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Commercial Secondary Window Program Development Research

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Executive Summary

The Northwest Energy Efficiency Alliance (NEEA) contracted with Cadeo to conduct targeted market research to better understand the nuance and factors behind decisions to upgrade the shell of an existing commercial building. As part of its larger Window Attachments Initiative NEEA promotes a specific product: Commercial Secondary Windows (CSW). Secondary windows can be added to existing commercial windows to improve overall performance

This study

This project solely focused on CSW and included several activities that together provide a picture of a complex market in which decision-makers balance multiple competing priorities when considering solutions for under-performing windows. The primary objectives of this research were to:

- 1. Assess awareness among the key market actors expected to be involved in selecting CSW: architects, window installers/contractors (referred to in this report as "glaziers"), and property managers.
- 2. Explore and confirm key scenarios for which CSW might be a viable solution, including hypothesized opportunities related to major building retrofits, historic buildings, and to address tenant needs.¹
- 3. Understand the decision-making process that accompanies projects that address window and building envelope improvements in existing buildings and explore the roles of key market actors.
- 4. Inform and refine preliminary estimates of market opportunity by reviewing NEEA's estimates and, where possible, incorporating additional information.

This project is informed by five activities, which occurred between December 2020 and June 2021.

- A **web-based survey** of 30 glaziers and architects designed to understand the current level of awareness among these professionals of CSW solutions and their perceptions of CSW benefits.
- Three **virtual focus groups** with glaziers and architects that allowed the research team to more deeply explore concerns, questions, and perceptions of CSW products. Focus groups also explored how these professionals approach window performance generally and specific scenarios for which CSW are a viable choice.
- **In-depth interviews** with five contacts involved in commercial property management, historic building management, and energy performance contracting in existing commercial buildings.

¹ The NEEA team included a scenario in which window attachments would be considered as part of an HVAC upgrade as a means of tightening the building envelope. HVAC and other mechanical upgrades did not emerge as a project scenario in discussions with key market actors. Commercial HVAC research could shed light on the prospect that shell improvements could be tied to HVAC replacement.



- A **review of market opportunity** assumptions, which included a review of regional commercial building stock information reflecting scenarios identified by the program and in this project.
- The team also developed a **glazier population frame** and contact list. This step supported the survey and focus group recruitment and will provide the NEEA team with a contact list that could support the training and relationship building work likely needed to support product adoption.

The focus of these research activities was on market actors operating in NEEA's coverage area in the northwest (Idaho, Montana, Oregon, and Washington), although some participants are also active at a national level.

1.1 Conclusions

Many factors affect a building owner's propensity to consider CSW for a window retrofit including structural characteristics of the windows, ownership structure, property management priorities, market actor recommendations, and general market conditions. The key findings of this research are organized by objective and described below.

Research Objective 1: Assess awareness.

There is very low awareness of CSW among key market actors, particularly for standard vintage commercial buildings.

- Architects, glaziers, and property managers are largely unaware of CSW products, particularly for non-historic buildings. Current level of awareness and use of CSW² among market actors is generally centered on historic buildings. Most had not specified or seen CSW installed in "normal" commercial buildings. Secondary windows are generally associated with residential storm windows.
- Architects reported the highest level of awareness but expressed concerns about recommending these products. Architect survey responses indicated a higher level of awareness of CSW options and a likeliness to consider these products, however two-thirds of them had never recommended, installed, or purchased these products and focus group discussions indicated this openness may be limited to historic buildings.
- **Property management contacts had almost no exposure to CSW solutions.** The two contacts reporting they had used secondary windows both described unique historic building applications. Those managing more traditional commercial building portfolios expressed surprise, and interest, in options to attach additional glass to existing window framing.

² All 14 architects surveyed had heard of CSW and 7 of 14 had heard of solutions used in commercial buildings.



Research Objective 2: Investigate and confirm key scenarios.

CSW will be most attractive in projects where building features and market drivers are both working towards product selection.

There are two sets of primary opportunities: stock-related opportunities and market-related opportunities. Each set has a different mix of leverage points. Stock-related opportunities reflect the vintage and construction of the building and the condition of the windows. These building stock-related opportunities are likely necessary conditions for any CSW project. However, these conditions are not sufficient *on their own* to trigger an investment in CSW. A more nuanced set of market barriers will need to be mitigated for a project to go forward. It is important to note that the mix of opportunities and barriers could be different for each building, as could the relative power of any specific variable. As is visible in Table 1, while there are numerous potential stock-related opportunities, there are also substantial market-based barriers—these are the barriers that tend to prevent shell improvements generally and selection of CSW specifically. Our research indicates that inertia is likely the single biggest barrier as interviewees universally reported the tendency for owners to wait until windows have failed before taking action. At that point, a building would no longer be an appropriate candidate for CSW.

Table 1: Building Stock and Market Based Opportunities and Barriers

Opportunity	Barrier
Building Stock Features	
 Historic buildings "Ribbon" windows Single pane glass Intact framing Vintage (pre-1990) Punched opening windows 	 Building height (for external mounting) Structural concerns about weight Curtain wall construction
Market and Decision Drivers	
Tenant complaints about comfortOwner occupiedInstitutional owner	 Inertia Information gaps Cost Low awareness Multiple decision-makers Concerns about liability

Nevertheless, the team identified several scenarios in which NEEA and proponents of CSW could potentially influence the decision. These are discussed in more depth in RecommendationsSection 4.



Research Objective 3: Explore decision making process for window upgrades.

Like many decisions affecting existing commercial buildings, the process involves multiple professionals and reflects competing priorities.

Understanding how window upgrades typically occur provides insight into alternatives. Multiple professionals are involved in shell and window project scoping, including architects, who would be involved in any project that requires a permit and glaziers, who often respond to specific bid requests. All market actors report striving for satisfied occupants and a happy client (typically the building owner) and will protect their professional reputation by recommending the highest quality solution. For more information on the decision-making process see Figure 8.

We found two primary barriers in the existing decision-making process that the NEEA team will need to be prepared to address:

- Glaziers are extremely busy and do not usually promote projects among otherwise reluctant building representatives. Glaziers report they do not tend to solicit work or identify solutions for those that have not requested a bid. Thus, the buildings in an inertia state—that could benefit from CSW but are not asking for solutions—are unlikely to be identified. Glaziers report that their proposals need to reflect bid specification, limiting their ability to propose different solutions.
- 2. Informational gaps are numerous and reflect the concerns of each market actor. Glaziers offered myriad specific questions about CSW products in focus group conversations, many of which reflected concerns about liability, cleaning requirements, and the extent to which CSW would meet bid-specified performance requirements. Architect questions focused more on visual and operational impacts to buildings and generally limited viable applications to historic buildings and those with low profile window construction. Property management contacts had questions about pricing and how to obtain the products.

Research Objective 4: Refine estimate of market opportunity.

The 2019 CBSA has information on many structural factors that impact CSW market opportunity but cannot account for market actor behavior.

Cadeo worked with the NEEA program team to analyze the 2019 CBSA for specific building characteristics relevant to CSW. Factors like window type, windowpane characteristics, building age, and building type all impact a building's propensity to consider CSW. While these building structural characteristics are not the only factors impacting CSW consideration, information on these factors gleaned from the CBSA can help frame discussions about market size and potential.



1.2 Recommendations

The following five recommendations emerged from this research. For more in-depth discussion of each item see Section 4. Many of the recommendations below are related to increasing awareness, which is a key activity associated with program success identified in the program team's logic model³

1. Conduct activities to spread information and increase education

To build awareness and ease concerns over outstanding questions, we recommend that NEEA develop clear, technically accurate answers to the most frequently asked questions. Providing examples of actual projects that have used CSW will also help build awareness, especially for architects and building owners who like to "see, feel, touch." NEEA should disseminate this information electronically through high profile web sites and partner with industry organizations like the National Glass Association (NGA).⁴

2. Commit to identifying key contacts with buildings of interest

To reach contacts likely to be associated with high propensity buildings, NEEA should prioritize identifying and connecting with building representatives. Property management contacts asked pragmatic questions and demonstrated an openness to simple solutions; however, they are extremely difficult to reach. A concentrated effort to build out contact lists, build on relationships with the Building Owners and Managers Association (BOMA⁵) and similar trade groups like International Facilities Management Association (IFMA), or attend regional facility events could help NEEA reach these important players in commercial building management.

3. Build relationships with NW architects, glaziers, and property managers

We also recommend that NEEA consider engaging a product representative with ties (or to build ties) with glazing and design professionals. This person could position themselves as a one-stop resource for questions on products and performance. This product ambassador will need to establish trust and build relationships. Our research showed substantial, but surmountable, initial skepticism to CSW and having a "face of the program" who can credibly answer technical and product level questions would help build trust.

4. Clarify outstanding questions about the link between CSW and building codes

During the focus groups questions emerged about how building and energy codes applied to commercial secondary windows. These questions point out an important area for education about CSW. While some concerns are unfounded, others present questions that should be investigated further. We found that market actors often had immediate questions when learning about CSW, we recommend that NEEA provide clear answers to those questions through

⁵ Building Owners and Managers Association <u>https://www.boma.org/</u>



³ Assessment of logic model barriers was not an objective of this research. However, the results suggest that focus on awareness is closely linked to those barriers. See Appendix B.

⁴ The team worked with a contact at the National Glass Association to recruit their members for survey participants in this research effort and NGA could be a valuable partner for the program team in the future.

information dissemination and training activities. (For a full discussion of these topics and questions, see Appendix A: Code Discussion.)

5. Educate market actors on the relative cost of CSW

Market actors often had questions regarding material costs, installation costs, and soft costs⁶ associated with CSW. Research, especially information from manufacturers, has shown that all three of these categories may prove to be drivers in favor of CSW over full window replacement, but without firm estimates for bidding purposes, market actors are unlikely to shift from the status quo.

⁶ Soft costs are those associated with a replacement project but not necessarily the core costs of material and labor. These include permitting, disposal, street closures, and tenant disruptions and similar that often accompany window replacements.



Section 2 Introduction

NEEA's Window Attachments Initiative is focused on identifying and promoting a variety of window attachments with energy savings potential. This research is focused specifically on Commercial Secondary Windows, a specific window attachment product appropriate for improving the performance of intact window systems installed in commercial buildings throughout the Northwest. The Initiative aims to differentiate CSW products by supporting the development and use of a third-party certification body for CSW,⁷ building awareness of CSW among supply- and demand-side audiences and developing a compelling value proposition for CSW products. The Initiative also expects to leverage opportunities emerging from government policies and regulations that prioritize monitoring the energy use intensity of existing commercial buildings.

This project focused on providing strategic market intelligence, building on prior work, and adding nuance to the NEEA team's understanding of the product and the market opportunity. The information presented here is expected to provide guidance to the team as it refines intervention strategies. This research sought to obtain and synthesize market insights that will help the CSW program team leverage identified market opportunities and position CSW for increased adoption.

This project had three core research objectives:

- 1 Establish the baseline level of awareness of CSW product options among the target market actors that NEEA has identified.
- 2 Confirm and describe the key purchase and decision-making scenarios for CSW, as well as how the market actors involved might differ across scenarios, to inform where NEEA can most effectively intervene.
- **3** Refine NEEA's current estimate of market opportunity. The program team is working to adjust the market estimates of existing conditions that could further reduce the applicability of CSW.

2.1 Background and Product Information

Commercial secondary windows are window units with one or more transparent panes in a frame that attaches to the interior or exterior of existing windows without replacing the original glass or frame. This creates an insulating pocket of air between the existing and new secondary window. Some products also incorporate low-e glass to reduce radiative heat loss and further improve insulating performance. Secondary windows are sometimes referred to by other names in the market such as interior storm windows, interior storms, insulating panels or inserts, and secondary glazing systems. These terms all describe similar products.

⁷ NEEA is part of the Attachments Energy Rating Council (AERC), a ratings organization working to ensure that energy performance expectations associated with window attachments are identifiable in the market.





Figure 1: Illustration of a Secondary Window Installation

Secondary window systems are customized to fit a building's existing window openings. Because of the variations of window configurations in existing buildings, CSW products are customizable and manufacturers offer products with a wide array of features including window operability, interior vs exterior mounting, different installation and sealing methods, and framing materials.

2.2 Methods

This document is informed by four primary research tasks, each of which sought to obtain insights into the research objectives listed above.

- **1** A **survey** to test awareness metrics and to provide preliminary information on the level of product awareness among glazing contractors and architects.
- 2 Three virtual focus groups with glazing contractors and architects to dig deeper into their experience with and perceptions of CSW and identify scenarios that could represent an opportunity for CSWs. Focus groups also encouraged attendees to talk directly with each other about their experiences.
- **3** In-depth interviews with contacts representing various perspectives from the building management side. These included staff from Energy Service Companies (ESCO), property management, historic preservation, and institutional campus management.
- **4** A review of NEEA's **market opportunity assessment**, integrating information obtained from the market research with the NEEA planning team's assessment of technical and market potential.

Table 2 displays the number of respondents by method.



Method	Respondents/Participants
Survey of glaziers and architects	30
Virtual focus groups	10
Interviews with building management contacts	5
Market opportunity review	NA

Table 2: Respondents by data collection method

NEEA did not have a population frame of glaziers, architects, and property managers from which to recruit survey and interview participants, so we deployed a multi-stepped process to reach each population. We began by purchasing a list from a vendor that compiles lists for marketing purposes. We found the population frame for architects was more than sufficient for our purposes, but that glaziers and property managers had far fewer records than the study required.

Glazier Population Frame

To augment the purchased list of glaziers, our team investigated contacts listed in the Blue Book (<u>http://www.thebluebook.com/</u>), a web-based directory of building and construction related companies. We conducted manual searches to identify glass contracting firms who work in commercial and small business markets. The resulting list of 272 records represents a substantial portion of the glazier market and will be provided to NEEA to support additional outreach and training efforts.

To narrow down the search and include only those firms within the project scope (commercial glass upgrades in the Northwest) we developed search criteria to qualify relevant contractors. We excluded glass contractors who are not active in commercial window work by removing those that specialize in residential, auto glass, or kitchen and bath. For contractors who perform a wide range of services, we opted to include any that do some commercial window work, even if they work in other specializations outside the project scope. A sample of our screening criteria is included in Table 3 below.

Keywords to Include	Keywords to Exclude
Commercial	Autoglass
Curtain wall	Automotive
Storefront	Windshield
Storm window	Manufacture
Window repair/upgrade/renovation	Shower

Table 3: Keyword Screening Criteria for Glazing Companies



Property Managers

Reaching contacts associated with building management proved more challenging than anticipated. Originally, the team had planned to include property/building managers in the awareness survey, but the sample frame would did support enough contacts for survey outreach. Because of low participation, we removed property/building managers from the survey population and augmented this list with referrals and existing connections provided by Cadeo team members and regional contacts working in this market. Ultimately, we completed five in-depth interviews with contacts representing a variety of perspectives, including the number of buildings and building types they manage.



Section 3 Results

3.1 Awareness Survey

3.1.1 Approach

The team developed a web-based survey, fielded in March and April of 2021, to assess awareness and understanding of commercial secondary windows, assess level of knowledge of product features and benefits, and explore confidence in CSW products including likelihood of future recommendation. (To review the full survey, see Appendix C: Data Collection Instruments)

The survey began with a series of screening questions to ensure that participants fit into the project scope, specifically that they were involved in window retrofits in commercial buildings in the Northwest. Table 4 shows the states in which participant's companies are active.

Service Type	ID	МТ	OR	WA
Architecture and design (n=14)	21%	0%	64%	79%
Glazing (n=16)	25%	13%	75%	69%

Table 4: Service States by Market Actor Type

Note: Row percent sums to more than 100% because some respondents do their business in multiple states.

3.1.2 Results

Awareness

Respondents first answered an unaided awareness question exploring solutions that they would consider when faced with a window upgrade or retrofit project in which issues like thermal heat loss, external noise, draftiness, or aesthetic concerns existed. Answers to this unaided, openended awareness question reflected the considerations contacts use to screen for solutions and an assumption that the best solution will often be replacement. Thermally broken metal framing emerged as a popular solution, particularly for complaints about heat loss.

Representative comments included:

An architect noting: "My first step would be to consider the building type; occupant use and condition of existing windows. If retrofit is an appropriate design consideration, I would provide a schematic solution based on the budget and user needs. I would contact a window representative, provide schematics and initiate a dialog with retrofit options in mind."

A glazier noting: "The very first thing we look at is existing glass type, age of existing glass, type and age of the system. Depending on the age and type of glass, the quickest fix to increase solar heat gain coefficient (SHGC) and sound transmission (SCT) ratings is to install new glazing, usually



thermally broken with some type of low-emissivity coating (Low E). If the system is too old, and is either deteriorating or won't house insulated glazing, then we look at replacement. Sometimes an applied film will provide desired results."

Ultimately, only two of the 30 respondents provided responses that included CSW or alluded to a description of CSW products—one specifically mentioning "interior/exterior secondary storm glazing". The survey then provided all respondents with a detailed description and basic drawing consistent with NEEA's definition of CSW and asked a follow up question to gauge aided awareness. As seen in Figure 2, the majority of architects surveyed are aware of secondary windows but did not associate them with commercial buildings. Likewise with glaziers, 57% of respondents had either never heard of CSW (including their associated names) or never heard of secondary windows used in commercial buildings.



Figure 2: Combined (Aided/Unaided) Level of Awareness

Similarly, among the 28 contacts reporting some level of awareness, most (20 of 28) had never recommended, installed, or purchased CSW (Table 5). While the sample sizes are somewhat limited, the fact that almost 80% (11 of 14) glaziers reported they had never recommended, installed, or purchased secondary windows is striking since glaziers should be most aware and informed of glass options. The two glaziers that had installed or purchased CSW both indicated that these had been part of historic building preservation.

Architects do not generally install or purchase windows, so it is not surprising none of them indicated they had done so with CSW.



	Architect (n=14)	Glazing (n=14)	Total (n=28)
Have recommended	36%	7%	21%
Have installed or purchased		14%	7%
Never recommended, installed, purchased	64%	79%	71%
Total	100%	100%	100%

 Table 5: Recommended, Installed/Purchased CSW Among Aware Respondents

Next the survey asked the 28 participants who were aware of CSW how they heard about the product. Figure 3 shows that architects were more likely to hear about CSW through advertisements and glaziers indicated they were more likely to hear about CSW through colleagues or directly from manufacturers. The finding that glaziers interact with manufacturers is consistent with previous CSW market research indicating that manufacturers market their products directly to end users and project specifiers.



Figure 3: Sources of information (if aware of CSW)

Respondents aware of CSW (aided or unaided) also responded to a series of questions rating their confidence in several aspects of product performance. In nearly every case, architects reported higher levels of confidence than glaziers. However, both groups expressed the least confidence in CSW installation and maintenance.



Note: Multiple responses allowed



Figure 4: Portion of Respondents "Confident" that CSW Would Meet Aspects of Product Performance

Next, the survey asked respondents how prevalent window performance issues (thermal heat loss, external noise, draftiness, etc) are among existing commercial buildings. Window performance issues appear to exist in a large portion of existing buildings with 24 out of 30 respondents saying that window issues are either "somewhat common" or "very common" (Figure 5).





Figure 5: Prevalence of Window Performance Issues in Existing Buildings

Respondents then estimated the percentage of building owners that opt to fix identified window performance issues. As seen in Table 6, respondents report building owners often do not opt to address window performance issues. Nearly 70% (11 of 16) of glaziers report that window performance issues are rarely addressed, indicating that inertia is a major barrier (and consistent with focus group findings, discussed later, indicating that owners and property managers avoid window projects unless they absolutely have to be addressed).

	Architect (n=14)	Glazing (n=16)	Total (n=30)
Rarely Addressed 0-40%	35%	69%	53%
Sometimes 41-60%	43%	13%	27%
Commonly Addressed 61-100%	21%	19%	20%
Total	100%	100%	100%

Table 6: How Often Identified Window Performance Issues are Addressed.

The next question explored whether the hesitancy to address window performance issues reflects competing priorities for other building upgrades. Sixty-four percent of architects (9 of 14) reported that window performance issues are "often or always" deprioritized relative to competing upgrades. Architects are more likely to have insight into competing projects in a building upgrade than glaziers, however nearly 45% of glaziers similarly report that other upgrades often take precedence.



	Architecture and design (n=14)	Glazing (n=16)	Total (n=30)
Never-rarely	7%	13%	10%
Sometimes	29%	19%	23%
Often-always	64%	44%	53%
Don't know	0%	25%	13%
Total	100%	100%	100%

Table 7: How Often Competing Upgrades are Prioritized over WindowPerformance Upgrades.

Further, as visible in Table 8, when window performance issues do get addressed, they are often part of a larger building retrofit project.

Table 8: Likelihood that Window Upgrades Occur as Part of Larger RetrofitProjects

Likelihood	Architecture and design (n=14)	Glazing (n=16)	Total (n=30)
More likely to occur with other retrofits	93%	56%	73%
Equally likely to occur with other retrofits as independently	7%	25%	17%
Less likely to occur with other retrofits	0%	19%	10%
Total	100%	100%	100%

The survey also gaged respondent likelihood to consider using CSW on future projects. This question helps establish a base level understanding of how confident market actors feel about recommending CSW to future clients.

Figure 6 shows the large difference between architects and glaziers on likelihood of future consideration, with architects being much more likely to consider CSW than glaziers (64% to 21% respectively). In fact, no architects reported they would be unlikely to consider CSW in the future.





Figure 6: Likelihood of Considering CSW for Future Projects (if aware of CSW)

Finally, CSW aware participants rated their level of agreement with claims about various elements associated with CSW. In general, architects and glaziers reacted similarly to these claims. A majority of respondents agree that CSWs offer the potential to save energy and increase tenant comfort. Both groups were most skeptical about CSW's ability to provide solutions for operable windows and the ease of installation without special skills. From previous research with manufacturers and discussions with subject matter experts in this study, the team's understanding is that there are CSW products compatible with operable windows and that they do not require specialized installation skills, indicating an information gap.





Figure 7: Level of Agreement with Various CSW Attributes (if aware of CSW)

3.2 Market Actor Interviews

This section provides a discussion of the findings from two qualitative data collection activities: three virtual focus group interviews with architects and glaziers, and five in-depth interviews with contacts involved in property management (including one ESCO contact).

3.2.1 Approach

Focus Groups

The team conducted three virtual focus groups in April 2021 to dig deeper into the experience and perspectives on CSW among glaziers and architects. To recruit focus group participants, we re-contacted the glaziers and architects that had indicated a willingness to participate in follow on research as part of the awareness survey, conducted outreach via phone and email to glaziers and architects that had not completed the survey, and added a request to National Glass Association members via a weekly newsletter. The team offered a \$150 gift card as incentive for participating.



Virtual focus groups have become more common during the Covid-19 pandemic, as video conferencing software and remote attendance has become common place. Ultimately, five glaziers and five architects attended the focus groups.

Group	Date	Attendees
Glazier only	4/14/2021	2 glaziers
Architect only	4/15/2021	4 architects
Mixed (glaziers & architects)	4/20/2021	3 glaziers 1 architect

Table 9: Focus Group Participant Summary

Discussions were semi-structured, based on an interview guide prepared in collaboration with NEEA staff, while also allowing for deviation to explore and understand emergent issues or unexpected comments. Focus group facilitators also encouraged attendees to talk directly with each other about their experiences.

Interviews

The team conducted interviews with four professionals involved in different aspects of commercial property management and one contact from an Energy Service Company (ESCO) working actively in the Northwest to improve the energy performance of existing buildings. ESCOs have a different perspective on energy consumption in existing commercial buildings, as their business model requires identifying projects with "guaranteed" energy savings, however all five contacts provided insightful perspectives on the competing priorities and potential opportunities for commercial secondary windows.

Contacts reported a variety of roles, including:

- Senior property manager for major commercial property manager in Portland, working with landlords on commercial building leasing, upgrades, and maintenance. Portfolio includes historic buildings.
- Chief engineer for nonprofit property management company with a portfolio of Seattlearea historic buildings.
- Real estate investment manager with national portfolio of commercial and industrial buildings.
- Property manager with a portfolio of multifamily buildings that includes large complexes and historic multiplexes.
- Project manager for ESCO focused on scoping and executing building and system upgrades in commercial buildings in the Northwest.



3.2.2 Findings

Awareness and Sentiment

One objective of the in-depth interviewing process (including both focus group conversations as well as individual interviews) was to gather additional information about the awareness of CSW among these key populations and their reactions to product descriptions. The interviews confirmed findings from the survey and revealed a relatively low level of awareness among all market actors of the CSW products. Interviewers provided a description of CSW products and asked contacts to react to it. Architects reported some familiarity, but their use cases were mostly limited to historic buildings, where replacing windows is discouraged or even forbidden. Glaziers lacked experience with and exposure to products similar to the NEEA CSW description, instead associating secondary glass with a "band-aid" akin to storm windows that would be installed in some homes.

None of the interviewed property managers had heard the term "commercial secondary windows." We provided a description of CSW, after which three then mentioned storm window products they had seen, two of whom reported using secondary windows (which they called internal storms) in historic properties. The contact with experience in the multifamily market immediately associated them with traditional residential storm windows (mounted on the exterior). When asked about installing these products in more standard commercial buildings, property managers were curious and somewhat incredulous, asking directly "you can do that?" The ESCO contact did reference CSW and mentioned Indow® products by name and reported seeing a similar system that uses magnets to attach to the existing window.

Because we had not expected a high level of awareness or experience with CSW (based on the awareness survey results), interviewers were prepared to explore the questions and concerns contacts had about these products. After hearing a brief description, market actors expressed mixed opinions about CSW. While they were able to identify potential scenarios for installation, they had concerns about client satisfaction. For architects this centered on visual satisfaction—how would the products look to occupants of the building, and what would the installation mean for the look of the building overall? For glaziers, concerns centered on liability and avoiding complaints or repairs.

Property managers had fewer concerns, and several were enthused by the idea. Property managers are called when window operability or performance becomes an issue for tenants and are thus open to solutions that are not disruptive or expensive. They also encourage building owners to replace poor performing windows to avoid complaints in the first place and to position the building for market rate rent.

Perspectives on Window Performance Issues

Focus group attendees mentioned several issues they typically encounter with existing windows. Architects reported that their clients are often focused on controlling noise, managing condensation, and maintaining (or improving) the aesthetics of their buildings. Window performance can be one aspect of a larger building investment decision. This could work against CSW, as one architect noted, if clients are already planning on a major upgrade, it may not be



worth keeping "old or cheap" window systems. Glaziers reported their clients are concerned about security, noise, and thermal performance. According to architects and glaziers it is rare for energy efficiency to emerge as a concern, (although thermal comfort is related to energy efficiency) at least with sufficient power to trigger investment.

Property management contacts are closer to the experience of those occupying their buildings and offered more detail about common issues they most associate with existing windows. These issues include:

- **Operability.** Tenant requests for operability include complaints about windows that are "stuck" open or closed. Operability is viewed as an attractive attribute of historic buildings.
- **Noise.** Tenants are likely to complain about noise in downtown areas or in buildings near highways or railroads.
- **Drafts.** Tenants will complain if they experience drafts, which can indicate that either seals have failed, or inefficient single pane glass is present which can create convection loops that are felt as drafts next to the cold glass.
- **Solar heat gain.** Issues associated with the sun include heat buildup as well as glare. Reflective film emerged as a solution (as reported by glaziers as well as property managers). One property manager expressed tempered enthusiasm based on his experience with failing or uneven films.
- **Security.** Property managers also field concerns about safety, including broken glass, vandalism, and perceived risk.

Property managers could not provide an estimate for how common these issues were in terms of percent of buildings, rather they discussed frequency with general examples: summer specific issues with increased heat buildup, coatings that deteriorate (both factory and self-installed), and any building with single pane glass, particularly those installed before 1980.

Solutions

In discussing the preferred solutions, contacts reported the most common choice for owners is to do nothing. While film emerged as an inexpensive and unobtrusive solution for heat gain or complaints about glare, all types of market actors reported it is common for window repairs to be delayed until failure, when there is no choice but replacement. Property managers report that they do not shy from recommending window replacement, noting that replacement is always an option, particularly if it improves building aesthetics and leads to higher rental income or a quicker building sale. One contact, with experience in the multifamily market said any windows installed before 1980 need to be replaced because tenants expect reasonably attractive, functional windows and old windows often result in charging less than market rate rent.

The team also interviewed and ESCO contact, who similarly reported that by the time an owner is considering addressing window issues, sufficient envelope damage has often occurred, which, according to this contact, would likely make secondary solutions less viable. Occasionally window performance problems will be elevated during the ESCO auditing process and reveal windows with water infiltration, condensate build up, or poor thermal properties. Complaints



about thermal performance from solar heat gain in the summer or heat transfer in the winter are also items that might emerge during the audit.

Opportunities

In focus groups and interviews contacts were asked to consider scenarios that might represent an opportunity for a solution like CSW. This section provides a brief summary of these scenarios and opportunities, (for a more in-depth

discussion, see Error! Reference source not found.).

Historic buildings. The most obvious application for glaziers and architects is associated with buildings that have restrictions that would prevent replacement. Among property managers who had installed any type of secondary glazing in commercial buildings, experience was limited to historic buildings. As one property manager noted, in these buildings the windows are so old they have become valuable again.

Older non-historic buildings. Unlike historic buildings, older buildings with single pane glass emerged as buildings most likely to benefit from window rehabilitation and replacement. When pushed for precise vintage cutoff dates, contacts referred to buildings from the 1980s or earlier. Glaziers and architects both cautioned that these older glazing systems often have performance problems that would prevent CSW installations most commonly framing failures and water infiltration.

What about the cost relative to replacement?

CSW manufacturers highlight the low cost of secondary windows relative to a full replacement*, in some cases 25% of the total cost including installation and avoided disposal costs, but glaziers and architects are less certain. In focus groups, these market actors often brought up concerns over the uncertainty about exact pricing comparisons between the two options. For market actors to recommend CSW, they will likely need more information about cost differences.

*Evergreen economics CSW Market Characterization, 2020

Safety and security. Glaziers report that bullet-or blast-proof windows are increasingly specified and that ground floor operable windows are sometimes screwed shut to improve building security. Secondary windows could provide additional security in both scenarios. Perceived increases in vandalism and window damage have made property managers more sensitive to upgrades that can reduce the susceptibility of their buildings to damage. Blast proofing, identified in previous research into use cases for secondary windows, continues to be a requirement for many government buildings. To the extent CSW are positioned as a solution for blast proofing retrofits, they could be specified for these buildings, although specialized designs to meet test standards may be required.

Occupied multifamily or office buildings. The prospect of upgrading windows without disrupting tenants or waiting until space is unoccupied had previously been documented as a benefit of secondary windows and was confirmed again in interviews with property managers.



Because they can be installed in occupied space, property managers agreed that CSW could provide a cheaper and less invasive solution than window replacement.

Major retrofits. A building undergoing multiple system retrofits could benefit from screening for window performance, particularly if improving the energy performance of the building is an objective. Contacts also noted that secondary windows might not trigger energy code requirements as the existing window system remains in place, which can be a driver However, unrelated to code and energy performance, the complexity of major retrofits can work against lifecycle cost analyses that could elevate CSW solutions, as one architect noted, *"I think most people want to think about lifecycle cost, but when they are weighing 40 or 80 budget line items, it starts to fade into the distance, unfortunately."*

Reducing overall building energy consumption associated with heating and cooling. The ESCO contact, who regularly conducts detailed energy audits, reflected a more holistic approach to building energy consumption than other market actors and was the only contact to mention the prospect of reducing mechanical systems (or at least defer increasing them) by improving overall shell performance.

Screening existing buildings. Identifying buildings for which CSW could be a potential solution remains a challenge. Glaziers are responding to bid requests, not conducting building/window audits and acknowledged that there were likely buildings that could benefit that are simply not in the market. Property managers indicated that owners generally do not invest in shell performance unless a system has failed. The ESCO contact suggested adding questions to walk through and site assessment questionnaires that would explore the comfort of those at the perimeter of the building, documenting the age of the glazing system, and considering options for improving systems that are intact but low performing.

Concerns

In focus group discussions and (to a lesser extent) interviews, contacts mentioned a variety of concerns about recommending or installing secondary windows.

Liability. The single biggest concern glaziers expressed related to perceived liability. As the professional responsible for the performance of the overall glazing system, glaziers are compelled to recommend products that they are confident in. Their professional reputations depend on satisfied customers and high-quality work, and they expressed concern that they might be accepting responsibility for not only the CSW but also the existing window, even if they are not changing the

"No commercial glazier is going to put their blessing on something that they don't know for certain is performing well. In five years, the thing you put on the outside might be fine, or the thing on the inside, but there's a problem and something is failing and now the whole thing is your responsibility." – Glazier



existing window.⁸ According to glaziers, "band-aid" solutions like secondary windows can create unforeseen failures that they would be responsible for.

Client/tenant satisfaction. All three market actor groups want happy clients and satisfied tenants. Architects expressed fear that CSW could result in client complaints about aesthetics or reduced operability. Glaziers offered examples of client satisfaction with new, high performing

windows as evidence that their customers might not be as happy with CSW. Property managers generally offered more pragmatic opinions, noting that if the product made sense for a building and they were convinced it would work for their buildings they would consider it.

"That's why our default is replacement, because we know we can make them happy, we stand behind the product. Better than going ahead and band-aiding the previous work." – Glazier

Installation. Glaziers had numerous questions associated with the installation process. They asked about cleaning requirements, time required to install, and if installation required special training. Property managers saw an opportunity to avoid soft costs associated with permitting, disposal, and street closures that often accompany replacement, and asked about installation options.

⁸ Cadeo recommends that NEEA include warranty details as part of an information campaign to address concerns and frequently asked questions among market actors. See section 5 for more detail.



3.3 Decision-Making Process

This section discusses how different roles affect the decision-making process around window repair or replacement. Each of the market actors (delineated with bold blue text) are discussed in the descriptions below Figure 8.

Figure 8: Market Actors Involved in Window Upgrades and Their Roles





- **Architects.** These professionals are expected to provide input and recommendation for product choices for windows. Architects are generally involved in products requiring a permit—property management companies and landlords without an in-house architect will engage them for ideas and product recommendations.
- **General contractors.** General contractors are typically selected by the owner or property manager and will work closely with an architect on projects that require a permit or with glazing subcontractors on window specific work. According to property managers, general contractors will also suggest alternative approaches or products if they think it will save their client money or hassle, or if a project budget is limited. The team did not interview general contractors directly as part of this research.
- **Glaziers (window installers/contractors).** Property management companies tend to have existing relationships with trusted glazing firms. When a project is scoped, they will contact these professionals for pricing and timing information. *"Speed is king,"* said one contact, *"unless we are doing the entire building... that requires more planning, and we can be more selective."* Note that the description includes bolded text associated with "daily" or "maintenance" work. In focus group discussions, several glaziers distinguished their firms from glazing firms that provided smaller, ad hoc service work and repair.
- **Property managers.** Property managers report determining who needs to inform options provided to the building owner. This could include contacting an HVAC, glazing, general contractor or similar. The property manager obtains bids, outlines different scenarios (including costs, expected payback, and effects on tenants) and presents this information to the building owner. *"If something has a quick payback, it's a no-brainer; if the upgrade addresses common areas and lowers the common area maintenance (CAM) costs, everyone absorbs the costs and experiences the benefits."* CAM costs are associated with atriums, parking lots, and lobbies.
- **Tenants.** Depending on the purpose of the upgrade and existing contractual relationships, tenants may also be involved in the decision-making process. If tenants are paying for the improvement (either because it's a negotiated tenant improvement project, or because it's something important to their business, for example special storefront glass for a retail or restaurant space), then tenants will often pay for the design and only get approval as required from the building management or ownership. The team did not interview tenants directly as part of this research.

Not all of these roles will be involved in every project or decision process. Deep retrofit projects will likely involve all of these roles, whereas smaller projects focused on addressing specific poor performing windows may only involve the building owner / occupant and a local contractor.

According to the ESCO contact, envelope measures are rarely incorporated in their commercial projects because of the long energy savings payback. These customers may decide to move forward if there are ancillary benefits that would offset the investment (for example, improved building integrity, or improved property value). However, institutional customers have longer time frames and more favorable economics for envelope improvements.



3.4 Stock Data Analysis

3.4.1 Approach

To support market opportunity review, Cadeo analyzed CBSA stock data. Our team met with the NEEA planning team to obtain background material and documentation and to understand where the largest areas of uncertainty were in the program team's calculations. The goal of this activity is to help refine the NEEA planning team's market estimates.

Many factors affect a building owner's propensity to consider CSW for a window retrofit including structural characteristics, ownership structure, property management priorities, market actor recommendations, and general market conditions. The findings discussed in this section attempt to account for structural characteristics and building ownership documented in the 2019 CBSA. These findings can frame discussions about potential market size but cannot account for the market-specific factors that lead to CSW installation.

3.4.2 Findings

The team reviewed the 2019 CBSA to confirm overall opportunity for the market, starting with single- and double-pane windows.

Market	Millions Square Feet (MM sf)
Single Pane	52
Double Pane	253
Total	305

Table 10: Square Footage by Window Type

Cadeo further analyzed the CBSA to adjust the overall opportunity for two key factors that impact savings estimates for CSW:

- Presence of glazing material including low-e, opaque, tinted, and reflective windows
- Absence of facility heating

These adjustments had the highest impact on double-pane windows, specifically tied to the glazing.



Market	Percent Glazed	Percent without Heating		Overall Adjustment ⁹	Adjusted MM sf
Single Pane	3%	2	4%	7%	49
Double Pane	10%	3	3%	11%	226
Total	8%	3	3%	10%	274

Table 11: Savings Impact Assessment, MM sf

The age of a building also has a significant opportunity impact as illustrated in Table 12.

Table 12: Square Footage by Building Age and Window Type, MM sf

Market	Built through 1990	Built after 1990	Total
Single Pane	47	2	49
Double Pane	152	73	226
Total	200	75	274

Cadeo further investigated opportunity by window and building type. The most significant opportunities are outlined in Table 13, over 80% of which is associated with punched opening windows according to the CBSA.

Primary Building Type	Building Economic Use	MM sf
Warehouse	Warehouse/Distribution	56
Office	Admin/Professional/Government/Financial	30
Lodging	Hotel	16
Mixed Commercial	Majority Office	15
Retail/Service	Other Specialty Merchandise	10

Table 13: Market Opportunities by Building Type

Punched-opening windows are the majority window type in most buildings built before 1991, with the exception of restaurants which are predominantly store-front windows.

⁹ The overall adjustment accounts for overlapping instances, i.e., presence of glazing and in an unheated facility.



Section 4 Recommendations

A primary research objective for this work was to explore and confirm key scenarios for which CSW might be a viable solution, including hypothesized opportunities. In this section the team discusses different opportunity scenarios that arose from the research. We also discuss specific activities that the program team could consider in order to capitalize on these scenarios.

4.1 Building Opportunity Scenarios

Opportunity scenarios are not mutually exclusive as they represent a combination of physical building attributes, ownership characteristics, and market conditions that all contribute to the assessment of whether or not a certain project is a good candidate for CSW. Each potential opportunity can act as a driver in favor of CSW. Whether they outweigh the barriers against CSW will be determined on a case-by-case basis.

Historic Buildings

Historic buildings are the most immediately amenable market to CSW. All market actors agreed that these buildings were prime candidates for CSW. Consistent with prior research, our team identified historic buildings as a logical entry point for CSWs into the commercial building market. The ability to upgrade windows without modifying the exterior façade of a historic building is often a key consideration in these projects. CSW can retain window operability, soundproofing, while preserving windows with historic value. These installations provide a good opportunity for architects, glaziers, and property managers to become more familiar with the product and our interviews found that market actors warmed to CSW as they learned more about the product.

To target the historic building market, the NEEA program team could identify the architects who are often consulted early in the historic restoration and renovation planning process. Ensuring that architects are aware of CSW will help ensure that the benefits of CSW are discussed. The team's interviews showed that lack of product awareness with CSW often means that they are not considered in the planning process, even in buildings where they may be good candidates. Architects need to have tangible experience with new products, so using pictures of specific examples of actual products and demonstration projects will be important. The program team might also consider outreach to regional historical preservation societies or historic building permitting offices to understand the decisions, players, and priorities in these building projects.

Single Pane Existing Windows

Poorly performing single pane windows are ripe for upgrade across the Northwest. Prior research suggests that CSW can often be a significantly lower cost than full window replacement, however specific pricing and installation costs will need to be provided to specifiers (architects) and glaziers before CSW are likely to be included in bids. Single pane



windows are often associated with tenant complaints about external noise and comfort issues that can be mitigated by CSW.¹⁰

Targeting specific buildings with single pane windows would likely require a substantial amount of effort. These buildings may not even be considering a window upgrade. One way to increase the likelihood that CSW are considered when buildings with single pane windows renovate is to make sure that the glaziers and architects consulted for the renovation are aware of the product. Also, as building performance standards such as HB1257 in Washington State start to require existing buildings to upgrade their performance or pay financial penalties, even hesitant building owners will likely be more open to consider window upgrades including CSW.

Window Type: "Ribbon" or "Storefront" Windows

Our research indicates ribbon and storefront window¹¹ types may be candidates for CSW because installers can mount the secondary window directly to the frame without worrying about the additional weight of the secondary window. This is opposed to curtain wall windows, where the existing window façade is not supported by the weight bearing structure of each floor of the building. In those cases, an installer would need to perform an engineering analysis to ensure that the façade could bear the weight of additional windows. With ribbon and storefront windows, the secondary window is supported by the floor, so installers do not need to worry about additional weight. Simple fixed rectangular secondary windows are installed to match the openings in the ribbon windows.

Security

Security upgrades have emerged as a major market trend in recent years, especially among buildings that have specific security mandates. Previous CSW research found that manufacturers will highlight the security features of CSW in marketing, touting the added security from break ins and window smashing due to the additional layer of glazing. CSW may also provide additional blast proofing if they are designed to meet

"In my market, really, it's security that's driving." — Glazier

specialized standards for the glazing, framing, and anchorage, which can anecdotally drive window upgrades in some buildings like federal facilities, police stations, and courthouses.

Institutional Owners

The team identified buildings with institutional owners as another potential opportunity. These buildings may also have the other key drivers that make a project a good candidate for CSW. These buildings are usually owner occupied, have longer payback periods for energy upgrades, often have an organizational sustainability or efficiency targets, and are more likely to have security mandates. Institutional owners include municipal/governmental, university, school, and

¹¹ Installing secondary windows in large storefront panes may require the installation of additional mullions.



¹⁰ CSW require the existing window frame to be in good condition so that the secondary window can be installed securely

hospital buildings. When the owner manages an entire campus of buildings, there may also be a single point of contact for a portfolio of buildings.

Owner Priorities

Like so many commercial building upgrade decisions, the final call typically resides with the owner. The level of involvement by owner and final decision will reflect several factors:

- **Reason for upgrade.** Tenant improvements are more likely to be scoped and driven by building tenants, although the owner or property manager is generally involved. These improvements tend to focus only on the interior of the space, but could include window treatments, films, or solutions to improve tenant experience of drafts, solar heat gain, and noise.
- Scale of upgrade. Not all projects are equally challenging to plan or pay for. Minor upgrades might be handled directly by tenants or property managers, while major investments are more likely to involve a general contractor or owner. The qualitative nature of our interviews did not identify a dollar value threshold for this shift. We did not hear a difference in how window performance is approached as projects move from single system to major renovations—in all cases owners will avoid window upgrades unless they cannot be avoided. If CSW defer that investment for another 10-20 years, they could be a viable option.
- **Type of owner**. In focus group conversations and in-depth interviews institutional owners (the municipal, university, hospitals and schools, or MUSH) emerged as property owners that tend to have a combination of robust budgets, long-term planning, and other concerns (security, aesthetics, historic buildings) that could align well with the attributes of CSW.

4.2 **Program Opportunities**

This section provides the team's recommendations for activities that can build upon the opportunities identified in this report.

1. Conduct activities to spread information and increase education

The program team can address low awareness levels and outstanding market actor questions by conducting outreach, training activities, or information dissemination. Architects and glaziers participating in focus group discussions expressed skepticism when provided with an initial product description. This led to questions, often detailed, about the cost, installation requirements, time to acquire/manufacture, and warranties. As they considered the diversity of buildings, they often identified specific scenarios for which CSW could be appropriate. Low awareness and strong bias towards full replacement create unfavorable market conditions for CSW. However, we cannot conclude that this bias would remain if the professionals involved were fully informed about the specifications and performance of CSW.

To build awareness and ease concerns over outstanding questions, we recommend that NEEA develop clear, technically accurate answers to the most frequently asked questions. Providing



examples of actual projects that have used CSW will also help build awareness, especially for architects and building owners who like to "see, feel, touch." NEEA should disseminate this information electronically through high profile web sites and through partner organizations like NGA.¹²

2. Commit to identifying key contacts with buildings of interest

To leverage the opportunity scenarios, the decision makers and recommending parties (property managers, architects, glaziers) need to be aware of CSW as a potential option. To reach these key contacts, we suggest that NEEA identify and connect with building representatives. Property management contacts asked pragmatic questions and demonstrated an openness to simple solutions; however, they are extremely difficult to reach. A concentrated effort to build out contact lists, work with BOMA¹³ or similar trade groups, or attend regional facility events could help NEEA reach these important players in commercial building management.

3. Build relationships with NW architects, glaziers, and property managers

We also recommend that NEEA consider engaging a product representative with ties (or to build ties) with glazing and design professionals. This person could position themselves as a one-stop resource for questions on products and performance. They could also participate in demonstration project showcases and conduct trainings/lunch and learns with window and design professionals. This product ambassador will need to establish trust and build relationships. Our research showed substantial, but surmountable, initial skepticism to CSW and having a "face of the program" who can credibly answer technical and product level questions would help build trust.

4. Clarify outstanding questions about the link between CSW and building codes

During the focus groups questions emerged about how building and energy codes applied to commercial secondary windows. NEEA has an opportunity to clarify the link between CSW and building codes to help dispel these concerns. These questions included the following topics:

- Will secondary windows meet aggressive new energy codes and U-factor requirements?
- Do secondary windows impede egress and meet building code requirements where egress windows are required?
- Are there other building code requirements that apply to secondary windows?

To address these questions, our team consulted with a subject matter expert, Dr. Tom Culp of Birch Point Consulting LLC. (For a full discussion of these topics, see Appendix A: Code Discussion.) These questions point out an important area for education about CSW. While some concerns are unfounded, others present questions that should be investigated further. We found that market actors often had immediate questions when learning about CSW, we recommend that NEEA provide clear answers to those questions through information dissemination and training activities.

¹³ Building Owners and Managers Association <u>https://www.boma.org/</u>



¹² The National Glass Association was a partner in this research effort and could be a valuable partner for the program team in the future.

5. Educate market actors on the relative cost of CSW

Market actors often had questions regarding material costs, installation costs, and soft costs¹⁴ associated with CSW. Research, especially information from manufacturers, has shown that all three of these categories may prove to be drivers in favor of CSW over full window replacement, but without firm estimates for bidding purposes, market actors are unlikely to shift from the status quo.

4.2.1 Prioritizing Next Steps

Considering the opportunities identified here (as well as previous research, which was largely confirmed in this project), the team provides the following recommended next steps for program outreach and market engagement.

Category	Approach
Highest Priorit	у
Historic Buildings	 Historic buildings emerged as the most logical market segment for CSW, given the restrictions on full replacement and the motivations of building owners to protect these buildings from damage. Architects and glaziers identified these buildings as likely opportunities. Leveraging this opportunity will require: Identifying candidate building owners from registries of historic buildings or engagement with historic preservation review boards. Identifying an initial cohort of architects that specialize in these buildings. Providing information to owners and architects about CSW solutions. Supporting 1-2 demonstration project installations in each state.
Middle Priority	/
Institutional Buildings	 Institutional buildings are a reasonable next step for program outreach and market engagement. The ownership of these buildings is largely a matter of public record, and they often have multiple social priorities that enable decisions based on factors other than first cost. Leveraging this opportunity will require: Identifying institutional owners (for example, governments, universities, health care systems). Preparing a market specific outreach plan that emphasizes how CSW can: Support goals associated with security and riot proof glass needs.

Table 14: Recommended Prioritization: Market Engagement Strategies

¹⁴ Soft costs are those associated with a replacement project but not necessarily the core costs of material and labor. These include permitting, disposal, street closures, and tenant disruptions and similar that often accompany window replacements.



- Protect historic or important buildings without requiring window replacement.
- Meet energy, climate, or sustainability goals.
- Avoid resident, tenant, or service disruption.

Property Management Outreach	 Property managers are associated with a variety of building types, making it difficult to target them based on stock characteristics alone. However, they approach building solutions from a pragmatic perspective that values simple solutions to common problems. Interviews revealed surprise and interest in the CSW option. Reaching these professionals is challenging, but potentially critical for CSW adoption. Leveraging this opportunity will require: Partnership and engagement with property management networks like BOMA. Attendance, tabling, and targeted FAQs at conferences, meetings, or similar in-person events. Answering questions is likely to be the first step in lead generation. Lunch and learn or breakfast events to increase awareness and address concerns.
Glazier Outreach	 Glaziers are important trade allies, but favor replacement products they have confidence in. Building their confidence in CSW will require a concerted engagement effort that anticipates their concerns and provides clear, technically accurate information on performance, cost, warranties, and product options to enable bidding and proposals. Maximizing the role of glaziers will require: Additional segmentation of existing glazier population list to identify smaller shops that might provide maintenance or daily repair services to buildings that could benefit from CSW. Outreach and product representative type presentations to glazier firms. A one-stop resource they can access for information or advice when considering CSW. (This could be a website, hotline, or a specific person.)

Lower Priority	
Architect Outreach	Architects are also important trade allies and tend to be present when a permit is required. The best way to ensure CSW are included as an option is for them to be specified in bid documents. However, architects will tend to recommend replacement for aesthetic reasons. We recommend NEEA develop an overall strategy for engaging architects with information similar to that provided on BetterBricks—adding CSW to the suite of products and services NEEA is promoting in commercial buildings will likely be more efficient than a CSW-specific effort. In approaching architects, NEEA will need:



- Specific architectural drawing examples for different types of products that reflects nuance of existing systems (show how CSW will work in *specific* scenarios).
- Overcome concerns about aesthetics. A showroom or high-quality photo catalog would help these design-oriented people specify CSW.



Appendix A: Code Discussion

The following questions emerged in focus group discussions.

- 1. Will secondary windows meet aggressive new energy codes and U-factor requirements?
- 2. Do secondary windows impede egress and meet building code requirements where egress windows are required?
- 3. Are there other building code requirements that apply to secondary windows?

To address these questions, our team consulted with a subject matter expert, Dr. Tom Culp of Birch Point Consulting LLC.

Will secondary windows meet aggressive new energy codes and U-factor requirements? To answer the first question, our team found that **energy codes are not a barrier to commercial secondary windows**, in that both ASHRAE 90.1 and the International Energy Conservation Code already provide allowances for secondary windows installed over existing windows because they are improving the building.¹⁵ (Note: while each state adopts and implements their own energy code, they are often based on either ASHRAE 90.1 or the IECC as a model code. For instance, Oregon's new energy code is based on ASHRAE 90.1-2019 with some local amendments.) ASHRAE 90.1 requires the secondary window to contain a low-e coating unless the existing window already has a low-e coating, whereas the IECC does not have this extra provision, but neither requires the secondary window to meet the same U-factor requirements as new windows. Nonetheless, this is an area of confusion, as well as energy codes in general.

One participant spoke about challenges meeting U-factors of 0.17 "required" by the new Oregon energy code, asking "how secondary windows would meet that". This comment was enlightening for the research team in that it shows the participants were (a) unaware of the allowance for secondary windows in the energy code, and (b) confusing specifications with energy code requirements. The new Oregon energy code is based on ASHRAE 90.1-2019, which has a prescriptive U-factor of 0.36 for fixed windows and 0.45 for operable windows. There is no requirement for anything close to U-0.17 in the new code, which was likely a U-factor in the specification for either just the glazing (not including window framing) or from a building owner specifying a very aggressive beyond-code product for new construction. Glazing contractors work to the specification provided to them, relying on the architect or general contractor to set the specification in compliance with the energy code, and in this focus group it was clear that there was a perception gap between the specifications and energy code.

Do secondary windows impede egress and meet building code requirements where egress windows are required?

When investigating second question regarding egress in operable windows, our team found that it is worth further investigation into how other aspects of the building code apply to secondary

¹⁵ See Section 5.1.3 of ASHRAE 90.1; Section C503.1 for 2015 IECC and later, Section 101.4.3 for 2012 IECC and earlier.



windows. It is clear that when a secondary window is installed in what is defined as a hazardous location by the building code (e.g., a glass door or sidelite), it must meet the applicable safety glazing requirements with either tempered or laminated glass. Also, when installed over egress windows (typically in lower floors of residential homes and apartments), the secondary window must not impede any egress requirements. This may simply be by choosing a product with operable sashes that match the primary window, but further confirmation with the building code requirements may be necessary. Neither of these situations affect typical secondary window installations but are important and a potential concern for installers. Conversations with manufacturers of secondary window products suggest that they have not had pushback from building code officials on prior projects, but it remains an important question to address¹⁶.

Conclusions and recommendations related building code concerns:

- Although awareness of how energy codes apply to secondary windows is low amongst market actors, we do not believe energy codes are a technical barrier to the use of secondary windows. In fact, secondary windows could be a strategy for improving window performance *without* triggering code requirements for new windows.
- The safety glazing requirements of building codes are clear, and also easily accommodated in secondary window products.
- NEEA may consider conducting further investigation of how the egress requirements in the main building code would apply to secondary windows to conclusively confirm that operable secondary windows satisfy egress requirements or conversely, if this is a true barrier for the limited locations where egress windows are required.
- NEEA has an opportunity to overcome concerns of market actors unfamiliar with these products by supplying them with clear answers to code questions.

¹⁶ SME works closely with CSW manufacturers and has discussed this question in prior projects.



Appendix B: Review of Market Barriers

Awareness is linked closely to other barriers, all of which work together to overcome inertia and standard practice solutions. Table 15 provides findings aligned with each of the barriers currently identified in the CSW program materials.

Considering the opportunities identified here (as well as previous research, which was largely confirmed in this project), the team provides the following assessment of identified market barriers.

Barrier	Findings		
Lack of awareness			
Supply side	There is clearly an opportunity to improve overall awareness among those that specify and install window products. Awareness was largely limited to historic building applications		
Demand side Low awareness among property managers and reluctance address shell measures prior to failure are both affecting This is less about demand for CSW specifically and more demand for upgrading the building envelope systems in absence of pressure to act. Energy efficiency will not be motivation—this outcome will need to be paired with improvements in sound transmission, glare, or property get the attention of building owners.			
Gaps in information and expertise			
Insufficient installer knowledge to sell	These barriers are closely related and all emerged organically in interviews. We recommend approaching these barriers holistically		
Lack of supply side installation expertise	by providing detailed information on product options, prices, installation and performance to glaziers. Window replacement - and repair contracting is a specialized trade and these contacts		
Missing proof of NW performance	require specific, detailed information in order to bid products. Their questions about installation practices, liability, and product options are not necessarily separate issues—they require all of these pieces to recommend and successfully complete CSW work. It is important to note that energy savings is not the top priority. They track U-value, solar heat gain, and NFRC ratings, but also focus on sound, aesthetics and water infiltration.		
High relative cost			
Inertia	The "relative cost" in this scenario refers to the option of doing nothing. Indeed, the expense of addressing shell improvements		

Table 15: Barriers and Research Findings Map



Commercial Secondary Windows Program Research Appendix B: Review of Market Barriers

means that many owners choose to do nothing until glazing systems are failing, after which they are inappropriate for CSW. This is likely the single biggest demand side barrier and is likely to be overcome on a building-by-building level, through customized solutions provided at the right time.

Lack of product differentiation

Lack of market signal or label to distinguish high performance product.

This barrier was not assessed directly; however it is important to note that introducing performance differentiation when basic awareness is low could reduce confidence in the overall product category. The questions the research team fielded from market actors indicate that answering fundamental product-level questions will be needed prior to introducing elements of differentiation. If labeling provides specific performance ratings (on sound transmission, solar heat gain, U-value) of <u>combined</u> <u>systems</u> (primary and secondary glass) it could potentially serve both purposes (increase awareness and confidence while also differentiating).



Appendix C: Data Collection Instruments

Survey Instrument

Table 16: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Web Survey
Estimated Time to Complete	Target: less than 10 minutes
Population Description	Architects, glaziers, and non-res property managers as primary in NEEA states
Sampling Strata Definitions	Three populations
Completion Goal(s)	10 per population
Call List Source and Date	Architects and property manager contacts obtained from Data Axle on Dec. 29, 2020. Additional glaziers sourced via internet search
Contact Sought	Contact with experience upgrading or rehabilitating existing commercial building shell (envelop), or part of the decision making process for these projects.

Table 17: Research Objectives and Associated Questions

Research Objective	Associated Questions	
Confirming they are active CSW market actors (architects, glazing installers, commercial property managers)	S1-S3	
Assessing CSW awareness from basic to advanced understanding		
 Unaided awareness (common solutions used for window retrofit and upgrade) 		
- Aided awareness (have heard CSW, have used CSW)	Q1-Q5, Q7-Q8	
- Information source		
 Frequency of dealing with window performance issues 		
Assessing knowledge of CSW product features and benefits	Q12	
Understanding attitudes		
- Confidence in CSW products	Q6, Q9, Q11, Q13	
- Likelihood to consider CSW for future projects		
- Questions or concerns in incorporating CSW		
Firmographics	Q14-Q15	
Recruiting for focus group studies	Q16	



Email Invitation

From: Cadeo Subject: Share what you know about window upgrades for \$50 in this 10minute survey

Hello \${m://FirstName} \${m://LastName},

Our firm, Cadeo, is conducting this study on behalf of the Northwest Energy Efficiency Alliance (NEEA) to understand awareness and market trends in commercial window upgrades. If you and your company are involved in upgrades or retrofits of existing commercial buildings in the Northwest, we would love to hear from you in this quick (less than 10 minute) survey.

You will receive a \$50 e-gift card as our thank you for your time.

Please know that we will keep your responses confidential, and we will only report aggregate findings without identifying any individual respondents.

First Page of the Survey

Thank you so much for agreeing to take part in this survey. We have a few basic questions to make sure you are qualified to take this survey.

Screening [ASK ALL]

[ASK ALL]

S1. Please select all the types of services your company provides.

[MULTIPLE RESPONSE]

- 1. Architecture and design
- 2. Windows or glazing installation, maintenance, and repair
- 3. Non-residential property management
- 4. None of the above [SKIP TO THE END OF THE BLOCK]

[DISPLAY IF S1 = 1 OR 2]

S2. Is your firm involved in window renovation or retrofit projects in existing commercial buildings?

[SINGLE RESPONSE]

- 1. Yes
- 2. No [SKIP TO THE END OF THE BLOCK]

[ASK ALL]

S3. Please select all the states in which your company does business.



[MULTIPLE RESPONSE]

- 1. Idaho
- 2. Montana
- 3. Oregon
- 4. Washington
- 5. None of the above

[DISPLAY IF S1 = 4 OR S2 = 2 OR S3 = 5, THEN TERMINATE]

Unfortunately, you are disqualified to take this survey. Thank you anyway for your willingness to participate.

[DISPLAY IF S1 <> 4 AND S2 <> 2 AND S3 <> 5, THEN CONTINUE]

Congratulations, you're qualified to take this survey and receive a \$50 Amazon gift card when you complete the survey. Let's begin!

Assessing Awareness, Knowledge, and Attitudes [ASK ALL]

[ASK ALL]

Q1. When dealing with window upgrade and retrofit projects in existing commercial buildings to address issues like thermal heat loss, external noise, draftiness, aesthetics, etc., what solutions would you consider? Please list any and all solutions you might consider.

1. [OPEN-ENDED RESPONSE]

-98. Don't know

[ASK ALL]

Q2. **PLEASE READ THIS PARAGRAPH CAREFULLY!** Commercial secondary windows are window units with one or more transparent panes in a frame that attaches to the interior or exterior of existing windows without replacing the original glass or frame. This creates an insulating pocket of air between the existing and new secondary window. Secondary windows have some other names in the market such as interior storm windows, interior storms, insulating panels or inserts, secondary glazing systems, all describing a similar product. The image below shows one example.



Before today, had you heard about secondary windows as a solution for window upgrade/retrofit projects in existing commercial buildings?

[SINGLE RESPONSE]

- 1. Yes, for commercial buildings
- 2. Yes, but not for commercial buildings
- 3. I had never heard of secondary windows before today.
- -96. Don't know

[DISPLAY IF Q2 = 1 OR 2]

Q3. Have you ever recommended, installed, or purchased a secondary window product as a solution for existing window performance issues in commercial buildings? Please select all that apply.

[MULTIPLE RESPONSE]

- 1. Yes, recommended
- 2. Yes, installed or purchased
- 3. Neither [EXCLUSIVE]
- -96. Don't know [EXCLUSIVE]

[DISPLAY IF Q3_2 = 1 (HAVE INSTALLED OR PURCHASED)]

- Q4. Were your previous secondary window installation(s) part of a historical building preservation project?
 - 1. Yes, all my experience with secondary windows is from historical buildings
 - 2. Yes, but I have experience with secondary windows in historical and non-historical buildings
 - 3. No
 - -96 Don't know

[DISPLAY IF Q2 = 1 OR 2]

Q5. How did you first hear about secondary window products for use in existing commercial building window upgrades or retrofits? Please select all that apply.

[MULTIPLE RESPONSE, RANDOMIZE ITEMS 1-7]

- 1. Manufacturer
- 2. Architect or designer
- 3. Glazing contactor
- 4. Trade association
- 5. Colleague or coworker
- 6. Advertisement
- 7. Saw them installed
- -96. Other, please specify: [OPEN-ENDED RESPONSE]
- -97. Don't know [EXCLUSIVE]

[DISPLAY IF Q2 = 1 OR 2]

Q6. The list below presents several features of secondary windows. Please rate your confidence in each feature using a 1-to-5 scale, where 1=not confident at all and 5= very confident. How confident are you that each of the following statements about secondary windows is accurate for commercial building upgrades or retrofits?



[SCALE RESPONSE: 5-POINT: 1=NOT CONFIDENT AT ALL – 5=VERY CONFIDENT, DK. RANDOMIZE ITEMS 1-5]

- 1. Secondary window solutions can meet client's energy performance expectations
- 2. Secondary window solutions can meet client's aesthetic needs
- 3. On-going maintenance of secondary windows is easy and low-cost
- 4. Installation of secondary windows is easy and low-cost
- 5. Overall cost of secondary windows is significantly lower than window replacement

[ASK ALL]

Q7. How common are window performance issues among the existing commercial buildings that you deal with? (thermal heat loss, external noise, draftiness, etc)

[SINGLE RESPONSE]

- 1. Very uncommon (less than 25%)
- 2. Somewhat uncommon (25-49%)
- 3. Somewhat common (50-74%)
- 4. Very common (75% or more)
- -96. Don't know

[ASK ALL]

Q8. Thinking about these existing commercial buildings with window performance issues, approximately what percentage of building owners decide to address the window performance issue?

[SINGLE RESPONSE]

- 1. 0%
- 2. 1-10%
- 3. 11-20%
- 4. 21-30%
- 5. 31-40%
- 6. 41-50%
- 7. 51-60%
- 8. 61-70%
- 9. 71-80%
- 10. 81-90%
- 11. 91-100%
- -96. Don't know

[ASK ALL]

Q9. Now, when building owners choose **not** to address window performance issues, how often is it because window performance improvements are competing with other upgrades such as mechanical systems, lighting, or adding insulation?

[SINGLE RESPONSE]

- 1. Never
- 2. Rarely
- 3. Sometimes
- 4. Often



5. Always

-96. Don't know

[ASK ALL]

Q10. Are window upgrades more likely to be implemented as part of a larger retrofit project? As opposed to window upgrades by themselves.

[SINGLE RESPONSE]

- 1. Much more likely to be implemented with other retrofits
- 2. More likely to be implemented with other retrofits
- 3. Roughly the same proportion by themselves and part of other retrofits
- 4. Less likely to be implemented with other retrofits
- 5. Much less likely to be implemented with other retrofits
- -96. Don't know

[DISPLAY IF Q2 = 1 OR 2]

Q11. How likely are you to consider secondary window products for future projects involving existing commercial building window upgrades or retrofits?

[SINGLE RESPONSE]

- 1. 1 = Not at all likely
- 2. 2
- 3. 3 = Neutral
- 4. 4
- 5. 5 = Very likely
- -96. Don't know

[DISPLAY IF Q2 = 1 OR 2]

Q12. The statements below describe several product features and benefits of secondary window products. Please tell us how much you agree or disagree with each of the followings.

[SCALE RESPONSE: 5-POINT: 1=STRONGLY DISAGREE, 3=NEITHER DISAGREE OR AGREE, 5=STRONGLY AGREE, RANDOMIZE ITEMS]

Product Features

- 1. I know secondary window products offer a wide range of glazing options
- 2. I know secondary windows provide solutions for both fixed and operable existing windows

Other benefits

- 3. I know most secondary windows do not require specialized installation skills
- 4. I know potential energy savings that secondary windows can provide
- 5. I know secondary windows can increase tenant comfort by reducing noise and thermal heat loss
- 6. I know that secondary windows can be more cost effective than window replacement
- 7. I know secondary windows are a viable solution for historic preservation projects

[DISPLAY IF Q2 <> 1 OR 2]

Secondary window solutions offer many benefits and application flexibilities such as:



Product Features

- 1. Secondary windows provide a wide range of glazing options
- 2. Secondary windows provide solutions for both fixed and operable existing windows

Other benefits

- 3. Most secondary windows do not require specialized installation skills
- 4. Secondary windows offer potential for energy savings
- 5. Secondary windows can increase tenant comfort by reducing noise and thermal heat loss
- 6. Secondary windows can be a cost-effective solution compared to replacement
- 7. Secondary windows are viable solution for historic preservation projects

[ASK ALL]

Q13. What questions or concerns are most top of mind when considering whether to incorporate secondary windows in your future projects for existing commercial buildings?

1. [OPEN-ENDED RESPONSE]

-98. Don't know

Firmographics [ASK ALL]

Finally, we have just a few questions about your company. These help us understand the frame of our research.

[ASK ALL]

Q14. In a typical year, approximately how many projects does your company do in all sectors (Commercial, residential, industrial) [IF S1_Non-residential property management=SELECTED, show: "In a typical year, approximately how many buildings does your company manage in all sectors?"]

[SINGLE RESPONSE]

- 1. [NUMERIC]
- -96. Don't know
- -97. Refused

[ASK ALL]

Q15. In a typical year, approximately what percent of your company's total number of projects are for existing commercial buildings? [IF S1_Non-residential property management=SELECTED, show: "In a typical year, approximately what percent of the buildings your company manages are commercial buildings?"]

[SINGLE RESPONSE]

- 1. _____[NUMERIC]
- -96. Don't know
- -97. Refused

In-Depth Interview Recruitment [ASK ALL]

[ASK ALL]

Q16. Lastly, we plan to conduct more in-depth interviews and virtual focus groups about commercial secondary windows within the next month. These interviews and focus groups will be on the phone, and will run 60 minutes and 90 minutes, respectively. Participants will receive an additional \$75 gift card for interviews and \$100 for focus groups. If qualified, would you be interested in participating in these discussions?



[SINGLE RESPONSE]

- 1. Yes
- 2. No
- -96. Don't know

These are all the questions we have today. Please confirm the information below so that we can send the \$50 Amazon e-gift card to the correct email address. <u>Please make sure you click on the "Submit" button to complete this survey.</u>

Thank you very much for your time!!

Email _____ [AUTO FILLED]

SUBMIT

Focus Group and IDI Discussion Guide

Table 18: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Focus Group and Interview Guide
Estimated Time to Complete	Focus Group: 90 minutes/Interviews 30-60 minutes
Population Description	Architects, glaziers, and non-res property managers in NEEA states
Completion Goal(s)	3 focus groups of up to 7 participants, and up to 5 interviews
Call List Source	Recruitment informed by survey opt-ins and as needed additional recruitment to add perspectives to group composition. Mix of Cadeo purchased and prepared lists.
Contact Sought	Contact with experience upgrading or rehabilitating existing commercial building shell (envelope/windows), or part of the decision-making process for these projects.
Fielding Firm	Cadeo

Table 19: Research Objectives and Associated Questions



Commercial Secondary Windows Program Research Appendix C: Data Collection Instruments

Research Objective	Associated Questions
Identify motivations behind window upgrade decisions and test assumptions about key scenarios for recommending CSW	Error! Reference source not found. Q19, Q20, Q22, Q23, Q25, Q27, Q29, Q30, Q31, Q34
Identify decision makers and understand decision making tradeoffs or motivations for each key role (e.g. property managers) as well as where the best opportunity for program intervention is.	Q17,Q21,Q26,Q33
Identify how NEEA can work with the existing market actors to support their existing efforts in CSW adoption.	Q24,Q27,Q31,Q34
Develop scoring or ranking of scenarios most conducive to adopting CSW	Q22,Q25,Q32

Moderator Notes

The general outline and schedule for the online focus group discussion includes time for technical set up and assistance as well as a brief wrap-up poll or activity. The total time for the small group discussion is between 60 and 90 minutes. The general schedule is as follows:

- Technical set up (5-10 minutes)
- Introduction and Goals (5 mins)
- Ground rules (5 mins)
- Focus group guide (about 20 mins per scenario, with 3 scenarios = 60 mins)
- Wrap-up (5-10 mins)

4.2.2 Focus Group Instrument

Thank you for joining us today! We appreciate your time and look forward to an interesting discussion.

We're here to learn about how professionals like you identify solutions for buildings with window performance issues, particularly when trying to avoid a full reglaze or window replacement. We encourage you all to share your perspectives with each other as well. Our discussion will take about 90 minutes.

We'll be recording the session today, but this is for our research purposes only. Your name will not be attached to any information or quotes we use in our reports.

Your \$150 incentive will be sent to the email address we have on file for each of you at the conclusion of the discussion.

Let's make sure everyone's technology is working.

[Test audio and other Zoom functions, remind about mobile device guidelines: 1) finding a quiet space, (2) propping up mobile device so that the camera remains stationary for the discussion, (3) Zoom-specific mobile navigation (where to access chat feature, how screen sharing will work, etc.)]



Before we begin, I would like to cover a few ground rules that are helpful to make sure everyone is able to fully participate in our discussion:

- 1. Each person's opinions should be respected as valuable there are no "right" or "wrong" ideas
- 2. Group members take turns talking everyone should be allowed their chance to speak without being interrupted
- 3. We want everyone to be candid, let's treat this conversation as confidential
- 4. Since time is limited, the group leader may ask participants to "wrap-up" or end their comment

Any questions before we begin?

4.2.3 Introduction

To get started, please introduce yourself. Tell us your:

- Name
- Current professional role at your organization

4.2.4 Focus Group Questions

- Q17. What are the most common issues or complaints do you encounter with older windows in existing buildings?
- Q18. What do clients or building owners typically want to do? (Probe to understand what they want other than limiting costs)
- Q19. [Show image/diagrams] This is a secondary commercial window [if needed: a secondary panel attached over the existing window, either on the interior or exterior, to upgrade an existing window without replacing it]. You may have heard other names for these products such as interior storm windows, interior storms, insulating/energy panels or inserts, secondary glazing systems.

... how many of you have seen these? Considered them for a project? Installed them? In what situations might you consider a secondary commercial window?

Now, let's discuss a few scenarios behind window upgrade decisions.

Major Building Retrofit

- Q20. Thinking about a major building retrofit, where multiple building systems are being upgraded at once... how does window performance typically come up in these conversations? (probe: to understand examples for when it would or wouldn't come up)
- Q21. Who drives the decisions on window or shell upgrades in these scenarios?
- Q22. Would you consider recommending secondary window attachments in these instances? Why or Why not?

Major Envelope Retrofit



- Q23. What about projects where the building envelope is already prioritized, either because the owner wants to upgrade the look of the building or because of damage or failure.... How are windows assessed in these projects?
- Q24. We want to understand how solutions like secondary windows might stand up to other options, for example total replacement... how do your clients or building owner approach these decisions?
- Q25. Would you consider recommending secondary window attachments in these Major Envelope Retrofit instances? Why or why not? (Probe for when CSWs would be a good idea for major envelope retrofits)
- Q26. Who typically makes the decisions during a major building envelope retrofit? (Probe to understand the role of they play vs. others—owner vs. architect vs. engineer... maybe these projects are sometimes driven by a buyer?)
- Q27. What would convince them to consider secondary windows?
- Q28. What concerns do you think they would have?

Window Rehabilitation

- Q29. Let's turn to projects where window rehabilitation has already been identified... what are the most common options considered in these scenarios? (Probe for other options besides replacement or window attachments)
- Q30. How often are you faced with specific building needs, for example to block out noise, reduce solar heat gain, or improve security? (How do these elements affect the recommendations?)
- Q31. Have you ever recommended window attachments in this scenario (refer to any scenarios that emerged in the conversation)?
- Q32. Did the project move forward with the window attachments? Why or Why not?
- Q33. Who is part of making the decision for window upgrades? What, in your opinion, would encourage them to choose secondary windows?

Outside of the scenarios we've discussed....

- Q34. Are there other instances where you would consider secondary windows as a solution? (Ask them to describe any ideas or scenarios that would be appropriate for considering secondary windows.).
- Q35. Thinking about our conversation today, what is the best-case scenario for selecting commercial secondary windows as a solution? How common is that?
- Q36. Are there any other final thoughts you would like to share about commercial secondary windows?

Those are all my questions for you. Thank you so much for all your helpful input today.

You will receive your \$150 e-gift card within 1 week via email.

Thank you for your time!



4.2.5 Interview Instrument

Thank you for talking with me today! We are interested in learning about your experience selecting solutions when a building has window performance issues. Particularly when the objective is to avoid a full reglaze or replacement.

We typically record these interviews to take more accurate notes. We do not share our notes with anyone. Everything you share is confidential and any findings we report will be deidentified. Does that work for you?

Your \$150 incentive will be sent to the email address we have on file for each of you within 1 week of this interview.

4.2.6 Interview Questions

- Q37. Can you briefly tell me about a time where you needed to change or upgrade windows in a commercial building? Why was the change needed?
- Q38. In your work, how common is it to find problematic performance in existing windows?
- Q39. What options do you consider in these scenarios?
- Q40. What are your preferred solutions?
- Q41. What do your clients or the building owners typically want to do? (Probe to understand want they want to do other than limiting costs)
- Q42. Are you familiar with secondary windows? (Provide definition if not familiar.) Have you considered them for a project? Installed them? In what situations might you consider a secondary commercial window?

Now, we are going to pose different scenarios to learn about the reasoning that goes into making window upgrade decisions.

Historic Building Retrofit

- Q43. Thinking about when you are doing a historic building retrofit, what options do you consider when window performance has been identified as an issue?
- Q44. Do you consider recommending secondary window attachments in these instances? Why or Why not?
- Q45. Who is part of making the decision for window upgrades? What, in your opinion, would encourage them to choose secondary windows?
- Q46. What other considerations are there in choosing or not choosing CSWs during historic building retrofits?

Major Building Retrofit

- Q47. Thinking about a major building retrofit, where multiple building systems are being upgraded at once... is window performance typically part of those scoping conversations?
- Q48. If yes: Can you briefly describe a scenario where window performance came up in a major building retrofit?
- Q49. If no: why not?



- Q50. Who drives the decisions on window or shell upgrades in these scenarios?
- Q51. Would you consider recommending secondary window attachments in these instances? Why or Why not?

Major Envelope Retrofit

- Q52. What about projects where the building envelope is already prioritized, either because the owner wants to upgrade the look of the building or because of damage or failure.... How is window performance assessed in these projects?
- Q53. We want to understand how solutions like secondary windows might stand up to other options, for example total replacement... how do your clients approach these decisions?
- Q54. Would you consider recommending secondary window attachments in these instances? Why or why not? (Probe for when CSWs would be a good idea for major envelope retrofits)
- Q55. Who is part of making the decision for window upgrades during a major building envelope retrofit?
- Q56. What would encourage them to choose secondary windows?
- Q57. What concerns do you think they would have?

Window Rehabilitation

- Q58. Let's turn to projects where window rehabilitation has already been identified... what are the most common options considered in these scenarios?
- Q59. How often are you faced with specific building needs, for example to block out noise, reduce solar heat gain, or improve security? (How do these elements affect the recommendations?)
- Q60. Have you ever recommended window attachments in this scenario (refer to any scenarios that emerged in the conversation)?
- Q61. Did the project move forward with the window attachments? Why or Why not? (Probe for other options besides replacement or window attachments)
- Q62. Who typically makes the decision on window upgrades? What, in your opinion, would encourage them to choose secondary windows?

Outside of the scenarios we've discussed....

- Q63. In what other instances would you consider recommending secondary windows?
- Q64. Thinking about our conversation today, what is the best-case scenario for selecting commercial secondary windows as a solution? How common is that?
- Q65. Are there any other final thoughts you would like to share about commercial secondary windows?

Those are all my questions for you. Thank you so much for all your helpful input today.

