

ENERGY SIMULATION IN FACILITY VE STUDIES – A PARADIGM SHIFT

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Biography

Benson Kwong is an independent consultant providing services in value engineering, energy analysis, sustainability design, and life cycle cost analysis. He holds master degrees in mechanical and electrical engineering, as well as in business administration. As the president of enVErgie consulting, LLC, Benson Kwong provides consulting services to facility owners, designers, and contractors, to help achieve projects that are energy efficient, sustainable, and economical.

Abstract

Energy efficiency for buildings is becoming more crucial in Value Engineering (VE) studies as owners are looking for ways to reduce utility cost, achieve LEED, meet regulations, and be more eco-friendly. Free software developed by the U.S. Department of Energy, eQUEST makes it possible to calculate energy savings for multiple alternatives within the duration of a VE study. This energy simulation software, based on DOE2, can be as detailed and powerful as desired when used for LEED and ASHRAE compliance calculations. Yet in the “wizard” modes it can quickly simulate energy savings resulted from changes in building envelopes, lighting and controls, and HVAC systems. The graphic feature offers opportunities to visualize building geometry as well as HVAC system configurations. The use of eQUEST will make VE studies “greener” both for the environment and for owner’s utility budget.

Introduction

Energy analysis has traditionally been a peripheral subject in a facility value engineering study. This is due to several factors:

- Owners are more interested in first cost savings than energy performance
- Energy cost is a small part of the overall life cycle cost
- There are no accurate means to estimate energy savings during a VE workshop

In recent years we have seen changes in the political, economical, and technical environments that upend the above assumptions. This paper documents a paradigm shift that would make energy modeling not only possible, but a necessary component in VE studies for buildings and facilities.

Energy Conservation should be an integral part of a facility VE study

The importance of energy conservation in a facility VE study is highlighted by the following three facts:

- Energy conservation can create significant value in the life cycle cost of operating a facility.
- Energy conservation is key factor in sustainable design.
- Energy conservation is required by law in many jurisdictions.

Value Engineering is about optimizing the value of a product. One of the ways is to reduce the life cycle cost associated with operating the product, which in our case is a facility or a building. Energy conservation can lead to significant life cycle cost savings. The energy cost of a typical office building in Washington DC, according to Whitestone Research, is \$2.82 per gross square foot a year. This amounts to 23% of the total operation and maintenance cost. If we use a 3% real discount rate and a project life of 25 years, the net present value of the energy cost would be \$49 per gross square foot, or about 25% of the replacement value of the building.

Energy conservation is also a major contributing factor towards sustainable design. Much of the energy used in a building today is either fossil fuel or electricity that is generated mostly from fossil fuel. Fossil fuel is not sustainable since it cannot be replenished. In addition, burning fossil fuel generates carbon dioxide, which is a greenhouse gas that contributes to global warming. In the current version of Leadership in Environment and Energy Design (LEED), energy related points account for 38 out of 110 possible credits. Energy performance alone is worth up to 21 points. Even in the recent recession, the green building movement thrived in the shaky economy. ENR magazine commented in the Nov. 24, 2010 issue: “Like a runaway recycling truck, green building’s momentum hasn’t been stopped by the economic recession and will keep speeding through the recovery...”

Energy conservation is required by law in many jurisdictions. The Federal government, in Executive Order #13514 signed by President Obama, requires all new federal buildings to be 30% more energy efficient than the ASHRAE 90.1-2004 standard. Furthermore, new Federal buildings, entering the design phase in 2020 or later, are to achieve zero net energy by 2030. The General Services Administration (GSA) announced in October 2010 that all new projects shall achieve LEED Gold. Most other federal agencies already required LEED Silver. Many local governments also have sustainability initiatives. For example, in Washington DC, LEED is mandatory for all buildings (not just government buildings) larger than 50,000 square feet. Where I live in Montgomery County, Maryland, LEED is mandatory for building larger than 10,000 square feet. A tax credit is available to help mitigate the additional cost.

Given the economic, environmental, and political importance of energy conservation, the VE community must be ready to place additional emphasis on energy analyses to provide value to the clients.

eQUEST enables quick and easy energy modeling

An energy modeling tool is available for use during VE studies. It is both fast and accurate. eQUEST is a user interface for DOE-2. DOE-2 is an energy simulation software engine for buildings that was first released in 1978 by Lawrence Berkeley Laboratory. Figure 1 illustrates the various building blocks of DOE-2. The personal computer version was developed in the early 1990's, with window-based, graphical user-interfaces developed in the late 1990's. eQUEST is a product of this millennium. The advancement that it brings include Schematic Design Wizards and Design Development Wizards, which enable an energy model to be quickly developed based on a few project parameters available early in the design process. The Energy Efficiency Measure Wizard is a tool for "what-if" scenarios, to quickly calculate energy savings based on changing one single parameters, e.g., wall insulation value, chiller efficiency, lighting power density..etc. In addition, eQUEST allows import of AUTOCAD floor plans to facilitate definition of building geometry, and have defined default inputs so that a project can jump-start into the analysis phase without spending too much time in defining all the detail parameters. It also has an extensive Help function to guide users through the complex DOE-2 engine. Figure 2 shows the relationship between the different modes in eQUEST.

One of the main advantages of eQUEST is that it is free. Its development is funded by Department of Energy and the full version can be downloaded at no cost. DOE-2 is a robust energy modeling engine that has seen more than three decades of use and refinement. Although there is a newer and more accurate energy modeling software, Energy Plus, which is the successor to DOE-2, the user interface for Energy Plus is not yet fully developed to match the ease of use in eQUEST. Moreover, eQUEST and DOE-2 is sufficiently accurate for most purposes. The various wizards make eQUEST a very useful tool for quick analyses such as those needed for a VE study.

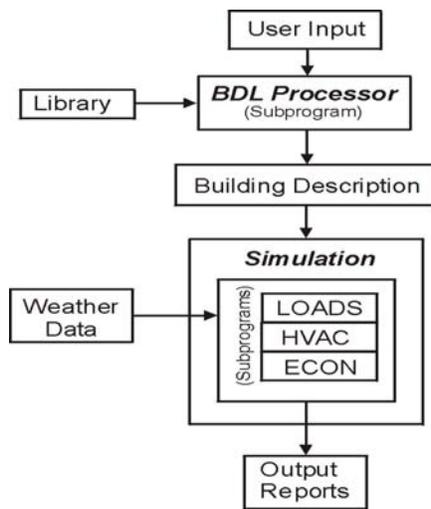


Figure 1 - DOE-2 Building Blocks

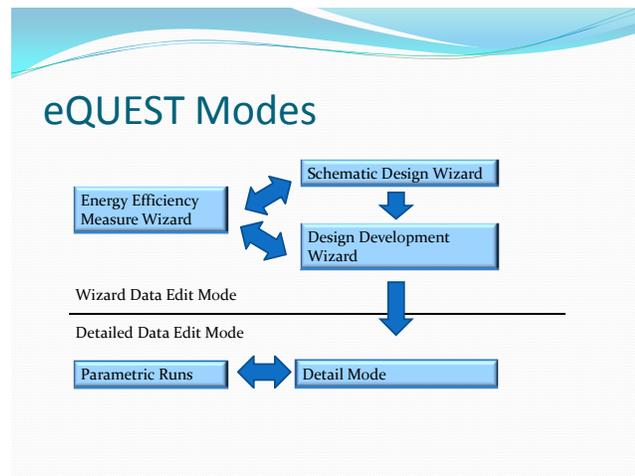


Figure 2 – eQUEST modes

How VE culture can be changed to adopt energy modeling

One obstacle to implementing energy modeling is that there are not too many energy modelers who have participated in VE studies. But there are many sources where energy modelers can be found. For most projects that are pursuing LEED certification, there would be an energy modeler on the design team; because without an energy model, the project would be giving up most of the 21 points on energy performance. As a result, most large mechanical engineering firms have energy modelers on staff. Some sustainability consulting firms could also provide this service. In addition, there are specialized firms whose primary business is energy modeling. Some architecture schools offer courses in energy simulation. For over a decade, the energy modelers have an industry association - the “International Building Performance Simulation Association” (IBPSA). Its North America chapter meets twice a year. Starting in 2010, ASHRAE offers a test for the Building Energy Modeling Professional (BEMP). This credential provides a quality assurance on the knowledge and skills of the energy modelers. The list of BEMP is available on the ASHRAE website. As of March 2011, this list has over 100 names and is growing fast.

There are many ways that we can promote energy modeling in VE studies. For value engineering firms, please consider adding energy modelers on VE teams, or select mechanical engineering team members who are proficient in energy modeling. For owner agencies, please specify VE team to include energy modeler, or request the design team to furnish an energy modeler to the VE team. If an energy model is part of the design team’s deliverable, it could be requested to be furnished to the VE team. This has the additional benefit to ensure that energy model is developed early in the design process so that it can be used to optimize the energy performance, instead of being developed at the end of the design process merely to fulfill the LEED requirement.

Additional considerations include specifying the energy modeling software to be eQUEST, which will ensure a common analysis platform between the design team and VE team; and requiring the VE energy modeler to be a BEMP, which is the only industry yardstick that currently exists to ensure the quality of the energy model. There are disadvantages to these additional considerations, namely that not everyone who does modeling uses eQUEST and is a BEMP. Perhaps these should be provided more as guidelines than requirements. But just as projects can require specific CAD and scheduling software, and require professionals on the team to have certain credentials, these considerations may provide quality control measures for the project.

In conclusion, we are seeing that the historical obstacles to incorporating energy modeling in VE studies are becoming irrelevant:

- Owners do not care about energy? - Most do now, and are increasingly so.
- Energy is too cheap to meter? – Energy is one of the most significant life cycle cost category.
- Energy modeling takes too long? – eQUEST wizards reduce modeling time to hours.
- Hard to find energy modelers? – There are many experienced energy modelers. They just have not been asked to do VE studies.

The economic, political, and technical environments have changed. All the above barriers for using energy modeling in VE studies no longer hold true. It is time for a paradigm shift and introduce energy modeling into the VE workshops on facility projects.