Window Replacement Symposium

Analysis of Breakout Group Responses

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TABLE OF CONTENTS

INTRODUCTION

The U. S. Centers for Disease Control and Prevention (CDC), the National Center for Environmental Health (NCEH), Division of Emergency and Environmental Health Services (DEEHS), Lead Poisoning Prevention Branch (LPPB), and the Department of Housing and Urban Development, Office of Healthy Homes and Lead Hazard Control hosted a one-day symposium on window replacement on November 7, 2003, in Atlanta, Georgia.

This meeting brought together health, housing, and energy professionals to examine the benefits of window replacement and offer possible strategies that could be used to expand its use. Many different ideas emerged from the meeting, both specific and general. This paper highlights and analyzes selected recommendations from the summary report.

Key Points:

Summary

- There is a need for additional research to understand differences in cost, energy efficiency and durability of different window replacement frames and other window replacement materials.

- Best practices for window installation need to be defined that consider energy efficiency, cost and health related issues.

- Decision guides for window replacement need to include the health considerations of lead hazard reduction, moisture and allergens.

- In some cases, repair of existing windows or replacement of parts of windows can be an effective way to increase energy efficiency and reduce waste generated from replacing large numbers of windows.

- Public subsidy may be needed to promote window replacement in homes, particularly in low-income communities or in communities where property values are not growing.

- When windows are replaced or repaired the whole house should be considered as a system to avoid creating new problems, such as inadequate ventilation and to address issues like historic preservation requirements early in the process.

- Additional research is needed to determine whether or not the cost and energy savings of using Polyvinyl Chloride (PVC) windows instead of wood or aluminum outweighs the environmental consequences.

- Including higher scoring opportunities in State LIHTC allocation plans for projects that include window replacement would motivate developers to replace windows when renovating affordable multifamily rental properties.

- Tax credits and incentives for window replacement at local and state levels would enhance the impact of the new tax credit for window replacement for homeowners included in the Energy Policy Act of 2005.

- Coordination among federal agencies and blending of funds used to remedy problems in the home could make these efforts more efficient and free funds to allow for window replacement.

- Programmatic agreements between the State Historic Preservation Office and agencies and non-profits can streamline the review process and target window replacement by specifying certain situations where replacing windows would be exempt from review.

- Window manufacturers, retailers and the insurance industry present potential avenues for the promotion of window replacement through the education of consumers about health and environmental gains and/or financial incentives.

BACKGROUND

Each year, over 16 million windows are replaced in the nation's housing. Although the predominant forces driving this effort are improved appearance and functionality, window replacement also has a large impact on energy conservation and health. These latter two benefits should be better recognized. Window replacement is known to yield substantial energy savings, improved protection of children from lead poisoning (form lead-contaminated dust and lead paint in old windows) and perhaps other diseases as well. Enabling the public to understand and value these hidden benefits will lead to more informed decisions about when and how to replace old windows. It can also enable public and private programs to leverage resources from disparate sources, such as housing rehabilitation and renovation, weatherization, home improvement financing, lead hazard control and public health programs. Window replacement appears to have large unrecognized potential to increase the public well being.

Decisions about if and how to expand the use of window replacement require an understanding of the advantages and disadvantages of the different replacement window products and the influences affecting this market. The following section addresses the essential research issues raised by the participants and includes general information about window products, installation and the window replacement market.

Material Options for Replacement Window Frames

The material that the window frame is constructed from is an important consideration when selecting a replacement window. Symposium participants felt that additional research needed to be done to understand the differences in cost, energy efficiency, and durability of the different window products. Further investigations into the performance of different brands could provide more detail, but the general characteristics of the different products are described below.

Manufacturers currently offer a number of options, including: vinyl (PVC), aluminum, wood, wood with plastic claddings, PVC-Wood composite, fiberglass.

Vinyl (PVC). Pure vinyl frames do not require maintenance and are the most popular type of replacement window. These windows are lower in cost than wood products and take a shorter time to manufacture special designs and sizes. Polyvinyl Chloride (PVC) is a commercial plastic used in a wide variety of construction materials. According to the Vinyl Institute, the lifetime of vinyl windows can be 20 to 30 years, although lower cost products may not have the same longevity.

Wood. Wood is a natural insulator that can be as energy efficient as vinyl windows, and is often a first choice in historic renovation projects to maintain the appearance of the home. Wood windows can last 20-50 years and older wood windows that are made from wood of slow-growth trees can last 100 years or more. However, wood windows only have a long lifecycle when they are properly maintained by periodic painting or staining. This additional upkeep adds to the long-term cost of the window. Because wood must be carefully harvested to keep from depleting the supply, wood windows are more costly than either vinyl or aluminum windows.

Aluminum. The once popular non-thermally broken aluminum and steel frames have been identified as conduits for indoor heat to the outdoors. Thermally broken alternatives using epoxy or vinyl to break up the aluminum continuum are still on the market, but are more prone to condensation than PVC windows and are generally not as energy efficient. Aluminum is estimated to have a life span of 10-20 years.

Fiberglass. Improved fiberglass window products have come back into the industry and are becoming increasingly popular. These windows are nearly maintenance free, durable, and are less likely to expand and contract with temperature than aluminum or vinyl. Because the current fiberglass products are relatively new to the market, estimates of durability are still being evaluated.

Other Options for Window Frame Material. Other products are also on the market that use improved materials or combine the benefits of wood, vinyl, and PVC. Because wood is a natural insulator, but is maintenance-intensive, manufacturers offer products where the wood is coated with vinyl cladding to offset some of the upkeep requirements. Manufacturers also combine scrap PVC from other production lines with wood to form a composite. This material has the strength of wood, but is maintenance free like PVC.
Comparison of Costs for Different Types of Windows. The price of windows varies widely depending on size, style, and quality. Cost information from one vendor in late 2003 ranked prices for a 6x4 foot window as wood ($300), fiberglass ($250), vinyl ($225), and aluminum ($190). These costs do not factor in the differences in installation and maintenance expenses.[1]

Other Window Replacement Material Considerations

In addition to the choices that are available for window frame material, there are a variety of choices in the spacers, gas fill, and coatings that make up the glass assembly. Spacers are used to separate multiple panes of glass. Traditional metal spacers have been identified as a conduit of heat loss from inside the home to outside, so preferable spacer materials include dense foam plastic, vinyl, fiberglass and wood. Multiple-pane windows can be filled with various gases, typically argon and krypton, that insulate better than air. Coatings that are applied directly to the glass panes, or as a thin polyester film hung within the air pocket, increase energy savings by restricting energy from passing through

[1] www.healthybuilding.net/pvc/020404-PVC_economics_summary.html.

the glass. The exact low-e coating and the pane faces chosen for application depend on climate and window orientation.

Environmental and Health Concerns Associated with Window Material and Production

Vinyl (PVC). Symposium participants pointed out that the health impacts of building materials, particularly PVC windows, needed additional investigation. While PVC has come under scrutiny for its potential environmental and health impacts, none of the building materials used to manufacture replacement windows is significantly better than the others when the entire lifecycle of the product is considered. Concerns have been expressed about the health impacts of PVC throughout its lifecycle from manufacturing by-products, to leaching during consumer use, and by-products created by disposal. However, the makers of PVC products assert that the long lifecycle and affordability of PVC products outweigh any environmental costs.

Critics of PVC say that problems begin with the chlorine used to manufacture the PVC. Chlorine and its by-products cause, among other things, dioxins that are persistent in the environment, bioaccumulative in humans and other mammals and toxic.[2] Concern has also been expressed about the stabilizers used to reduce deterioration of the vinyl, such as lead and cadmium. The stabilizers have the potential to leach from the PVC because they are added to the PVC rather than chemically bonded to it. Phthalates, plasticizers that make PVC more pliable, have been linked to reduced fertility, miscarriage, birth defects, abnormal sperm counts, and testicular damage[3].

The Vinyl Institute and the American Chemistry Council dispute the harmful effects of phthalates and vinyl building materials. They cite studies that show that releases of phthalate esters to the environment are low because they have low volatilities and solubilities, and rapidly degrade under aerobic and anaerobic conditions. In addition, even though the phthalates are not covalently bound to the PVC, they are tightly bound in the vinyl by physical-chemical forces so that they do not easily leach out.

A final criticism of PVC is the amount of energy required, an estimated 47 billion kilowatt hours per year[4], to generate the chlorine used to create the annual world supply of PVC. The manufacturing of windows and siding in the United States and Canada

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[2] Thornton, Joe PhD. Environmental Impacts of Polyvinyl Chloride (PVC) Building Materials, A Briefing paper for the U.S. Green Building Council prepared under the direction of the Center for Maximum Potential Building Systems and the Healthy Building Network, available at http://www.usgbc.org/LEED/tsac/pvcvinyl.asp

[3] McGinn, Anne Platt. Why Poison Ourselves? A Precautionary Approach to Synthetic Chemicals Worldwatch Paper 153, Worldwatch Institute November 2000

[4] Thornton, Joe PhD. Environmental Impacts of Polyvinyl Chloride (PVC) Building Materials, A Briefing paper for the U.S. Green Building Council prepared under the direction of the Center for Maximum Potential Building Systems and the Healthy Building Network, available at http://www.usgbc.org/LEED/tsac/pvcvinyl.asp

accounts for about 5 percent of this production. Not only is the manufacturing of PVC energy intensive, but PVC is also difficult to dispose of because it is a compound material. Even though the manufacturing process for PVC is generally a closed-loop process where unused raw materials are recycled back into production, significantly reducing the amount of waste generated, the same is not true of recycling PVC at the end of its lifetime. Recycled PVC is usually downgraded, and must be used for products with low performance standards such as railroad ties and highway sound barriers. In the U.S., only about 0.1 percent of post-consumer PVC is now recycled.[5]

Wood. The process of making windows from wood requires less energy and produces fewer pollutants than other materials, but the environmental impacts of wood windows are still a consideration because wood takes time to replace, even if it is a renewable resource.

In addition to concerns about the loss of forests for window production, wood windows require preservatives to prevent them from deteriorating. Paints, stains and other preservatives must be regularly applied as part of a proper maintenance program. Although the preservatives are made from a range of chemicals, the use of products with higher levels of volatile organic compounds (VOCs) can adversely affect air quality.

Aluminum. The production of these alternative window materials is also energy intensive. The aluminum manufacturing industry uses large amounts of electricity each year to produce aluminum. The Department of Energy, Energy Information Administration reports: "According to the most recent Manufacturing Energy Consumption Survey (MECS), the U.S. aluminum industry consumed about 727 trillion Btu of energy in 1994 (including electricity losses). This amount represents slightly less than 1% of domestic energy use and 2-3% of all U.S. manufacturing energy use."[6] Aluminum production for the construction industry represents about 13% of the total aluminum production. Much of the electricity used is generated by coal and contributes to harmful air pollution. In addition, aluminum windows are more prone to condensation than PVC windows and are generally not as energy efficient.

Window Installation

Proper installation is key to obtain the energy and health benefits of window replacement. Most manufacturers and retailers, including Pella, Anderson, Home Depot, and Lowes offer installation services.

Certification Programs. Several different certification programs exist for window installers. The Association of Window and Door Installers (AWDI) certification requires a test and/or field inspection following the submission of an application that includes experience and references. Membership must be renewed annually.

[5] McGinn, Anne Platt. Why Poison Ourselves? A Precautionary Approach to Synthetic Chemicals Worldwatch Paper 153, Worldwatch Institute November 2000.
[6] http://www.eia.doe.gov/emeu/mecs/iab/aluminum/page2.html

Building Performance Institute, Inc. provides a certification for qualified contractors that use a "whole house" approach. The U.S. Environmental Protection Agency's Home Performance with ENERGY STAR program uses BPI contractor accreditation as one of the qualifying credentials for contractor participation.

In addition, some states have adopted BPI certification as a means of ensuring a consistent skill base for technicians delivering low-income Weatherization Assistance Program services funded by the U.S. Department of Energy (DOE).

Best Practices. Symposium participants expressed a need to define best practices for window replacement. Several sources exist that give guidance on window installation, but further research is needed to determine the methods that best consider energy efficiency, cost, and health related issues such as lead-hazards, mold and allergens.

The New England Asthma Regional Council's Healthy Homes Building Guide provides guidance on replacing windows. It recommends installation of pan flashings on all windows and exterior doors. Window pan flashings should be applied over building paper at sill and corner patches because flashing helps direct water away from wall cavities and to the drainage plane. The complete Building Guide is available at http://www.asthmaregionalcouncil.org/

The American Society of Testing and Materials (ASTM) set ASTM E2112-01 Standard Practice for Installation of Exterior Windows, Doors and Skylights covers new and existing construction and is available in full at the ASTM web site www.astm.org.

The DOE Lead-Safe Weatherization training course also provides guidance on lead-safe window replacement (see www.pct.edu/wtc/news.htm)

Window Replacement Market

Symposium participants expressed interest in the window replacement market, including the size of the market and the forces that drive window replacements.

Market size. According to data from the American Architectural Manufacturers Association (AAMA) and the Window and Door Manufacturers Association (WDMA), 61 million windows were sold in 2001. Of these, 29% were used in remodeling and 26% were used for replacement.[7] In 1998, twenty-four million window units were sold for remodeling and replacement. Forty-six percent of these were vinyl, 36% were wood or wood clad, 15% were aluminum, and 2% were made of other materials.[8] Remodeling involves making a transformation in a space, for example, adding or expanding a room. The term replacement is used when the space retains the original state but old windows are removed and new put in their place. This paper focuses primarily on replacement.

[7] Walker, R, "Window and Door Channel Distribution Study Traces Big Box Success" American Architectural Manufacturers Association., November 2003 www.aamanet.org/pdf_files/Industry_Watch/2003-Nov_issue.pdf

[8] www.acadiawindows.com/window.htm

Based on the 1993 Residential Energy Consumption Survey, approximately 53 million pre-1980 homes had single-pane glass on most windows and no double-pane replacement windows. Assuming an average of 12 windows per dwelling, over 600 million windows in 1993 could have improved their energy efficiency through replacement windows. Even if most windows sold for remodeling or replacement in the past ten years were used on these older windows, a significant portion of this older window stock remains today.

Factors Influencing the Window Replacement Market. A variety of motivations push homeowners, property owners, and government programs to replace windows. The influence of improved energy efficiency, comfort, and appearance is illustrated by the use of these benefits in manufacturer and retailer marketing and advertising. An article by the Oregon Remodelers Association states that "while there are many reasons homeowners consider replacing their windows, in most cases decisions hinge on energy efficiency and appearance."[9] Condensation has been added to the list of potential benefits, and the window replacement market has likely benefited from media reports about the health risks of mold in the home.

The benefit of lead-hazard reduction does not appear in manufacturer or retailer information about window replacement. However, lead hazard reduction programs and other programs that use federal dollars to rehabilitate housing are required to follow the HUD Lead Safe Housing Rule and expand the window replacement market. A report on the energy-efficient windows market in the Midwest notes that window replacement programs for lead abatement have expanded its window replacement market. Additionally, this report states that a recent ruling by the Wisconsin Supreme Court that holds apartment owners liable if their tenants are poisoned by lead is motivating landlords to replace an estimated eight million dollars in windows annually. [10]

Symposium participants thought a decision guide that considered climate and the market would help property owners. Decision guides exist on both the Energy Star web site created by the Environmental Protection Agency (http://www.energystar.gov) and at the Efficient Windows web site sponsored by the Efficient Windows Collaborative run by the Alliance to Save Energy (www.efficientwindows.org). However, these guides focus on the energy saving aspect of window replacement and do not address the health considerations of lead-hazard reduction, moisture, and allergens.

Current Knowledge of the Benefits of Window Replacement

Research and evaluation studies conducted over the past several decades offer evidence of the benefits of window replacement, including financial gains for the property owner

[9] Wilson, K and Windows, M. "Replacement Windows—What Every Consumer Should Know." Oregon Remodelers Association/NARI. 2002.
[10] DePaola, R, Mapp, J, Meunier M. "Market Transformation of Energy Efficient Windows in the Midwest" Wisconsin Department of Administration.

through energy savings, increases in property values, and improved health from lead-hazard reduction and improved outdoor air quality.

Energy Savings

Energy savings from reduced heating and cooling needs are a well-recognized benefit of window replacement. The federal government's ENERGY STAR website states that "if all residential windows in the United States were replaced with ENERGY STAR qualifying models, the nation would save $134 billion in energy costs over the next 15 years." [11]

The amount of energy saved is determined by a number of factors, including climate and the type of windows that are being replaced. The Efficient Windows Collaborative estimates that energy savings in a heating dominated climate like Boston could range from 27% to 38% in the same 2000 sq ft house. A 27% savings is approximated if single clear aluminum frame windows are replaced with double clear wood/vinyl frame windows. When single clear aluminum frames are replaced with triple clear mod-solar-gain low-E insulated frames, the savings is estimated at 38%.[12]

Energy Savings and Outdoor Air Quality

Outdoor air quality improves when homes become more energy efficient because local power plants emit less sulfur dioxide (SO_2) and nitrogen oxides (NOx). SO_2 and NOx contribute to the formation of ground-level ozone and particle pollution. Particle pollution, also called particulate matter, is the presence of microscopic particles in the air that can get deep into the lungs and pose serious health problems, particularly for people with heart or lung disease (including asthma). Ground-level ozone irritates the respiratory system, aggravating asthma and reduced lung capacity problems and increasing the chances of respiratory illnesses like pneumonia and bronchitis.

Lead Paint Hazard Reduction

Studies have shown that replacing windows can be an effective way to reduce lead-paint hazards. An analysis of data from the Evaluation of the HUD Lead Hazard Control Grant Program found that window treatments significantly influenced dust lead loadings on bare floors, windowsills and window troughs.

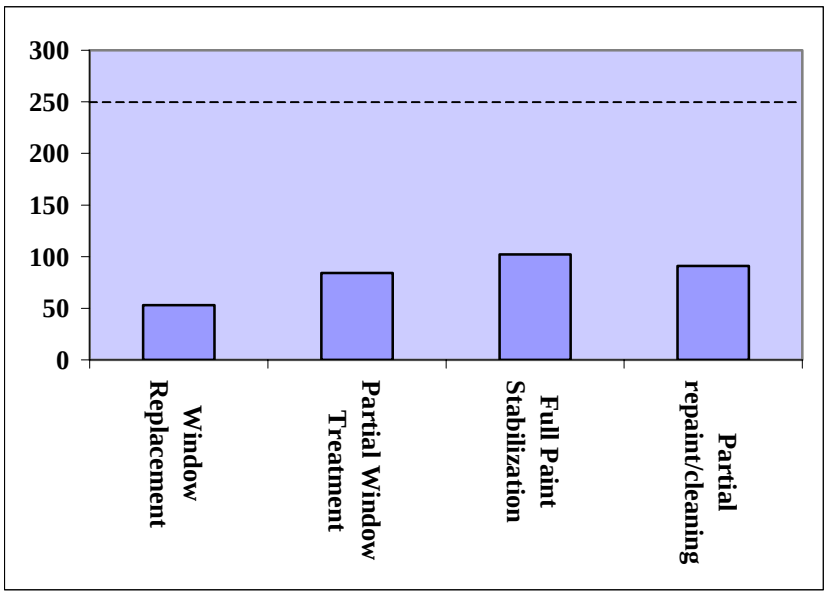
At one year post-intervention, window sill and window trough dust lead loadings in rooms with window replacement were significantly lower than those in rooms treated with all other treatments. Other treatments included installation of jamb liners, painting, and cleaning. Window replacement performed better at clearance; rooms treated with window replacement had the lowest final clearance window sill dust lead loadings (15

[11] www.energystar.gov
[12] www.efficientwindows.org/energycosts.cfm

ug/ft^2) and the largest percentage declines from pre-intervention (94%) compared to rooms with other window treatments. (Fig. 1) The rooms with window replacement also had the smallest increase in dust lead loadings after clearance (27 ug/ft^2).[13]

Rooms treated with window replacement also had lower bare floor dust lead loadings than rooms that received no window treatments. However, because grantees tended to treat many components in a room when window replacement was conducted, attributing lower floor dust lead loadings only to the window replacement needs to be done with caution.[14]

Figure 1. Geometric Mean Window Sill Dust Lead Loadings (µg/ft^2) 1 Year Post Intervention Compared with Current Clearance Standard for Window Sills (250 µg/ft^2)



An additional benefit of replacing windows is the health cost savings from the removal of lead based paint. ICF Consulting's Economic Analysis of the Federal Lead-Safe Housing Rule found that the monetized health benefits of the lead hazard reduction with window replacement exceeds $20,800 per unit in pre-1960 homes with children under age six. [15] A study published in the June 2002 issue of *Environmental Health Perspectives* found that the 15.1 µg/dl decline in mean blood lead levels in 1 to 5 year old children from 1976

[13] National Center for Healthy Housing. "National Evaluation of the HUD Lead Hazard Control Grant Program, Final Report" 2004.
[14] ibid
[15] ICF Consulting. "Economic Analysis of the Final Rule on Lead-Based Paint: Requirements for Notification, Evaluation and Reduction of Lead-Based Paint Hazards in Federally Owned Residential Property and Housing Receiving Federal Assistance" prepared for the HUD Office of Lead Hazard Control September 7, 1999

to 1999 represented a 2.2-4.7 point increase in IQ and an estimated economic benefit for each year's cohort of $110 billion to $319 billion in lifetime earnings[16].

Increased Property Values

A 1998 ICF Consulting study found that energy efficiency increases home market value by about $20 for every $1 reduction in annual fuel bills.[17] A second ICF study compared this finding with the collective judgment of real estate agents participating in a *Remodeling Magazine* (RM) "Cost vs. Value" survey, and concluded that the cost of window replacement can be fully recovered by the market value of energy efficient windows. A 1995 RM survey estimated the cost of replacing 10 windows at $5,500, which would reduce annual energy bills by about $240, resulting in a market value gain of about $5,800 and offsetting the $5,500 upgrade cost. [18] The current trend of increasing energy prices and lower mortgage interest rates add to the financial benefit, although the increase in home value is limited by the upgrade cost.

Repair Options To Total Window Replacement

A commonly cited disadvantage to retaining rather than replacing windows is the potential for energy loss. A recent study, however, demonstrated that window rehabilitation can result in high levels of energy performance. The study performed over 150 in-place and several laboratory air leakage rate tests of pre- and post-rehabilitation historic wood windows. Treatments included a wide variety of improvement strategies including retaining original sash, replacement window inserts, replacement sash with vinyl jamb liners, and whole window replacements. Most treatments resulted in similar post-treatment energy use. The report recommends that preservationists not base decisions about window upgrades primarily on energy concerns. The choices for treatment are not only "retain or retire", but also a continuum of possibilities that includes retaining and repairing, modifying or replacing specific parts of the window, and complete window replacement. Once a rehabilitation strategy is chosen the energy performance of that strategy should be maximized.[19]

Several options exist to make existing windows more energy efficient without replacing them with new windows. There are two key components of upgrading existing windows

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[16] Grosse, Scott D. et al. Economic Gains Resulting from the Reduction in Children's Exposure to Lead in the United States *Environmental Health Perspectives* volume 110 number 6 June 2002

[17] Nevin, R, Watson,G. "Evidence of Rational Market Valuations for Home Energy Efficiency." The Appraisal Journal., October 1998, p401-409.

[18] Nevin, R, Bender, C, Gazan, H. "More Evidence of Rational Market Values for Home Energy Efficiency." The Appraisal Journal, October 1999, p 454-460.

[19] Shapiro, AM and James, B. "Retain or Retire? A Field Study of the Energy Impacts of Window Rehab Choices." Window Rehabilitation Guide for Historic Buildings. Vermont Energy Investment Corporation, the University of Vermont's Departmen to Civil and Environmental Engineering, and the U.S. Army Cold Regions Research and Engineering Laboratory for the Vermont Division for Historic Preservation, Department, Department of Housing and Community Affairs, Agency of Commerce and Community Development, State of Vermont. DATE?

to make them more efficient. The windows must be sealed so that they do not allow either cold air to leak in or warm air to leak out. This can be done by caulking, weather stripping or installing storm windows on either the interior or exterior of the home. The second component is the installation of low-e glass that reduces the amount of heat transferred through the glass. Home Energy magazine did a case study on a home in Wisconsin and explored several different options to upgrade the home's existing single pane windows including[20]:

Install interior storm sash with low-e glass
The interior storm windows work the best when the existing window still provides an effective weather barrier. They can reduce condensation on the window glass and minimize moisture migration from the house to cold window surfaces. The interior storms can often be upgraded to low-e glass for an additional $2/ft2. The one drawback to an interior storm is that it must be removed in the summer months if the window is used for ventilation.

Install exterior storm windows
The exterior storm windows can also be made from low-e glass, which significantly improves the energy efficiency above and beyond cost savings from simply having a better-insulated window. In addition, exterior storms come as triple-track storm windows that allow ventilation in the summer without removal of the window. In an example provided by Home Energy magazine, adding low-e storms to single pane windows could reduce one home's heating bills by up to $300 per year, if the prime sash was reasonably tight.

Install sash kit
A sash kit consisting of a new sash with low-e glass, jamb liners and hardware and can be installed by do-it-yourselfers. The kit offers low-e glass units readily available in standard and custom sizes. This is an option if the homeowner wants to keep the existing frame for appearance reasons. This option will work if the existing window frame is structurally sound with no wood deterioration and is relatively plumb so a new sash may be inserted.

Install replacement insert or pocket low-e windows within existing frame
This option is the closest to actually replacing the entire window. The sash is removed leaving only the window frame where the new low-e windows are installed.
Table 2 shows the energy costs with various window treatments in the home featured in the Home Energy Magazine article that was titled, "What should I do about my windows?" The full article is available at:
http://homeenergy.org/hewebsite/2002features/19-4/19-4_text.html.

[20]Mattinson, Bill. Et al. What should I do about my windows? Window repair decisions will be made easier with a little help from an advisory tool. Home Energy Magazine, 2002 http://homeenergy.org/hewebsite/2002features/19-4/19-4_text.html

Lead Based Paint Abatement with Window Repair

In addition to these techniques that are used to improve energy efficiency, the City of Milwaukee has used alternative to window replacement that abates the lead-based paint on windows. Milwaukee removes the sashes from the window, strips the paint from the sash and then reinstalls the sash with a jamb liner.

Table 2. Annual Window-Only Heating and Cooling Costs in Madison, Wisconsin

Case	Option (All have wood prime window)	Infiltration	Annual Cost	Description
1A	Single-pane	0.3 CFM	$356	Best-case, very tight-fitting, single-pane wood windows
1B	Single-pane	1.0 CFM	$389	Tight single-pane wood windows
1C	Single-pane	2.0 CFM	$437	Loose, leaky single-pane wood windows
2A	Single-pane +storm	0.3 CFM	$176	Tight single-pane wood windows with storm windows
2B	Single-pane +storm (existing DePaola)	1 CFM	$211	Loose fitting single-pane wood windows with storms
2C	Single-pane +storm	2 CFM	$257	Single-pane wood with storm—large air leaks
3A	Single-pane + low-e storm	0.3 CFM	$138	Existing single-pane + low-e storm; low air leakage
3B	Single-pane + low-e storm	1 CFM	$170	Add low-e storm, moderately tight
4A	Single-pane + interior storm	0.3 CFM	$180	Add interior DIY storm —very tight fitting
4B	Single-pane + interior storm	1 CFM	$214	Add interior storm—moderately tight
5A	Single-pane + exterior storm + interior storm	0.3 CFM	$104	Add both interior and exterior storm —low leakage
5B	Single-pane + exterior storm + interior storm	1 CFM	$135	Add interior + exterior storm —moderate air leaks
6	Single-pane + cellular shade	NA	NA	Not available—Results depend on whether blind is open or closed
7	Double-pane clear	0.3 CFM	$178	New double-pane wood or vinyl window
8A	Double-pane hard low-e	0.3 CFM	$137	New double-pane wood or vinyl with high solar gain low-e
8B	Double-pane low solar low-e	0.3 CFM	$137	New double-pane wood or vinyl with low solar gain low-e
9A	Double-pane, clear glass + exterior storm	0.3 CFM	$109	New Double-pane wood + exterior storm (tight)
9B	Double-pane, clear glass + exterior storm	1 CFM	$141	Existing Double-pane clear wood + exterior storm (moderate leak)
10	Double-pane low-e + exterior clear storm	0.3 CFM	$100	High solar low-e (Note: Double-pane clear window/low-e storm performance is similar.)

Note: This table accounts for heat loss and gain through windows only.

Is Increasing the Use of Window Replacement a Good Idea?

There are clear benefits to replacing old windows with newer energy-efficient windows, but each home and each rehabilitation effort comes with a different set of priorities and available resources. The immediate cost of replacing windows is often higher than an intermediate solution of repairing individual parts of the window either to increase energy efficiency or to protect against a lead hazard. When funds are limited, decisions have to be made about the trade-offs involved in choosing to rehabilitate one part of the home vs. another. In a home that is appreciating in value, a property owner can use a home equity line of credit or their personal wealth to finance the window replacement. However, in a low-income community where home values may be stagnant or declining and the property owners either don't have available cash or are unwilling to invest in a declining investment, window replacement is not an option without public subsidy. One example of this trade off is the typical weatherization activities recommended by the Department of Energy's weatherization energy audits. Windows replacement rarely shows up at the top of the list of recommended activities because the higher energy savings can be attained through a combination of lower cost efficiency measures rather than the high cost of replacing a few windows. However, these audits do not take into account the potential health benefits from the removal of a lead hazard and/or the reduction in the amount of moisture in the home.

If there were additional funding available for window replacement, it would be easier to justify the high cost of replacing windows. However, in certain homes, window replacement may still not be the most cost effective way to remove lead or make the house more energy efficient. Because funding is limited, the question must be raised whether public subsidies would be better spent on window replacement, window repair, or other possible solutions. Unfortunately many of the benefits such as improved outdoor air quality from a lessening of power plant emissions as homes are more energy efficient or reduced health care costs from better outdoor air quality are benefits to the public overall but generally not direct economic benefits to the homeowner. This makes it more difficult to encourage the homeowner to invest their available funds in new windows, and can justify the need for public subsidy. The characteristics of the home and the needs of the homeowner in each unit must be considered on an individual basis so that the best possible solution for that home is found, whether it is window replacement or not.

Whether windows are replaced or repaired to make them more energy efficient, property owners should ensure that any changes made do not create an indoor air hazard. When a change is made to the building envelope, the whole house should be considered as a system rather than piece by piece. For example, studies have shown that reducing ventilation in a home by replacing leaky windows can result in poor indoor air quality.[21,22] Concerns also include problems with increased mold and allergens caused by

[16] Engvall K, Norrby C, Norback D. "Ocular, nasal, dermal and respiratory symptoms in relation to heating, ventilation, energy conservation, and reconstruction of older multi-family houses." Indoor Air. 2003 Sept; 13(3): 206-11.

less than adequate ventilation. These problems can be avoided by using a comprehensive whole-house system to analyze the ventilation and the impact of any changes. Programs such as the Environmental Protection Agency's Energy Star Home Sealing Requirements and the Department of Energy's Weatherization Assistance Program are skilled in these types of diagnostics. An additional benefit to completing whole house diagnostics before making any changes to the house is that it enables all parties to review the plan for the house and take care of any potential problems such as meeting historic preservation requirements before work begins.

A main concern about increasing windows replacement voiced by symposium participants was the question of whether or not PVC is harmful to the environment. The PVC manufacturers state that PVC's durability and long lifespan are enough to balance the environmental costs of emissions from manufacturing. Groups such as the Vinyl Institute and the American Chemistry Council cite research that any off-gassing from vinyl used in homes generates such small amounts of by-products that human health is not affected. This assertion is directly countered by research presented to the U.S. Green Building Council as they investigate whether PVC should be certified as a "green" product. The research shows direct health effects on workers in PVC factories, people living near PVC factories, and people exposed to PVC in their homes, especially children. One important factor specific to windows replacement is whether or not the cost and energy savings that can result from using PVC windows instead of wood or aluminum windows outweighs the environmental consequences. Additional research on this subject is needed.

The final concern with a windows replacement program is the amount of waste generated from replacing large numbers of windows. As demonstrated by the research from historic preservation in Vermont, referenced later in this document, it may be possible to achieve the same level of energy efficiency by repairing a window rather than replacing it. Depending on the condition of the paint on the window, it may make more sense to perform interim controls for lead hazards rather than changing out the entire window, but this must be determined on a case-by-case basis. These concerns confirm that each house and each window must be considered before it is replaced to find the best possible energy efficiency and lead hazard reduction strategy.

[22] Hirsch T, et. al., "House-dust-mite allergen concentrations (Der f 1) and mold spores in apartment bedrooms before and after installation of insulated windows and central heating systems." Allergy. 2000 Jan: 55(1); 79-83

OPTIONS FOR EXPANDING THE USE OF WINDOW REPLACEMENT

A. Tax Incentives

A critical barrier to window replacement, in general, but especially in the world of affordable housing, is the limited amount of funds that are available for rehabilitation. Another obstacle is the lack of awareness about the range of benefits that can come from replacing windows, including environmental and health. The participants at the Window Replacement Symposium proposed tax credits as an incentive and financial resource for window replacement. Tax credits, in their various forms, also present an opportunity to expand awareness about the different benefits of window replacement.

Tax credits reduce, dollar for dollar, the actual amount of tax owed, as compared to tax deductions and exemptions that reduce the amount of income that is taxable. A variety of both state and federal tax credit programs are currently in place. For example, the Low Income Housing Tax Credit Program and Historical Tax Credits give financial incentives to developers. Other programs, such as state energy efficiency tax credits, provide incentives to residential homeowners and businesses. Additional information on these programs is provided below.

Existing Tax Credit Programs

Low Income Housing Tax Credits (LIHTC). The Low Income Housing Tax Credit Program was established by the Tax Reform Act of 1986 to provide a federal tax incentive for the construction or rehabilitation of rental housing units occupied by low-income households. State agencies, typically state housing finance agencies allocate LIHTCs. Each state is required to submit an updated allocation plan, on a yearly basis, that outlines the basis for their allocations. They are given the flexibility to assess needs, identify preferences, and establish policies for the allocation of the tax credit resources.

Two methods are typically used by the states—preferences and set-asides. Set-asides are funds that are set aside every year from the state's allocation pool for specific types of projects. The federal government requires states to set aside 10 percent of their total allocation for projects sponsored by non-profit organizations. Many states specify additional set-asides that fit with their housing priorities.[23]

Preferences are housing priorities that are used to award extra points to projects with desired characteristics. Applications are ranked using a point system that gives the highest rating to projects that best match the specifications of the allocation plan. Multifamily construction or rehabilitation projects that most closely follow the allocation

[23] The Urban Institute, Metropolitan Housing and Communities Policy Center. "Analysis of State Qualified Allocation Plans for the Low-Income Housing Tax Credit Program", May 2002.

plan are awarded the tax credits. Construction and rehabilitation costs determine the size of the tax credit.

The application process for LIHTC's is very competitive, and developers work to fit the specifications of a state's allocation plan to their development plan. LIHTC state allocation plans push developers to construct projects that meet the specific state objectives. For example, additional allocation points are often awarded when developers are building or rehabbing in certain geographical areas of the state.

Building characteristics have been included in the allocation preferences of several states. Some states specify the criteria on unit size and others on the number of units. For example, the 2004 Maryland LIHTC State Allocation Plan includes 7 points for projects when "material selections are of better quality and designed for durability and long term performance with reduced maintenance" Seven points are also given when "design features provide comfort and energy efficiency over the extended period of the project life."[24] Developers applying for LIHTCs would be motivated to replace windows in their rehabilitation projects if states altered their allocation plans to award more points to projects that included window replacement. This change would require that discussions take place at the state level. It might be possible to initiate a change in the tax credit allocation process at the federal level, but usually each state mandates its own allocation requirements. Some requirements are federally mandated, but these are more general requirements, such as income restrictions and credit compliance periods.

Modifications to the tax credit incentives that promote window replacement would benefit low and moderate-income households. However, these changes could be far-reaching and impact a significant number of units considering that tax credit production averaged approximately 1300 projects and 88,000 units annually between 1995 and 2000. Although two-thirds of these projects were new construction, this still leaves a sizeable number of rehabilitated units.[25]

Rehabilitation of affordable housing is expected to expand as affordable housing developments built or rehabilitated in the 1970's expire. When these developments expire, either because of Section 8 contract expiration or LIHTC restriction expiration, the owners can consider converting the properties to market rate housing. Affordable housing preservation efforts work to restructure the loans to preserve and extend the affordability of these properties. Properties undergoing this process usually change ownership and need to be rehabilitated.

There are potential pitfalls to this approach that need to be addressed to avoid pushing developers toward window replacement when it is not appropriate. Many larger multifamily properties were built in the 1960's, and probably do not contain significant amounts of lead paint. However, the increase in energy efficiency and other benefits may

[24] Maryland Department of Housing and Community Development. "Multifamily Rental Financing Program Guide" January 2, 2004.
[25] Abt Associates, Inc. "Updating the LIHTC Database: Projects Placed in Service through 2000" prepared for U.S. Department of Housing and Urban Development, December 2002.

still make window replacement worthwhile. Properties built before 1960, more likely to have lead paint on their windows, may already have had windows replaced. Changes in allocation plans need to be carefully drafted to target properties by age and acknowledge that the age of the building may not reflect the age of the windows.

Historical Preservation Tax Credits. The Federal Historic Preservation Tax Incentives Program fosters private sector rehabilitation of historic buildings and promotes economic revitalization. These tax credits are available for buildings that are National Historic Landmarks, that are listed in the National Register, and that contribute to the National Register Historic Districts and to certain local historic districts. To qualify for the program properties must be income producing and must be rehabilitated according to standards set by the Secretary of the Interior.

Although Historic Tax Credits provide resources for rehabilitating old buildings for rental properties, they also present a potential barrier for window replacement, since deteriorated historic features usually need to be repaired rather than replaced when possible.

Lead paint hazards do need to be addressed in these rehabilitation projects, whether windows are repaired or replaced. Projects receiving Federal Historic Tax Credits must meet the requirements of the HUD Lead Safe Housing Rule. This regulation includes an exemption that allows for use of interim controls for lead hazards instead of abatement methods, if requested by the State Historic Preservation Office, but ongoing lead-based paint maintenance and reevaluation need to be conducted.[26]

Energy Efficient Tax Credits. Energy Efficient Tax Credits provide tax relief to home and business owners that make energy efficient changes to their properties. These tax incentives can bring the cost of energy efficient products into line with standard models, eliminating the barrier of higher cost for energy efficient technology. The availability of tax credits also increases awareness of new products, moving manufacturers and retailers to more actively market the products.

The Federal Energy Policy Act of 2005 was signed into law in August of 2005. Two major energy efficiency provisions of the bill are; manufacturer and consumer tax incentives for advanced energy saving efficiency technologies and practices, and minimum energy efficiency standards on 16 products. Minimum energy efficiency standards were not set for any window products.[27]. Replacement windows are included as an eligible improvement for homeowners with the incentive amount set at 10 percent of cost up to $200. The maximum credit for all improvements combined, however, cannot

[26] HUD Lead Safe Housing Rule, 24 CFR 35, subparts B through R, reflecting changes made by the technical amendment issued June 21, 2004 (69 Federal Register 34262-34276).

[27] Nadel, S. "The Federal Energy Policy Act of 2005 and its Implications for Energy Efficiency Program Efforts." Report Number E053, American Council for an Energy-Efficient Economy, Washington, DC. September 2005.

exceed $500 during the two-year period of the tax credit, January 1, 2006 through December 31, 2007.[28]

Some states have moved forward on their own, implementing residential energy efficient tax programs that give credit on state income taxes for making a home more energy efficient. Arizona's energy efficient home income tax credit allows homeowners an income tax deduction of 5% off purchase price if the residence is certified to be 50% more energy efficient than the 1995 model energy code (MEC) at closing. Hawaii offers an income tax credit for resident individual or corporate taxpayers for installation of renewable energy systems and heat pump water heaters. Idaho gives homeowners a deduction for the cost of insulation, storm doors, caulking, and weather-stripping. Maryland, Oregon and New York have green building programs that encourage resource efficiency in buildings, including energy efficiency.

The Oregon residential tax credit program operating since 1979 gives credit on Oregon State income taxes for making a home more energy efficient through appliances, heating and air conditioning systems, water heaters, and wind systems. However, energy efficient windows are not part of this program. The Energy Trust of Oregon currently offers incentives for energy efficient measure taken by homeowners and windows are included in its list of eligible measures. Results from the evaluation for this program provide some insight into the effectiveness of state energy efficient tax credits. In a survey of residential program participants, sixty-three percent of the respondents said that the Oregon tax credit influenced the appliance they purchased and 97% said they would use the program again. Eighty-five percent indicated that they received program information from the retailer, showing the importance of involving retailers in program outreach.[29]

A 2002 publication by the American Council for an Energy-Efficient Economy (ACEEE) lists ways to make tax incentives work effectively:

- The tax credit validates the technology or practice with the credibility of the state's endorsement.
- The actual incentive if it is the "right" size is a powerful motivator for purchasing decisions.
- Set thresholds for credits at a high performance level, but one that is available in the market. Too low a performance standard increases program cost without significantly changing the market.
- Allow enough money for effective marketing and program evaluation. Consider revenue loss caps.
- Provide a long enough duration for the program (probably 5-10 years) for credits to affect the market.

[28] "Federal Tax Credits for Residential Energy Efficiency". http://www.energystar.gov/index.cfm?c+products.pr_tax_credits

[29] Prindle, W., et. al., "Energy Efficiency's Next Generation: Innovation at State Level" American Council for an Energy-Efficient Economy, Report Number E031, November 2003.

- Allow choice among recipients of the credits. For example if credits can only be taken by building owners, they are essentially unavailable for government, religious, and educational buildings. Interest will be increased if contractors or others can take the credit as part of their job compensation.
- Complement other policy initiatives (federal, municipal, and public benefits).[30]

New Tax Credit Programs

A proposed new tax credit program could provide other ways to motivate developers to include window replacement.

Homeownership Tax Credit. The Homeownership Tax Credit Bill (H.R. 1549) was introduced in April 2005 in the House by Rep. Benjamin Cardin (D-MD) and Rep. Thomas Reynolds (R-TX) and in the Senate by Rick Santorum (R-PA) and John Kerry (D-MA). These bills are similar to legislation that was introduced in both the House and Senate in the last session. There is widespread support for this legislation in the Congress, from the President and within the affordable housing community, but the projected large tax revenue loss presents a challenge for the creation of this new tax credit program.

The homeownership tax credit is modeled after the LIHTC but would provide tax credits to developers constructing or rehabilitating housing for low and moderate-income families to purchase. This is in contrast to the LIHTC program that only includes rental properties. The credit would generate equity investment sufficient to cover the gap between the cost of development and the price at which the home can be sold to eligible buyers. Window replacement incentives could be included as part of the federal requirements or state allocation plans.

B. Blending Federal Funding

Affordable housing is not truly affordable if the utility bills for the home are so high that a tenant cannot afford to pay the rent and the utility bill. In addition, the blessing of having a home is tempered if the home has a lead-based paint hazard. At the local level, community organizations leverage various federal funding sources to remedy these problems. HUD funds are available for making the home safe and cleaning up lead hazards and DOE Weatherization Assistance Program (WAP) funds are available to make homes more energy efficient. Unfortunately, the ability of these programs to work together is limited by different income requirements and different end results required by the programs. For example, WAP does not replace windows often because they are usually not the most energy efficient measure for a given amount of funds to be spent in a unit. And HUD grants are encouraged to produce many units at lowest cost so may not choose more expensive energy efficient products. If the barriers that keep these programs

[30] American Council For an Energy-Efficient Economy. "Tax Credits for Energy Efficiency and Green Buildings: Opportunities for State Action", Report Number E021, March 2002.

from working together were removed or adapted to allow them to cooperate more easily, the skills and infrastructure necessary to administer a windows replacement program could be tapped within these programs.

Community action workers have expressed frustrations at the local level when they cannot fix all of the problems within a given housing unit either because of funding constraints or program made barriers. Allowing providers to combine funding from various programs to perform window replacement will add value to the existing stock of affordable housing by removing lead hazards and ensuring energy efficiency, as well as cutting the administrative costs generated by multiple programs visiting the same units. More collaboration could also increase the affordability of housing because of added energy efficiency and improved indoor air quality. There are several federally funded programs that could participate in a window replacement program as well as some private partners that have existing relationships with these federal programs. Background information on these sources is provided below.

Descriptions of Federal Programs

Each year, $8 billion in federal funding is provided to state and local governments for low-income housing rehabilitation and energy assistance, affordable housing construction, new homebuyer assistance, and economic development. Just over 25% of these federal funds are used for housing rehab assistance, but only 2% of these funds are used for window replacement. However, there is the potential to increase the rate of window replacement by blending funding from various federal housing programs at the local level. These federal sources include the Department of Housing and Urban Development's (HUD) Community Development Block Grant Program (CDBG) Home Investment Partnerships (HOME) Program, The Office of Healthy Homes and Lead Hazard Control (OHHLHC) and the HOPE IV program. Energy efficient mortgage (EEM) programs from Fannie Mae, and the Department of Energy's (DOE) Weatherization Assistance Program (WAP) are also potential funding sources.

Department of Housing and Urban Development. About 75% of federal assisted rehab funds (almost $2 billion per year) are disseminated through the HOME Investment Partnerships Program and Community Development Block Grant (CDBG) programs. In addition, the Office of Healthy Homes and Lead Hazard Control (OHHLHC) has funding for the removal of lead based paint hazards and for broader healthy homes initiatives. The HOPE VI program awards grants for rehabilitation, demolition and new construction, and other physical improvements as well as planning and technical assistance.

The Department of Energy (DOE)- Weatherization Assistance Program (WAP). The DOE WAP is charged with reducing the energy bills of low-income Americans. A priority is placed on providing assistance to families with children, the elderly, the disabled, high residential energy users, and households with a high energy burden. The average expenditure limit per house for program year 2003 was $2,600 and approximately 105,000 homes were weatherized.

Summary of Eligibility Requirements for Weatherization, HOME, and CDBG. Programs use different determinations of income requirements to determine eligibility of their grants (Table 3). However, a comparison of the program requirements performed by ICF consulting found that generally across the country the HUD standard of 60-80% of the Median Family Income (MFI) that is used to qualify for a grant matched closely with the 130% of the poverty level. Weatherization currently uses approximately 125% of the poverty level to determine eligibility for funding, making the program cut off fairly close.

Table 3: Summary of Eligibility Requirements for Weatherization, HOME, and CDBG

	Income Requirements	Type of Housing Unit	Owner Occupied	Other Requirements	Priorities	Meet Housing Quality Standards
Weatherization Assistance Program	At or below 125% of poverty threshold	All	Not required		A priority is placed on providing assistance to families with children, the elderly and the disabled. Also those that are high residential energy users and households with a high energy burden.	Not required
HOME Rehab funds	Low-income-annual income does not exceed 80% of the median family income for the area	Single-family owned fee simple, rented, condominium unit, cooperative unit, and manufactured homes including mobile units.	Property must be the principal residence of the income eligible homeowner	The value of the assisted property after rehab must not exceed 95% of the median purchase price for the area.		Unit must meet the PJ's written rehab standards and local, state and national Housing Quality Standards
CDBG	Either very low-income (50% of the median family income) or low-income (80% of the median family income).	All	Not required		1) No less than 70% of the benefits go to low/moderate income persons 2) The funding is used to prevent slums and blight 3) The funding goes to urgent needs	Not required

Utility Partners. Utilities often work with WAP grantees to increase energy efficiency for low-income households. This partnership enables the utility to contribute to the energy efficiency of low income families without taking on the overhead that is required to maintain the crews and equipment required to do Weatherization work. This benefits the utilities because they have fewer unpaid utility bills and efficient windows reduce their peak-load capacity.

Fannie Mae Energy Efficient Mortgages (EEMs). An EEM recognizes the value of energy efficiency improvements as part of the mortgage underwriting process and some EEMs are specifically designed to serve low-income homebuyers. For example, Fannie Mae's "My Community" EEM, available to borrowers below median area income, requires a minimum down payment of just $500, adds monthly energy savings to income for loan qualification purposes, and adjusts the value of the home to reflect the value of the energy efficiency measures (see Table 4 for example).

Table 4: Savings from an Energy Efficient Home Financed with an EEM

	Non Energy Efficient Home - Conventional 30 Yr Loan	**Energy Efficient Home - 30 Year Energy Efficient Mortgage**
Purchase Price	$200,000	$203,000
Borrower Contribution	$6,000	$6,090
Loan amount	$160,000	$162,400
Interest	5.85%	5.85%
Monthly Principal, Interest, Taxes and Insurance	$1,673	$1,698
Monthly Utility Bill (avg.)	$186	$93
Total Monthly Expenses	$1,859	$1,791
Monthly Savings		**$68**

Source: Fannie Mae (www.efanniemae.com/hcd/pdfs/EEMbrochure.pdf)
Note: Assumes qualifying annual income of $49,000 for conventional loan; $48,584 for energy efficient mortgage product.

Implementing Blended Programs

The window replacement program could be financed with a combination of funding from HUD programs such as the lead-hazard reduction program, CDBG, and HOME. In addition, the Weatherization Assistance Program has a skilled workforce that could implement windows replacement if it made the homes more energy efficient. For example, the program could blend CDBG and HOME rehab money to replace the windows, remove the lead-based paint and do clearance testing. It could use WAP funding to perform the duct sealing, add insulation and the diagnostics to ensure energy efficiency. An EEM could enable the homeowner to finance part of the cost of the

upgrade. The My Community EEM allows funding to come from any source, so utility funds could also be used if they were available.

The blending of programs would require cooperation and coordination at the federal, state and local levels. Federal program eligibility requirements need to be modified to allow the different sources of money to be used together. A State level window replacement program would provide a repository for these resources. The structure for administering the blended federal funds exists at the community level in the Community Action Programs (CAPs).

A network of over 1,100 CAPs serves 96 percent of the counties in the United States. Community Action originated with the enactment of the Economic Opportunity Act of 1964. The act established a federal Office of Economic Opportunity, formed state economic opportunity offices, and created these community-based organizations. The CAPs administer the Community Services Block Grant (CSBG) funded by HHS, programs such as Head Start, the DOE WAP and several HUD funded programs. The CAPs operate at the local level and have extensive experience with blending funds from various sources to match families' needs. The CAPs that carry out weatherization, about 900 of the 1,100, could administer a windows replacement program if additional funding was available specifically targeted to windows replacement. The CAPs that administer WAP funds are often highly technically trained and have existing crews with the necessary tools and skills to install new windows while performing other weatherization measures. The Rhode Island Weatherization program is currently conducting a demonstration project that includes window replacement.

As long as funding is available and the CAPs accept the new program, the information will be disseminated throughout the Weatherization network and the network of CAPs through the ongoing training and technical assistance that is an integral part of the CAP structure. This culture of ongoing training is one of the major strengths of both the Weatherization network and the network of CAPs.

C. Satisfactorily Resolving Historic Preservation Issues

Federal programs that work to rehabilitate single and multifamily homes offer potential avenues for expanding window replacement. However, these programs often rehabilitate older buildings, and historical preservation issues frequently come into play. Window replacement in historical buildings can be particularly challenging because they are often an important historical feature of a building. Wooden replacement windows for historical buildings are usually a custom order, which can take as long as two months for delivery. Vinyl windows are stock items that are less expensive and can be delivered in two to three weeks.

The Secretary of the Interior: Standards for Rehabilitation. The Secretary of the Interior: Standards for Rehabilitation are ten basic principles created to help preserve the distinctive character of a historic building and its site, while allowing for reasonable change to meet new needs. (Appendix B)

Rehabilitation projects must meet the following Standards, as interpreted by the National Park Service, to qualify as "certified rehabilitations" eligible for the 20% rehabilitation tax credit. The Section 106 review of federal undertakings also requires conformation to theses standards.

Section 106 of the National Historic Preservation Act. The National Historic Preservation Act of 1966 established a program for the preservation of historic properties in the United States. The Act directed the Secretary of the Interior to maintain a National Register of Historic Places, authorized the Secretary to approve state historic preservation programs, and directed federal agencies to take into account the effects of their activities and programs on historic properties. An Advisory Council on Historic Preservation was established to advise the President, Congress, and federal agencies on historic preservation issues. The Advisory Council has the authority to issue regulations instructing federal agencies on how to implement Section 106 of the Act.

Section 106 of the National Historic Preservation Act requires Federal agencies to consider how their work affects historic properties. The goal of the Section 106 process is to accommodate historic preservation concerns along with the needs of Federal activities. The Section 106 review process identifies historic properties that are involved in a federal undertaking, evaluates the effects of this activity and tries to find ways to avoid, minimize, or mitigate any adverse effects on historic properties.

The Section 106 review process can create bottlenecks for programs involved in rehabilitating buildings. These include weatherization, lead-paint hazard reduction, and affordable housing programs. Often historical preservations issues are identified at the end of the planning process when changes are difficult to implement. This can be especially problematic when windows are involved because of the potential for much greater costs and delays involved in producing custom wooden windows.

Historical Preservation in Vermont—Simplifying the Process.

Recognizing the challenges that federal programs faced when working with historical properties, the State of Vermont worked to streamline the Section 106 review process. Programmatic agreements with different agencies and non-profits designate historical preservation professionals within the program to act on behalf of the federal government. Historical preservation professionals work within the agencies that are administering the federal funds, and must meet qualifications of education, skill and experience. The State Historic Preservation Office holds trainings and consults with the professional on projects, as needed. These professionals are available as the project is being formulated, so that historical issues are identified and discussed at a very early point in the rehab process.

These streamlining programmatic agreements also include a list of items that are exempt from review because they have little potential to change the historical value of a property. An example would be plain baseboard trim that is deteriorated and needs to be replaced.

Streamlining the Section 106 review process benefits not only window replacement, but also the entire rehabilitation process. However, the list of exempt items within the programmatic agreements could more specifically target window replacement by emphasizing conditions where windows could be replaced without review. These programmatic agreements can also include guidelines for the conditions where vinyl or other less expensive options would be appropriate to use in place of wood windows.

D. Involving Window Manufacturers/Retailers in Consumer/Contractor Education

Increased energy efficiency, comfort, and ease of use are well-recognized benefits of window replacement. Manufacturers, retailers and consumers are less aware of the health and environmental gains from replacing windows. In particular, reduced exposure to lead paint hazards has not been used by retailers and manufacturers to promote window replacement. The window industry is made up of several large companies and many smaller manufacturers. Pella and Armstrong are the leaders in the industry. These companies market their products directly and through retail stores, lumberyards and dealers.

In previous inquiries with window manufacturers and retailers, NCHH found that they had some interest in disseminating lead-safe work practice information with their product information. However, since their reaction to this idea was not very enthusiastic, it would take a significant effort to move this concept into action. Mold and moisture issues were of little interest to manufacturers, since windows are not the only contributor to this problem. Without liability concerns about either lead or mold and moisture, there is not a strong incentive for these groups to devote resources to educational efforts.

E. Involving the Insurance Industry

Symposium participants suggested the insurance industry as another path for creating incentives for the use of window replacement. The wide range of the insurance sector means that programs have the potential to reach all income groups and can impact businesses as well as individuals.

Property and Homeowner Insurance. It has recently been proposed that lowering energy consumption, and therefore greenhouse gas emissions, is a promising strategy for the insurance industry because they have so much to lose from increasing natural disasters related to global climate change.[31] Additionally, several studies have documented the benefits of energy-efficient windows. First, energy efficient windows are less likely to shatter from differential expansion near the frames, reducing the chance that the flow of air through the broken window will spread the fire and toxic fumes. [32] Efficient multiple-

[31] Mills, E., 2003. The insurance and risk management industries: new players in the delivery of energy-efficient and renewable energy products and services. Energy Policy 31, pp 1257-1272

[32] Kluver, M., 1994. Observations from the Southern California Wildland Fires. Building Standards 12-17, January-February

pane windows or windows with retrofit films are also more resistant to breakage by thieves or windstorms. [33]

Some examples of insurance companies providing premium reductions if customers implement risk management programs do exist. The Hanover Insurance Company (c.1980, Worcester, MA) gave a 10% credit on homeowner property insurance premiums in six states to solar, underground, and energy-efficient homes, because the shorter running hours for the heating system reduced the fire hazard to the home.[34]

Insurance companies can promote certain activities through educational programs. The USAA Insurance Company published a consumer energy guide for energy conservation. It has an educational website with information for homeowners who are building or remodeling that includes a section on choosing the correct window for their home.

Life and Health Insurance. The health advantages of window replacement, such as lowered exposures to lead-paint hazards, would benefit the life and health insurance industry. Again, it is unlikely, even with documented evidence on the health benefits, that insurers would give premium reductions that were significant enough to encourage more window replacement. However, companies could promote window replacement through educational programs, since this would be a good marketing and public relations tool.

Medicaid may offer a route to help families living in low- income homes replace windows. Rhode Island currently has a federal waiver that allows Medicaid to pay for window replacement in homes of lead-poisoned children. This concept could be expanded into a preventative measure to include homes that contain lead-hazards but before a child has been poisoned.

Liability Insurance. Indoor air quality and mold-related problems have triggered some insurance companies to take proactive steps with liability insurance. These include assessment protocols to help building mangers reduce their potential liability and liability coverage that includes payment for the correction of problems.[35] Window replacement, as a mechanism to reduce liability concerns from environmental health related illnesses, could be incorporated into these types of liability assessment and reimbursement plans.

[33] Mills, E., Rosenfeld, A., 1994. Consumer non-energy benefits as a motivation for making energy-efficiency improvements. Proceedings of the 1994 ACEEE Summer Study on Energy Efficiency in Buildings, pp 4.201-4.213

[34] Gordes, J.N. 2000. The power to insure: reducing insurance claims with new electricity options. Greenfield, MA; Northeast Sustainable Energy Association.

[35] Mills, E., 2003. The insurance and risk management industries: new players in the delivery of energy-efficient and renewable energy products and services. Energy Policy 31, pp 1257-1272

CONCLUSION

Targeted window replacement offers a potential solution to remedy lead-based paint hazards within low-income housing while making that housing more energy efficient and therefore more affordable for the homeowner. The majority of the participants at the November 2003 Windows Symposium worked from the premise that window replacement is an activity that is worthy of governmental support and incentives. The participants discussed a number of options to expand window replacement use; this paper focused on the five that were most commonly mentioned: tax incentives, blending of Federal funds, satisfying historic preservation concerns, involving manufacturers/retailers in consumer/contractor education, and involving the insurance industry. This review found that there are barriers to implementation for each of the options that must be overcome, but almost all offered some potential for action.

For some of the participants, the question as to whether or not window replacement is the best use of limited funding and limited environmental resources was a concern. They believed that the same end results could be accomplished through several smaller and less costly measures rather than the replacement of the entire window. They also had deep concerns about the potential for health problems that may be caused by the materials used to make the windows or by the inappropriate installation the new windows. Instead of promoting a national campaign for new windows, they felt that the individual considerations of each home (including the historic nature of the building) must be taken into account when deciding the best course of action.

The challenge for Federal policy makers is to structure a program that offers the necessary incentives/subsidies to inspire action among those owners who could otherwise not afford to improve their health and energy status, but does not coerce property owners/communities that find window replacement a less optimal option. If a windows replacement initiative were developed, there appears to be a variety of sources for potential funding and people experienced with the topic to make the program successful.

APPENDIX A

DEFINITIONS OF WINDOW REPLACEMENT TERMS

Absorptance. The ratio of radiant energy absorbed to total incident radiant energy in a glazing system.

Argon. An inert, nontoxic gas used in insulating windows to reduce heat transfer.

Bottom rail. The bottom horizontal member of a window sash.

Btu (B.T.U.). An abbreviation for British Thermal Unit--the heat required to increase the temperature of one pound of water one degree Fahrenheit.

Check rail. The bottom horizontal member of the upper sash and the top horizontal member of the lower sash which meet at the middle of a double-hung window.

Condensation. The deposit of water vapor from the air on any cold surface whose temperature is below the dew point, such as a cold window glass or frame that is exposed to humid indoor air.

Double glazing. In general, two thicknesses of glass separated by an air space within an opening to improve insulation against heat transfer and/or sound transmission. In factory-made double glazing units, the air between the glass sheets is thoroughly dried and the space is sealed airtight, eliminating possible condensation and providing superior insulating properties.

Flashing. Sheet metal or other material applied to seal and protect the joints formed by different materials or surfaces.

Frame. The fixed frame of a window that holds the sash or casement as well as hardware.

Gas fill. A gas other than air, usually argon or krypton, placed between window or skylight glazing panes to reduce the U-factor by suppressing conduction and convection.

Heat gain. The transfer of heat from outside to inside by means of conduction, convection, and radiation through all surfaces of a house.

Heat loss. The transfer of heat from inside to outside by means of conduction, convection, and radiation through all surfaces of a house.

Infiltration. The movement of outdoor air into the interior of a building through cracks around windows and doors or in walls, roofs, and floors.

Insulating glass. Two or more pieces of glass spaced apart and hermetically sealed to form a single glazed unit with one or more air spaces in between. Also called double glazing.

Jamb. A vertical member at the side of a window frame, or the horizontal member at the top of the window frame, as in head jamb.

Low-emittance (low-E) coating. Microscopically thin, virtually invisible, metal or metallic oxide layers deposited on a window or skylight glazing surface primarily to reduce the U-factor by suppressing radiative heat flow. A typical type of low-E coating is transparent to the solar spectrum (visible light and short-wave infrared radiation) and reflective of long-wave infrared radiation.

Mullion. A major structural vertical or horizontal member between window units or sliding glass doors.

Muntin. A secondary framing member (horizontal, vertical, or diagonal) to hold the windowpanes in the sash. This term is often confused with mullion.

Pane. One of the compartments of a door or window consisting of a single sheet of glass in a frame; also, a sheet of glass.

Polyvinylchloride (PVC). An extruded or molded plastic material used for window framing and as a thermal barrier for aluminum windows.

R-value. A measure of the resistance of a glazing material or fenestration assembly to heat flow. It is the inverse of the U-factor (R = 1/U) and is expressed in units of hr-sq ft-°F/Btu. A high-R-value window has a greater resistance to heat flow and a higher insulating value than one with a low R-value.

Sash. The portion of a window that includes the glass and the framing sections directly attached to the glass, not to be confused with the complete frame into which the sash sections are fitted.

Sill. The lowest horizontal member in a door, window, or sash frame.

Single glazing. Single thickness of glass in a window or door.

Thermal break. An element of low conductance placed between elements of higher conductance to reduce the flow of heat. Often used in aluminum windows.

Triple glazing. Three panes of glass or plastic with two air spaces between.

U-factor (U-value). A measure of the rate of non-solar heat loss or gain through a material or assembly. It is expressed in units of Btu/hr-sq ft-°F (W/sq m-°C). Values are normally given for NFRC/ASHRAE winter conditions of 0° F (18° C) outdoor temperature, 70° F (21° C) indoor temperature, 15 mph wind, and no solar load. The U-factor may be expressed for the glass alone or the entire window, which includes the effect of the frame and the spacer materials. The lower the U-factor, the greater a window's resistance to heat flow and the better its insulating value.

Vinyl-clad window. A window with exterior wood parts covered with extruded vinyl.

Weather stripping. A strip of resilient material for covering the joint between the window sash and frame in order to reduce air leaks and prevent water from entering the structure.

APPENDIX B

THE SECRETARY OF THE INTERIOR STANDARDS FOR REHABILITATION

1. A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.
2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.
3. Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.
4. Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.
5. Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a historic property shall be preserved.
6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.
7. Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.
8. Significant archeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.
9. New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.
10. 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.