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

tech primer

High Performance Windows

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

cost & benefits

GHG savings

Tenant Experience Improvements

Utility Savings

Capital Costs

Maintenance Requirements

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

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.

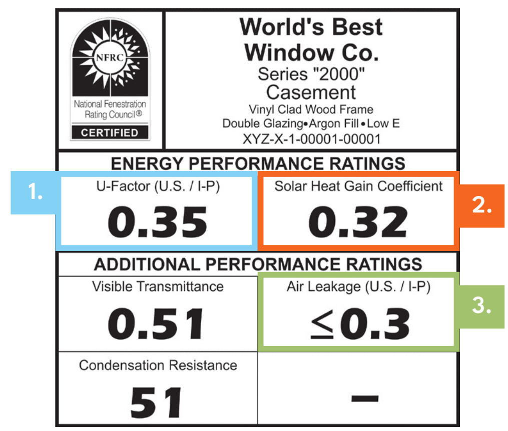
Why improve windows?

Typical framed windows have a life expectancy of about 30 years, after which they must be replaced as part of general building maintenance. Window replacement is an excellent opportunity to increase energy efficiency and comfort by selecting and installing high performance windows. High performance widows improve a building's insulation and air tightness by reducing heat transfer, drafts and noise infiltration.

Installing high performance windows in conjunction with wall insulation upgrades and proper air-sealing will improve the building envelope (the barrier between the inside and outside of a building), and in turn reduce operating costs and energy use of the heating and cooling system.

When selecting windows, it is important to understand the performance criteria upon which they are rated. The National Fenestration Rating Council (NFRC) rates windows on thermal conductance (also known as U-factor, or it's insulation value), the amount of solar radiation filtered (known as the solar heat gain coefficient (SHGC)), the amount of light filtered (known as visible transmittance), and air leakage (see Fig. 1). A window's U-factor, SHGC, and air leakage have a direct impact on the energy performance of a building and should be carefully specified for high performance.

Fig 1. The NFRC label provides energy performance ratings in multiple categories, including U-factor, SHGC, and air leakage. It is recommended that high performance windows exceed the requirements of the New York City Energy Conservation Code listed below.



1. U-Factor range: 0.2-1.2
Code compliant windows must have U-factors less than 0.38 for fixed fenestration (window openings) or 0.45 for operable fenestration.

2. SHGC range: 0-1
Code compliant windows must have a 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 (PSF).

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.

The ventilation system should be assessed to ensure proper indoor air quality after the installation of 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 needs 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 to selecting and installing high performance windows:

A **Select High Performance Windows–** Choose windows that meet and exceed New York City Energy Conservation Code requirements for U-factor, SHGC, and air tightness. Glazing (the glass part of a window) must be specified with low-emissivity (Low-E) coatings to reduce unwanted radiation heat transfer.

1. The U-factor describes how quickly heat is conducted through the window, with lower values indicating less heat transfer and higher values indicating more heat transfer.
   - Vinyl or fiberglass window frames have low U-factors, whereas aluminum and other metal frames have high U-factors, equating to low energy performance.
   - Fiberglass window frames are recommended for low and mid-rise properties, however 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 layers of glazing with argon gas or other inert gas between layers also lowers U-factors.

2. The SHGC describes the ratio of solar heat gain entering the space through the window area to the incident solar radiation.
   - The SHGC is an indicator of the capacity for windows to allow or block solar radiation in order to passively heat or cool the space.
   - The preferred SHGC depends on the climate and construction type. In general, select windows with higher SHGC for colder climates, and lower SHGC for warmer climates.
   - According to the NYC Energy Conservation Code, 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, whereas higher numbers are recommended for buildings with more openings (see Fig 1, #2, on pg 2).

3. Air leakage is defined as the amount of air that passes through a window construction at a given difference in pressure across it, which influences the air tightness (and thus draftiness) of the window.
   - Window frame type has a significant impact on air tightness. 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 the weather-stripping caused by the sliding motion.
   - Casement widows are typically less prone to leaks since their opening mechanism creates less wear on the weather-stripping and a more secure latch.

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 in order to effectively reduce air leaks and drafts.

- During major renovation work, air sealing can be achieved by installing flashing around the rough opening, sealing the interior and exterior edges of the window frame to the flashing with backer rod, caulk, and /or non-expansion foam, and allowing proper drainage with weep holes and drip-edges in the appropriate locations.
- In circumstances where just windows are being replaced,windows must still be fully sealed with backer rod and/or caulk to the rough opening to provide as continuous of an air barrier as possible.
- Architectural details must specify and clearly display where air sealing occurs in the construction.

C **Install Smart Controls–** Install window sensors tied to the space heating's central control.

- Open windows in the winter are usually signs of overheating. Sensors can monitor if windows are open and turn off heat in that area.

Costs and 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 through the reduction of 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 in order to hold windows closed, and sashes must be properly installed and aligned in order 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.

Take Action

This document is one of more than a dozen High Performance Technology Primers prepared by the Building Performance Partnership (BPP) to introduce decision-makers to solutions that can help them save energy and improve comfort in their buildings.

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The Building Performance Partnership (BPP), created by Building Energy Exchange (BE-Ex) and the Institute for Market Transformation (IMT), supports the creation and operation of local high-performance building hubs that accelerate measurable, equitable, and sustainable action to improve the health, comfort, and performance of buildings. With support from both BE-Ex and IMT, partner hubs serve their respective regions with customized resources that cater to the needs of their communities while benefiting from the existing resources and expertise of our network.

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*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, **dark blue** 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.