

Considering the REPAIR, RETROFIT and REPLACEMENT of Historic Windows

preservation
PENNSYLVANIA



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INTRODUCTION

Preservation Pennsylvania serves as a resource for a wide variety of property owners, local preservation organizations, and communities working to preserve historic properties. During the course of our work, we continue to be asked questions like, “When is it appropriate to replace historic windows?” and “What type of replacement windows are the best?” These are by no means new questions. So we set out to review the body of existing research on the subject and talk to experts like architects and contractors, in order to prepare a publication that provided answers.

Of course, the short answer is, “It depends.” After spending a couple of months immersing ourselves in the issue, we learned that **historic windows can almost always be repaired or retrofitted to meet the needs of today’s property owners, often at less cost than replacing the windows. This solution lasts longer and has less of an impact on the environment.** As a result, we can’t in good conscience recommend any replacement window as a good solution across the board.

Since we still can’t provide easy answers, our goal with this publication is to share the information that we gathered so that property owners and review boards can make the most informed and responsible decisions possible. We don’t want to lose historic windows unnecessarily. And we certainly don’t want to lose them because people didn’t have the information they needed (or had the wrong information) to choose wisely.

Whether you are a property owner considering window replacement, a member of a review board who has to make decisions about window replacement, or just someone who cares about their community and/or the environment, we hope you find this information to be valuable.



This historic building has a wide variety of old and new windows.



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Through creative partnerships, targeted educational and advocacy programs, advisory assistance, and special projects, Preservation Pennsylvania assists Pennsylvania communities to protect and utilize the historic resources they want to preserve for the future.



THE IMPORTANCE OF HISTORIC WINDOWS

Windows are an important part of the fabric of any existing building. They reflect the technology and fashion of the era in which your house was built. They can impart a sense of character and quality through their wavy glass or handcrafted muntins. They impact how you view the world from inside the house, and how people experience your building from the outside. They provide daylight and ventilation. Windows can also impact your comfort, productivity and even your health. Historic windows are often character-defining features of older homes. Because they are an important part of your home, their removal and replacement should be considered carefully.

In order to determine how important your windows are to your building and your community, Preservation Pennsylvania suggests that you ask and answer the following questions:



Is the building in a historic district?

If it is, your decision impacts not just your building, but those around you as well.

Are the windows original?

Different window configurations were common at different times in history, and in different types and styles of buildings. Refer to an architectural guide book or your community's design guidelines to determine what your original windows probably looked like. If your windows are original, they are particularly well suited to your home and have already proven to be very durable, so you should do your best to retain them.

If your windows are not original, how old are they?

If you determine that your windows are not original, try to figure out how old they are. Windows built with old-growth wood (installed before the 1950s) are of extremely high quality. Even if your windows are not original, if they are old, you might want to retain them. If properly maintained, they will almost certainly outlast windows built of new wood or other modern materials.



Do your windows have any unique or notable features?

If they are arched or curved, have unique patterns in the panes of glass, decorative trim or other distinctive features, you should do all you can to preserve those features.



Can people see your windows from a public right of way?

If your windows can be seen from public streets, alleys or sidewalks, your decisions will impact the experience of other people in your community. Keep the historic character of your home in mind when making decisions about window repair or replacement.





MAINTAINING and REPAIRING HISTORIC WINDOWS

Historic windows require maintenance. It's a simple fact.

We've all seen windows in need of attention. Their paint is peeling, their glazing is cracked. Sometimes their glass is broken, or their sash are stuck open or shut. When it gets really bad, the bottom of the window sash is deteriorating, and the sill is rotted.

ROUTINE MAINTENANCE

In order to maintain your windows in good condition and avoid costly repairs or replacement, it is recommended that you conduct cyclical maintenance of your windows.

Inspecting Windows – Yearly

Regular inspection identifies deterioration or damage early so that minor repairs can be made before the problem escalates.

A handyman or window restoration contractor can do this for you if you prefer not to do it yourself.

Painting – Every 7-15 Years

To prevent windows from deteriorating, it is important that their paint remain intact and in good condition. Surface preparation is the most important factor in the life expectancy of a paint finish. Make sure the surface is clean and dry prior to brushing on high-quality paint.

A painter or window restoration contractor can do this for you if you prefer not to do it yourself.

Replacing Broken Glass – As Needed

In order for your windows to function, broken glass should be replaced as soon as possible. This can be done while the window is in place, or by removing the sash and taking it to a shop.

A handyman, glass supply store or window restoration contractor can do this for you if you prefer not to do it yourself.

WINDOW REPAIR BASICS

The good news is that older windows can be repaired!

Traditional windows are made from individual parts, which are pieced together to make the window. Each piece of the window can be individually repaired or even replaced. If the glass is broken, you can replace it. If the bottom rail or sill is rotted, you can repair or replace them. All is not lost! Just because the condition of a window is poor does not mean that it needs to be replaced.

Sometimes it is overwhelming to look at your windows and imagine tackling the project of fixing them. It seems easier to just call someone who will come and replace them with new ones. While that may be easier, in most cases, it's not better.

Start by looking at your windows and determining what condition they are really in. Use a notebook or spreadsheet to help you. Go window by window, part by part. See diagram on page 3. Let your inner critic shine, and note what's wrong with each window. Take pictures as you go.

You may be surprised to find that your windows are not all in horrible condition like the one that first caught your attention. The location of a window on the building often makes a big difference in its condition. Those on the south and west sides of the

building, which face the sun, tend to suffer more from peeling paint and dried-out glazing putty, while windows on the north and east sides, which get less sun, tend to have more problems with rot from moisture getting trapped in the joints or sitting on flat surfaces.

Talk to a qualified professional who can tell you what needs to be done to address the problems you identified.

If you want, they can also give you an estimate to do the work. In the hands of a qualified contractor, repairing your windows can be just as easy as replacing them. There are a number of things that your contractor can do for you. If the glazing is failing, they can reglaze your windows for you (or you can do it yourself). If elements of the window are deteriorated or failing, they can perform Dutchman or epoxy repairs, or they can replace the individual part – be it a muntin, rail, sill or whole sash – for you.

Preservation work is labor intensive as opposed to materials intensive. This means that the money you spend to repair your windows is paying for skilled labor, rather than buying new materials that are having an impact on the environment.



MAINTAINING and REPAIRING HISTORIC WINDOWS

WINDOW RESTORATION

For the most part, routine maintenance and occasional repairs will be sufficient to keep your windows in good condition. However, from time to time (probably every 50-100 years), the layers of paint and grime build up to a point where they are no longer stable, or major repairs are needed. When your windows require restoration, your contractor will do the following:

❖ **Disassemble window unit and remove window sash.** They'll remove the stop that holds the window sash in, and then disconnect the sash cord and weights that allow the window to move up and down. They'll put a temporary window (or board) in the window opening, and take the sash with them back to their shop.

❖ **Remove existing paint and putty.** In their workshop, they'll remove the existing paint and glazing putty. Most professionals seem to prefer using steam because it makes relatively quick work of the paint removal without negatively impacting the window sash. Other methods, such as heat or chemical paint strippers, may be acceptable as well.

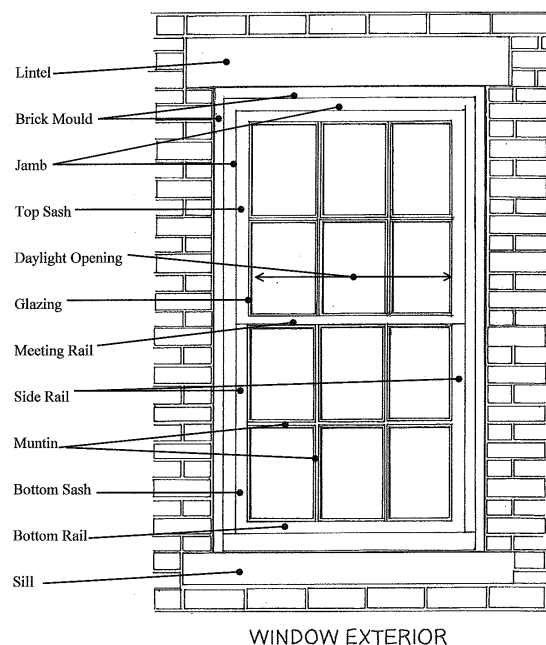
❖ **Conduct repairs.** Once the paint and glazing compound have been removed, they'll take the glass out. Then they'll conduct any necessary repairs, such as gluing and re-pegging joints, replacing broken muntins or damaged rails, or replacing broken glass. In the hands of a qualified carpenter or contractor, any historic window can be fixed.

❖ **Apply oil-based primer with a brush.** After the repairs have been made and the sash has been sanded, they will prepare the wood for primer. This involves the application of a combination of linseed oil and turpentine, often several layers. Once the surface is ready, they'll apply one coat of oil-based primer with a brush, and allow it to dry.

❖ **Replace the glass and paint.** When the primer has dried, they will create a bed of glazing putty to set the glass in, and then install glazing points to hold the glass in place. The window will then be sealed with additional glazing putty. Once the putty has cured, they will prime it using oil-based primer, and then apply two coats of high-quality paint.

❖ **Reinstall the windows.** Before reinstalling the windows, the contractor will make any necessary repairs or modifications to the window frame. They can repair or replace rotted sills or pieces of the frame or trim. They will make sure your pulleys and other hardware are working properly. In addition to prepping, priming and painting the frame, they can add weather stripping, if so desired. They will then reinstall the window sash, replacing the cords (sometimes with chain upon request) and adjusting the weights, as needed. Some contractors even apply wax to make the windows easier to open and close. If you would like to be able to clean the outside of your window easily, ask your contractor to reinstall the stop using a screw in a threaded barrel so that you can easily remove the stop and swing the sash in for cleaning.

Once the restoration is complete, your windows will be as good as new...or better! All lead paint will have been removed, eliminating that problem completely. You'll have windows that were made to fit your home, from materials that are durable and have no environmental impact. *For more information on window repair and restoration, see Resources on page 17.*





ADDRESSING COMMON REASONS for REPLACING WINDOWS

When assessing the feasibility of a historic preservation (or rehabilitation) project, we often ask the question, “Can it be saved?” And the answer is almost always, “Yes.” From the standpoint of technical feasibility, it is almost always possible to save a building. However, that doesn’t mean it’s always a good idea, or fiscally responsible. We expected this to be the same for building components, namely windows. Instead, what we learned is that saving windows is almost always possible, AND it can often be done at a cost that is comparable to (often less than) replacement.

Therefore, rather than asking whether a window can be repaired, it might be more relevant to ask:

- What are the goals of the project?
- Can that be accomplished without replacement?

Windows CAN be repaired. But sometimes that still doesn’t accomplish what the property owner is hoping to accomplish. According to Preservation Pennsylvania’s research, the most common reasons for replacing historic windows with new ones include: aesthetics, safety, comfort and convenience, and energy efficiency.

Unfortunately, many people base their decision to replace windows on incomplete or inaccurate information provided by individuals or companies that profit from selling new windows. Significant investment is made in marketing replacement windows, and convincing homeowners that they need them. Attention grabbers like those illustrated on this page are evidence of the large quantities of money being invested in making people think that window replacement is their only or best option.

When you are clear about what you are trying to accomplish, you can consider a variety of alternatives that will achieve those goals. Those alternatives may include but are not limited to replacement. For instance, if your goal is to improve the appearance of your house, you can accomplish that with maintenance or restoration of your historic windows (see pages 2-3). If you want windows that are easier to clean, you can make the stops easily removable so that you can readily access both sides of the sash (see page 3). There are a number of ways to make historic windows as energy efficient as new windows, almost always at less cost (see pages 7-10). If your goal is to reduce or eliminate future maintenance, you may be surprised by the shortcomings of new windows (see pages 6, 14, 15 and 17). In many cases, repairs or modifications to the existing windows can achieve your goals at lower cost than replacement, while maintaining the integrity of the property and historic district. The following pages address the common reasons people give for replacing their windows, and explains how similar goals can be accomplished without replacement.





KEEPING HISTORIC WINDOWS SAFE

Some window manufacturers claim that old windows are less safe because they are often not operable, have broken glass, encourage mold growth, and contain lead paint. The information on this page explains how these safety concerns can be addressed without replacement.

❖ Making Windows Operable

Some window manufacturers say that old windows are unsafe and should be replaced because they don't operate properly, which may keep people from using them for egress in an emergency. Historic windows were designed to be operable. If they are not functional today, it is most likely because they have been altered or allowed to deteriorate. Here are a few common problems and solutions for making historic windows operable:

Windows are painted shut	Carefully run a putty or utility knife around the painted seams to unstick the window. If necessary, remove the stop and/or casing to free the window sash, and then reinstall.
Sash cords are broken	The cotton rope that holds the sash and counter weights can deteriorate over time. If it has broken, you can disassemble the window and replace it with new rope or chain.
Pulleys are rusted or broken	Rusted pulleys may keep windows from operating properly. Disassemble the window to inspect the pulley. It can be removed and cleaned, or replaced.

❖ Preventing Mold

Some manufacturers claim that old windows cause mold, which is hazardous to your health. It is true that historic, single-pane windows are prone to condensation, which is water or frost that collects on the surface when warm, moist air comes into contact with cold surfaces or air. Glass is usually the first place you notice condensation because it often has the lowest temperature of any surface on the house.

However, condensation is not exclusive to historic windows. In fact, a recent article states, "The reason you may observe more condensation in your home is because of modern energy-efficient homebuilding techniques and products. While energy-efficient designs and weather stripping keep cold air outside, they also keep warm, moist air inside. Older window designs were less efficient and consequently allowed moisture to escape." Because old windows draw moisture out of your house to condense on the cold glass surface and then allow it to escape, they are actually found to reduce the amount of moisture and mold found in houses, not cause more mold.

The case where this might not be true is if your window is not in good condition, and water is allowed to pool on the surface, or seep into the wall in quantities that cannot evaporate or be absorbed. If you do have mold on or around your historic window, contact a qualified window restoration contractor to address the problem through repair.

❖ Replacing Broken Glass

At least one window manufacturer states that "cracked and broken glass are dangerous," so you should replace your windows. True, broken glass can cut you, and no one wants that. Broken glass can also be a security issue. In traditional windows, replacing broken glass is easy to do. A homeowner or handyman can fix it in just an hour or two. *See page 2.*

New windows are made with glass, too. But because most modern replacement windows are sealed systems with welded joints, rather than being able to replace the glass when it is broken, the entire sash or window unit will need to be replaced. This can take time and money, leaving the unsafe situation in place longer.

❖ Addressing Lead Paint

Lead paint, which is hazardous to your health and should not be ingested, is often found on historic windows and trim. **Replacement is not required to address these concerns.** Windows that contain lead paint can be managed safely with frequent cleaning to eliminate lead-laden dust, and periodic repainting to keep the lead paint encapsulated. To eliminate lead problems completely, historic windows can be stripped of all of their paint by a qualified contractor. The historic windows can then be repainted, and no further lead hazard will be present. *For more information regarding lead paint hazards, please refer to our Resources on page 17.*



ADDING COMFORT and CONVENIENCE to HISTORIC WINDOWS

In addition to safety, added comfort and convenience are often used as selling points for replacement windows. The stated benefits of new windows include insect screens, reduced noise, more convenient window cleaning, and being maintenance free. Here is some additional information to consider when contemplating window replacement for reasons related to comfort and convenience:

❖ Insect Screens

Historic windows can be fitted with insect screens. Historically, wood-framed screen panels were common. People would put on storm panels in the winter and then remove them and replace them with screens in the summer. Although slightly inconvenient, this system is still available today.

More recently, self-storing (triple-track) storm windows that include moveable screen panels have become common. The appearance of these units can be minimized if they fit the window opening properly, the meeting rail lines up with that of the window, and the frame is painted to match the window sash or frame. As an alternative to the triple-track variety, combination storm/screen windows are available, with the exchange made either from the interior or exterior, depending on the preference of the homeowner.

Small temporary window screen inserts are also available. Much like the wide variety of storm windows available, a range of insect screen options are available for historic windows.



These historic windows have full screens inside the casements, which are hinged to open easily to facilitate window operation.

❖ Noise Reduction

Windows with double-pane glass do limit noise more than single-pane windows. However, since the primary factor in noise reduction through glass is the distance between the panes, greater noise reduction occurs when the panes of glass are 2-4" apart, as is the case when a single-pane historic window is paired with an exterior storm window or an interior window insert.

❖ Window Cleaning

Modern windows tilt in for easy cleaning. Unfortunately, the hardware that allows modern windows to tilt in is often one of the places where replacement windows commonly fail. The plastic clasps that hold the window closed get brittle over time and break off, making it impossible to keep the window sash closed. This presents problems for both security and weatherization.

If making the windows easier to clean is a priority, historic wood windows can be easily modified. Simply remove the nails that hold your window stops in place. Removing the stops allows the sash to swing in on the sash chords for easy cleaning. When you replace the window stops, use screws (preferably in a threaded barrel to minimize future wear) to put the stops back in. The next time you want to clean the window, you can leave the ladder in the garage and simply remove the screws to swing the window sash in for cleaning.

❖ The Truth About Maintenance

One of the most common reasons people give for wanting to replace their windows is to reduce future maintenance requirements. New windows promise to be “maintenance free,” while historic windows require routine maintenance to remain in good condition. This maintenance includes repairing or replacing glazing compound and painting approximately every 7-15 years. If maintained in good condition, additional maintenance and repairs will be limited. Every 50-100 years, windows will likely require more in-depth repairs or restoration. *See page 3 for more information.*

Although most modern replacement windows don't require glazing and painting, and so are considered to be “maintenance free,” they still deteriorate. Most replacement windows depend on caulk to seal them, and the life expectancy of caulk is 0-10 years. When water infiltrates, it causes deterioration. If the windows are covered in cladding, this deterioration may not be visible, giving the appearance that the window is performing well. This type of deterioration is not covered by most warranties. Generally speaking, “maintenance free” equals disposable. **New windows may not require maintenance, but they will have to be replaced approximately every 10 to 20 years, which is nearly as often as historic windows will need to be painted (every 7-15 years).**



RETROFITTING HISTORIC WINDOWS to IMPROVE ENERGY PERFORMANCE

The most common and probably the most important reason that people give when considering window replacement is wanting to improve their energy performance. They care about the environment or their wallet (or both), and so want to reduce their energy consumption.

The National Trust for Historic Preservation and its partners (including the National Center for Preservation Technology and Training, the Preservation Green Lab, the Cascadia Green Building Council, and Ecotope) have conducted studies in various climates that demonstrate: **1) that historic windows can be retrofitted to achieve energy performance results comparable to new replacement windows, and 2) almost all of these retrofit options offer a better return on investment than replacement windows.** In addition to reducing energy consumption and saving money, these retrofits extend the life of existing windows, avoid unnecessary production of new materials, and reduce waste, all while maintaining historic character and authenticity. If you want to achieve significant energy savings through window replacement, please review this information to be sure you're making an informed, responsible decision. It is likely that the goals of your project CAN be achieved without replacement.

New high-performance replacement windows provide an average of 17-29% energy savings. However, these new, high-performance windows are costly, averaging approximately \$30,000 for materials, installation and general construction commonly required for an existing home.

Upgrading older, single-pane windows with high-performance enhancements can result in substantial energy savings. Retrofitting existing windows by air sealing with caulk and weather stripping, insulating by adding storm windows, and/or reducing solar gain using films or shading is a much more cost effective way to achieve similar energy savings and lower a home's carbon footprint. **Installing either interior window panels (interior storm windows) or exterior storm windows combined with cellular blinds provides energy savings within the range of savings expected from new, high-performance replacement windows.**

Air Sealing

Sealing gaps between window sash and frames and around window frames is a retrofit measure that provides a high return on investment. Use caulk and weather stripping to measurably reduce air infiltration at very little cost.

❖ Caulking

Caulk provides an effective, flexible seal for cracks, gaps and joints that are no more than a quarter inch wide. In order to limit air infiltration, caulk around the window opening on the exterior, and around the window trim on the inside. According to the U.S. Department of Energy, the cost of properly-applied caulking can usually be recovered in energy savings within one year.

(www.efficientwindows.org/existing_repair.php)

❖ Weather Stripping

Weather stripping comes in a variety of materials, including copper and brass, felt, and rubber, among others, which compress when the sash is shut to prevent air leaks around windows sashes. A recent study found that weather stripping provided energy savings of 1 to 3%. When weather stripping was installed by a professional, it had a low return on investment relative to other window improvements. However, when homeowners installed the weather-stripping themselves, it produced a higher return than any of the other window retrofit options studied (30.9%).

Weatherizing Historic Windows

Making the windows of your older or historic home more energy efficient does not have to break the bank.

Here are four easy tips to get you started:

1. Caulk around the window opening on the exterior.
2. Caulk around the window trim on the inside.
3. Add weather stripping to the window sash.
4. Use a storm window or thermal panel.



As part of a comprehensive restoration and energy upgrade, a homeowner routs his historic window sash to insert weather stripping.



RETROFITTING HISTORIC WINDOWS to IMPROVE ENERGY PERFORMANCE

When it comes to the energy performance of windows, two panes are better than one. As a result, windows with double-pane glass are more efficient than those with a single pane of glass. But studies show, it doesn't matter whether those two panes of glass are installed together as part of a manufactured, insulated unit, or are formed by adding a storm window (exterior or interior) to an existing or historic window.

Storm Windows

Storm windows help reduce air leakage and improve the insulating value of existing windows. They can be installed on the interior or exterior side of windows, and can be mounted permanently or for seasonal use. Industry guidelines indicate that the addition of a storm window to an existing single-glazed window will reduce the energy loss through the window area by approximately 50%. This savings applies to both heating and cooling.

Replacing existing, single-pane, leaky windows with new windows can significantly improve a building's energy performance and reduce operational CO2 emissions. New high-performance replacement windows were found to provide an annual percent energy savings between 17 and 29%. However, upfront costs are substantial. Despite their effectiveness, because of their high cost, new high-performance windows offer a poor average rate of return of just 1.7%.



Can you see the storm windows on this historic house? The left three windows on the second story have exterior storm windows, while the others do not.

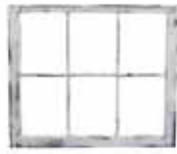
❖ Exterior Storm Windows

Comparable energy savings are offered by exterior storm windows, especially when used in combination with insulating cellular shades. Exterior storm windows alone provide energy savings of 14 to 24%. When used in combination with insulating cellular shades, exterior storm windows provide an energy savings ranging from 19 to 26%. But because the cost of storm windows is lower, the average return on investment for exterior storm windows nationwide was 3.5%. Adding the cellular shades increases both efficiency and cost, and reduces return on investment slightly to an average of 3.2%. Both of these are approximately double that of the return on investment (1.7%) for high-performance replacement windows. This generally means you are achieving a nearly equivalent energy reduction at half the cost by retrofitting your historic windows with exterior storm windows rather than replacing them.

Many people find exterior storm windows to be unattractive. And they certainly can be. But there are a number of manufacturers and craftsmen who can make wood or metal storm windows that fit your window well and have a relatively limited visual appearance. It is important that they fit properly, that the meeting rail match the rail on your windows, and that the frame be as thin as possible and painted to match the surrounding window elements.

Wood storm windows can be purchased commercially or custom made. They can be hinged at the top and open out at the bottom to allow air in when the weather is good; they can be removable, going on in the cold months and coming off in the warm months; and they can be partially removable, where the frame remains in place year-round, but the glazing panel is removed using toggle clips, and replaced with a screen panel.

In addition to wood storms, metal (typically aluminum) storm windows are also available. Like wood windows, these can be curved, arched or otherwise customized to fit your window opening. A number of different types are available, including: fixed, self-storing (triple-track), inside removal, or outside removal. Depending on your desired aesthetic, operation preference and budget, storm windows can be found or made to suit your needs.



RETROFITTING HISTORIC WINDOWS to IMPROVE ENERGY PERFORMANCE

❖ Interior Window Panels

Exterior storm windows achieve notable energy savings, and serve to protect the historic window from the elements. However, interior window panels provide a slightly greater energy savings than exterior storm windows alone, and are not visible from the exterior. Interior window panels can also be more easily installed and removed for ventilation or cleaning.

Often referred to as interior storm windows, interior window panels were found to provide an energy savings of approximately 14 to 27%. These were especially effective in cold climates, such as Portland, Boston and Chicago, all heating-dominated climates like that found in Pennsylvania. With costs comparable to exterior storm windows, interior window panels have an average return on investment of 3.5%, or 3.7% in heating-dominated climates. So, like exterior storm windows, **interior window panels allow you to achieve energy reduction comparable to new high-performance replacement windows at half the cost.**

As people become aware of the effectiveness and ancillary benefits of interior window panels, more and more manufacturers and installers are appearing. Some use glass, while others use flexible plexiglass. Some permanently affix the storms, while others have removable inserts. We anticipate that this market will continue to grow as the demand increases.



A Note About Storm Windows and Condensation

Storm windows can reduce air leakage, which is good when trying to improve the energy efficiency of a home. However, it is important that the humid air that gets caught between a storm window and window is allowed to escape to the outdoors. Whether exterior or interior storms are used, the outer window unit must have weep holes (exterior storm) or allow some air leakage (historic window) to avoid condensation between the panes, and the interior part of the window/storm window pair should be airtight.



The staining on the muntin, rail and sill of this window are the result of condensation.

Storm windows address a number of the concerns or help achieve many of the goals of those contemplating window replacements. They help with:

- Energy Savings
- UV Reduction
- Reduced Heat Gain
- Noise Reduction
- Sash Protection
- Reduced Condensation

This historic window has an interior window panel that improves its efficiency without detracting from the appearance and historic character of the building.



RETROFITTING HISTORIC WINDOWS to IMPROVE ENERGY PERFORMANCE

Reducing Solar Heat Gain

Caulking and weather stripping help to reduce air infiltration. Storm windows (exterior or interior) insulate the window by adding a second surface separated from the first by an air space. To help control solar heat gain that occurs when solar energy is absorbed through the window, consider window films or shading.

❖ Window Films

In a hot climate like Arizona, where keeping cool dominates energy concerns, interior surface film offers the greatest return on investment of any of the energy-reduction retrofits tested, at 5.9%. However, in heating-dominated climates like that in Pennsylvania, homeowners *benefit* from direct solar exposure on windows during cooler months. Thus, films are not generally desirable here as they reduce the amount of solar energy that can enter the house through these windows. Windows on elevations facing the sun that have clear glass with no window film or low-e coating will pass more beneficial energy into the house. If you do decide to use window films, the National Park Service recommends installing clear film without noticeable color, NOT retrofitting historically clear windows with tinted glass or reflective coatings.



Awnings are a historic method of shading that is still a viable way to reduce solar gain today.

❖ Shading

The most effective way of reducing solar heat gain is to block the sun's radiation before it reaches the windows. Shade trees, awnings, shutters and solar screens are examples of exterior shading solutions.

Trees and Landscaping

Trees are an effective way to shade buildings so that excessive solar heat does not reach the home. Deciduous trees are best because they block the sun in the summer when it is undesirable, and allow it to reach the house when the leaves have fallen in the winter, when passive solar gain is welcome.

Besides providing shade, trees and other vegetation also reduce the air temperature around them by as much as 9° F due to evaporation of moisture.

Awnings

Opaque awnings, preferably of light color, provide shade to historic windows, and help to reflect a large portion of sunlight and solar heat. Removable or retractable awnings are preferred so that they can be removed to allow for beneficial solar heat in the winter.

Shutters

Shutters that are operable and utilized can help to reduce solar heat gain as well as protect the historic windows from storms and vandalism.

Cellular Shades

In Pennsylvania, it makes sense to use cellular shades or other shading methods that can be deployed when needed to keep out excessive sunlight, but which will not impede desired solar gain in cooler months.

Although some people have and use air conditioning, Pennsylvania is considered to be a heating-dominated climate. In heating-dominated climates, insulating cellular shades offer by far the highest average return on investment. They are relatively inexpensive to purchase and install, and provide energy-performance returns averaging 5.2% nationwide, and 6.0% to as much as 7.8% in heating-dominated climates. This low-cost measure offers the biggest “bang for the buck” in terms of investment, likely because it is easy to operate, allowing you to open the shades daily to allow for passive solar gain on the winter days, and close the shades to keep heat in at night and block sun during the hot summers.

Although cellular shades are generally the most efficient, other types of draperies and window treatments can help control solar gain and reduce energy consumption.



OTHER CONSIDERATIONS

❖ Other Environmental Impacts

Reducing energy consumption and related carbon dioxide emissions by improving home energy performance is an important aspect of environmental sustainability. But we must not neglect to consider other types of environmental impacts, as well.

When windows are replaced, existing windows made from natural materials such as wood for sash and frames and silica for glass, using significant quantities of energy decades ago, are thrown away. As a result, those materials and that energy is wasted. Producing new windows requires the manufacture of new materials – which in today’s world are not always derived from natural materials. Their production requires large quantities of energy, and they often generate hazardous byproducts or toxic gasses. These new windows must then be transported from the place where they are manufactured to the place they will be installed, requiring the expenditure of additional energy, and resulting in additional carbon dioxide emissions.

So, even if replacement windows reduce a home’s operational use of energy slightly more than retrofitting existing windows, their overall impact on the environment is greater. In addition to operational energy, it is important to keep in mind embodied energy in the old windows, and the environmental impacts related to the manufacture, transportation and disposal of the new windows.

Saving existing windows is greener than producing new windows.

Window Manufacturer Claim:

Replacement windows filter ultraviolet (UV) light, which can be damaging to your belongings. UV light can be damaging to the contents of your home, such as wall hangings and upholstery. Traditionally, people used awnings, blinds and drapes to control the amount of UV light in the home. This can still be done today. By limiting the amount of sunlight that enters in this manner, you can also reduce the amount of energy needed to cool your home.

Window Manufacturer Claim:

New windows will allow more natural light into your home. In most cases, replacement windows are inserted inside the existing window frame, reducing the size of the window opening, and thus the amount of daylight that can pass through. Additionally, if they have a low-e coating, they will further limit the amount of light passing through your windows into your house.

LIFE CYCLE COST COMPARISON

This Queen Anne style house was built in 1894. When it was remodeled in 2008, its beautifully detailed, rot-resistant hardwood windows had been in place for 114 years. They were removed and replaced.

Despite the homeowner’s expectations of energy savings, they’ve now entered a costly cycle of regular window replacement every 15-20 years. While the typical cost of a replacement window ranges from \$300-\$700, high quality windows can easily cost from \$1,000 to \$4,000 per window. Although new high-performance windows provide an average of 17% to 29% energy savings, it is doubtful that those savings will cover the cost of the windows before the windows must be replaced again. Only if this house has no more than 30 windows, each costing \$700, lasting 20 years and resulting in an energy savings of 25%, and if their energy bills were at least \$4,000 per year (\$335 or more per month) would there be a chance that the energy savings would justify the cost of window replacement before needing to be replaced again.

On the other hand, if the building owner had restored the historic windows (\$280-\$700 per window) and added storm windows (\$165-\$295), they would have achieved similar energy savings (14% to 24%), escaped the replacement cycle by having windows that can last another 50-100 years without significant work needed, and in so doing reduced their total cost and overall environmental impact.

Sources:

home.costhelper.com/window-replacement.html
www.homeadvisor.com/cost/doors-and-windows/repair-windows/
www.homeadvisor.com/cost/doors-and-windows/install-replace-storm-windows
www.improvenet.com/r/costs-and-prices/storm-windows





SELECTING APPROPRIATE REPLACEMENT WINDOWS

Most problems can be solved by repairing or modifying historic windows to suit current needs. But in some instances, replacement may be warranted.

The Secretary of the Interior's Standards for Rehabilitation (Standards) (www.nps.gov/tps/standards/rehabilitation.htm) are commonly used to guide and/or regulate decisions in historic communities or for historic properties. Among other things, the Standards say, "Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture and, where possible, materials."

This standard provides a good starting point for considering window replacement. Once it has been demonstrated that the existing (deteriorated) windows cannot be maintained, repaired or modified to meet the needs of the project or applicant, replacement can be considered.

The new window should match the design of the old window. By matching the design, we typically mean all of the following:

- Size
- Shape
- Pane Configuration
- Type/Operation
- Location
- Trim Details

Size

The new windows must fit within the existing window opening and fill it completely. Framing or blocking window openings down to accept a smaller window is not appropriate. Enlarging a window opening to fit an oversized window is not recommended.

Shape

Arched windows should be replaced with arched windows, curved windows with curved windows, etc. Tall windows should not be divided into several shorter windows, and wide windows should not be comprised of smaller windows placed adjacent to each other.

Pane Configuration

The configuration of the panes of glass should also be replicated. Whether they are nine-over-twelve, six-over-six, two-over-two or three-over-one, windows should match those they are replacing. If true divided lites are not feasible, this should be done with an exterior grille, sandwiched grille and interior grille to mimic the appearance of historic muntins and provide depth and shadow to the sash.

When is Replacement Acceptable?

As a rule of thumb, replacement is only appropriate when repair is not possible. And as the prior pages indicate, windows can almost always be repaired.

But at some point, there are so many windows to repair and the repairs are so extensive that replacement does merit consideration. Where this point is will vary for each person, project or community. We recommend that your community define for itself when a building's windows are "too far gone."

Contact Preservation Pennsylvania if your community would like assistance developing a policy for evaluating window replacement projects that suits your particular goals and needs.



The historic windows in this building were removed and replaced with new windows that are not the same shape, configuration or material as the historic windows.



SELECTING APPROPRIATE REPLACEMENT WINDOWS

Type/Operation

The new window should operate in the same manner as the historic window. For instance, a double-hung window should be replaced with a new double-hung window, a casement replaced with a casement, and so on. In some cases, such as a window being required by code to be egressable, changing the operation may be acceptable. In these situations, the window should have the appearance of the historic window. For instance, a window may have the appearance of a single- or double-hung window, but may swing out like a casement in order to clear an opening large enough for a person to move through in case of emergency.



This window is the wrong shape, pane configuration and type.

Location

In some instances, replacement windows are set too close to the exterior wall surface, or recessed too far in toward the interior wall surface. To prevent inappropriate visual changes, new windows should be installed in the same place the historic windows were.



Photo Credit: Ken Nuttle

Because this window replacement is changing the size of the window opening, it is not appropriate.

Trim Details

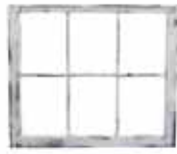
Existing trim should be retained whenever possible. If the trim must be replaced, it should be replaced to match the existing trim. The window trim and molding profiles should not be altered or covered. Window trim should not be wrapped in aluminum or other cladding because it masks historic details and hides potential deterioration from view, often leading to significant problems in the future.



This window replacement used windows of the wrong size, shape and pane configuration for the window opening, and failed to maintain the existing trim.



This historic school building is in its second cycle of window replacement. Those in the center bay and basement appear to be original. The windows on the left were replaced inappropriately with smaller windows that required alteration of the original window opening. The windows on the right, which are replacing earlier replacements, are restoring the size of the window opening and approximating the original pane configuration.



SELECTING APPROPRIATE REPLACEMENT WINDOWS

MATERIALS

The Standards also say that the new window should match the old in color, texture and, where possible, materials. Because “where possible” is open for interpretation, it is wise to consult with your local authorities (municipal staff or design review board) prior to making a decision or purchasing replacement windows. If they allow replacement of historic windows, they may require them to be replaced in kind (wood for wood, steel for steel). Or they may be more flexible, allowing modern materials that approximate the appearance of your original windows.

❖ Color

The color of paintable windows can change, so color selection at the time of purchase and installation is not as important. But most modern replacement windows are intended not to require paint, and as a result, their color is permanent. While most window sash are white or light/neutral colors, in several historic periods, window sash were more commonly dark. Before selecting a color, consult an architectural style guide or your local design guidelines to determine what color or colors might be appropriate for your windows.

❖ Texture

Historic wood windows were planed, sanded and painted to have a smooth finish. New replacement windows should also be smooth. This will aid in limiting dirt collecting on the surface, and best mimic the historic appearance. Avoid “rustic” rough textures or finishes on replacement windows.



Photo Credit: Jack Maquire

This new, custom-made wood replacement window is being made from a larger salvaged historic window. The old window was disassembled and new joints made to connect the rails and muntins, making a new window out of old-growth wood.

❖ Material

Replacement “in kind,” or of the same material is preferable. Whenever possible, the new window should be made of the same material as the historic window. Wood windows should be replaced with wood, steel with steel, and aluminum with aluminum. In some instances, however, this is not practical. For instance, aluminum is a good conductor, and as such, aluminum frame windows do not have good insulating values. In situations like this, alternatives may be considered. The following information may help your decision-making process:

Wood Windows

Wood windows are tried and true. Wood is thermally efficient and easy to work with. This means new custom windows in custom shapes and sizes can be made by skilled carpenters, or manufactured by larger window companies.

Old-growth lumber is higher in quality than most new wood, and is thus more durable and preferable for use in windows. Wood windows made prior to the 1940s or 1950s are likely to be made from old growth wood — a stable, dense wood that mills well, holds paint and stain well, is not as attractive to insects, and has natural rot resistance. This wood was most likely harvested locally, making it better suited for local climate conditions. Whenever possible, old-growth lumber should be used. Salvaging wood from other buildings is one possibility, as is researching current sources of quality lumber.

Maintenance is the biggest downside with wood windows because they require painting and sealing, typically every 7-15 years. Unlike other window types, wood windows are fairly easy to repair because individual parts can be replaced as needed. The life expectancy of new wood windows is 30 years or more — a lot more with proper care. Wood windows made from old-growth lumber have already proven they can last for 100 to 200 or more years!



SELECTING APPROPRIATE REPLACEMENT WINDOWS

Aluminum and Aluminum-Clad Windows

Aluminum is a highly versatile material for window construction, allowing for custom shapes. It is a very durable material that doesn't rot or rust when exposed to the elements. The biggest problem with aluminum windows is that they conduct heat and cold. This is not as pronounced for aluminum-clad wood windows due to the wood core. Aluminum-clad windows have the durability and versatility of aluminum, and are expected to last 15 to 20 years without maintenance.

Vinyl and Vinyl-Clad Windows

Vinyl windows are very popular because they are relatively inexpensive, are thermally efficient, and never need to be painted. Vinyl is not inherently strong, so to make relatively durable windows, profiles tend to be bulky. This can result in a loss of daylight opening, which changes the proportions of the building elevation. Vinyl-clad wood windows have thinner profiles than vinyl windows. Vinyl is not readily paintable, so its color is permanent.

One downside to vinyl is that it expands and contracts more than other materials, which makes vinyl windows more prone to failure than other types of windows — especially in high-heat situations. Several sources say that vinyl windows are expected to last 20 to 40 years, although most warranties are for between 15 and 25 years, with conditions. Vinyl windows installed in an area exposed to the bright sun or high temperatures will not last as long. Vinyl windows in places with moist air and limited sunlight are subject to water damage and harmful microorganisms.



This aluminum-clad replacement window is well-suited to this historic building.

Fiberglass replacement windows were installed in this building because of their narrow profile and ability to match the 4/4 pane configuration.



Fiberglass Windows

Fiberglass is strong, so fiberglass windows typically have thinner profiles than vinyl windows. Some sources say they are more durable than vinyl, but others indicate that when exposed to the sun, fiberglass windows become brittle and are prone to breakage.

Regardless of material, if the other window characteristics (size, shape and configuration) are not matched, the window will not be appropriate.

Common Problems with Replacement Windows:

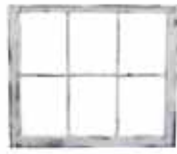
- Fogginess, condensation or haziness between panes of glass resulting from a broken seal.
- Lack of function because of warping (often the result of expansion and contraction in the sun), broken hardware or rot.
- Rot occurring behind cladding, leading to sash failure.

The Problem with Cladding:

Because of the way they are constructed, replacement windows are prone to failure. Clad windows — typically made of wood with an applied exterior surface of vinyl or aluminum — have lots of seams. If (when) those seams fail, water will get in behind the cladding and rot the wood. Clad wood windows use new wood, which will deteriorate behind the cladding. The deterioration will not be visible, and cannot be repaired. The appearance of clad windows remains good on the surface for quite some time because the cladding holds its shape. This gives the false appearance that they are performing better than painted wood windows but their lifespan is often actually shorter.



The hidden wood is rotting behind aluminum cladding.



THE IMPORTANCE OF PROPER INSTALLATION

Replacement windows come in a variety of designs, materials and qualities. Despite all of these variables, a window replacement project is only as good as its installer. No matter how high the quality of the window, if it is not installed with an air- and water-tight fit that allows for expansion and contraction, the window will not perform well, and may cause damage to your home. Always follow manufacturer's installation guidelines, and use trained professionals for window installation.

"When the window replacement goes bad, the hapless customer is often faced with a three-way finger pointing exercise where the window supplier, the window manufacturer and the window installer each blame one another for the bad window replacement. The customer spent good money for windows and got bulls#t instead."*

~Mark Meshulam, Chicago Window Expert

❖ Finding Quality Installers

The first place to inquire about quality installers is the manufacturer from whom you are purchasing the windows. Each manufacturer has detailed installation requirements and specifications for their products and may have recommendations of in-house installers, third-party installers, or installation certification programs.



The windows on this building are being replaced with windows of an inappropriate type, pane configuration and possibly material.

Reversibility

One of the Secretary of the Interior's Standards for Rehabilitation (#10) states that, "New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired." Generally speaking, that means that the project should be reversible.

There are two types of window replacements. 1) **An insert window**, which installs a new window in the existing window frame, and 2) a **full window replacement**, which removes the existing frame and installs an entirely new window unit. As interpreted by Preservation Pennsylvania, Standard #10 suggests that insert windows are preferred, because if at some time in the future, the building's owner decides to remove the replacement windows and reinstall historic windows, that would be possible with little impact on the building. The downside to insert windows is that they reduce the size of the daylight opening, which can alter the proportion of solid to void that characterize the building's elevations.

Based on the goals of your specific project, keep reversibility in mind, and consider what type of window replacement is more suited to your needs and the historic character of your home and neighborhood or district. If at all possible, preserve your historic windows on site for potential future reinstallation.



IF YOU ARE GOING TO REPLACE YOUR WINDOWS, DO IT FOR VALID REASONS.

Window Manufacturer Claim: Government Rebates
Because modern windows are energy efficient, the government will give you a rebate to help subsidize the cost of their purchase and installation.

In June 2016, Preservation Pennsylvania conducted an online search in an effort to identify government incentives for window replacement. We found several sources of information, all of which pointed us to specific programs available in certain places for limited times. Although our research wasn't exhaustive, we found two things available now in (parts of) Pennsylvania:

Adams Electric Cooperative offers low-interest loans of up to \$35,000 for homeowners payable with payments added to your residential electric bill. This can be used for caulking and weather stripping and/or for storm windows, among other activities. Replacing windows is not mentioned in the list of eligible activities. www.adamsec.coop/content/low-cost-loan-financing

In some parts of Pennsylvania (none of the zip codes tested), rebates are available in the form of a tax credit for the purchase of ENERGY STAR qualified windows. Homeowners may receive a tax credit equal to 10% of the product cost (not including installation), and that amount may not exceed \$200 for windows in years 2006-2016. This program expires December 31, 2016.

www.energystar.gov/products/building_products/residential_windows_doors_and_skylights/tax_credit



THE REAL MEANING of “MAINTENANCE FREE”

Like it or not, historic windows require maintenance. The good news is that older windows can be maintained and repaired. Traditional windows are made from individual parts, which are pieced together to make the window. Each piece of the window can be individually repaired or even replaced.

This provides an advantage over modern windows, which are manufactured as a unit and do not have individual components that can be repaired. When part of a modern window fails, whether a pane of glass is broken, the seal on the insulated glass fails and the window fogs, the caulk joints fail and water seeps in and rots the window, or the vinyl warps, the entire unit must be disposed of and replaced. Modern windows might not require maintenance, but they also cannot be repaired.

Many say, “They call them replacement windows for a reason. Because you’ll have to keep replacing them.” This may not be the image window manufacturers want you to have, but it’s true. Maintenance free equals disposable. You don’t have to maintain them, but they still wear out. And when they do, you can’t fix them. You have to throw them out and get new ones.



FINDING A QUALIFIED CONTRACTOR

A lot more people would maintain and restore their historic windows if it were easier for them to find contractors willing and qualified to do the work. Preservation Pennsylvania recognizes the need, and is working to develop better resources to help you. *Please contact us if you need assistance.*

Window Preservation Alliance • www.windowpreservationalliance.org/directory

The Window Preservation Alliance is a network of window restoration experts with a directory of qualified professionals that is searchable by zip code. Not many contractors in Pennsylvania are currently participating, but we expect that to change in the future.

RESOURCES

Appropriate Methods for Reducing Lead-Paint Hazards in Historic Housing
<https://www.nps.gov/tps/how-to-preserve/briefs/37-lead-paint-hazards.htm>

Community Preservation Coalition
www.communitypreservation.org/enews/windows.htm

Cost Helper Home and Garden
home.costhelper.com/window-replacement.html

The Efficient Windows Collaborative, Incentives and Rebates for Energy-Efficient Windows
<http://www.efficientwindows.org/UtilityIncentivesWindows.pdf>

ENERGY STAR Rebate Finder
<http://www.energystar.gov/rebate-finder>
https://www.energystar.gov/products/building_products/residential_windows_doors_and_skylights/tax_credit

Home Advisor
www.homeadvisor.com/cost/doors-and-windows/install-replace-storm-windows
www.homeadvisor.com/cost/doors-and-windows/repair-windows

How Long Do Vinyl Windows Last?
<http://www.newmanwindows.com/long-vinyl-windows-last/>

How To: Paint a Wood Window Sash
<http://thecraftsmanblog.com/how-to-paint-a-wood-window-sash/>

ImproveNet
<http://www.improvenet.com/r/costs-and-prices/storm-windows>

National Park Service, Preservation Brief 9: The Repair of Historic Wooden Windows
<https://www.nps.gov/tps/how-to-preserve/briefs/9-wooden-windows.htm>

National Park Service, The Secretary of the Interior’s Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings
<https://www.nps.gov/tps/standards/rehabilitation/guidelines/maintenance.htm>

National Trust For Historic Preservation, Window Resources
https://savingplaces.org/stories/preservation-tips-tools-retrofitting-historic-windows#.V3GOLaJ5_20

Repairing Old Wood Windows: Glazing and Painting
<http://www.hereandthere.org/oldhouse/windows-glazing-steps.html>

Replacement Windows: How Many Years Can They Last?
<http://www.improvementcenter.com/windows/replacement-windows-how-many-years-they-last.html>

Restoring a Historic Double-Hung Window Sash
<http://renovateqc.org/node/189>

Testing the Energy Performance of Wood Windows in Cold Climates (1996)
<https://www.ncptt.nps.gov/blog/testing-the-energy-performance-of-wood-windows-in-cold-climates-a-report-to-the-state-of-vermont-division-for-historic-preservation-agency-of-commerce-and-community-development-1996-08/>

U.S. Department of Energy
<http://energy.gov/savings>

Window Condensation: Causes and Remedies
<http://www.pgtindustries.com/about/window-condensation-causes-and-remedies>

Window Preservation Alliance
<http://www.windowpreservationalliance.org/directory>



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National Trust
Partners Network

SHARE THE KNOWLEDGE ABOUT OLD WINDOWS



As preservationists, we're also advocates for saving original windows. But it's tough to compete against the avalanche of ads and promotions that encourage homeowners to buy replacement windows and unknowingly embrace a repeating cycle of rip-out-and-replace and its negative consequences for architectural integrity and the environment. This guide was prepared as an informative resource for individuals and review boards on the importance of historic windows and issues related to their repair, retrofitting, and replacement. Studies show that historic windows can almost always meet the needs of today's property owners, often at less cost than replacement. **SHARE and SPREAD THE WORD!**



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