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High-Performance Windows Market Characterization Study

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Executive Summary

The Northwest Energy Efficiency Alliance (NEEA) contracted with Cadeo (the research team) to conduct market characterization research focused on the high-performance residential window market to understand the awareness of and potential market for thin triple windows (TTWs). These "thin triples" have emerged as a promising new opportunity for super-efficient residential windows. To support this product NEEA requires insight into how the mid- and down-stream window markets function in the Northwest. This project focused specifically on understanding the perspectives of three important market influencers: the homeowners that purchase and live with window products, the glazing professionals who install residential window products, and the midstream supply chain responsible for supplying both groups. This project focused primarily on retrofits in existing homes, not new construction. While manufacturer research is not included in this project, previous research has documented barriers associated with manufacturer risk and technical challenges associated with supplying TTW. [1]

High Performance Windows

NEEA's High-Performance Window (HPW) Initiative is focused on promoting windows that meet all of the following criteria:

- U-value of </= 0.22
- Air leakage rate </= 0.3
- National Fenestration Rating Council's (NFRC) Condensation Resistance Value >/= 45
- Installation or retrofit ability in an existing wall with 2x4 framing construction

(Note: NEEA intentionally chose to NOT include "thin triple pane" as a specific criterion as there are likely to be other strategies to achieve U-values at or below 0.22 while meeting the additional criteria noted above.)

For supply chain research, the team focused primarily on U-value and TTWs as a proxy for performance and avoided asking about air leakage and condensation resistance. Because these criteria are technical and not generally obvious to homeowners, the homeowner survey defined HPWs as products that provide superior reduction in home heat loss, are ENERGY STAR® certified, provide superior performance in blocking exterior noise and solar heat gain in the summer, provide the highest level of insulation, and reduce condensation and heating and cooling costs. HPWs typically do this by including a thin third pane of insulating glass and two layers of low-emissivity coating.

[1] Stephen Selkowitz, "Thin Triple Pane Windows: A Market Transformation Strategy for Affordable R5 Windows" Report #E20-310, Piedmont, California: NEEA, 2020. and Apex Analytics "Energy Trust of Oregon 2018 Windows Market Research Report."

Findings and Recommendations

Barriers to HPW Adoption

Finding: Many barriers to wider adoption of HPW generally and thin triples specifically are embedded in the choice architecture within which the supply chain makes recommendations and homeowners select windows. This architecture comprises several elements:

- ***Availability and familiarity***. Increasing familiarity with a product that is not widely available is difficult, and any product that is perceived as unavailable or unfamiliar will likely not be recommended or selected. Data from supply chain research indicate that these supply chain contacts are aware of triple pane windows but not necessarily thin triples—in fact, some responses indicate they are confounding these products. When asked to describe the highest performance window they sell, almost half mentioned specific U-values, typically at or near 0.20 (including three specifically mentioning an "R-5" window). Existing NEEA research indicates that while TTW products can be custom ordered, the lack of regional manufacturing constrains regional availability.
- ***A potential mismatch between stated values of homeowners and supply chain assumptions***. The survey research conducted as part of this study confirmed recent research by the National Association of Home Builders that homeowners and homebuyers value the efficiency and insulative value of their windows above all else. Supply chain contacts report a belief that cost is the most important factor and discouraged mystery shoppers from pursuing thin triple or extremely low U-value products, stating the incremental improvement in efficiency did not justify the increased cost and that standard, double-paned argon-filled windows provided sufficient performance for most Northwest homes.
- ***Incremental Cost***. The additional cost associated with TTWs and/or extremely low U-value products deters both homeowners and those who advise them. Homeowners in the market for new windows view installers and window vendors as trusted sources of information. In mystery shopping and interview phone calls, supply chain contacts often positioned their recommendation as looking out for the homeowner, noting that potential customers should not spend more than they need to and that they will not recoup the additional cost. However, homeowner survey results from this study indicate that 60% of those intending to purchase new windows "probably" or "definitely" would pay more for HPW.

Recommendation: NEEA should continue efforts to increase regional availability of HPW products and promote market research to supply chain actors demonstrating that homeowners place high value on the efficiency and insulative value of their windows. In the supply chain survey interviews, respondents noted that they could obtain super-efficient products if needed and mentioned R5 and krypton-filled high-performance products available to them from suppliers. Still, these products come with an incremental cost premium. Overcoming barriers

related to cost will likely require new or more aggressive utility rebate promotions, midstream buydowns, or financing products designed to subsidize efficient improvements to the existing housing stock.

Perceptions of Existing Windows

Finding: Homeowners and supply chain contacts expect that all new windows are efficient. Window suppliers describe standard double-pane, argon-filled, vinyl frame windows as efficient and code compliant. In mystery shopping calls, suppliers counseled against upgrades for efficiency. Homeowners choosing replacement windows compare the performance of new windows relative to the windows they are replacing—leading them to conclude that new windows are a substantial improvement in efficiency and performance. Supply chain contacts acknowledged edge case scenarios in which they would recommend more efficient or different glass configurations, but generally relegated those to extreme noise or weather. Interview data indicated an opportunity to build on the sentiment that window improvements have largely stalled and that the time is right for additional innovation to further improve efficiency. As one supply chain contact noted, window technology has not materially changed in decades and the market has "stagnated."

Recommendation: NEEA and the Partnership for Advanced Window Solutions will need to test messaging and identify value propositions for suppliers and homeowners that normalize and encourage consideration of these products. Positioning HPW as a natural progression for window innovation and a solution for increasing the efficiency of existing homes could generate interest from early adopters in both suppliers and homeowners.

Path to Purchase

Finding: There are multiple purchase triggers for homeowners who need new windows; however, it is extremely common for homeowners to deliberate on the decision and delay action for years. Almost 40% of single-family homeowners reported that they intend to replace one or more windows in the next five years. In focus groups, contacts described multiple types of performance "failures"; however, only breakage created a need for immediate action. Survey data indicate that issues with drafts and condensation are the top reasons for window replacements, regardless of window vintage.

Homeowners dissatisfied with the performance or appearance of their otherwise functional windows may live with these issues for years to avoid the cost and hassle of window replacement, especially if more urgent home repairs are required. Approximately two-thirds (68%) of the homeowners who had replaced windows reported the old windows were more than 20 years old, while about a third replaced windows that were less than 20 years old. In focus group discussions, those intending to replace windows described prioritizing failed water and space heating equipment and struggling with the estimated cost of replacement windows. Living with poor performing windows is especially an issue for those in manufactured and low-rise multifamily homes. The level of satisfaction with existing window performance was significantly lower for these homeowners than among single-family homeowners.

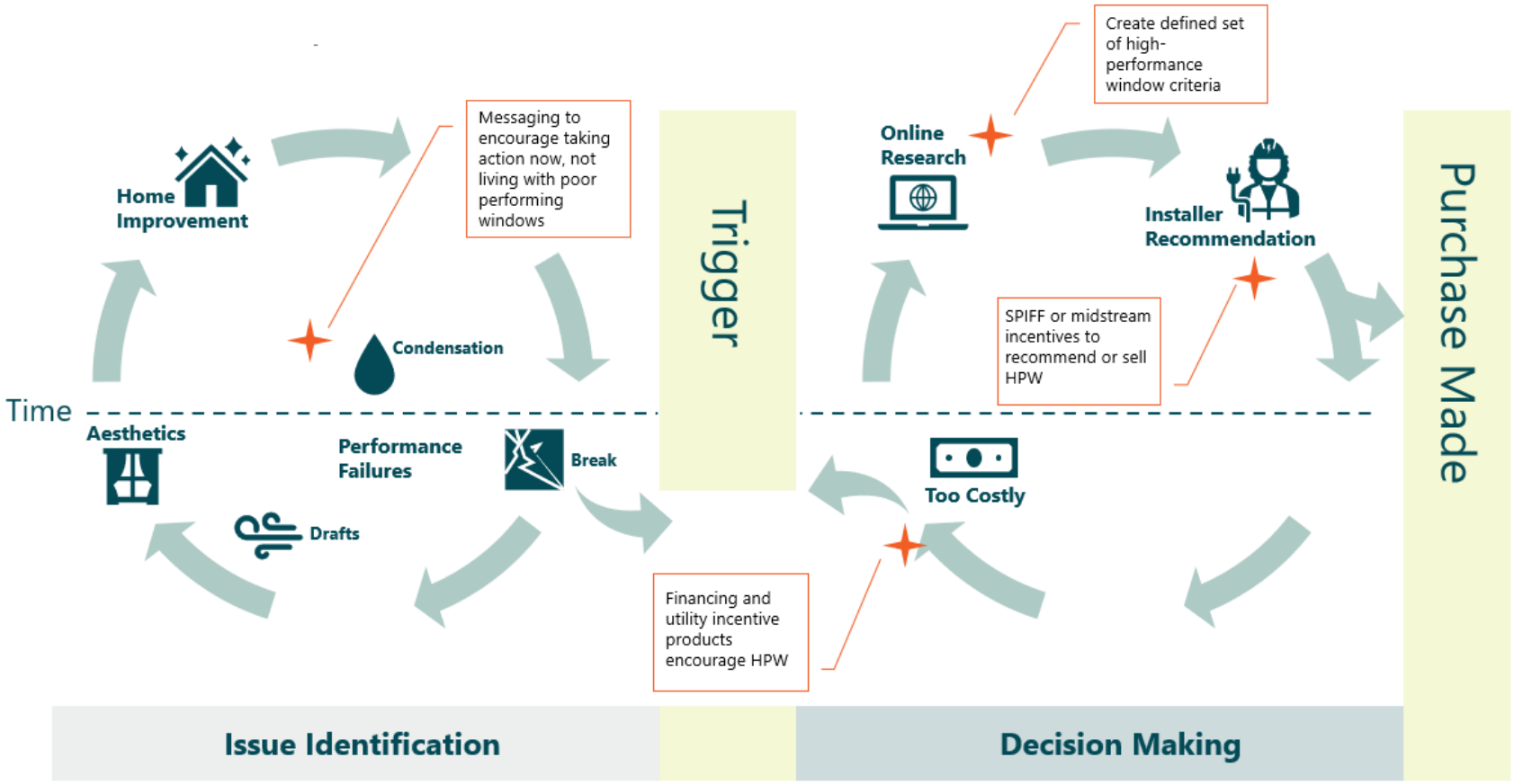
Once the decision is made to move forward, purchasers describe relatively straightforward processes—often going directly to a window vendor or shopping for known manufacturers. Survey data indicate that contractor/installer recommendation is the most influential source of information for window purchasers, followed by online research. Purchasers did not describe being overwhelmed by choice, likely because many only considered one or two options after providing information about their home (vintage, window style, and existing window openings) to a vendor or installer.

Recommendations: The cost of new windows creates delays, even among those wanting to move forward. A variety of marketing and financial products are likely to be required to spur action, particularly if the promoted product costs more than "standard" windows. Appealing to those living with poor performing windows with solutions that reduce up-front or out-of-pocket costs (such as price reductions or financing) and encourage action (such as limited-time-offers, or additional support for qualified purchasers) could help homeowners move from consideration to action.

Window manufacturers provide summaries of their product lines and the relative performance of different features, but pricing information is harder to find. Providing a credible resource for consultation and recommendation outside the standard supply chain could help ensure HPW products are represented in options provided to homeowners. NEEA should consider strategies for leveraging audit programs, home energy score audits, and interest in sustainability to encourage consideration of HPW options. This would also provide experience and market intelligence that could guide improvements to messaging and product positioning.

The next page presents a graphical representation of the path to purchase for a typical homeowner, which involves a range of performance considerations that can exist for many years prior to a purchase decision. The stars and orange text represent potential influence points that NEEA and its collaborators could consider as market intervention strategies are developed.

Figure 1: Path to Purchase Diagram, with Potential Influence Points



Likelihood of Stocking, Promoting, and Installing HPW

Finding: Windows for existing homes are not typically stocked. Nearly all windows sold for existing homes are "custom," meaning they are measured and ordered specifically for a given home. Ninety percent of installers reported that greater than 80% of the windows they sell are custom orders. In 2021 and 2022, window orders were delayed due to pandemic-driven manufacturing shutdowns, shortages of raw materials, and increased demand.

Recommendation: Focus more on encouraging promotions and installations rather than increasing on-hand stock, as these windows will likely all be custom-made for a given home.

Finding: There are substantial gaps in awareness and understanding of TTW products. Among the 14 supply contacts reporting awareness, over half (8 of 14) reported that TTW products are available from their suppliers. Six of the eight respondents reporting thin triples were available from their supplier reported that they had ordered or installed them. However, in follow-up comments it became evident that many of these respondents conflated TTWs with standard triple panes. Without education and exposure, supply chain contacts are unlikely to mention these products and even less likely to recommend them to customers.

Recommendation: Work with manufacturers, trade groups, and trusted experts to increase awareness of and interest in HPW products among installers and vendors. If possible, align NEEA's HPW criteria with specific products that are already available, for example "R-5" windows. Trainings, trade show seminars, and lunch and learn–type presentations could steadily increase the likelihood that HPW and TTW products are promoted and ultimately installed.

Finding: The research team experienced substantial challenges obtaining complete and detailed interviews with "retail" store level contacts. This was expected based on experience with data collection efforts in projects researching adjacent products (for example, insulation, heating equipment, and water heating), but leaves a gap in understanding associated with the volume and characteristics of products flowing through big-box retail. Even when reached, store-level contacts often can't or won't answer questions. Obtaining insight into this market segment will likely require corporate-level coordination and contact with ProDesk/wholesale contacts that can speak to sales patterns across multiple stores, a region, and/or nationally.

Recommendation: Given the trust and sensitivity involved, this level of contact is probably best developed by NEEA staff directly, leveraging relationships built through other initiatives.

Finding: Contacts described conflicting roles and associated influence of window manufacturers. On the one hand, vendors (the installers, distributors, and retailers delivering windows to existing homes) described themselves as experts who are responsible for recommending the best product for a given homeowner or situation. On the other hand, they make recommendations based on product availability, pricing, and features that are determined far upstream. If manufacturers are failing to supply and promote windows that meet the criteria NEEA and others have established to further increase window efficiency, there is almost nothing

an individual vendor can do. Interviews indicated a preference for local fabricators and manufacturers, both among supply chain contacts and interviewed purchasers.

Recommendation: NEEA should conduct manufacturer research to map supply of HPW to Northwest manufacturing and ensure the manufacturer perspective is eventually integrated into the findings documented in this report. Supply chain contacts repeatedly mentioned Milgard and Ply Gem products, as well as Anderson and Cascade (to a lesser extent). Building an understanding of manufacturers relationships with vendors and if or how the sales differ for retail entities would help NEEA focus limited program resources. Manufacturers could also speak to their role in promoting specific products to distributors, how "high performance" is defined and marketed, the impact and expected duration of the global glass shortage, and potentially identify other supply chain considerations that did not emerge in this study.

Section 1 Introduction and Background

The Northwest Energy Efficiency Alliance (NEEA) contracted with Cadeo (the research team) to conduct market characterization research focused on the residential high-performance window (HPW) market to understand the awareness of and potential market for thin triple windows (TTW). These "thin triples" have emerged as a promising new opportunity for super-efficient residential windows. NEEA would like insight into how the mid- and down-stream markets function in the Northwest. This project focused specifically on understanding the perspectives of three important market influencers: the homeowners that purchase and live with window products, the glazing professionals who install residential window products, and the midstream supply chain responsible for supplying both groups. This project focused primarily on retrofits in existing homes, not new construction. While manufacturer research is not included in this project, previous research has documented barriers associated with manufacturer risk and technical challenges associated with supplying TTW. [2] In a separate effort NEEA staff are also investigating opportunities in the new construction market.

Table 1-1 presents the high-level research objectives prioritized for this project.

Table 1-1: Research Objectives

Research Objectives
Identify triggers for window purchase/replacement among homeowners: • Describe the path to purchase. • Assess awareness of HPW. • Understand barriers to HPW purchase. • Gather information to help NEEA estimate the average age of windows when replaced.
Build understanding of the window supply chain, including awareness of HPWs: • Assess awareness of HPW generally and TTW specifically. • Document experience and perception of HPW. • Explore likelihood of stocking or selling HPW. • Explore likelihood of installing or recommending installation of HPW.

[2] Stephen Selkowitz, "Thin Triple Pane Windows: A Market Transformation Strategy for Affordable R5 Windows" Report #E20-310, Piedmont, California: NEEA, 2020. and Apex Analytics "Energy Trust of Oregon 2018 Windows Market Research Report."

1.1 Background

The NEEA team provided a variety of background documents to help the research team build on existing work and to guide the development of data collection instruments. Among the documents provided was a market summary prepared by DuckerFrontier (Ducker). Ducker prepares a report for the Fenestration and Glazing Industry Alliance (FGIA, of which NEEA is a member) that summarizes a variety of market trends. The report provided a framework for understanding the different types of vendors involved in selling windows (Table 1-2).

Table 1-2: Window Supply Market (DuckerFrontier)

Attribute	Millwork Wholesaler	Big-Box	Lumberyard	Shortline Distributor	Specialty Retailer
Primary customer types	Distributor	Homeowner, Remodelers, Builders	Builders, Remodelers	Builders, Remodelers	Homeowner, Builders
Level of inventory	Large	Large	Medium to large	Small to med	Small to med
Product variety	Medium	Widest	M to wide	Narrow	Most narrow
Installation	Not typically	Yes, some	Very limited	Very limited	Yes
Size of facility	Med – large	Very large	Wide range	Wide range	Small to med
Market focus	Remodel/new	Remodel/new	Remodel/new	Remodel/new	Remodel, new increasing
Space allocation	I-S, some P-S	I-S, R-S	I-S, some R-S and P-S	I-S, R-S, some P-S	I-S, R-S

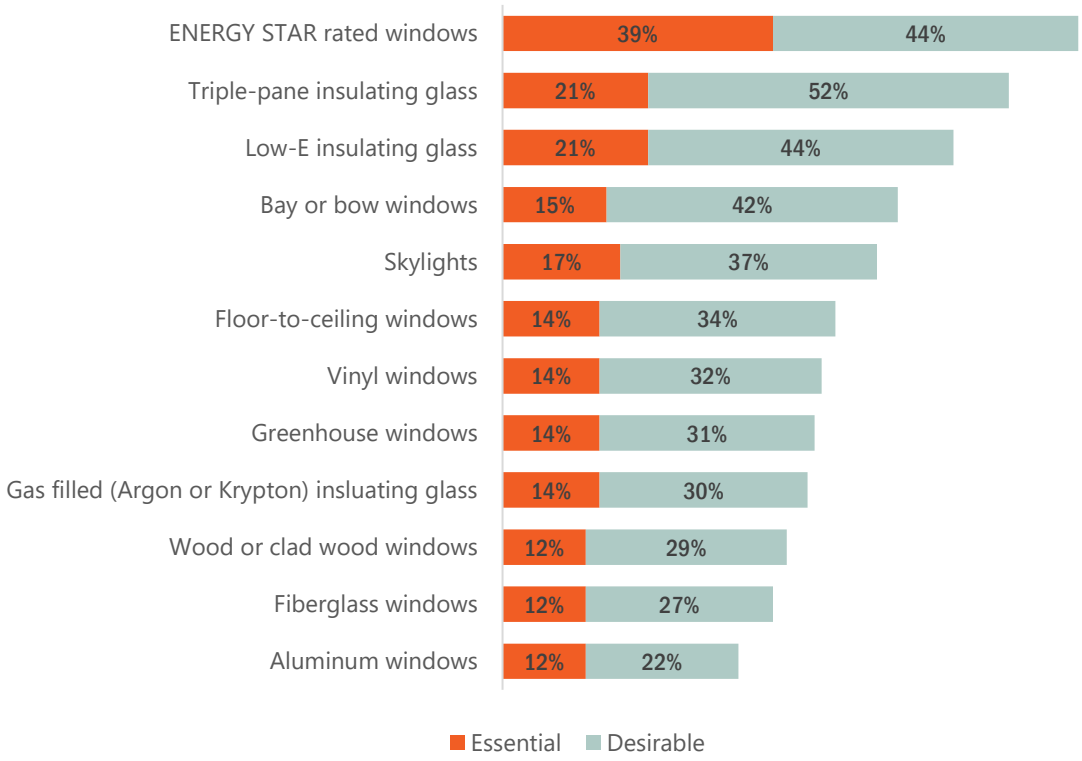
Space allocation: R=retail/showroom, I-S= inventory/storage, P-S=processing/lumber storage.

This report summarizes the national market for windows, and includes the following takeaways:

- Approximately 90% of windows have low-emissivity coating although the coverage varies by frame type.
- Nearly all residential windows are rated by the National Fenestration Rating Council (NFRC), and 83% are both NFRC and ENERGY STAR rated.
- Sales of glass units are 55% replacement and 45% new construction, indicating that a large volume are being sold into the existing homes market.

A 2021 article[3] published by the National Association of Home Builders (NAHB) provided evidence that new home purchasers are valuing the efficiency of their windows over many other attributes.

Figure 1-1: NAHB Research Indicates Homebuyers Value Efficiency



**Source: NAHB (2021)*

A 2019 report prepared for NEEA by Stephen Selkowitz[4] documents the opportunity associated with promotion and adoption of TTWs, primarily through inclusion of a thin third pane of glass and replacing argon gas fill with krypton. This report discusses the benefits of triple glazing or updates to window performance that would achieve R-5 performance—reducing window heat loss and improving comfort and describes the technical advancements that have resulted in availability of extremely thin glass at reasonable incremental cost.

Consistent with the recommendations embedded in a market transformation plan developed with NEEA staff, NEEA is engaged in a new, coordinated window market transformation effort. The research presented here is designed to support that effort.

[3] Paul Emrath, "Home Buyers Want Energy Efficient Windows," *Eye On Housing*, (June 2021), https://eyeonhousing.org/2021/06/home-buyers-want-energy-efficient-windows/ (accessed May 27, 2022).

[4] Stephen Selkowitz, "Thin Triple Pane Windows: A Market Transformation Strategy for Affordable R5 Windows" Report #E20-310, Piedmont, California: NEEA, 2020. and Apex Analytics "Energy Trust of Oregon 2018 Windows Market Research Report."

Section 2 Supplier Research

This section provides a discussion of the findings from three data collection activities: mystery shopping, interviews with vendors and installers, and a qualitative dyad interview with two vendors following individual interviews.

To prepare for eventual supply chain interviews, the Cadeo team developed a population frame of those engaged in window supply in Idaho, Montana, Oregon, and Washington. This combined supply chain list included wholesalers/lumberyards, specialty retailers, and installers and was built by augmenting lists prepared for previous window research projects with additional supply and installation firms focused on residential windows.[5] In addition, the list of 109 builder supply and big-box supply chain contacts was augmented with a search of window suppliers, adding any entities that were not already included (for example, including wholesalers or specialty retailers focused specifically on residential windows, such as *Window World*). The initial list included 562 records.

Cadeo then used this list to conduct mystery shopping calls. These calls helped us refine language prior to developing the final interview guide and helped screen contacts to understand if our list contained a high portion of unqualified records. After removing these unqualified records, our supply chain list dropped to 522 records.

2.1 Mystery Shopping

Cadeo conducted mystery shopping calls between January 24 and February 1, 2022. Interviewers attempted to reach 50 contacts from the Cadeo-created population frame, which included contact information for a wide range of market actors. As part of the mystery shopping calls, we sought to improve the accuracy of the population frame by identifying and removing contacts that did not sell or install residential windows.

The mystery shopping activity included several objectives:

- Build understanding of the window supply chain, including characteristics of those that sell directly to homeowners.
- Assess awareness and availability of thin TTW.
- Document product recommendations, including likelihood of recommending high-performance products generally and TTW specifically.

[5] To support previous commercial window research, the research team prepared a population frame of firms that worked in commercial window replacement. Many firms do both commercial and residential projects. To explore questions about multifamily buildings, we included all firms and adding any additional residential-only firms identified.

The dispositions of the mystery shopping calls are included in Table 2-1.

Table 2-1: Mystery Shopping Disposition

Disposition	Count
Complete	24
Refused, recommended in-home/installer assistance	7
Refused, recommended in-store assistance	3
No response	10
Not qualified (do not sell windows)	6
Total	50

Scenarios

To guide the conversations, the research team developed two purchaser scenarios: (1) an "environmental" purchaser primarily concerned with sustainability and willing to spend more to achieve a super-efficient home; and (2) a "standard" purchaser seeking new windows while also wanting to decrease noise, increase comfort, and save on energy bills.

Environmental Purchaser

Contacts most commonly recommended this purchaser consider double-paned argon-filled vinyl windows with a low-e coating, noting that this type of window provided sufficient efficiency and upgrading to triple panes was not worth the extra money.[6] Many salespeople also mentioned payback challenges, noting a customer would almost never recoup the higher price of the triple-pane window through energy savings. When asked about potential benefits associated with blocking solar heat gain, contacts typically noted that low-e coating (a few mentioning SunCoat by name) provided sufficient performance for a lower cost than triple-pane windows. Even when assured that cost was not an issue, none of the supplier contacts recommend triple-pane windows, and none reported stocking or selling thin triples.

When this purchaser also asked specifically for the top-of-the-line efficient products, contacts most frequently recommended upgrading the framing material, instead of glass type. They typically recommended fiberglass frames, claiming that these frames offer the best efficiency and can expand and contract more easily than vinyl, arguing that this is an essential feature for the variable climate of the Northwest. Contacts reported that fiberglass frames can be two to three times as expensive as vinyl.

> "You'll never get money back buying a much better window."

[6] The purchaser asked specific questions to probe on availability and recommendation of triple-paned and TTWs.

Contacts sought to persuade the interviewer of energy efficiency performance of the double-paned argon-filled windows by mentioning the codes for which these windows complied, including the Title 24 Building Code in California and the Northern Region ENERGY STAR rating. Many market actors also mentioned the low U-value. One contact noted that you could get a 0.24 U-value in a double glaze versus a 0.21 U-value with a triple glaze through Ply Gem, but that the difference did not justify the increased price.

Standard Retrofit Purchaser

With this different purchaser perspective, contacts continued to recommend double-paned argon-filled vinyl windows with a low-e coating. When the shopper mentioned a desire to reduce road noise, the primary change to recommendations centered on glass width. To decrease the experience of road noise contacts recommended double-paned windows with *dissimilar glass*. In these products, the exterior glass pane is thicker than the inside pane, which makes it more difficult for sound waves to reach the home's interior.

> "Triples help with sound for sure, but double with offset thickness to reduce sound is better."

Contacts only suggested triple-pane glass if the bedroom window was flush with a busy road, or the house was in a very loud location such as next to a highway or an airport. Triple-paned window suggestions only emerged after prompting by the interviewer. Window market actors generally described this solution to be more than what a normal homeowner would need, especially since the different glass thickness is considered an appropriate solution to excessive outside noise.

Contacts did not offer concerns about triple-pane windows fitting into window openings. Only one contact mentioned that triple-pane windows are usually heavier than double-pane windows, which could create stress on the surrounding walls over time.

Pricing

Under both purchaser scenarios, the shopper asked about relative pricing. Window prices are highly variable, driven primarily by frame material, nonstandard sizing, number of panes, window style, and frame color. This task did not collect sufficient specific pricing data to model pricing, but we did find that standard-size, double-pane, white vinyl sliders are the reference case with prices increasing (and occasionally decreasing) as one deviates from this choice (Table 2-2). In general, adding window features increases the price.

Table 2-2: How Window Features Affect Price

Category	Effect on Price
Frame Material	
Vinyl	no effect
Fiberglass	substantial increase

Wood	increase
Size	
Standard size	no effect
Irregular size	increase
Panes Number	
Double	no effect
Triple	increase
Window Style	
Casement	increase
Single hung	slight decrease
Double hung	increase
Fixed pane	slight decrease
Slider	no effect
Frame Color	
White	no effect
Other	slight increase

Barriers for Potential Purchasers

The mystery shopping analysis revealed several persistent barriers that exist in the supply chain, which could emerge when homeowners begin to consider their options.

- Most suppliers view anything beyond double-pane as superfluous and appropriate only in extraordinary situations.
- Suppliers expect that customers will rely heavily on installer and vendor opinions. Given most suppliers view double-paned gas-filled products as sufficient, it is unlikely a customer would push for additional, higher-cost options.
- Double-pane, gas-filled windows meet the current residential building codes, which contacts described as requiring high-efficiency windows.
- The relatively mild climate of the Northwest affects supplier recommendations. Some contacts noted that if they were based in Alaska or Arizona, a more efficient window might make sense.
- The number of options and features homeowners must choose from could lead them to (1) rely even more heavily on the recommendations of an installer or vendor, or (2) reduce their decision burden by eliminating less-compelling options immediately.

Industry Insights

During mystery shopping calls, contacts spontaneously mentioned product delays and limited availability related to a global glass shortage. To prepare for the supplier interviews, we investigated the factors behind this glass shortage and found multifaceted supply chain issues:

- Float glass manufacturing facilities shut down because of COVID-19 outbreaks and local restrictions. Manufacturers have struggled to restart glass production due to labor shortages, shortages of raw materials, and the lengthy process of restarting production. (Glass manufacturing is challenging to stop and start; the manufacturing plants are designed for continuous production.)
- Shipping and transportation logistics have also been affected by COVID-19 and led to delays in obtaining raw materials and reduced the overall reliability of the shipping industry.
- Shortages of raw materials are also related to COVID-19, and include polyvinyl butyral (PVB), the material that adheres glass panes together. PBV is a necessary input for double-paned windows and helps in sound reduction and energy efficiency. PVB itself is affected by shortages of raw material inputs like krypton, propylene and ethylene.
- Krypton gas, the insulating gas often used in HPW and TTW, is globally in short supply. Ukraine, Russia, and China are some of the largest producers of the gas (a byproduct of steel production). Ukrainian and Chinese factories are currently at reduced production capacity, and export bans are limiting access to Russian commodities. Prices are expected to increase as supply decreases, especially with competition from other industries that rely on noble gases like the semiconductor industry.

These materials shortages, production delays, and shipping challenges combined with import tariffs have combined to increase prices and lead times for all window products. An increase in prices overall is likely to affect the positioning of TTW, already an expensive option.

Aside from the supply chain challenges, TTW face barriers associated with a lack of supply chain recommendations to encourage homeowners to purchase. When pushed for the most efficient window, no contacts mentioned "thin triple" or described a window consistent with NEEA's HPW description. Contacts also indicated that multiple low-e coatings decrease natural light transmission.

2.2 Supply Chain Interviews

This section presents the results of interviews with supply chain representatives as well as a follow-up in-depth small-group interview with two window suppliers.[7] For the interviews, the

[7] The team originally planned to host two focus groups with supply chain contacts. Of the 41 that responded to our questions, 29 opted in to be contacted for follow up research. From that 29, the team recruited eight contacts for a virtual focus group interview; however, only two ultimately attended.

team used a programmed short-answer instrument, ultimately interviewing 41 supply chain actors (a response rate of 14%). The supply chain contact list included a mix of retailers, distributors, and installers.

Table 2-3 presents the disposition of the supply chain survey.

Table 2-3: Supply Chain Survey Disposition

Final Disposition Summary	Count
Complete	**41**
Refusal or "soft" refusal (includes those that received an email invitation but did not complete an interview and appointments made but not kept)	172
Non-contact	62
Not attempted (primarily multiple locations and "big box" retail)	97
List Errors	
Duplicate	2
Missing contact information	1
Business or contact no longer available	1
Bad or wrong number	9
Didn't pass screening (did not sell or install residential windows for existing homes)	137
Total	**522**

Sample Characteristics

We used screening questions to categorize respondents into three main roles: installer, distributor, or retailer. We found that the supply chain roles were not mutually exclusive, as many contacts fit into two or three categories. The breakdown in Table 2-4 displays the overlap in perspectives, with many respondents installing and distributing windows. Given these overlapping responsibilities, we did not find substantial differences by perspectives.

Table 2-4: Substantial Overlap in Respondent Roles (n=41)

Role	Count	Portion Reporting Role
Installer	36	88%
Distributor	35	85%
Retailer	25	61%

There are numerous small vendors and installers operating in the Northwest. Seventy percent of respondents work for an organization with only one location, and 75% reported fewer than 10 employees. Most of the respondents were from Oregon and Washington. The breakdown of respondents per state is displayed in Table 2-5. Note that contacts could sell or install windows to homeowners in neighboring states.

Table 2-5. Respondents per State (n=36)

State	Count	Portion
Idaho	2	5%
Montana	6	15%
Oregon	16	39%
Washington	12	29%

Awareness and Availability

The survey began with an aided awareness question that provided a description of TTW technology and asked if they had heard of these windows. Perhaps reflecting their overlapping roles, installers, distributors, and retailers reported similar levels of knowledge about TTW technology. Fourteen of 41 (34%) reported they had heard of thin triples previously. Respondents who indicated awareness of TTW also tended to interact with the market in multiple ways, selling, distributing, and installing windows concurrently.

Among the 14 supply contacts reporting awareness, over half (8 of 14) reported that TTW products are available from their suppliers. Six of the eight respondents who reported that thin triples were available from their supplier also reported that they had ordered or installed them (approximately 15% of all respondents). In the follow-up interview and as the survey continued, interviewers noted that many respondents that had indicated awareness or experience later provided comments or responses that contradicted this stated awareness. Typically, these comments indicated the respondent was conflating thin triples with standard triple-pane windows, a dynamic that should be borne in mind when interpreting this report's findings with regard to reported supply chain perceptions of TTWs.

Aware respondents then described where they had learned about TTWs. Respondents reported learning about these products from manufacturers, window blogs, industry associations, and from colleagues on the job. Several responses indicated respondents were thinking of standard triple-pane windows or an older product. Several described product failures associated with prior products:

- *"It was experimental in the 1980s. We had a lot of failure. It hasn't been until the last 5-10 years that we've had the technology to do it correctly. The thinness of the glass is not really relevant."*
- *"Being in the field, I do a lot of replacement of IGUs, therefore we run across them. I know the millworks department at Home Depot does not push. I don't know if they even have a company that is manufacturing triple pane, but I've worked there in the past, so I know that it's not really on their radar."*
- *"I was working on a job where they had some of those pieces in their home. They ended up breaking and I removed them and replaced them with standard triple panes."*

To understand if the supply chain defined "high performance" consistent with NEEA's definition, we asked respondents to describe the highest performance window they sell. Almost half (19 of 41) mentioned specific U-values ranging from a low of 0.17 to a high of 0.27. Most reported U-values at or just above 0.20, including three specifying R-5 windows. Several contacts provided more detail or explanation, without specifying a U-value. These comments included:

- *"We can go as low a U-value as the manufacturer can, depending on the type of glass the customer wants, and their budget. The availability from the manufacturer is the only cap on our high-performance windows."*
- *"Your question needs more specificity. Are you only concerned about U-value? What about solar heat gain coefficient or visible light transmittance? Most brands can hit most efficiency levels, so it is more a question of window options vs. brand."*
- *"Our highest energy performance is any of the clad wood products with true-triple pane glass units or a combination of 2nd and 4th surface low-e coatings. Our highest exposure performance is any of the luxury aluminum products designed for high exposure applications."*

Ten contacts specifically mentioned Milgard products, referencing "Ultra series fiberglass," "R5-.20 rating," and "Tuscany with Northern ENERGY STAR package." Respondents also mentioned Cascade, JELD-WEN, Ply Gem, Andersen, and Marvin. Overall, supply chain contacts referenced high efficiency products available from major manufacturers, while acknowledging limited sales of those products.

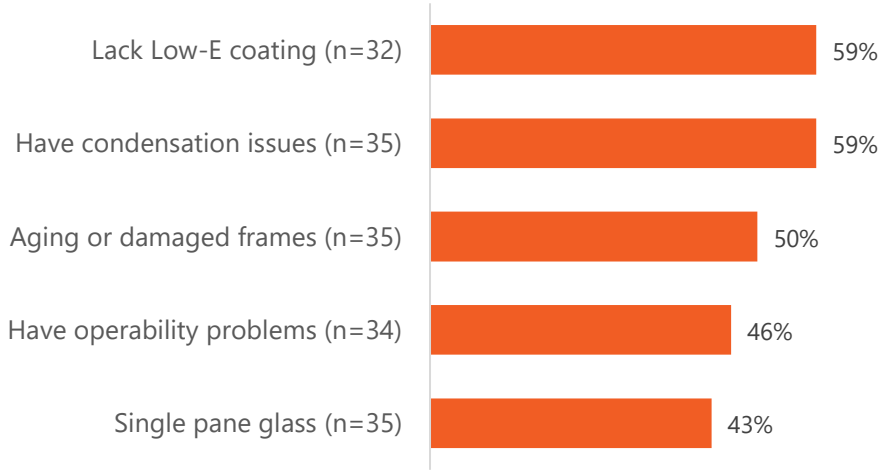
- *"The R5 window that Milgard offers is a tripled paned window with low-e coating and argon fill. We don't sell a lot of these. The higher performance with surface package is what we sell 95% of the time."*
- *"I'd consult the factory and see what they say, because all of our windows are custom."*
- *"We don't really take note of this sort of thing. We just sell the same standard windows."*

Window Replacement Considerations

We asked respondents indicating that their company installed windows (n = 36) to estimate the portion of their projects in which they replaced the entire window, the insulating glass unit (IGU)

only, or only the IGU and sash. Installers indicated that, for existing homes, they replaced the entire window 48% of the time and the IGU alone 37% of the time. A small portion of projects (11%) involved replacing the IGU and sash. Because retrofit projects often stem from a problem with existing window performance, we asked installers about what portion of their projects have a variety of performance issues (Figure 2-1). Note that a given window could have multiple issues (e.g., be single pane *and* have operability problems *and* aging frames).

Figure 2-1: Characteristics of replaced windows



Sales Process and Recommendations

Vendors and installers described how they determine which products to recommend to a homeowner in the market for replacement windows. After deciding that a window replacement is necessary, the customer selects the window type with input from the supply chain actors with whom they are interfacing. When we asked respondents about how they determine homeowner product recommendations, respondents noted a wide variety of factors go into the decision-making process. About half commented that they determine the specific needs by asking the customer what they want specifically:

- *"I look to homeowners for feedback on their project expectations. What are the primary goals they want to achieve, and which are the most important factors driving their decision to replace?"*
- *"I ask a series of questions such as budget, wants, and needs for the window, and what is most important in the purchase, then show them some examples of varying window manufacturers and styles that they can choose from that we offer."*

- *"It's very consultative. By interacting with the homeowner in the home, we make a recommendation. It does depend on what the homeowner can afford. We generally replace same with same."*

Three respondents, who installed and sold windows (as distributors), commented that on-site visits were an important part of the window recommendation process as well, and that consultations were typically done in person.

Vendors and installers reported the content of their conversations revolved around window characteristics, such as the pricing, efficiency, frame material, sun-blocking capabilities, and home location. The window attributes discussed are typically those that offer solutions to homeowner's existing problems, such as high heating bills, drafty windows or aging frames:

- *"It's based on the existing opening for the window, based on the amount of sun and on customer preferences."*
- *"We determine their needs. If they have high heating bills and drafty windows, then I'm going with a whole window replacement."*

A smaller portion of contacts also commented that their window recommendations were dependent on their manufacturer relationships and window availability. While some respondents noted that they work with a wide variety of manufacturers, others indicated that they offered products from a limited set of suppliers:

- *"We usually go with a couple of local vinyl manufacturers. Throw a lot of business at a few manufacturers, and deal with about 7 of them. For residential vinyl, we have a good relationship, good pricing, and fast service. A lot of time [choices are] dictated by production capacity."*
- *"If people can't make up their minds, we give them a price on Ply Gem and Milgard and explain everything about both companies and what they are getting for their money and let them decide what they want."*
- *"Lately lead times about when these products are available is important."*

Project Types

Most vendors sell windows for both new home construction and retrofit projects. When asked if the products sold for new home construction differed from those purchased for installation in existing homes, vendors described some differences between the products sold for new construction versus retrofit, elaborating that, compared to retrofit, new construction projects usually use "builder grade" windows, request more standard sizes, and meet increased energy code requirements. According to one respondent, new home construction typically uses lower cost, lower quality products. Another commented that new homes are more likely to use single hung and horizontal sliding windows because they are the lowest-cost option. Within the new construction category, respondents also mentioned that custom homes have different priorities and are more likely to use premium products.

Retrofit projects were described as less standard, as new windows have to match the existing opening and the other windows in the home. Homeowners with wood windows will often request new wood windows, which are a premium product. Vendors also described older homes as using less consistent styles and sizing. With increased variability, one contact noted that replacement projects require increased labor as well because the windows need to match an existing opening.

Installers were more likely to report not working in new construction, as builders typically install windows in new homes. Because of the overlap between distributor and installer role, responses were similar—with most contacts noting that the products installed do not vary by project type unless an architect has specified more casement windows, or if the walls are a nonstandard thickness. One contact noted the effect of residential energy codes on window selection specifically:

- *"New construction is more likely to use very high efficiency products due to energy credits available in the total envelope performance calculation as well as the ability to increase the glazing area and stay within the performance requirements. Custom mid- and high-end homes are more likely to use projected and fixed windows (casements and awnings) in place of single hung and horizontal sliders. Production homes are likely to use single hung and horizontal sliders as these provide cost savings. Existing homes will see a mix of all products."*

A minority of respondents (33%) reported the windows used for new construction are similar to those installed in retrofit projects:

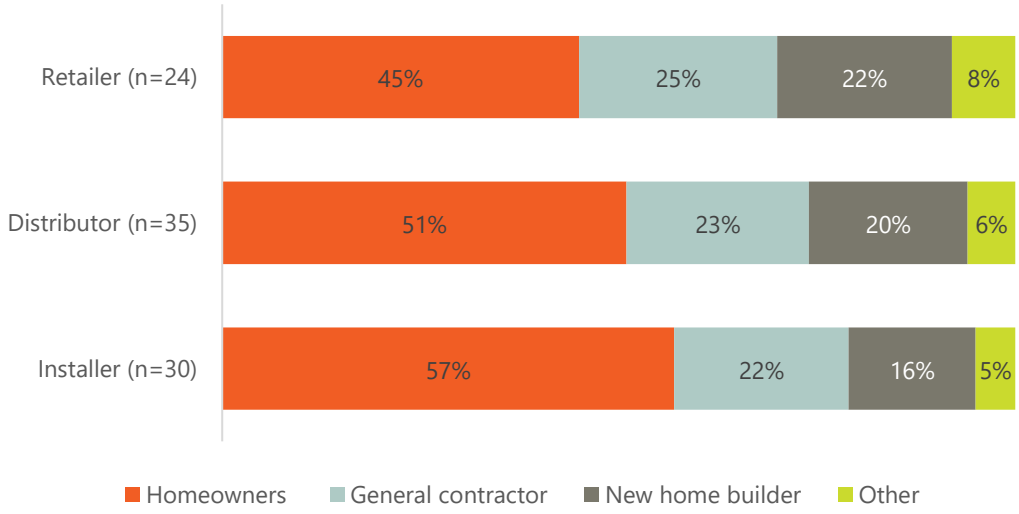
- *"Vendors offer different frame styles; we usually order the same for new construction and replacement. Replacement just may involve more labor since existing homes may require modification. "*
- *"There's no difference between retrofit and new construction windows, other than increased energy efficiency requirements for new construction [code]."*
- *"We sell the same type of windows for retrofit installation as new construction. We* generally *recommend lower U-value and low-e."*

Supply Chain Recommendations

Recommendations from installers and vendors are important influences in product selection. Because most of our respondents reported interacting with the window market in multiple roles, we did not find major differences in their responses for who they most typically sell to (Figure 2-2). Retailers were somewhat less likely to sell to homeowners and somewhat more likely to sell to builders. New home builders emerged as a customer to the suppliers we interviewed—they were not among the respondents. None of the contacts we spoke to reported selling to other installation firms, perhaps reflecting a vertically integrated market that sells and installs windows through full-service affiliate organizations.

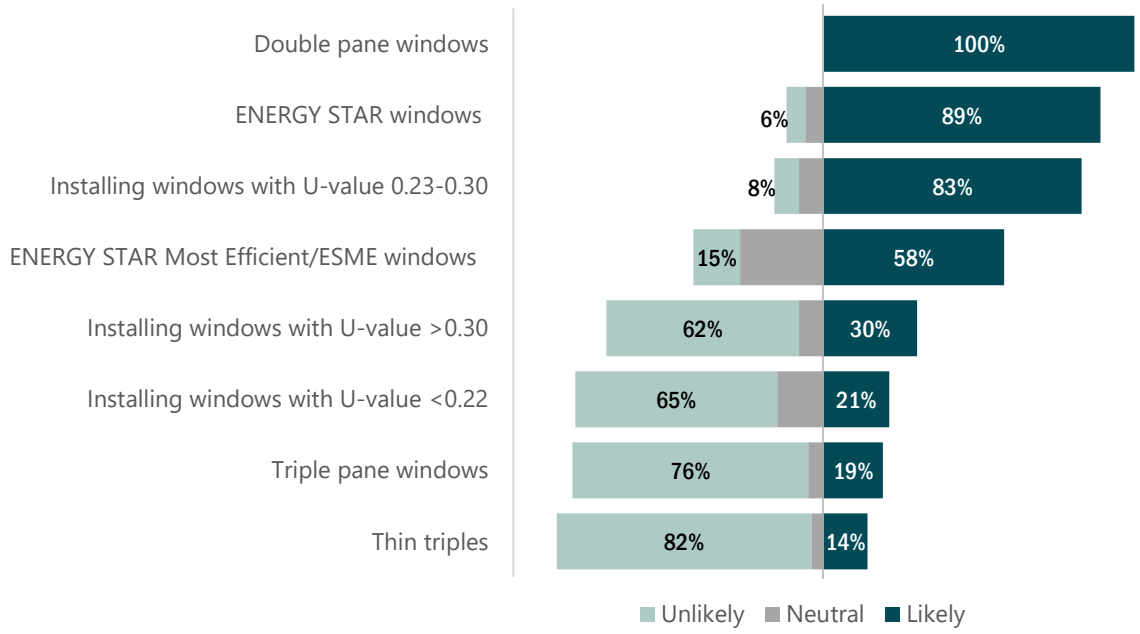
Nearly all of the installation firms (who may also be vendors or distributors) reported purchasing windows directly from a manufacturer. One installer (unaffiliated with a distributor) noted that they purchased from a distributor, particularly when they need Milgard, which is only available through distributors. Perhaps unsurprisingly, installers reported selling to homeowners almost 60% of the time.

Figure 2-2: Customer distribution consistent across roles



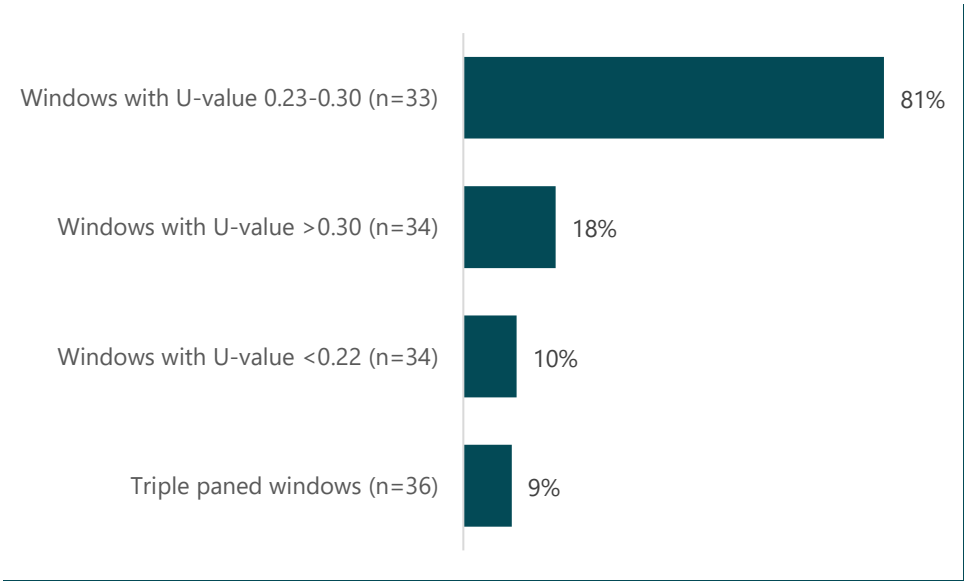
As indicated in Figure 2-3, respondents were very likely to recommend windows with U-values between 0.23-0.30 and double-pane windows, but unlikely to recommend triple-pane windows.

Figure 2-3: Supply chain unlikely to recommend triple pane windows



In contrast to the likelihood to recommend certain products, we also asked contacts about the sales or installation projects respondents had finished over the past two years. Respondents largely indicated that windows between a U-value of .23 and .30 were the most common installation or sale (Figure 2-4).

Figure 2-4. Most new windows have U-value between 0.23-0.30



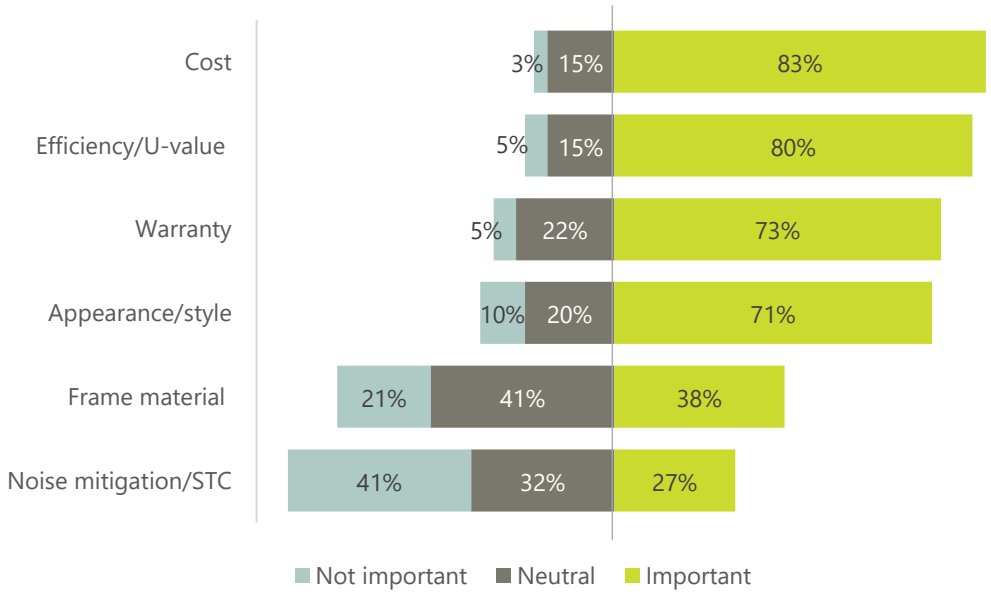
Supply chain contacts elaborated on their decision to infrequently install or sell triple pane windows:

- *"Double pane technology has come a long way with argon fill, so usually don't find reason to do triple panes."*
- *0.28 is normal. We pretty much sell a .28 whether they want it or not."*
- *"It's very rare for .22 or under. The cost goes up a lot to achieve that. It's for sure triple pane and krypton instead of argon. The fractional improvement for .22 window is 15-20%, but you pay double for it."*

We asked supply chain contacts to rate the importance of several window features to their typical consumers (

Figure 2-5). Contacts reported that cost and efficiency were the most important features for their customers, while frame material and sound transmittance class rating were least important.

Figure 2-5: Supply chain contacts' perceived importance of features to customers



We asked contacts about the features they talk about with customers who are considering HPWs. Respondents commonly reported mentioning energy efficiency (61% reporting), including efforts to emphasize U-value and discus energy savings. Other characteristics, such as aesthetics, cost, sound, operational performance, and warranty, were mentioned less frequently.

Manufacturer Influence

We asked supply chain contacts about the information, guidelines, and incentives that might be available to them from manufacturers. Respondents most commonly (19 of 41) described receiving little to no input from manufacturers on product recommendations. Those that reported interacting with manufacturers on product specifications described receiving information on product line modifications, overall product/catalog information, and specific guidelines on efficiency, pricing, and sizing. Spontaneous comments indicated some dissatisfaction with manufacturers—both the quality of window products as well as the information provided.

- *"The guidelines are typically generic, and our customers do not ask for [additional] details."*
- *"We don't get guidelines, just tutorials on features and benefits. Of course, it is commission based, so they want you to sell those products. Lately, there's not a manufacturer that I have a lot of faith in. Stuff is being sent that is really bad quality. I know there are staffing issues and COVID impacts."*
- *"I don't buy directly from manufacturers anymore, I buy through a middleman like Parr, Home Depot, Builders First Source."*

Responses were similarly mixed when asked about training or best practice guidelines provided by manufacturers. According to supply chain contacts, manufacturers provide some training services and basic online videos, but on a limited scope. While 14 respondents indicated manufacturers provided no training, several described working more closely with manufacturers—asking for guidance or clarifications when problems arise. Manufacturers do provide manuals and one contact noted installation inconsistent with the guidelines could result in a voided warranty. However, the overall supply chain responses indicate that they view themselves as experts in installation and product selection and that manufacturers expect them to be professionals.

Manufacturer sales incentives are rare, especially given supply chain constraints and product delays. As one vendor installer noted "at this point, we are lucky to get any, because it's weeks out to get any product." As opposed to direct sales incentives, contacts described cooperative marketing and advertising dollars, and an occasional sales incentive for a specific product line.

- *"It's very rare that there would be incentives. We don't usually experience it. We are a modestly sized dealer who specializes in JELD-WEN. Our orders used to take 10 days to fill, now we are ordering out four months."*

- *"They don't give incentives for specific lines, but they have a whole host of things they do to get us to sell more windows in general. There are tiers of dealers. They commonly hold thing over you around marketing and providing leads."*
- *"They may give us reduced prices if we sell a certain amount."*

Most windows ordered for existing homes are custom. Respondents reported having very little product in stock, as shown in Table 2-6., Lumberyards are the only other location windows are purchased, but interviewees positioned lumberyards as the location for emergency window purchases if a window hadn't been ordered correctly and the project had standard window sizes.

Table 2-6: Custom Windows as a Percent of Sales (n=35)

Percent of Sales That Are Custom	Percent of Respondents
Less than 50%	6%
50%-79%	3%
80%-99%	20%
100%	71%

2.3 Future of Efficiency

We asked contacts how much more energy efficient windows are likely to get based on their experience in the window market. Twenty-nine percent (12 of 41) did not offer an opinion or did not know if or how windows might get more efficient in the future.

Among the remaining 27 respondents, most (23 of 27) reported windows are likely to get more efficient, primarily through manufacturing innovation and improvements, new technology, and regulation. Some contacts referenced higher performance standards and energy codes specifically driving the market toward increased energy efficiency. Others offered caveats—acknowledging that cost will affect the willingness to push for increasingly efficient windows. Comments included:

- *"I believe the push to get U-values lower and lower will begin to slow in the coming years due to the impact on project costs. I do expect higher efficiency will be required in years to come, [but] anticipate more attention to the efficiency of other building components."*
- *"Windows have come a long way in the last 15 years. Is it still going in that direction? It kind of depends on programs like what NEEA is doing and if you can push to market."*

One contact posited that they expect to see an increase of about .03 U-value every five to 10 years. A small number (4 of 41) believe windows aren't likely to get more efficient. Their comments centered on the progress made over the past 20-30 years and noted that the window market might have reached peak efficiency. One respondent indicated that cost is a barrier

because customers currently are not willing to pay a higher price for more efficient windows, such as those lower than a U-value of.30.

When asked about the portion of customers that would pay more for HPWs, respondents reported that about 20% of customers would be willing to pay more from their experience, explaining that higher price points are acceptable in specific instances and among certain populations. For example, one respondent noted that homeowners on Bainbridge Island often don't care about the cost and would be willing to pay more. Another noted that new energy efficiency standards could force customers to purchase HPWs.

> "Everyone would pay a little more, hardly anyone would pay much more."

> "Customers replace their single for double to have more efficiency during winter or summer—but nobody really calls or asks for high efficiency windows."

Respondents noted that the remaining 80% of the population would not be interested in paying more. They commented that "normal" homeowners are not trying to break the bank, are not searching for sound proofing of their homes, and just want better than their current windows.

2.4 Conclusions

This section summarizes the key takeaways from the supply chain data collection and analysis.

Mystery Shopping

Mystery shopping questions sought to elicit advice and recommendations on products and features for two types of scripted homeowners. We found many respondents reluctant to discuss options in depth for several reasons, including:

- The expectation that a homeowner will require in-person assistance, either in a showroom or through in-home consultation and measurement provided by an installer. Among the 24 contacts that completed a mystery shopping interview, half suggested a professional would need to physically view the windows.
- Pricing is complex and reflects specific attributes chosen by the homeowner. This makes contacts reluctant to offer specific price information before the homeowner narrows down options.
- Ongoing demand for residential contractors and remodeling activity means busy window suppliers who are often unavailable or too busy to discuss options at length with a homeowner.

Overall, interviews indicate that window professionals expect residential window purchasing will require in-person interaction, either in a showroom or through consultation with an installer. Contacts were reluctant to provide detailed pricing information because most retailers wanted to wait to until after a professional had verified measurements, reflecting a desire to provide

accurate information and manage customer expectations. Because of the numerous variables affecting price (nonstandard window sizes, architectural decisions, and glass options), contacts wanted customers to confirm options before taking the time to create detailed quotes. In addition, pandemic-driven sustained investment in home improvement projects and construction meant that window suppliers were frequently at job sites or did not have time to chat at length with a potential customer.

Supply Chain Survey

Supply chain survey results indicate a disconnect between what *installers and vendors* believe homeowners value and what *homeowners* say they value. Windows are expensive, so cost is always a factor; however, once homeowners consider their options, they value efficiency and performance. This disconnect may reflect the improved performance homeowners experience when they replace old windows with new, versus the perceived benefit of incrementally better performing new windows.

Window vendors and installers have a substantial influence on what gets selected. Although manufacturers do not directly recommend products to the supply chain, they influence the overall landscape in which that influence occurs.

Section 3 Homeowner Research

Cadeo developed a concise homeowner survey instrument designed to be self-administered online in 10–15 minutes (see Appendix B). It contained three main sections, designed to assess:

1 | Contacts' housing and demographic information to screen/qualify respondents who can answer our questions.
2 | Triggers for window purchase or replacement and decisions made about window features among those who recently purchased or replaced windows in their homes.
3 | Performance and satisfaction of current or existing windows, the relative values placed on window features using MaxDiff technique, and awareness of window options and likelihood of replacing windows soon.

We distributed the programmed survey to a Qualtrics® online panel of confirmed homeowners. We qualified respondents who live in one of the four NEEA states; who live in single-family, manufactured, or low-rise multifamily (excluding anyone in a building four stories or larger); and whose homes are at least 10 years old. We completed 312 surveys, distributed according to the population distribution of housing units across the four states. This overall sample size is sufficient to achieve 95% +/-6% confidence and precision.

MaxDiff, or best-worst scaling, is a survey research technique for measuring the preference and importance that customers place on a list of items. It can play a critical role in understanding the trade-offs that people would make and ultimately provides a rank-ordering of the list with relative importance scores

For detailed respondent demographics, see Appendix A.

3.1 Key Takeaways

- About one-third of homeowners surveyed had already carried out window replacement projects, replacing on average 54% of the windows in their home (approximately six to seven windows). Two-thirds of replaced windows were 20 years or older (Figure 3-4). Drafts and condensation buildup were the leading triggers of these replacements.
- A substantial portion of homeowners expressed dissatisfaction with the energy efficiency, insulation, and noise blocking performance of their existing windows. Owners of manufactured or low-rise multifamily homes expressed significantly higher levels of dissatisfaction with the performance of existing windows.
- About one-third of homeowners reported considering replacing windows in their home in the next five years. These homeowners are more likely to be under 45 years old, have an income greater than $60,000 and live in homes built after 2000.

- When provided with a description of HPWs, more than two-thirds of the homeowners expressed positive attitudes. Among those intending to replace windows, the majority (87%) expressed interest.
- "Reducing heating and cooling costs by 10-20%" was by far the best performing attribute in the MaxDiff analysis, earning more than triple the relative importance of the next highest group of attributes, which were generally about comfort.
- In focus groups, homeowners described a long consideration process prior to purchase and installation, often waiting years, even decades, before moving forward with replacement.
- Homeowners in Montana replace windows at a significantly higher rate than those in other states.

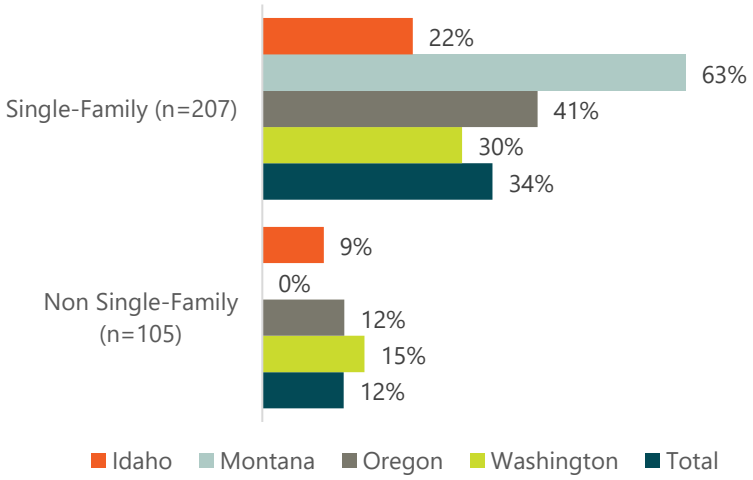
3.2 Survey Results

The sections below provide detailed results for the homeowner survey described above.

Window Replacement Experience

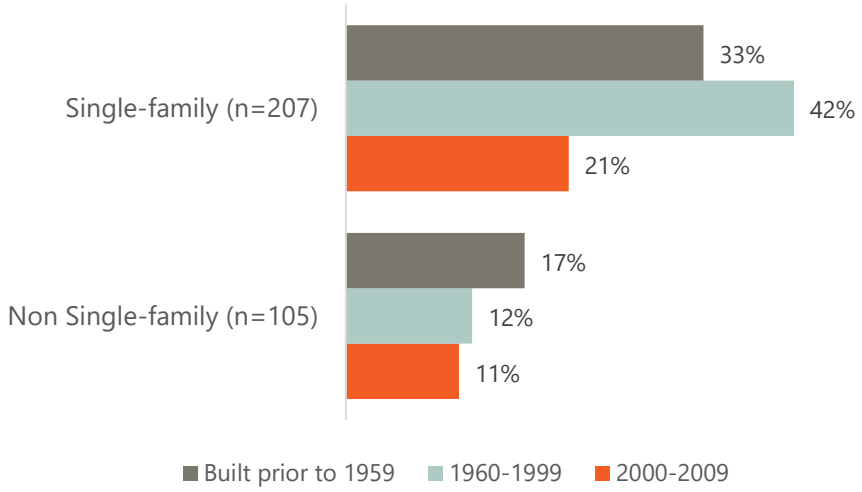
This section focuses on the window replacement experiences among those who reported having replaced any windows in their home. About one-third of single-family homeowner contacts (34%) reported they had replaced at least one window in their home, but the portion varied significantly by state, ranging from a low of 22% in Idaho to a high of 63% in Montana (Figure 3-1). Non-single-family homeowners (including manufactured homes, townhomes, and low-rise multifamily) reported replacing windows at a much lower rate (12% overall).

Figure 3-1: Window replacement varies by geography and home type



Single-family homeowners with homes constructed between 1960 and 1999 reported the highest replacement rate (Figure 3-2). Later in the survey, we asked homeowners about the status of their existing windows and found that very few of the pre-1959 homes had all original windows, indicating that many of those may have been replaced some time ago.

Figure 3-2: Homeowners in 1960-1999 vintage homes have highest replacement rate



Those replacing windows reported having replaced about half of their windows, an average 6.7 windows for single-family homes and 3.8 windows for non-single-family homes (Table 3-1). According to the Residential Building Stock Assessment, single-family homes in the Northwest have approximately 16 windows per home on average, while manufactured and multifamily residences have about 12 and 4 windows, respectively.

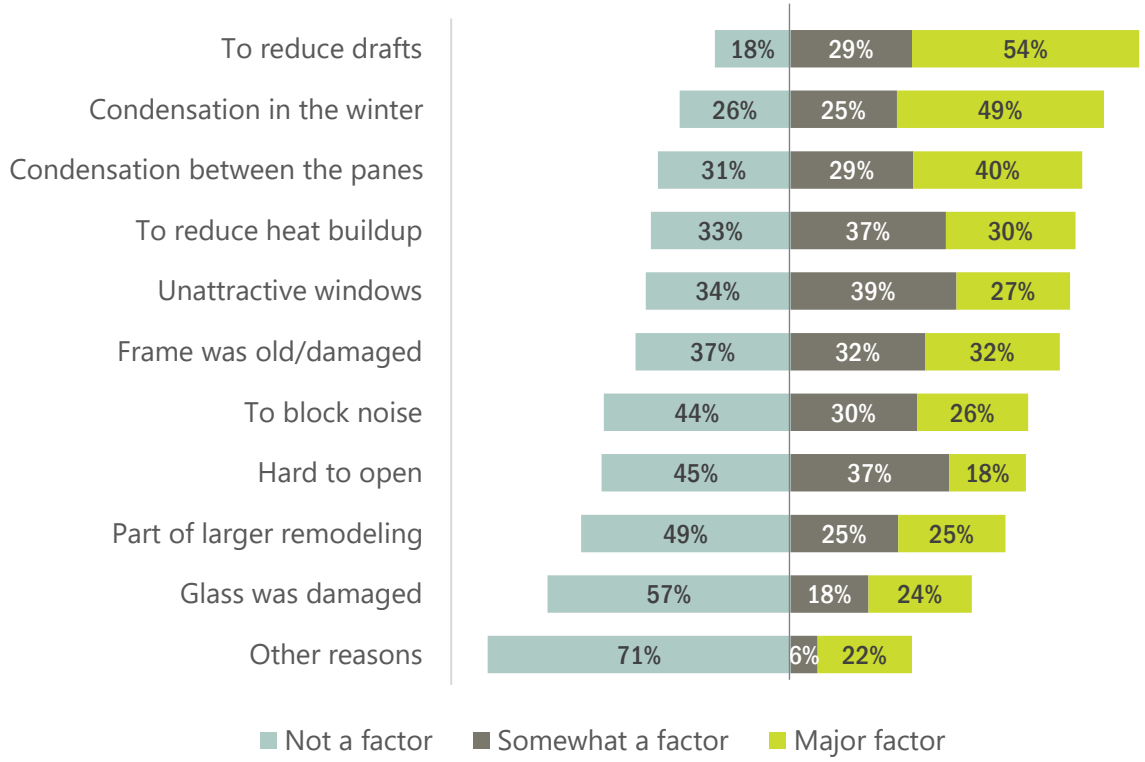
Table 3-1: Percent and Number of Windows Replaced

	Single-Family (n=71)	Non-Single-Family (n=13)
Mean percent of windows replaced	54%	55%
Mean number of windows replaced (Std. dev)	6.7 (5.3)	3.8 (4.2)

We asked those who had replaced windows to rate a set of potential triggers for window replacement (Figure 3-3: Solving drafts and condensation issues most common triggers for window replacement (n=84)). Respondents indicated that reducing drafts and solving condensation were the most common triggers for window replacement. These triggers were followed by reducing heat buildup, obtaining more attractive windows, and solving issues with old or damaged frames.

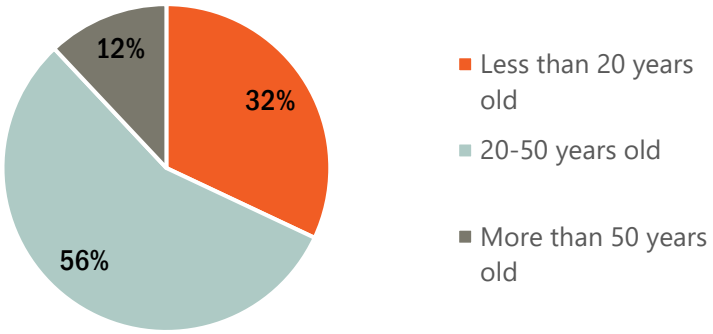
Additionally, 43% of the homeowners who had replaced windows reported their window replacement was a part of a larger remodeling project, while 57% said they were window replacement only projects.

Figure 3-3: Solving drafts and condensation issues most common triggers for window replacement (n=84)



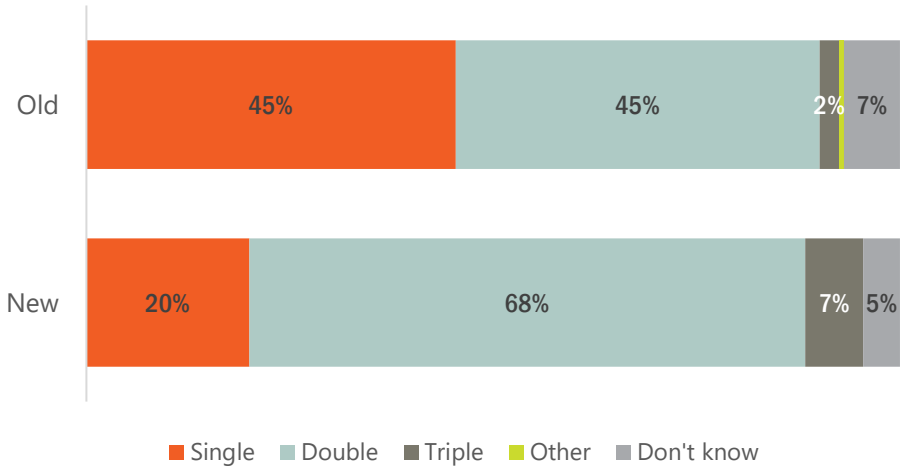
We inquired about the vintage and some key characteristics of the old/replaced and new windows. More than two-thirds (68%) of the homeowners who had replaced windows reported that the old windows were more than 20 years old when replaced (Figure 3-4). About a third said the replaced windows were less than 20 years old.

Figure 3-4: Majority of replaced windows are more than 50 years old (n=84)



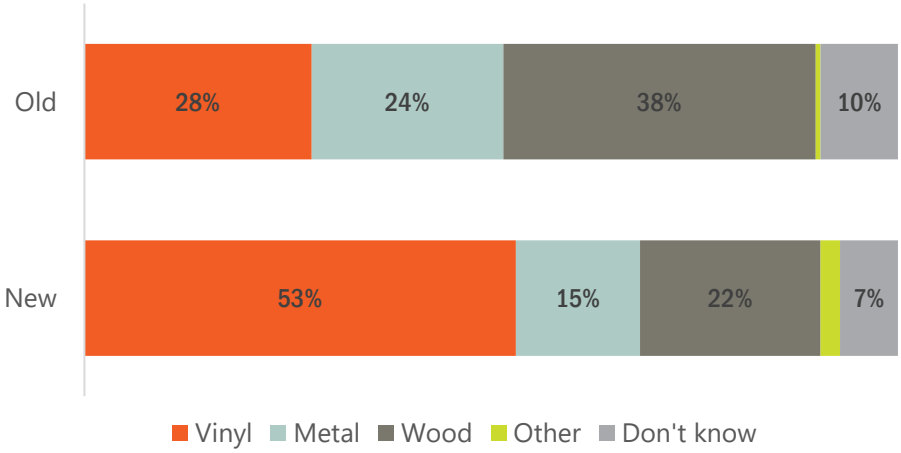
We sought to understand the characteristics of the windows removed and replaced, asking respondents about a few key window features—pane, frame material, and presence of low-e coating—comparing their old/replaced windows to the new windows.

Figure 3-5: Replacement windows are most commonly double-paned



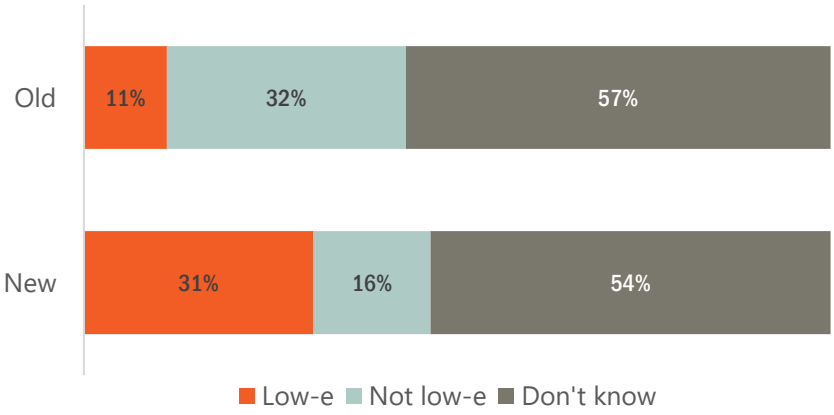
The replaced windows represented a mix of frame types, with wood comprising nearly 40%. These windows were most commonly replaced with vinyl frames. The portion of vinyl windows reported in the survey is lower than might be expected from recent market research, indicating that 80% or more of new windows are vinyl. The survey did not require that the replacement be recent, so this discrepancy could reflect older retrofit projects (respondents were asked if the replacement was in the past five years (57%), 5-10 years (25%), or more than 10 years ago (18%)).

Figure 3-6: Majority of new windows are vinyl



Responses indicate that while the proportion of low-e coated windows increases substantially with new windows, most respondents were unfamiliar with the feature.

Figure 3-7: Homeowners unsure about presence of low-e coating

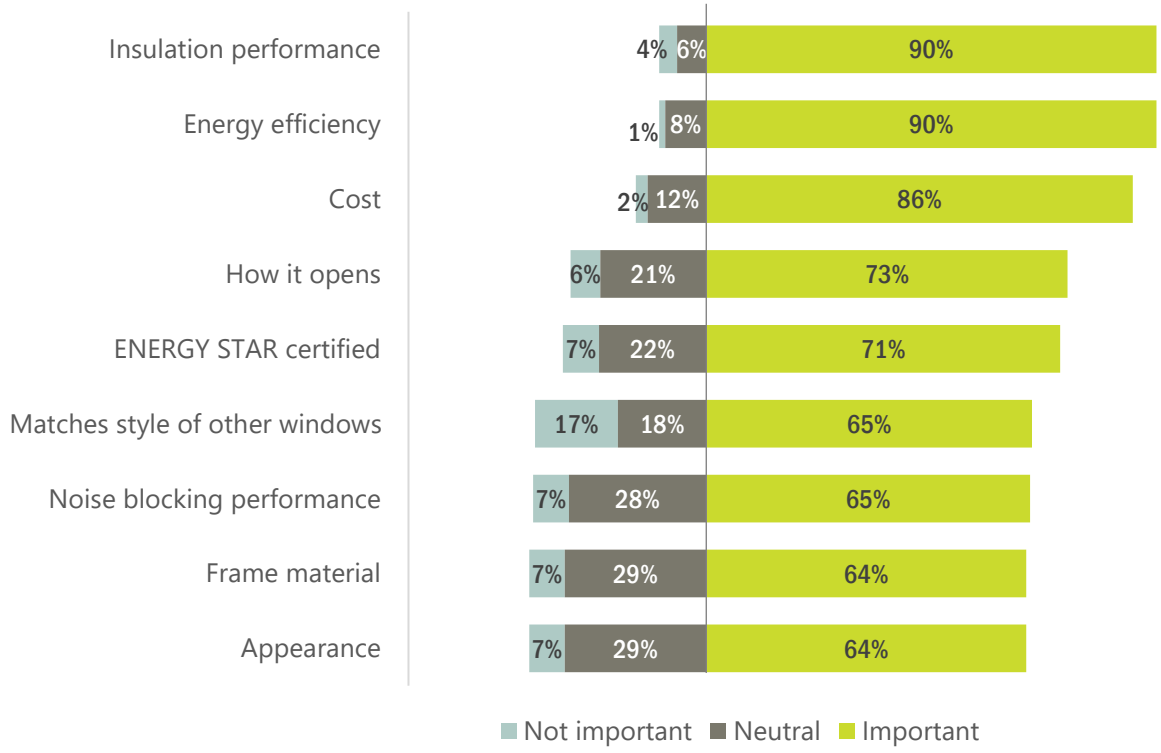


Survey responses also indicate that wood was the most common frame type of replaced/old windows regardless of replaced/old windows' vintage. Vinyl frame windows are more common among the replaced/old windows replaced within the last 20 years compared to those older than 20 years. Among homes built before 1960, replaced windows were more commonly single pane or wood frame materials. Among newer homes (built after 1960), double-pane and/or vinyl-frame windows are most commonly replaced.

We presented several factors homeowners might consider when buying new windows and asked how important each factor was in their purchase decision (Figure 3-8). Consistent with the NAHB survey findings presented earlier, insulation performance and energy efficiency received the

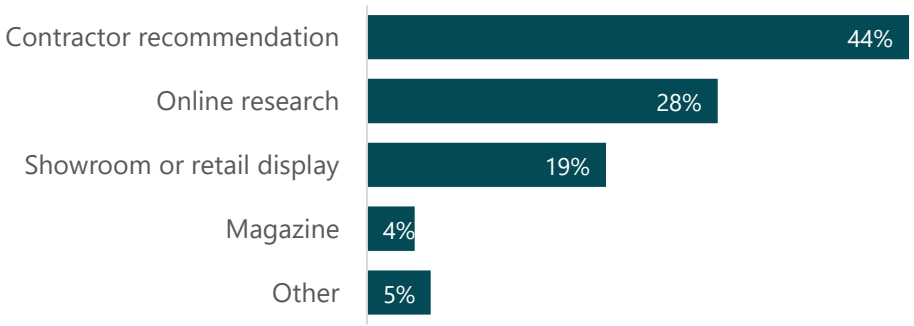
highest ratings of "important." ENERGY STAR certification received lower ratings than cost and operability design—indicating a divergence between energy efficiency and ENERGY STAR.

Figure 3-8: Homeowners value insulation and efficiency in window selection



We asked homeowners who had replaced their windows how they learned about window replacement options and, if they consulted multiple sources, which information source was the most influential in their decision. Figure 3-9 summarizes the responses to these questions. Contractor recommendation was most influential for almost half of those who replaced windows (44%), followed by online research and showroom or retail display.

Figure 3-9: Contractors are most influential source of information for purchasers (n=84)

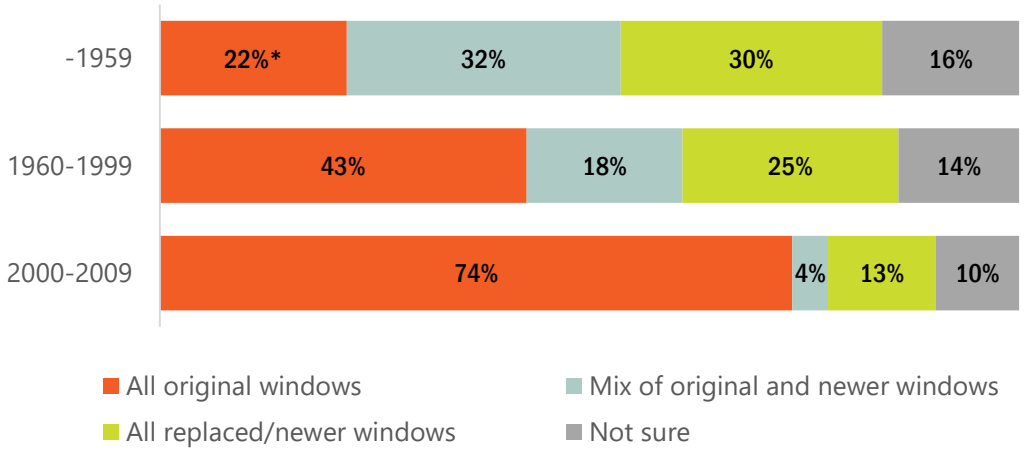


Existing Windows: Satisfaction and Experience

All respondents answered a series of questions about the performance status and their satisfaction with current windows. To all the respondents, we inquired about the status of and satisfaction with their current windows.

We first asked about the mix of window vintage in their home (Figure 3-10). The presence of original windows is significantly correlated with home vintage—older homes have fewer original windows. However, a large proportion of homes in the Northwest retain some original windows, regardless of home vintage. Nearly 80% of homes built in 2000 or later retain some original windows. Sixty-one percent of homes built between 1960 and 1999 and 54% of homes built before 1960 have at least some original windows. These trends are similar in both single-family and non-single-family homes.

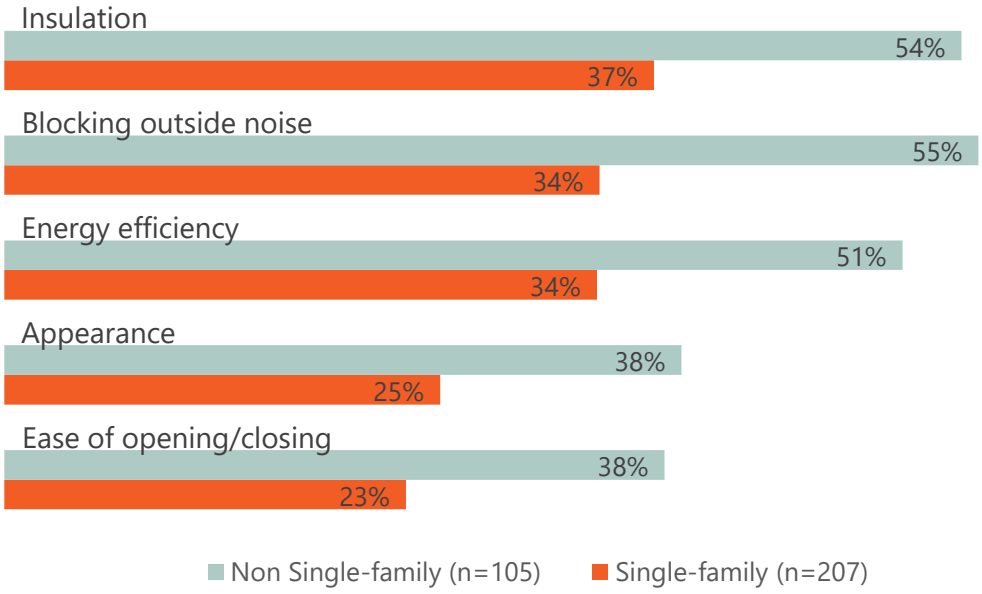
Figure 3-10: Presence of original windows associated with home vintage



**Homes built before 1960 are significantly less likely to have all original windows (X^2=43.03, p<.05).*

We asked respondents to rate their satisfaction with their existing windows generally using a 5-point scale ("not at all satisfied," "slightly satisfied," "moderately satisfied," "very satisfied," and "completely satisfied"). We combined "not at all satisfied" and "slightly satisfied" to understand the portion of respondents not satisfied with the performance of their existing windows on five domains (Figure 3-11). Non-single-family respondents (those living in manufactured or low-rise multifamily homes) were significantly less satisfied with the performance of their existing windows than those living in single-family homes.

Figure 3-11: Residents of non-single-family homes more dissatisfied with all aspects of window performance.

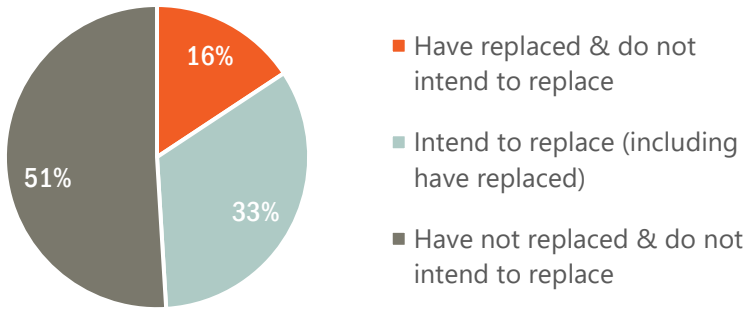


Window Replacement Plans and Attitudes

This section focuses on respondents' expectations for and attitudes toward window replacement. Thirty-nine percent of single-family homeowners and 23% of non-single-family homeowners reported they are considering replacing windows in their home in the next five years.

Figure 3-12 groups respondents' window replacement status and intention (expecting to replace in the next five years). Sixteen percent of homeowners had replaced some of their windows but are not intending to replace any additional windows in the next five years. One-third intend to replace some windows in the next five years; some but not all of these respondents have already replaced some windows. About half (51%) have not replaced and do not intend to replace in the near future.

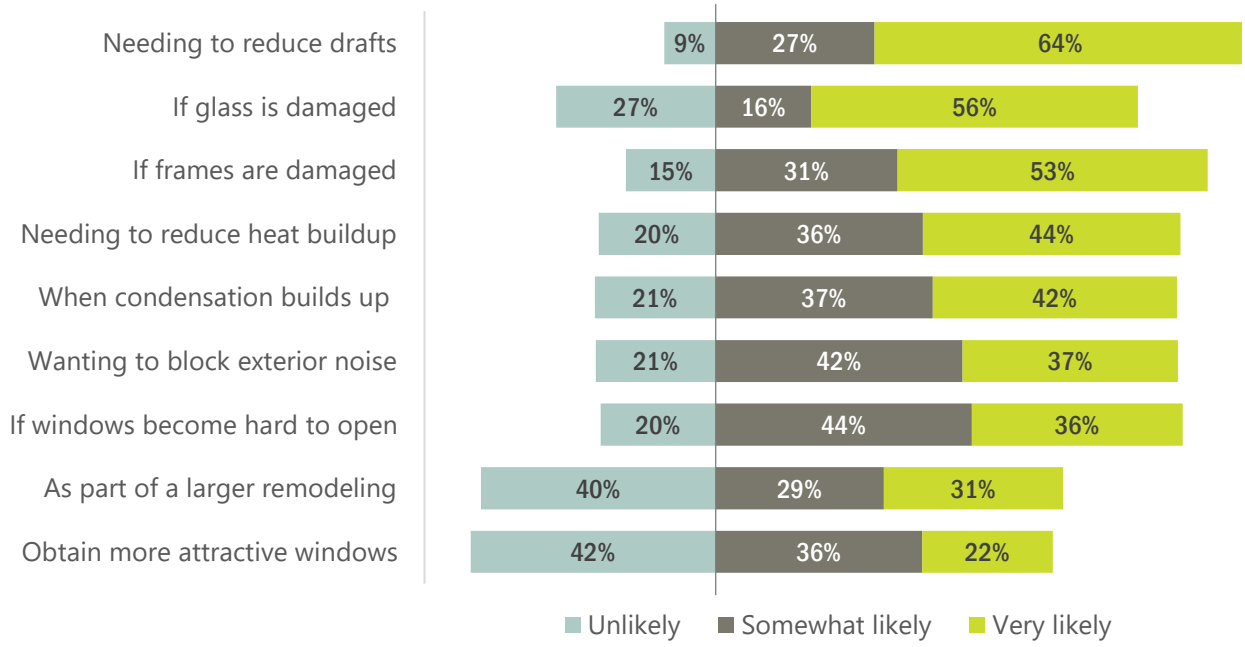
Figure 3-12: Majority do not intend to replace windows



Those reporting replacement intention are demographically distinct. Homeowners younger than 45 with household income greater than $60,000 household income are more than twice as likely to report window replacement intention as other homeowners (62% versus 26%).

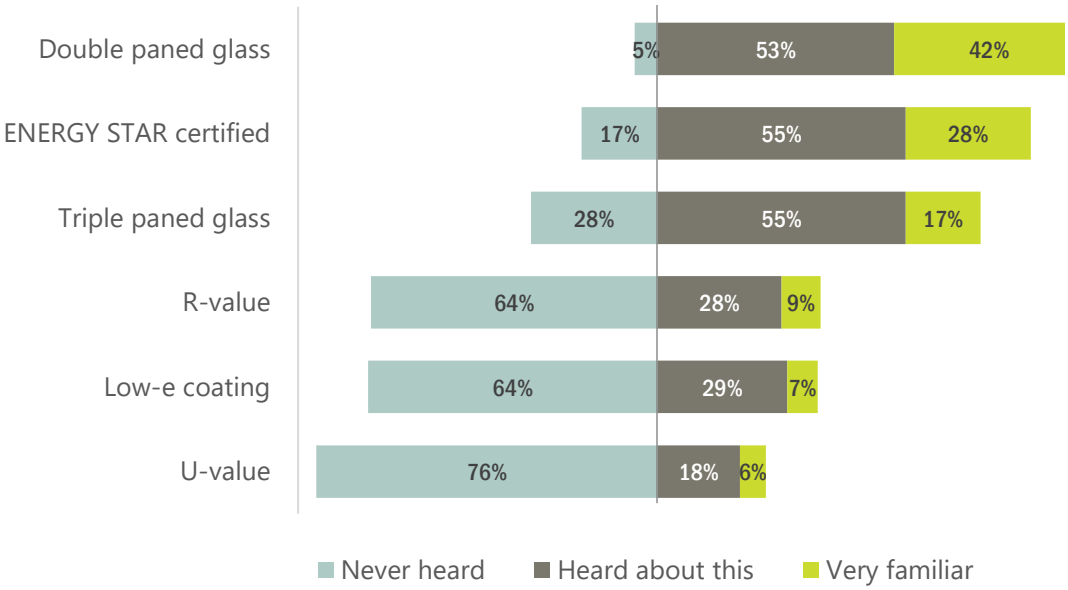
Homeowners in newer vintage homes, built between 2000 and 2010, report the highest percentage of intention, compared to midcentury or older homes. This could reflect the fact that newer vintage homes are more likely to have original windows. Homeowners in Montana are significantly more likely to report intending to replace windows than homeowners in other Northwest states. For those reporting they had not replaced their windows, we asked what scenarios would likely trigger replacement (Figure 3-13). Comparing this with the actual triggers reported by homeowners that had replaced windows (Figure 3-3) reveals that mitigating drafts is a top expected and actual trigger for window replacement.

Figure 3-13: Solving drafts and damage common triggers for replacing windows (n=228)



The survey also sought to understand the level of familiarity homeowners had with a variety of window performance terms. Respondents rated their familiarity by noting if they were "very familiar," had "heard of this," or "never heard of this term." Double-paned glass and ENERGY STAR certification earned the highest ratings of familiarity, while the more technical, performance-based ratings like R-value, U-value and low-e coating all had majorities reporting they had never heard of the term. Awareness of these terms were generally higher among those who have replaced and intend to replace their windows in the near future.

Figure 3-14: Respondents most familiar with double-paned glass and ENERGY STAR



MaxDiff and Customer Preference

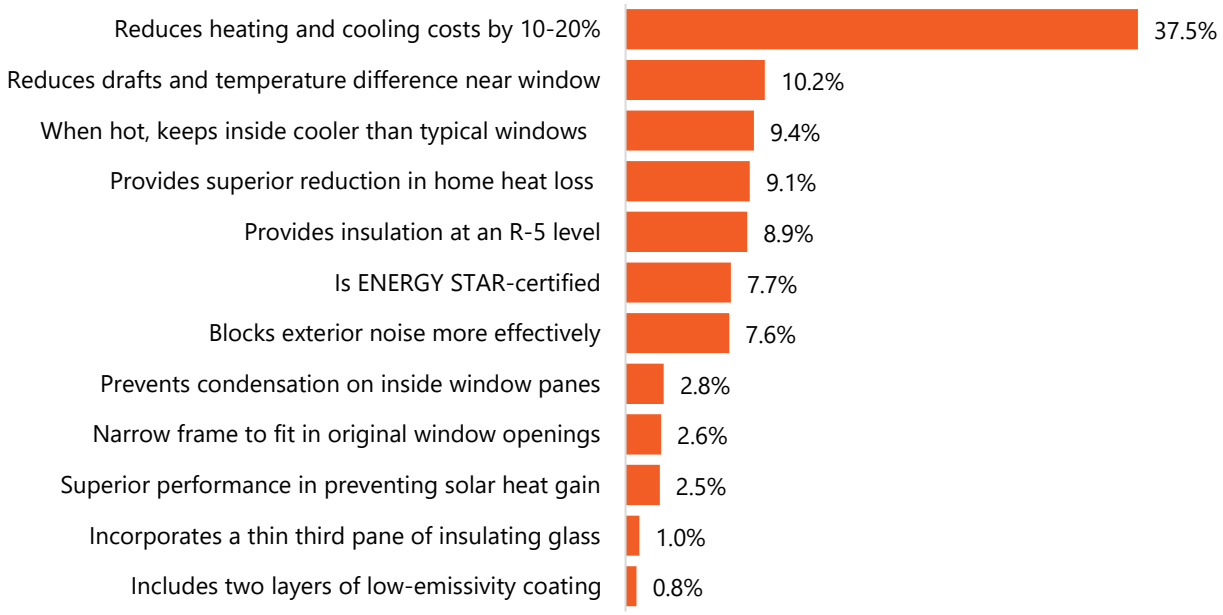
The survey included a MaxDiff choice-based exercise to explore the relative importance of distinct window features to homeowners. MaxDiff results can be helpful to inform marketing efforts and to better understand consumer tradeoffs in purchase decisions. Respondents receive a randomized set of window product features and are asked to select the most important and least important feature in each set. The results (shown in Figure 3-15) indicate that the highest preference share by far is assigned to the product feature associated with reducing heating and cooling costs by 10% to 20%.

Average preference share:

The average preference share is the measurement of the probability that an item would be chosen over another if a respondent was asked to select the best from all options.

The second-tier preference shares generally relate to comfort and user experience of windows such as reduced drafts and heat loss, cooler inside when hot, superior insulation, or reduced noise.

Figure 3-15: Reducing heating and cooling costs highest preference



HPW-Specific Attitudes

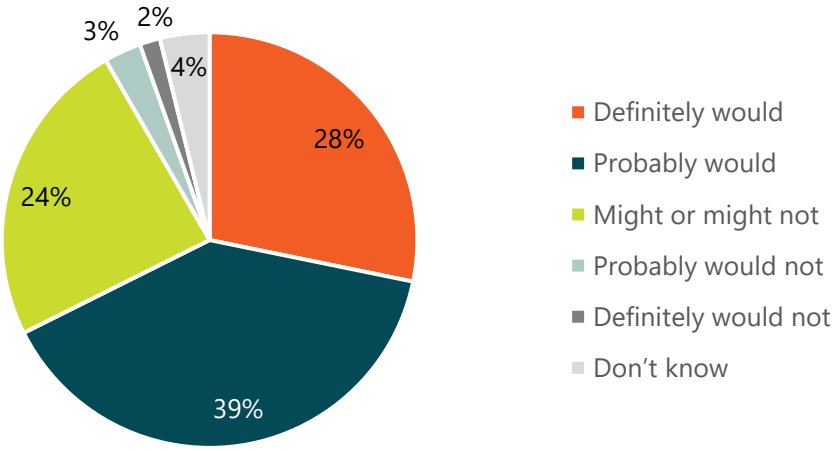
After the MaxDiff questions, we provided contacts with a brief description of HPWs and asked a set of follow-up questions to assess their interest in HPW.

After providing a brief HPW description, we asked how likely they would be to replace existing windows with HPWs the next time they complete a window replacement (Figure 3-16).

More than two-thirds of the homeowners (67%) reported they would 'probably' or 'definitely' replace existing windows with HPWs.

Figure 3-16: Providing information increased interest in considering HPW

How we described HPWs: High Performance Windows provide superior reduction in home heat loss, are ENERGY STAR certified, provide superior performance in blocking exterior noise and solar heat gain in the summer, provide the highest level of insulation, and reduce condensation and heating and cooling costs. They typically do this by including a thin third pane of insulating glass and two layers of low-emissivity coating.

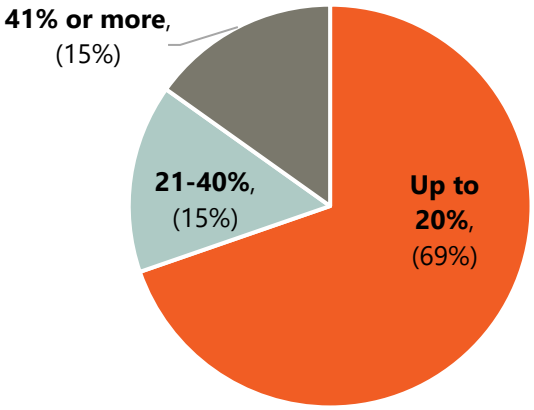


Perhaps more importantly, among those *who intend to replace windows* in the next five years, a majority (87%) said they were "probably" or "definitely" likely to choose HPWs.

When asked about how much more they would pay for features offered by HPWs over non-HPWs windows (

Figure 3-17), 69% of homeowners who intend to replace windows in the next five years reported they would pay up to 20% more for HPWs. A small but noteworthy portion of intenders said they would pay over 20% or even over 40% more to obtain HPW.

Figure 3-17: Intenders would pay more for HPW



We also asked whether the availability of financing options or utility cash rebate would increase their likelihood to purchase HPWs over standard windows. Seventy-six percent of intenders (and 45% of non-intenders) reported likelihood of purchasing HPW would increase with availability of financing options. Ninety-two percent of intenders (and 67% of non-intenders) reported increased likelihood with utility's cash rebate.

3.3 Homeowner Focus Groups

The team conducted two virtual focus groups in April 2022 to dig deeper into the experience and perspectives of homeowners who had already replaced their windows or planned to in the next five years. To recruit focus group participants, we recontacted homeowners who had indicated a willingness to participate in follow-up research as part of the homeowner survey, conducted outreach via phone and email, and offered $100 gift cards 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, 10 homeowners attended one of two focus groups.

Table 3-2: Focus Group Participant Summary

Group	Date	Attendees
Intender (Future Purchaser)	4/19/2022	6 homeowners
Purchaser	4/21/2022	4 homeowners

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.

Understanding Purchase Triggers and the Path to Purchase

One objective of the focus groups was to discuss the decision-making process behind obtaining new windows—understanding purchase triggers, challenges, and the window features

homeowners are most likely to focus on. To explore this process, we asked both purchasers and intenders to describe the factors that led them to pursue new windows.

Focus group participants described a variety of reasons behind their decision to replace, or begin shopping for, new windows including:

- **Wanting to improve the thermal comfort of their homes**. For intenders, this included comments about the 2021 heat wave and the temperature changes experienced every year. Purchasers expressed similar reasons, including losing significant amounts of heat during the winter months and wanting to solve overall draftiness.
- **Performance failures**. These included frames affected by mold and mildew from both intenders and purchasers. One purchaser reported living in a relatively new home (constructed in the early 2000s) with failing windows. A manufacturing flaw means the windows in her home are systematically failing, with interior glass spontaneously shattering. The windows are under warranty, but she must negotiate each replacement with the builder.
- **Aesthetics**. Both intenders and purchasers noted that aesthetics were a key part of their decision-making process, with one intender and one purchaser both mentioning that they wanted to keep up with the neighbors and their homeowners' association because their previous windows looked old or didn't match the neighborhood.

Another focus group objective was to understand the process and time required for homeowners to decide to replace a window and then act. Performance failure emerged as a major factor behind decisions to move forward and shortened timelines between consideration and purchase. Without window failure, homeowners reported prioritizing other, more urgent projects such as water heaters or heating system replacements. One purchaser described staging her project to reduce the upfront cost required. Another purchaser reported wanting new windows for "years and years" before completing her project. Focus group participants described situations in which they began the process of finding new windows, researching products, and even getting bids without acting. Intenders, who had not yet purchased, described a range of time frames within which they might move forward with their window replacement project, with some reporting they intended to purchase windows within a month and others reporting they would in the next "two to three years."

> "I did the front of the house first, and then I did the back. I think it was two years overall because I had to pay for it".

Focus group participants described their priorities for the window purchases, often reflecting the issue they are trying to solve:

- **Increased energy efficiency**. Comments about efficiency centered on resolving drafts and a desire for reduced energy bills. Intenders hoped that new windows would improve the comfort and efficiency of their home.

- **Frame material**. Focus group participants indicated a preference for matching the frame material of other windows or upgrading poor performing frames like aluminum. Two intenders indicated that they preferred vinyl frames, while another intender wanted to match their existing wood frames.
- **Aesthetics**. Like the frame material selection, intenders and purchasers wanted their new windows to match their home and provide an upgrade to the look of their home. Purchasers were particularly aware of the improved look of their homes.
- **Sun-blocking capabilities**. Low-e coating emerged as a priority for some contacts. One intender reported prioritizing low-e coatings, which he had on his existing windows. This participant had worked as a contractor and reported familiarity with a variety of window performance terminology. He knew that he wanted to ensure any new windows also had low-e coatings.

In the discussions, participants described their efforts (or plans) for finding an installer. Although one intender planned to install the windows themselves, most contacts described looking for recommendations on Angie's List, Google searches, or through recommendations from friends or family members. Most contacts described a limited process, with only one bid or occasionally two. Two intenders described getting estimates but not moving forward—one found the installer insulting, while another received a bid for $100,000 for replacing all of his windows with high quality wood frame replacements. Both contacts still wanted their projects to move forward, however. The first intends to find a better installer. The second is considering staging his project—starting with the highest priority windows and moving forward on the others as he could afford to.

Barriers to Window Replacement

Contacts described a variety of barriers to purchasing windows. Intenders described awareness of supply chain challenges and expected that these might increase the time and cost associated with their projects. Other barriers included:

- **Cost**. Intenders and purchasers discussed cost as a large barrier to window replacement projects. The cost of the windows delayed replacement projects, caused projects to be smaller and more spread out over time, and influenced window selection. Intenders reported surprise at the cost of windows, especially if their home had many windows. One intender also mentioned the availability of rebates, noting that if these were available it could allow him to purchase higher performance windows.

> "If we had the money, we would have just pushed a 'go' button six months ago when we got the initial bid."

- **Other home projects**. Homeowners frequently pushed window projects down the list of home priorities. With cost remaining a part of this decision-making process, focus group participants noted they could only spend a certain amount at a time on home projects.

- **Options**. Intenders noted that they wanted windows that matched their homes and had started researching the window features they wanted. Several acknowledged the number of options were somewhat confusing. Interestingly, those who had already completed a window project did not describe challenges with product selection.

Focus group participants were largely unfamiliar with window performance terminology, recognizing ENERGY STAR, but less sure of U-value and low-e. Most expected new windows would provide a substantial improvement in performance relative to their existing (or previous) windows, making the term "high-performance window" less compelling. Focus group participants expressed interest in double-pane windows, a few noting that they had heard triple-pane windows were not necessary unless they lived in an area with extreme weather.

Focus group participants indicated interest in efficient windows and were not opposed to TTW when the technology was described. Purchasers indicated openness to more efficient windows. Several purchasers upgraded their windows using public loan or subsidy programs designed to improve residential efficiency and/or maintain housing stock. These participants were pleased to obtain new windows but noted that they had limited choices and might have made different decisions if they had had more control over their projects. Another purchaser experienced ongoing window failure in a relatively new home. She reported having no choice in replacement windows as the builder and manufacturer addressed replacements via warranty.

Appendix A Respondent Demographics

Table A-1: Respondent Demographics

Attribute	Item	Count	Percent
States	Washington	158	51%
	Oregon	92	29%
	Idaho	38	12%
	Montana	24	8%
Rural-Urban Classification	Urban	231	74%
	Suburban	43	14%
	Rural	38	12%
Housing type	Detached single-family	207	66%
	Multifamily buildings (<=3 stories)	63	20%
	Manufactured home	25	8%
	Townhouse, rowhouse	17	5%
Year home built	2000 – 2009	72	23%
	1980 – 1999	97	31%
	1960 – 1979	74	24%
	1940 – 1959	34	11%
	Before 1940	35	11%
Age	18 – 24 years old	27	9%
	25 – 44 years old	135	43%
	45 – 64 years old	83	27%
	65 years or older	67	21%
Household income (2020)	Less than $40,000	120	38%
	Between $40,000 and $49,999	40	13%
	Between $50,000 and $59,999	29	9%
	Between $60,000 and 79,999	34	11%
	Between $80,000 and $99,999	27	9%
	Between $100,000 and $119,999	21	7%
	$120,000 or more	29	9%
Education	High school or less	140	45%
	Associate's degree	79	25%
	Bachelor's degree	55	18%
	Graduate or professional degree	35	11%
Race (multiple response)	Caucasian	282	90%
	Non-Caucasian	38	3%

Appendix B Market Planning Inputs

This Appendix includes several inputs collected to inform market planning.

Market Size

This project did not include specific sales volume estimation for the four-state region, however secondary sources can be used to derive an estimate.

National 2019 sales of residential window products (estimated in DuckerFrontier):

Type	2019 Sales
Residential new construction	23 million
Residential remodel	11 million
Residential replacement	17.6 million
Manufactured housing	1.3 million (likely counted at factory)

There are several sources for average number of windows per home:

Source	Home type	Estimate
RBSA	Single family	15.9
	Manufactured	11.7
	Multifamily	4.2
Homeowner Survey	Single family	12.5
	Manufactured	9
	Multifamily	7.7
EPA	Single family	17-28 (average 22)

Window replacement rate, estimated from homeowner survey responses:

State	Estimated replacement rate (pre 2000 built)
Idaho	1.54%
Montana	1.57%
Oregon	1.15%

Washington	1.13%
Total	1.22%

This research did not enable reliable estimates into the split between early replacement vs. natural replacement (at end of useful life). In part because of the myriad reasons for window replacement and the substantial delays in replacing windows that are failed or failing. The definition of "failure" is not stable among homeowners and trade allies. Supply chain contacts report nearly 60% of replaced windows lack low-e coating and/or have condensation issues. 50% have aging or damaged frames, and 46% have operability problems. 43% of windows replaced are single pane glass. Windows can have multiple issues and remain in place if a homeowner lacks the capacity to upgrade.

New construction values are derived from residential energy code, which is dropping in Washington. Washington currently requires 0.3, which will drop to 0.28 in next cycle (2023). Oregon currently requires 0.27. Survey responses indicate that 0.27 is standard practice, and 81% of installations are between 0.23 and 0.30 (installers aim for an average of 0.3, so installations are generally below that to allow for occasional product above). Retrofit projects are not required to meet energy code building-wide, but code often affects the selection practices and results in similar efficiency being installed in new and existing homes. According to Ducker 85.7% of windows installed in 2019 were ENERGY STAR certified. Only 1.7% were ESME.

U-Value	Estimated Market Share
U between 0.23 and 0.30	81%
U > 0.30	18%
U ≤ 0.22	10%
Triple paned windows	9%

Appendix C Homeowner Survey

Table C-1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Web Survey
Estimated Time to Complete	Target: 15 minutes
Population Description	Homeowners in OR, WA, ID, MT
Sampling Strata Definitions	State
Completion Goal(s)	Target: WA: 153 OR: 87 ID: 36 MT: 24 [Expected to include a limited sample of homeowners in homes other than detached single family. Exact incidence rate is unknown, reflects panel characteristics plus screening criteria.]
Call List Source and Date	Qualtrics: Regional Panel
Type of Sampling	Random
Contact Sought	Owners of homes >10 years old.
Fielding Firm	Qualtrics

Table C-2: Research Objectives and Associated Questions

Research Objective	Associated Questions
Understand homeowner experience with window replacements	Q1, Q5,Q6, Q8, Q17
Understand triggers for window replacements	Q10,Q11, Q12,
Document what types of windows were replaced	Q4, Q13, Q14
Investigate characteristics of replacement windows	Q15
Satisfaction with existing windows	Q2, Q3, Q18
Understand awareness of window options	Q9, Q16
Assess relative value of different window features (MaxDiff)	Q21
Investigate how information on thin triples/High Performance Windows [8]affects intention, test program incentives	Q22,**Error! Reference s ource not found.**, Q23, Q25, Q26
Demographics	S1-S3, Q27-Q31

[8] This instrument uses elements of "thin triple" windows to define High Performance Windows towards the end of the survey.

Instrument

Screening and Background

[ASK ALL]

S1. In what state do you currently reside.

1. List 50 US states in a dropdown **[THANK & TERMINATE IF NOT ID, MT, OR, OR WA]**

[ASK ALL]

S2. Please indicate the type of home you live in:

[SINGLE RESPONSE]

1. Detached single-family home
2. Townhouse or rowhouse
3. Duplex, triplex, or fourplex
4. A multifamily building with three floors or fewer
5. A multifamily building with four or more floors **[THANK & TERMINATE]**
6. Manufactured home

[ASK ALL]

S3. How old is your home? Please indicate if your home was built...

[SINGLE RESPONSE]

1. Since 2010 **[THANK & TERMINATE]**
2. 2000-2009
3. 1980-1999
4. 1960-1979
5. 1940-1959
6. Before 1940

Window Features

[ASK ALL]

Q1. Approximately, how many windows (not including doors) does your home have?

1. **RECORD NUMBER: _____**

-98. **I'M NOT SURE**

[ASK ALL]

Q2. **BELOW IS A LIST OF WINDOW FEATURES. THINKING ABOUT THE WINDOWS IN YOUR HOME IN GENERAL, HOW SATISFIED ARE YOU WITH THE PERFORMANCE OF THEM ON EACH FEATURE? [RANDOMIZE ALL ITEMS]**

Factor	Not at all satisfied	Slightly satisfied	Moderately satisfied	Very satisfied	Completely satisfied	DK
The appearance of my windows						

The energy efficiency of my windows						
Ease of opening and closing my windows						
How well my windows block outside noise						
How well the windows insulate my home.						
For this item, please enter 'Slightly satisfied' to confirm you're not a bot						

Q3. THINKING ABOUT THAT SAME LIST OF WINDOW FEATURES, HOW IMPORTANT IS EACH FEATURE TO YOU? [PROGRAMMING: DISPLAY IMPORTANCE SCALE NEXT TO SATISFACTION SCALE.]

Factor	Not at all important	Somewhat important	Moderately important	Very important	Extremely important	DK
The appearance of my windows						
The energy efficiency of my windows						
Ease of opening and closing my windows						
How well my windows block outside noise						
How well the windows insulate my home.						
For this item, please enter 'Somewhat important' to confirm you're not a bot						

[ASK ALL]

Q4. Are the windows in your home "original?" By that we mean that they are the windows that were installed when your home was built.

[SINGLE RESPONSE]

1. Yes, all windows in my home are original
2. No, none of the windows in my home are original
3. I have a mix of original and newer windows
-98. I'm not sure

[ASK ALL]

Q5. **HAVE YOU REPLACED ANY WINDOWS IN THIS HOME?**

1. Yes
2. No [SKIP TO Q9]

[ASK IF Q5=1]

Q6. **APPROXIMATELY HOW MANY WINDOWS HAVE YOU REPLACED?**

1. RECORD NUMBER: _____

[ASK IF Q5_1 > 0]

Q7. **IN HOW MANY OF THESE WAS THE GLASS REPLACED WITHOUT REPLACING THE FRAME?**

1. RECORD NUMBER: _____
2. I'm not sure

[ASK IF Q5=1]

Q8. **WHEN DID YOU REPLACE THEM (MOST RECENTLY IF STAGED)?**

[SINGLE RESPONSE]

1. Within the last five years
2. Five to 10 years ago
3. More than 10 years ago

[ASK ALL]

Q9. **THERE ARE SEVERAL TERMS USED TO DESCRIBE WINDOW SPECIFICATIONS. PLEASE INDICATE YOUR FAMILIARITY WITH EACH TERM. (RANDOMIZE OPTIONS)**

Term	Very familiar	Heard of this	Never heard this term
Low-emissivity (low-e) coating			
Double paned glass			
Triple paned glass			
ENERGY STAR certified			
U-Value			
R-Value			

[ASK ALL]

Q10. **ARE YOU CONSIDERING REPLACING ANY WINDOWS IN THE NEXT FIVE YEARS?**

1. Yes
2. No
3. Don't know

[ASK IF Q5 = 1 HAVE REPLACED WINDOWS, ELSE SKIP TO Q21]

We have a few questions about your window replacement experience. Thinking about your most recent window replacement project...

Q11. What prompted you to replace your old windows?

[**PROGRAM AS MATRIX, WITH RESPONSE OPTIONS FOR EACH: NOT A FACTOR, SOMEWHAT A FACTOR, MAJOR FACTOR**]

1. It was part of a larger remodeling project
2. The windows had become hard to open
3. The frames were old/damaged
4. The glass was damaged
5. There was condensation between the panes
6. Condensation builds up on the inside of the window during cold weather
7. Wanting to reduce drafts or cold air
8. Wanting to block exterior noise
9. Wanting to reduce heat buildup from summer sun
10. They were unattractive

-96. Some other reason? please specify: [**OPEN-ENDED RESPONSE**]

-97. Don't know

[ASK IF Q5 = 1 HAVE REPLACED WINDOWS]

Q12. Would you say your window replacement project was:

[SINGLE RESPONSE]

1. Part of a larger remodeling project
2. Window replacement only
3. A mix of remodeling and replacement

-96. Another type of project? please specify: [**OPEN-ENDED RESPONSE**]

-97. Don't know

[ASK IF Q5= 1 HAVE REPLACED WINDOWS]

Q13. About how old were the windows you replaced?

[SINGLE RESPONSE]

1. Less than 20 years old
2. 20-50 years old
3. More than 50 years old

-96. Other, please specify: [**OPEN-ENDED RESPONSE**]

-97. Don't know

[ASK IF Q5 = 1 HAVE REPLACED WINDOWS]

Q14. We'd like to understand a little bit about the type of ***window(s) you replaced***. You indicated you replaced [pipe-in from Q6_1] windows. In the boxes below, please enter the number of windows that describe the characteristics of your ***old windows***. They should total up to [pipe-in from Q6_1] windows.

[NUMERIC,]

Panes	Frame type	Low-e coated
__ Single pane	__ Vinyl	__ Yes
__ Double pane	__ Metal	__ No
__ Triple pane	__ Wood	__ Other (specify)
__ Other (specify)	__ Other (specify)	__ Don't know

__ Don't know	__ Don't know	

[ASK Q5 = 1 HAVE REPLACED WINDOWS]

Q15. In the previous question, you told us about the windows you replaced. We'd also like to understand the characteristics of the ***new windows that you installed.*** In the boxes below, please indicate the characteristics of the windows you had installed. They should total up to [pipe-in from Q6_1] windows.

[NUMERIC]

Panes	Frame type	Low-e coated
__ Single pane	__ Vinyl	__ Yes
__ Double pane	__ Metal	__ No
__ Triple pane	__ Wood	__ Other (specify)
__ Other (specify)	__ Other (specify)	__ Don't know
__ Don't know	__ Don't know	

[ASK Q5 = 1 HAVE REPLACED WINDOWS]

Q16. There are a variety of factors homeowners consider when purchasing new windows. Please indicate how important each factor was in your decision.

Factor	1 'Not at all important'	2 'Slightly important'	3 'Moderately important'	4 'Very important'	5 'Extremely' important	DK
The appearance of the windows						
The cost of the windows						
The energy efficiency of the windows						
How the window opens						
The frame material (wood, metal, vinyl)						
How well the windows block outside noise						
How well the windows insulate the home						
Finding an Energy Star certified window						

Ensuring the style matches other windows in home						

[ASK Q5 = 1 HAVE REPLACED WINDOWS]

Q17. How did you learn about your window replacement options?

[MULTIPLE RESPONSE, DISPLAY WITH TWO COLUMNS, FIRST TO INDICATE THEY USED A SOURCE SECOND FOR THEM TO SELECT THE SOURCE MOST INFLUENTIAL TO THEIR FINAL DECISION.]

1. Online research
2. Installer or contractor recommendation
3. Showroom or retail display
4. Magazine

-96. Other, please specify: **[OPEN-ENDED RESPONSE]**

-97. Don't know

[**ASK Q5 = 1 HAVE REPLACED WINDOWS]**

Q18. Would you recommend the windows you purchased to a family member or friend if they were considering purchasing new windows?

[**SINGLE RESPONSE**]

1. Yes
2. No

-96. Other, please specify: [**OPEN-ENDED RESPONSE]**

-97. Don't know

[**ASK IF Q18 = NO]**

Q19. Why would you not recommend the windows you purchased?

[**SINGLE RESPONSE**]

1. [**OPEN-ENDED RESPONSE]**

[ASK IF Q5 = 2/HAVE NOT REPLACED WINDOWS]

Q20. We would like to understand what might cause you to replace your windows. For each of the situations below, please indicate how likely you would be to replace your windows in each scenario.

[PROGRAM AS MATRIX, WITH RESPONSE OPTIONS FOR EACH: NOT LIKELY, SOMEWHAT LIKELY, VERY LIKELY]

1. My home is undergoing a larger remodeling project
2. The windows become hard to open
3. The frames are old/damaged
4. The glass is damaged
5. The windows become "foggy" because of condensation between the panes
6. Condensation builds up on the inside of the window during cold weather

7. I want to reduce drafts or cold air
8. I want to block exterior noise
9. I want to reduce heat buildup from summer sun
10. I want more attractive windows
11. For this item, please enter 'Somewhat likely' to confirm you're not a bot

Max/Diff & Value [ASK ALL]

Q21. In the next several pages, we'll show several product features window purchasers often consider. In each page, we would like you to select the most important and least important features to you if you were choosing new windows for your home.

TO BE PROGRAMMED IN QUALTRICS' MAX/DIFF SOFTWARE TO ALLOW FOR RANDOMIZED PRESENTATION OF A COMBINATION OF 4-5 ATTRIBUTES FOR WHICH RESPONDENTS WILL CHOOSE THE "MOST IMPORTANT" AND "LEAST IMPORTANT."

[DISPLAY RANDOMIZED SETS OF FOUR ATTRIBUTES FOR BEST/WORST CHOICE.]

Provides superior reduction in home heat loss
Is ENERGY STAR-certified
Blocks exterior noise more effectively
Superior performance in preventing solar heat gain
On hot days, keeps a home cooler than typical windows
Excellent at reducing drafts and temperature difference near the window
Better at preventing condensation on inside panes of the window
Reduces heating and cooling costs by 10-20%
Incorporates a thin third pane of insulating glass
Provides insulation at an R-5 level, the highest level currently available **Hover-over text (R-5 level):** R-5 is a measure of insulation thickness and currently the highest level available in the market.
Includes two layers of low-emissivity (Low-E) coating **Hover-over text (low-emissivity coating):** Low-e coating improves windows' thermal efficiency (heat gain is reduced in the summer and heat loss is reduced in the winter) and helps reduce energy bill.
Has a narrow enough frame to fit in original window openings

HPW-Specific Attitudes [ASK ALL]

High Performance Windows provide superior reduction in home heat loss, are ENERGY STAR certified, provide superior performance in blocking exterior noise and solar heat gain in the summer, provide the highest level of insulation, and reduce condensation and heating and cooling costs. They typically do this by including a thin third pane of insulating glass and two layers of low-emissivity coating.

[ASK ALL]

Q22. Knowing these features, how likely would you be to replace existing windows with High Performance Windows the next time you do a window replacement?

[SINGLE RESPONSE]

1. Definitely would not
2. Probably would not
3. Might or might not
4. Probably would
5. Definitely would

-98. Don't know

[**ASK ALL]**

Q24. Approximately how much more do you think you would pay for windows with these features, as a percentage?

1. I would pay _____% more.

-98. Don't know

-99.

[ASK ALL]

Q25. Would the availability of financing options increase your likelihood to purchase High Performance Windows?

1. Yes
2. No

-98. Don't know

[ASK ALL]

Q26. Would the availability of a cash rebate from your utility increase your likelihood to purchase High Performance Windows?

1. Yes
2. No

-98. Don't know

Demographics [ASK ALL]

We have just a few final questions to help us understand the characteristics of respondents.

Q27. Please enter your zip code

1. **[OPEN-ENDED NUMERICAL RESPONSE]**

Q28. Which of the following best describes your age range:

[**SINGLE RESPONSE**]

1. Under 18
2. 18 to 24
3. 25 to 44
4. 45 to 64
5. 65 and over

-98. Prefer not to say

Q29. Which of the following categories best represents your approximate annual gross household income in 2020?

[SINGLE RESPONSE]

1. Less than $40,000
2. Between $40,000 and $49,999
3. Between $50,000 and $59,999
4. Between $60,000 and 79,999
5. Between $80,000 and $99,999
6. Between $100,000 and $119,999
7. $120,000 or more

-98. Don't know
-99. Prefer not to say

Q30. What is your race?

[MULTIPLE RESPONSE]

1. White
2. Black, African American
3. American Indian or Alaska Native
4. Asian
5. Native Hawaiian or Other Pacific Islander

-96. Other, please specify: **[OPEN-ENDED RESPONSE]**

-98. Don't know
-99. Prefer not to say

Q31. What is the highest level of education you've completed so far?

[MULTIPLE RESPONSE]

1. Some high school, no diploma
2. High school diploma or GED
3. Associates degree
4. Bachelor's degree
5. Graduate or professional degree

-98. Don't know
-99. Prefer not to say

[ASK ALL]

Follow up research

Q32. As part of this project, we will be conducting a limited set of virtual focus groups to explore the window purchasing process in more depth. Would you be willing to consider participating in this follow-on research? The focus groups will last 90 minutes and occur in Spring 2022. You would be compensated for your time.

[**SINGLE RESPONSE**]

1. Yes

2. No

[ASK IF Q32=1]

Q33. Please enter your contact information to reach you for the follow-on research.

1. Your full name _____
2. Email _____
3. Phone _____

Thank you for your time.

Appendix D Supply Chain Interview Guide

Table D-1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Short-Answer Interview
Estimated Time to Complete	Target: 10-15 minutes
Population Description	Installers, distributors, vendors of residential windows
Sampling Strata Definitions	Installers/glaziers: and supply chain contacts, including retailers, distributors, and millwork/lumberyards.
Population Size	Unknown. Estimated at approximately 530
Call List Size	532 (284, or 53% of the list is installer/glaziers. The remainder are supply chain/distribution contacts.)
Completion Goal(s)	45 total completes. 20-25 installers/glaziers and 20-25 supply chain contacts.
Call List Source and Date	Cadeo developed population frame
Type of Sampling	Random within two strata: installer/glaziers and supply chain contacts. Supply chain contacts include a mix of big box, distributor, millwork/lumberyard, and wholesale distribution. No firm sample established for sub categories given small sample sizes within sub categories and uncertainty in categorization scheme.
Contact Sought	Contact with experience selling or installing windows for residential buildings
Fielding Firm	Cadeo

Table D-2: Research Objectives and Associated Questions

Research Objective	Associated Questions
Document role of the respondent and organization characteristics; identify diffusion links between new construction and retrofit	S4, 9.-99.S6, Q5
Document share of sales/installations that are new construction vs. existing homes	Q5, Q6, Q12
Build understanding of the supply chain	Q7, Q12, Q13 Q14,
Document sales process	Q7, Q8, 0, Q25
Investigate likelihood to recommend HPW and TTW	Q21, Q25,
Document standard practice for product recommendation and installation	Q15, Q16, Q18, Q29, Q31
Identify barriers to selling and/or installing HPW and TTW	Q27, Q25, Q17

Instrument

Introduction

Our firm, Cadeo, is conducting a study on behalf of the Northwest Energy Efficiency Alliance to understand market trends in residential window products. Your perspective and insights are extremely valuable to this research, and we would like to include you in this effort. We are offering $100 for each completed interview.

Email outreach: Our questions should take approximately 10 minutes to complete.

Phone outreach: My questions should take approximately 10-15 minutes. Is this a good time, or should we schedule for a better time?

Thank you for participating in this study about window products in the Northwest.

Screening [ASK ALL]

We'd like to speak to someone with insight into the residential window market, and your organization's residential window sales.

S4. Does your firm install new residential windows?

4. Yes
5. No
6. Sometimes
-98. Don't know

S5. Does your firm sell new residential windows to other professionals?

7. Yes
8. No
9. Sometimes
-99. Don't know

S6. Do you have a space where customers can see and touch window products prior to purchasing them, like a showroom? (Interviewer: record any unique or alternative ways customers are given access in verbatim.)

10. Yes
11. No
-96. Other, please specify: [**OPEN-ENDED RESPONSE**]

[**IF NO TO ALL THREE SCREENING QUESTIONS, THANK AND TERMINATE**]

Introduction and Awareness

[**ASK ALL**]

Q1. New window technology uses the availability of super thin glass, like that used in flat screen TVs, to manufacture triple pane windows that improve thermal performance without the bulk of traditional triple pane windows. Before today, had you heard of these ***"thin" triple paned windows***?

[SINGLE RESPONSE]

1. Yes
2. No
-96. Optional verbatim: [OPEN-ENDED RESPONSE]

[ASK IF Q1= 1/YES]

Q2. Where did you learn about thin triple windows?

[SINGLE RESPONSE]

1. [OPEN-ENDED RESPONSE]

[ASK IF Q1 = 1/YES]

Q3. Are "thin" triple window products available from your suppliers?

[SINGLE RESPONSE]

1. Yes
2. No
-96. Optional verbatim: [OPEN-ENDED RESPONSE]
-97. Don't know

[ASK IF Q3=1/YES]

Q4. Have you ordered or installed them? [Record response, if unclear probe to understand if they are aware they can order them, or if they have actually ordered them, or even have them in stock.]

1. Yes
2. No
-96. Optional verbatim: [OPEN-ENDED RESPONSE]
-98. Don't know

Distributors [ASK IF Q33.6.-98.S5=YES OR "SOMETIMES"]

You indicated that you sell windows to other professionals.

Q5. We are trying to understand the volume of sales that go to different types of folks. Thinking about the windows you ***sell;*** about what portion are sold to…

[INTERVIEWER READ EACH ITEM, SUM TO 100%. DO NOT REQUIRE VALIDATION.]

1. Developers or builders working on new homes?
2. General contractors, who typically work on existing homes
3. Other retailers
4. Installation firms
5. Homeowners
-96. Another market or explanation: RECORD VERBATIM

[IF Q5, 1>ZERO AND <100%]

Q6. How do the products sold for new home construction differ from those purchased for installation in existing homes (retrofit or remodeling type projects)? [Are they typically a different quality, sold to different folks, more likely single hung, or a more consistent design.]

[SINGLE RESPONSE]

1. **RECORD VERBATIM**

[ASK ALL]

Q7. Over the past two years, about what portion of your sales have been custom orders (meaning, the products are not stocked and must be ordered)?

1. 0-9%
2. 10-19%
3. 20-29%
4. 30-39%
5. 40-49%
6. 50-59%
7. 60-69%
8. 70-79%
9. 80-89%
10. 90-99%
11. 100%

-98. Don't know

[ASK IF Q7 DOES NOT EQUAL 100%]

Q8. What type of window products do you keep in stock? [Note: we are trying to understand both the portion of windows that are custom ordered AND any driving characteristic for stocked items.]

1. [**OPEN-ENDED RESPONSE**]

[ASK IF Q4 =2]

Q9. Do you sell triple pane windows?

1. Yes
2. No

-98. Don't know

Q10. [If Q5=Yes] What types of triple pane windows do you sell? Standard triple panes, thin triple windows, both?

-96. [**OPEN-ENDED RESPONSE]**

Q11. Are triple pane windows always custom ordered, or are they in stock?

-96. [**OPEN-ENDED RESPONSE]**

Installers [ASK IF Q33.3.S4=YES]

You indicated that your company installs windows.

Q12. Thinking about the windows you ***install;*** about what portion are installed in new homes as opposed to existing home retrofits…

1. New homes % _____
2. Existing homes%_____

-96. Another type of project [SPECIFY]

[ASK IF Q12_2 > 0%]

Q13. Thinking about the windows you install in **existing homes**, from whom do you typically purchase those? For example, do you purchase direct from manufacturers, through distribution, a lumberyard, or some other type of organization?

1. [**OPEN-ENDED RESPONSE**]

[ASK IF Q12_1>ZERO AND < 100%]

Q14. Does this change for new construction? When installing windows in new homes, do you purchase them from the same supplier, or do different vendors supply new construction? (Note: we want to understand if installers have a different approach for windows obtained for new construction.)

[**SINGLE RESPONSE**]

1. [**OPEN-ENDED RESPONSE**]

[ASK ALL]

Q15. Thinking about a typical window replacement project over the past two years, about how old are the windows ***on average that are being replaced?***

[SINGLE RESPONSE]

1. [**OPEN-ENDED NUMERIC RESPONSE**]
-98. Don't know

[ASK ALL]

Q16. Again thinking about your typical window replacement project, about what portion of the windows you replace… [Interviewer: read each characteristic, not mutually exclusive and therefore will not total to 100%.].

[MULTIPLE RESPONSE]

1. Are single pane glass
2. Have aging or damaged frames
3. Lack low-e coating
4. Have operability problems
5. Have condensation issues

-96. Other, please specify: [**OPEN-ENDED RESPONSE]**

-97. Don't know

[**ASK ALL]**

Q17. Thinking about the projects in which you replaced windows in an existing home (not new construction) over the past two years, what portion of these projects involved….

[**PROGRAM AS LIST WITH NUMERIC RESPONSE, WITH DON'T KNOW OPTION FOR EACH**]

1. Replacing whole window (IGU, sash, frame)
2. Replacing IGU + sash
3. Replacing IGU only (in existing frame)

-98. Don't know

Sales Process and Recommendation [ASK ALL]

I have some questions about the sales process.

[ASK ALL]

Q18. How do you determine what product to recommend to a homeowner looking to replace windows?

1. [OPEN-ENDED RESPONSE]

Q19. I'm going to read several window features; based on your experience selling windows, how important do you think each is to typical consumers? We are going to use a scale of 1 to 5 where 1 means not at all important and 5 meaning extremely important in their decision. For a typical consumer, how important is…

Feature	1	2	3	4	5	DK
The appearance of the windows (style)						
The efficiency of the windows (U-value)						
How well the windows block outside noise (STC rating)						
The cost of the windows						
The framing material (wood, vinyl, metal…)						
The warranty						

PROGRAMMER: INCLUDE OPTIONAL TEXT BOX FOR CAPTURING ANY VERBATIMS OFFERED DURING THIS EXERCISE.

[ASK ALL]

Q20. Thinking about your window sales or installations in existing homes (not new construction) over the past two years, what portion involved….

[PROGRAM AS LIST WITH NUMERIC RESPONSE, WITH DON'T KNOW OPTION FOR EACH]

1. Installing triple paned windows
2. Installing windows with a U-Value of 0.22 or less
3. Installing windows with a U-Value of 0.23-0.30
4. Installing windows with a U-Value over 0.30

[ASK ALL]

Q21. What is the highest performance window you sell?

1. [OPEN-ENDED RESPONSE]

Q22. What features or benefits do you talk about with consumers who are considering these high-performance windows?

1. [**OPEN-ENDED RESPONSE**]

[**ASK IF Q20 ITEM 1 IS >0]**

Q23. You indicated that you had sold or installed triple pane windows. Have you sold or installed thin triples?

[**SINGLE RESPONSE**]

1. Yes
2. No

-96. Other, please specify: [**OPEN-ENDED RESPONSE]**

-97. Don't know

[**ASK IF Q23=YES]**

Q24. Based on your experience are thin triple windows easier to install than standard triples, the same, or harder to install? [Interviewer, if easier or harder probe to understand why.]

[**SINGLE RESPONSE**]

1. Record Verbatim: Response Text

[**ASK ALL]**

Q25. Thinking specifically of retrofit and replacement projects, how likely are you to recommend

[**READ EACH, PROGRAM RATING SCALE 1=VERY UNLIKELY TO 5=VERY LIKELY, INCLUDE DK**]

1. ENERGY STAR Windows
2. ENERGY STAR Most Efficient (ESME) Windows
3. Installing windows with a U-Value of 0.22 or less
4. Installing windows with a U-Value of 0.23-0.30
5. Installing windows with a U-Value over 0.30
6. Double pane windows
7. Triple pane windows
8. "Thin" triple pane windows

-96. Don't know

[**ASK ALL]**

Q26. Based on your experience, how much more energy efficient are windows likely to get?

1. [**OPEN-ENDED RESPONSE**]

[**ASK ALL]**

Q27. What portion of your customers do you believe would be willing to pay more for super-efficient, quiet, high performing windows?

1. RECORD NUMERIC RESPONSE _____

Q28. How do the products installed in new construction differ from those installed in existing homes? For example, are they typically a different quality? More likely single hung? Or more consistent design?

1. [**OPEN-ENDED RESPONSE**]

[ASK ALL]

Q29. What kind of guidelines to you get from window manufacturers about product recommendations?

Q30. And what about installation best practices, what type of training or guidelines do manufacturers provide?

Q31. Do manufacturers provide guidance on determining the appropriate product for a given application?

Q32. Finally, what type of sales incentives do manufacturers provide to encourage the purchase of specific products?

Firmographics [ASK ALL]

Thank you, I have just a few more questions about your firm overall. This will help us ensure we have a good representation across the region.

Q33. Including yourself, how many employees work at your location?

1. 1
2. 2-4
3. 5-9
4. 10-19
5. 20-99
6. 100-499
7. 500+
98. Don't know

Q34. Including yourself, how many employees work at this organization across all locations?

1. 1
2. 2-4
3. 5-9
4. 10-19
5. 20-99
6. 100-499
7. 500+
-98. Don't know

Q35. How many locations does this organization have?

1. 1
2. 2-4

3. 5-9
4. 10-99
5. 100-499
6. 500+
-98. Don't know

Q36. As a follow-up, NEEA might be conducting focus groups or inviting people like you to other potential NEEA engagement opportunities. Would you be interested in being contacted for these future opportunities?

[**SINGLE RESPONSE**]

1. Yes
2. No

Q37. Finally, Please enter your contact information below so that we can send your $100 e-gift card to the correct email. We will also use this contact information to follow up with you as needed. Please make sure you click on the "Submit" button to complete this survey.

1. Your full name
2. Your email
3. Your phone number

Q38. If you'd like to add anything we haven't discussed before submitting your response, please feel free to type in here.

1. [**OPEN-ENDED RESPONSE**]