tech primer

High Performance Windows

High performance windows that improve comfort, reduce operating costs, and save energy.

tech overview

applicable building types
all buildings

when to implement
at time of window replacement; mid-cycle; or refinance

fast facts
- decreases GHG emissions
- improves acoustics
- improves comfort
- reduces heating and cooling loss
- enhances building performance

costs & benefits*

GHG Savings

Tenant Experience Improvements

Utility Savings

Capital Costs

Maintenance Requirements

*ratings are based on system end use, see back cover for details.

be ex STL

getting to know high performance windows

As part of a building's envelope, windows play an important role in moderating indoor temperature. Upgrading to high performance windows improves comfort and lowers operating costs by reducing demand on the building's heating and cooling systems.

why improve windows?

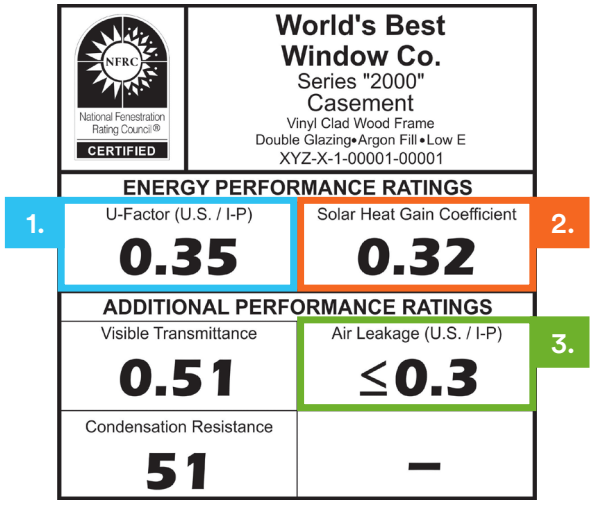
Typical windows (known as "fenestration") have a life expectancy of about 30 years, after which they must be replaced as part of general buildng maintenance. Window replacement is an excellent opportunity to increase energy efficiency and comfort by selecting and installing high performance products.

Installing high performance windows in conjunction with wall insulation upgrades and proper air-sealing improves the overall performance of the building envelope (the barrier between the inside and outside of the building) by reducing heat transfer, drafts, and noise infiltration. This, in turn, reduces heating and cooling energy demand, as well as operating costs.

When selecting windows, it is important to understand the performance criteria used to rate them. The National Fenestration Rating Council (NFRC) rates windows on thermal conductance (also known as U-factor, or insulation value), the amount of solar radiation filtered (known as solar heat gain coefficient or SHGC), the amount of light filtered (known as visible transmittance), and the rate of air leakage (see Fig. 1).

A window's U-factor, SHGC, and air leakage rate have a direct impact on the energy performance of a building, and should be carefully specified for performance targets.

Fig 1. NFRC labels provide energy performance ratings for multiple categories, including U-factor, SHGC, and air leakage.



1. U-Factor, range: 0.2-1.2
Code compliant windows must have U-factors below 0.38 for fixed fenestration, or 0.45 for operable fenestration.

2. SHGC, range: 0-1
Code compliant windows must have an SHGC of at least 0.4 for buildings with less than 20% fenestration, 0.48 for buildings with 20%- 50% fenestration, and 0.64 for buildings with greater than or equal to 50% fenestration.

3. Air Leakage, range: 0.1-0.3
Code compliant windows must have no greater than 0.2 CFM/ft² of air leakage at a pressure difference of at least 1.57 pounds per square foot.

Assess
Always consult a qualified service provider before undertaking any building upgrades.

Coordinate for Maximum Savings
Installing high performance windows in conjunction with wall and roof insulation upgrades and proper air sealing will improve the overall building performance.

The ventilation system should be assessed to ensure proper indoor air quality after installing high performance windows, which improve the air tightness of a building.

Plan Ahead for Success
The best time to implement window upgrades is during mid-cycle, refinancing, or when windows need replacement.

Window upgrades should be considered during scheduled insulation or air-sealing upgrades to save costs and reduce disruption to residents.

how to upgrade to high performance windows

Installing high performance windows in conjunction with insulation upgrades and proper air sealing completes a whole building envelope retrofit that will greatly enhance building performance.

retrofit solutions

There are multiple requirements for selecting and installing high performance windows:

A **Select High Performance Windows:** Choose windows that meet and exceed local code requirements for U-factor, SHGC, and airtightness. Glazing (the glass part of a window) must be specified with low-emissivity (Low-E) coatings to reduce unwanted radiation heat transfer.

1) U-factor describes how quickly heat is conducted through a window, with lower values indicating less heat transfer and higher values indicating more heat transfer, or poorer energy performance.

- Vinyl or fiberglass window frames have relatively low U-factors, compared to aluminum and other metal frames.
- Fiberglass window frames are recommended for low and mid-rise properties, but structural and wind load requirements may limit the use of fiberglass frames in larger buildings.
- To improve U-factors in metal frames, use rubber or plastic to interrupt the flow of heat through the frame.
- Adding argon gas or other inert gas between glazing layers reduces the window's U-factor.

2) SHGC is an indicator of a window's capacity to allow or block solar radiation, to passively heat or cool a space.

- The optimal SHGC for a project typically depends upon the construction type and local climate. In general, windows with higher SHGC are recommended for colder climates, and lower SHGC for warmer climates.
- In many municipalities, SHGC requirements are determined by a building facade's window-to-wall ratio. Windows with low SHGC ratings are recommended for buildings with low window-to-wall ratios or fewer openings across the facade. In contrast, products with high SGHC ratings are recommended for buildings with higher window-to-wall ratios, or more openings across the facade (see Fig. 1 for details).

3) Air leakage describes the amount of air that passes through a window assembly, as measured at a given pressure level. The air leakage rating corresponds to a window's airtightness and the degree of draftiness impacting interior spaces.

- Window frame type has a significant impact on airtightness. Casement windows should be considered over double-hung or sliding windows when specifying operable models.
- Double hung and sliding glass windows are typically prone to leaks due to window latches that are difficult to seal and wear on weather-stripping caused by the sliding motion.
- Casement windows are typically less prone to leaks since they have robust gasketing and latching around the perimeter of the entire window, and their opening mechanism creates less wear on weather-stripping.

B **Install High Performance Windows:** Per code requirements, windows must have a continuous air barrier at the transition between the wall opening and the window to effectively reduce air leaks and drafts.

- During major renovations, air-sealing can be achieved by installing flashing around a window's rough opening, sealing the interior and exterior edges of the frame to the flashing with a backer rod, caulk, and/or non-expansion foam, and allowing proper drainage with weep holes and drip-edges in appropriate locations.
- In renovations where only windows are being replaced, use a backer rod and/or caulk to fully seal around the rough opening and ensure continuity of the air barrier.
- Architectural details must specify and clearly display all locations where air-sealing occurs.

C **Install Smart Controls:** Open windows in winter are usually a sign of overheating. Install window sensors that detect when windows are open, and connect them to central heating system controls, to turn off heat in segments of the building, as needed.

costs & benefits of window upgrades*

Greenhouse Gas (GHG) Savings

A moderate reduction in heating and cooling related GHG emissions can be expected from a high performance window upgrade, depending on the condition of windows being replaced and the current heating and cooling demand.

Tenant Experience Improvements

High performance windows improve resident comfort by eliminating drafts, improving insulation, and reducing pollution and noise infiltration.

Utility Savings

A moderate amount of utility savings can be achieved by reducing heating and cooling loads inherent in improving window performance.

Capital Costs

High performance windows require a moderate capital investment, best implemented at the time of window replacement or when building insulation upgrades are required. The cost of selecting high performance windows over minimally code-compliant alternatives is marginal. New high performance windows will lower the heating and cooling loads of the building and may allow for future downsizing of equipment.

Maintenance Requirements

Window function is key to resident comfort and energy efficiency. Double-hung window balances must work correctly to hold windows closed, and sashes must be properly installed and aligned to make sure air leakage is minimized and windows are easy to operate. Latches must work smoothly to ensure a tight seal between the windows and frame.

**The Costs & Benefits rating system is based on a qualitative 1 to 4 scale where 1 (●○○○) is lowest and 4 (●●●●) is highest. Green correlates to savings and improvements, orange correlates to costs and requirements. Ratings are determined by industry experts and calculated relative to the system end use, not the whole building.*

Note: GHG and utility savings are dependent on existing window conditions and are based on the heating and cooling loads. Assumes existing windows are leaky, un-insulated, and without special coatings.

take action

This document is one of more than a dozen High Performance Technology Primers prepared by Building Energy Exchange and its partners to introduce decision-makers to solutions that can help them save energy and improve comfort in their buildings. Access the complete Tech Primer library: **be-exstl.org/building-blocks**

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Call: (212) 349-3900
Visit: be-exchange.org
Email: info@be-exchange.org