Building Envelope

The components of a building envelope directly affect overall cooling and heating performance, and you can significantly reduce energy consumption by implementing measures that target these areas. This Tech Brief will help you identify and select envelope-related measures that will maintain or improve occupant comfort while reducing energy use. By combining effective strategies with efficient technologies, we can help you save money, maximize equipment performance, and build a “green” image.

This Building Envelope Tech Brief outlines the pros and cons of various energy-efficiency measures and is designed to serve as a comprehensive, quick-reference guide for everyday use. For more in-depth information, visit **www.FPL.com/bizenergyadvisor** to access additional details on specific topics.

Insulation

In Florida, according to the U.S. Department of Energy, nearly 45 percent of a building’s energy consumption goes toward fulfilling HVAC requirements. Unfortunately, a significant portion of this energy is wasted due to heat gain from air infiltration and inadequate insulation. By sealing air leaks and improving your building’s insulation levels, you can minimize the amount of energy used to condition your building.

» **R-value.** R-value is a measure of a material’s resistance to heat flow, with a higher number representing a more insulating material. R-value is additive, meaning that you can lay a strip of R-7 insulation onto an R-10 material to get a combined R-value of 17. However, heat gain is not directly proportional to R-value, and there are diminishing returns with larger amounts of insulation—doubling R-value does not cut heat gain in half. Table 1 shows typical R-values for different commonly used insulation materials.

The amount of insulation needed to effectively reduce energy consumption varies widely depending on the climate and building type. Table 2 (next page) shows recommended R-values for ceiling insulation based on the overall cooling/heating load for various climates.

» **U-value.** U-value is a measure of a material’s ability to conduct heat, and represents the inverse of R-value. For example, a material that has an R-value of 7 would have a U-value of $1/7 \approx 0.14$. U-values can range from 0 to 1, with 0 representing a perfectly insulating material that no heat can pass through and 1 representing a perfect conductor.

For more information on insulation, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Building Envelope, and then Insulation).

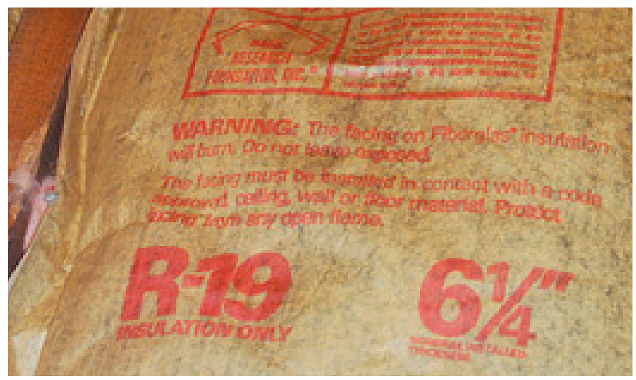


TABLE 1: R-VALUES OF VARIOUS INSULATION MATERIALS

Insulation Type	R-value per inch
Fiberglass	2.2-3.1
Vermiculite/perlite	2.4-2.8
Cellulose	3.8-4.2
Polystyrene (SIPs)	4.0-5.0
Closed cell polyurethane	6.0
Polyisocyanurate	6.0-7.1

© E Source; data from Florida Power & Light Co.
Note: SIP: Structural Insulated Panel. Although commonly used, fiberglass insulation actually underperforms in comparison to many other materials.

Windows

Windows tend to have lower R-values than the surrounding wall, so they are a big source of heat gain. Also, because they are translucent, they can allow radiant heat energy into a building, thereby increasing the cooling load (Figure 1). Most of this heat gain can be reduced by adding window treatments rather than replacing the entire window.

» **Window film retrofit.** Retrofit window films are a low-cost method of reducing cooling loads, and they have the side benefits of glare reduction, increased shatter resistance, and absorption of ultraviolet radiation. About half of the sun’s radiation is visible light and most of the rest is invisible infrared energy. A 1/8-inch-thick sheet of clear glass transmits about 88 percent of the solar radiation, both visible and invisible, that strikes it. Window films allow visible light to pass through while reflecting infrared radiation, lowering the amount of radiative heat entering the room.

Because the overall quantity of glazing, building orientation, building construction, and many other factors all contribute to how much energy a window upgrade can save, Lawrence Berkeley National Laboratory (LBNL) created a tool called **COMFEN** to estimate savings from window retrofits in commercial buildings. For buildings in Florida, it's generally best to look for window films with a solar heat gain coefficient (SHGC) of less than 0.45 and a visible light transmittance (VT) of at least 50 percent. Tinted films generally cost \$4 to \$6 per square foot (ft^2), whereas spectrally selective films can cost \$9 to \$12/ft^2, including installation. For more information on window film, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Building Envelope, and then Window Film).

- **Window replacement.** In some cases, it may be more effective to replace the window itself than to just add a window film. Installing new, high-performance windows can yield HVAC energy savings of 6 to 8 percent, resulting in a simple payback period as short as three years. Some factors to consider when looking at window upgrades are:
  - **SHGC radiation**, which ranges from 0 to 1. Look for windows with an SHGC of 0.55 or less.
  - **U-value heat conductance**, which ranges from 0.2 to 1.2 (with corresponding R-values of 5.0 to 0.8). Look for windows with U-values of 0.4 or smaller (equivalent to an R-value of at least 2.5). Windows with vinyl material and inert gas generally have lower U-values.
  - **VT**, which ranges from 0 to 1. Look for windows with a VT of at least 0.60.
  - **Air leakage (AL)**, an optional rating, which ranges from 0.1 to 0.3 cubic feet per minute (cfm) per ft^2.

For more information on windows, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Building Envelope, and then Windows).

Roofs

Modifying your existing roof can be a great way to cut down on cooling costs and potentially create a new look for your building.

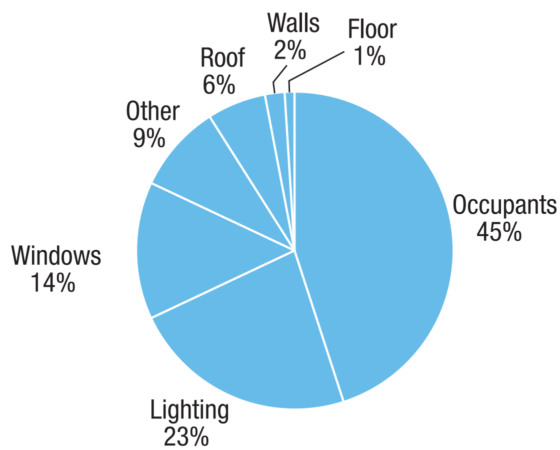
- **Cool roofs.** A cool roof is one that combines high reflectivity with infrared emittance to lower the temperature of the roof, thereby decreasing cooling bills. When properly implemented, cool roofs can be as much as 60° Fahrenheit (F) to 70°F cooler than a traditional roof, resulting in annual net savings between \$0.10 and \$0.20/ft^2 of roof area. Cool roof products must have an initial solar reflectance level of 25 percent (for a steep-slope roof) or 65 percent (for a low-slope roof) to achieve Energy Star certification. Some different options include:
  - **Coatings.** Liquid coatings, usually made from an acrylic, elastomeric, or polyurethane material, can be rolled or sprayed onto low-slope roofs.
  - **Single-ply membranes.** These are thin coverings typically made from thermoplastic polyolefin or polyvinyl chloride (PVC).
  - **Cool metal roofing.** Sheet metal is most commonly installed on roofs with steep slopes.
- **Green roofs.** A green, or vegetative, roof essentially consists of growing plants on top of a building. It is generally an extension of the existing roof and involves a high-quality waterproofing and root repellant system, a drainage system, filter cloth, a lightweight growing medium, and, of course, plants. In addition to creating a unique aesthetic, green roofs provide an estimated 6 to 25 percent decrease in cooling energy and reduce storm-water runoff. If you are considering adding a green roof, make sure to protect the underlying roof membrane to ensure a long material life span.

TABLE 2: RECOMMENDED LEVELS OF CEILING INSULATION

Climate Area	Ceiling R-value
Miami, FL	R-19
Pensacola, FL	R-30
Phoenix, AZ	R-30
Washington, DC	R-38
Springfield, IL	R-38
Denver, CO	R-49

© E Source data from Florida Power & Light Co. Proper insulation levels depend largely on climate.

FIGURE 1: PEAK SENSIBLE COOLING LOADS



© E Source; data from the Florida Solar Energy Center. Windows represent a major source of heat gain in most Florida buildings and are therefore a great target for upgrades.

Ventilation

Proper ventilation is essential for maintaining a steady supply of fresh air in a building. As defined by ASHRAE 62.1-2007, "Ventilation for Acceptable Indoor Air Quality," proper air quality entails "air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction."

Ventilation is expressed in units of cfm and is generally normalized by either floor space (in ft2) or occupancy.

Demand-controlled ventilation (DCV) adjusts ventilation rates based on actual occupancy at any given time instead of at a fixed rate for full occupancy. DCV sensors monitor carbon dioxide levels to determine how many people are inside, which in turn signals the HVAC system to adjust the amount of outside air brought into the building to comply with ventilation standards. For more information on DCV, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, Ventilation & Air Handling, and then Demand-Controlled Ventilation).

Weatherization

There are a number of opportunities for air to leak into and out of a building, including door and window frames, recessed lights, electrical outlets and switches, sill plates, plumbing and utility access, dropped ceilings, water and furnace flues, and ductwork. Sealing these effectively can result in significant energy savings.

- **Caulk.** Caulks are airtight compounds (usually latex or silicone) that fill cracks and holes.
  - Old caulk or paint residue should be removed before new caulk is applied.
  - The best time to apply caulk is during dry weather when the outdoor temperature is above 45°F (7.2° Celsius).
- **Weather stripping.** Weather stripping is a narrow piece of metal, vinyl, rubber, felt, or foam that seals the contact area between the fixed and movable sections of a window joint or door frame.
- **Duct sealing.** Leaky ductwork can have a tremendous impact on energy usage, causing the air-conditioning system to run longer and consume more energy. Research from LBNL shows that 10 to 20 percent of the air from an HVAC supply fan is wasted through leaks in ductwork in commercial buildings. At 15 percent leakage, buildings must use 20 to 25 percent more fan power to distribute air than if there were no leakage. In addition to fan power energy, there will also be an increase in cooling energy. There are two basic ways to seal ducts: with tape and mastic, and using aerosol sealants.

Metal-reinforced tapes and mastic approved by Underwriters Laboratories are the conventional choice for sealing ducts. Mastic is rubbery, fiber-reinforced goo that is applied with a brush. Large holes are generally patched with sheet metal and then sealed with mastic. Although duct tape is still often used to seal ducts, it is actually a poor material for that purpose.

The idea of using aerosol adhesives to seal ductwork was developed by LBNL, and the technology is now sold under the trade name of Aeroseal. It works by blowing sticky particles into ducts, which attach themselves to the edges of leaks and effectively seal any holes up to 1 inch in diameter. At the moment, this is the only approach that can seal leaks in ducts made inaccessible by walls and insulation. For more information on duct sealing, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Ventilation & Air Handling, and then Duct Sealing).