The Benchmark Comparison EZ Sim or DOE-2

EZ Sim is the next step in energy accounting software. It is a quick spreadsheet template that achieves results equivalent to the accurate and more sophisticated DOE-2 engineering analysis, but you don't have to be an engineer to use it.

We recently were able to compare the savings estimates generated by EZ Sim with those from DOE-2 as part of an evaluation of a new commercial construction conservation program and found close agreement between the two models. The purpose of the benchmarking exercise was to verify that EZ Sim, the simpler of the two energy modeling software programs to use, provides results similar to the more complex DOE-2 model.

Among EZ Sim's functions is the ability to use utility bills to calibrate a simulation of a commercial building in an interactive graphic window. Once it matches the building's utility bills, the simulation model provides reliable and realistic estimates of potential conservation savings. In addition, with EZ Sim, the calibration process reveals how energy is used within the facility and helps diagnose reasons for excessive consumption or poorly functioning components.

How modeling is done

Evaluators generally use simulation models to determine the impact on energy use of installing energy saving measures. During the design process, at least two simulation models of a building are developed to predict savings: a "baseline" building without energy efficiency measures and a "final" building with the measures in place.

In new construction, the alternative or baseline building was never constructed, so there is no set of "before" billing data that can be compared to "after" data. For that reason, the major problem in modeling new buildings is establishing a clear baseline to know what the energy consumption would have been had the efficient building not been built.

Once the building is built and has had sufficient time to produce utility bills, then the calibration or tuning process can be conducted. The tuning process is similar with any of the modeling software. First, the modeler includes all the available updated site information. Based on the site visit, this might include lighting densities, operating schedules, descriptions of equipment and building characteristics.

Often, the actual building behaves differently than the modeling software predicts. When that happens, the modeler decides which parameters should be adjusted to better match the model to the building's actual performance. This decision-making process involves a degree of expert judgment as well as deductions about the facility's operations and equipment characteristics. The final result is the "tuned, as-built" model.

Modeling provides an approach to the evaluation problem, but it is not an easy method to implement. DOE-2 is complicated and time-consuming to set up and generally requires the knowledge of an engineer for input and adjustments. Many of the modeling parameters must be assumed. Even when the model matches billings, evaluators cannot be certain the parameters are correctly specified.

▶

How well does EZ Sim work?

Results are shown in Figure 1. The amount of savings predicted by the two methods vary greatly depending on the size of the facility. To simplify comparisons, results are presented as the Realization Rate or the ratio of the final, modeled savings to the initial design estimate. EZ Sim provides similar results to DOE-2 but is much easier to operate.

Improvements in Accuracy

In the modeling process, differences in the modeler's judgement occur. All of the models were "tuned" so that annual consumption matched closely the actual bills for the as-built building. However, modeling the hypothetical baseline building required "back-casting" to model conditions that did not exist. Differences in allocating consumption to end uses in the "tuned" case affected the "back-cast" of energy usage in the baseline case. Since savings are defined as the difference between the as-built and baseline building, savings could differ depending on the modeler's allocation of end uses.

An example of the difficulty in modeling for one specific site is shown in Figure 2. In this graph, average energy consumption is shown on the Y-axis and average temperature is shown on the X-axis. Actual billing data are shown as black triangles. The EZ Sim model (blue line) is in good agreement with the actual billing data.

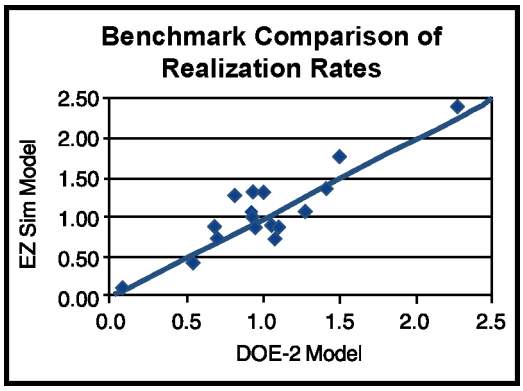

Figure 1. Benchmark Comparison

Notice that the DOE-2 model (red line) departs from the actual billing data. The DOE-2 model shows more heating and less cooling for this particular building. The deviation reflects a fundamental problem with DOE-2 — that it is difficult to match actual consumption under actual weather with consumption using average (TMY) weather. Since DOE-2 requires complicated weather files, it is usually not possible to provide files based on actual weather, as it is possible with EZ Sim. Instead, the modeler runs DOE-2 using average or TMY weather and tries to compare some TMY points with some actual points. As this example shows, the DOE-2 matching step can be inaccurate.

When the end uses are incorrectly specified, the problem is not immediately apparent for the "tuned" model. That is because the annual energy consumption appears to match actual bills. But when this model is "backcast" to the hypothetical baseline, significant differences can occur in the end uses of the baseline model. In turn, this can lead to errors in estimating the savings because the baseline model can now be seriously in error.

In this specific example, the misallocation of energy to space heating resulted in a recommendation to install more insulation measures than were actually cost-effective. At the same time, the misallocation failed to give full credit to lighting measures for reducing cooling load. Because EZ Sim uses actual weather, it is easier to match to actual bills.

The benchmark comparison between models run under the same input parameters shows that comparable results could be achieved between the two models. Results from the simple model were used preferentially in evaluating savings because these models utilized more complete information about the facilities and their energy consumption.

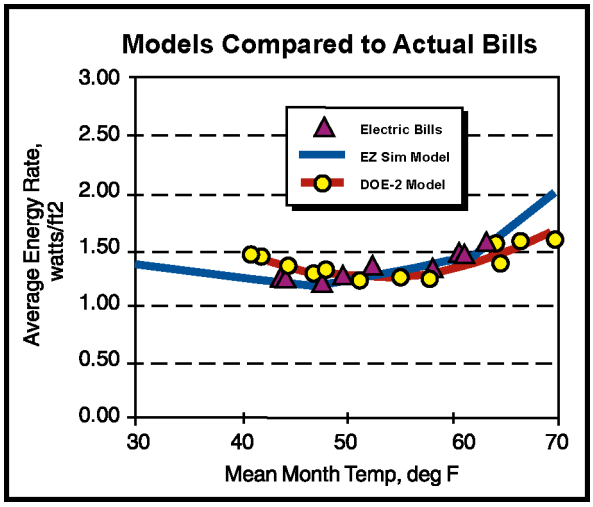

Figure 2. Model Comparisons

We believe that the simplified EZ Sim method provides a more accurate model of consumption than the DOE-2 approach. There is no loss of quality and potentially a gain in accuracy.