MARKET CHANGES

Energy Star homes in Phoenix save energy for homeowners, but there is still room for improvement.

by COLBY SWANSON

Eleven years after EPA launched its Energy Star Homes program, the marketplace for new homes has changed—but by how much? That's the question we set out to answer by assessing more than 7,000 homes in the Phoenix Home Energy Efficiency Study. In 2004, Advanced Energy partnered with the U.S. Environmental Protection Agency (EPA), Arizona Public Service (APS), Southwest Gas, and several national home builders to assess thousands of homes in the Phoenix area and to compare actual energy use data for homes built to various efficiency standards. Through assessing the results, we wanted to determine how much energy the baseline and Energy Star homes actually consumed; if homes built to Energy Star standards were more efficient than baseline homes; and if the implementation of Energy Star and other efficiency programs in new home construction resulted in a reduction of total energy consumption.

When EPA launched its Energy Star Homes program in 1995, it was reasoned that Energy Star-labeled homes would offer consumers dependable savings on their monthly energy bills, and would reduce the overall consumption and impact of residential sector energy use. To qualify for labeling as an Energy Star home, home design plans must first meet program criteria for energy use, as predicted using computer energy simulation modeling. Second, a random sample of homes built to those design plans must pass duct and envelope leakage field tests to ensure that actual construction matches the computer modeling in terms of whole-house infiltration and duct leakage. To date approximately 400,000 Energy Star-labeled homes have been built nationwide.

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Our study has shown that the Energy Star program is working, and that it is effecting market change in the Phoenix area. When the Energy Star program entered the Phoenix market area and won many strong supporters, it raised the energy performance bar for all housing in the market. Consumers are now requesting energy-efficient features in their homes because programs such as Energy Star have elevated awareness.

The major catalysts for this market transformation have been programs such as Energy Star and all the activities that go into supporting them. The Energy Star program has influenced type, price, and availability of building products (such as low-e glass and higher-efficiency HVAC systems), thus lowering prices for these products. The program has also had an influence on building contractors. And—particularly in a dense area like Phoenix—having even one contractor change his or her business practices to meet Energy Star standards can affect a significant portion of the market.

During the time of this study, the Energy Star program homes, by definition, promoted savings in residential energy costs: Homes were to be 30% more energy efficient by design than 1993 Model Energy Code (MEC) homes. A quick look at Energy Star homes in Phoenix—which include 12-SEER air conditioners, reduced air infiltration, low-e glass, duct sealing, and performance testing—suggests almost

certain energy savings. However, only an exhaustive energy use assessment of occupied homes would offer real-world proof of energy savings.

Home Variations

New homes were classified as either baseline or Energy Star, with baseline homes defined as homes built to local industry standards. Because energy efficiency was an issue in Phoenix before the Energy Star program was introduced, baseline homes were further divided into two categories. Baseline Regular (BaseREG) homes are those built to the 1993 Model Energy Code (MEC 93). Baseline Energy Star (BaseES) homes are those built to more efficient, near-Energy Star standards. In fact, some "baseline" homes actually meet the Energy Star standards without being in the program. These baseline homes provided a benchmark for energy use in new homes, allowing the research team to determine the approximate savings presented by comparable Energy Star program homes. Most of the builders included in the study offer both baseline and Energy Star homes, built to similar designs.

Phoenix was selected for the study because it offered large populations of homes designed and built to different levels of energy efficiency. Phoenix was an early adopter of Energy Star; the first builders entered the program in 1997. The existence of these large groups of homes provided an excellent opportunity to conduct a side-by-side comparison of energy use under real-world conditions (see Table 1).

The Phoenix Home Energy Efficiency Study was designed in part to identify both the energy efficiency and the total energy use of comparable baseline and Energy Star homes, taking into consideration a large number of home design variables. The survey covered a range of homes built from 1995 to 2004 by six different national production building companies. It included a total of 3,336 baseline homes and 2,979 Energy Star homes. (Complete information was not available on all of the homes, so some homes had to be removed from the study.) Details on the physical design and construction of the various homes were obtained from home builders, utilities, contractors, and testing companies. Monthly energy use histories for the homes were provided by APS and Southwest Gas Corporation.

This study did not attempt to determine why certain homes or categories of home performed well or poorly, nor did it compare actual performance against computer modeling. We were simply interested in knowing where we stood. The study did not consider the impact of the occupants' lifestyle on overall energy use. Lifestyle choices can drive large changes both in total energy use and in the energy performance of a home. Some lifestyle choices, such as thermostat settings, are easily documented. Others—such as opening and closing doors and windows, or running frequent loads of laundry—are harder to account for, and can skew the results for an otherwise energy-efficient home. To reduce the impact of lifestyle choices on the results of the study, we used a statistically large sample of homes.

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Table 1. Number of Houses by Square Footage

Interior Size	BaseES	Energy Star
< = 1,000	83	7
1,001–1,500	702	816
1,501–2,000	1,283	1,126
2,001–2,500	426	680
2,501–3,000	91	159
3,001–4,000	23	167
> = 4,001	0	11

Isolating the Results

Even with the high number of observations, direct comparisons of energy use among the three categories of home—BaseREG (built to MEC 93), BaseES (built to near-Energy Star standards) and Energy Star—are difficult at best. Swimming pools, in particular, add significantly to the overall energy use of a home. But it was difficult, at least within this study, to isolate pool-related costs, since most pool systems are not metered separately from the home energy supply. Even seasonal

differences in the costs of operating electric water heaters versus gas heaters could alter energy use profiles by as much as 900 kWh per year, invalidating certain study results. To mitigate these large variables, it was essential to compare homes only within certain definite data sets.

Because the different categories of home differed considerably in size (BaseREG homes averaged 1,509 ft² while Energy Star averaged 1,967 ft²), energy intensity (electric usage /ft² of living area) was used as the comparison (see Table 2). The most comparable subset of homes (gas-heated homes with no pool) suggested that the Energy Star homes on average used 3.5 kWh/ft², compared to 4.16 kWh/ft² for the typical baseline (BaseREG) homes. This represents a savings of 16% for cooling intensity. However, baseline homes built to near-Energy Star standards actually outperformed the Energy Star homes. The BaseES homes all came from one particular subdivision (built by one builder), which used low-e windows and 12-SEER equipment standard, while the Energy Star homes came from numerous builders and subdivisions with window and HVAC specifications that varied. More specifics are described further in the full report. Applying regression analysis for this same data set (gas heated, no pool), Energy Star homes used 10% less cooling energy than BaseREG homes.

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Table 2. Energy Use for Gas-Heated Homes With No Pool

	BaseREG	BaseES	Energy Star
Number of homes	340	537	1,195
Living area (ft²)	1,509	1,878	1,967
Adjusted total use (kWh/yr)	13,915	14,228	15,831
Cooling Intensity (kWh/ft²/yr)	4.2	3.3	3.5

Energy Trends

Our study highlights a trend that we believe is of great concern to those who design, implement, or utilize energy efficiency programs. Although Energy Star homes and their nonprogram cousins are outperforming regular baseline homes with regard to space cooling/heating and water heating, actual total energy use is increasing. According to Arizona Public Service (APS), in 2000 the average weather-adjusted annual kWh sales per residential customer was 12,800 kWh. In our study kWh/yr jumped to 15,831 kWh/year for Energy Star homes. Baseloads and plug loads average 70% of a home's total energy use. The size of homes, and the number of electronic devices within a home, are increasing at a pace that makes any energy savings tied to space cooling/ heating and water heating barely noticeable. There are substantial gains that can be made by reducing baseloads and plug loads.

Continued efforts to reduce overall energy use in residential buildings should not be focused solely on space cooling/heating and water heating. While the savings are positive, the larger context of these savings is less impressive. Space cooling/heating is one of the largest individual energy users in a home, representing roughly 40% of total energy use. This means that even a 10% reduction in cooling and heating costs—a significant reduction—only equates to a 4% savings on the home's total energy bill. Obviously, all areas of energy use within residential buildings must be investigated, and ways must be found to deal with the trend of increasing home size, if homes are to realize their maximum energy savings potential.

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FOR MORE INFORMATION:

Through its Applied Building Science Center, Advanced Energy provides training and consultation to improve the health, safety, durability, and energy efficiency of houses and commercial buildings. Find out more at www.advancedenergy.org.

To download the full report for this study, go to www.advancedenergy.org/buildings/programs/energy_star.