

THE BOTTOM LINE OF GREEN IS BLUE: HOW ENERGY STAR IS TRANSFORMING HOME- BUILDING WHILE GENERATING ECONOMIC AND ENVIRONMENTAL IMPACTS

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Abstract

In the U.S., the traction gained by the ENERGY STAR residential energy efficiency program and its highly-recognizable cyan-blue logo illustrates how a voluntary program can stimulate innovation, transform markets, and conserve greenhouse emissions. From light bulbs to heating equipment, American homes are becoming more efficient as a result. When the EU instituted home energy ratings, the business of residential energy auditing began to emerge. As this industry takes hold, learning the lessons of ENERGY STAR is critical.

In 2006, the U.S. Environmental Protection Agency's (EPA) ENERGY STAR Guidelines for New Homes will align with recent changes in federal residential energy efficiency standards. An estimated 2,000,000 new housing starts annually could be affected by these changes. Reliance on "branding" is one way to achieve continued program participation, yet alignment of state programs with these new guidelines is no easy task.

This paper describes ENERGY STAR's outreach aimed at ensuring builder and rater retention, identifies the impacts on the stakeholder sectors, and details innovations like the Indoor Air Package (under pilot in 3 states) and the highly-contentious Thermal Bypass Checklist that assures builders address areas prone to envelope inefficiency. This research compares the consequences and emissions reductions of more energy-efficient homes across eight climate zones and fifty states, analyzes the barriers faced and concludes with programmatic solutions and lessons learned as these radical changes to a national program (and mindset) seek to green the American dream.

Background

According to conservative estimates, the United States could save up to 0.70 quads by 2010 by implementing simple energy efficiency measures in buildings, if mandated by specific policy changes. And forty billion pounds of CO₂ could be prevented from entering the atmosphere if only 10 percent of U.S. homes were able to meet ENERGY STAR's guidelines for new construction.

Today, 90 percent of new U.S. homes are found in large developments in suburban settings and the 2000 U.S. Census found that the majority of Americans now reside in those suburban areas. Urban sprawl and the development of all rural areas are worsening. For example, from 1985 to 1997, the U.S. population grew 16 percent while the area of land developed grew 47 percent. In addition, the average single-family home size has increased more than 700 square feet since 1970.

Inefficiency, increasing home size, and urban sprawl are three factors that have led to an unsustainable situation. To impact the energy use of all new homes and prevent the resultant environmental degradation due to ever-increasing home sizes and escalating urban sprawl, the U.S. Environmental Protection Agency (EPA) began its new homes initiative in 1995.

The ENERGY STAR for New Homes program continues today as a voluntary program under the EPA ENERGY STAR suite of programs aimed at environmental preservation through market transformation. This program has had the aggressive goal of transforming the U.S. housing market to energy efficient construction in the residential sector. What began as a modest initiative in 1995, today has gained traction in every state in the union through a network of more than 90 utility partners, 2,900 builders, and 360 providers and rater (verification) organizations.

To achieve the sweeping market transformation in the residential sector envisioned by the ENERGY STAR for New Homes program, the EPA worked with an implementation team at ICF International for marketing, sales, and technical support services to builders, subcontractors, and broader international stakeholders including Home Energy Raters (HERs), mortgage lenders, utilities, and product manufacturers. This singular team construction has lent the ENERGY STAR for New Homes program the robustness of a government-backed program and the corresponding budget security coupled with the market-based approach of a consulting firm that has expertise in all relevant areas from product labeling to home-building.

For a home to be labeled as ENERGY STAR qualified, the New Homes team has worked through builders and third-party verifiers (Home Energy Raters or HERs raters) to authenticate the energy efficiency of each ENERGY STAR home. Figure 1 shows the ENERGY STAR qualified homes label. Figure 2 illustrates how homes may be labeled under the ENERGY STAR process.

The Strategy

The ENERGY STAR new homes team works through the vehicle of ‘account management’ to provide technical and market support to all target regions and target groups identified. The team lends support to all relevant stakeholders in that target area. For example, there may not be a utility program, or a rating infrastructure in a particular target area. The team will work with the utility (or provider) to train raters and assist them in starting their businesses providing building science consulting to local builders who seek to participate in the ENERGY STAR New Homes program. Builders, too, must be convinced to participate in the program. As shown in Figure 2, the builder begins this process by signing a Partnership Agreement with EPA.



Figure 1 ENERGY STAR Qualified Home Label

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Thus far, the ENERGY STAR for New Homes program has targeted large production builders (those who build more than 300 homes a year) as its primary catalysts in the marketplace. Small builders, too, are welcomed to the program, however, their impact is limited by their size. Through a program of sales training, marketing support, co-branding, and “advertising partnerships” with local builders, the ENERGY STAR program has flourished, with nearly 3,000 builders participating presently.

Through training, capacity-building, advertising support, co-branding with the ENERGY STAR logo, and a host of other support mechanisms, the ENERGY STAR for New Homes program has labeled more than 500,000 homes across the United States as having achieved the targeted energy efficiency levels. Table 1 shows how the energy efficiency of the typical U.S. home has increased since 1993.

Key Features of the Program

The key features and activities of the ENERGY STAR for New Homes program include developing regional strategic plans for supporting ENERGY STAR New Homes within the various stakeholders in each region, identifying, recruiting, and cultivating program champions (like utilities or providers) in each local market considered of interest to the goal of nationwide market transformation. Additionally, the ENERGY STAR for New Homes team has worked to foster strategic alliances between partners, conducting and/or facilitating meetings, seminars and workshops, and developing tools and materials aimed at strengthening recruiting and account management. Since its inception in 1991, the ENERGY STAR program has conserved emissions equal to the removal of 150,000 cars from U.S. highways and has the goal to prevent carbon emissions of 9 million metric tons by 2012. The ENERGY STAR for New Homes program expects this initiative will account for another 1,000,000 new homes being built efficiently by the end of the decade. So the need to retain program partners is clear.

		Hot Climate		Mixed Climate		Cold Climate	
		1993 MEC	2006 ENERGY STAR	1993 MEC	2006 ENERGY STAR	1993 MEC	2006 ENERGY STAR
SHELL INFORMATION							
Wall Insulation	(R-Value)	13	13	21	13	21	19
Door	(R-Value)	5	1.33	5	2.5	5	7.75
Attic Insulation	(R-Value)	30	30	38	38	49	49
Slab Insulation	(R-Value)	0	0	5	10	5	10
Window U-Value	(U-Value)	0.68	0.55	0.49	0.4	0.33	0.4
Window SHGC	(SHGC)	0.38	0.35	0.58	0.45	0.88	0.55
Infiltration	(nach)	0.35	0.46	0.46	0.4	0.55	0.33
SYSTEMS INFORMATION							
Cooling Efficiency	(SEER)	10	14	10	13	10	13
Heating Efficiency	(AFUE)	78	80	78	90	78	90
Heating Efficiency	(HPSF)	n/a	8.2	6.8	8.5	6.8	8.5
Duct R-Value	(R-Value)	5	6	5	6	5	6
Duct Loss	(cfm/cfa)*	~8	4	~8	4	~8	4
Thermostat Type		Man.	Prog.	Man.	Prog.	Man.	Prog.
Water Heater Type		Gas	Gas	Gas	Gas	Gas	Gas
Water Heater Efficiency	(EF)	0.56	0.61	0.56	0.61	0.56	0.61
EVALUATION LOCATION							
City		Phoenix, AZ		Baltimore, MD		Minneapolis, MN	

Table 1. Increase Energy Efficiency of Various Home Building Components, 1993-2006.

Present Challenges in the ENERGY STAR Program

As markets for energy efficiency mature (e.g., the U.S. market began with the 1973 Energy Conservation Act) various elements must adapt to keep pace with technological and practical changes. During the past few years in the U.S., the Home Energy Raters (HERS) guidelines were amended to be based on the International Energy Conservation Code (IECC) beginning in 2006.

The national requirements for air conditioners, too, were changing, to require a 13 SEER (a more efficient unit). Additionally, the IECC became the standard for performance over the older Model Energy Code (MEC). Some of those code changes are that the insulation requirements are now defined by the 2004 IECC not MEC 93; the operating assumptions are now matched with the 2004 IECC; and equipment efficiencies in the Reference Home were updated to reflect air conditioning/heating industry changes like the aforementioned

upgrade from a 10 to a 13 SEER air conditioner, from 6.8 to 7.7 HSPF for heat pumps, and increased water heater efficiency. Even the HERs Index was changing to reflect a much different system of measurement where “zero” energy use was the preferred score (0) and 100 now constituted a code-built home (the least efficient). And there were even revisions to the Reference Home used by the IECC upon which to base this index.

In short, the industry was changing and the EPA guidelines for ENERGY STAR qualified homes needed revision to reflect these shifts.

The ENERGY STAR team began modeling the impacts and effects of various scenarios, using Department of Energy (DOE-2) modeling software. These changes to the guidelines were announced in early 2005, with the request from EPA to builders, raters, utilities, and providers to submit written comments back to the ENERGY STAR team. Those comments were received, reviewed, and incorporated into the final guidelines issued in December 2005.

In 2006, the ENERGY STAR for New Homes program guidelines will go into effect, to align all stakeholders with recent changes in federal residential energy efficiency standards, making it more important than ever to right-size equipment, seal the building envelope, ensure clean indoor air quality, and secure emissions reduction. An estimated 2,000,000 new housing starts annually could be affected by these changes in the ENERGY STAR guidelines. Continued compliance was seen as key to ongoing success of the program.

Reliance on “branding” was seen as one way to achieve continued program participation, however, alignment of state programs with these new guidelines remains a challenge. In some states, equipment manufacturers pose a potential obstacle to widespread implementation of this long-standing and highly successful voluntary program (as manufacturers of more efficient equipment fail to release pricing information so critical to builders seeking to incorporate this equipment into their procurement strategies, for example). The single-most important challenge to the ENERGY STAR New Homes program is still how to ensure retention of key partners (and their trust) as this well-known program transformation is being rolled-out to thousands of implementing agencies across the U.S. in the coming months.

Strategy to Effectuate These Changes

The goals of the new guidelines were to respond to industry changes, use tried-and-true energy efficiency improvements to make those changes, balance energy efficiency with cost-effectiveness, integrate more ENERGY STAR qualified products into the homes and promote their use, and create equivalent construction improvement requirements across the country. This last goal is likely the most interesting and relevant to the EU market, where each country has its own standards for construction and not unlike the U.S. states, often has very different regional and climate-sensitive approaches to home-building.

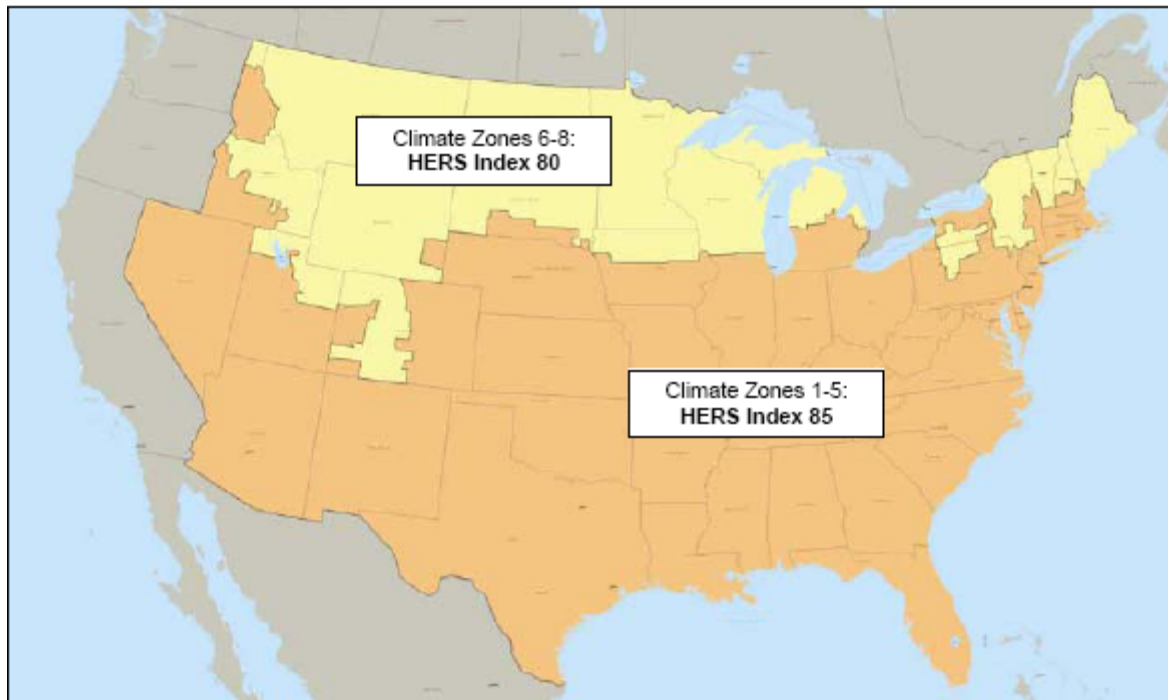
The new ENERGY STAR guidelines are effective immediately, but contain a grandfather clause, allowing homes that have been permitted before July 1, 2006 or that have been enrolled in a utility program before December 31, 2005, to continue to be labeled using the old guidelines until January 1, 2007. And there are essentially two paths by which a home may be labeled ENERGY STAR. The first is the “performance path” that allows any efficiency of equipment to be used as long as the overall performance target is reached. The lower the efficiency of the equipment, the more upgrades need to be made. The second path is the “builder option path” otherwise known as the BOP. The BOP prescribes the efficiency levels of equipment needed to comply. Both paths require the accompaniment of a completed “Thermal Bypass Inspection Checklist”.

Since the United States covers such a vast landmass, there was the need to divide the country into “climate zones”. There are eight climate zones used by the present EPA guidelines, as well as numerous other agencies. Different climate zones may use the Builder Options Package (BOP) to

comply with the ENERGY STAR guidelines. That BOP includes heating and cooling equipment ratings, energy efficient windows specifications, maximum duct leakage and insulation requirements, maximum envelope leakage requirements, and completion of the mandatory Thermal Bypass Inspection Checklist (TBC).

Different climate zones may opt to use the Performance Path to comply with the ENERGY STAR guidelines for new homes. In that case, builders in various climate zones would ensure envelope tightness using the Thermal Bypass Inspection Checklist, ensure maximum duct leakage was not exceeded, and include at least one ENERGY STAR qualified product category within the home to achieve a HERs Index, as specified by each climate zone. Figure 3 illustrates the various HERs Indices required in each climate zone.

Minimum HERS Index Required to Earn the ENERGY STAR¹



Note: Due to the unique nature of some state codes and/or climates, EPA has agreed to allow regionally-developed definitions of ENERGY STAR in California, Hawaii, and the Pacific Northwest to continue to define program requirements. The States of Montana and Idaho may use either the requirements of the national program or the regionally-developed program in the Pacific Northwest.

Figure 3 Climate Zones and HERs Indices

Thermal Bypass Inspection Checklist

Completion of this thermal bypass checklist is mandatory for either path taken by a builder in any climate zone. This checklist covers the sixteen areas known to cause energy inefficiency in homes. Preventing thermal bypass in those areas, the ICF modeling showed, will result in home energy efficiency that is within the limits acceptable to EPA. Each builder must use a HERs rater to verify that the builder has, in fact, avoided thermal bypass in these problem areas. The checklist provoked immediate and strong reaction from builders and raters alike after it was formulated. The comments from utilities, state energy offices, HERs providers and raters, as well as interested stakeholders were considered by the ENERGY STAR team, acted upon, and then posted on the ENERGY STAR Web site to ensure transparency of all actions resulting from this feedback. In general, stakeholders were in favor of the checklist however some worried that it might increase costs or require additional site visits by raters. Upon resolution of these concerns, the checklist was agreed and approved, becoming part of the new guidelines to builders.

To prove that thermal bypass has not occurred in the home's construction, the rater will test each home, or may sample "batches" of homes. And because some inspections cannot be completed in one or two visits by a rater, the builder is allowed to check up to four items on the list. Completion of this checklist ensures that the home buyer receives a third-party quality check of the home; and the builder gains the advantage of fewer "callbacks" and reduced warranty costs for each home sold. The subtler effect of this checklist may be a harmonization of construction practices for these problematic areas in residential construction, such that more efficient homes become the norm.

The ENERGY STAR program has used numerous business tactics and market leverage to reach builders, raters, realtors, and manufacturers. Consequently, there has been an increase in the visibility of concepts like quality assurance and quality control. And in the marketplace, consumers are increasingly requesting "green" homes, as witnessed through green programs like Environments for Living, USGBC LEED-H, and Southface's Earthcraft initiative. EPA foresaw this increased focus and developed the timely Thermal Bypass Inspection Checklist (in 2006) and the Indoor Air Quality Package to answer the need for quality construction as well as address the need for baseline "green" using ENERGY STAR guidelines as the threshold.

Another market impact has been that utility-funded programs continue to rely on selling ENERGY STAR to their customer-base through rebates and have not yet begun to sell the "added value." This gap in sales strategy has made it difficult for utility-based programs to help consumers understand not just the "added value" aspects but also the "added cost" requirements. Yet builder partners around the country have become sensitized to the need to reduce callbacks and insurance claims to remain competitive in an increasingly competitive homebuilding market; so the climate for going "green" using ENERGY STAR program has continued to be successful. And in part, the cooperative advertising builders are able to use, that depicts them as part of the ENERGY STAR family carrying this cyan-blue logo has continued to hold sway.

Present Challenges in the EU Residential Program

The EU Energy Performance of Buildings Directive (EPDB) became law in January 2003. Like the U.S. regulatory mechanisms mandating energy efficiency, the EU Directive has far-reaching implications for the owners, operators, and developers of all buildings—homes and offices alike. European experts estimate that more than U.S. \$17 billion (13 bl Euro) in potential costs savings could be captured by 2015 if energy saving measures (like insulation, window replacement, etc.) were undertaken in all building stock. In the residential sector, the average EU household could easily save a range of 200 to 1,000 Euros per year, according to its consumption level.

Not unlike the ENERGY STAR new homes program, the EU directives require that new homes be benchmarked using a whole building energy performance calculation and be certified by a "suitably qualified and/or accredited expert in an independent manner". (The EU version of a HERs rater, the third-party verifier). The major difference between the EU and the U.S. approach to achieving energy efficient homes and ratings is that the U.S. ENERGY STAR program is voluntary and provides substantial cost-effective rationale and support to the process of building and rating energy efficient homes. The EU approach is via a mandatory mechanism—leaving the pathway for "getting to" energy efficient homes (and the rating of those homes) largely up to the builders and raters.

The next significant difference lies in the approach to market transformation. ENERGY STAR's consumer outreach was aimed at generating a "market pull" for energy efficient homes, thereby creating business opportunities for both the sales of new energy efficient homes (by ENERGY STAR qualified builders) as well as a ready market for the services of the certified raters (by the ENERGY STAR qualified builders who seek to have their new homes labeled and who will hire the raters to do so).

Rating Scales in the UK

The two EU countries that presently exhibit the most developed home energy ratings infrastructure are Denmark and the UK. In the UK, there are two energy scales for rating homes. The first, Standard Assessment Procedure (SAP) utilizes a scale from 1-120, with 120 being excellent. A SAP rating is required for all new buildings like homes, as well as those existing ones being retrofit. Like the changes to the U.S. HERs index, in 2005, the SAP 2005 will be introduced (effective April 2006) as the basis for the implementation of the Energy Performance in Buildings Directive.

Similar to the ENERGY STAR's more stringent guidelines being rolled out in 2006, the SAP 2005 differs from SAP 2001 in that it takes account of building integrated renewable energy systems and fixed internal lighting. And to make it more difficult for raters, the SAP scale will change to be 1 to 150, not 120. The second method of home energy rating afoot in the UK is the National Home Energy Rating (NHER) scale. The National Home Energy Rating (NHER) has a 0 -10 scale and provides an estimate of the amount of carbon dioxide emitted each year as a result of the home's energy use.

The two energy scales (SAP and NHER) measure slightly different things: the SAP looks at the fixed elements of the home and is the same wherever the property is located in the UK. (All homes built to the same design should have the same SAP). Whereas, the NHER includes various location-specific elements (including whether the home is South-facing or sheltered from wind by other buildings), occupancy patterns and cooking. And so the NHER reflects actual running costs—much like the U.S. HERs index. However, unlike the UK system, the U.S. system standardized on one scale, the HERs index (which, as previously mentioned, has recently been amended to reflect current industry conditions). Standardization and agreement on one system of scoring is highly recommended for the EU, to prevent misalignment of energy efficiency labeling of similar homes in different countries.

The UK Homes Label

Both the SAP and the NHER scales produce a label for rating homes in the UK and are based on the BREDEM (Building Research Establishment Domestic Energy Model). The UK label uses a logarithmic scale (e.g., increasing an NHER rating by one point will reduce the energy bills by a more or less constant percentage). Not only are the U.S. and UK (EU) systems different, but the home labels (certificates) too, differ. The ENERGY STAR label (as a voluntary program) specifies that the home was rated, the date, and the rater's name. The UK building certificate (as part of a mandatory program) goes much further in that the certificate shows the watts per square meter of energy used, the kg of CO₂ per square meter of net area per year, the rated performance of each mechanical component, and the expected performance summary for the home (or building).

There are many features of the building certificate that are more detailed than the ENERGY STAR label. While it is unlikely that the voluntary ENERGY STAR label would benefit from adding these features, the Energy Guide label (also used in the U.S.) to denote actual energy use of equipment might benefit from comparison with the UK building certificate which incorporates such innovations as "decibel levels" of the operating equipment. As U.S. consumers become more informed about ergonomic stressors like noise pollution, learning from the EU experience is also recommended.

The UK Rating Infrastructure

Not unlike the U.S. HERs raters, the UK NHER raters are trained by a central organization (National Energy Foundation), a registered charity that also developed the National Home Energy Rating Scheme for British homes. In the U.S., all raters are certified through the organization known as the Residential Energy Services Network (RESNET). Although RESNET began as an organization serving the mortgage industry, today it provides a critical link to the rating infrastructure of the U.S. The ICF

team assisted RESNET five years ago to revise the RESNET Vision Statement to more closely align with this growing rating industry. ICF continues to participate on RESNET's technical and procedural committees in an advisory capacity. RESNET's vision has changed since its inception and its role has changed, too. Now RESNET certifies raters and works closely with the ENERGY STAR team to standardize rater qualifications and training, track rating transactions, and provide mechanisms ensuring the quality of all home energy ratings.

Unlike the U.S. guidelines, the EU directives require that a valid energy performance certificate be produced for all dwellings when they are rented out. And while much uncertainty remains over exactly how the EU Directive will be implemented in the rental sector, the use of the EU home labels is highly innovative in scope. The EU Directive is similar to the ENERGY STAR for new homes program in that the EU Directive mandates that an energy certificate be provided for all homes. But it is dissimilar in that the ENERGY STAR program does not mandate the prominent display of this energy certificate. Precisely where to locate the ENERGY STAR label on a home remains a point of discussion to this day and is largely up to the discretion of the HERs rater.

Experts believe the average home in England would currently receive an NHER rating of between 4.5 and 5.5 (with 10 being excellent). A home meeting the current Building Regulations would probably score higher, perhaps around 8.0 or more, these experts claim. Yet in 2006, a new version of the NHER will be introduced to model lighting and appliances more accurately. And its scale will also be extended from 0 to 20! Before these latest alignments, refinements, and adjustments occur, the lessons learned by the ENERGY STAR for New Homes program may be instructive.

Conclusions and Lessons Learned

Probably the most important benefits of retaining ENERGY STAR partnerships with builders and the rating infrastructure have been the constant communication from the field and feedback between EPA and the various stakeholders who will implement the new guidelines. The back-and-forth dialogue that allowed partners to vent frustration, vet the new guidelines, and become vested in the new specifications has led to maintained partnership in key areas. Additionally, this collaboration has proven beneficial in achieving greater stakeholder "buy-in" of the new guidelines.

The next important aspect has been the ongoing issuance of guidelines updates and increased partner training in the changes to the guidelines. When the new ENERGY STAR guidelines were originally changed, a shorter implementation period was envisioned. However, numerous complaints from stakeholders and a near "crises of confidence" on their part led to a more reasonable timeline, along with a grandfather clause, allowing builders to make the change in construction once all homes permitted had been completed.

The presence of a strong rating infrastructure has proven beneficial (and perhaps necessary) to make inroads into new markets through ENERGY STAR across the U.S. Support to this rating infrastructure in terms of training and capacity-building has meant that ENERGY STAR's best proponents to "sell" the program to builders were on-board with the new shifts in the guidelines at a time when their retention was crucial. The continued improvement trajectory of the ENERGY STAR New Homes program through vehicles like the Indoor Air Quality Package and the Thermal Bypass Inspection Checklist has increased the public presence of the ENERGY STAR brand and captured a whole new audience of consumers searching for "green homes". As builders relay this new product to their customers, the knowledge about the integrity, quality factors, and benefits of the purchase of an energy efficient home (and ENERGY STAR in particular) increase exponentially. And the reduced callbacks and warranty costs to builders help reinforce their decision to remain ENERGY STAR partners and practitioners.

Homebuyers the world-over seek answers to immediate questions and want to avoid searching through onerous and technically-challenging information to get those answers. Over the years, consumers have

“looked for the ENERGY STAR label” as an indicator of quality. The one-stop shop of ENERGY STAR provides U.S. consumers with a central clearinghouse for information on how to make more informed choices. Much attention has been given by the EPA team to the challenge of simplifying the buying decisions for consumers and making program participation by industry stakeholders economically-justifiable as well as pragmatic from an implementation standpoint.

It is important to note that the ENERGY STAR program has been built upon market transformation principles. The ENERGY STAR program has been adopted by utilities, state energy offices, and program champions across the U.S. Some locales and states have even made ENERGY STAR the threshold for their residential building codes. Yet as the program matured and the market began to be transformed, the ENERGY STAR team (both within EPA and at ICF) found they needed to carefully target which markets were “ready” for ENERGY STAR, which messages resonated with new partners, which tactics needed revision, and how to best nurture the program through the identification and use of champions or “market mavens”. As the EU program grows, similar strategy adjustments will no doubt be required.

As the U.S. housing market changes and U.S. builders attempt to “go green” with energy efficiency, there is real opportunity in the decades-old ENERGY STAR brand. As home buyers have higher expectations, do more research, and are increasingly time-poor, prospective home buyers search the Internet and look through the websites of many builders before they ever encounter a salesman. Savvy builders realize this, and will continue to follow this known brand. As the EU rating infrastructure grows alongside the implementation of the new directives for homes, European consumers will benefit from the trail blazed by this decades-old program and be able to foreshadow the coming adjustments to the SAP and NHER home energy rating systems by seeing that the bottom line of green is probably blue.

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