The Road to Carbon Neutral: ENERGY STAR for Homes and Beyond

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ABSTRACT

Since its inception in 1995, ENERGY STAR for Homes has helped contribute to significant leaps in technology improvements for envelope systems, higher efficiency HVAC equipment, more air-tight duct systems, advanced windows and maybe most importantly, a building science infrastructure for verifying home performance. Thousands of the nation's home builders have voluntarily built nearly 1 million ENERGY STAR Qualified Homes that are substantially more energy efficient than code. Over 50 percent of these homes received no cash incentive and an additional 30-plus percent received $500 or less. Thus a market-based approach to market transformation is working.

Having gone through two specification changes, EPA is now looking forward as to what a third generation program might look like. While any program changes are not imminent, developing concepts for public review early can allow a substantial amount of industry feedback prior to decisions being made and thus foster a smooth transition to the next level. Recognizing that building codes are increasingly becoming more stringent and programs such as zero energy and sustainable housing are becoming more prominent, EPA also realizes a need to chart a path for a fourth generation program that incorporates advanced technologies and minimizes a home's carbon footprint.

EPA's new Climate Choice builds upon ENERGY STAR's success in transforming markets and will in part help identify technologies that could eventually become part of the fourth generation of the New Homes program. Specifically, Climate Choice will look for opportunities to promote promising advanced technologies that currently don't meet ENERGY STAR criteria for cost-effectiveness and market-readiness.

For new homes, EPA will work with builders to construct demonstration low or carbon neutral homes featuring advanced technologies. These homes will minimize onsite energy use by combining best available and advanced technologies with advanced design and construction practices. This will minimize energy consumption so residual energy requirements can be easily mitigated with reliable carbon offset options.

This paper includes a brief history of ENERGY STAR, establishes a path to achieving carbon neutrality, identifies possible technologies for a third generation program and presents results of computer simulations showing the potential energy and carbon savings, identifies advanced technologies which could become part of a fourth generation program, discusses some of the barriers and strategies for adopting these advanced technologies, and lays out EPA's implementation plan for progressing to the fourth generation New Homes program.

ENERGY STAR Background

The Environmental Protection Agency (EPA) has been promoting ENERGY STAR since 1992 when it introduced labeled computers. From this beginning, ENERGY STAR has served as a simple government-backed label consumers can use to make truly energy efficient choices that are good for the environment. Now, ENERGY STAR is a widely recognized ‘brand’ including over 70 percent consumer awareness[1].

In 1995, the ENERGY STAR label for homes was launched. At that time, EPA identified a ‘bundle’ of technologies and construction practices that were underutilized but market-ready for both significant energy savings and improved whole building performance. These technologies and construction practices included:

- Tightly sealed ducts
- Construction air sealing
- High-performance low-E windows
- Energy efficient heating and cooling equipment
- Quality assurance verification

By the end of 2005, tremendous progress was achieved transforming the housing industry to this original targeted ‘bundle’ of technologies. This included more than 500,000 labeled homes[2], over 2,500 builder partners[3], and a national HERS rating infrastructure. Based on this progress and external pressures from increasingly rigorous energy codes and increased energy efficiency requirements in the National Appliance Energy Conservation Act (i.e., air conditioning equipment SEER increased from 10 to 13), EPA raised the threshold specifications for ENERGY STAR labeled homes in 2006. In addition to maintaining or increasing original technical requirements, the following best practice construction methods were mandated because they provide significant additional energy savings and performance enhancements:

- Proper installation of insulation
- Complete air barrier assemblies
- Right-sizing of cooling equipment

In the short time since these new specifications have been in place, significant market transformation for the new technologies and construction practices is already underway. In fact, by the end of 2007, the total number of labeled homes was approximately 850,000, the number of builder partners nearly doubled to about 5,000[4] and the national HERS infrastructure has shown strong development[5].

The Next Generations of ENERGY STAR

Building upon the success of the ENERGY STAR for Homes program, EPA is now looking forward to what a third generation program might look like. While any program changes are not imminent, developing concepts for public review early can allow a substantial amount of industry feedback prior to decisions being made and thus foster a smooth transition to the next level. Some of these potential technologies are identified in the section below.

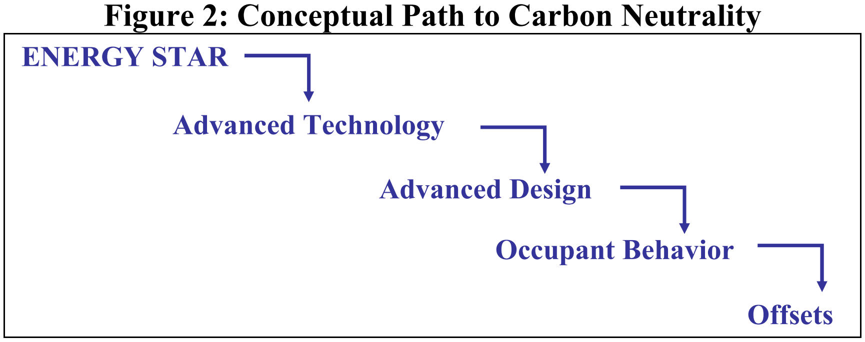
Further, recent developments suggest aggressive building code changes are looming ahead as many communities, states and the nation look for opportunities to meet climate change challenges. This includes numerous plans put forward for codes targeting ENERGY STAR, carbon neutrality, and zero-energy capable homes over the next two decades. One example is that new homes built in the Long Island towns of Babylon, Brookhaven and Riverhead must comply with ENERGY STAR standards[6]. Recognizing these coming changes, EPA also realizes a need to chart a path for a fourth generation program that incorporates advanced technologies to minimize a home's carbon footprint and eventually leads to carbon neutrality.

A Path to Carbon Neutrality

Partially in response to the developments mentioned above, EPA has developed the Climate Choice Initiative. This initiative builds upon the success of the ENERGY STAR program transforming markets across the country and internationally to adopt cost-effective energy efficiency technologies. Specifically, Climate Choice looks for opportunities to promote promising advanced technologies that currently don't meet ENERGY STAR criteria for cost-effectiveness and market-readiness. In effect, Climate Choice serves as a 'farm system' for ENERGY STAR. This will be accomplished by setting up new initiatives addressing key market barriers for targeted next generation technologies.

For new homes, EPA will provide a advanced technology demonstration program under Climate Choice that showcases advanced homes which are either low or carbon neutral. These homes will minimize onsite energy use by combining best available and advanced technologies with advanced design and construction practices. Additionally, savings can be realized through changes in occupant behavior. While not formally part of the advanced homes being promoted, studies have shown that significant savings can be achieved by educating occupants and providing a ready means for monitoring consumption[7]. Together, these measures and practices will minimize energy consumption so that remaining energy requirements can be easily mitigated with carbon offset options. These offsets may include on-site renewable power (e.g., photovoltaic system); renewable power purchases from utilities, or trees planted on set aside land. This conceptual path is shown in Figure 2.

Figure 2: Conceptual Path to Carbon Neutrality



Estimating Impacts Realized Along the Path to Carbon Neutrality

In order to assess the potential impacts that each step in Figure 2 may have, ICF International performed an analysis using DOE-2 energy modeling. The analysis included 4 cities (Houston, Baltimore, Minneapolis, and San Francisco) and the following 5 permutations of house efficiencies:

- 2006 HERS Reference Home
- 2006 ENERGY STAR Home
- 2006 ENERGY STAR Home + Advanced Technologies
- 2006 ENERGY STAR Home + Advanced Technologies + Advanced Design

- 2006 ENERGY STAR Home + Advanced Technologies + Advanced Design + Occ Behavior

Because many of the advanced technologies are still emerging, they can be difficult to model. Hence, for this analysis only a subset of some of the best available and advanced technologies was modeled. These measures represent some of the technologies that might be expected in a third generation ENERGY STAR for Homes program. Note that analyses on a fourth generation program were not conducted for this paper.

Details on the baseline house characteristics and upgrade measures analyzed are provided in Tables 1 - 4. The results of the analyses are provided in Tables 5 – 8.

Table 1: Key ENERGY STAR Home Characteristics

ENERGY STAR House Characteristics	**Houston, TX**	**Baltimore, MD**	**Minneapolis, MN**	**San Francisco, CA**
Square Feet per Floor	2350	2350	2350	2350
% Window Area	18%	18%	18%	18%
Attic Insulation	30	38	49	30
Wall Insulation	13	13	19	13
Window U	0.75	0.4	0.35	0.65
Window SHGC	0.40	0.45	0.35	0.40
Infiltration (ACH50)	8	8	8	12
Cooling Efficiency	13	13	13	13
Heating Efficiency	80	80	80	80
DHW Energy Factor	0.59	0.59	0.59	0.59

Table 2: Subset of Best Available and Advanced Technologies Assessed

Advanced Technologies	**Houston, TX**	**Baltimore, MD**	**Minneapolis, MN**	**San Francisco, CA**
> ENERGY STAR HVAC	x	x	x	
ECM Motors	x	x	x	x
Super-Tight Shell with HRV		x	x	
Increased Insulation	x	x	x	
Insulated Doors	x	x	x	
Best-in-Class Windows	x	x	x	
Instant Gas Water Heater	x	x	x	x
Pipe insulation	x	x	x	x
Low Flow Showerhead	x	x	x	x
Advanced Lighting Package	x	x	x	x
ENERGY STAR Clotheswasher	x	x	x	x
ENERGY STAR Dishwasher	x	x	x	x
ENERGY STAR Refrigerator	x	x	x	x
ENERGY STAR Ceiling Fans	x	x	x	x

Table 3: Advanced Designs Assessed

Advanced Design	Houston, TX	Baltimore, MD	Minneapolis, MN	San Francisco, CA
Reduced Window Area	18% -> 15%	18% -> 15%	18% -> 15%	18% -> 15%
Reduced House Size	2400 -> 2000	2400 -> 2000	2400 -> 2000	2400 -> 2000
Optimal Orientation	North	South	South	South
Ducts in Conditioned Space	x	x	x	x
Overhangs	x	x	x	x

Table 4: Occupant Behavior Impacts Assessed

Occupant Behaivor	Houston, TX	Baltimore, MD	Minneapolis, MN	San Francisco, CA
Real-Time Energy Display	7% Savings	7% Savings	7% Savings	7% Savings
Reduced DHW Setpoint	120 F	120 F	120 F	120 F

Table 5: Modeling Results for Houston

	HERS Index	Total Carbon Saved (lbs)	Total Carbon Saved (%)	Total Purchased Energy Saved ($)	Total Purchased Energy Saved (%)	Net Cash Flow Impact ($/Mo)
Baseline	100	-	-	-	-	-
ENERGY STAR	82	2,616	12%	221	13%	2
Advanced Technologies	67	5,547	26%	470	27%	-6
Advanced Design	58	7,358	35%	613	35%	-6
Occupant Behavior	56	8,320	39%	694	39%	0

Table 6: Modeling Results for Baltimore

	HERS Index	Total Carbon Saved (lbs)	Total Carbon Saved (%)	Total Purchased Energy Saved ($)	Total Purchased Energy Saved (%)	Net Cash Flow Impact ($/Mo)
Baseline	100	-	-	-	-	-
ENERGY STAR	85	2,905	12%	303	15%	9
Advanced Technologies	61	7,216	30%	687	34%	-4
Advanced Design	56	9,212	38%	872	43%	-4
Occupant Behavior	54	10,255	43%	954	47%	2

Table 7: Modeling Results for Minneapolis

	HERS Index	Total Carbon Saved (lbs)	Total Carbon Saved (%)	Total Purchased Energy Saved ($)	Total Purchased Energy Saved (%)	Net Cash Flow Impact ($/Mo)
Baseline	100	-	-	-	-	-
ENERGY STAR	76	5,592	18%	495	20%	25
Advanced Technologies	60	9,117	30%	773	32%	2
Advanced Design	54	12,123	40%	1,028	42%	2
Occupant Behavior	52	13,416	44%	1,126	47%	9

Table 8: Modeling Results for San Francisco

	HERS Index	Total Carbon Saved (lbs)	Total Carbon Saved (%)	Total Purchased Energy Saved ($)	Total Purchased Energy Saved (%)	Net Cash Flow Impact ($/Mo)
Baseline	100	-	-	-	-	-
ENERGY STAR	85	2,274	13%	216	14%	1
Advanced Technologies	72	3,849	22%	356	23%	-3
Advanced Design	70	4,642	27%	430	28%	-3
Occupant Behavior	67	5,517	32%	509	33%	3

With the mix of best available and advanced technologies, designs and improved occupant behavior specified above, a maximum of 44% carbon was saved (in Minneapolis). In order to reach carbon neutrality, offsets need to be purchased. Assuming $35/ton, the cash flow impact of these purchases is summarized in Table 9.

Table 9: Summary of % Carbon Saved Through Upgrades and With Offsets

	Without Offsets		With Offsets	
Location	**Total Carbon Saved (%)**	**Net Cash Flow Impact ($/Mo)**	**Total Carbon Saved (%)**	**Net Cash Flow Impact ($/Mo)**
Houston	39%	0	100%	-19
Baltimore	43%	2	100%	-18
Minneapolis	44%	9	100%	-16
San Francisco	32%	3	100%	-14

Additional Savings Opportunities from Current Technologies

Table 9 presents a summary of how a third generation of the ENERGY STAR for Homes program might perform. In addition to some of the advanced technologies and designs assessed above, EPA has identified a new 'bundle' of technologies and construction practices also likely to be incorporated in the third generation of the ENERGY STAR for Homes specifications. All of these technologies and construction practices are already highly cost-effective today, but their energy savings are not recognized by current energy metrics used in code analyses and Home Energy Rating System (HERS) evaluations. Partially as a result of this, they are not as pervasive in the marketplace as they could be. These technologies, and the additional savings opportunities, include:

- *Thermal-break wall assemblies*: thermal break wall assemblies eliminate thermal bridging through wood framing that significantly undermines insulation R-value. This is because framing factor assumptions used in performance-based analyses and prescriptive tables do not appear to be enforced. [author's observations from extensive travels across the country] Hence, additional R-value can be realized by more accurately capturing the reduction in thermal bridging of wall assemblies.

- *Best-practice installation for HVAC systems*: poor installation practices common with HVAC system installations across the county can decrease rated efficiency levels up to 35 percent or more[8]. Increased HVAC equipment efficiencies can be accounted for by requiring key quality installation practices such as proper duct design, terminal design, air flow, pressure balancing, and refrigerant charge.
- *Efficient water distribution systems*: typical water heating distribution system configurations result in significant energy and water losses through the various components. For example, a California study illustrated what happens to the energy in a hot water heater. The study was based on a standard gas water heater of a small house (~ 1400 square feet). This study determined that 31% of the heat was lost from the pilot light and water heater tank, 17% was lost up the flue, and 18% of the heat was lost on its way to the fixtures. The overall efficiency in this example is 43%. The study also pointed out that the inefficiency is much worse for large homes and multifamily buildings.[9] In addition, inefficient hot water distribution can result in the waste of thousands of gallons of water down the drain each year while waiting for hot water to arrive at the fixtures. For example, if 10 gallons of water were wasted a day, inefficient hot water distribution could result in the waste of 3,700 gallons or more of water[10]. This depletes a valuable natural resource and imposes significant additional energy requirements to pump water through the regional water delivery system. Although efficient water distribution systems can lead to significant water and energy savings, they are not recognized in current energy use calculations – but doing so could increase the energy factor of water heaters.
- *Advanced lighting, appliances, and plug-load management*: with some regional exceptions, most energy codes do not consider energy used for lighting, appliances and plug loads. This is important because plug loads are the fastest grow energy load in the residential sector[11]. For example, recent studies indicate that the entertainment center alone can impose over a 220 watt 24-hour load even with equipment turned off[12]. Better accounting for these energy uses can yield additional savings opportunities, e.g., switches for vampire loads at entertainment centers/offices.
- *Size limitations*: a perverse outcome from code and HERS evaluations is that larger homes have no additional energy efficiency requirements even though they impose so much great energy requirements per family. In fact, the current HERS scoring system makes it much more difficult for small houses to meet energy efficiency program requirements than a super-sized homes.
- *Moisture control*: energy ratings do not provide any incentive to include a comprehensive moisture control system. However, as energy efficiency increases, homes become much less tolerant to moisture problems because their drying potential decreases as they become tighter and better insulated. Thus, moisture control should become a mandatory feature of any energy efficient home - not to save energy, but to ensure durability because energy efficient construction has much less drying potential.

Based on field observations and research findings, EPA is confident these targeted technologies and construction practices provide more cost-effective and reliable energy savings than would be achieved by simply specifying improvements referenced to a percent above code or specific HERS scores. EPA will actively communicate this technical direction for feedback from stakeholders and work with the HERS industry on possible changes to HERS scoring systems to recognize their full value. However, at this time they represent a 'best available' bundle of cost-effective technologies that will likely be included in third generation of the ENERGY STAR for Homes program.

Advanced Technologies on the Horizon

EPA recognizes that there are a number of advanced technologies and construction practices that are not yet cost effective, but have the potential to be down the road. The Climate Choice initiative will help identify these technologies which could eventually become part of the fourth generation of the ENERGY STAR for Homes program. Some of these technologies and practices are described in this section.

'Super Insulation' Wall Systems

Insulation is typically rated by R-value. However, the performance outcome for a specific R-value varies substantially based on four key attributes to the insulation 'system':

- *Zero-tolerance Installation*: different insulation materials experience a wide variety of installation quality control issues regarding gaps, voids, and compression that can dramatically undermine the effective R-value. For example, a study of attic insulation found that voids of just 5% in the insulation—typical in many homes—could reduce the overall R-value by more than 30%.[13]
- *Air Tightness*: some insulation materials seal as well as insulate (e.g., spray foam and rigid insulation) while others rely on extensive air sealing to ensure a tightly sealed envelope (fibrous insulation and cellulose).
- *Thermal Bridging*: wood framing can account for 25% or much more of the insulated wall assembly. This results in extensive thermal bridging because wood is such a poor insulator (~R 1/inch compare to R-3.5 to R-7/inch for insulation). Advanced envelope systems have a continuous or near-continuous insulated buffer resulting in minimal or no thermal bridging.
- *Complete Air Barrier*: some insulation materials require extensive on-site work to install air barrier assemblies needed to ensure six-side assemblies around the insulation. These air barriers are needed because many insulation materials do not stop air flow that undermines effective R-value. Other insulation materials function as both an air barrier and insulation. In addition, advanced wall systems are available that provide a complete six-sided assembly.

A 'super-insulation wall system' in this paper is identified as any wall assembly or advanced wall system that completely addresses all four performance attributes listed above while providing 50% to 100% more R-value than minimum rated code requirements. The following technology options are currently available:

- *Conventional Wall Framing with Rigid Insulation Sheathing*: this wall system employs a conventional 2"x4" or 2"x6" wall framing with a complete exterior layer of rigid insulation sheathing leaving only the door and window apertures un-insulated. Although this is wall system is often used today, it is not used to the degree needed for a super-insulated wall with much greater R-value for the combined assembly. One of the important indirect benefits of this wall system is that the rigid insulation effectively raises the first surface temperature of the wall sheathing above the dew point for greater moisture resistance and durability.

- *Double Framed Wall*: two sets of conventionally framed walls are installed with offset vertical framing to minimize thermal bridging except at top and bottom plates. This wall system also provides much greater depth which allows increased R-value.
- *Structural Insulated Panels (SIPs)*: a rigid insulation core (expanded or extruded polystyrene or polyisocyanurate) is sandwiched between two-layers of structural sheathing for a highly effective wall system inherently installed with, no gaps, voids, or compression, minimal thermal bridging, air tight details, and complete six-sided assembly. Although oriented strand board (OSB) is most commonly used for the sheathing panels, new systems with concrete wall board can provide additional thermal mass storage benefits. There is still some thermal bridging with most of these systems because they have up to an 8 percent framing factor, but this is much less than conventional framing with about 25 percent framing factor[14].
- *Insulated Concrete Forms (ICFs)*: polystyrene insulation is used to form open-cell blocks that are stacked to form exterior walls. Reinforcing steel bars are easily placed and then concrete is poured into the voids or between sandwich layers. The result is a wall with zero-tolerance insulation, complete thermal-break assembly, maximum air-tightness, and a complete air barrier assembly. Additional R-Value can be achieved by increasing the thickness of the ICF blocks.

All ‘super insulation’ wall system options are widely available because they are either constructed with conventional building materials or available from a large number of ‘wall system’ manufacturers (e.g., SIP and ICF). One ‘super wall insulation’ system developed in Germany called Passivhaus is experiencing a recent surge in interest in Europe and colder U.S. regions[15]. Homes built with these systems typically rely on the double-wall framing system.

‘Super Efficient’ Windows

High-performance windows today feature soft coat low-E coatings, inert gas in a vacuum sealed air gap, warm edge spacers, and more efficient frame technology[16]. The result is windows that block over 70 percent of solar heat gain and provide overall R-3 thermal resistance. The most efficient windows today enhance performance further with one or two additional low-e glazing layers, gas-filled insulating gaps, and more efficient frames. However, they are only available as high-cost specialty products from a limited number of manufacturers[17]. The additional glazing can be either glass or Mylar films for reduced weight. In addition, frames are more efficient with tighter construction and in some cases insulated cores. The result is that ‘super efficient’ windows can deliver block nearly 85 percent of solar heat gain while delivering R-8 thermal resistance. New advanced window technologies in the pipeline include vacuum windows, aerogel windows. Vacuum windows utilize low-e coatings and an evacuated air space (which virtually eliminates conduction/convection), much like a thermos bottle. Aerogel is a silica-based, open-cell, foam like material with microscopic cells that trap air and maximize the insulating value, but still allow visible light transmittance. These windows offer the potential for an R-10 window with solar heat gain coefficients as low as 0.1[18].

Air-Tight Air Handlers with High-Efficiency Variable-Speed Fans

Research indicates that typical leakage in air handler cabinets can lead to significant energy losses[19]. A few manufacturers such as Carrier are starting to offer air-tight cabinets by effectively sealing joints and using gaskets at access door panels. However, no manufacturers currently offer high-efficiency fans. Typical air handler fans run at about 500 watts per 1000 CFM.[20] This could be reduced by up to 70 percent using more efficient fans and motors just like more efficient spot ventilation fans have reduced wattage from 70 to 13 with equivalent ventilation rates. Air handlers with high-efficiency fans are under development and should be available in the next few years.

Super High Efficient HVAC Equipment

NAECA minimum requirements are SEER 13 for air conditioning, 7.7 HSPF for heat pump heating, and .78 AFUE for gas heating. Commercially available super efficient heating and cooling equipment include SEER 18 cooling, 9.0+ HSPF heat pumps, and 95% AFUE furnaces. When heating and cooling loads are substantially minimized with advanced wall systems, windows, much more expensive but highly efficient geothermal heat pump systems can become more cost-effective because the expensive ground loop requirements are minimized.

High-efficiency gas heating equipment is already widely available and commonly used to meet current ENERGY STAR Qualified Homes requirements. Super high-efficiency conventional heat pumps, air conditioners, and geothermal heat pumps are widely available although at a significant cost premium.

Solar Domestic Water Heating Systems

Water heating becomes a much more significant part of total energy requirements once heating and cooling loads have been dramatically reduced. Solar systems capture the free energy of the sun and transfer it to domestic hot water. Most systems can deliver 50 to 90 percent of the water heating load. For best results in cold climates, an evacuated tube collector system is recommended that costs more than a more typical flat plate collector, but is able to perform much better in low temperature conditions. In less rigorous climates, lower cost flat plate collectors with drain-back, antifreeze or integral water heating/storage designs can be used.

Barriers, Strategies and an Implementation Plan

Clearly homes that achieve low carbon much less carbon neutrality are a niche product. But recent developments indicate aggressive building code changes are looming and coupled with increasing energy prices and growing interest in climate change, a more compelling business case can be made for building advanced homes. However, incorporating some of the advanced technologies and construction practices discussed above into the fourth generation of the ENERGY STAR for Homes program will require overcoming numerous market barriers including:

- *High first cost*: first-cost is typically very high compared to conventional construction and housing industry sales are driven by first cost.

- *Industry resistance to change*: home builders have experienced increased liability and reduced customer satisfaction with some past technology innovations. For instance, exterior insulation finish systems (EIFS) were first introduced as an effective thermal-break insulation wall system, but were promoted without mandating an effective weather resistant barrier assembly. These systems were exposed to leakage at transitions (e.g., wall/window; wall/doors, etc.), but trapped moisture inside due to the elastomeric coatings employed that were vapor impermeable. As a result, there were many instances where trapped moisture led to rot wall sheathing and framing.
- *Lack of consumer awareness*: many consumers are not educated about the benefits of advanced construction technologies compared to minimum code requirements. And if the old sales adage that people retain 15% of what they hear and 90% of what they experience is true, what may be more important is that consumers have not experienced the superior comfort, quiet, and quality of advanced technologies. If they did and were given a choice, many might be willing to make the increased investment.
- *Lack of technical infrastructure*: design professionals and construction crews are not familiar with advanced technologies and systems.

Developing strategies for overcoming these barriers as well as identifying potential partners will be important for future generations of the ENERGY STAR for Homes program to be successful.

Implementation Plan

EPA anticipates the following three overlapping phases of activities for developing and launching a fourth generation of the ENERGY STAR for Homes program:

Phase 1. Develop strong technical specifications through a prescriptive path called the Advanced New Home Construction Option Package. A performance compliance path is not considered viable at this time because current energy simulation tools used in HERS and code-based programs do not recognize the energy impacts of advanced technologies and construction practices. As part of this development process, EPA will seek input from the building industry, HERS industry, building science community, environmental organizations, utility and state administered program leaders, and product manufacturers.

Phase 2. Recruiting will target approximately ten to twenty of the best-matched builders in the country for this initiative. Likely builder partners are those currently constructing super-efficient homes far beyond code including in some cases renewable power systems. The goal of this effort will be to set up effective demonstration homes across the country. These demonstration projects will be actively promoted so consumers can visit and experience the benefits of advanced technologies. Additionally, these homes will be used to fine tune the technical specifications, technical assistance, and marketing messages needed to promote advanced technology homes in the future.

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