Efficient Windows Collaborative

Design Tools for Energy Efficient Office Facades

www.efficientwindows.org January 2011

Energy-efficient office façades play an important role in achieving energy and environmental goals and contribute to the comfort and productivity of building occupants. Window technologies such as low-E coatings and low-conductance frames as well as strategic placement of glazing areas and shading devices for daylight access and glare control can help achieve the following design goals:

- Heating, cooling and lighting energy savings
- Thermal and visual comfort
- Reduced peak electricity demand and reduced mechanical equipment cost

This fact sheet discusses design tools and key principles to consider when pursuing energy-efficient office façades.

Photo courtesy of Viracon
Photo by Wes Thompson

This fact sheet was produced with funding from the Building Technologies Program at the U.S. Department of Energy in support of the EWC. For more information, contact:

EWC / Alliance to Save Energy
1850 M Street NW, Suite 600
Washington, DC 20036
Phone: 202-530-2254
Email: ewc@ase.org

Visit www.efficientwindows.org for more information on the benefits of efficient windows, how windows work, how to select an efficient window, and what manufacturers provide efficient products.

Tools and Principles for Energy Efficient Façades

Assess Options through Schematic Design

Start early in the concept phase to assess the impacts of typical façade design options on energy use, comfort, daylighting potential and peak demand. Early assessments will help you consider the interplay between façade design, HVAC sizing and lighting systems.

To quickly compare the benefits of different glazing and shading options, use the Façade Design Tool at www.commercialwindows.org.

For more specific façade and shading designs scenarios, use COMFEN, a commercial fenestration design tool by Lawrence Berkeley National Laboratory (see page 2).

Ensure Compliance with the Energy Code

Whichever façade design options you consider, they must allow the building to meet the locally applicable energy code. In most places in the United States, the energy code is based on the International Energy Conservation Code (IECC) and ASHRAE Standard 90.1. Building energy codes allow for design flexibility but include prescriptive requirements to facilitate compliance. In any case, codes require that fenestration energy performance claims are based on certified ratings.

Specify Certified Energy Ratings

Specify energy ratings certified through the National Fenestration Rating Council (NFRC). NFRC ratings are third-party verified and are recognized by all major energy codes in the United States and Canada.

For commercial projects, NFRC has developed the Component Modeling Approach (CMA) certification program (see page 2). Energy performance ratings generated through CMA can be used for bidding purposes and code compliance and can be exported into EnergyPlus for building energy simulation.

Take Advantage of Advanced Simulation Tools

Once you have narrowed down the façade design options for a give project, the detailed impact on energy use and occupant comfort can be analyzed with whole-building energy simulation tools. See page 2 for information on powerful tools such as EnergyPlus, the engine behind COMFEN.

NFRC Fenestration Energy Ratings

National Fenestration Rating Council (NFRC) ratings are third party verified and recognized by energy codes as indicators of whole-window energy performance.

U-factor: The rate of non-solar heat transfer through a window in Btu/(hr·ft2·°F). The lower the U-factor, the better a window's insulating value.

Solar Heat Gain Coefficient (SHGC): The fraction of incident solar heat admitted through a window. Appropriate SHGC depends on the climate, orientation, and shading conditions.

Visible Transmittance (VT): The fraction of visible light transmitted through a window (also often referred to as VLT).

Air Leakage (AL): Most energy codes require a tested air infiltration rate no higher than 0.3 cubic feet of air per square foot of window area (cfm/sf). AL is an optional NFRC rating and can also be obtained in accordance with the North American Fenestration Standard (AAMA/WDMA/CSA 101/I.S.2/A440).

The NFRC Component Modeling Approach

For commercial fenestration, including windows, curtain walls, storefronts and skylights, NFRC has launched a nonresidential rating procedure, the Component Modeling Approach (CMA). The CMA program and the CMA Software Tool (CMAST) address the following needs of commercial sector architects, fenestration industry and code officials:

- Third-party validated label certificates for code compliance purposes
- Accurate energy ratings for bid purposes
- Project-specific performance data for product evaluation and building energy analysis

CMAST permits fast project creation from predefined and NFRC-approved components—glazings, frames and spacers. From these components, whole products can be modeled to obtain project-specific label certificates for code compliance. The modeled data can also be exported into EnergyPlus for building energy simulation.

For more information on CMA, see www.nfrc.org.

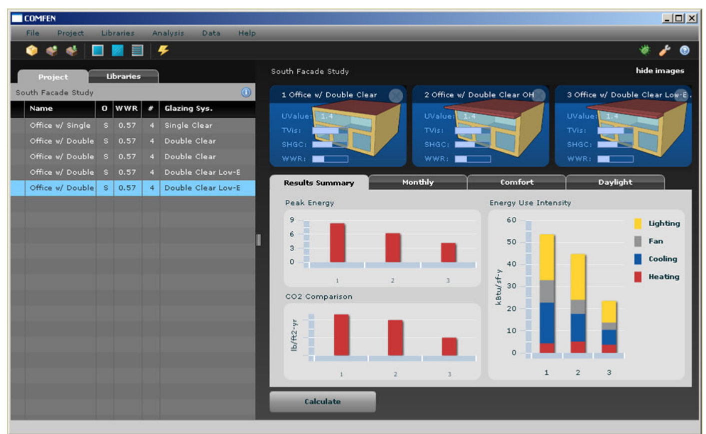
Façade and Building Energy Simulation Tools

Façade Design Tool

If you'd like spend just a few minutes to start comparing different glazing and shading scenarios, use the online Façade Design Tool at www.commercialwindows.org. See examples of this tool's functions on the following pages.

COMFEN

COMFEN, by Lawrence Berkeley National Laboratory, is a schematic tool for quick what-if scenarios on specific façade, lighting, and shading designs. Under the hood, the EnergyPlus engine simulates the effects of these key fenestration variables on energy consumption, peak energy demand, and thermal and visual comfort. See examples of some COMFEN scenarios on the following pages. COMFEN can be downloaded for free at windows.lbl.gov/software.



EnergyPlus

EnergyPlus is a building energy simulation program offered by the U.S. Department of Energy. EnergyPlus offers accurate, detailed simulation capabilities through complex modeling that can give you detailed information on how specific façade design options may affect building performance.

Radiance

Radiance is an advanced lighting simulation and rendering package that calculates spectral radiance and irradiance for interior and exterior spaces considering electric lighting, daylight and interreflection. Architects and designers can use Radiance to predict illumination, visual quality and appearance of design spaces. Researchers can use it to evaluate new lighting and daylighting technologies and study visual comfort and similar quantities related to the visual environment.

Further Tools

Find a comprehensive directory of building energy software at: apps1.eere.energy.gov/buildings/tools_directory.

Facade Design Tool

The Façade Design Tool allows for quick easy comparison of general design considerations. These include:

- Orientation
- Window Area
- Daylighting Controls
- Shading
- Glazing Type

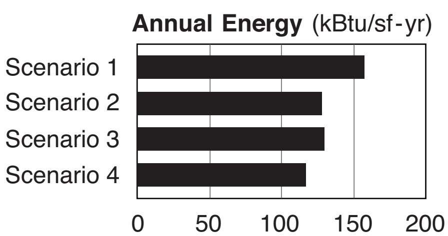
By setting up scenarios that change these variables, you can quickly compare design options. These two examples show situations where a designer wants to answer a specific question about window design options; however, there are many more issues that a designer could want to explore The Façade Design Tool can be found at: www.commercialwindows.org.

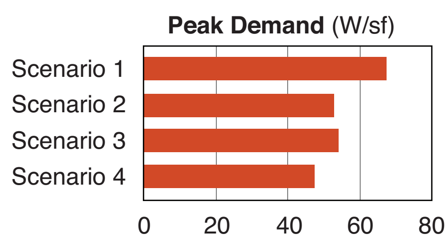
Analyzing Shading and Low-E Glass (Washington, DC)

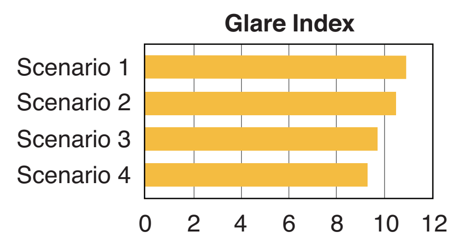
In the example to the right, a designer is interested in considering using shading devices, clear glass, and triple silver low-E glass. Since both the triple silver low-E and the shading device represent an additional cost, the designer wants to know which provides the most benefit, and whether it's worth installing both at once. She's concerned about annual energy, as well as about glare in the office.

Washington, DC
South façade, 30% WWR, No daylighting controls
Scenario 1: Clear Glass, No Shade
Scenario 2: Triple-silver Low-E Glass, No Shade
Scenario 3: Clear Glass, 4ft Overhang
Scenario 4: Triple-silver Low-E Glass, 4ft Overhang

By comparing the four scenarios, the designer can see that adding the low-E glass or the 4ft shade have very similar benefits for annual energy, but using the shading device has the best glare control. Using both strategies at once (Scenario 4) is incrementally better for both energy and glare, and the magnitude of this benefit can be seen in the graphs.







Visible Transmittance and Daylighting (Houston, TX)

In this example, a designer has decided to implement daylighting controls, and wants to know what glass option will provide the best energy savings. He knows that glass with high visible transmittance provides much more daylight, but the slightly higher SHGC can also have a cooling penalty.

Houston
West façade, 45% WWR, Continuous Dimming
Scenario 1: Reflective Glass, No Shade
Scenario 2: High VT Low-E Glass, No Shade
Scenario 3: Low VT Low-E Glass, No Shade
Scenario 4: Low VT Low-E Glass, 4ft Overhang

In this Houston climate, the lighting benefit of high VT glass is not enough to outweigh the cooling penalty—Scenario 3 has slightly lower energy use than Scenario 2. However, the designer was right about the additional light, as can be seen in the daylighting graph—Scenario 2 has much higher daylighting illuminance. However, this comes with higher glare, particularly since the window is on the west side. The addition of a shade lowers the daylighting further, but also lowers the total energy consumption.