

# Energy Modeling and Daylighting Analysis

Adapted from *The Architect's Handbook of Professional Practice 2005 Update*, originally contributed by John A. Boecker, AIA

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## SUMMARY

Energy modeling and daylighting analysis are two possible areas to receive credits toward certification in the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) Green Building Rating System™. Analysis software can help determine a building's intended energy usage and daylighting levels; some of the more popular software options are listed below.

## ENERGY MODELING

Modeling tools can simulate the interactions of building systems and how they affect overall energy performance. To gain credits for optimizing energy performance, the LEED program requires project teams to use such modeling to compare a building's annual "design energy cost" with the "energy cost budget" for a building of the same use and configuration that complies with ASHRAE 90.1. The 90.1 standard is the most widely accepted energy standard cited by codes in the U.S. With it as a benchmark, LEED projects are awarded credits on a sliding scale, based on the percentage of energy savings predicted to be above the benchmark standard.

Architects do not need the technical skills required to perform energy modeling, but they must understand its capabilities. Architects may use energy modeling as an essential decision-making tool during design, rather than solely as a means of documenting results. In particular, early use of energy modeling provides insights that can contribute to more effective design decisions.

Accordingly, architects need to be aware of how building systems affect energy performance, so they can guide iterative modeling of alternative parameters and energy efficiency, measured until the predicted performance of a design has been optimized.

There are several available software programs that can simulate whole building energy consumption. Perhaps the simplest of these tools is Energy-10, a PC-based program that enables architects to quickly

identify cost-effective energy-saving measures for commercial and residential buildings under 10,000 square feet. Larger and more complex buildings require more sophisticated programs such as the ones listed here:

- **eQuest** is available at no charge at [www.doe2.com](http://www.doe2.com)
- **Visual DOE** is available at [www.archenergy.com/products/visualdoe](http://www.archenergy.com/products/visualdoe)
- **HAP**, an hourly analysis program, is developed and owned by Carrier. Go to [www.commercial.carrier.com](http://www.commercial.carrier.com) and choose "software"
- **TRACE** is owned by Trane and is available at [www.trane.com/commercial/software](http://www.trane.com/commercial/software)
- **Energy Plus** is from the U.S. Department of Energy and is available at no charge at [www.energyplus.gov](http://www.energyplus.gov)

Energy modeling tools are often used to examine the paybacks of a single energy-efficiency measure, such as augmented insulation, high-performance windows, a specific aspect of daylighting, and so on. However, this type of analysis takes only limited advantage of energy modeling. The real value of these tools is their ability to analyze and quantify highly complex interactions between systems. For example, more efficient lighting will translate into less energy for cooling because of reduced internal loads. In many cases, savings will result from factors beyond lighting, with the greatest savings in the hottest climates and the least in the coldest climates, according to the LEED reference guide.

## DAYLIGHTING ANALYSIS

The use of naturally lighted spaces is a particularly valuable strategy for achieving energy savings and earning LEED credits. Beyond energy savings, careful use of daylighting can contribute to occupant well-being and productivity as previously cited. Consequently architects are encouraged to improve

their ability to apply daylighting strategies to building design solutions.

Physical models are an accurate way to evaluate the effects of daylighting and can be a cost-effective method of analysis. However, software programs are increasingly used to simulate and analyze daylighting effects.

The LEED program currently requires verification of daylighting performance with a simplified calculation method. This calculation takes into account window area, room floor area, window geometry, window height, and the visible light transmittance of glazing. However, as an approximation, the calculation excludes factors such as orientation, room cavity ratios, visible angle to the sky, latitude designation, and interior room reflectance. Several daylighting software analysis programs can address these factors, resulting in development of more sophisticated design strategies that demonstrate LEED compliance. Some currently available programs include

- **Radiance**, developed by Lawrence Berkeley National Laboratory, is available at no charge at <http://radsite.lbl.gov/radiance/home.html>
- **Lumen Designer** is available at [www.lighting-technologies.com/](http://www.lighting-technologies.com/)
- **AG132** is available at <http://www.agi32.com>

#### ABOUT THE CONTRIBUTOR

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#### ADDITIONAL RESOURCES

The LEED® Green Building Rating System™ is a voluntary, consensus-based national standard for developing high-performance, sustainable buildings. The LEED Rating System can be downloaded at no cost by visiting the Web site at [www.usgbc.org](http://www.usgbc.org)

#### More Best Practices

The following AIA Best Practices provide additional information related to this topic

- 16.02.08 Steps towards LEED Certification
- 16.01.02 Green Roof Design
- 16.02.06 Differences in Environmentally Preferable Products

#### For More Information on This Topic

See also “Energy Analysis and Design” by Donald Prowler, FAIA, in *The Architect’s Handbook of Professional Practice*, 13th edition, Chapter 18, page 616.

See also the 14th edition of the *Handbook*, which can be ordered from the AIA Bookstore by calling 800-242-3837 (option 4) or by email at [bookstore@aia.org](mailto:bookstore@aia.org).



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#### Keywords

- Building performance
- Sustainability
- Energy-efficient buildings