tech primer

High Performance Windows

State-of-the-art windows significantly improve comfort, reduce operating costs, and save energy.

tech overview

applicable building types
all buildings

implementation
at window replacement, mid-cycle or refinance

fast facts
- increases GHG savings
- improves acoustics
- improves comfort
- reduces heat 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
building energy exchange

NYC Retrofit ACCELERATOR

getting to know high performance windows

Upgrading to high performance windows can significantly enhance comfort, improve indoor air quality, and lower operating costs by reducing demands on the heating and cooling systems.

why improve windows?

Because windows have an average life span of 30 years or more, window replacement is an excellent opportunity to increase energy efficiency and comfort for decades. High performance windows reduce heat transfer between inside and outside, limit drafts created by cold interior surfaces and can limit noise infiltration. High performance windows are ideally installed in conjunction with upgrades to wall insulation and air-sealing to improve the overall building enclosure.

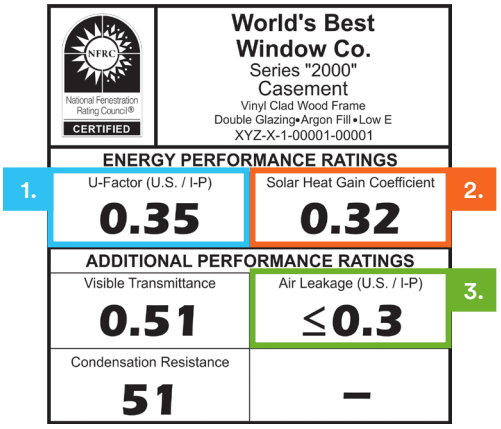
Window criteria for US energy codes is provided by the National Fenestration Rating Council (NFRC), and includes thermal conductance (U-Factor), solar radiation (solar heat gain coefficient, or SHGC), the visible transmittance of light, and air leakage (see Fig. 1).

In general, the NFRC requirements represent the legal minimum. To ensure the full range of benefits are enjoyed every effort should be made to select higher performance windows. Project-specific criteria can be developed, but selecting Passive House certified windows is an effective means to ensure excellent performance. These windows have robust thermal breaks in the frames, are far more carefully air sealed, and typically include triple-glazing for significantly increased performance and comfort. Air tightness and triple-glazing are especially important if people will be sedentary near the windows, like living rooms and bedrooms.

See additional BE-Ex Tech Primers on **Wall Insulation** and **Roof Insulation** to achieve a **high performance** building envelope.

To learn more about **Passive House**, see our briefing, Passive NYC, here: https://be-exchange.org/report/passive-nyc/

Fig 1. A mock NFRC label.



1. U-Factor NFRC range: 0.2-1.2
Current NFRC U-factors are 0.38 for fixed windows or 0.45 for operable. Passive House windows can have U-Factors as low as 0.14, more than 60% superior.

2. SHGC NFRC range: 0.40-0.64
NFRC criteria for SHGC varies depending on the % of exterior that is fenestration. Passive House ensures that the windows account for more heat gain than loss across the year.

3. Air Leakage NFRC 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 (PSF).

Fig 2. Mock Passive House Component label

A Level of efficiency achieved (A+, A, B, C)

B Suitable climate region (Arctic to very hot)

C Type of component (Windows, doors, services, etc.)

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

Coordinate Upgrades 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.

Plan Ahead for Success
The best time to implement window upgrades is during refinancing, when windows require replacement, or alongside other enclosure improvements (such as additional insulation or air sealing).

upgrading to high performance windows

Installing high performance windows in conjunction with other building enclosure improvements, such as insulation upgrades and proper air sealing, completes a whole building envelope retrofit.

retrofit solutions

A **Select High Performance Windows**– Choose windows that significantly exceed energy code requirements, such as windows that are Passive House certified. In most cases, glazing should be specified with 'low-E' coatings (which reduce heat gain but not visible light.)

1. The **U-Factor** describes how easily heat travels through the window assembly, with lower values indicating less heat transfer and higher performance. Selecting Passive House certified windows will reduce heating demand, lower the risk of interior condensation, and can eliminate drafts. Window frame materials have significantly different U-factors.
   - Wood , fiberglass, and uPVC have lower U-factors, but typically require structural reinforcing to meet high wind load conditions and are therefore more common in low- and mid-rise buildings.
   - Aluminum frames perform better structurally but only models with robust thermal breaks should be selected to ensure a low U-factor.
   - Selecting insulating glazing units (IGUs) with three (rather than two) layers of glass significantly improves the thermal and acoustic performance of the system and is highly recommended. Select IGUs with inert gases such as argon between the layers of glazing.
   - The spacers (often aluminum or stainless steel) between glazing panes in insulated glass units should include thermal breaks whenever feasible.

2. The **Solar Heat Gain Coefficient (SHGC)** indicates the amount of solar radiation that will enter (and therefore heat) the interior spaces.
   - Projects should carefully consider window position and exterior shading to optimize heat gain.
   - In typical code compliant buildings select windows with higher SHGC for colder climates, and lower SHGC for warmer climates. SGHC should be carefully calculated for high performance buildings.
   - In typical energy codes, SHGC requirements are determined by the window-to-wall ratio of a facade. Low SHGC numbers are recommended for buildings with less openings across the facade, and higher SHGC numbers for buildings with more openings.(see Fig. 1, pg. 2)

3. **Air leakage** is defined as the amount of air that passes through a window at a given difference in pressure and leads to heat loss, creates drafts, and increases the risk of condensation.
   - Window operation has a significant impact on air tightness. Casement windows (which swing in or out, like a door) should be considered over windows which slide vertically or horizontally.
   - Sliding windows (whether vertical or horizontal) have no means of secure gasketing when closed, latch on only one side of the operable units, and the sliding mechanisms degrade with use.
   - Casement windows can securely latch to the frame on all sides, can include continuous, sealed gasketing, and do not significantly degrade over time. Select multipoint locking hardware that engages the operable frame on all sides.

4. In addition to energy codes, for taller buildings window selection is often driven by structural requirements to meet wind load criteria, as well as acoustic requirements, and/or fire codes.

B **Install High Performance Windows**– How you install windows is just as important as which windows you select. Codes require that windows are installed with a continuous air barrier at the transition between opening and window frame. Choose an installation contractor experienced with the type of windows selected, especially if they are high performance, which can be heavier and include unfamiliar hardware.

- The rough opening should include flashing on all sides, including water protection at a sill which is sloped to the exterior.
- Once in place, install loose fill insulation at the perimeter of the window filling any cavity between frame and rough opening.
- Provide continuous flashing of membranes and tapes to connect any exterior membranes (for air, vapor, or water) to the window assembly. Do the same for any interior air or vapor membranes.
- Architectural details must specify where air sealing occurs in the construction. Conduct an isolated pressure test at a limited number of window installations to ensure the steps above result in an airtight assembly.

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, limiting condensation, and reducing pollution and noise infiltration.

Utility Savings

A moderate amount of utility savings can be achieved through the reduction of heating and cooling loads due to improving window performance.

Capital Costs

High performance windows require a moderate to high 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 typically 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

High performance windows should require little maintenance over their lifespan, beyond occasional hardware adjustment.

*The Costs & Benefits rating system is based on a qualitative 1 to 4 scale where 1 (Ğ) is lowest and 4 (ĞĞĞĞ) 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 the Retrofit Accelerator to introduce decision-makers to solutions that can help them save energy and improve comfort in their buildings. Access the complete library of Tech Primers here:

be-exchange.org/tech-primers

The **NYC Retrofit Accelerator's** team of Efficiency Advisors offers free, personalized advisory services to help streamline the process of making energy efficiency improvements to your building. The **High Performance Retrofit Track (HPRT)** of the **Retrofit Accelerator** can help you design and implement a 10-15 year capital plan to reduce your building's energy use by 40-60%.

HPRT participants commit to accomplishing deep energy reductions by holistically upgrading all major building systems, including the heating system, cooling system, and the building envelope.

Get in touch with the **NYC Retrofit Accelerator** today!

Call (212) 656-9202
Visit nyc.gov/RetrofitAccelerator
Email info@nycretrofit.org

The **Building Energy Exchange (BE-Ex)** is a center of excellence dedicated to reducing the effects of climate change by improving the built environment. **BE-Ex** accelerates the transition to healthy, comfortable, and energy efficient buildings by serving as a resource and trusted expert to the building industry.

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