The Oracle Peers through a Window: Using a Delphi Approach to Estimate Impacts of Windows Programs

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ABSTRACT

Energy Trust of Oregon has supported efforts for residential homeowners to install higher efficiency windows since 2003, and currently offers a two-tiered incentive for homeowners installing high-efficiency windows. Energy Trust is looking to establish a market transformation model for the residentrial windows market, and worked with Apex Analytics to conduct a Delphi panel to help understand the market for high-efficiency windows in the Pacific Northwest. The primary goals of the Delphi panel were to help Energy Trust establish a baseline for the current state of the efficient windows market, understand how the incentives have influenced the current market, and project where the market is headed over the next five years. The research focused on the market for windows in existing residential single-family homes. Since Energy Trust is considering shifting its windows incentives towards a market transformation model, the estimated current market share for high-efficiency windows from this study can be used as the baseline should Energy Trust choose to move towards this alternative incentive design. This paper presents findings, and methods used to derive the findings, from the recently completed Delphi panel on the current and projected market for high-efficiency windows. Findings showed the program has had strong market influence, and that there continues to be need for high-efficiency window incentives to support the market. The success of the online Delphi panel shows that this approach may be considered when travel, costs, and logistics necessitate.

Introduction

The Pacific Northwest has led the nation in spearheading program support for residential energy efficient windows. Originally launched in the late 1990's, one of the first market transformation programs initiated by the Northwest Energy Efficiency Alliance (NEEA) led to more manufacturing, and ultimately lower retail prices for efficient windows. Over the last decade, Energy Trust of Oregon has supported efficient windows through installation incentives for new and existing homes. Ongoing research continues to demonstrate that sales of efficient windows in the Northwest are higher than any other region in the U.S., indicating of the ongoing success of these program efforts[1].

Energy Trust is looking to establish a market transformation model for the residential windows market, with the long-term goal of moving toward higher efficiency windows as the standard for all consumers. The objective of this study was to characterize the regional window market, to form a baseline, and to understand how Energy Trust involvement may support the window market going forward. A secondary objective was to understand how past Energy Trust efforts have affected the window market. Although panelist feedback in answering defined questions (e.g., market share and costs) was the ultimate goal of the Delphi approach, one of the primary advantages of this approach was supporting interactive dialogue while soliciting nuanced insights that would not normally be collected using a simple survey approach. Some of the key questions of interest to Energy Trust include:

[1] Ducker Worldwide (December 2014). *ENERGY STAR Window & Door Tracking Program Triple Glazing Market Assessment.* Troy, MI: Ducker

- What is the current and projected baseline for energy efficient windows?
- What might the recently studied market share look like in the absence of previous incentive support (i.e., the counterfactual)?
- Where is the market for high-efficiency windows headed over the next few years?
- Is Energy Trust support still needed?
- Where are window costs projected to head in five years?
- Is it feasible to lend support for a more aggressive efficiency standard, such as windows with a U-value of 0.20?

Background

The market for high-efficiency windows in the Pacific Northwest has been primarily driven by the work of regional and national entities. Between 1997 and 2001, the Northwest Energy Efficiency Alliance (NEEA) helped initiate the Pacific Northwest region's high-efficiency window efforts with a market transformation model that injected approximately $1.8 million to help drive demand for windows below a U-value of 0.35. NEEA's effort paralleled ENERGY STAR's first efficient window specification for a U-value of 0.35, which was initiated between 1998 and 2001. NEEA partnered with regional utilities, window manufacturers, window dealers, the manufactured home industry, and builders across the Northwest to reduce market barriers to ENERGY STAR qualified windows. To build on this initiative, Energy Trust has been offering residential homeowners incentives for installing high-efficiency windows since 2003.

Incentives for high-efficiency windows are offered through Energy Trust's Existing Single-Family Home Performance with ENERGY STAR and Existing Manufactured Homes programs in Oregon and Washington, along with the Existing Multifamily program for properties with more than two units (offered only in Oregon). The overarching goal of the incentives is to accelerate the adoption and market penetration of cost-effective, energy efficient residential windows. The focus of Energy Trust's windows efforts (and of this study) is on existing homes; windows installed as part of the new residential construction program were not in the scope of this study. In addition to the regional- and state-level support for efficient windows by Energy Trust and the Pacific Northwest region, there was also support at the federal level with EPA's ENERGY STAR leading the efforts for efficient windows.

Federal support for efficient windows did not end with ENERGY STAR. Various tax credits have and continue to be offered for the installation of high-efficiency windows. More recently, as part of the funding for the American Reinvestment and Recovery Act of 2009, the federal tax credit for efficient windows was significantly increased in 2009 and 2010. As of June 1, 2009, only products with both a U-value and solar heat gain coefficient (SHGC) of less than or equal to 0.30 qualify for a tax credit of up to$1,500 to cover 30% of the product price.

In an effort to continue pushing the high-efficiency windows market forward while staying ahead of the ENERGY STAR specifications, Energy Trust proposed a change to its program window tiers at the beginning of 2015, in anticipation of expected 2016 changes to ENERGY STAR window specifications for the Northern climate zone (version 6.0). Energy Trust currently offers incentives for two tiers of efficient windows:

- U-value 0.28–0.30 receives an incentive of $1.75/sq ft.; and
- U-value ≤ 0.27 receives an incentive of $4.00/sq. ft.

Energy Trust program staff believes that by shifting one year ahead of ENERGY STAR they will have time to better prepare the Pacific Northwest market for the 2016 changes. Table 0-1, below, lists

the ENERGY STAR Northern Zone version 6.0 specifications for windows planning to become effective January 1, 2016[2].

Table 0-1. Expected ENERGY STAR Version 6.0 Northern Zone Window Specifications for 2016

U-value	Solar Heat Gain Coefficient (SHGC)
≤ 0.27	Any
= 0.28	≥ 0.32
= 0.29	≥ 0.37
= 0.30	≥ 0.42

Methodology

The primary focus of this study was to design and oversee a Delphi panel composed of window manufacturers and experts to better understanding the market share and costs of high-efficiency windows in the Pacific Northwest. Several subtasks were required to successfully implement the panel: identify, recruit, and confirm the Delphi panel; develop and administer a preliminary Web survey; and conduct the Delphi panel.

An initial online web survey and subsequent Delphi panel were the two primary data collection components associated with this evaluation. In addition to these data collection efforts, the study team also leveraged a previous study compiled by Energy Trust (2014) that contains a number of similar research questions and objectives[3]. The following sections provide a detailed discussion of the methodology employed for data collection and analysis.

Identify, Recruit, and Confirm Delphi Panel

Energy Trust was not able to provide a contact list of window manufacturers and experts to include in the Delphi panel because the previously completed window study was performed by a third-party contractor that promised complete anonymity and privacy for participating manufacturers and experts. As a result, the research team began by identifying and contacting potential recruits. Web searches, phone calls, research papers, and other industry contacts were utilized to compile a list of potential candidates. Once the list was compiled, the research team distributed recruitment emails. The recruitment email included details about the Energy Trust window incentives and the Delphi study. All potential panelists received an introductory memo outlining the key attributes of the incentives and results of the recent (2014) study. Candidates were offered an incentive of $350 to participate in the study. The research team was able to recruit nine participants. Corporate policy was the primary reason various recruits chose not to participate.

[2] ENERGY STAR has also initiated a windows-based "Most Efficient" designation. The ENERGY STAR Most Efficient designation was launched in 2013, though current (2015) Northern Zone specifications have not changed. The 2015 Most Efficient specifications for the northern zone are windows that meet the current ENERGY STAR criteria, exceed the National Fenestration Rating Council (NFRC) performance grade of 15, have a U-value less than or equal to 0.20, and a Solar Heat Gain Coefficient greater or equal to 0.2.

[3] Energy Trust of Oregon; April 18, 2014; Residential Windows Market Research Report

Develop Online Web Survey

Apex developed an initial online survey for participants, which included all the intended questions for the Delphi panel. The research team believed this pre-panel survey would help facilitate the actual Delphi panel for several reasons: by initiating participant feedback; expediting the administration of the panel; establishing a common understanding of the current market; and giving a voice to panelists unable to attend or failed to attend the subsequent group webinar.

Panelists received instructions on how to take the online survey prior to the webinar, including a deadline for completing the survey. Although multiple reminders were distributed to the group, as of the deadline, only two panelists had completed the entire survey. With such a small sample size and low participation rates, the evaluation team decided, with Energy Trust approval, to move forward with the Delphi panel and not require participants to complete the survey. The team felt that the panel design allowed sufficient time to review all of the topics Energy Trust wanted covered.

Conduct Delphi Panel

The Delphi method brings together a facilitator and a group of experts for an interactive discussion to develop consensus on a range of topics. The process is an iterative one whereby the facilitator poses various questions to the panelists and asks the panelists to vote or respond to the questions. A dialogue about the summary responses then begins, enabling the panelists to revise their original responses based on the discussion. The technique is often used for forecasting (hence the Oracle of Delphi name origin). In the energy efficiency realm, the technique is often used to evaluate market transformation incentives due to the lack of primary or secondary market data.

For this study, panelists were asked to participate in an online group webinar, rather than attend an in-person meeting (which would have been cost-prohibitive). During real-time web conferencing, the research team asked panelists to validate their original estimates, making adjustments and developing consensus estimates as needed. Energy Trust and Apex believed that administering the panel using real-time web conferencing would effectively compile panelist feedback while allowing group discussions and debate. An online webinar-based Delphi provided the panelists with a seamless and convenient experience, but the underlying coordination required considerable time and resources to ensure a robust panel experience.

Panelists received instructions on how to connect to the webinar, as well as the link to complete the real-time survey. Panelists received the webinar's PowerPoint presentation prior to the meeting in case they either couldn't connect to the webinar or lost Internet connectivity during the panel. The research team decided to use Microsoft Lync webinar software. Lync is a browser-enabled webinar software that allowed the facilitators to: display real-time video as they led the discussion; maintain privacy settings so that panelists remained anonymous; enable screen sharing so that panelists could view the presentation; and moderate a chat room where panelists could submit questions.

The research team reviewed numerous webinar tools, with the ultimate goal of using a single platform to run the webinar, permit screen sharing and allow panelists to answer real-time survey questions via the same platform. Unfortunately, although most of the webinar platforms allow simple polling-based surveys (yes/no, multiple choice selection), they do not allow for more advanced survey questions, as required for this study. SurveyMonkey, an online survey tool, accessible via any standard web browser, was selected for the survey administration due to its professional user interface and visually simplified real-time reporting of panelists' responses[4]. Ultimately, the team determined that

[4] Simplified graphics included tables and charts in an administrator control panel screen that are auto-generated as participants complete the survey.

having two browser windows (or simply tabbed browsing) would allow participants to easily navigate between the webinar screen and the survey screen, when responses were required.

The general methodology employed for this study followed commonly employed Delphi processes, although a few customized steps were added to allow for a fluid panelist experience. The research team stated and reviewed each question using the PowerPoint presentation and webinar tool and ensured panelists did not have any questions or concerns related to providing responses. The research team then requested that panelists navigate between the webinar screen and the survey screen to answer the specific survey question. Panelists were not able to review the results of the other panelists until all responses were received. Results were then displayed on the research team's screens (webinar) and discussion about the results of each question ensued. When the discussion was exhausted or a consensus was reached, panelists were asked to revise their previous responses if their opinions had changed during the debate. This process was then repeated for each question. Figure 1 presents an overview of this process.

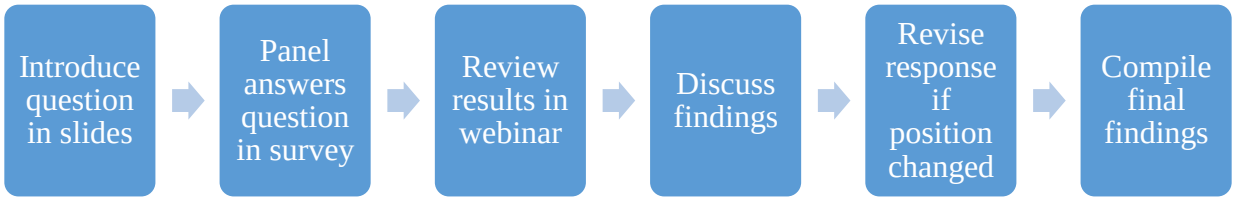

Figure 1. Delphi Panel Process

The Delphi panel was conducted on February 19, 2015, and progressed without any serious technical (IT, connectivity, webinar) issues. The research team managed the Delphi panel and led the discussion while Energy Trust attended the panel primarily as an observer. When asked, Energy Trust staff helped answer questions about the incentives and study scope. In addition to the Delphi panel, the research team conducted a follow-up call with a member of the ENERGY STAR windows group to help contextualize the findings and made several attempts to connect with panelists about some of the issues introduced during the discussion. Seven panelists, including representatives for window manufactures, glass manufacturers, retailers, and technology and industry experts, ultimately participated in the Delphi panel.

Findings

The findings include the results of the survey questions (provided in pie or bar charts), highlights from the dialogue that developed for each topic, and comprehensive findings gleaned from both the dialogue and survey response. The key areas reviewed include:

- Incentive Familiarity and Historical Incentive Influence
- Current and Projected Market Share
- Window Costs

Incentive Familiarity and Historical Incentive Influence

The Delphi panel began with a few "warm-up" questions to gauge the group's familiarity with Energy Trust's window incentive offerings for existing homes and the potential influence of the

incentives on the market. The majority of participants (N = 4) were somewhat familiar with the offerings. Two participants were not very familiar with the offerings and one panelist was very familiar. No participants indicated that they were unaware of the offerings. Questions to determine the impact of Energy Trust's incentives on the efficient window market were asked in two ways: (1) asking for a direct solicitation using a three-point scale from "no impact" to "strong impact," and (2) considering the current market share for windows, asking participants to estimate the "counterfactual" market share (if the incentives had not existed). For the first approach, the research team asked panelists. "From your perspective, would you say that the Energy Trust incentives have had an impact on the market share of high-efficiency windows in the Pacific Northwest over the past several years?" Two of the seven panelists believed that the incentives have had a strong impact on the market; three respondents thought the incentives have had a small impact; and two respondents were not sure of the incentive impact. None of the respondents thought that the incentives have had no impact.

For the second approach, the research team provided information on past (2013) incentive performance and the related high-efficiency window market share, asking panelists to provide what they believed the market share for U-value sales would have been if Energy Trust program support had not been offered over the past several years. In addition, the previously calculated Pacific Northwest U-value market share (from the original 2014 study) was provided for participants and appears below in **Error! Reference source not found.**.

The originally estimated market share (from the 2014 study) for the least efficient tier (U-value > 0.35) windows was most likely low. All panelists placed this share at approximately 6% (it was originally half that, at 3%). This estimate mirrors the Pacific Northwest non-ENERGY STAR market share of 5% reported by Ducker in 2013[5] (assuming that Ducker survey respondents mistakenly believed the cutoff for ENERGY STAR to be U-value 0.35). Panelists believed that the Energy Trust incentives had a substantial influence on the windows market in 2013, having moved the market from the lower efficiency (U-value > 0.30) bins to the higher efficiency bins (U-value 0.26–0.30). 15% of the windows that would have been included in the lower efficiency market share in absence of incentives were shifted to the higher efficiency, incentive-qualified market. The results of the Delphi panel indicate that the highest efficiency tier (U-value < 0.26) was not influenced by the incentives, and likely reflects a price-inelastic consumer segment influenced more by consumer preference and architectural requirements than by price. Based on the panelist feedback, the impact of the 2013 incentives was to shift sales from an average efficiency of 0.32 to 0.31.

[5] Ducker Worldwide (December 2014). *ENERGY STAR Window & Door Tracking Program Triple Glazing Market Assessment.* Troy, MI: Ducker.

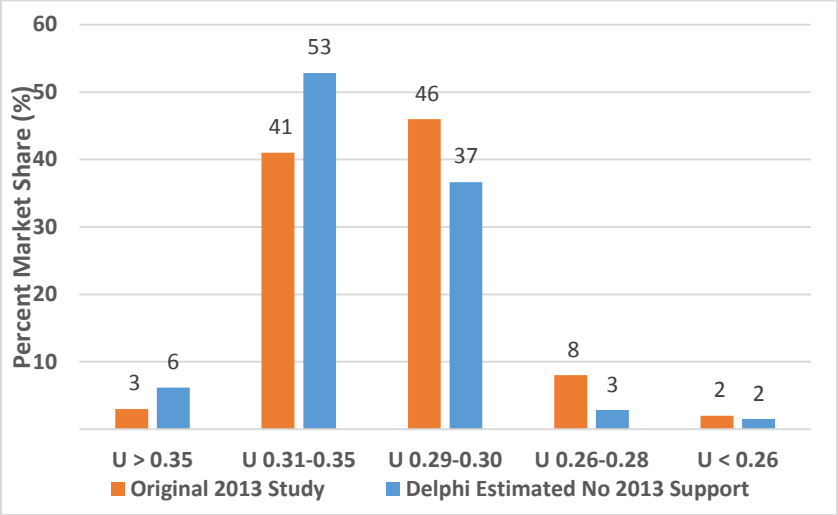

Figure 2. Originally Estimated (2014 Study) and Delphi Estimated Market Share of High-Performance Windows, by U-Value, in Absence of Incentive Support

Some of the key findings from the discussion include the following insights, introduced by the panelists:

- The federal tax credit drove the market forward and had the most significant impact on high-efficiency windows, but this support was a brief boost and without sustained support the market would have reverted back to the less efficient windows tiers.
- Energy Trust incentives served as the sustained support for high-efficiency windows and helped maintain demand in the high-efficiency windows market.
- The high U-values (> 0.35) would not have been significantly affected due to design characteristics (double hung and slider) and/or frame material (wood or wood-clad); these windows are inherently higher U-value with little variance due to particular house/architecture types.

Current and Projected Market Share

Delphi panel participants were also asked to comment on the current (2015) and projected (2020) market share by U-value for high-performance windows in the Pacific Northwest. Since the Energy Trust incentive qualified window tiers changed in 2015, panelists were provided with new U-value bins to assign current (2015) market share. These bins are shown in **Error! Reference source not found.** below. Panelists were asked to provide two market share estimates: the first assumed continued incentives while the second asked panelists to assume no continued support for the higher efficiency windows.

As seen in **Error! Reference source not found.**, the market share of the least efficient windows (U-value ≥0.35) is not impacted by incentives. The panelists indicated that this window group will be in demand regardless of any high-efficiency program. As one panelist stated,

> "The high U-values (>0.35) are not much impacted because of design type [double hung and slider] and/or frame material [wood or wood-clad]. These windows are inherently higher U-value. As a homeowner [these

windows types] are what they get, with no choice because of house/architecture type."

The incentive support will primarily affect the mid-range efficient windows of U-value 0.28-0.35, and will drive demand to the lower U-value 0.25–0.27 range. With incentive support, even the higher efficiency U-value 0.20–0.24 range will increase. Windows with U-value <0.20 will only be marginally affected by incentives. This highest-efficiency group is constrained by technology and cost.

Regardless of incentive support, the trend in windows is a shift towards higher efficiency. This trend is partially attributable to the ENERGY STAR program; however, participants suggested that the Energy Trust program appears to accelerate the market trend toward efficiency. The Delphi panel estimated market share of high-efficiency windows is slightly different between the scenario that assumes the continuation of Energy Trust incentives and the counterfactual (without the continuation of Energy Trust incentives).

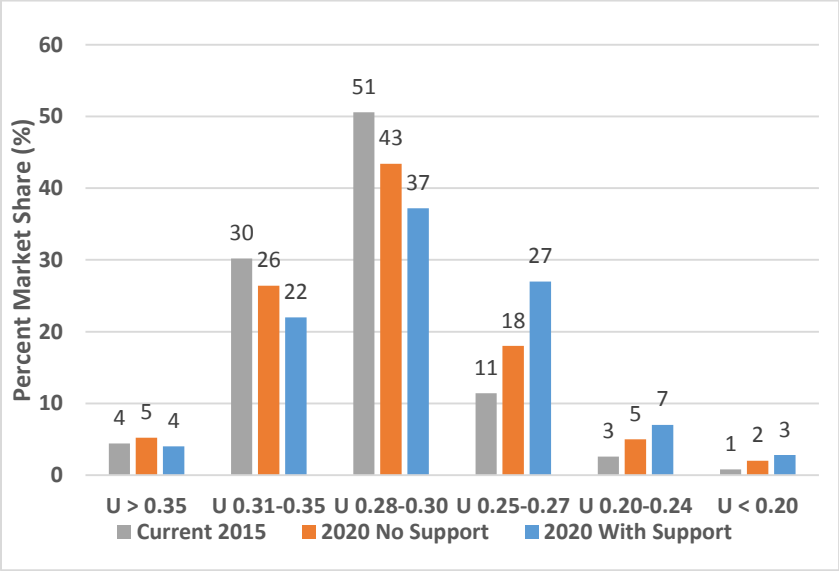

Figure 3. Current (2015) and Projected (2020) High-Efficiency Window Market Share, by U-Value, with and without Energy Trust Incentive Support

Some of the key findings from the discussion include the following insights, introduced by the panelists:

- According to panelists, summarizing and distilling the windows market into a generalized U-value market share is very difficult, even for windows experts and market actors.
- Panelists agreed there was no doubt that Energy Trust incentive support for windows has had a positive and significant impact on the efficient windows market, helping to accelerate the shift towards higher efficiency windows.
- ENERGY STAR has had, and will continue to have a major impact on the windows market. Projections reported by panelists will be irrelevant if ENERGY STAR specifications change between now and 2020.
- U-value is not the only fenestration-based driver for home efficiency; solar heat gain and air leakage are two major issues that Energy Trust should factor into their incentives.
- There are other products currently available in the market, including low-e storm windows, which panelists believe could be a cost-effective alternative for Energy Trust to consider.

Window Costs

The Delphi panelists were asked a series of questions to help understand the current retail unit cost (per square foot) and where this price is likely to shift over the next several years (2017 and 2020). Estimating the incremental cost of moving toward higher efficiency windows is extremely difficult for several reasons: (1) the lack of retailer-based market data; (2) participants' unwillingness to provide survey responses and their potential inaccuracy; and (3) the inability to isolate the value of moving between U-value groups (exclusive of other window options and features).

One panelist mentioned the difficulty of assessing average window cost, because there could be a pricing difference of a third between the lowest performing and highest performing window within the same product line. Another panelist noted that the combination of frame material, glazing, and operational design can all have an impact on the price range, from a low of $10/sq. ft. to a high of $30/sq. ft. The ENERGY STAR representative interviewed by the research team confirmed this comment, and stated that energy cost differences for the same window could be even greater, with a $150 window on the low end to a $1,500 window on the high end. Additionally, another panelist noted that they were not able to respond to the question because of the highly sensitive nature of product pricing and costs. Ultimately only four of the seven panelists were willing and able to provide cost estimates.

Panelists were asked to rate their confidence level on a scale of 1-5, with "1" representing very low confidence, and "5" representing very high confidence. Of the four panelists who responded, three indicated being "somewhat confident" ("3") in their estimates; one panelist had low confidence ("1"). In reviewing the panelist responses to the cost estimate questions, the research team believes that three of the four Delphi panel members were most likely considering wholesale costs and not retail costs to the end-use consumer, because they were benchmarking their estimates against the wholesale costs provided by Apex from the prior study.

An overview of the final Delphi-estimated incremental costs is shown in **Error! Reference source not found.**. The largest jump in relative incremental costs occurs once the windows efficiency drops below the U-value of 30 (Delphi panel estimates showed only $0.33 jump in square foot cost going from 0.35 to 0.31-0.35, but a $1.09 jump in per square foot costs from U-value of 0.31-0.35 to 0.28-0.30). Based on feedback received from conversations with ENERGY STAR staff, coupled with the review of the results of the Delphi panel, it is clear that there is a tipping point for incremental costs in current and anticipated windows sales: this tipping point appears to be around a U-value of 0.27. Between a U-value of 0.30 to a U-value of 0.25, the rate of change between the Delphi panel-estimated incremental costs increases significantly. Interviews with ENERGY STAR staff regarding their analysis of window manufacturer cost data revealed that payback, based on energy savings relative to incremental cost, was best around the U-value 0.27. Any U-value below 0.27 showed a relatively steep increase in cost with payback exceeding the ENERGY STAR benchmark given for windows. Another interesting finding from the incremental cost data is involves the group of windows where the U-value <0.20. The findings clearly indicate that the panelists believe the incremental costs for the ultra-efficient windows group will decline by 2020.

The research team made several cost adjustments to the results from the Delphi panel in order to ensure the results represent actual incremental retail costs, displayed in Figure 4. First, for the three respondents who benchmarked their estimates to the wholesale price, the research team used the retail-to-wholesale adjustment factor developed in the Energy Trust measure approval document for windows (a 1.41 multiplier). Second, the individual responses were weighted based on the panelists' confidence levels - those with lower confidence were weighted less and those with higher confidence were weighted more. Finally, the overall adjusted and weighted estimates were compared to the Energy Trust installed cost estimates from their tracking database system, assuming 50% of the installed cost to be labor and

installation cost. The Delphi-based baseline (using the measure approval document for windows with a U-value baseline of 0.334) is therefore $13.04 per square foot, and the original measure approval document for windows-based estimate is $12.70.

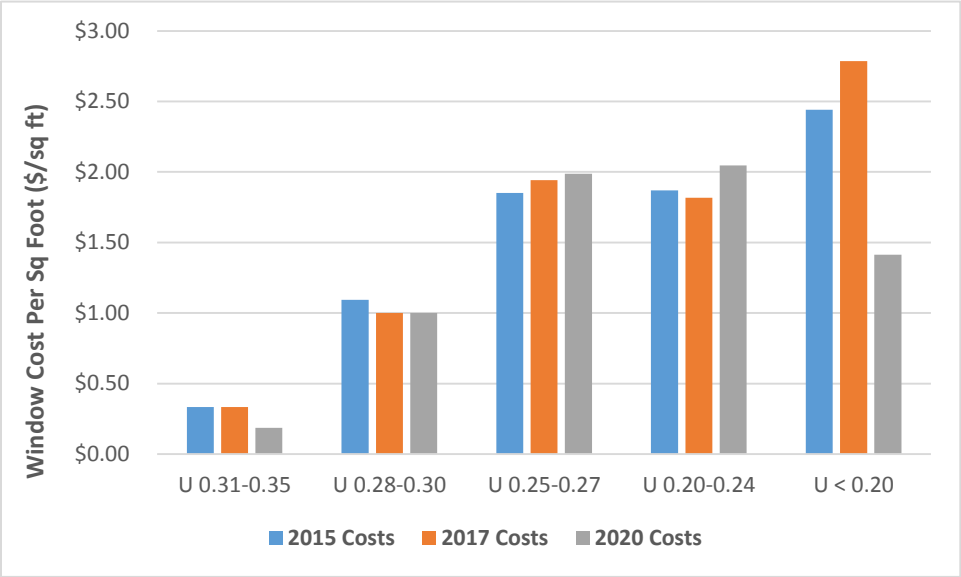

Figure 4. Current (2015) and Projected Incremental Retail Costs

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Some of the key findings from the discussion include the following insights, introduced by the panelists:

- The three biggest drivers for a decrease in the cost of U-value 0.27 and lower windows were program rebates and promotions, followed by ENERGY STAR, consumer awareness and demand, technology, and volume.
- Summarizing and generalizing window costs is very difficult. With so many options (window type, frame type, glass, gas, features), panelists described a vast range of window costs.
- Some panelists questioned the cost-effectiveness after passing the mid-range efficiency (lower than 0.28), where there's a significant increase in price without the associated increase in thermal comfort and energy savings.

Conclusions

Overall, the Delphi panel was a successful undertaking. The panelists provided feedback that it was a "great process," and that the only challenge was "figuring out the technology at first but it ultimately worked well." The research team concluded that the ability to administer the Delphi panel session remotely was beneficial to this process. Using the latest technology, the research team was able to meet Energy Trust's policy of not paying for panelist's travel and time, and the remote panel also prevented travel limitations from interfering with panelist participation.

There were several challenges to running the Delphi panel, including lower-than-anticipated participation rates and identifying a date and time that would work for everyone. While the anonymity the technology provided offered certain benefits, it also may have enabled some participants to remain silent without the real-time, in-person pressure to contribute. Some panelists were hesitant to share their insights or cost data because of corporate policy and the webinar style presentation may have magnified

this proclivity towards non-participation. To help address recruitment challenges, program administrators should develop and foster relationships with regional window and glass manufacturers, retailers, and other industry experts. Establishing and maintaining partner relationships is especially important if program administrators are considering an upstream, market transformation type of incentive structure. Taking this one step further, the creation of an ongoing panel of experts would also be helpful.

Past, Present, and Future Market Share

The Findings section showed that panelists believed the Energy Trust incentives did impact the regional efficient windows market share. A more exact attribution estimate was not part of this effort, nor can a retrospective value necessarily be generated from this study since the focus was on establishing a baseline to help inform future market transformation. Panelists indicated that the previous incentive efforts (in 2013) shifted 15% of the less efficient market share toward the efficient (incentive-qualified) market. Panelists also believe that by 2020, the highly efficient window market (U-value <0.27) will gain approximately 10% of the market share because of the availability of incentives and other activities In addition, one of the underlying assumptions about the market share and cost projections in this study was that the ENERGY STAR specifications would not change between now and 2020. If the ENERGY STAR specifications do change, and are made either more or less stringent, that will have an impact on the realized efficient market share relative to what was projected in this study.

Incremental Costs

The incremental costs were the most difficult values to develop through the Delphi panel. The question related to incremental costs had the lowest response rate, because of uncertainty surrounding costs, panelist unfamiliarity with the retail market, or corporate policy that precluded panelist response. There also appeared to be some panelist confusion about estimating wholesale versus retail cost. Ultimately, the research team indicated that the incremental cost focus for this study was to determine the incremental cost difference between U-value groups. The incremental costs developed from the Delphi panel are slightly higher than the Energy Trust findings from the previous 2014 study.

One issue that arose during the review of the previous studies was that the current lower tier window incentives ($1.75/sq ft) currently exceed the incremental costs ($1.16/sq ft) developed in the previous study and measure approval document for windows. The incentives also exceed the estimated incremental costs for the lower tier windows based on this study ($1.43/sq ft).

Other Issues for Efficient Windows

Several side discussions towards the end of the Delphi panel session focused on issues outside of U-value that highlight the impact of windows on the overall efficiency of a home. One issue mentioned was air leakage. One panelist claimed testing showed that some manufacturers were currently offering high-efficiency (low U-value) windows that are manufactured with poorly integrated weather sealing. This poor weather sealing effectively shifted the U-value of the window by approximately 0.03. For example a window with a U-value of 0.27 would effectively function like a window with a U-value of 0.30. There was also a discussion on solar heat gain, and the fact that ENERGY STAR recognizes the trade-offs between U-value and SHGC. Another panelist mentioned current trends to integrate add-on systems during retrofits, with some newer storm window options including built-in shading and insulating devices as well. Several manufacturers currently offer single-pane, NFRC-rated, low-e storm

windows that are half the cost of replacement windows in any of the U-value categories, with roughly the same performance. This panelist believed that these products will have a significant impact on the market.

Hyper-Efficient Windows

One of the objectives of the Delphi was to better understand whether program support is a viable option for windows with U-value ≤0.20. Panelists agreed that the costs for this group of windows are very high. Most of the windows at this efficiency level require triple-pane glass, which is a large component of the cost. Although there are significant barriers to the hyper-efficient windows market, ENERGY STAR has moved in this direction with the development of the Most Efficient designation. The ENERGY STAR Most Efficient windows must meet or exceed U-value 0.20. The ENERGY STAR partner website lists the manufacturers and models that meet these strict criteria.

Market Transformation Incentives

Energy Trust has indicated an interest in potentially shifting the current downstream window incentives towards an upstream or market transformation type of incentive structure. In fact, one of the primary objectives of this study was to help establish a market baseline with which to benchmark current market saturation of efficient windows for future evaluation and impact efforts. The Achilles heel of market transformation programs has been the difficulty in assessing market influence primarily attributable to the lack of a detailed baseline with which to understand the true impacts of the "hidden" incentives. If Energy Trust decides to move forward with a market transformation model for high efficiency windows, the Team recommends having all potential partners (retailers, manufacturers) review the findings contained in this report and provide feedback and potentially adjustments to this report's findings before the incentives are initiated. With more "skin in the game" partners may be more forthcoming and willing to share market related information.

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