ENERGY STAR® Labeled Homes Evolving with State Energy Codes: Ensuring Success in a Changing Context

Matt Howes, ICF Consulting
Sam Rashkin, U.S. Environmental Protection Agency
Jay Hall, ICF Consulting

ABSTRACT

ENERGY STAR Labeled Homes is experiencing tremendous growth. In 2000, more homes were labeled than in the prior five years combined. In 2001, the number of homes nearly doubled from 2000. Large corporate builders have made public commitments to implement ENERGY STAR across all divisions. Manufactured housing participation has grown exponentially in just a few years with 75 plants currently certified or being certified to produce ENERGY STAR labeled homes. This represents over one-third of the approximately 185 manufactured housing plants currently producing about 185,000 HUD-code homes. Market penetration of labeled homes is exceeding 10 percent in at least five major markets, including over 25 percent in two markets, and over fifty utility partners are providing a wide range of support to keep this growth going. It would be great to just sit back and reap the rewards. ***But we can't***. External forces continually act on the program that demand a response. One of the most critical forces involves revisions to state building codes that increase energy efficiency requirements. Where state energy codes start approximating ENERGY STAR performance levels, the 'brand' integrity is threatened because ENERGY STAR fails to deliver on its promise of significantly higher energy efficiency than code compliance. This paper will document efforts to benchmark the ENERGY STAR labeled homes threshold against several state building codes and provide an example where the threshold was changed in one state to ensure ENERGY STAR labeled homes continues to represent a meaningful improvement in energy efficiency.

Introduction

The goal of ENERGY STAR is to establish a highly effective 'brand' for promoting energy efficient products, homes and buildings that are good for the environment. Informal feedback remarks from different 'brand' consultants interacting with EPA staff have suggested that successful brands 'under promise' and 'over deliver' to build customer loyalty. The key ENERGY STAR brand promise is that consumers simply need to look for the easily recognized ENERGY STAR logo to identify product choices that are significantly more energy efficient than standard. To meet this promise, specifications are carefully established for products, homes and buildings that represent a meaningful improvement over standard levels of efficiency. By promoting energy efficiency and its benefits, ENERGY STAR aims to achieve market penetration and market transformation. In parallel, other organizations, such as U.S. Department of Energy's Building Energy Codes Program, also promote the improvement of state codes and standards. However, when codes are improved and market penetration grows, ENERGY STAR specifications need to be periodically ratcheted up to maintain its brand promise. For instance, an increase in specifications for ENERGY STAR

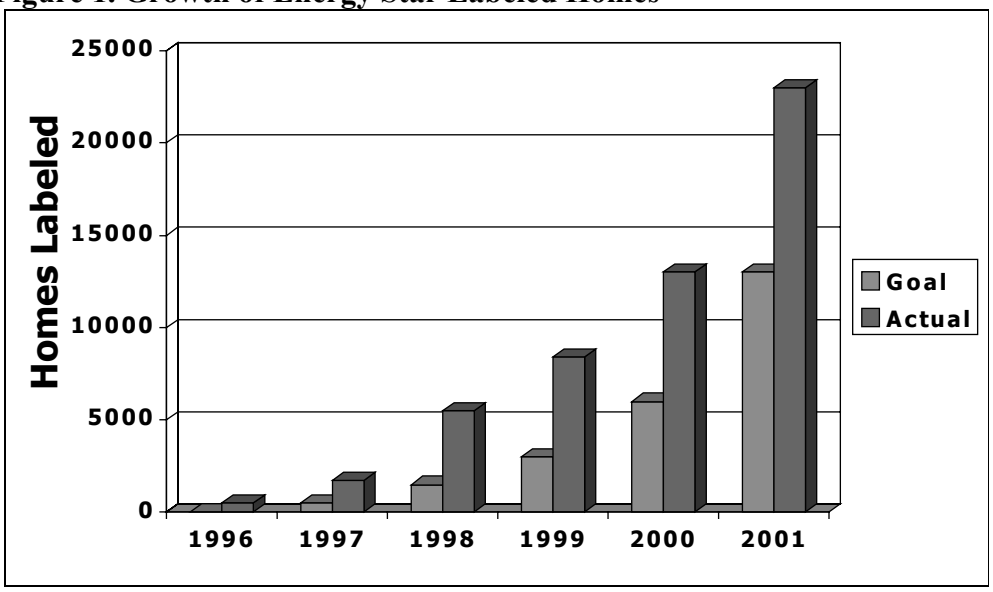
labeled air conditioners from SEER 12 to 13 was announced in March 2002 to begin in October 2002. This change was made in response to pending National Appliance Energy Conservation Act (NAECA) changes for air conditioners (from SEER 10 to SEER 12) and the large market penetration already achieved for SEER 12 equipment.

This paper will address similar changes being implemented with ENERGY STAR labeled homes. The initial threshold established for labeled homes was a minimum 30 percent more energy efficient performance than the national 1993 Model Energy Code (93 MEC). 93 MEC is a voluntary code unless adopted by state and/or local jurisdictions (then becomes mandatory). While many states use 93 MEC, many others choose codes with different levels of energy efficiency. The challenge currently being faced by ENERGY STAR for homes is that a number of states have implemented very rigorous energy codes that potentially undermine the brand promise of energy efficiency significantly better than code. In other words, the codes in some states are approximating, and in some cases, exceeding ENERGY STAR. EPA must be aware of these changes and evolve appropriately. This paper will outline how EPA has undertaken technical analysis to benchmark state energy codes in several states (Minnesota, Florida, and Oregon) and provides an example of where action was taken because a state code (California) was determined to approximate and in some cases exceed the current ENERGY STAR labeled homes specification. In this way, EPA is promoting market transformation and yet evolving to ensure the ENERGY STAR brand delivers on its promise of energy efficiency.

Overview of Recent Changes in Several State Energy Codes

Success with ENERGY STAR labeled homes is exceeding expectations including over 26,000 labeled homes in 2001 (see Figure 1 comparing growth to goals). But with success comes obligations to control the quality of the program and relevance of the label in all markets.

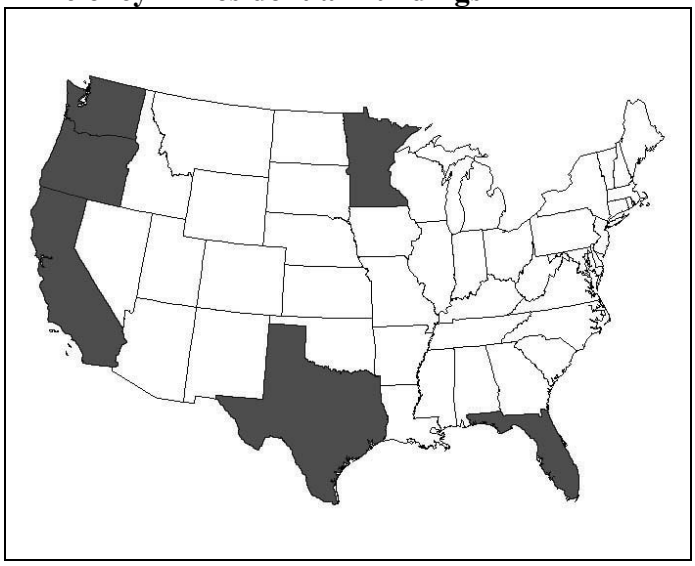
Figure 1. Growth of Energy Star Labeled Homes



Source: ENERGY STAR Labeled Homes database

EPA staff and its contractor team monitor developments in state codes on a regular basis through extensive travels and meetings around the country, review of relevant technical publications, and updates provided by a state energy code newsletter (BCAP 2002). Based on these efforts, EPA is tracking a number of states that have adopted more rigorous residential energy efficiency codes and now require home energy performance substantially greater than the 1993 Model Energy Code (the traditional reference point for ENERGY STAR due to its use of the Home Energy Rating Systems [HERS] score[1]). Due to stakeholder interest and changing codes, EPA decided to examine the codes in California, Minnesota, and Florida. Input from energy experts in the Pacific Northwest has suggested that new homes in Washington and Oregon often exceed the code (Ecotope 2001). This is because the code requires a very rigorous envelope in order to allow electric resistance heating, but most homes are built with more efficient heat pumps or gas heating while still requiring the rigorous envelope requirements. In addition, the 2000 International Energy Conservation Code is being adopted by a number of states, Texas being one of the most significant due to its high number of housing starts. Figure 2 below illustrates the most critical states being evaluated by EPA regarding increased building codes.

Figure 2. Several States Where States Codes and Building Practices Are Increasing Energy Efficiency in Residential Buildings



Source: BCAP 2002.

Overview of Recent Changes in State Energy Codes

To gain an understanding of the energy performance of homes in these different states built to code, a limited technical analysis was conducted of the state codes of Florida, Oregon and Minnesota. Note that California was analyzed separately as part of a stakeholder process

[1] For a detailed explanation of the HERS score and its underlying methodology, consult the Residential Energy Services Network (http://www.natresnet.org/)

discussed later, and Texas analysis results are not included here due to differences in methodology.[2] The goals of this analysis were to:

1. Understand the impact of varying home characteristics on the energy performance under a given state code;
2. Understand the impact of different climate regions on the energy performance of code-compliant homes; and
3. Evaluate this energy performance for each of the different states codes under consideration, using a common Home Energy Rating System (HERS) scoring metric and taking into account both varying climate and home characteristics.

The first step of the analysis was to identify the different requirements or applicable specifications in each of the target states. These requirements were extracted from the appropriate state codes (Florida Department of Community Affairs 2002; Minnesota Department of Commerce 2002; Oregon Office of Energy 2002) and included important thermal envelope and HVAC system specifications. It is important to note that within each state there are often a number of climate zones with distinct requirements.

The next step in the analysis was to model the code-compliant homes with the DOE-2 modeling software and the latest normalized modified load scoring methodology approved for HERS. The software provides hourly modeling of the home energy performance and makes it possible to calculate a HERS scores for each home under consideration. The HERS score is as an indicator of the home's energy performance compared with the standard reference home (as defined by 93 MEC) and therefore a useful benchmark of energy efficiency. Each of the possible home configurations were modeled for each of the four states under consideration (over 1,000 homes in total). The modeling assumptions for these homes are described below.

Modeling Assumptions

Instead of modeling a single home for a given state code, a range of building configurations closely aligned with regional design preferences were modeled. By modeling these variations it is possible to better understand the variability in the energy performance of a region's housing stock instead of basing this understanding on the modeling of a single prototypical home. The specifications and variations considered are summarized in Table 1 below.

[2] At the time of this analysis, the Washington State Energy Code was under review. It was officially modified by the state legislature in December 2001 calling for increased requirements similar to the Oregon Code.

Table 1. Home Characteristics Used in Modeling

Home Characteristic	Variation
Location	Cities with weather data available within the state
Number of Stories	Single; Double
Type of Home [3]	Crawlspace; Slab-on-grade; Basement
Floorspace per Floor	1000; 1500; 2500 (square feet)
Type of Heating System	Heat Pump; Gas Furnace
Cooling System	Air Conditioner; Heat pump
Aspect Ratio	2:1 (no variation)
Window to Floor Area	18% (no variation)
Window Distribution	50% front; 25% back; 12.5% per side (no variation)
Orientation	Front facing West (no variation)
Attic Insulation	As indicated by the different prescriptive state codes
Floor Insulation	
Roof Insulation	
Basement/Crawlspace/Slab Insul.	
Window U-Value and SHGC	
House Infiltration (nac/h)	
Duct Insulation	
Duct Air Loss	
Heating/Cooling Efficiency	
Hot Water Heating Efficiency	

Modeling Results

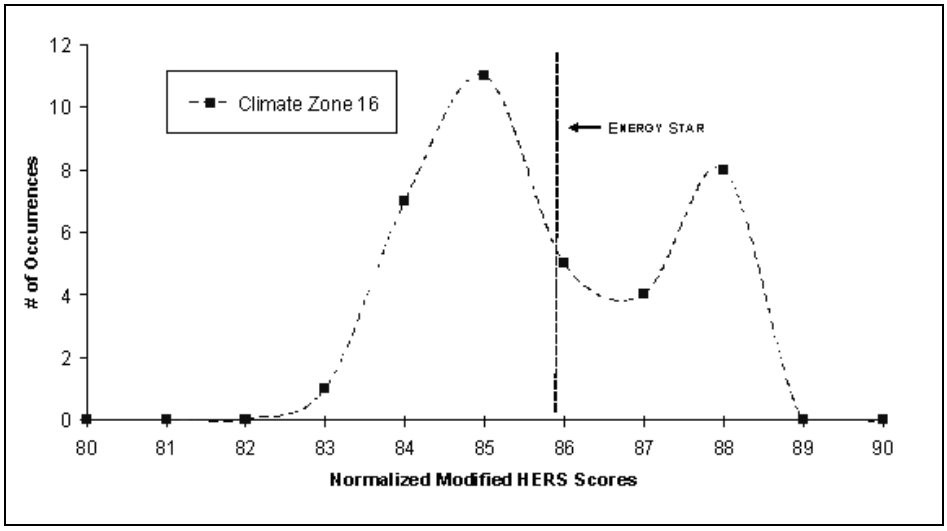
Point #1: energy performance of homes vary under state codes. Modeling the different home configurations for each of the state codes revealed substantial variability in home energy performance (as indicated by the HERS score[4]), even within a given state or at a single location. This variability exists because the state codes modeled were prescriptive packages allowing a significant range of inputs for those housing characteristics not specified (i.e. variations in floorspace and other home characteristics not specified by the code affect the energy performance of the home).

Figure 3 illustrates this variability for climate zone 16 in Minnesota by showing the large range of HERS scores resulting from modeling each possible configuration (a total of 36 DOE-2 runs). The HERS scores range from 82 to 89 due to varying home characteristics allowed by the code. This indicates how important it is to consider a diverse range of home types that reflect the regional building stock when performing ENERGY STAR Labeled Homes benchmarking analyses.

[3] In some areas not all the home types were modeled due to regional practice differences (slab-on-grades are not typically built in Washington State, etc.)

[4] The standard reference home has a HERS score of 80. Every HERS point above that represents an improvement in energy efficiency of roughly 5%.

Figure 3. Estimated Distribution of HERS Scores for Homes Built to the 2001 Minnesota State Code



Source: Based on DOE-2 analysis of residential buildings built to state energy code

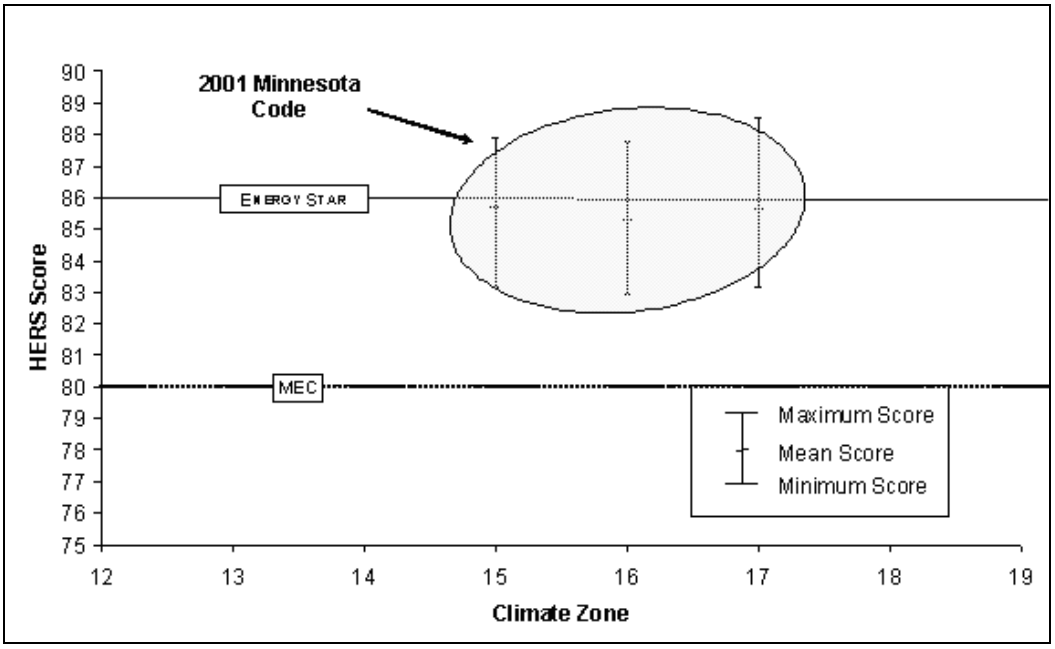
It is important to note that this analysis is based on modeling of prescriptive codes. Actual energy performance will vary from these estimated values depending on degree of code enforcement, local building practices, and the use of performance-based compliance paths[5].

Analysis results could be shown in similar fashion for each of the other climate zones in Minnesota (e.g. climate zones 15 through 17). However, a more useful graphic display was developed to summarize the results for the entire state by graphically combining the HERS score variations for all climate zones. This graphic is provided for Minnesota below in Figure 4. Although this graph is not able to show the weighting of the distribution, it does indicate the high, low, and average HERS scores achieved (each vertical bar represents the range of HERS scores for each climate zone). A line is drawn at HERS 80 to represent a home built to 93 MEC, and another line is drawn at HERS 86 to represent the ENERGY STAR requirement. It can be seen that the state code performs substantially better than 93 MEC; the mean score is consistently just below a HERS 86; and many code-compliant homes meet or exceed the HERS 86 threshold for ENERGY STAR.

Point #2: state energy codes continue to evolve. This analysis was then expanded to include two additional states currently under consideration (Florida and Oregon[6]). Figure 5 below includes analysis results from these other states (it was not possible to include California in this graphic due to its unique climate zones and code based on source energy. It can be seen that these states all experience significant variability in the HERS scores for code-compliant homes in each climate region.

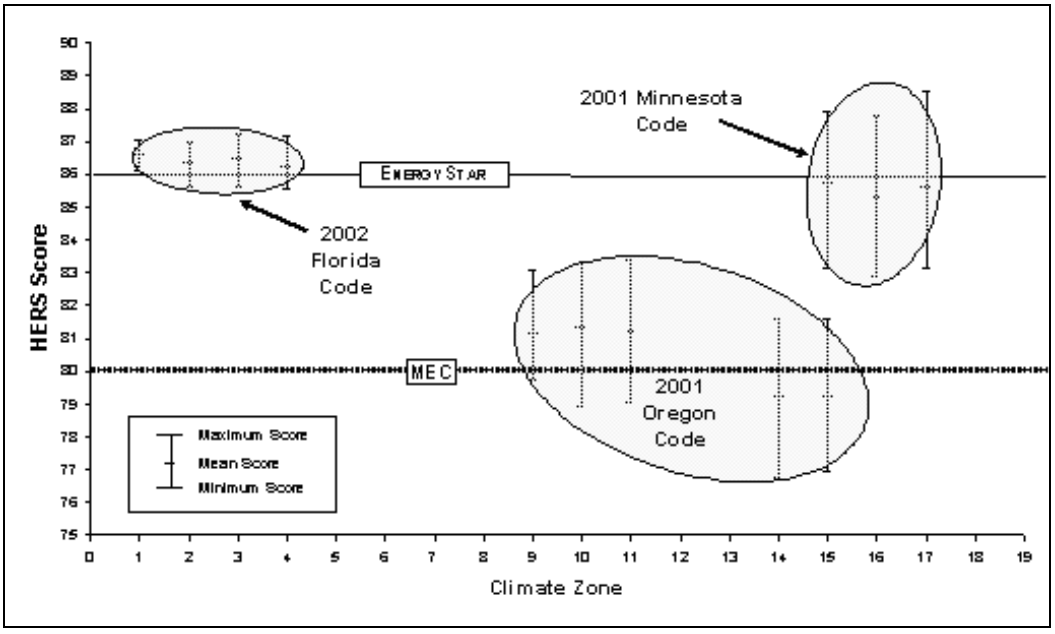
[5] Each of the states has alternative performance-based compliance methods that were not considered but whose energy performance must meet or exceed the prescriptive approach's performance.
[6] Not all climate zones in Oregon could be modeled due to limited weather information

Figure 4. Estimated Distribution of HERS Scores for Homes Built to 2001 Minnesota State Code



Source: Based on DOE-2 analysis of residential buildings built to state energy code

Figure 5. Estimated Distribution of HERS Scores for Homes Built to State Codes



Source: Based on DOE-2 analysis of residential buildings built to state energy code

California. In addition to the states outlined above, basic monitoring of developments in California revealed that the state legislature was responding to the energy crisis with a rapidly expedited ramp-up of the state energy code, Title-24. Since the California energy code was already one of the most rigorous in the country, EPA had to be proactive in looking

at the changes and impact on ENERGY STAR labeled homes. This was possible using technical results from a benchmarking analysis comparing the revised Title-24 energy code (Assembly Bill 970) to a California HERS score (C-HERS) provided by Enercomp, a Title-24 software company. The results of this analysis are given in Table 2.

Table 2. New Construction Performance under AB 970 Title-24

California Climate Zone	AB970 Title-24 (relative percent to 93 MEC)	AB970 Title-24 (C-HERS score)
1	-1%	79.8
2	11%	82.2
3	-3%	79.4
4	5%	81.0
5	2%	80.4
6	7%	81.4
7	12%	82.4
8	18%	83.6
9	24%	84.8
10	28%	85.6
11	27%	85.4
12	24%	84.8
13	31%	86.2
14	29%	85.8
15	46%	89.2
16	5%	81.0
State Average	**17%**	**83.4**

Source: Nitler 2001.

It can be seen that the HERS scores for code-compliant homes in these states (California, Florida, and Minnesota) are getting close enough to a HERS 86 that the brand integrity of ENERGY STAR needs to be further investigated. Thus, this analysis allowed EPA to better understand the energy performance of the state codes relative to the ENERGY STAR labeled homes threshold, and to target appropriate action based on this knowledge.

Case Study: Responding to the Rigorous State Energy Code in California

Although analyses revealed the ENEGY STAR for homes threshold was being approached in several states, California was the state with the potential for most labeled homes. Therefore, it was identified as the first choice for EPA to pursue a revised performance threshold. Based on initial input from the Enercomp analysis, EPA was very concerned that the ENERGY STAR brand integrity was threaten in seven of the sixteen California climate zones approximating or exceeding the ENERGY STAR guideline (C-HERS 86). A stakeholders meeting for new home construction in California was convened including building industry, utility, state energy commission, environmental group, home energy rating, and energy specialist representatives. This meeting held on May 9, 2001 in Sacramento, California produced the following consensus and action items:

Consensus Items

- 93 MEC does not work in California because it doesn't appropriately recognize the mild coastal climate and rigorous inland deserts. The result is that Title-24 along the coast barely meets 93 MEC and substantially surpasses 93 MEC for inland desert regions. Thus, ENERGY STAR in California should be changed to reference an improvement above Title-24.
- The revised Title-24 was 15 to 20 percent above 93 MEC on average.
- The incremental improvement above Title-24 should be between 10 to 15 percent more efficient.

Action Items

- The California Building Industry Association (CBIA), through its representative, agreed to analyze the incremental requirements and cost to achieve 5, 10 and 15 percent increments above Title-24.
- The stakeholder group would reconvene by teleconference to go over the CBIA analysis and provide final input before EPA made a decision for California.

At a teleconference meeting held two months later, the CBIA representative presented informal analysis results (no formal report has been published) showing that 5, 10 and 15 percent improvements could be achieved above the new code at a cost to California builders of $208, $460 and $671 respectively. CBIA asked to have the new threshold at 10 percent above Title-24 because it more closely aligned with the 30 percent above 93 MEC threshold used in other states. All other stakeholders, except for one utility (out of five represented), strongly preferred a threshold at 15 percent above Title-24. In fact, the utilities in this group were unwilling to provide programs at the 10 percent level. EPA finally chose to use the 15 percent level for the following reasons:

- CBIA's own analysis showed it was highly cost-effective to achieve this level of performance;
- EPA had determined that the brand message was better supported with a more meaningful improvement;
- Initial utility programs that would only be initiated at the 15 percent level would more than compensate builders for their incremental costs to achieve ENERGY STAR; and
- CBIA concerns were balanced with a generous 'grandfather' transition period they recommended for projects already permitted.

As a result, beginning January 1, 2002, EPA implemented the new 15 percent above Title-24 threshold for ENERGY STAR labeled homes in California. Since then, the California Public Utilities Commission had directed all independently owned utilities in California to coordinate with a single residential program and they have chosen to use the ENERGY STAR platform. The utility programs started April 1, 2002 with incentives ranging from $400 to $600 depending on location (coastal or inland) and housing type (single or multi-family).

Evolution of the ENERGY STAR Program

Based on the California experience, EPA found it could effectively respond to the different forces threatening the brand integrity of ENERGY STAR by being proactive and engaging stakeholders in a cooperative process. This stakeholder group included builders, manufacturers, utilities, government representatives, and other organizations that would have valuable input and be affected by the evolution of the ENERGY STAR program. Currently, a stakeholder group is working together on behalf of the Pacific Northwest states and a new stakeholder group will be convened in June for Minnesota. EPA is also performing internal analysis to see if Texas and Florida warrant similar efforts and will continue to examine other states as the need becomes apparent. In general, in those states where HERS 86 no longer represents significant energy savings (whether due to the adoption of 2000 IECC[7] or other codes), the new EPA policy is:

> "Energy Star labeled homes performance threshold shall be whichever is the more energy efficient of 30 percent savings above 93 MEC or 15 percent energy savings compared with the state code.".

These steps are being undertaken by the EPA in order to ensure that its brand promise of "significantly greater energy efficiency" is guaranteed as building codes continue to evolve and market transformation causes energy efficiency to improve in new homes. The EPA is committed to working with builders, manufacturers, and its other partners to ensure that this evolutionary process is successful in each of the different markets. Different manufacturers and builders have all expressed a high degree of comfort with this state-specific evolution of ENERGY STAR labeled homes and find the requirements clear and logical for each of the states.

Conclusion

Success with ENERGY STAR labeled homes is exceeding expectations (over 26,000 labeled homes in 2001). But with success comes obligations to control the quality of the program and relevance of the label in all markets. Comprehensive benchmarking analyses and creative approaches to mapping results have helped identify problems with changing codes reducing the value of the ENERGY STAR 'brand' promise and where proactive efforts are needed. Furthermore, based on a process used in California, EPA is confident it has a model to proactively work in states with rigorous codes. Although the CBIA is still not happy with the decision to use the 15 percent above Title-24 as the new California ENERGY STAR labeled home threshold, the stakeholder collaborative process proved effective identifying regionally specific issues and developing compromise solutions that balanced widely varying agendas and points-of-view. In addition, since ENERGY STAR is a voluntary rather than regulatory program, this process was able to be quickly implemented to meet critical deadlines. It is still unclear as to how the new threshold will play out in California, but initial

[7] The DOE has issued a determination that "Each state is required to certify to DOE by January 10, 2003, that it has reviewed the provisions of its residential building code regarding energy efficiency and made a determination as to whether it is appropriate for the state to revise its residential building code to meet or exceed the 2000 IECC."

responses from both builders and utilities have been excellent and EPA will follow through with similar efforts in other states. The ENERGY STAR Labeled Homes Program will need to evolve as building codes across the country increase in rigor and the recent experience in California has identified a good framework for this evolution.

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