

Multi-Level Evaluation of a Residential Windows Market Transformation Project

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ABSTRACT

The ENERGY STAR® Residential Fenestration Program seeks to reduce market barriers to the adoption of high efficiency windows, glass doors, and skylights in the Pacific Northwest. The program and this evaluation are funded and directed by the Northwest Energy Efficiency Alliance, a nonprofit consortium of regional private and public utilities, and government and energy experts. quantec conducted a multi-level evaluation of the program. The evaluation employed a triangulation methodology in which various sources of information were pulled together to not only estimate changes in market share, but to also estimate:

- the current state of fenestration energy efficiency standards in the Northwest
- market barriers to the adoption of high efficiency window products
- efficacy of the ENERGY STAR® Residential Fenestration Program's efforts to transform the market for high efficiency window products
- how these efforts might be optimized

Introduction

Background

The ENERGY STAR® Residential Fenestration Program (ENERGY STAR Windows Program) and this evaluation are funded and directed by the Northwest Energy Efficiency Alliance (Alliance). This effort is but one of many such market transformations directed by the Alliance; a nonprofit consortium of regional private and public utilities, and government and energy experts.

The ENERGY STAR Windows program is a voluntary partnership between the U.S. Department of Energy (DOE) and the fenestration industry to promote sales of energy-efficient windows, doors, and skylights. The Northwest ENERGY STAR Program's primary objective is to make purchasing of energy-efficient windows an easy and informed choice for Northwest consumers. To do so, the program seeks to create an infrastructure to increase market share by working in partnership with window product manufacturers, wholesaler/distributors, retail suppliers, and builders. The program is designed to reach two key markets: residential new construction and home remodels.

The ENERGY STAR Residential Fenestration Program was created to achieve the following goals in the Northwest:

- Decrease at least two market barriers – lack of awareness and initial cost premiums – that limit sales of high-efficiency fenestration products.
- Increase market share for high-efficiency fenestration products in the residential new construction and remodel market to 54% after the year 2001.

Table 1 summarizes the key market actors, the market barriers that affect them, and program intervention strategies designed to reduce these market barriers.

Table 1. Summary of Market Actors, Market Barriers, and Intervention Strategies

Market Actor	Market Barriers	Intervention Strategies
Manufacturers	<ul style="list-style-type: none"> • First Cost • Split incentives (Builders incur the cost of installing energy efficient windows but do not perceive that they receive any of the benefits (energy savings). • Lack of Demand 	<ul style="list-style-type: none"> • Signing partnerships with cash incentives to promote marketing of ES Windows • Developing strategies to facilitate the production and lower the cost of producing ES Windows • Creating more demand among the downstream market actors (e.g., buildings and homebuyers) via information
Builders/ Developers	<ul style="list-style-type: none"> • Lack of Information • Split Incentives (Incur the first cost of windows but homeowners earn the savings) • Lack of Awareness 	<ul style="list-style-type: none"> • Advertising in magazines • Attending home builder shows • Contacting home builder associations
New Home Buyers / Remodelers	<ul style="list-style-type: none"> • Lack of awareness • Insufficient information • Bounded rationality (Homeowners and remodelers are unable to evaluate the cost-effectiveness of ENERGY STAR window products) • Availability • Product Inseparability (ENERGY STAR window products may be packaged with undesirable house characteristics) 	<ul style="list-style-type: none"> • Point of sale displays • New labels on windows • Increasing availability through upstream interventions (e.g., with manufacturers and builders)

Methodology

The ultimate benefits of market transformation efforts are sustainable energy and demand savings. Total sales, or market shares, are ways to measure such savings. Ideally, assessments of market transformation programs would measure either or both of these effects. For several reasons, however, neither the measurement of energy and demand savings nor the measurement of sales or market shares are generally feasible within the time frame normally associated with energy program evaluations. These reasons are discussed at length in a number of publications by Prah & Schlegel (1993 and 1994) and by Feldman (1995a 1995b), and will not be restated here.

In addition, *intrinsic* characteristics of markets complicate the measurement problem; these characteristics include the fact that markets are interactive, markets are dynamic, and fundamental changes in market structures and functioning may occur only slowly. (Feldman, pp. 88-89)

For all these reasons, evaluators and theorists cited have argued the importance of focusing on market effects as proximate indicators of changes in the structure or functioning of markets, or of reductions in the market barriers that inhibit the achievement of energy efficiency. As summarized in a recent presentation by Schlegel (1997), this alternative focus offers the following advantages:

- Timeliness
- Observability
- Provision of ongoing feedback to program managers
- Closer linkage to the specific activities of an initiative
- Lower potential for the intervention of confounding factors and alternative explanation

Moreover, several recent program evaluations have shown the feasibility of this approach. (Rosenberg, M. 1995, pp. 3.69-3.80) Perhaps the most difficult requirement for the use of market indicators is selecting just those indicators that are pertinent, credible, and persuasive indices of changes in markets that are likely to presage later changes in energy efficiency. Among these are:

- Evidence of the changes in the market caused by the market transformation initiative
- Logical analysis of why and how the initiative caused the changes
- Rationales for the assessment of confounding factors and alternative explanations

In light of these findings, the evaluation of the ENERGY STAR Residential Fenestration Program chose a multi-level approach:

1. Determine the existence of market barriers.
2. Determine the magnitude of these barriers.
3. Specify whether the market barriers have been reduced, eliminated, or bypassed.
4. Estimate a baseline and periodic market share estimates.
5. Assess the permanence of the observed changes.

A number of data collection and statistical approaches were combined to assist in this analysis (Table 2). For consumers, we conducted large-scale telephone surveys; for builders, we conducted more detailed telephone interviews and applied a statistical technique known as Analytical Hierarchy Process; and, for manufacturers, we conducted even more extensive telephone interviews and included an Analytical Hierarchy Process section.¹ Each of these actors in the marketplace was tracked according to their levels of information, sources of decision-making, and energy efficiency preferences and behavioral choices.

¹ AHP uses ratios as a measure of comparative judgments. Specifically, it uses pairwise comparisons to estimate the relative importance of specific criteria within each hierarchy level (e.g., energy efficiency vs. location when purchasing a new home).

Table 2. Data Collection Summary

Segment	Completed Surveys	Analytical Techniques
New Home-buyers	239	Direct elicitation
Remodelers	93	Direct elicitation
Manufacturers	11	Direct elicitation and Analytical Hierarchy Process
Builders	68	Direct elicitation and Analytical Hierarchy Process

Market share was estimated using a triangulation approach (Figure 1). The methodology assumes that findings found across respondent groups (e.g., consumers, manufacturers, and builders) tend to be more generalizable and more reliable than findings which differ among groups. However, triangulation does not necessarily assume that results differing between respondent groups are not valid. This is so for both factual information and opinions/perceptions. For certain information, one group may best reflect the marketplace as a whole, while other groups may reflect subsets of that market. The decision to rely on findings of specific respondent groups for other respondent groups or the market must be related to knowledge of the expertise held in a specific area by each respondent group.²

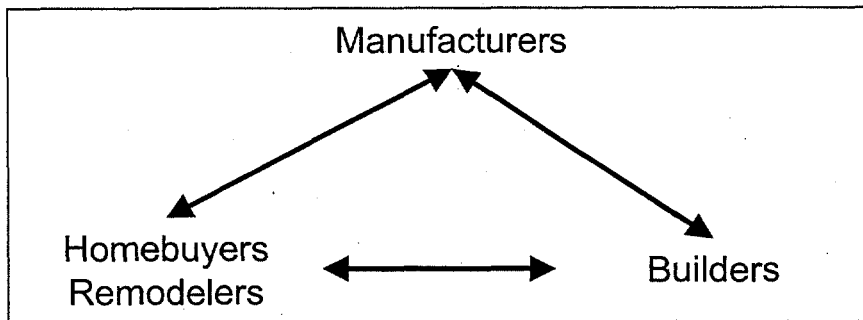


Figure 1. Triangulation of Market Share

As an evaluation validation strategy, information was collected from homebuyers and remodelers, manufacturers, and builders. The triangulated methodology for data collection will be employed in 1999 and 2000 to assess longitudinal changes.³

² For example, producers of a good (e.g., manufacturers), may have a better estimate of actual numbers of products produced and sold within a particular market. Conversely, segments of that market tend to have (depending on their information) the best estimate of their own consumption patterns of the good.

³ A fourth source – retailers – will also be supplying data in the next two years.

Results

Consumers

Although energy efficiency was important to new homebuyers and remodel customers, both were generally unaware of ENERGY STAR Windows. The most important factors that these homebuyers considered were floor plan (86% rated this as “somewhat” or “extremely” important), overall price (82%), size of home (79%), and energy-saving features (78%). However, homebuyers are generally unaware of ENERGY STAR Windows. Of those 16.7% of the new homebuyer respondents aware of the ENERGY STAR Program, the most common products mentioned were washer/dryers (7.5%), refrigerators (5.4%), computer monitors (3.3%), and dishwashers (3.3%). Only 2.9% of all respondents are aware of ENERGY STAR windows/skylights, despite being asked directly if they were aware of ENERGY STAR windows.

Table 3. Awareness of ENERGY STAR Products

	Frequency*	Percent of Total
Aware of Any ENERGY STAR	40	16.7%
Washer/Dryer	18	7.5%
Refrigerators	13	5.4%
Computer monitors	8	3.3%
Dishwasher	8	3.3%
Water heater	4	1.7%
Furnace/heater	4	1.7%
CFL/Lights	3	1.3%
Microwave	3	1.3%
Windows/Skylights**	7	2.9%
Don't know of any products	12	5.0%
Total	239	100.0%

* Respondents could give more than one response

** Includes 5 respondents that were aware only after being aided.

Furthermore, new homebuyers think they already have energy-efficient windows. Over half (53%) of the homebuyer respondents reported that they already had energy-efficient windows in their homes, despite data from manufacturers and builders that show that this percentage did not exceed 36%. *Many respondents, therefore, believe that the windows in their homes are more energy efficient than building and manufacturing standards, when, in fact, they are not.*⁴ This perception will be explored in future surveys of new homebuyers.

⁴ This may be due to a propensity on the part of new homebuyers to believe that a “new” home includes the latest in improved and efficient products. Or homebuyers’ may have faith that their builder has given them state-of-the-art efficient products and/or a belief that new homes, in general, exceed building codes in energy efficiency. Or it may be based on an intuitive comparison of their former home with the brand-new homes’ windows and the accompanying assumption that the new one has much more energy efficient windows.

New homebuyers are interested in benefits and willing to pay for them. More than half of the respondents to the new homebuyer survey were willing to pay the higher incremental price (\$2.15/square foot) to have energy-efficient windows (Figure 2). Only 19% of the respondents were not interested in paying *any* incremental cost to have energy-efficient windows.

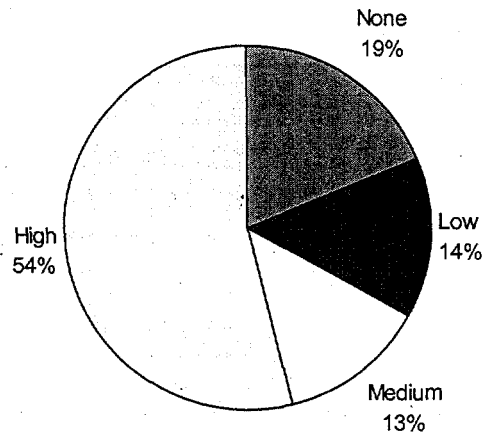


Figure 2. Homebuyer Willingness to Pay (Price) for Energy-Efficient Windows

Only 16% of the new remodel respondents were aware of the ENERGY STAR Program. Only about half of these (7.5%) could identify an ENERGY STAR Product. Only 4.3% could identify ENERGY STAR window products even after being asked if they were aware of ENERGY STAR windows.

Remodel customers were very interested in the features of energy efficient window products. About 50% or more rated them as “somewhat” or “extremely” important (Figure 3).

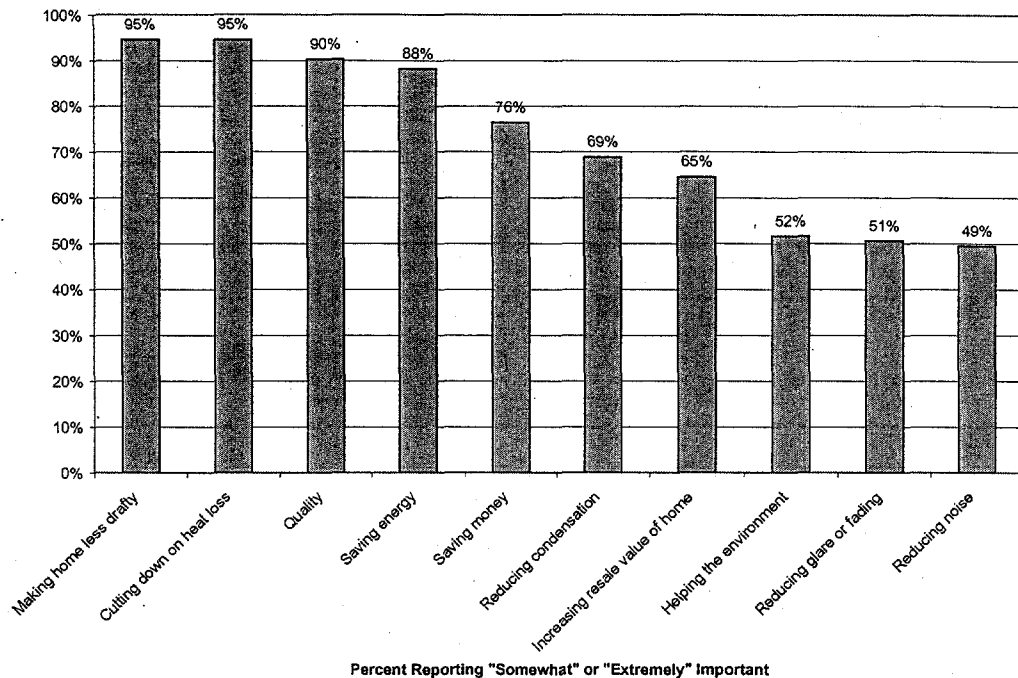


Figure 3. Importance of Features of Energy Efficient Window Products to Remodelers

Manufacturers

Nine of the eleven manufacturers surveyed identified market barriers to transforming the market. First cost, lack of awareness, communication problems, differences in who benefits versus who controls decision-making, and lack of demand by customers were some of the market barriers reported by manufacturers. Thus major market barriers included:

- Incremental first costs of energy-efficient windows to builders and consumers. Based on the results of the AHP analysis, cost is still perceived by manufacturers as the highest market barrier to marketing energy-efficient windows.
- Lack of awareness and information on energy-efficient windows, particularly on the part of builders and consumers.
- Lack of communication, and/or communication breakdowns in the transmission of information on the benefits of energy-efficient window products in the supply chain between manufacturers and end-use customers.
- Significant differences in who makes decisions in residential new construction (builders) versus homebuyers who are affected over the long run by energy efficiency choices.
- Lack of demand by customers (wholesale/distributors, retail suppliers, builders/contractors, and end-use customers) In the AHP analysis, manufacturers ranked lack of information second in importance only to cost as a market barrier.

Manufacturers often reiterated the comment that customers must express more demand for energy efficiency before the market will be transformed but that customers must be made aware and be given essential information before they can express that demand.

Builders and Developers

Builders and developers appear to have a little, but not a lot more, information on ENERGY STAR windows.

- Only 20% of homebuilders have heard about ENERGY STAR windows. The overwhelming majority of those that were familiar with ENERGY STAR windows have learned about them from an advertisement in a magazine.
- The largest barriers to installing energy-efficient windows are, in descending order: high cost, lack of customer interest, and builders' belief that they are unnecessary.
- Energy-efficient products appear to be valued by custom-home builders, by users of electric heat, and by builders who are familiar with ENERGY STAR windows based on the results of regression analyses.⁵
- Energy efficiency may rank lower in importance than other factors considered important in marketing a home.

Concerning the last finding, the results of the AHP analysis suggest that energy efficiency ranks lower in importance than the other salient attributes that homebuilders consider important in marketing a home. This should not be interpreted to mean that energy efficiency is *not* an important attribute. It simply means that other attributes, such as price and location, ranked higher. *The change in the importance weight with time is going to be a very interesting and informative indicator of market transformation. What we have estimated in this report is simply a baseline of importance.*

Product Market Share

An overall market penetration rate for energy-efficient windows in the Northwest of 10% – 15% was estimated in 1997. (D&R International, Ltd, 1998 and Macro International, Inc., 1999) New window market sales data for 1998 reveal that market penetration of ENERGY STAR products has sharply increased in the last year. Results from various respondent groups (consumers, manufacturers, and builders) also indicate very different perceptions concerning penetration of energy efficient

⁵ The following regressions were run in order to determine the circumstances under which builders would choose to install energy-efficient products: (1) %EEW = $a_0 + a_1\text{Heard?} + a_2\%\text{Custom} + a_3\%\text{Electric}$; (2) %EED = $b_0 + b_1\text{Heard?} + b_2\%\text{Custom} + b_3\%\text{Electric}$; and (3) %EES = $c_0 + c_1\text{Heard?} + c_2\%\text{Custom} + c_3\%\text{Electric}$ where: %EEW, %EED and %EES respectively denote the percent of energy-efficient windows, doors, and skylights installed by the builder; Heard? is a dummy variable indicating whether or not the builder had heard of Energy Star windows before; %Custom is the proportion of single family homes that were custom built by the builder; %Electric denotes the proportion of units constructed that were electrically heated. Results were that in regressions 1 and 3, the estimated coefficient on %Custom is significant at the 95% and 90% levels, respectively. In regression 2, the variable %Electric is found to be positively related to the use of energy-efficient doors, and is significant at the 89% level. The results also indicated that having heard of ENERGY STAR windows increases the likelihood of using energy-efficient skylights (at the 85% level of significance).

windows.⁶ However, when examined in the context of their applicability to the market as a whole versus segments of the market, triangulation of this information makes more sense.

Market share was estimated using a triangulation approach. The methodology assumes that findings found across respondent groups (e.g., consumers, manufacturers, and builders) tend to be more generalizable and more reliable than findings that differ among groups. However, as noted, triangulation does not necessarily assume that results differing between respondent groups are not valid, nor does it assume that they should be equally weighted in forming composite conclusions. For certain information, one group may best reflect the marketplace as a whole, or at least be weighted more strongly than others in making conclusions. In this case, it was judged that manufacturers' responses best reflected the marketplace as a whole, while other groups (consumers and builders) best reflect subsets of that market.

Therefore, based on available data for the first three quarters of 1998 for manufacturers with approximately 80% of the market, market share for ENERGY STAR level windows is likely in the range of 42% – 47% of all residential window sales in the Northwest.⁷ The low end of the range is based on manufacturers' reports of a 42% penetration for energy efficient windows in the Northwest. The high end (47%) is a composite rate, derived by applying penetration rates from a mix of sources, including the manufacturer, builder, remodeler surveys, and expert opinion to housing starts for the Northwest. This range (42% – 47%) of market share is considered a reasonable estimate for energy-efficient window regional market share, based on triangulation of the available information.⁸

Conclusions

The multi-level approach of collecting data from the various market actors in the form of surveys, interviews, and sales data appeared to be an effective method of estimating the progress of the ENERGY STAR® Fenestration Program in decreasing market barriers and increasing the market share for ENERGY STAR fenestration product.

⁶ The 68 builders interviewed indicated that the proportion of energy-efficient (U-factor ≤ 0.35) windows they installed was approximately 35% for single-family homes, 44% for multifamily homes, and 36% overall. Preliminary sales data from Northwest window product manufacturers indicate that approximately 36% of single-family Northwest window sales in 1998 were high efficiency (U factor ≤ 0.35). However, reported market penetration of high efficiency windows by surveyed new homebuyers and remodel customers was 53% and 66%, respectively. It is likely that both homebuyers and remodel respondents, although purchasing a more energy-efficient product than one owned previously, are probably not purchasing ENERGY STAR level products.

⁷ The next set of manufacturer interviews, scheduled for late 1999, will ask manufacturers what they attribute the large gain in market share to between 1997 and 1998. Builder and manufacturer surveys agree upon a 35%-36% penetration rate for new single family homes.

⁸ The estimate of 19% for new manufactured homes is based on factory observations of home construction by experienced observers. The estimate of 66% penetration of energy-efficient windows is from the remodel customers. It is judged that this last estimator likely overestimates window efficiency and thus is the weakest parameter, accounting for much of the difference between the low-end estimate of 42% market share and the high-end estimate of 47% market share.

The use of survey and interview data in a triangulation approach revealed that market barriers continue to inhibit the adoption of ENERGY STAR fenestration products. Among new homebuyers and remodelers, for example, there is a distinct lack of awareness and information about ENERGY STAR fenestration products in the Northwest.

The use of market share data, however, reveals that estimates of market penetration of ENERGY STAR windows have risen sharply from 1997 levels. All groups, manufacturers, consumers, and builders indicated much higher penetration levels for 1998. Relying most heavily on manufacturers' estimates for the entire Northwest market, estimates are that energy-efficient windows ($U \leq 0.35$) make up approximately 42% of the residential windows sold. Use of builders, homebuyers, remodeler, and expert judgement of manufactured housing penetrations applied to 1998 housing starts results in an even higher market penetration rate estimate of 47%. The range estimated by the multi-level triangulation methodology therefore leads to an estimate of 42% – 47% market penetration for energy-efficient windows in the Northwest. This represents a substantial increase from the baseline market share, and indicates that the program is beginning to make progress in decreasing these barriers and increase the use of ENERGY STAR fenestration products in the Northwest.

References

- D&R International, Ltd., "Northwest ENERGY STAR Window Program: 1998 Annual Report"
- Eto, J., Pahl, R., & Schlegel, J. (1996). A scoping study on energy-efficiency market transformation by California utility DSM programs. Lawrence Berkeley National Laboratory (LBNL-39058; UC-1322). Berkeley, CA. pp. 88-89
- Feldman, S. (1995a). "How Do We Measure the Invisible Hand? Energy Program Evaluation: Uses, Methods, and Results." Proceedings of the 1995 International Energy Program Evaluation Conference. Pp. 3-8. Chicago, IL
- Feldman, S. (1995b). "Measuring Market Effects: Sales Data Are the Last Thing You Should Look At. Competition: Dealing with Change." Proceedings of the 1995 AESP Annual Meeting 83-90). Boca Raton, FL.
- Macro International Inc., "Baseline Market Assessment: ENERGY STAR High Efficiency Residential Windows," Report # E98-018, January 1999
- Pahl, R., & Schlegel, J. (1993). "Evaluating Market Transformation. Energy Program Evaluation: Uses, Methods, and Results." Proceedings of the 1993 International Energy Program Evaluation Conference. Pp. 469-477. Chicago, IL
- Pahl, R., & Schlegel, J. (1994). "DSM Resource Acquisition and Market Transformation: Two Inconsistent Policy Objectives?" American Council for an Energy-Efficient Economy. Proceedings of the ACEEE 1994 Summer Study on Energy Efficiency in Buildings. (Pp. 6.157-6.166). Washington, DC

Potomac Communications Group, Inc., "Market Barriers & Opportunities for Promoting High-Efficiency Windows in the Northwest." Market Research Report, June 30, 1997

Rosenberg, M. (1995). "Strategies to Quantify Market Transformation and Spillover Effects of DSM Programs." *Energy Services Journal* (Vol. 1, pp. 143-157) and Lee, A.D., & Conger, R. (1996). "Market transformation: Does it work? The Super-Efficient Refrigerator Program." American Council for an Energy-Efficiency Economy: Proceedings of the ACEEE 1996 Summer Study on Energy Efficiency in Buildings (Pp. 3.69-3.80). Washington, DC

Schlegel, J. (1997). "Evaluating market transformation initiatives: Issues, challenges, and State-of-the-art." Presented to ACEEE Market Transformation Workshop. Washington, DC

Stout, J., Herman, P., Khawaja, M., Feldman, S., & Hosseini, J. (1997). "Residential New Construction: Market Transformation Study." Prepared for Southern California Edison Company & Pacific Gas & Electric Company