



Where Growth is a Tradition

HISTORIC WINDOWS AND SUSTAINABILITY



Historic, wood casement windows
in the Wyncote Historic District.

building is through the windows, and that windows account for only 25% of the heat loss. An analysis of the air infiltration patterns and rates, the U-factor (the rate at which glazing conducts non-solar heat flow), and the solar heat gain coefficient of your windows shows that properly functioning, historic wood windows with low-emissivity storm windows and standard window treatments are nearly as efficient as modern replacement windows, with the added advantage of already-expended energy in their manufacture and installation. It is also important to note for those concerned with sustainability/green issues that retaining existing building materials, where reasonable, reduces both the landfill space dedicated to storing discarded building materials and the environmental impacts associated with manufacturing and transporting new materials.

Historic buildings in the United States are facing unprecedented impacts resulting from the sustainability/green movements. It is often the case that older buildings and systems are dismissed as inefficient and replaced with newer, so-called more efficient systems, without regard for the overall lifecycle of the material, the already-expended energy represented by the material, or the implications of disposing of the material.

Older building systems, particularly windows, are often unfairly targeted as the primary avenue for energy loss in historic buildings. There is a growing perception, fueled by new window manufacturers and installers, as well as the federal government, that historic and older windows are the main reason for energy loss in historic buildings. The United States Department of Energy goes as far to state: "If you have old windows in your home, the best way to improve your home's energy efficiency is to replace them with new, energy-efficient windows."¹ With some analysis, it is possible to disprove this statement. The same organization goes on to state that only 10% of the air infiltration of a typical

These guidelines were developed in conjunction with Cheltenham Township's Boards of Historical and Architectural Review (BHAR). The BHARs review Certificate of Appropriateness (COA) applications for proposed exterior alterations that are visible from the public right-of-way within historic districts. The COA applicant is responsible for complying with the provisions of the Zoning and Building Codes at the time of application. The applicant must obtain a COA as well as all necessary permits prior to proceeding with any work. For more information, or to obtain permit applications, please call the COA Administrator at 215-887-6200, extension 213.

This brochure is intended only as a guide, is not regulatory in nature, and should not replace the guidance of a licensed professional architect or engineer. Although the information presented in this brochure is based on current knowledge and practices, Cheltenham Township and its historic preservation consultant, Cultural Heritage Research Services, Inc. (CHRS, Inc.), do not accept liability for any losses or damages resulting from its use.



When exploring ways to make a home more energy efficient, it is best to begin with a whole-building energy audit, rather than starting with costly overhauls of existing building systems. This approach will result in a more targeted and phased plan for increasing energy efficiency. All too often, historic windows are unfairly targeted as the primary culprit for a building's energy losses.

The issues surrounding the energy efficiency of historic windows is particularly timely, with the inception of new Federal tax credits for energy-efficient upgrades. Adrian Scott Fine of the National Trust for Historic Preservation recently wrote an article in *Forum News* called "The Outlook on Windows: New Threats, New Strategies."² This article explores the reconciliation of the often-conflicting goals of high energy efficiency and the historic character of a building and its historic windows by harnessing the already-expended energy that is inherent in existing architecture. Properly repaired and functioning historic windows, combined with storm windows, can meet or exceed the performance standards of newer materials and technologies.

Windows are a key character-defining element in historic buildings that are often removed without completing a thorough analysis of the conditions present, and therefore with little exploration into the costs for repair by a qualified craftsman. Because it is typically free to receive estimates from contractors for window repairs, Cheltenham Township's Building and Zoning Department encourages homeowners to obtain an estimate for repairs, along with estimates for window replacements, in order to fully understand the cost implications.

Based on testing performed for English Heritage, officially known as the Historic Buildings and Monuments Commission for England, it was found that a properly functioning historic window assembly (including both the sash and frames) has a U-factor of approximately 4.3. When this same window was combined with other traditional elements, the U-factor dropped substantially: with

heavy curtains it was 2.5, with well-fitting shutters 1.7, with a reflective rolling blind 1.9, and a honeycomb blind 2.1. When the properly functioning wood window assembly is combined with a low-emissivity (low-E) secondary glazing (a storm window) the U-factor drops to 1.8. This translates to a 58% reduction in the heat lost through the window assembly.³



Different U-factors for alternate window configurations and treatments (Note that this graphic originates from the United Kingdom, where the U-Factor is referred to as the U Value. Graphic is from "Energy Conservation in Traditional Buildings," printed by English Heritage in 2008. Accessible at http://www.climatechangeandyourhome.org.uk/live/content_pdfs/526.pdf).

To earn an Energy Star rating for new windows, the U-factor must be below 0.30 in the northern climate zone of the country.⁴ Although the U-factor for new windows is lower than the combination of a low-E storm windows with a historic window, other factors must be considered. For example, wood has a higher R-value (a material's resistance to heat flow) than vinyl or metal, so considered alone, and not as part of a system, wood is a better insulator. If you are concerned about the environment, retaining and repairing historic windows saves landfill space and no resources are expended in the manufacture and shipping of new products. The long-term performance of many, if not most, modern replacement windows has not been fully evaluated. Many of the vinyl replacement windows installed in the 1980s and 1990s are already warping, resulting in gaps between the glazing and the sash, which allows for air infiltration. Windows constructed of wood pre-dating the early twentieth century are constructed of old-growth wood, so the material is denser and inherently more durable. New wood windows are constructed of new-growth wood and are generally less durable than old growth wood.



prove more cost-effective than replacement windows; sometimes it is not cost-effective or prudent to repair older windows. If the windows are not repairable, different replacement materials should be considered, while taking into account the appearance of the windows, the historic character of the building, and the energy efficiency of the replacement windows.

No major repair campaign, such as whole-scale window replacements, should be undertaken without an energy audit of your building to gain a comprehensive understanding of your energy use. Before replacing all of the original windows in your building, which were designed to operate as part of a whole-building system, it is imperative for homeowners to explore and weigh all options, including heating and cooling costs, the appearance of the building, the environmental impacts of the discarded windows occupying landfill space, and the energy associated with the manufacture and transport of new material. It is critical to understand the long- and short-term implications of repair versus replacement and different replacement options with a life-cycle cost analysis. In some cases, replacing historic windows may be the most efficient, cost-effective option, or it may be more prudent to replace the windows on the secondary elevations while repairing those on the primary.

This document is intended to give homeowners an introduction to issues surrounding the repair and replacement of historic windows—it should not take the place of consultation with qualified architects, engineers, energy auditors and skilled craftsmen.



What is Energy Star? (from Energy Star 2010)
 ENERGY STAR is a joint program of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy which helps us all save money and protect the environment through energy-efficient products and practices. In 1992, the U.S. EPA introduced ENERGY STAR as a voluntary labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions.

Another issue to consider when replacing windows is that the area of glazing is oftentimes reduced. This is a result of “insert” windows that create a second, modern frame in the existing frame, resulting in a wide frame surrounding the window and thereby reducing the area of glazing. Using “insert” windows on the primary elevation of a house changes the character of the fenestration of the overall property.

When the windows in your house are structurally compromised or deteriorated, an intervention level exceeding quick fixes such as caulk or weather stripping may be necessary. Window repairs may



Historic, wood double-hung sash windows with modern storm windows in Wyncote.



Repair

From the standpoint of historic preservation and sustainability, it is always better to repair rather than replace existing windows. With proper maintenance, historic windows have an indefinite lifespan.

The National Park Service has published numerous guidelines for the repair of historic wood windows and historic steel windows. This discussion will focus on the repair of historic wood windows, which are the primary type of residential windows in Cheltenham Township.

Before beginning a window repair project in your home, it is best to start with a window survey. This will help to create a comprehensive plan for your proposed window repairs. A window survey will create a comprehensive list of all of the existing windows, their conditions, and proposed treatment recommendations. For a detailed summary of repair methodology and techniques, please refer to the National Park Service's *Preservation Brief 9: The Repair of Historic Wooden Windows*, available online at <http://www.nps.gov/history/hps/tps/briefs/brief09.htm>.⁵



These semi-attached dwellings in the La Mott Historic District illustrate the role that windows play in the appearance of a building. The dwelling on the left has the original steel casement windows, whereas the one of the right has modern vinyl windows.

After historic windows have been properly repaired, their performance in terms of energy efficiency increases. Combined with storm windows, properly repaired historic windows have the dual benefit of longevity (in some cases more than 200 years) and can virtually meet the performance of modern replacement windows, which have a much shorter lifespan.



This dwelling in Wyncote has properly maintained, historic, wood, double-hung sash windows with operational shutters.

Replace in Kind with Wood

If your window survey shows that certain windows are not repairable, it is best to replace those windows with wood replacement windows to match the existing windows. It is possible to order custom replicas of historic wood windows that retain the traditional window components, including true divided lights, sash weights, wood casements, wood frames, and wood sills. When replacing only a small number of windows in a building, it is ideal to replace those windows in kind in order to maintain continuity of style throughout the building.

As a building material, wood has the advantage of being strong and easy to manufacture for custom windows, and has excellent insulating properties. The downside of traditional wood window construction is that it requires regular maintenance to ensure that finishes are sound and are keeping water out of the wood.

Contractors

A list of contractors who specialize in the repair of historic wood in the greater Philadelphia region is available in Cheltenham Township's Building and Zoning Department. You may reach the office at 215-887-1000, extension 213.



Replacement windows can alter the overall appearance of historic buildings, as illustrated in these row houses. The fiberglass windows on the left mirror the original Queen Anne configuration and maintain a narrow frame profile. The vinyl windows on the right are less sympathetic to the original design of the building.

Vinyl Replacements

If wood windows are not an option, other materials can be considered. Vinyl windows are the most common replacement window on the market today. The advantages of vinyl, or polyvinyl chloride (PVC), windows are that they are generally inexpensive and maintenance free.

Vinyl windows come with disadvantages. Vinyl typically only comes in light or white colors, which, combined with the plastic appearance, is incompatible with historic and older buildings. Vinyl is susceptible to deterioration from ultraviolet light from the sun, causing crazing on the surface of the window, as well as yellowing. Vinyl can begin to warp at approximately 160 degrees Fahrenheit, a temperature that is common in direct sunlight on hot summer days. With very cold temperatures, vinyl is susceptible to cracking. The temperature sensitivity and rate of expansion of the vinyl exceeds that of the glass and sealant, which leads to a breakdown of the seal between the glazing material and the frame. This creates an avenue for air infiltration through



the window. Vinyl is a weak material, so the frame and sash elements cannot be manufactured into thin parts, therefore reducing the glazing area of the window. Finally, when vinyl windows fail, they are not repairable, which again leads to full-scale replacement of window units rather than repair.

Although not fully researched, the lifespan on vinyl windows is much shorter than traditional wood windows for the reasons listed above. . Vinyl used in a household application is also responsible for releasing small amounts of vinyl chloride, which is a gas that can be potentially hazardous to humans.⁶

Aluminum

Although less common now than several decades ago, aluminum was a common material for windows. Aluminum has the benefit of being lightweight, durable and maintenance free. However, aluminum readily conducts heat, so it is not an effective insulator. After weathering for several years, most aluminum will have a “chalky” appearance. Aside from being used for storm windows, aluminum is generally incompatible in appearance with historic buildings.

Aluminum is also used as a cladding material on wood windows to take advantage of the durability of aluminum as well as the insulating and strength properties of wood.

Fiberglass

Fiberglass windows are constructed of fiberglass combined with a resin. As a material, fiberglass composites are durable, strong, have an R-value comparable to that of wood, and a low coefficient of expansion and contraction. Fiberglass windows can be painted, but the windows will not deteriorate if the finish is compromised.

Fiberglass windows tend to be slightly more costly than stock vinyl windows, but the durability of fiberglass far exceeds that of vinyl. Fiberglass is a stronger material than vinyl, allowing the sash and frames to be thinner in proportion. This allows for a greater retention of glazing surface area, since vinyl windows require a thick profile.



Wood and Plastic Composite

Composite windows are constructed of a polymer combined with woodchips, creating a durable, strong material that is resistant to rot. The insulating properties of wood composite materials are almost as high as wood. Additionally, the expansion and contraction rates of the composite windows are similar to that of wood. Wood composites are stronger and more rigid than vinyl, and as a result, the profiles of the window can be thinner, resulting in more surface area of the glazing. The durability of the wood composite windows exceeds the appearance and durability of vinyl. Composite windows tend to cost more than standard vinyl windows.

References

¹ United States Department of Energy, *Energy Efficiency and Renewable Energy: Energy Savers, Your Home*, United States Department of Energy. <http://www.energysavers.gov/your_home/windows_doors_skylights/index.cfm/mytopic=13490>.

Updated on February 24, 2009.

² Adrian Scott Fine, "The Outlook on Windows: New Threats, New Strategies," *Forum News*, Vol. 16, No. 5, January 2010.

³ Paul Baker, *Research into the Thermal Performance of Traditional Windows: Timber Sash Windows*. Glasgow: Prepared for English Heritage by Glasgow Caledonian University, June 2009.

⁴ Energy Star, "ENERGY STAR Program Requirements for Windows, Doors, and Skylights: Version 5.0." <http://www.energystar.gov/ia/partners/product_specs/program_reqs/windows_prog_req.pdf>. Updated April 7, 2009.

⁵ John H. Myers, *Preservation Briefs 9: The Repair of Historic Wooden Windows*. Washington, DC: Technical Preservation Services, U.S. Department of the Interior, 1981.

⁶ United States Environmental Protection Agency, *Technology Transfer Network Air Toxics Web Site: Vinyl Chloride*. <<http://www.epa.gov/ttn/atw/hlthef/vinylchl.html>>. Content updated November 6, 2007.

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Please contact the Township to see if your "greening" project requires a permit. Please call the COA Administrator at 215-887-6200, extension 213.

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The historic wood windows on this property were repaired and storm windows were installed.

Definitions

(Quoted from United States Department of Energy 2009)

U-factor

The rate at which a window, door, or skylight conducts non-solar heat flow. It's usually expressed in units of BTU/hr-ft²-°F. For windows, skylights, and glass doors, a U-factor may refer to just the glass or glazing alone. But National Fenestration Rating Council U-factor ratings represent the entire window performance, including frame and spacer material. The lower the U-factor, the more energy-efficient the window, door, or skylight.

R-value

An R-value indicates a material's resistance to heat flow. The higher the R-value, the greater the insulating effectiveness. The R-value depends on the type of material, thickness, and density.

Low-emissivity (Low-E)

Low-emissivity (Low-E) coatings on glazing or glass control heat transfer through windows with insulated glazing. Windows manufactured with Low-E coatings typically cost about 10% to 15% more than regular windows, but they reduce energy loss by as much as 30% to 50%.

A Low-E coating is a microscopically thin, virtually invisible, metal or metallic oxide layer deposited directly on the surface of one or more of the panes of glass. The Low-E coating reduces the infrared radiation from a warm pane of glass to a cooler pane, thereby lowering the U-factor of the window. Different types of Low-E coatings have been designed to allow for high solar gain, moderate solar gain, or low solar gain.

Solar heat gain coefficient (SHGC)

A fraction of solar radiation admitted through a window, door, or skylight—either transmitted directly and/or absorbed, and subsequently released as heat inside a home. The lower the SHGC, the less solar heat it transmits and the greater its shading ability. A product with a high SHGC rating is more effective at collecting solar heat gain during the winter. A product with a low SHGC rating is more effective at reducing cooling loads during the summer by blocking heat gained from the sun. Therefore, what SHGC you need for a window, door, or skylight should be determined by such factors as your climate, orientation, and external



shading. For more information about SHGC and windows, see passive solar window design.

Air leakage

The rate of air infiltration around a window, door, or skylight in the presence of a specific pressure difference across it. It's expressed in units of cubic feet per minute per square foot of frame area (cfm/ft²). A product with a low air leakage rating is tighter than one with a high air leakage rating.

Visible transmittance (VT)

A fraction of the visible spectrum of sunlight (380 to 720 nanometers), weighted by the sensitivity of the human eye, that is transmitted through a window's, door's, or skylight's glazing. A product with a higher VT transmits more visible light. VT is expressed as a number between 0 and 1. The VT you need for a window, door, or skylight should be determined by your home's daylighting requirements and/or whether you need to reduce interior glare in a space.

Light-to-solar gain (LSG)

The ratio between the SHGC and VT. It provides a gauge of the relative efficiency of different glass or glazing types in transmitting daylight while blocking heat gains. The higher the number, the more light transmitted without adding excessive amounts of heat. This energy performance rating is not always provided.



Windows in poor condition require intervention to maximize your home's energy efficiency.