

Clues to Technical Intervention's Role in New Home Market Transformation: A Measure of Penetration Rates Using Building America and ENERGY STAR® Datasets

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ABSTRACT

An important part of transforming markets is motivating manufacturers to improve their products. In the case of housing, manufacturers consist of a complex mix of builders ranging from Fortune 500 companies building thousands of homes per year all over the country, to small local companies that may build less than ten homes per year. Motivating these diverse companies to adopt energy-efficient building practices requires a combination of technical development, education, and the creation of a market that clearly identifies efficiency as a preference. But, in order to participate, builders need to know what to build and how to build it.

ENERGY STAR® for homes has successfully found niches in many of the most active building markets in the nation. This paper explores the relationship between ENERGY STAR's success, especially in the early years, and the role of building research and education as undertaken by DOE's Building America Program. Using an empirical review of builder participation databases maintained by these two programs, the paper will show that Building America was instrumental in establishing a nucleus of competent builders in key markets that went on to participate in the ENERGY STAR program. Building America's activities involved design intervention and field instruction for production builders. The paper will show that these builders went on to actively participate in ENERGY STAR, building 50% of labeled homes in some years, in selected markets. At the same time, the ENERGY STAR program motivated builders not trained by Building America to build the other 50% of houses.

Introduction

The U.S. Department of Energy (DOE)'s Building America database provides detailed proof of the technologies and projects pursued by the Program consortia. Although the database lists much good work, an ongoing question for the program and its potential evaluators is what is Building America's penetration rate. The lower bound for estimating the rate is set by the number of actual houses built with direct Building America involvement; this number totaled nearly 31,500 house completions nation-wide in February 2006 according to the database. But what about the uncounted additional houses that Building America builders produce incorporating technologies and practices they learned while working on Building America assisted projects?

Without detailed surveys, a complete answer to these questions will be difficult to achieve. However, as an exercise in preparation for Department of Energy (DOE) planning, we attempted an approach that at least provides a glimpse of the number of homes built by Building America builders beyond the research houses built directly under the program.

Our thesis is that Building America established a nucleus of competent builders in key markets that went on to participate in the ENERGY STAR program. Using an empirical review of builder participation databases maintained by Building America and ENERGY STAR[®], this paper reviews:

- the number of builders and the houses they build in key markets;
- the number of houses Building America builders went on to build in ENERGY STAR during specific years;
- the percentage contribution of the Building America builders to Energy Star; and
- and the percentage penetration rates of ENERGY STAR and Building America to state and local market housing building permits.

The data suggest that Building America Builders contributed as much as 50% or more of ENERGY STAR houses in some years in the states assessed. When more specific markets are parsed out, the influence of Building America is sometimes greater. This suggests to us that Building America was a critical factor in early ENERGY STAR success. This observation has also been made by ENERGY STAR program management, although they did not quantify it.

These numbers also suggest that, by 2003, ENERGY STAR attracted and motivated enough builders not affiliated with Building America to match the number of houses coming from Building America builders. If Building America provided a technical push to leading builders in the markets, ENERGY STAR pulled in other builders to match the number of built homes.

Before jumping into the numbers, we will review the types of activities that Building America teams participated in with builders and some of the observed motivations for builders to work with the teams. We also briefly describe the ENERGY STAR for Houses Program.

Building America Background

Building America is a private/public partnership sponsored by DOE that conducts research to find energy-efficient solutions for new and existing housing that can be implemented on a production basis. Building America conducts systems engineering research to do the following:

- produce homes on a community scale that use on average 30% to 90% less energy;
- integrate onsite power systems leading to "zero-energy" (ZEH) homes that will ultimately produce as much energy as they use by 2020;
- help home builders reduce construction time and waste;
- improve builder productivity;
- provide new product opportunities to manufacturers and suppliers; and
- implement innovative energy- and material-saving technologies.

Over the last ten years, the Building America program has worked with more than 120 builders and 470 industry partners that have completed nearly 31,500 homes nationwide. Partners include national and regional builders who produce about 50% of all new housing. Although these are national companies, decisions about house construction are typically made at the division level.

Building America partners are organized by team. Currently, there are seven Building America teams. Each team is led by a research group or engineering consulting firm and teams consist of builders, architects, engineers, equipment manufacturers, material suppliers, community planners, mortgage lenders, and contractor trades totaling more than 500 industry partners represent the nation's largest home builders and leading building scientists. Organizations and the teams they lead are listed below.

<u>Consortia Lead</u>	<u>Consortia Name</u>
Building Science Corporation	Building Science Consortium (BSC)
ConSol	Building Industry Research Alliance (BIRA)
Davis Energy Group	Contributes to CARB, BIRA, and other research
Florida Solar Energy Center	Industrialized Housing Partnership (IHP)
Integrated Building and Construction Solutions	IBACOS
National Association of Home Builders (NAHB) Research Center	NAHB Research Center
Steven Winters Associates	Consortium for Advanced Residential Buildings (CARB)

The teams work directly with builders on three phases of building research in new homes:

- Phase I- System Evaluations
- Phase II-Prototype House Evaluations
- Phase III-Initial Community Scale Projects.

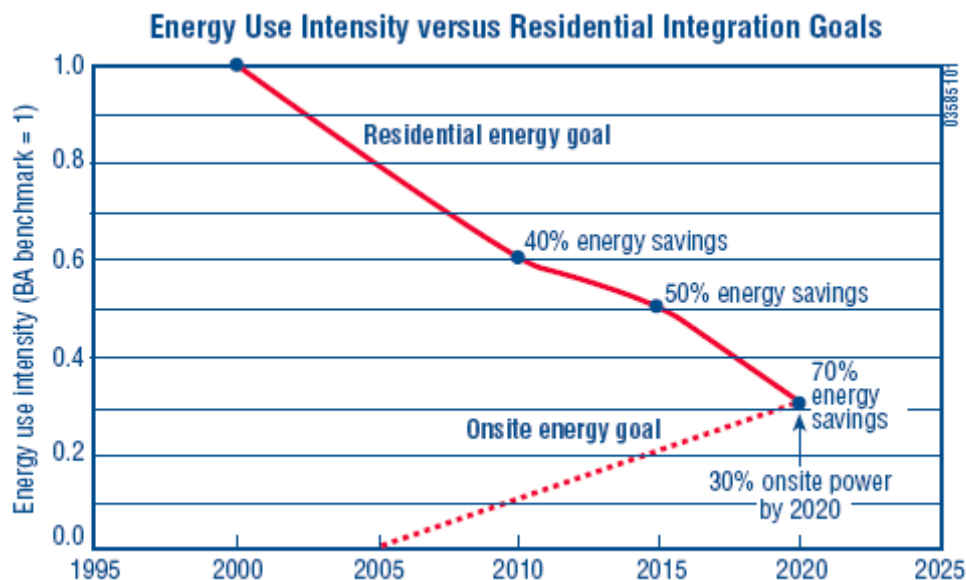
These research phases are intended to result in building packages meeting ever more aggressive levels of energy efficiency. In fiscal year 2005 (which ended September 30th) the program developed research reports that demonstrate how leading builders can successfully reduce whole-house energy consumption by 30% in the hot-dry/mixed-dry climate and cold climate (DOE 2005 d and e). Table 1 shows DOE's target energy savings for five major climate regions in the United States over the next eight years.

Table 1. Target Energy Savings for Five Major Climate Regions in the United States

Target Energy Savings	Marine	Hot Humid	Hot-Dry/ Mixed Dry	Mixed Humid	Cold
30%	2006	2007	2005	2006	2005
40%	2008	2010	2007	2008	2009
50%	2011	2015	2012	2013	2014

Figure 1 illustrates how advanced energy efficiency levels will mesh with on-site generation to develop homes that produce as much energy as they use.

Figure 1. Building America Goals



Early projects were directed toward achieving roughly 15% whole-house reductions in energy consumption. Best practices manuals have been developed for five climate regions based on this initial 15% goal (DOE 2004, DOE 2005 a, b, and c, and DOE 2006). It is this early work that involved the builders counted in this paper.

Building America's early work often involved persuading builders to adopt advanced building techniques. Five key elements stand out as motivators for builders. This list is based on insights from the teams from published reports, presentations, and informal discussions:

- Solving specific problems plaguing the builder. Examples include lack of durability, mold, and customer complaints.
- Reducing call backs – which is another way of saying improving quality. Pulte Homes of Tucson reported a first year reduction of 10% after working with the BSC team. They tracked complaints to drywall (cracks, nail pops, cornerbead pops), and HVAC (balance, air handler, cooling, compressor, ductwork, noise, and furnace) (BSC 2006). Town and Country Homes states that “Building America’s technical assistance helped reduce callbacks by 70% in our Chicago Division” (DOE 2004).
- Cost performance trade-offs. The cost of energy-efficiency features are often balanced with reductions of other construction costs. The program strives to be cost neutral.
- Improved customer referrals. Pulte received top ranking for customer satisfaction in 12 of the 21 markets evaluated by J.D. Power and Associates in 2003. In 2005 Pulte was ranked highest in 16 of 30 markets and Centex won the highest ranking in 10 markets. Both Pulte and Centex work with Building America teams and hopefully the program has contributed to their success. However, the point here is that referrals are highly effective sales tools and energy efficiency can lead to more referrals. J.D. Power found that customers who give their builders the highest ratings recommend their builder to nearly twice as many people as average new-home buyers (J.D. Power 2005). Based on

customer service surveys, the September 2003 issue of *Professional Builder* provides six top reasons why a customer is willing to refer a contractor and energy efficiency is first among the reasons related to product (rather than service) (*Professional Builder* 2003).

- Value-based sales. Much Building America activity came in the earliest days of ENERGY STAR, but builders were looking for ways to differentiate their product based on quality and value.

ENERGY STAR Background

In 1992 the US Environmental Protection Agency (EPA) introduced ENERGY STAR as a voluntary labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions. Computers and monitors were the first labeled products. Through 1995, EPA expanded the program to brand additional office equipment products, and residential heating and cooling equipment, and new homes. In 1996, EPA partnered with the US Department of Energy for particular product categories. The ENERGY STAR label is now on major appliances, office equipment, lighting, and home electronics - 35 product categories in total.

Energy Star for new homes has focused on rapidly expanding markets in California, Texas, Phoenix, Las Vegas, and other areas. Many of these same markets have been actively served by Building America.

Historically, ENERGY STAR qualified homes were independently verified to be at least 30% more energy efficient than homes built to the 1993 national Model Energy Code or 15% more efficient than state energy code, whichever is more rigorous. These savings are based on heating, cooling, and hot water energy use and are typically achieved through a combination of:

- building envelope upgrades;
- high performance windows;
- controlled air infiltration;
- upgraded heating and air conditioning systems;
- tight duct systems; and
- upgraded water-heating equipment.

These are the program criteria that applied at the time data were collected for this analysis. However, ENERGY STAR has implemented new performance guidelines and a new national builder option package that utilizes the 2004 International Energy Conservation Code and the new HERS rating system. These new guidelines and the new HERS rating system must be used to qualify homes for the ENERGY STAR label that are not enrolled in a state or utility program before December 31, 2005, or permitted before July 1, 2006.

Approach

ENERGY STAR tracks by builder the number of qualified homes built in particular cities and states. Thus, it is possible to determine for a given state the number of ENERGY STAR homes produced by Building America builders. And, using Census data showing housing permits, it is relatively straightforward to calculate the total penetration rate of both ENERGY STAR homes and ENERGY STAR homes built by Building America builders.

Here is the procedure we followed.

- A list was developed of builders from the Building America database for states of interest. We call these Building America builders.
- We referred to the ENERGY STAR partner database for a count of qualified houses that Building America builders produced in the specified states in the last 12 months. The partner database rolls over on a 12-month basis. This rolling count feature limits our ability to do historical studies.
- We used single-family housing permit data from the U.S. Census website for the number of 2003 and 2005 housing permits for the given states and metropolitan areas.
- We calculated the percentage of ENERGY STAR homes as a portion of residential construction permits for each state and for key metro areas. And we calculated the percentage of ENERGY STAR homes and overall housing starts built by Building America builders.
- We conducted the exercise for 2003 and 2005. The 2003 work was conducted at that time for DOE planning. In 2005 we revisited the analysis for the ACEEE Summer Study.

We chose states where Building America was most active. In an attempt to delve beyond state-wide numbers and look more closely at specific markets, we parsed the ENERGY STAR data into metropolitan regions that approximated regions identified by the Census. The Census metropolitan regions are clustered by cities, for example Las Vegas-Paradise or Los Angeles-Long Beach-Santa Ana. The ENERGY STAR data lists builder names and service areas. By comparing the service areas to the metropolitan region names and verifying they shared county boundaries and that the service areas were not included in other metropolitan regions, we delineated five markets as subsets of three states.

The key assumption in this process is that Building America builders are producing ENERGY STAR homes because of their Building America experience. We cannot be sure of this causal relationship. These are motivated builders and they may have found their way to ENERGY STAR without Building America's help. We know that some Building America builders chose not to partner with ENERGY STAR. But, the numbers do give some indication of the persistence of builders over time and a sense of how the programs worked in tandem.

There are some peculiarities associated with the data sources that add to the uncertainty of the analysis. The ENERGY STAR partner database reports house counts on a rolling 12-month basis. The U.S. Census housing permit data is divided by calendar year. Thus, matching these two data sets using public web-based information introduces error because the time scales do not match, unless accessed shortly after the start of the calendar year. The Census data reports housing permits. Not all permitted houses are completed within one year. Another source of error could be the inclusion of multifamily contractors in either the Energy Star or the Building America data sets. If this is true, the Census numbers for single-family permits will not directly

correspond with ENERGY STAR and Building America data sets. Census, ENERGY STAR, and Building America data sources are listed in the references (Building America 2006, Census 2006a, Census 2006b, and ENERGY STAR 2006).

Results

Using this approach, Table 2 contains the 2003 results for Arizona, California, Minnesota, and Nevada. Penetration rates refer to the number of homes compiled by ENERGY STAR as a percentage of total state housing starts. The states evaluated in 2003 include Arizona, California, Minnesota, and Nevada.

Table 2. 2003 Penetration Rates

State	2003 Housing Permits	Total ENERGY STAR Homes*	ENERGY STAR Penetration rate	ENERGY STAR Homes from Building America Builders*	Building America Builder Penetration Rate	Building America Builder Percentage of ENERGY STAR
Arizona	64143	9058	14%	5775	9%	64%
California	140512	13724	10%	6960	5%	51%
Minnesota	30915	313	1%	214	1%	68%
Nevada	33033	10085	31%	4923	15%	49%
*From ENERGY STAR partner database – 12-month rolling count based on data accessed in March 2003.						

Table 3 shows 2005 penetration rates for the same states plus Florida and Texas.

Table 3. 2005 Penetration Rates

State	2005 Housing Permits	Total ENERGY STAR Homes*	ENERGY STAR Penetration rate	ENERGY STAR Homes from Building America Builders*	Building America Builder Penetration Rate	Building America Builder Percentage of ENERGY STAR
Arizona	80648	16641	21%	7580	9.0%	46%
California	151022	27673	18%	14363	10%	52%
Minnesota	29276	1038	4%	724	2%	70%
Nevada	37438	20135	54%	6918	18%	34%
Florida	208528	1810	1%	349	0%	19%
Texas	165579	59930	36%	3206	2%	5.0%
*From ENERGY STAR partner database – 12 month rolling count based on data accessed in February 2006.						

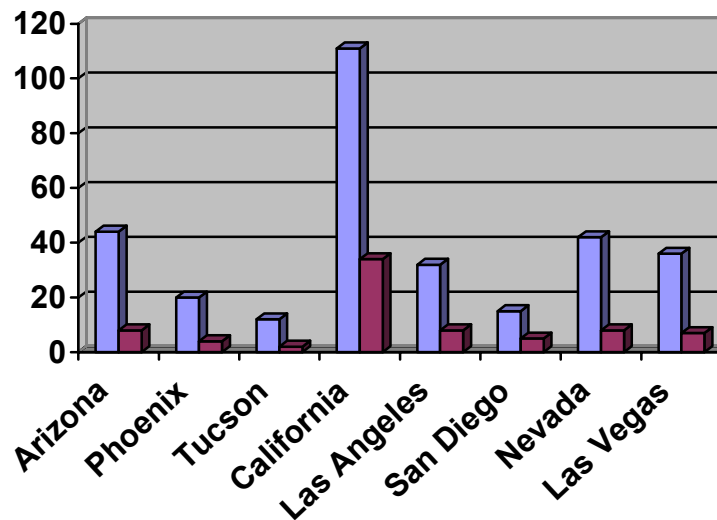
Using the 2005 data we were able to take the analysis to the level of key metropolitan areas in Arizona, California, and Nevada. Table 4 shows that both ENERGY STAR and Building America had greater influence on specific markets that they did on states as a whole.

**Table 4. 2005 Penetration Rates for Metropolitan Areas in
Arizona, California and Nevada**

State	2005 Housing Permits	Total ENERGY STAR Homes as of 1/06*	ENERGY STAR Penetration rate	ENERGY STAR Homes from Building America Builders*	Building America Builder Penetration Rate	Building America Builder Percentage of ES
Arizona	80648	16641	21%	7580	9%	46%
Phoenix- Mesa- Scottsdale	53964	11885	22%	4751	9%	40%
Tucson	11006	1703	15%	198	2%	12%
California	151022	27673	18%	14363	10%	52%
LA-Long Beach- Santa Ana	16399	9517	58%	4607	28%	48%
San Diego- Carlsbad-San Marcos	7485	5510	74%	3290	44%	60%
Nevada	37438	20135	54%	6918	18%	34%
Las Vegas- Paradise	30358	17526	58%	5250	17%	30%
*From ENERGY STAR partner data base – 12 month rolling count, data accessed in February 2006.						

Another take on the interaction of the two programs comes from looking at the number of builders that each program has listed for selected markets. Figure 2 compares the total number of builders listed by ENERGY STAR in each market, and the subset of that total influenced by Building America.

Figure 2. Numbers of Builders Contributing to ENERGY STAR (larger number) and Building America (lesser number) in Selected States and Local Markets



Conclusions

Building America and ENERGY STAR are complimentary programs. Building America provides technical expertise in building science and research; ENERGY STAR offers marketing materials and criteria to help consumers and builders clearly identify homes with energy efficient construction. This complimentary nature was especially apparent in the early days of both programs when both were focused on housing achieving about 30% savings in space conditioning and water heating.

In some locations, it appears that Building America has contributed a critical mass of trained builders that participated in ENERGY STAR and helped that program reach impressive market penetration rates. Arizona, California, and Nevada are three states where Building America builders have made substantial contributions to ENERGY STAR: 64%, 51%, and 49% respectively in 2003, and 46%, 52%, and 34% respectively in 2005. However, Building America's strategy of targeting large production builders also shows through. For example, while Building America influences 52% of the ENERGY STAR houses in California in 2005, Building America builders account for about 30% of the ENERGY STAR builders. In Arizona, Building America influences 44% of the houses in 2005 with about 19% of the ENERGY STAR builders.

Looking at local markets, both programs have had substantial impacts. The best example of this is in San Diego, where in 2005 ENERGY STAR homes accounted for 74% of all housing permits and Building America builders were responsible for 60% of these. These builders made up one-third of the ENERGY STAR builders as shown in Figure 2. Southern California was an active area for both programs. In Los Angeles ENERGY STAR accounted for 58% of all housing permits and Building America builders were responsible for 48% of those with 25% of the builders. Metropolitan areas in Arizona and Nevada more closely matched statewide averages.

Some regions are achieving ENERGY STAR prominence without large numbers of starts from Building America builders. Texas is one example. This analysis did not explore the

catalysts that sparked ENERGY STAR interest in Texas, but State attention to building codes has been high and incentives are available.

It is likely that the Building America house count underestimates the number of homes the programs has affected. We offer this observation not as a criticism of Buildings America's data compilation, but more as recognition of the difficulty of giving the program full credit for the houses it has influenced and the energy savings it has achieved. The lower bound for estimating the rate is set by the number of actual houses built with direct Building America involvement.

For example, Building America counts a total of 5,855 houses in Nevada (as of February 2006). This count covers the entire life of the program (1996 – 2006). For the purpose of this count, Building America houses are defined as all prototype houses, and all production houses that were substantially influenced by a Building America team and that meet the ENERGY STAR requirement of 30% energy savings compared to the HERS Reference Home (prior to July 2006). However, the count included in this paper for just two years found nearly 12,000 homes that meet ENERGY STAR standards coming from builders that have worked with Building America. Once teams are no longer working with a builder, or when a builder has multiple projects underway, it is difficult to track the Building America's total influence. As a research program, the number of houses directly influenced may not be as important as the technologies and approaches tested, but an understanding of how those technologies are entering the market is still important to policy makers.

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