Putting the Byte into Your Analysis Toolkit

by Bion Howard

When it comes to energy efficiency analysis, you have specific needs. Chances are, there's a software package out there that fits your needs. But if you're new to the world of energy software, it's hard to know where to start.

The sheer volume of energy design software (EDS) packages that are available challenges me as a building science practitioner. I have used calculators and computers. I've written programming code for my own software and used other folks' programs. And I've tried to keep up with the revolutionary progress of EDS over the last 20-plus years. But when someone asks me what they should buy, it's hard to suggest a specific choice.

There are more than 125 EDS tools available to evaluate the energy-related aspects of buildings, and others are in development. Some tools are best for executing a basic load calculation; others, for doing year-long simulations with custom climate data. Some are best at the beginning of the design process. Others are useful for coming up with detailed performance reports on a fin-ished building. Choosing the correct EDS is like choosing any other tool—you figure out which is the right one for the job. In the end, it is better to select a few EDS tools that meet your specific needs than to try to use many different ones, because it takes considerable time to become proficient with most of them.

Tool Types

There are three major types of EDS tool that you can use.

Correlation-based tools analyze data statistically and simplify it into a mathematical representation (a curve), which is then correlated (curve-fitted) with similar shapes from other data. Correlation data are often corrected with sensitivity study information to take into account systematic variations on usual situations. Since correlation tools are based on curve-fits to results from a more detailed simulation program, they can be no more accurate than the source program and are limited to the combinations and ranges of input used in the development of the correlation. They are less flexible than true simulation tools. WinGuide and PEAR are examples of correlation-based tools.

Seasonal-based tools are usually set up to minimize the time it takes to perform an analysis, by using only portions of the full year in order to make reasonably reliable calculations when run time is a concern. This approach can produce somewhat more accurate results on an individual building than a correlation-based tool can provide, but it still sacrifices some detail and cannot analyze whole-year weather data. Seasonal tools are highly simplified and
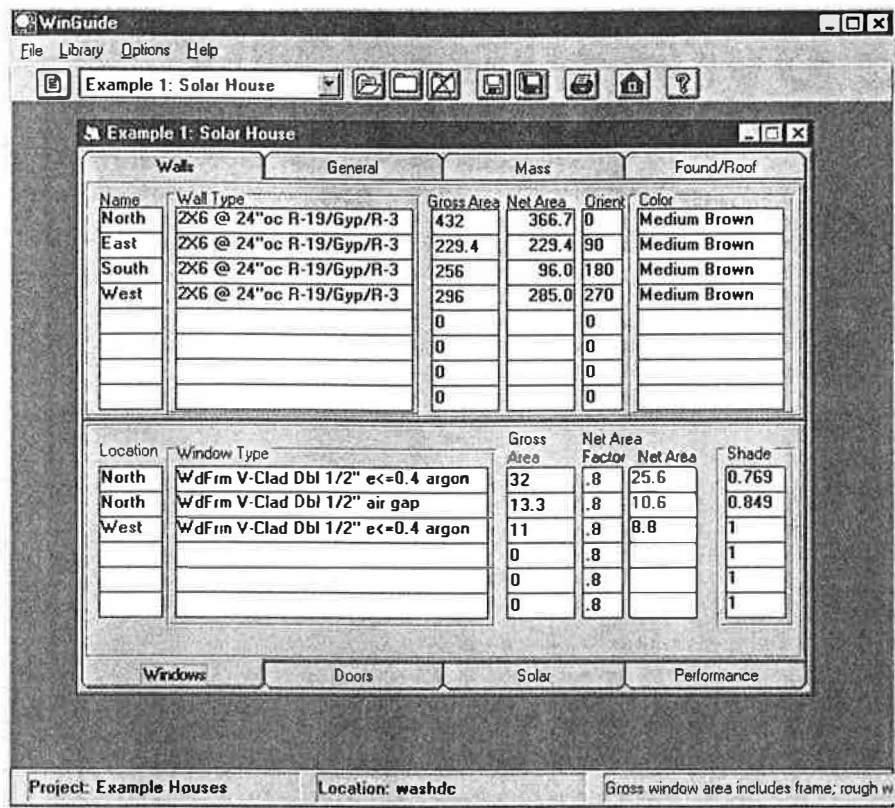
WinGuide uses a handy tabular "index card" approach to entering input data, shown here.

Early-Design Tools

Early in the schematic phase, when a building may exist only on the back of an envelope, I use either a correlation-based software program, WinGuide; a seasonal-based tool, REM/Design; or a simulation-based tool, Energy-10. These software packages allow me to quickly verify my initial recommendations. For example, sometimes I think a roof might need a large overhang to avoid air conditioning penalties. All three of these EDS tools can rapidly recalculate different scenarios, and can show whether adding the overhang would cut too much off solar gain during the heating season. Such results are helpful for creating reports for builders in the early phase of design.

WinGuide

This compact and useful program is MS-Windows–based and is a significantly revised version of the passive solar oriented "BuilderGuide" program developed initially by the National Renewables Energy Laboratory (NREL) for the Passive Solar Industries Council (PSIC). It is placed within a Visual Basic shell and has some very simple but useful tools to edit the materials and building propoèrty values. There is also a "rotating" function so a designer or

cannot model dynamic effects very well. A well known example is REM/Design, from Architectural Energy Corporation.

Simulation tools model the building down to each hour (or less) of the year. In principle, they are the most accurate. They typically use either thermal networks (model interactions between individual components based on heat and mass transfer) or response factors that are generated to describe the characteristics of building materials and systems, and interactions. Once a building model is created, the software uses hourly weather data to calculate building loads, fuel use of the mechanical equipment, and indoor conditions.

The user has considerable control over the level of detail in a simulation model. But he or she must have more expertise in building science and mechanical engineering to select correct input values, to check his or her work, and to analyze the detailed performance reports that these tools produce. Simulation tools include DOE-2 and Energy-10 (see "Energy-10," *HE* Sept/Oct '97, p. 37), though the two use quite different approaches to simulating building performance.

Within these three categories of energy design tools, there are many individual programs that you can turn to, depending on the task at hand.
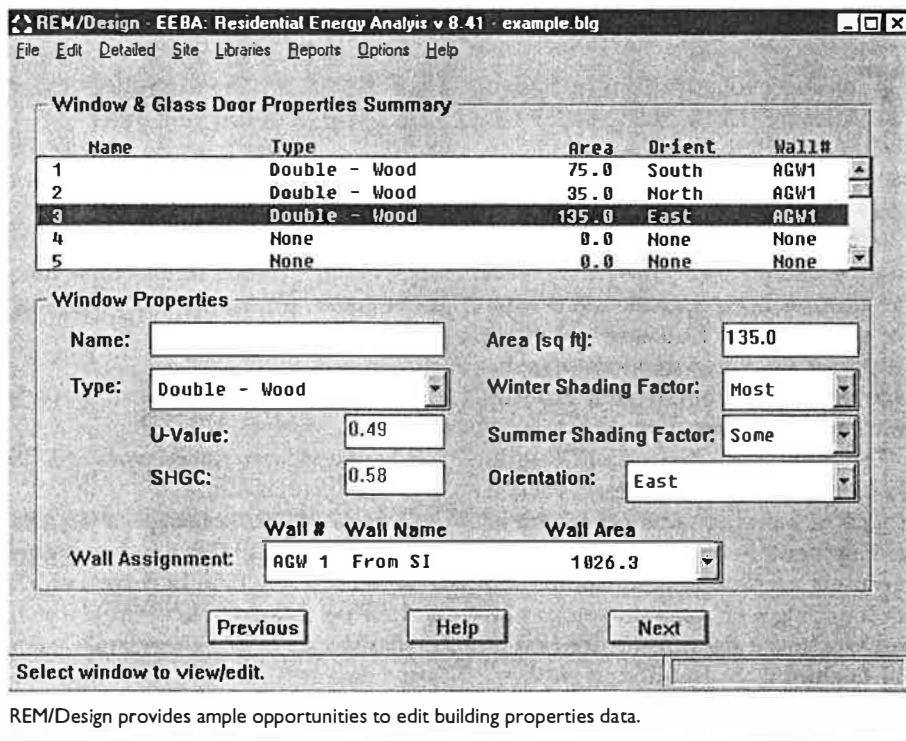
REM/Design provides ample opportunities to edit building properties data.

builder can examine the impact on overall energy performance of changes in the orientation of a home design. The graphical bar-charting function allows for quick comparisons between energy scenarios on the same building, and shows whether or not the building meets the Model Energy Code (International Energy Conservation Code—see p. 7).

REM/Design

REM/Design is an example of a tool whose "engine" is based on seasonal performance. Such programs often include a significant amount of default data, which can be accepted or, in selected cases, can be opened for editing by the user. REM/Design was recently updated for use in concert with the 1998 *Criteria* of the Energy Efficient Building Association (EEBA).

Energy-10

Energy-10 was developed by NREL with Lawrence Berkeley National Laboratory (LBNL) and others. It is marketed by the PSIC. Energy-10 includes a very useful manual, and comes with a training course called Designing Low Energy Buildings. Energy-10's user-friendly training and support make it stand out from other EDS tools.

REM/Design shows a "quick view" of reported energy factors for an example building. When you plug in energy prices, the program will calculate predicted operating costs. Then you can compare savings on subsequent runs.

One key advantage of Energy-10 is the Autobuild function in which the program erects a default rudimentary model. You then can edit the model to reflect the actual building, which is much quicker than creating a model from scratch. I also appreciate Energy-10's ability to run optimizations—which let me consider competing efficiency measures on the basis of their costs versus their benefits—and to suggest that I "go get a cup of coffee" while the results are being compiled.

I think Energy-10 is the best-developed simulation-based tool and the easiest one to use. But despite the recent release of version 1.2, there is still room for improvement. Specifically, I would like more control over inputting and modifications to the data sets and more emphasis on residential buildings. The program was originally written for small commercial applications. There are some minor bugs—such as problems getting correct units for energy factors to be furnished under some conditions—but NREL claims that these are likely to be taken care of in the next version. In my mind, these problems are pretty minor.

Consider Building Types

These programs are suited to different types of building. REM/Design, for example, is best suited to production housing, while WinGuide is intended specifically for passive solar designs. If the project is passive solar and will have thermal mass added, I use either WinGuide or Energy-10. If home efficiency is emphasized, I would be more likely to use REM/Design. It can also consider typical sun-tempered passive solar design.

REM/Design's "card" is used for editing the wall properties. Similar input forms exist for other envelope subsystems like roof/ceiling and glazings.

The Energy Expert in the CD-Drive

Over the past four years, utilities have gradually recognized that competition is coming. In preparation for that event, many utilities have sacked their demand-side management staff as so much money-losing, feel-good fat.

At the same time, the World Wide Web has come into its own. It's no surprise that software developers and demand-side managers have wracked their brains trying to figure out how to use the Web to give consumers the energy audit services they're used to, without costing the energy service providers much money.

The results of these brainstorms have had their good points. Several utilities are using Web-based software packages to conduct rudimentary home energy audits. According to users, the audits provide reasonable advice. However, anyone who has experienced the "World Wide Wait" knows that multiple-choice questions and slowly scrolling graphics are a poor substitute for a real human who walks around the house, examines the utility bill history, makes suggestions—and answers questions.

A new combination CD-ROM and Web site from NeXus of Newton, Massachusetts, attempts to respond to these problems. Their software walks users through a basic energy audit and offers suggested improvements. It also provides state-by-state information on restructuring and advises consumers on the relative costs and benefits of various green power options. The green power comparison area has a comprehensive list of power suppliers, with several green power options listed for each supplier.

For speed, much of the software is on the CD-ROM, but fast-changing information is updated off the Web. Also, the CD links users to the Web when they want to buy energy efficiency devices like low-flow showerheads. The Web site includes various additional bits of energy-efficiency information for residences and small business, ranging from "energy-saving tips" to reprints of *Home Energy* articles.

Anyone can log onto the Web site, but the CD-ROM is not available directly to consumers. Energy service providers buy the CD in bulk, to be sent out to customers—or potential customers—it wants to appeal to. The CDs can be customized for certain demographics, providing more information on green power, for example, and less on energy-efficient buildings.

—Steven Bodzin

Fastest Spreadsheet in the West

Sometimes I'm asked to do a real quick-and-dirty study. My client may say, "Help me tweak this house so it meets the International Energy Conservation Code (IECC)" or, "I'm getting hassled by my building official and can't make my calculations work." For this sort of simple work, I use an Excel spreadsheet based on ACCA's *Manual J*, or possibly Program for Energy Analysis of Residences (PEAR) or MEC-Check, which is short for Model Energy Code-Check.

At my company, we developed—first in Lotus 1-2-3 for DOS, and later in Microsoft Excel—worksheets based on ACCA's *Manual J*. This permits us to quickly plug in many details about a building that can be taken off plans. Then we can calculate how much heated or cooled air might be required in a given room, and how large a

home's space conditioning system would be. Many code jurisdictions require or recommend that a *Manual J* calculation be done to size home heating and air-conditioning systems. *Manual J* is also cited in the IECC.

Right-J

There is also a computer program called Right-J that does *Manual J* calculations, but we don't currently use it, as we are happy with our Excel spreadsheet. Wright Associates has issued a new Windows-based version of Right-J that is packaged with other computerized versions of ACCA technical manuals, such as Right-D, which designs duct systems according to *Manual D*. HVAC contractors who do a lot of equipment-sizing work for home builders and retail strip malls might benefit from checking out these programs.

PEAR

For simple calculations on new home designs, I still like the 10-year-old PEAR, which was developed by LBNL. This program is correlation based and uses a data set produced from thousands of individual DOE-2 runs performed on a set of typical houses with rather basic energy features. The user has only moderate control, selecting from a preset features listing, and most users have no control over the data that underpin the program.

Although it is DOS based and sort of clunky by today's standards, PEAR is handy for a quick run-through of envelope and basic mechanical system options. Its menu options are simple; it can com-

Materials	Density #/ft³	Specific Heat Btu/#-F	Thermal Conductivity Btu/ft-h-F	U Btu/hr-ft²-F
<none>	0.00	0.00000	0.00000	0.00
<none>	0.00	0.00000	0.00000	0.00
adobe	120.00	0.20000	0.33200	0.00
block	115.00	0.20000	0.46000	0.00
builder brick	120.00	0.20000	0.42000	0.00
carpet	25.00	0.34000	0.02000	0.00
ceiling air space	0.00	0.00000	0.00000	1.00
cellular concrete	30.00	0.20000	0.06900	0.00
concrete	140.00	0.20000	1.00000	0.00
dead air film	0.00	0.00000	0.00000	1.50
drywall	78.00	0.26000	0.25000	0.00
earth	100.00	0.20000	0.45000	0.00
eps foam	1.00	0.29000	0.01916	0.00

The "materials" library in Energy-10 is where a user can edit information on the building materials in a project. It is especially helpful when unusual building materials are used.

```
USE ARROW KEYS TO MOVE THE CURSOR ( ▶ ◀ ▲ ▼ ), <Space> TO EDIT, ? FOR HELP
    <PgDn> FOR NEXT SCREEN, <PgUp> FOR PREVIOUS SCREEN, (End) TO QUIT

    GENERAL INPUT              CONSERVATION MEASURES

    State......  GEORGIA Keywd.    Ceiling Insulation........    11.0 R-Val
    City......   ATLANTA Keywd.    Roof Color............        DARK Keywd

    Prototype.........  1S Keywd.  Wall Insulation........        0.0 R-Val
    FoundationType......SLAB Keywd. Wall Mass Location.......    NONE Keywd
                                   Wall Color...............     DARK Keywd
    Floor Area.......  1548.0 sq.ft.
    Wall Perimeter.....  166.0 ft.  Foundation Insulation.....   NONE Keywd
    Cross Wall Area....  1328.0 sq.ft. Floor Insulation........    0.0 R-Val

    North Window Area   38.5 sq.ft.  Window Layers...........      1 Pane
    South Window Area   38.5 sq.ft.  Window Sash Type.........  PLAIN Keywd
    East  Window Area   38.5 sq.ft.  Window Glass Type.......     REG Keywd
    West  Window Area   38.5 sq.ft.  Window Movable Insulation.  NONE Keywd

    Run Name  BASE CASE            Infiltration..............     1.0 AC/hr

HEATING ENERGY 749 THRM.                COOLING ENERGY 2968 KWH.
```

PEAR is clunky by today's standards, but still handy.

pare different option packages with a base-case house; and it does a quick and simple economics analysis to boot.

MEC-Check

MEC-Check, developed by Pacific Northwest National Laboratory, is helpful for quickly checking a home's compliance with the IECC. Like PEAR, it is a DOS program and may be difficult to set up on Windows-based PCs. It is best run in full-screen mode. It can be downloaded with documentation via the Internet (see "Software Resources").

Home Energy Saver

Developed by LBNL, the Home Energy Saver is available on-line as a Web-based analysis tool. It provides information and energy analysis for the whole house by letting the user build a virtual home to estimate energy savings.

Detailed Analysis

For more detailed energy analyses of homes, I use typically use REM-Design or Energy-10. But sometimes, I turn to one of the following programs.

Micro-PAS

Before I started using Energy-10 for residential building studies, I typically used a simulation-based program called Micro-PAS. It was developed by Enercomp, based on the earlier CALPAS code by that the Berkeley Solar Group wrote for the California Energy Commission. One advantage of Micro-PAS is that it is a thermal network program. Thermal network programs are inherently flexible; they can model a wide variety of simulations. In this kind of model (one that requires some skill and good data on material properties), you can "erect" in the computer nearly any sort of building—even complex heat storage systems.

If I am called on to evaluate a passive system with a rock bed or air-core block bed system, I go straight to Micro-PAS. I have used the program in the past to do energy studies of buildings with these systems, and the buildings performed well when constructed. I saved the files from those buildings, and now I can simply update some variables to analyze a new building. Making a habit of saving old input files is useful, particularly in structured programs like Micro-PAS and Energy-10. It takes a lot less time to update old project files than to type in a new project from scratch.

NEAT

The National Energy Audit Tool (NEAT) was originally distributed to weatherization agencies, utilities, and community action programs. It is a DOS-based program for personal computers, and though learning to use it can be somewhat difficult, it can produce useful results—including an economic assessment of the savings-to-investment ratios of selected energy efficiency measures.

In NEAT, a user inputs data on the building and its heating and cooling systems. The program responds with a prioritized list of cost-effective energy

---

HOT2 XP

When I began this article, I had never tried the latest version of the HOT-2000 family, Hot 2 XP. I was not particularaly impressed by early DOS-based versions of the program, but the new version—for Windows 95/NT—appears focused on less technical users.

This program can be opened in a variety of interactive screens. In them, one builds a new home design, or edits a design that comes with the program. The program allows users to edit the shell, mechanical system, and utility costs. Users cannot edit the standard default data, but they can build their own library files to use during analysis. They can select from a variety of Canadian and U.S. weather data.

After the user edits the building parameters, the program processes loads in a bin method calculation. The program can then display the results in a variety of formats. The results are not as accurate or detailed as those from the complete HOT-2000 program, but Hot2 XP reduces data entry time.

I really liked the ability to input past utility bills. This could help evaluate weatherization scenarios.

Aside from some minor installation difficulties, the program performed well. It might prove quite useful for builders, energy auditors, and even technically inclined home owners to explore building energy efficiency concepts.

Match Your Software to the Task

Type of project	Energy-10	REM/Design	DOE-2	MicroPAS	WinGuide	PEAR	Right-J	MEC-Check	NEAT
Weatherization audit	◎	✪★	◉	◉	◉	◉	✪★	◎	✪⚒
Multifamily retrofit	✪★	◎	✪⚒	✪★	◉	◎	✪★	◎	◉
Efficient new home — early design phase	✪★	✪	★⚒	✪★	✪	✪	◉	✪	◎
Efficient new home — detailed evaluation	✪	✪	✪★	✪	◉	◉	✪	◉	◎
Basic compliance with International Energy Conservation Code	✪	✪	✪★⚒	◎	✪	◎	✪	✪	◎
Residential load calcs — early design phase	✪★	✪	✪★	✪★	◎	◎	✪	◎	◎
Residential load calcs — detailed evaluation	✪★	✪	✪⚒	✪★	◎	◎	✪	◎	◎
Passive solar home — early design phase	✪★	✪	◉	✪	✪	◎	◉	◎	◎
Passive solar home — detailed evaluation	✪	✪★	✪★	✪	✪★	◎	◉	◎	◎

✪   Reviewer has found tool to have acceptable performance
◉   Not an advisable use for this tool
◎   Tool not relevant to project type
⚒   Tool can be excessively "user-hostile" for this task
★   Reviewer has not used tool frequently in this type of project

efficiency measures. The selected measures are customized for individual homes. An upcoming version will also be able to analyze utility bill histories. According to Oak Ridge National Laboratory, as of October 1995 NEAT was being used by about 500 local weatherization agencies in 30 states to make retrofitting decisions on low-income, single-family dwellings.

DOE-2

Multifamily buildings, such as garden apartments and condos, may have multiple zones and complex HVAC systems more like the ones that commercial structures employ. We usually use the detailed DOE-2 program to tackle such projects. A thorough site study gathers input data, sometimes over a three-day period. We use these data, along with building plans and as-built updates to plans, to create a building description for use by DOE-2. We run the simulation several times to check the inputs for reasonableness before we explore efficiency options. Sometimes we perform an initial analysis with Energy-10. If it is a big enough project, then once Energy-10 has recommended the best measures, we run DOE-2 as well. This is the one case in which we will use two EDS tools to confirm one another's results. It can be

important to run multiple programs in expensive projects, where more than $250,000 may be available for improvements (see "Simulations Save Money").

Green Building

The integration of green building attributes into EDS packages has a long way to go. Building codes and incentive programs in places like Austin, Texas, and Boulder, Colorado, are going beyond energy, into green building. These codes and programs require a minimum level of green attributes, including water conservation, recycled building materials, energy efficiency, and waste reduction.

Like energy codes, the green building programs allow trade-offs between different measures. However, there are no widespread standards for environmental attributes. There are standards for energy and water use, but these are only two parts of the equation. This poses a problem for EDS packages—consumers want to know how green a building is, but different software packages have different ways of calculating environmental effectiveness.

Professor Jan Krieder, of the University of Colorado, has examined software assessment tools with his graduate stu-

dents. When he and his students ran one home design through various applications, they received reliable and consistent results for energy efficiency, but the green building scores were inconsistent. When run on the same house design in several states, such as Texas and Colorado, where green building programs exist, the different tools did not equally indicate that code compliance was met.

Special Programs

If you or your clients participate in programs such as Energy Star Homes, Edison Electric Institute E-Seal, Good-Cents Environmental, or certification by insulation manufacturers, their requirements might affect which EDS you choose.

Some programs require that specific proprietary EDS tools must be employed in order to meet certain objectives and requirements. In other programs there is considerable leeway for selecting among competing tools.

Some utility and government incentive programs rely on analyses of individual buildings, either in plan review or as a result of field assessments such as energy audits, home energy ratings, and residential environmental performance assess-

ments. These require numbers calculated from an EDS. As a practicing Energy Star Ally, for example, I must use computer tools such as REM/Design and DOE-2 to demonstrate that residential buildings are at least 30% better than the IECC.

Both the Residential Energy Services Network (RESNET) and the Home Energy Ratings System Council (HERS-Council) have created accreditation standards for energy performance assessment systems and support personnel. If you are consulting for builders who want to qualify for home energy ratings, you should get software that will conform to the RESNET or HERS-Council standards. Both groups require that accredited software be tested with NREL's HERS-BESTEST procedure. Contact either HERS Council or RESNET to find out whether they recommend an EDS that would be most suitable for residential energy efficiency performance assessments.

Know Your Needs

Keep in mind the following details when you shop for an EDS tool:

- The type of project the tool will be applied to. Will it be commercial or residential, a new design, a remodel, an addition, or a total rehabilitation and adaptive reuse;
- The amount of information that will

be sufficient for your client's needs;
- The size of the project;
- The proposed occupancy and initial use for the structure—Will multiple uses be implemented in the same project? Is adaptive reuse anticipated over the life cycle of the building?
- The site characteristics that will be known at various stages of the project and that may affect the results of the EDS assessment (performance predictions);
- Whether the tool supports climate-specific design. Does it support calculations of renewable energy source contributions—such as architectural daylighting, passive cooling, or solar heating? Not all EDS tools are up-to-date or user-friendly in this respect.

Ask Questions Before You Buy

Once you've identified the type of software you need and narrowed down your choices to a few specific programs, it is time to ask yourself some hard questions. Before you buy any software, talk to the vendors and other users, keeping in mind your specific needs. There are many details you need to think about:

- Do you have the right level of computing power for running the software? At a large firm with the latest

Pentiums on a local area network, you can run just about anything. But with an older laptop or a single Mac, your selection will be more limited.
- How much interactivity do you need? Some software can analyze the relationship between improved envelope performance and reduced HVAC sizing, which in turn affects distribution design. This sort of interaction is possible only with the more advanced software.
- Do you intend to input each specification of every building component? Or do you prefer to rely on a generic set of data? If you want the EDS to provide some options, you should ask about "default data" and "data libraries."
- How accurate are the results? Some programs have been verified for accuracy by the U.S. Department of Energy's BESTEST, which is good for evaluating Home Energy Rating System software tools, but is not definitive. If HERS is your game, check out the BESTEST results. Otherwise, find out if the vendor can verify the software's accuracy.
- Does the software have built-in error control and identification? When you're typing in hundreds of variables, for example, a single typo could easily supply inconsistent floor and wall areas. Some software packages will notice the discrepancy and ask if you want to fix it.
- What kind of customer support is offered? Some companies offer on-

---

Software Contacts

DOE-2: Web site: www.doe2.com.

Energy-10: Passive Solar Industries Council (PSIC). Tel: (202) 628-7400; Web site: www.psic.org/energy10.htm.

HOT-2000, HOT-2XP: Conservation Capital Corporation. Tel: (800) 263-5974; E-mail: neca@neca.ca; Web site: www.greenbuilding.ca.

Micro-PAS: Enercomp Incorporated. Tel: (800) 755-5908 or (916) 885-9890; E-mail: info@micropas.com; Web site: www.micropas.com.

NEAT: ESTSC. Tel: (423) 576-2606; E-mail: estsc@adonis.osti.gov; Web site: www.ornl.gov/divisions/energy/oscp/Neatmhea.htm.

PEAR: Lawrence Berkeley National Laboratory. Web site: http://eande.lbl.gov/CBS/EEsoftware.html.

REM/Design: REM/Design. Tel: (303) 444-4149; E-mail: reminfo@archenergy.com.

Right-J, Right-D: Air Conditioning Contractors of America. Tel: (202) 483-9370; Web site: www.acca.org/catalog/rightj.htm.

WinGuide: Solaequis Software. Tel: (800) 953-4996; E-mail: info@solaequis.com; Web site: www.solaequis.com.

line help, a Web site with more information, or a phone number to reach live technical support.

- How hard is the software to install? Some programs have a known history of problems, such as using too much space on the hard drive or not getting along with certain video drivers. These can create unforeseen costs and lower productivity.
- How user-friendly is the program? How helpful is the documentation that comes with it? How much training is available for you to learn the software's many features? This is very important for long-term productivity.

Once you've made these assessments, you'll be ready to put your money on the line.

Become an Informed User

Choosing the right EDS tool is a complicated job—yet it's only the first step. Ultimately, the tool's usefulness will depend on you. To make full use of EDS tools, you must become an informed power user of whichever ones you select. Delve into the documentation, question assumptions about what the software can do, visit the vendor Web sites frequently, and talk to colleagues (and even competitors) who use the tools, always seeking to wring out the most information you can get. ⬛

Bion Howard is a building environmental science and technology consultant with Howard Associates in Harwood, Maryland. He is a member of the Energy Efficient Building Association (EEBA).