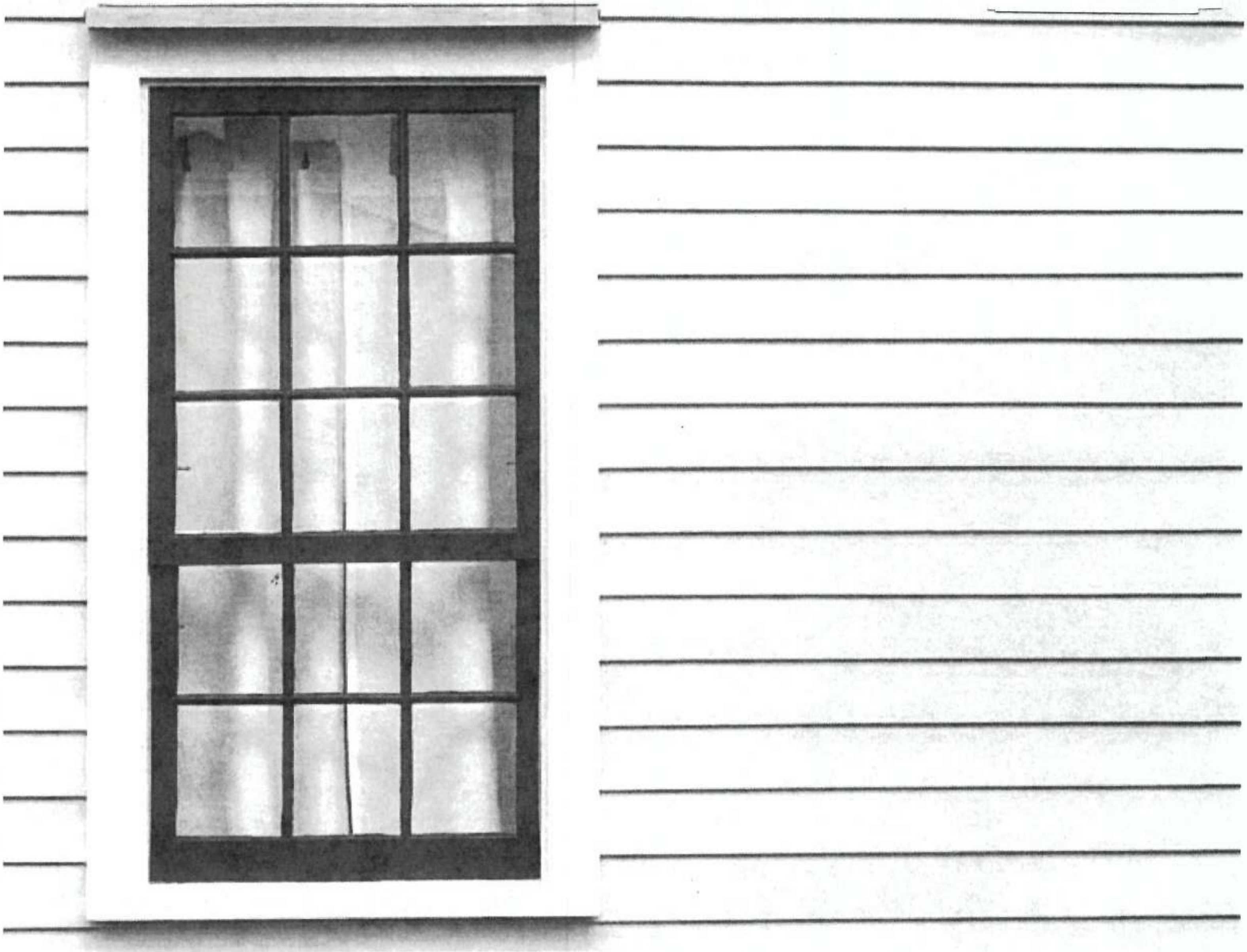
ATTACHMENT G



Saving Windows, Saving Money:
Evaluating the Energy Performance of Window Retrofit and Replacement

A REPORT BY:

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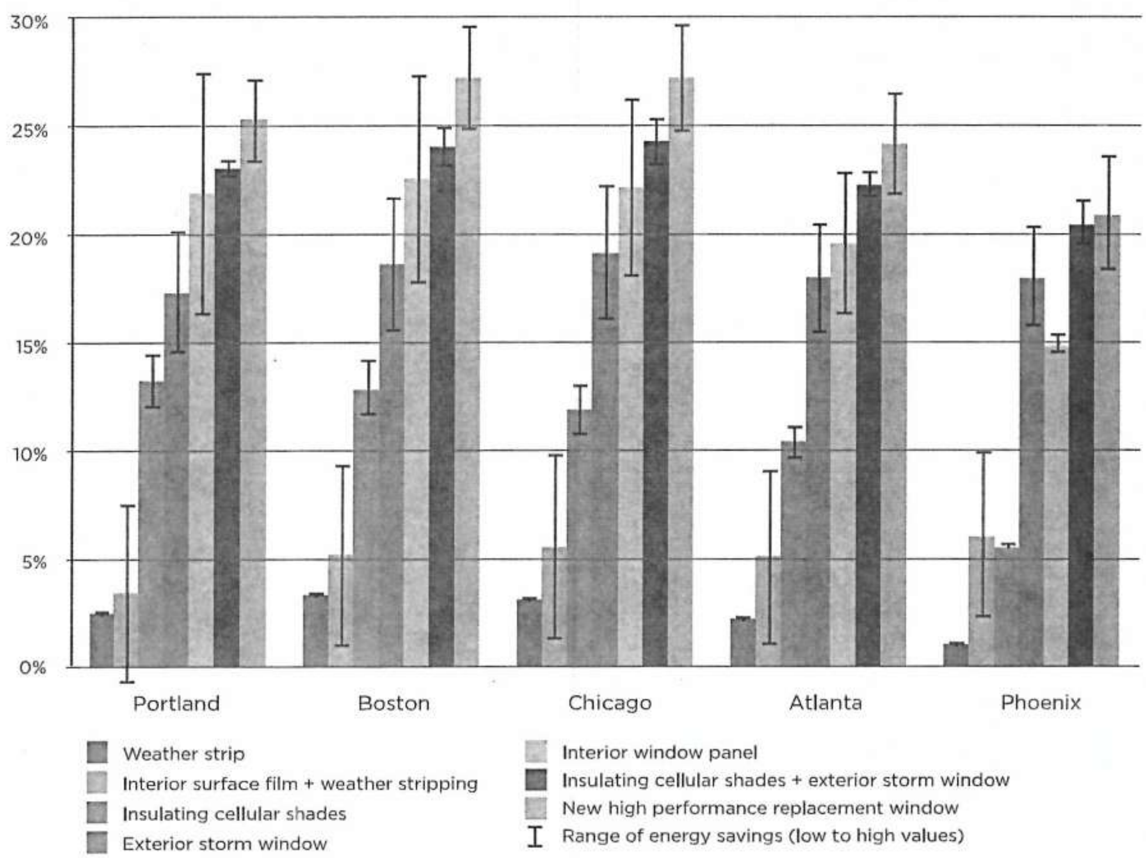
EXECUTIVE SUMMARY

Homeowners and design professionals seeking to upgrade the performance and efficiency of existing windows are faced with many choices—from simple, low cost, do-it-yourself solutions such as window films and weather stripping to replacing older windows with new ones that require investments costing tens of thousands of dollars. Often these decisions are made without a clear understanding of the range of options available, an evaluation of the ability of these options to provide energy and cost savings, or proper consideration for the historic character of the existing windows.

This study builds on previous research and examines multiple window improvement options, comparing the relative energy, carbon, and cost savings of various choices across multiple climate regions. *Results of this analysis demonstrate that a number of existing window retrofit strategies come very close to the energy performance of high-performance replacement windows at a fraction of the cost.*

Annual Percent Energy Savings For Various Window Upgrade Options



Note: Percentage savings are not intended to predict actual savings. Instead, the results are meant to be used to evaluate the relative performance of measures where other more cost-effective energy saving strategies have been implemented first.

KEY FINDINGS

RETROFIT MEASURES CAN ACHIEVE PERFORMANCE RESULTS COMPARABLE TO NEW REPLACEMENT WINDOWS.

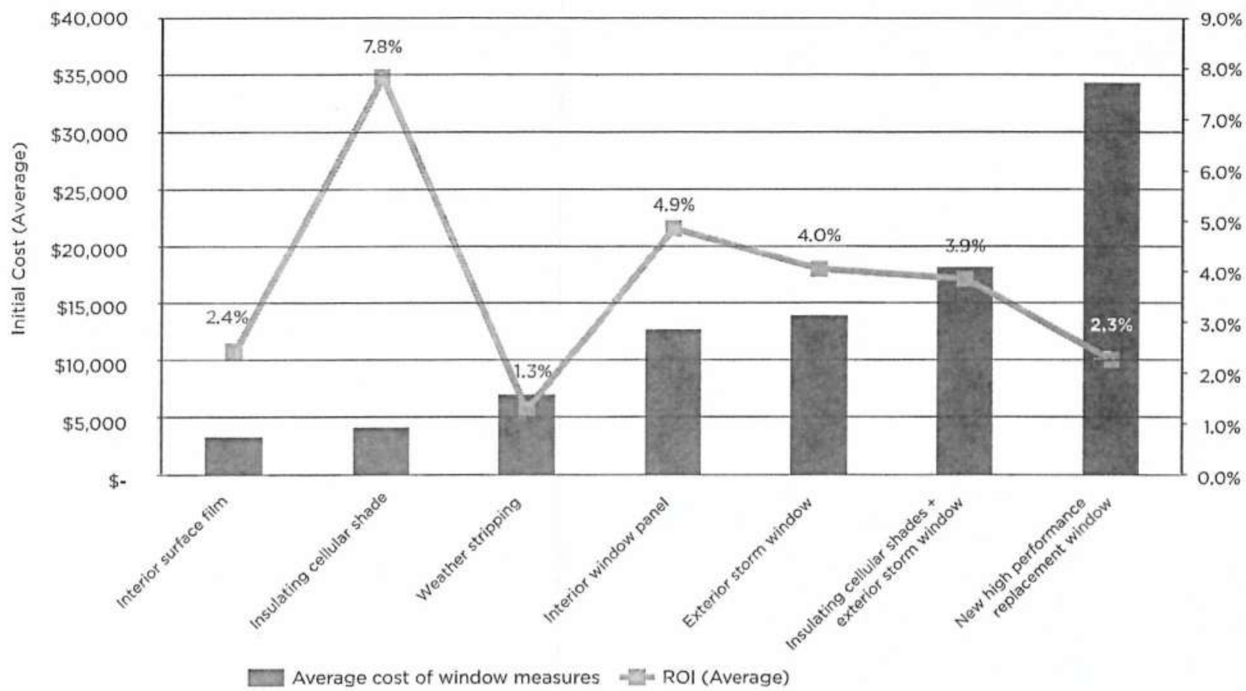
There are readily-available retrofit measures that can achieve energy savings within the range of savings expected from new, high performance replacement windows. This challenges the common assumption that replacement windows alone provide the greatest benefit to homeowners.

The figure on the previous page shows that for all cities, at least one and often two of the selected measures can achieve energy savings within the range of savings expected from new, high performance replacement windows. Specifically, interior window panels, exterior storm windows combined with cellular blinds, and in some cases even exterior storm windows alone fall within the range of performance for replacement windows.

ALMOST EVERY RETROFIT OPTION OFFERS A BETTER RETURN ON INVESTMENT THAN REPLACEMENT WINDOWS

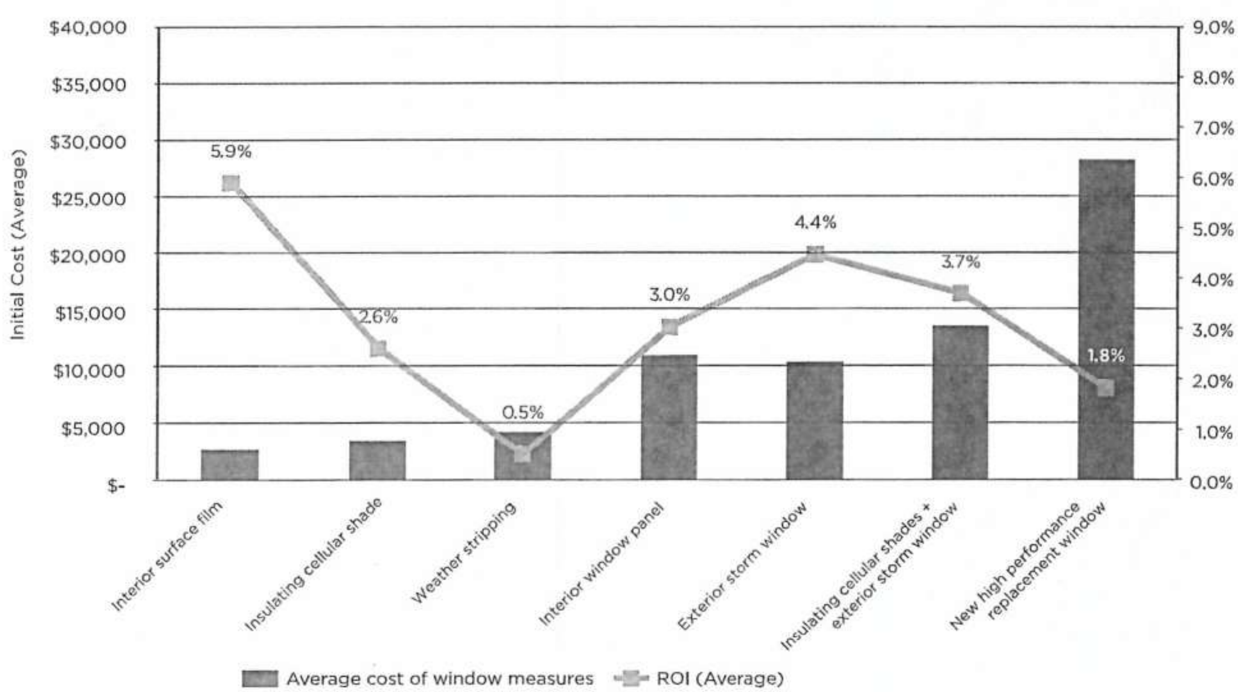
Energy savings alone should not influence decisions to upgrade windows without consideration of initial investment. For all climates, the cost analysis shows that new, high performance windows are by far the most costly measure, averaging approximately $30,000 for materials, installation, and general construction commonly required for an existing home. In cold climates, all other retrofit measures, with the exception of weather stripping and heat reducing surface films, offer a higher average return on investment when compared to new, efficient replacement windows. In hot climates, all of the study retrofit measures offer a better average return on investment than new windows, with the exception of weather stripping.

Financial Comparison of Various Window Upgrade Options for Boston



Due to high utility costs and high heating and cooling loads, window upgrade options in Boston generally produced the highest return on investment of any of the regions studied. Simple financial analysis such as Return on Investment (ROI) provides a decision making framework to allow informed choices between options for a given location.

Financial Comparison of Various Window Upgrade Options for Phoenix



STUDY OBJECTIVES AND APPROACH

In recent years, awareness around energy use and its financial and environmental impacts have placed buildings in the spotlight. Residential buildings alone are responsible for approximately 20 percent of total U.S. energy use and carbon dioxide emissions. The vast majority of these buildings are single-family homes where heating and cooling represent the largest use of energy. Windows are one important aspect of how heat loss (and gain) affects a home's operational efficiency and cumulatively represent over $17 billion in annual U.S. household expenditures on heating and cooling.

In this study, computer simulation is used to model energy use in a typical, prototype home both before and after window improvements. Several commercially available window improvement options were analyzed ranging from simple, low cost applications to more expensive options representing the highest energy performance on the market.

The study analyzed energy, cost, and carbon savings for seven selected measures: weather stripping existing windows; interior window panels; exterior storm windows; insulating cellular shades; a combination of exterior storm windows and insulating cellular shades; interior-applied surface films; and new, high performance replacement windows.

Variations in climate and regional energy grids were addressed by evaluating the home's performance in five U.S. cities—Boston, Atlanta, Chicago, Phoenix, and Portland. A thorough cost analysis allowed for the comparison of average return on investment for each window option in each of the cities.

RECOMMENDATIONS AND CONCLUSION

Findings from this study demonstrate that upgrading windows (specifically older, single-pane models) with high performance enhancements can result in substantial energy savings across a variety of climate zones. Selecting options that retain and retrofit existing windows are the most cost effective way to achieve these energy savings and to lower a home's carbon footprint. Due to the cost and complexity of upgrading windows, however, these options are not likely to be the first intervention that homeowners undertake. For many older homes, non-window-related interventions—including air sealing, adding insulation, and upgrading heating and cooling systems—offer easier and lower cost solutions to reducing energy bills.

In addition to providing insights into the energy performance and investment costs of window options, the study's findings reinforce several additional benefits in choosing to retrofit existing windows rather than replace them. Retrofits extend the life of existing windows, avoid production of new materials, and reduce waste. Additionally, wood windows are often a character defining feature of older homes, and conserving them helps to preserve the historic integrity of a home. *The Secretary of the Interior's Standards for the Treatment of Historic Properties* and *The Secretary of the Interior's Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings* offer guidance on how best to approach the preservation of windows in historically designated homes, or homes that may be eligible for listing.

Selecting the most appropriate measure for upgrading windows requires a detailed understanding of climate and energy costs in addition to window performance and installation costs. This study provides a valuable analysis of these variables that can be used to help inform the decision to improve the energy performance of and reduce the carbon dioxide emissions from older and historic single-family homes.