Marketing Energy-Efficient Residential Construction Nationwide EPA's ENERGY STAR Homes Program

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The average household in the United States spends more than $1,200 a year on energy consumed in the home (Energy Information Agency [EIA] 1995). Yet prospective home buyers are not provided with information on energy consumption and are unable to distinguish an energy efficient dream house from an energy sieve. Clearly, the builder has no incentive to invest in the energy efficient upgrades that can save the homeowner money. The EPA ENERGY STAR Homes Program seeks to overcome market barriers that can limit the energy efficiency of new homes. With primary carbon emissions for the residential sector approaching 288 million metric tons of CO_2 by the Year 2010, the potential environmental benefits of a nationwide program are significant.

The ENERGY STAR Homes Program is a voluntary and market-based program, presently in the pilot stage. Participating builders, who construct homes that meet the Department of Energy's (DOE) Home Energy Rating System (HERS) level for a Five-Star home, are granted usage of the Energy Star logo. EPA works with the builders and provides evaluation tools and technical support to assist them in meeting the efficiency criteria for the program.

This paper describes the process of launching a national marketing program aimed at transforming the energy efficiency of residential construction in the United States. Key components of the program include builder technical support; marketing support; partnerships with mortgage providers, utilities, and product manufacturers; and selection of states to target builder recruitment. Recruitment efforts are aimed at builders with large market shares to maximize energy savings and pollution prevented. Barriers to marketing energy efficient homes are addressed with financing and sales training programs for builders and their sales teams. This paper includes estimates of avoided emissions for the homes that have been committed to the program at the time of this writing.

INTRODUCTION

Background

Carbon dioxide emissions from fossil fuel use in the residential sector were estimated at 270 million metric tons of carbon for 1993, 20% of total U.S. carbon dioxide emissions (EIA, 1994; U.S. Climate Action Report 1994). Increasing energy efficiency in the residential sector will not only reduce emissions of carbon dioxide and other pollutants at the source, but will save consumers money and improve comfort in U.S. homes. The EPA's ENERGY STAR Homes Program is designed to make builders and consumers aware of the profits and benefits of energy efficient homes. The market-pull strategy of the program is effective at attracting builders and is expected to influence the new construction market on a large scale.

Program Implementation

Defining an ENERGY STAR Home. The program strategy is to create partnerships with large builders by marketing the program in target areas. Industry endorsements and utility allies help attract builders to the program. Builders that join the program have access to technical assistance, marketing tools, and special mortgage financing.

An ENERGY STAR Home uses at least thirty percent less energy than the DOE Home Energy Rating System (HERS) Guidelines' Reference House, which is based on the 1993 Model Energy Code (MEC) requirements. According to the HERS Guidelines, the ENERGY STAR Home would achieve a five star rating. The energy features of the reference house will vary depending on the climate, but Energy Star will always represent a consistent performance level. Some states have energy codes more stringent than MEC. However, even in these cases, Energy Star still represents a

Table 1. *Energy Star Homes Targeting Matrix*

	State	1994 (Census) New Home Starts[a] Single/ Duplex	1994 (Census) New Home Starts[a] Three +	1980–1994 Housing Growth Trend[a]	1993 (EIA)[b] Electric Rates ($/kWh)	1993 (EIA)[b] Gas Rates ($/MBtu)	1990 Heating Fuel Type %[e] Gas	1990 Heating Fuel Type %[e] Electric	1990 Heating Fuel Type %[e] Oil	1993 Emission Factors[d] SO_2 g/kWh.e	1993 Emission Factors[d] NOx g/kWh.e	1993 Emission Factors[d] CO_2 gC/ kWh.e	Existing/ Future HERS[e] (H,M,L)	1995 Energy Code Rating (Alliance Report)[f]	Heating Degree Days[g]	Cooling Degree Hours[g]
1	AZ	42,416	8,718	Steep	0.090	6.64	14	86	0	1.9	1.5	129	Medium	D	1,591	45,175
2	CA	79,552	17,954	Flat	0.100	5.60	78	22	0	0.0	0.6	63	Existing	A +	2,423	7,376
3	CO	28,745	8,956	Steep	0.070	4.55	85	15	0	2.5	3.0	269	Existing	F	6,358	5,718
4	FL	107,432	30,860	Medium	0.078	7.79	2	98	0	5.0	2.0	197	Existing	A +	819	31,963
5	GA	50,527	11,053	Flat	0.075	6.64	77	23	0	7.1	1.5	167	Medium	A	2,370	22,027
6	IL	37,854	9,384	Medium	0.099	4.95	98	2	0	5.6	1.9	123	Existing	F	6,110	9,434
7	IN	30,457	5,062	Steep	0.069	5.28	60	39	1	11.9	4.0	292	Existing	A	5,849	9,245
8	MA	17,392	904	Flat	0.097	7.56	39	11	50	5.0	1.6	186	High	B +	5,954	4,728
9	MD	26,824	3,552	Flat	0.072	6.28	26	74	0	6.2	1.7	183	High	B	4,714	9,504
10	MN	21,314	4,651	Down	0.068	4.61	96	4	0	3.8	2.5	193	High	A +	8,792	3,639
11	MO	21,660	4,022	Steep	0.074	5.15	82	18	0	8.6	3.3	230	Existing	F	5,021	16,996
12	NC	52,621	12,771	Medium	0.078	5.98	43	57	0	4.7	1.8	179	Medium	A −	3,463	13,021
13	NV	23,328	8,190	Steep	0.057	5.49	96	4	0	2.7	2.5	276	High	D +	6,050	1,679
14	OH	39,006	10,083	Medium	0.081	5.08	65	35	0	15.7	3.1	254	Existing	A	5,924	6,308
15	TN	28,158	4,651	Flat	0.057	4.94	60	38	2	11.5	2.4	223	Medium	A −	3,700	16,664
16	TX	63,735	30,340	Flat	0.072	5.55	69	31	0	2.0	2.3	220	Low	F	2,161	32,178
17	UT	20,358	3,775	Steep	0.071	4.85	96	3	1	0.9	1.3	279	High	B +	5,895	9,239
18	VA	40,183	7,449	Flat	0.073	6.48	13	87	0	3.8	1.2	148	Existing	A +	4,019	10,900
	Median	*34,156*	*8,454*		*0.074*	*5.52*	*67*	*27*	*0*	*4.8*	*2.0*	*195*	*8 Existing*		*4,867*	*9,469*
	Average	*40,642*	*10,132*		*0.077*	*5.75*	*61*	*36*	*3*	*5.5*	*2.1*	*201*	*9 Likely*	*C*	*4,512*	*14,211*

a. Bureau of the Census 1994.
b. Energy Information Administration 1994.
c. Bureau of the Census 1993.
d. Koomey 1995.
e. Rinebolt, David 1995.
f. Alliance to Save Energy 1995.

significant efficiency improvement over a code-built home. The ENERGY STAR Home energy performance target may be met through any combination of: 1) envelope upgraded beyond the MEC; 2) controlled air infiltration; 3) upgraded heating and air conditioning equipment; and 4) upgraded water heating equipment. ENERGY STAR Homes also are required to maintain or improve indoor air quality as per American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 62-1989 or Standard 90.2-1993. In addition, EPA encourages Partners to equip ENERGY STAR Homes with energy efficient lighting and appliances, or to offer such equipment as upgrades. Recom-

mendations for energy improvements are based on a systems approach. The house is modeled as a system, with a variety of different energy efficiency options, to find several least-cost packages of efficiency improvements. Thus, if several options reduce energy use significantly, downsizing of equipment is possible, thereby lowering first cost of the improvements.

Selecting Target Areas. The goal of the ENERGY STAR Homes Program is to maximize profitable pollution prevention. To achieve this goal, the program must be promoted in locations with high levels of home construction and where pollution from residential energy use is high.

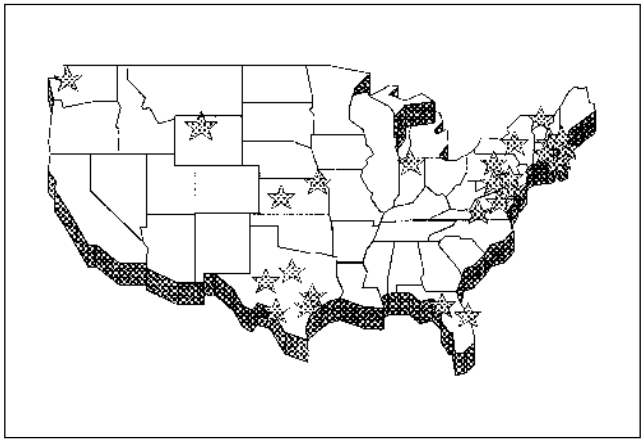
A number of factors were considered in selecting locations for promoting the program. States were ranked according to criteria that were deemed relevant to the success of the program, including: housing starts and growth trends, average residential electric and gas rates, pollution prevention potential based on the heating fuel mix and emission factors, HERS infrastructure, strength of the energy code, and severity of climate based on heating degree days and cooling degree hours. Table 1 shows the 18 states that ranked highest in terms of potential for pollution prevention. Major cities within these states were chosen as target areas as well as locations that also had been chosen as target areas for EPA's ENERGY STAR HVAC Program, so that this ''sister'' program would benefit from cooperative marketing.

Forming Partnerships

Large Builders. While no builders are excluded from participation in the program, initial recruitments were aimed at the largest builders in the country in order to maximize participation and ultimate pollution prevention. This strategy is based on the premise that if a few large, mainstream builders can increase their profits by constructing ENERGY STAR Homes, then the stories of their success will spread quickly throughout the homebuilding industry, which is known for capitalizing on popular trends. Goals for program impact include a market share of 10 percent of new construction by the year 2000 and more than 95 percent by 2010. The figure below shows the current distribution of ENERGY STAR Home builder partners across the United States.

Arranging Attractive Financing Options. Builders' concerns about constructing high-efficiency homes are primarily cost based. Because the profit margins on homes tend to be extremely thin, builders are reluctant to add any costs that are not directly related to common buyer preferences. The critical area of concern is the possibility of a larger down payment limiting the number of home buyers that can qualify for the home. To address this barrier, EPA is working with lenders and secondary mortgage institutions. Lenders who agree to join the program benefit from both increased

Figure 1. *Current Distribution of ENERGY STAR Home Builder Partners*



business because they have created a marketing niche and reduced risk of loan default. Reduced risk arises from borrowers having lower monthly energy bills, and therefore more income to pay their mortgage.

Forming Alliances

Financing partners represent only one of the industries with which the ENERGY STAR Homes Program is forming strategic alliances. Utilities, trade associations, product manufacturers and energy service companies are all critical to the long term success of the program. In order to sustain quality control as the program matures, allies are encouraged to provide the following services:

(a) Promote and endorse the ENERGY STAR Homes Program;

(b) Provide home energy inspections on ENERGY STAR Homes;

(c) Provide energy bill or comfort warranties on ENERGY STAR Homes.

Utility Allies can improve the marketability of ENERGY STAR Homes by providing value-added customer services. In particular, utilities are encouraged to provide field inspections and energy bill warranties, services that directly address critical quality control issues and yet are expected to cost much less than expensive rebate programs. Utilities may join the ENERGY STAR Program because they perceive a benefit from load shaving, as well as from better public relations, and increased marketing opportunities.

Buy-in from the National Association of Home Builders (NAHB) was seen as a pivotal step in launching a successful program and the program was endorsed by the Energy Com-

mittee of the NAHB at their 1996 Builder's Conference. Other related industry trade associations, including the North American Insulation Manufacturers Association, Polyisocyanurate Insulation Manufacturers Association, Cellulose Insulation Manufacturers Association, and the Structural Insulated Panel Association, have been instrumental in marketing the program at the commercial level.

In addition, as building product manufacturers constantly search for innovative ways to market their products to major national builders, ENERGY STAR Homes presents a lucrative opportunity for residential construction industries, such as insulation, high-efficiency windows, housewrap, HVAC equipment, lighting, and major appliances. Developing ally partnerships with manufacturers allows them to position their companies as environmentally sensitive, and in turn sell more high-end products. Additionally, program allies can add significant value to the ENERGY STAR Homes Program by offering some value-added services, such as home ratings, quality inspections, and energy bill warranties.

Providing Evaluation Tools and Technical Assistance

In the initial implementation phase of the program, EPA offers technical assistance to participating builders. In areas where an established home energy rating infrastructure is not present, builders can supply EPA with a copy of their building plans. In states such as Colorado, where a rating system is actively being supported by the state energy office, EPA provides referrals to this service.

Where technical support is needed, EPA, along with its contractors and regional cooperative partners, can evaluate the plans and make recommendations regarding cost-effective, energy efficient upgrades. There are usually several options for the builder to select from to meet program guidelines. Recommended upgrades do not change the architectural design or appearance of the house; however, many upgrades will increase the comfort and quality of the house.

In order to make these energy improvement recommendations to the builder, EPA models the building with a computer simulation tool, in an iterative process that includes modeling each of the lowest cost efficiency upgrades and the appropriately sized equipment. For accuracy, only those computer simulation tools which have been approved by DOE's HERS-BESTTEST procedure are used by EPA. Once the most cost-effective efficiency upgrade measures have been identified, the builders choose the modifications that best fit within their design needs or preferences. To compare the ENERGY STAR Home with the HERS reference house, only the thermal envelope, water heating, and HVAC upgrades are considered; energy-efficient appliance and lighting upgrades are not considered in determining the relative efficiency of the home. However, EPA provides additional, optional recommendations to the builder, which include appliance and lighting upgrades that will further decrease the energy bill of the new home below the thirty percent target. Some of the components of the new homes that are considered for improvements include duct systems; air sealing of the envelope; indoor air quality (IAQ) ventilation; insulation; low-emissivity (low-E) windows; energy-efficient heating, cooling, and water heating equipment; energy-efficient lighting (indoor and security) and appliances (refrigerators, dishwashers, clothes washers, and dryers); and solar-reflective roofing.

As the program moves into a high production phase, building plans will be evaluated through a home energy rating system which complies with the DOE Guidelines. The infrastructure of home energy rating systems is currently strengthening nationwide. The major players now include state energy offices, independent HERS systems, and utilities. EPA expects that the ENERGY STAR Homes Program will significantly increase the market demand for ratings. Ultimately, a strong HERS industry helps the ENERGY STAR Homes Program achieve its aggressive market penetration goals by assuring the availability of critical technical support and five-star home documentation for builders.

Marketing Support

Builders who join the program and commit to build homes that perform to the stated energy levels are entitled to use the ENERGY STAR Logos (Figure 2) in their marketing materials and on the homes themselves. EPA provides builder partners with camera-ready hard copies and electronic versions of the logo. In addition, EPA provides partners with advertising concepts and camera-ready drop-in ad modules developed with input from focus groups held with both home builders and new home buyers. The focus groups were held with builders and home buyers in the Washington Metropolitan Area (D.C., Maryland and Virginia) and Las Vegas, Nevada.

Figure 2. *Examples of Camera Ready Logos*

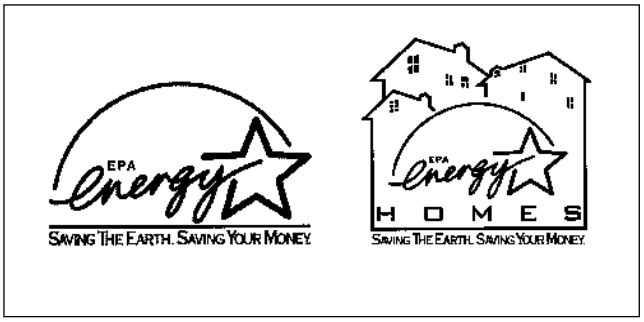


Table 2. *Emissions of SO_2 (kg/yr) from Central Space Heating, Central Space Cooling, and Water Heating in an Average New Single-family*

State	Electric Heat	Electric Water Heating	Electric Cooling	Oil Heat	Oil Water Heating
New England	**26**	**10**	**4**		**4**
Connecticut	9	3	1		
Maine	7	3	1		
Massachusetts	48	18	8		
New Hampshire	33	12	5		
Rhode Island	26	10	4		
Vermont	1	0	0		
Middle Atlantic	**37**	**15**	**7**	**3**	**367**
New Jersey	15	6	3		
New York	20	8	4		
Pennsylvania	51	21	9		
East North Central	**86**	**34**	**15**		
Illinois	53	21	9		
Indiana	114	45	20		
Michigan	37	15	6		
Ohio	150	60	26		
Wisconsin	36	14	6		
West North Central	**38**	**14**	**9**		
Iowa	46	17	10		
Kansas	16	6	4		
Minnesota	17	7	4		
Missouri	71	27	16		
Nebraska	21	8	5		
North Dakota	37	14	8		
South Dakota	48	18	11		
South Atlantic	**20**	**14**	**20**		
Delaware	23	16	23		
DC	20	14	20		
Florida	17	12	17		
Georgia	25	17	24		
Maryland	21	15	21		
North Carolina	16	11	16		
South Carolina	8	6	8		
Virginia	13	9	13		
West Virginia	41	28	41		
East South Central	**61**	**27**	**27**		
Alabama	41	18	19		
Kentucky	69	31	31		
Mississippi	45	20	20		
Tennessee	83	37	37		
West South Central	**15**	**6**	**9**		
Arkansas	12	5	7		
Louisiana	16	6	9		
Oklahoma	17	7	10		
Texas	16	6	9		
Mountain-N	**18**	**8**	**2**		
Colorado	27	12	3		
Idaho	0	0	0		
Montana	9	4	1		
Nevada	29	13	3		
Utah	10	4	1		
Wyoming	20	9	2		
Mountain-S	**9**	**6**	**7**		
Arizona	9	6	6		
New Mexico	9	6	7		
Pacific-N	**7**	**3**	**1**		
Oregon	4	2	0		
Washington	7	3	1		
Alaska	8	3	1		
Pacific-S	**1**	**0**	**0**		
California	0	0	0		
Hawaii	17	8	4		

Note: Electric heating includes electric heat pumps. The burning of natural gas does not produce SO_2, and is therefore not represented. Data for oil heating was only available in two superdivisions.

At the time this paper was prepared, results were available from only the Washington, D.C. focus group meeting. The first session with builders began with a 15-minute builder recruitment presentation used by EPA, followed by a moderated discussion about the presentation's effectiveness. The respondents understood the general purpose and overall goal of the program, but still had numerous questions about the specific opportunities to increase profits. Additionally, the respondents were familiar with the systems approach and agreed that the approach is critical to achieving program goals. The respondents also agreed that the ''EPA label'' will add credibility to the program. One builder commented that ''EPA should convince the buyer that if your builder is not giving you an energy-efficient home, you're making a mistake.''

The second focus group session involved people who had recently purchased a new home. They participated in a moderated discussion about ways the EPA could effectively promote the ENERGY STAR Homes Program, reviewed ENERGY STAR Homes marketing materials and then offered their immediate reactions. Most agreed that they

Table 3. *Emissions of NOx (kg/yr) from Central Space Heating, Central Cooling, and Water Heating in an Average New Single-family Home*

State	Electric			Gas		Oil	
	Heat	Water Heating	Cooling	Heat	Water Heating	Heat	Water Heating
New England	**8**	**3**	**1**	**3**	**2**	**3**	**2**
Connecticut	4	1	1				
Maine	1	0	0				
Massachusetts	15	6	2				
New Hampshire	12	4	2				
Rhode Island	8	3	1				
Vermont	0	0	0				
Middle Atlantic	**10**	**4**	**2**	**4**	**1**	**2**	**1**
New Jersey	8	3	2				
New York	7	3	1				
Pennsylvania	12	5	2				
East North Central	**27**	**11**	**5**	**5**	**2**		
Illinois	18	7	3				
Indiana	39	15	7				
Michigan	24	10	4				
Ohio	30	12	5				
Wisconsin	23	9	4				
West North Central	**24**	**9**	**6**	**2**	**1**		
Iowa	31	12	7				
Kansas	25	9	6				
Minnesota	23	9	5				
Missouri	27	10	6				
Nebraska	24	9	5				
North Dakota	16	6	4				
South Dakota	17	6	4				
South Atlantic	**6**	**4**	**6**	**3**	**1**		
Delaware	9	6	9				
DC	6	4	6				
Florida	7	5	7				
Georgia	5	4	5				
Maryland	6	4	6				
North Carolina	6	4	6				
South Carolina	3	2	3				
Virginia	4	3	4				
West Virginia	10	7	10				
East South Central	**18**	**8**	**8**	**3**	**2**		
Alabama	14	6	6				
Kentucky	24	11	11				
Mississippi	12	5	5				
Tennessee	17	8	8				
West South Central	**17**	**7**	**10**	**2**	**1**		
Arkansas	12	5	7				
Louisiana	16	6	9				
Oklahoma	20	8	12				
Texas	18	7	10				

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Table 3. *Emissions of NOx (kg/yr) from Central Space Heating, Central Cooling, and Water Heating in an Average New Single-family Home*
—continued—

State	Electric			Gas		Oil	
	Heat	Water Heating	Cooling	Heat	Water Heating	Heat	Water Heating
Mountain-N	21	10	2	3	2		
Colorado	32	15	4				
Idaho	0	0	0				
Montana	19	9	2				
Nevada	26	12	3				
Utah	14	6	1				
Wyoming	22	10	2				
Mountain-S	**10**	**6**	**7**	**1**	**1**		
Arizona	7	5	5				
New Mexico	16	10	11				
Pacific-N	**4**	**2**	**1**	**4**	**2**		
Oregon	4	2	0				
Washington	3	1	0				
Alaska	3	1	0				
Pacific-S	**3**	**1**	**1**	**1**	**1**		
California	3	1	1				
Hawaii	8	3	2				

Note: Electric heating includes electric heat pumps. Data for oil heating was only available in two superdivisions.

liked the idea of a home that is energy efficient and added that the ''EPA label'' is important. Participants also responded to numerous slogans that were being considered for print ads, including writing down their top three preferences and their two least favorite. The three most preferred slogans were ''Home Buying Just Got Simpler,'' ''What Are You Going to Do With The Money?'' and ''The Investment of a Lifetime Just Got Better.'' Their comments on these three included ''It makes me curious,'' ''I want to know—what is this Energy Star?'' and ''It says savings.'' The feedback received from both of these focus groups is being applied directly to marketing and communications materials.

Providing Sales Training Support

The sales staff of a new home builder is the critical link to the home buyer. EPA provides tools and training to educate sales representatives about energy efficient homes, how efficient homes can help them meet their business objectives and how to use the unique benefits of energy efficient homes as selling points. The sales staff of builder partners are encouraged to attend regional sales workshops developed and conducted by EPA and EPA contractors. These workshops cover all aspects of the program, including distinctive features of the home, sales tools that are available, and techniques for selling ENERGY STAR Homes. The key points emphasized are the comfort and low operating costs of ENERGY STAR Homes, and that the homes also sell for standard prices and can have healthy indoor air. Sales tools that are provided include a consumer brochure, a financing brochure, related program fact sheets, concept ads based on focus group results, advertising drop-in modules that builders can insert into their ads, and the camera-ready and disk versions of the ENERGY STAR Logo to be used on a wide variety of promotional materials.

RESULTS

Savings Estimates

Emission savings from the ENERGY STAR Homes Program were projected for homes already committed by builders. The analysis was done regionally, using Census superdivision-level[1] averages of heating and cooling and water heating loads for homes in the Lawrence Berkeley Laboratory

Table 4. *Emissions of Carbon as CO_2 (kg/yr) from Central Space Heating, Central Cooling, and Water Heating for an Average New Single-family Home*

	Electric			Gas		Oil	
State	Heat	Water Heating	Cooling	Heat	Water Heating	Heat	Water Heating
New England	**972**	**364**	**156**	**1199**	**437**	**994**	**524**
Connecticut	591	221	95				
Maine	238	89	38				
Massachusetts	1772	664	284				
New Hampshire	829	311	133				
Rhode Island	972	364	156				
Vermont	86	32	14				
Middle Atlantic	**1101**	**451**	**201**	**1314**	**308**	**696**	**367**
New Jersey	585	240	107				
New York	947	388	172				
Pennsylvania	1317	539	240				
East North Central	**1984**	**787**	**341**	**1721**	**501**		
Illinois	1179	468	203				
Indiana	2799	1110	481				
Michigan	1850	734	318				
Ohio	2434	965	418				
Wisconsin	1668	661	287				
West North Central	**1953**	**741**	**443**	**818**	**357**		
Iowa	1911	725	434				
Kansas	2011	763	457				
Minnesota	1829	694	415				
Missouri	1903	722	432				
Nebraska	1655	628	376				
North Dakota	2590	983	588				
South Dakota	1208	458	274				
South Atlantic	**630**	**435**	**626**	**881**	**354**		
Delaware	989	682	982				
DC	630	435	626				
Florida	686	473	681				
Georgia	582	401	578				
Maryland	637	440	633				
North Carolina	623	430	619				
South Carolina	334	231	332				
Virginia	515	356	512				
West Virginia	940	649	934				
East South Central	**1591**	**708**	**716**	**1177**	**406**		
Alabama	1396	622	628				
Kentucky	1886	840	848				
Mississippi	1216	542	547				
Tennessee	1605	715	722				
West South Central	**1612**	**629**	**923**	**607**	**304**		
Arkansas	1171	457	670				
Louisiana	1364	533	781				
Oklahoma	1798	702	1029				
Texas	1705	666	976				

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Table 4. *Emissions of Carbon as CO_2 (kg/yr) from Central Space Heating, Central Cooling, and Water Heating for an Average New Single-family Home*
—continued—

State	Electric			Gas		Oil	
	Heat	Water Heating	Cooling	Heat	Water Heating	Heat	Water Heating
Mountain-N	**2614**	**1186**	**286**	**1158**	**442**		
Colorado	2882	1307	315				
Idaho	0	0	0				
Montana	1950	884	213				
Nevada	2957	1341	323				
Utah	2860	1297	313				
Wyoming	2989	1356	327				
Mountain-S	**801**	**530**	**586**	**462**	**301**		
Arizona	590	391	432				
New Mexico	1300	860	951				
Pacific-N	**327**	**146**	**42**	**1494**	**556**		
Oregon	294	132	38				
Washington	286	128	37				
Alaska	2	1	0				
Pacific-S	**313**	**137**	**69**	**473**	**328**		
California	278	122	62				
Hawaii	1129	496	250				

Note: Electric heating includes electric heat pumps. Data for oil heating was only available in two superdivisions.

National Laboratory Geographic Information System (GIS) developed for EPA. The GIS includes data from the Census Bureau and the EIA Residential Energy Consumption Survey (RECS) (Brown et. al 1995). The steps that were followed were:

(1) Homes were selected for analysis, divided by fuel type and census superdivision, and averaged to produce energy consumption data by category (e.g. gas heated home in New England).

(2) Energy consumption data were multiplied by emission factors to produce emissions by category (e.g. NO_x emissions for gas heated home in New England). Electricity emission factors were available at the state level.

(3) Emissions were estimated for a ''typical'' home in each state or census superdivision, by using data on percentages of homes using each fuel type. For cooling, emission estimates of the typical home reflected the percentage of new homes that are centrally cooled.

(4) Prevented emissions were estimated as 30 percent of the emissions of the ''typical'' new home as described above.

Homes selected for the analysis were single-family homes built after 1980, producing a total data set of 482 homes. Centrally heated homes were separated by fuel type to produce average energy consumption by census superdivision for electric heating, gas heating, and oil heating. Similarly, the same data set was separated by water heating fuel type, to produce average energy consumption by census superdivision for electric, gas and oil water heating. Lastly, homes that were centrally cooled were used to produce cooling energy consumption averages by census superdivision. Thus, the energy consumption data include regional differences in building characteristics and weather. Since the average electric home may have different characteristics from the average gas home (i.e., size of the home, number of windows) direct comparisons between fuels are not possible.

Emissions factors for electricity at the state level (Koomey 1995a) were used to generate emissions estimates for heat-

Table 5. *Carbon (CO_2) Emissions and Fuel Mixes of Average New Single-family Homes*

Census Superdivision	CO_2 (metric tons C/yr)	Central Cooling	Central Heating			Water Heating		
			Gas	Electric	Oil	Gas	Electric	Oil
East North Central	2.63	74%	90%	9%	0%	51%	49%	0%
East South Central	2.59	96%	64%	36%	0%	43%	57%	0%
West South Central	2.35	99%	67%	33%	0%	43%	57%	0%
Mountain - North	2.26	50%	76%	24%	0%	77%	23%	0%
West North Central	1.77	87%	92%	8%	0%	69%	31%	0%
South Atlantic	1.76	96%	42%	58%	0%	14%	86%	0%
Pacific - North	1.74	58%	90%	10%	0%	47%	53%	0%
Mid-Atlantic	1.62	68%	18%	64%	19%	11%	76%	13%
New England	1.55	33%	40%	7%	53%	21%	52%	28%
Mountain - South	1.25	50%	76%	24%	0%	52%	48%	0%
Pacific - South	0.76	58%	90%	10%	0%	68%	32%	0%

Note: Percentages may not add due to rounding.

ing, cooling, and water heating of new homes. Emission factors for gas and oil (Koomey 1995b) do not vary by region, so emission estimates for heating and water heating are presented for the entire census superdivision (Tables 2–4). Saturation data from the RECS data set of new single family homes were used to estimate SO_2, NO_x, and CO_2 emissions from water heating in a typical new home in each Census superdivision. For space conditioning, saturation data originated from the 1993 Census Bureau survey of new homes (a larger data set than RECS). Table 5 shows the average carbon emissions from the homes in each superdivision, in descending order. The areas with the highest carbon emissions were the East North Central and East South Central.

For homes that have been committed to the program, we estimate prevented pollution by assuming that space heating, space cooling and water heating for an ENERGY STAR Home is thirty percent less than our estimates for the ''typical'' new home in that state. In Table 6 all homes of builders who have committed to the program are included, as well as some homes that will be built by three developers. Note that these estimates should be conservative because most ENERGY STAR Home builder partners to date have made modifications to building plans that will save more than thirty percent of the energy projected for space conditioning and water heating. Furthermore, additional savings that may be achieved by following lighting and appliance recommendations are not included in our savings estimates.

At the time of this writing, more than 60 builder partners have joined the ENERGY STAR Homes Program, representing more than 14,000 homes in 24 cities. We estimate annual emissions prevented by these commitments to be 6420 metric tons of carbon, as CO_2, 127 metric tons of SO_2 and 54 tons of NO_x (Table 6). In terms of carbon, the projected emissions prevented by the program is equivalent to removing almost 5000 cars[2] from the road. We estimate that the residents of these homes will save over $5 million/year[3] collectively on their energy bills.

CONCLUSIONS

Marketing advantages and innovative financing solutions are concepts which are of great interest to large, mainstream builders. When energy efficiency is couched as a by-product of increased builder profits through these two concepts, sales meetings are more easily arranged with high-level executives. Once in the door, the ENERGY STAR Homes Program is a no-lose situation for EPA, the builder, and the consumer. Builders that choose not to join are made fully aware of the

Table 6. *Estimated Annual Pollution Prevented by ENERGY STAR Homes*

State	Number of Homes Presently Committed	Prevented Emissions SO_2 (metric tons/yr)	Prevented Emissions NO_x (metric tons/yr)	Prevented Emissions CO_2 (metric tons C/yr)
CT	3	0.01	0.01	1.35
DC	4,000	52.40	17.7	2110
FL[a]	9,003	73.8	32.5	3830
IL	10	0.09	0.05	7.36
KS	9	0.02	0.04	4.85
MA	24	0.21	0.1	18.8
NY	1	50.01	0.01	0.45
PA	25	0.41	0.11	13.4
RI	2	0.01	0.01	0.93
TX	197	0.49	0.83	106
VA	459	0.03	2.9	324
VT	10	0.05	0.04	5.14
TOTAL	13,743	127	54.4	6420

a. Estimates for FL include homes of potential developers that are interested in the program. One of these developers intends to build 6,000 homes but it is unclear how many of them will be ENERGY STAR homes. Thus, we have included only half of these homes as committed homes in our estimates.

program and follow program progress, while builders that sign on are quickly shown the small incremental costs and the advantages of building ENERGY STAR Homes.

The ENERGY STAR Home energy performance level of 30 percent less energy use than the DOE HERS Reference House, based on 1993 MEC, allows for substantial pollution prevention while remaining an achievable level for mainstream builders to attain. This type of balance point between maximizing energy efficiency and market penetration is critical in developing a successful market-based pollution prevention program.

At the time of this writing, 60 builder partners have signed up, or verbally committed to join the ENERGY STAR Homes Program. The partners plan to build more than 14,000 homes in 24 cities across the United States. We estimate annual emissions prevented by these commitments to be 6,420 metric tons of carbon as CO_2, 127 metric tons of SO_2 and 54 metric tons of NO_x (Table 6). In terms of carbon, the projected emissions prevented by the program is equivalent to removing almost 5000 cars from the road. We estimate that the residents of these homes will save over $5 million/year collectively on their energy bills.

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ENDNOTES

1. Assuming a car is driven 10,000 miles/year, gets 20 miles to the gallon, and emits 6 pounds of carbon/gallon.

2. Assuming an annual savings of $360/home.

3. The Mountain and Pacific Census divisions were split into northern and southern parts, producing a total of 11 divisions for the U.S.

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