy you are interested in evaluating — increased insulation in ceiling or walls, for example — and apply it to the evolving description. Energy-10 will then run a simulation and produce graphical output that compares the design's performance with and without the selected energy-efficient feature. In less than 10 minutes, you'll know whether this energy-efficient feature has a significant effect on the way the home — as

Colonial Case Study

Annual Energy Use



Ranking of Energy Strategies



* The numbers above each bar represent annual energy savings in millions of Btu (base case = 281 million Btu).

Energy-10 generated the graphic displays above based on weather data for the Philadelphia, Pa., area and using construction details input by the program's author. The program creates a chart to compare the annual energy use of the base-case house with an energy-efficient modified design (left).

The base-case house has 2x4 framing with R-11 batt wall insulation, R-19 ceiling insulation, an uninsulated foundation, an 80%-efficient furnace, and an 8.9 EER air conditioner. The low-energy-use house depicted in the right-hand bars keeps the 2x4 framing, but adds R-10 foundation insulation and an R-7 exterior foam on the framed walls. Ceiling insulation is doubled to R-38. Furnace efficiency is raised to 90%, air conditioner EER is bumped up to 13, and windows were rearranged to increase winter solar gains but shaded to cut summer heat gain (right).

The combined changes in the assumptions cut the predicted heating costs by more than 50%, accounting for the bulk of energy gains. With Energy-10, the designer can go on to alter specific elements, and quickly generate new graphs to show the incremental effect of each change. A rank-order chart (right) shows where the greatest gains can be made.

it is currently designed — will use energy. If you supply the computer with information on fuel or electric costs, the output will tell you the annual dollar savings, allowing you to balance construction costs with energy savings in dollar terms.

Works for Remodeling

Energy-10 can also be used on remodeling projects. You would simply have to input the parameters that describe the existing structure as the reference-case building. The design incorporating the remodeling work would serve as the low-energy case.

Energy-10 was conceived and developed under a five-year program led by National Renewable Energy Laboratory in Golden, Colo., and supported by Lawrence Berkeley Laboratory, the Berkeley Solar Group, and the Passive Solar Industries Council (PSIC). The software was developed as a design tool for integrating energy-efficiency measures into small commercial structures of less than 10,000 square feet, but it works effectively for residential designs as well.

To run Energy-10, you need a PC running Windows with at least 8 megs of RAM. The program is now being distributed by the Passive Solar Industries Council as part of the package Designing Low-Energy Buildings, which includes Energy-10 software, a user's manual, and a 150-page book on energy-efficient and renewable-energy building design. The price is $250, or $50 for full-time students. For information, contact Blaine Collison at the Passive Solar Industries Council (1511 K Street NW, Suite 600, Washington, DC 20005; 202/628-7400, ext. 210). ■

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