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Commercial Secondary Windows Field Observations and Decision-Maker Interviews Report

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1 Introduction

Through their work to develop a Window Attachments market transformation program, the Northwest Energy Efficiency Alliance (NEEA) seeks to accelerate the adoption of high-performance commercial secondary windows (CSW) in commercial buildings with low-performing windows. The market transformation goal is that commercial secondary windows are established as the standard product to address existing low-performing windows. To reach this goal, the market must address barriers created by lack of differentiation, lack of awareness among demand-side audiences, and high first cost. The market must also leverage opportunities made available by emerging local and state policies and regulations.

In spring 2021, NEEA contracted with Energy 350 to conduct research aimed at better understanding the real-world installation techniques, benefits, key barriers, and manufacturer long-term goals associated with CSW. To complement the suite of concurrent field tests, NEEA requested Energy 350 conduct onsite observations and follow-up interviews with select market actors. The objective was to gain insight into the installation process and determine if there were training and education needs NEEA might support with their program, or other future programs aimed at commercial building retrofits. Specifically, NEEA was interested in achieving the following research objectives:

- Observe and document CSW installations to understand the techniques, challenges, workaround solutions, and perceptions of the product and the process.
- Characterize the before-and-after experiences of occupants and decision-makers of buildings where CSWs have been installed.
- Identify any considerations that influence building owners' or other decision-makers' choice to invest in CSWs for their window retrofit, including value proposition, and whether energy efficiency plays a role.
- Provide insight into if those considering commercial building window retrofits (with CSWs or another window product) also consider impacts to their commercial HVAC system.
- Document any evidence these project decision-makers consider window retrofits as part of a deep energy retrofit of their building.

2 Methodology and Research Activities

The CSW program recruited seven installation sites between 2021-2023 to study the energy savings potential of various products. Of those seven sites, five were available for onsite observation and/or market-actor interviews or occupant surveys. Our focus for these sites included a mix of onsite observation accompanied by follow-up interviews and surveys with vendors, decision-makers, and occupants. We did not perform the same mix of observations and interviews on every site because some sites used the same CSW vendors and because of lack of availability of some site decision-makers during the project's timeline. Table 1 provides a list of the field sites, their location and electric utility service provider, as well as the research activities fielded at each site.



Table 1: Installation Site Location, Research Activities Performed, and Other Site Details

Project & Location	Utility Partner	CSW Vendor	CSW Installer	Site Observation & Installer Interview	Vendor Interview	Decision Maker Interview	Occupant Survey
Site A Vancouver, WA	Clark PUD	Alpen	Alpen	X	X		
Site B ¹ Lynnwood, WA	Snohomish PUD	Alpen	Alpen			X	
Site C Beaverton, OR	PGE/Energy Trust	Inovues	Dallas Glass	X	X		
Site D Portland, OR	PGE/Energy Trust	Indow Windows	Retrofoam ²	X		X	X
Site E Bozeman, MT	Northwestern Energy	Allied	Gables Glass	X	X		

1. We did not conduct an onsite observation at Site B because the same product and installer was used on the recently completed project at Site A.

2. Although Retrofoam performed the install at Site D, they noted that Indow Windows was ending the preferred third-party installer program so they are unable to install their products in the future.

For each site, the Energy 350 evaluation team coordinated with the CSW vendor and site installer to schedule the site visit and conduct the observation. While onsite, we witnessed the installation of at least one CSW and interviewed the site installer regarding their technique, project difficulty, potential issues, remedies to fix incorrect installations, and overall impression of the CSWs.

Although CSW products varied by site, observations and installer interviews typically lasted two hours with most of the time dedicated to the interview itself. We asked installers about their familiarity with the specific products they installed as well as the learning curve associated with the CSWs. We also inquired about the amount of site preparation needed and any challenges they encountered during the installation process.

3 Key Findings

Information gathered from the onsite observations, interviews with installers, vendors, decision-makers, and occupant surveys led to several key findings regarding CSWs grouped according to each market actor interviewed or surveyed below.

3.1 Observation and Installer Interview Findings

Several key takeaways emerged from our onsite observations and parallel interviews with the installation crew. Although most installers had no previous experience with CSW, they all commented on the need for a cost-competitive product and noted that cost is the main driver of their product choice when bidding on jobs. Across all sites, installers and vendors also stated that



the most important pre-work to ensure a quality installation was taking careful field measurements. Without those, they noted how easy it would be for these products to show up onsite and either not fit or need substantial re-work to adequately fit the window opening. This requires careful measurements done by professionals in most cases, and results in every site needing a tailored approach. Several vendors did allow the site's building staff to perform the pre-work measurements, while others required manufacturer's reps or trusted local installers to be present to ensure measurements were done correctly. However, even with careful pre-work measurements, minor re-work on several CSWs was needed across all sites to correctly fit the existing window frames. This stresses the need for diligence before the CSWs are manufactured or installed.

While all products qualified as a CSW, no two products we observed were alike. For interior-based products, the installation varied between setting a magnetic strip to attach the CSW, to a pressure-fitted windowpane that created a sealed cavity between the existing window and the CSW. As expected, exterior-mounted CSWs required more site prep to install metal framing and securely attach the glass pane, as well as weatherproofing and caulking around the frame. Additionally, although each observation included a different manufacturer's product, each installer commented on the ease of installing the CSW and how much faster it was compared to a traditional window replacement¹.

For major renovations, installation of CSWs occurs after the interior finishes are complete, which contrasts with traditional window replacements that happen during the rough-in phases of a project. As such, a CSW installer's timeline can become impacted due to myriad other trade activities that occur before the interior finishes are complete. This contrasts with a traditional window replacement where window installs occur prior to the completion of interior finishes, leaving fewer trade schedules to coordinate.

A key finding from talking to installers was that, aside from a few hours of oversight from the manufacturer's rep, no formal training was required for first-time glass installers. Though one externally mounted CSW product required more oversight initially, most installers, vendors, and decision-makers felt their facility staff could also install the CSW product with little instruction, should they need to in the future. Furthermore, building owners plan to have their maintenance staff install any future CSWs rather than contracting with a third party.

3.2 Vendor Interview Findings

All three vendors interviewed recognized that CSWs are a retrofit product and that the greatest value has been in applications where traditional window replacement was necessary but expensive. All expect growth in their business over the coming decade, with many investing in training local glass installers to perform measurements and installs rather than sending manufacturer's reps to each jobsite for pre-measurement and install QC. This will allow them to offer more cost-competitive products and tackle smaller jobs because they can lower their own operation cost to make it profitable.

¹ The one externally mounted solution required more careful fieldwork to install compared to the internally mounted products, however the installer felt the learning curve was not too steep after the initial install.



While vendors expect to offer products to more corners of the market, historic building renovations are where vendors have found the most uptake. Vendors also agreed that areas of the country where state energy policy or utility incentives were present greatly helped increase the market uptake of CSW. They commonly mention the potential for utility incentives in their value proposition to prospective customers.

To market their products, vendors almost exclusively target building owners directly. In some cases, vendors also provide energy-modeling support and sit with the decision-maker of the site to review cost options and quantify many of the benefits. Though energy efficiency is not always a part of the conversation with customers, return-on-investment (ROI) does often drive product decisions. For many projects, vendors aim to specify a product with an ROI fewer than 7 or 8 years so their product will be cost competitive in the market when the project goes out to bid. This helps the value proposition compared to traditional window replacement. For example, some vendors see curtain walls for large retail stores as a growth opportunity where there may not be a substantial number of total windows; however, a window replacement would be too costly to undertake, making CSWs an attractive alternative.

All three vendors interviewed promoted their CSW product as an alternative to window replacement and found that it was a cost-effective solution when viewed in that way. They also recognized it is difficult for CSWs to compete with other efficiency upgrades or fixes, especially if existing windows are still functioning. One of the most difficult elements of the business, regardless of the window product offered, is getting in front of the correct business decision-makers. Vendors also universally agreed that in general the main competition to their product is owners doing nothing at all. Meaning, they do not compete with traditional window replacements but rather inaction (to improve the building envelope).

3.3 Decision-maker Interview Findings

Only two decision-makers were available for interviews across the five sites that were part of this evaluation. Key factors that led decision-makers to install CSW included noise reduction and thermal comfort concerns. While neither decision-maker noted efficiency as the primary reason for installing the product, both were aware of the energy benefits that CSW provide. Additionally, one decision-maker noted that because their firm works in the sustainability field, improvements to their envelope would also allow them to “walk-the-talk” with regards to efficient design.

One of NEEA’s market transformation objectives is to assess whether CSWs are considered as part of a deep retrofit for building owners. While a deep retrofit was not considered at the time of CSW installation, both decision-makers stated they recognized the interactive benefits from upgrading their envelope. One decision-maker will pursue an HVAC upgrade in the coming year and commented that having CSW will allow them to reduce the capacity of a new HVAC system in the future, saving capital cost and energy. This is important as both decision-makers also noted they look for ROIs in the 2 to 3-year timeline. While CSWs fall outside of that as a standalone upgrade, when viewed as an alternative to a traditional window replacement, they are a cost-effective choice. Using this comparison, both decision-makers were able to move the CSW installation through their capital budget process.

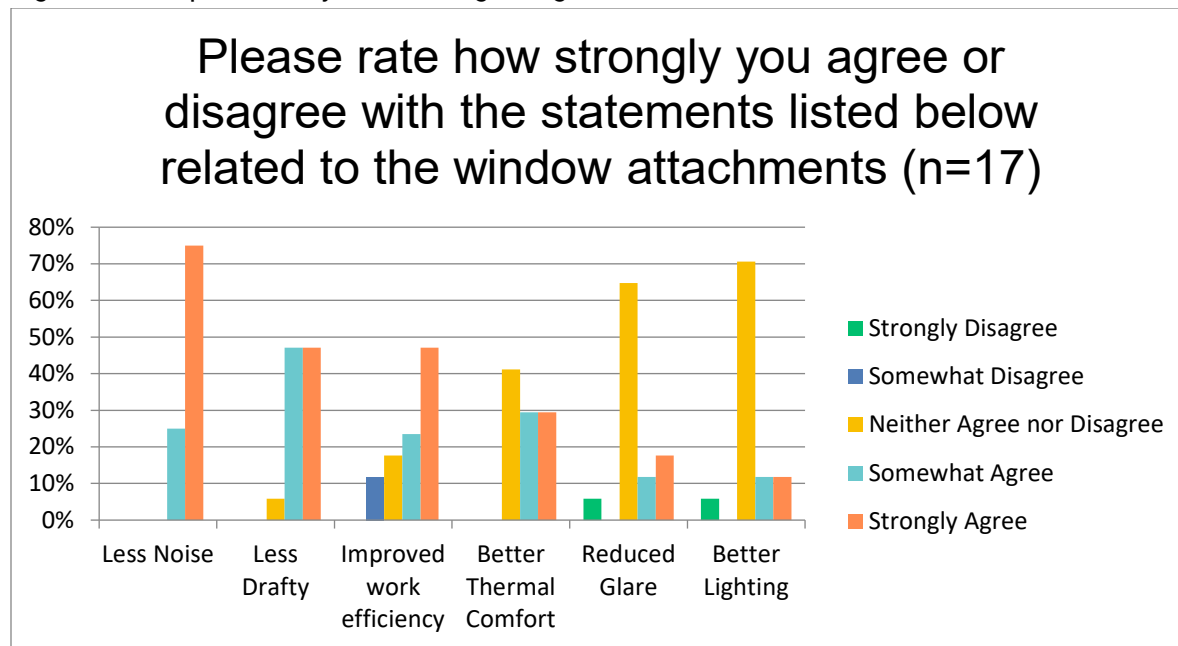


3.4 Occupant Survey Findings

Due to several factors affecting occupancy across the project sites, we chose to deploy an occupant survey on only one site². Of the survey respondents at this site, most sat next to a window both before and after the CSW installation and were able to comment on working conditions pre- and post-installation. Occupants who responded to the survey experienced a high degree of outside noise through the existing single-pane windows. Additionally, more than half of those surveyed noted inconsistent space temperatures prior to the install of the CSWs. Respondents either used blankets, fans, or space heaters to maintain a comfortable temperature before the install.

As shown in Figure 1 below, following the installation of the CSWs all respondents noted that they experienced less noise from outside and more than half noted they were now more comfortable in the space and said it felt less drafty. When asked about additional benefits that CSW provide, we found mixed responses regarding reduced glare, better lighting, and the ability to work more efficiently.

Figure 1: Occupant Survey Results Regarding CSW Attributes



4 Installation Themes & Programmatic Barriers

Of the four site observations conducted, we noted very few installation challenges or hesitation on the part of the installation contractors. Overall, installers were able to take what basic training they received and complete installations efficiently and to the manufacturer’s specifications. Each of them also remarked that the product they were installing seemed like the best solution for that

² Site D was chosen for the occupant survey due to most occupants being present in both the pre and post retrofit case. Other sites had varying degrees of pre/post occupancy due to COVID-19 protocols and/or the unique nature of the renovation.



particular site and agreed that a major benefit was how little site prep was needed at the time of installation. This is notable due to the difference between the CSW products used at each site, as noted in Table 2 below.

Table 2: CSW Product Differences

Project & Location	CSW Vendor	Product	Install location	CSW pane type	Frame type	Features
Site A Vancouver, WA	Alpen	WinSert Plus	Interior	Double-pane insulated glass	Fiberglass	Air-sealing, removeable
Site B Lynnwood, WA	Alpen	WinSert Lite	Interior	Single-pane glass	Fiberglass	Air-sealing, removeable
Site C Beaverton, OR	Inovues	Exterior Glazing Shields	Exterior	Single-pane glass	Metal	UV, Air-sealing
Site D Portland, OR	Indow Windows	Acoustic Grade Inserts	Interior	Acrylic panel	Compression silicone tubing	Air-sealing, removeable
Site E Bozeman, MT	Allied	Magnetic One Lite	Interior	Single-pane glass	Aluminum	Operable, removeable

Apart from the one externally mounted CSW that required a half-day training, the three remaining installers received only a few hours of training by the manufacturer. Once training was complete, the installation team stated that they could rapidly install the mounting hardware and place the CSWs with ease. This also proved to be the case for the externally mounted CSWs, though tighter tolerances in setting the mounting frame on the existing windows meant the project took longer to complete.

Although supply chain disruptions played a part in obtaining CSWs in 2019-2021, installers did not perceive these products to have longer lead times compared to traditional windows. For each of the interior-mounted CSW installations, several products that arrived onsite were damaged and sent back to the manufacturer for repair/replacement. Installers noted replacements could be performed by site-facility personnel rather than scheduling a return visit by a contractor or manufacturer rep. Unlike traditional windows, the ease of installing CSWs means that any future replacements are likely to be handled by onsite staff instead of needing to schedule dedicated installers, saving building owners time and money.

Vendors whose CSW products provide air sealing benefits (three of the four observed) stated the primary barrier to installation is typically the existing vertical window surface which needs to be flat enough to achieve a proper air seal. Minor imperfections can be addressed by the installer and foam inserts or additional magnets can be used to pull the frame tight. However, if the vertical surface of the window is not flat, the CSW will be ineffective at air sealing. Vendors did not encounter this issue on the projects we observed but said it has been an issue in the past on sites with old and out-of-plane windows.

While we observed the installation to be simple and require little training, programmatically CSWs face a high hurdle with respect to ROI. This is a problem from a market adoption perspective because CSWs are typically competing against a building owner's choice to do nothing to the



envelope. Decision-makers and vendors both noted that most windows get replaced naturally only when an owner is forced to make a change to the envelope, or if the windows fail—which is neither often nor on a building-wide scale. Therefore, owners who are not forced to consider window replacements pursue cheaper alternatives such as doing nothing or addressing targeted thermal comfort issues with space heaters or blinds. In this way, CSWs compete with low-to-no cost options and are viewed as a high-cost alternative to building owners, making them harder to gain widespread adoption in the market.

When an owner does choose to address the envelope, the opposite is true as CSWs are viewed as an alternative to a full window replacement. In this scenario CSWs have a favorable ROI and compete cost-effectively against a full window replacement option. Decision-makers who chose CSWs stated they received approval to purchase CSWs because they were a less invasive, more cost-effective solution than a full window replacement.

5 Benefits and Non-Energy Impacts

Decision-makers had a favorable opinion of the CSWs selected for their sites. Although energy efficiency was never their primary driver for pursuing CSWs, all noted it was a part of their overall decision. A related energy benefit identified by one participant was the ability to tout their building as being more sustainable, as they design energy-efficient buildings and felt the need to “walk the talk.” Additionally, one site plans to upgrade their HVAC units in the future and when asked about the potential benefit of CSWs to help lower the HVAC load, they stated they will take that into account for HVAC sizing. The facility manager at this site understood the additional benefit CSWs have for his site to reduce future HVAC size and cost, at the same time they made the building occupants more comfortable.

With respect to value proposition, most customers who vendors encounter choose to do something about their windows for reasons other than window failure. Vendors remarked that the main reason for exploring window replacement was addressing issues that affect worker productivity, such as comfort or noise. This was reinforced through decision-maker interviews, where a primary non-energy impact (NEI) mentioned by several market actors interviewed was noise reduction. Noise is typically hard to mitigate without costly envelope modifications, including traditional window replacement, and CSWs provide excellent noise reduction benefits for a fraction of the cost.

NEIs also manifest in historic buildings where owners wish to keep the existing window aesthetic or may be restricted with choices to replace it with newer windows due to local ordinances. These types of situations create a value to the owner where envelope upgrades are necessary and few other options exist.

Related to NEEA’s goal of understanding the opportunity for CSWs as part of deep retrofits, decision-makers noted they understood how CSWs could contribute to lower HVAC sizing when considering a deep retrofit. However, none pursued CSWs for this reason. CSWs were chosen to address occupant complaints over thermal comfort, noise issues³, or for sustainability goals, and in some cases were installed after the building had already undergone an HVAC retrofit. Still, one decision-maker did say

³ On one project, the building had just undergone a complete renovation and CSWs were considered after occupants moved in and realized how distracting the outside noise was.



they plan to upgrade their HVAC system in the future and will account for the reduced envelope loads due to the CSWs being installed. This lends weight to the concept of CSWs being considered an integral part to whole-building retrofits, even if they happen over a longer period of time.

As for market outreach, CSW vendors have found success pursuing building owners directly as opposed to Architectural/Engineering (A/E) firms or other traditional outreach means. They have found that interacting directly with owners allows them to communicate the NEIs of CSWs better, including the potential for increased rent, increased building occupancy, or carbon reduction goals. Vendor interviews revealed that often they will explain how the numerous NEIs, in addition to energy savings, can add up to make a project more attractive to customers. However, because they often target building owners directly, they may miss chances to tie these products in with other building retrofit opportunities occurring at the same time.

6 Conclusion

Findings from the site observations and follow-up interviews with market actors revealed that when viewed as an alternative to a traditional window replacement, CSWs provide a clear cost-advantage and were well accepted by building decision-makers and occupants. Additionally, only one of the projects had an installation crew that was familiar with the CSW product, yet all installers felt the products had a very quick learning curve, could be installed with minimal training, and needed significantly reduced site-prep time compared to traditional window replacements. Furthermore, due to the ease of installation, future CSWs could be installed by facility maintenance crews onsite rather than a manufacturer's rep or their trained crews. While this is a benefit to each site that installed CSWs, they do need to be tailored to each site through careful pre-installation measurements which leads to a customized approach and a barrier to widespread adoption.

Although CSWs were universally viewed in a positive light by all market actors interviewed as part of this evaluation, the pursuit of CSWs appears to be heavily influenced by NEIs, compared to energy reduction. While decision-makers agreed energy savings were part of their decisions, the research did not find it to be a primary driver. Decision-makers said noise reduction and helping address thermal comfort issues were the primary benefits of CSWs. Occupants were also extremely satisfied with the better thermal comfort and noise reduction benefits the CSWs provided. Additionally, while all vendors noted their inclusion of energy savings when describing the value proposition, they commonly pitch CSWs based on NEIs such as noise reduction, increased building rental rates, increased occupancy retention, or as a cost-effective option for historic buildings.

CSWs may be an attractive product for a building owner who needs to address the building envelope for a variety of reasons but cannot pursue traditional window replacements. Conversely, they may not be a cost-effective alternative to simply reducing energy costs, or even thermal comfort issues, when the owner is not already inclined to take action to improve the envelope. The high price tag is difficult for decision-makers to overcome if not viewed as a necessary alternative to window replacement. Vendors also agreed that while ROI is favorable when viewed as a window replacement alternative their biggest competition is owners who choose to do nothing to the envelope. Therefore, from a market perspective, the high cost and customized approach to CSWs, especially when competing against doing nothing, presents a challenge for widespread adoption. CSW vendors agreed that while return on investment is favorable for CSWs when viewed as a



window replacement alternative, their biggest competition is owners who choose to do nothing to the envelope.