PATH
Partnership for Advancing Technology in Housing

Technology Roadmap:

Energy Efficiency in Existing Homes

Volume Two: Strategies Defined

U.S. Department of Housing and Urban Development

PD&R

PATH (Partnership for Advancing Technology in Housing) is a private/public effort to develop, demonstrate, and gain widespread market acceptance for the "Next Generation" of American housing. Through the use of new or innovative technologies, the goal of PATH is to improve quality, durability, environmental efficiency, and affordability of tomorrow's homes.

PATH is managed and supported by the U.S. Department of Housing and Urban Development (HUD). In addition, all federal agencies that engage in housing research and technology development are PATH Partners, including the Departments of Energy, Commerce, and Agriculture, as well as the Environmental Protection Agency (EPA) and the Federal Emergency Management Agency (FEMA). State and local governments and other participants from the public sector are also partners in PATH. Product manufacturers, home builders, insurance companies, and lenders represent private industry in the PATH Partnership.

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TECHNOLOGY ROADMAP:

ENERGY EFFICIENCY IN EXISTING HOMES

Volume Two: Strategies Defined

Prepared for:

U.S. Department of Housing and Urban Development
Office of Policy Development and Research
Washington, D.C.

Prepared by:

NAHB Research Center
Upper Marlboro, Maryland

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About the NAHB Research Center

The NAHB Research Center, located in Upper Marlboro, Md., is known as America's Housing Technology and Information Resource. In its nearly 40 years of service to the home building industry, the Research Center has provided product research and building process improvements that have been widely adopted by home builders throughout the United States. The Research Center carries out extensive programs of information dissemination and interchange among members of the home building industry and between the industry and the public.

Disclaimer

PREFACE

This document, *PATH Technology Roadmap: Energy Efficiency in Existing Homes—Volume Two: Strategies Defined*, is one in a series of technology roadmaps created to serve as guides to help the housing industry make decisions about research and development investments.

The Partnership for Advancing Technology in Housing (PATH), administered by the Department of Housing and Urban Development, is focused on improving the affordability and value of new and existing homes. Through public and private efforts, PATH is working to improve affordability, energy efficiency, environmental impact, quality, durability and maintenance, hazard mitigation, and labor safety. To accomplish this, PATH has identified research and established priorities for technology development that will enable the home building industry to work toward the PATH mission. This priority setting process, known as "Roadmapping," has brought together many industry stakeholders, including builders, remodelers, trade contractors, material and product suppliers, financial representatives, codes and standards officials, and public sector R&D sponsors. This is a year-two progress report for one of the four roadmap topics identified by PATH's Industry Steering Committee. Other technology roadmap topics are: *Information Technology to Accelerate and Streamline Home Building*, *Advanced Panelized Construction*, and *Whole House and Building Process Redesign*.

This document focuses specifically on improving energy efficiency in existing housing. It describes the challenges, and outlines activities and accomplishments that will lead to the achievement of the vision. These include promoting new technologies, evaluating products and processes for retrofit, building capabilities among trade contractors, and identifying potential consumer incentives.

By addressing these issues through research, the home building industry will continue to play a key role in providing affordable, durable housing for America's families.

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PATH PROGRAM GOALS

The Partnership for Advancing Technology in Housing (PATH) advances technology in the home building industry to improve the affordability and value of new and existing homes. Through public and private efforts in technology research, information dissemination, and barrier analysis, PATH adds value to seven of the nation's key housing attributes: affordability, energy efficiency, environmental impact, quality, durability and maintenance, hazard mitigation, and labor safety.

Three overarching goals have been established that affect each of these attributes:

- **To determine the needs for improved housing technology development and provide relevant strategic services.**

PATH investigates the institutional barriers that impede innovation, proposes alternative, improved, or negotiated services to overcome those barriers, and develops networks and agreement among participants to implement these services.

- **To develop new housing technologies.**

PATH supports and performs technological research at all R&D levels of the home building supply chain with governmental and industrial funds and resources.

- **To disseminate new and existing technological information.**

PATH coordinates the dissemination of innovation information (both for specific technologies and for industry-wide technological information) that remains unbiased, technically accurate, and relevant to specific housing audiences to increase the familiarity with, availability, and use of technologies in home building and homeowner communities.

Partners in the PATH program—the U.S. Departments of Housing and Urban Development (HUD), Energy (DOE), Agriculture (USDA), and Commerce, the Environmental Protection Agency (EPA), the Federal Emergency Management Agency (FEMA), and home builders, researchers, and manufacturers of building materials and products—have long recognized the importance of incorporating current and emerging technologies into the home building process. The PATH program has identified many of the relevant technologies and facilitated the implementation of research, pilots, demonstrations, and evaluation projects across the United States—important steps as the home building industry works toward the PATH mission and sets technology development priorities, a process known as *roadmapping*.

ROADMAPPING PROCESS

The objective of PATH technology roadmapping is to identify technology areas for immediate technological research in home building to serve as a guide for research investments by government and industry. The PATH Industry Steering Committee (ISC), comprised of builders and manufacturers of building products and materials, oversees the development of all technology roadmaps.

As the primary planning activity for PATH's research, the roadmaps dictate the main areas for research and development in PATH's research portfolio (which includes background, applied, and development activities), as well as provide the home building industry with a strategic plan for future technology development. Roadmaps approved by the PATH ISC will be provided to private sector interests to guide their technology development and to the government to guide its investment in research and development. Through this process, new technologies and additional research work are generated as the roadmaps are implemented.

The ISC initiated the roadmapping process during the first quarter of 2000. A group of 40 builders, materials and products suppliers, academicians, researchers, and other stakeholders identified and rank ordered technologies that hold the promise of guiding PATH's research. The ISC then assembled the technologies with the highest potential benefits into four technology portfolios as follows:

- *Energy Efficiency in Existing Homes;*
- *Information Technology to Accelerate and Streamline Home Building;*
- *Advanced Panelized Construction;* and
- *Whole House and Building Process Redesign.*

The PATH ISC recommended development of technology roadmaps for each of the four areas, with *Energy Efficiency* beginning in October 2000, *Information Technology* initiated in November 2000, *Advanced Panelized Construction* in December 2000, and *Whole House* in March 2001.

The roadmapping reports are available on both the PATH website (www.pathnet.org) and the NAHB Research Center's ToolBase Services website (www.toolbase.org).

This report deals specifically with *Energy Efficiency in Existing Homes*. Its content is based on a May 2002 follow-up meeting of industry stakeholders, which further developed strategies, defined action items, and set priorities for the topics introduced in the initial roadmap report on this subject.

VISION

A unified home remodeling and repair industry strategy leads to the responsible use of energy and enables trade contractors to assist homeowners in improving the energy performance of existing housing, minimizing energy use in the nation's existing housing stock as part of a national priority for energy conservation. As a result, energy use decreases by an average of 30 percent in at least 50 million existing homes by the year 2010.

OVERVIEW OF ENERGY USE

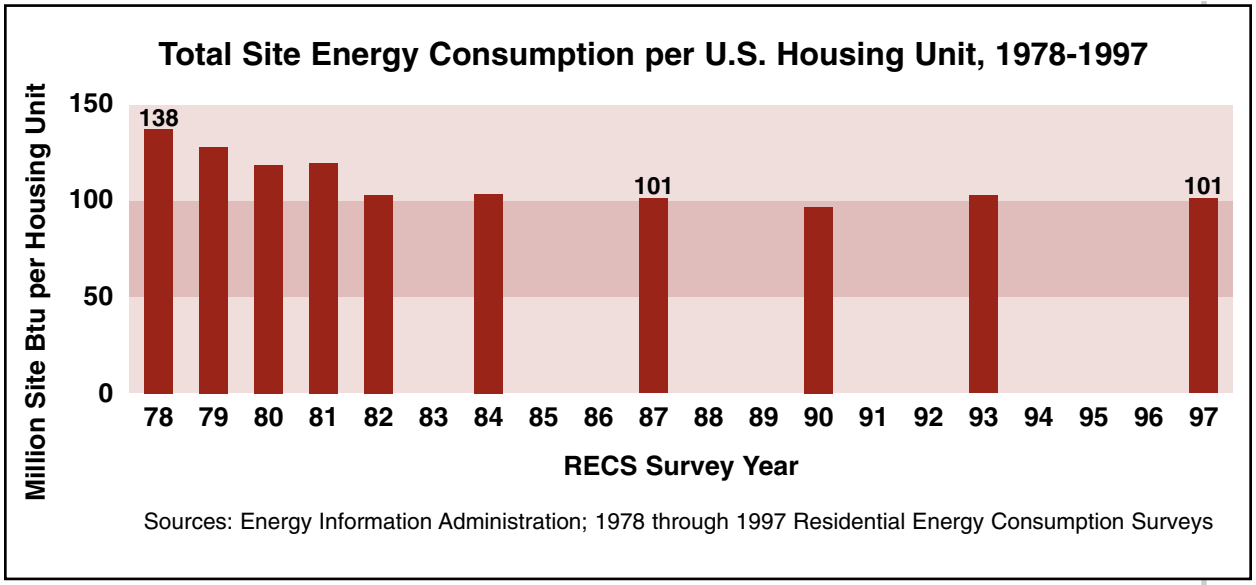
The latest authoritative information about how energy is used in U.S. housing stock comes from the 1997 Residential Energy Consumption Survey (RECS), performed by DOE's Energy Information Administration (EIA). Results appear in *A Look at Residential Energy Consumption in 1997* (November 1999), publication DOE/EIA-0632 (97).[1] The 2001 survey is not yet complete.

According to the RECS, in 1997 there were more than 101 million U.S. housing units, and a total energy use of 10.25 quadrillion Btus (quads) as measured at the building site.[2] This represents dramatic improvement on a per-household basis since 1978, when the 77 million housing units in the United States used a total of 10.6 quads of site energy. Figure 1 shows this trend from 1978 through 1997 for the housing stock as a whole. Notice that the entire drop occurred in the 1978-1982 period, with no systematic change since that time.

Looking to the future, the EIA *Annual Energy Outlook* for 2002 calls for residential consumption to grow at 1.0 percent per year from 2000 through 2020.[3] Assuming the housing stock grows at a comparable rate, residential consumption per housing unit would remain relatively steady.

It is noteworthy that in spite of improvements in the energy efficiency of homes—a tighter and better insulated envelope and more efficient appliances and HVAC—energy use remains about constant. Although all of the reasons for this are not apparent, it is certainly true that Americans are buying and using more energy-consuming products than ever, such as extra and larger TVs, VCRs, DVDs, PCs, printers, scanners, and cordless phones. Many of these products have standby power, so they are consuming power even when turned off—a significant source of energy consumption, as discussed in the RECS report. The report also indicates that Americans have recovered from the energy scare of the late 1970s, as evidenced in part by their preference for SUVs. Additionally, the cost of fuels in the United States is sufficiently low that utility and gasoline bills are not limiting factors for the average American.

Figure 1



[1] The full report can be downloaded at http://www.eia.doe.gov/pub/pdf/consumption/063297.pdf.

[2] "Site" energy consumption excludes all energy consumed in the generation and transmission processes.

[3] For an overview of the 2002 *Annual Energy Outlook*, see http://www.eia.doe.gov/oiaf/aeo/index.html.

To summarize the problem: Residential energy accounts for approximately 20 percent of the total energy consumed in the United States. In addition to consuming non-renewable energy resources, residential energy use dumps about four million metric tons (a metric ton is about 2,200 pounds) of carbon into the atmosphere every day from fossil fuel combustion. Other combustion products also are problematic, such as SO2 and NOx.

Given that existing homes consume the majority of energy for residences, and that many of them, certainly those built before 1975, tend to be energy inefficient, we need to significantly reduce the energy consumed in today's homes, both to reduce energy consumption and to reduce energy costs, which are a significant factor in housing affordability. In 1997, according to the RECS, the average household spent $1,338 a year on energy.

HOW ENERGY IS CONSUMED IN HOMES

The $1,338 per-year average energy costs for a home in 1997 was allocated as follows:

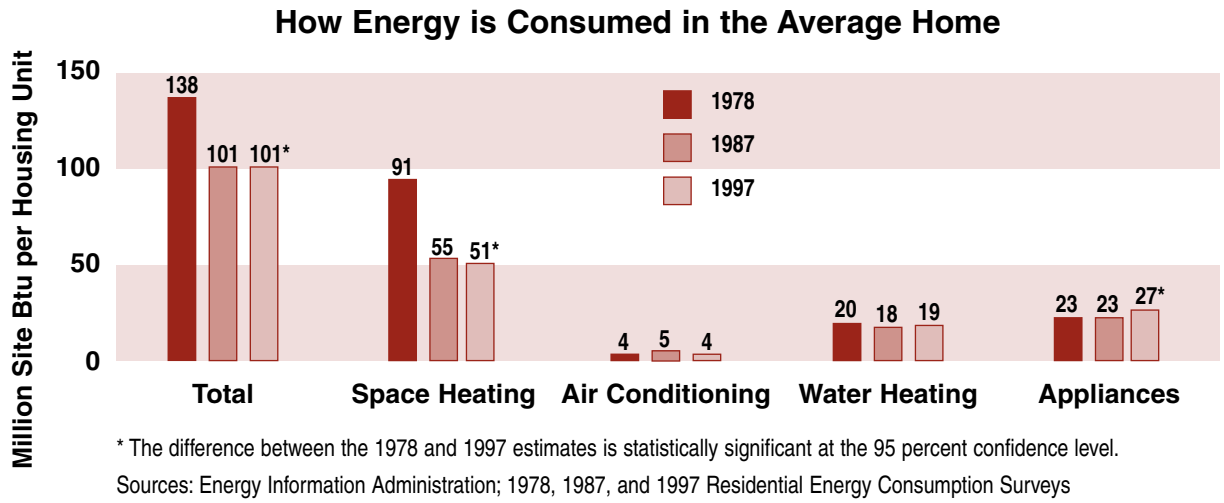
- 45 percent appliances and lighting;
- 30 percent space heating; and
- 25 percent water heating and air conditioning.

The expenditures were, on average, 35 percent for gas and 62 percent for electric power.

The breakout of energy by end use per site in 1997 is shown in Figure 2. This includes all sources of energy—gas, oil, electric, and propane (LPG). The significant decrease in space heating from 1978 to 1987 is notable, and was clearly the reason for the significant reduction in site energy during that period.

Of this site energy, 35 percent is electric, 52 percent is natural gas, and the other 13 percent is oil and LPG. This does not accurately represent the *total* energy impact of electrical power, however. The total energy consumed to generate electrical power at the power plant, called primary power, is almost twice the site electrical energy because of generation losses at the plant and losses over the lines and through the transformers in the distribution system. Using the measure of primary energy, electrical power accounts for 61 percent of the energy consumed in the average home, with all other energies accounting for 39 percent. This means that energy-efficient improvements in electrical appliances and air conditioning will have almost twice the impact on energy consumption as indicated by the chart.

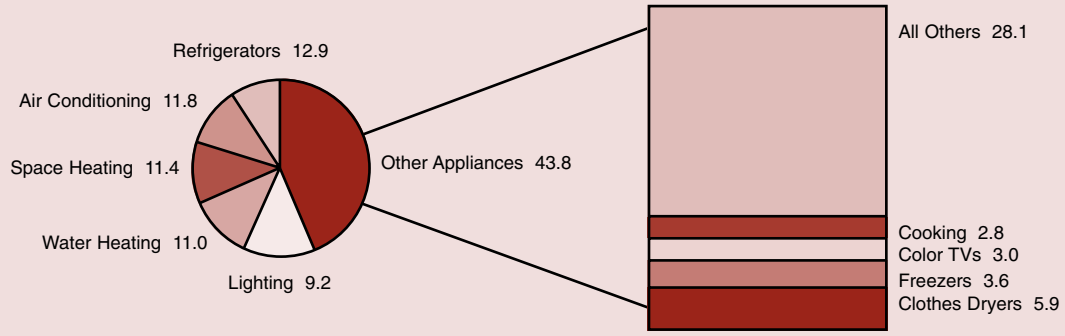
Figure 2



* The difference between the 1978 and 1997 estimates is statistically significant at the 95 percent confidence level.

Sources: Energy Information Administration; 1978, 1987, and 1997 Residential Energy Consumption Surveys

Percent of Total Electricity Consumption in U.S. Housing Units, 1997



Source: Energy Information Administration, Forms EIA-457A, B, C, E, and H of the 1997 Residential Energy Consumption Survey.

Figure 3

Figure 3 shows how electrical energy was used in the average 1997 housing unit. One fact that becomes apparent from this chart is that electrical energy is consumed by so many different items in a home that improving energy efficiency in just one or a few of the items will have a rather small impact on overall consumption. This validates the EPA's approach of including almost all electrical energy consuming devices in the Energy Star program.

Natural gas use, shown in Figure 4, is from the 1993 RECS report. Main space heating and water heating combined account for 94 percent of all residential natural gas consumption. On one hand, this indicates large potential for significant energy-efficient improvements. On the other hand, many space heating improvements already have been made, such as improvements in the building envelope and the efficiency of the heating equipment.

FEDERAL ENERGY PROGRAMS

Current federal energy programs target improvements in energy efficiency in existing as well as new homes. All of the strategies described in this Roadmap will benefit from taking advantage of these programs that collectively:

- Educate homeowners and installers about energy efficiency and help them make informed energy decisions;
- Provide incentives for manufacturers to develop energy-efficient products;
- Facilitate development and diffusion of energy-efficient technologies; and
- Provide incentives to homeowners.

The applicable programs of three federal organizations—EPA, DOE, and HUD—are described in order below.

EPA's Energy Star Home Improvement Program

Energy Star's Home Improvement Program targets major homeowner repairs, renovations, and improvement to the 120 million existing homes by:

- Providing unbiased information to homeowners on their energy use, either directly or through contractors and retailers, and

Figure 4

Residential Use of Natural Gas, 1993	
Main Space Heating	69.1 %
Water Heating	24.9 %
Appliances	5.5 %
Secondary Space Heating	0.5 %
Air Conditioning	< .1 %

providing Energy Star solutions to high energy costs.

- Extending Energy Star to in-home services, such as duct sealing and air sealing, to enhance the energy performance of the heating and cooling systems within homes.
- Promoting a whole-house approach where service infrastructure exists to improve the overall performance of the home.

Providing Unbiased Information to Homeowners: The Energy Star Home Improvement Toolbox was developed to make it easier for homeowners to understand how energy efficient their homes are and how they can improve the energy performance of their homes. The web-based Toolbox includes the following:

- The Home Energy Yardstick—a tool developed with statistical support by Oak Ridge National Laboratory (ORNL), that measures a home's energy performance relative to similar homes.
- Home Energy Advisor—a simple interactive audit that provides residential consumers with the top five cost-effective, energy-efficient improvements they can make to their homes.
- Home Doctor—a list of frequently asked questions that is written in a medical symptom-diagnosis-prescription style.
- Home Remodeler—a guide that summarizes the comfort, safety, and energy-saving opportunities available during different remodeling projects.

Extending the Energy Star Brand to In-Home Services: Currently, EPA is extending Energy Star to services rendered at a home, usually by a trained technician, that improve the energy performance of the HVAC system and the home's thermal envelope. This effort currently includes:

- Energy Star Ducts/HVAC Systems Approach, which combines duct sealing with proper sizing and installation of Energy Star HVAC equipment; and
- Energy Star Home Sealing, which combines proper insulation and air sealing with Energy Star-labeled windows to improve the overall thermal performance of the home's envelope. This presents a new marketing opportunity to insulation manufacturers, home improvement retailers, and contractors that provide insulation and air sealing services.

Promoting Whole-House Performance: Home Performance with Energy Star is a process that promotes whole-house diagnostics by trained technicians to improve the home's overall efficiency. The process is an effort to use the growing awareness of Energy Star to help encourage and facilitate whole-house energy improvements. Key components of the process, which the EPA is piloting in New York, Wisconsin, and Austin, Texas, include:

- Home energy inspection with an energy specialist;
- Targeted advice on the home's energy and maintenance problems;
- Summary report with results and recommendations;
- Performance of any and all of the recommendations by a participating contractor;
- Oversight, quality control, and certification; and
- Financing.

DOE'S Existing Residential Programs

In partnership with home builders, industry, states, and communities, DOE works to improve the energy efficiency in new and existing homes through R&D, demonstrations, and regulatory strategies. The following

DOE programs, ranging from research to implementation to grants, relate to existing homes.

Building America—Increased Emphasis on Existing Buildings: Traditionally a new construction program, Building America employs strategies such as improved design techniques that greatly reduce thermal leakage through the building envelope, and improved insulation and windows, the costs for which are offset by reductions in space-conditioning equipment. Building America uses chartered industry teams to conduct systems engineering research to evaluate advanced system costs and performance tradeoffs, integration barriers, and benefits. The program contains incentives and resources to help system developers overcome risks that otherwise might discourage them from developing the systems. In 2002, Building America developed and tested system integration and whole-house designs that are applicable to the 120 million existing homes in the country.

Existing Buildings Research Program: DOE and its national laboratories will team with manufacturers, leading contractors, trade associations, states, and federal agencies to develop cost-effective, system-integrated, market-driven approaches that reduce energy use in existing buildings. The national laboratories will develop research results and Building America teams will use them in engineered building systems. The focus is on a whole-building approach as applied to the repair, replacement, remodeling, and addition market. The program also depends on the component research being developed in the HVAC, lighting, building envelope, and windows programs that DOE's Office of Building Technology supports.

Rebuild America—The Community Energy Program: This program provides technical assistance, demonstrations, training, and education to communities to accelerate the use of innovative and cost-effective energy technologies, strategies, and methods. The program helps communities, towns, and cities save energy, create jobs, promote economic growth, and protect the environment through improved energy efficiency and less energy-intensive building design and operation. DOE's Rebuild America partnerships are wide-ranging, with partners encompassing mayors' and governors' offices; community and economic development agencies; school boards; citizen conservation groups; building owners, operators, and financiers; and energy specialists.

The State Energy Program: This program supports federal and state partnerships that transfer energy-efficient technologies to the state and local level through formula grants that allow states to tailor energy-efficient programs to local needs and leverage non-federal resources. Some of these grants go toward existing buildings.

The Weatherization Assistance Program: This program works to maximize the number of low-income households receiving cost-effective, energy-efficient improvements for existing homes while ensuring the health and safety of the people served. DOE implements the program by providing technical assistance and formula grant monies to state and local weatherization agencies throughout the United States. The network of approximately 970 local agencies provide trained crews that perform the weatherization services for eligible low-income households, including single-family homes, multifamily dwellings, and mobile homes. Homes receive a comprehensive energy audit and a cost-effective combination of energy-saving measures.

HUD's Energy-Efficiency Programs for Existing Housing

HUD is responsible for the Partnership for Advancing Technology in Housing (PATH) program as well as other housing programs. PATH's vision includes the goal of reducing energy use in existing homes by 30 percent.

PATH develops new energy- and resource-efficient systems, promotes the recycling of

building materials, and helps homeowners and developers remodel their homes with technologies that are proven to reduce energy bills. PATH partners include DOE and EPA.

PATH supports the study of new mechanical, plumbing, and construction systems with upfront costs that are competitive with traditional technologies. PATH seeks to supply builders and remodelers with information and alternatives they can present to their clients to improve energy use in their homes. Most importantly, PATH works with EPA through Energy Star to educate home buyers and lenders. This work will increase the demand for Energy Star homes as PATH helps builders prepare to supply them. PATH also can offer suggestions to improve construction sites by reducing the amount of waste produced or using alternative materials.

PATH provides information about alternative and emerging energy-saving technologies that can be used to improve energy efficiency. The websites, www.pathnet.org and www.toolbase.org, provide this information to consumers as well as builders, remodelers, and trade contractors.

Although a significant number of PATH technologies are focused on new construction, many are equally appropriate for use in remodeling or renovation. Examples of these technologies include interior storm windows, heat pumps and tankless hot water heaters, insulative vinyl siding, radiant barriers, and tubular skylights.

In addition to the PATH program, HUD promotes energy efficiency in the existing housing market through several programs:

- HOME Investment Partnerships that buy and rehabilitate affordable housing or provide direct assistance to low-income people.
- Energy-efficient mortgage programs that allow home buyers to finance the cost of adding energy-efficient features to new or existing housing as part of their Federal Housing Administration (FHA) mortgage.
- Energy Rehabilitation Energy Guidelines that help owners and remodelers of single- and multifamily housing save energy and money. Guidebooks and pamphlets explain how property owners using HUD's popular Section 203(k) rehabilitation mortgage insurance, as well as other programs, can increase the energy efficiency of residential properties.

FINANCIAL INCENTIVES FOR RESIDENTIAL ENERGY EFFICIENCY

While most electric utilities no longer offer rebates for the installation of energy-efficient appliances and lighting, and many states have stopped offering tax incentives for additional insulation or energy-efficient windows, there still are incentives available from many states, some utilities, and from federal financial institutions, as summarized below.

Federal Institutions

Energy efficient mortgages are available through FHA, Veterans Administration (VA), Fannie Mae, and Freddie Mac. A home energy rating performed by a trained energy rater is required. According to those institutions, the advantages to consumers are:

- Cost-effective, energy-saving measures may be financed as part of the mortgage.
- Make an older, less efficient home more comfortable and affordable.
- Increase your buying power.
- Stretch debt-to-income qualifying ratios on loans for energy-efficient homes.
- Qualify for a larger loan amount. Buy a better, more energy-efficient home.

An overview of what these loans offer and how they work go to: http://www.pueblo.gsa.gov/ and click on housing.

A listing of organizations that offer these loans is provided at: http://natresnet.org/dir/lenders/.

State Programs

In addition to federal incentives, many states provide incentives for energy-efficient residential improvements, especially for renewable energy sources such as wind, geothermal, and solar energy. The incentives offered by states vary widely. The Database of State Incentives for Renewable Energy website (http://www.dsireusa.org/) describes these incentives for each state.

Many states also have programs that are implemented with the help of federal resources, some of which are summarized above. These programs assist low-income residents with energy-efficient improvements, such as new appliances, insulation, and so on. These programs vary significantly by state as these randomly selected examples demonstrate.

- Oregon offers tax rebates for purchases of energy-efficient appliances, HVAC systems, and water heaters.
- Arkansas offers unsecured loans up to $20,000 for specified energy-efficient improvements with no upfront costs.
- New York offers 4.5-percent loans for energy-efficient improvements.

SNAPSHOT OF THE REMODELING INDUSTRY

A very brief snapshot of the remodeling industry is provided below. More detail is provided in a 2001 study from the Joint Center for Housing Studies at Harvard University titled, "Remodeling Homes for Changing Households." The report is available on the Joint Center's website in pdf form at http://www.jchs.harvard.edu/. It is also available by calling (617) 495-7908.

According to the Harvard report, homeowners spent about $135 billion on remodeling projects in 1999, with 77 percent of the dollars going to improvements and 23 percent to routine maintenance and repairs. Professionals performed more than 75 percent of the work, with the remainder done by do-it-yourselfers.

Remodeling firms usually are either general contractors that typically hire trade contractors to do much of the work, or specialty trade contractors, such as siding contractors, roofers, plumbers, electricians, HVAC technicians, and others that sell their services directly to consumers and/or subcontract to general contractors.

Remodeling and trade contracting are comparatively easy businesses to enter because they require minimal capital investment and minimum training and credentialing, with the possible exceptions of the plumbing and electric trades. According to "Home Sweet Home Improvement," a 1998 article on the Federal Consumer Information Center website (http://www.pueblo.gsa.gov):

"... only 36 states have some type of licensing and registration statutes affecting contractors, remodelers, and/or specialty contractors. The licensing can range from simple registration to a detailed qualification process. Also, the licensing requirements in one locality may be different from the requirements in the rest of the state."

Data in the Harvard study indicate that approximately 60,000 general contractors and 109,000 trade contractors achieved at least half their revenues from remodeling in 1997. These were firms that had employees and therefore a payroll. The Harvard study estimates there were about 200,000 more self-employed remodelers or firms without payrolls.

The Harvard study also showed that more than 60 percent of the 169,000 firms with payroll had annual revenues less than $250,000 in 1997. These firms accounted for less than 16 percent of annual remodeling industry revenues. The largest firms accounted for more than half of the total revenues. These firms, which made up just 9 percent of the contractor firms, had more than $1 million in annual revenues.

BARRIERS/CHALLENGES

Conditions that are perceived to be barriers or challenges along the way to achieving this Roadmap's vision are summarized below.

BARRIERS TO CREATING CONSUMER DEMAND

The first, and perhaps most all-encompassing, factor that may work against creating consumer demand for energy-efficient solutions is the heavy competition for consumers' attention and spending dollars. No matter how straightforward or logical the goal of increasing energy-saving techniques and products seems, it is by no means the only option that consumers consider when remodeling, renovating, or replacing.

Each consumer has a different driver or combination of drivers that motivates decision-making. One consumer may consider making energy-efficient upgrades out of concern for the global environment and may understand that reducing energy use will contribute to the greater good. Another consumer may be swayed by the fact that new windows and improved duct sealing will significantly cut monthly utility bills. Still another decision driver may factor in some element of both these scenarios. The categories of decisions drivers could be described loosely as social and economic, and both must be addressed in any successful strategy.

Overall consumer skepticism and mistrust is another barrier. Consumers may perceive that energy efficiency is just the latest fad that the government, building industry, and product manufacturers are trying to sell. This mistrust also links to the unfortunate media depiction of remodelers as "scam artists." Although this generalization may be unfair and inaccurate, it is out there and is a force with which the industry must contend.

Several other barriers to creating consumer demand for energy-efficient decisions include:

- Inconsistent energy efficiency messages received from the various federal government agencies.
- Consumers that are not motivated by economics. They are affluent, energy prices are stable, and currently there are few incentives, such as tax credits, rebates, or financing advantages, that make investing in energy efficiency look like a smart financial decision.
- Consumers that are not driven by social consciousness to conserve energy, possibly as a result of the mixed messages from different political factions.
- Consumers misinformed about the effectiveness or benefits of energy-efficient strategies.

BARRIERS TO CREATING TECHNOLOGY PUSH BY REMODELERS AND TRADE CONTRACTORS

This segment of the industry is comprised primarily of very small entrepreneurs who typically coordinate work at the jobsites and also perform the myriad functions required to run the business. Some of the barriers for these small businesses include:

- Limited time to spend on education and changing business practices.
- Preference to stay in their niche business.
- Investment and risk, as well as uncertainty about revenues and profits.
- Unknown learning curve for acquiring new knowledge, learning new skills, and integrating different systems and trades.
- Scattered and difficult-to-find information on energy-efficient products and systems; the availability of energy-efficient products; and questions about which information is accurate and correct. Who do you believe?

- Lack of performance standards, which makes it difficult to distinguish a good, high-quality job from a bad one.
- Skepticism about consumer demand for energy-efficient solutions.

BARRIERS TO DEVELOPMENT OF RETROFIT TECHNOLOGIES AND PRODUCTS

Barriers to the development of needed retrofit technologies for existing homes identified in the roadmapping process include:

- Propriety research activities in the private sector that inhibit the free exchange of product and control technology information.
- Lack of a uniform, standard communications protocol for integrated solutions that monitor energy efficiency.
- Intermittent, 20-year focus on reducing energy efficiency of existing housing stock that has lead the industry to believe that everything possible has been tried before and new ideas are not possible.
- Wide differences in the condition of the existing housing stock that prevent broadly applicable, common energy retrofit solutions.
- Continued subsidy of the real costs of energy, which allows for the belief that homeowners will not take advantage of energy-efficient measures because their utility bills are too low.
- Lack of tax credits, which removes incentives to improving individual home energy performance.
- Insufficient R&D devoted to energy-efficient technologies for homes, perhaps due to low return on investment (ROI) for producers of these technologies.
- Savings predictions that tend to be inaccurate, as savings are significantly affected by the habits of the occupants. The net result can be consumer distrust in predicted savings.

LACK OF INFRASTRUCTURE

The nation lacks the necessary infrastructure to market and deliver energy-efficient solutions to homeowners. This barrier cuts across all strategies for improving the energy efficiency of the existing housing market. In effect, it attempts to create market *pull* from consumers, yet discourages remodelers and trade contractors from developing, producing, and distributing energy-efficient products and solutions for the retrofit market. This Roadmap lays out the strategies and actions required to provide this infrastructure.

ROADMAP

OVERVIEW

A unified home remodeling and repair industry strategy leads to the responsible use of energy and enables trade contractors to assist homeowners in improving the energy performance of existing housing, minimizing energy use in the nation's existing housing stock as part of a national priority for energy conservation. As a result, energy use decreases by an average of 30 percent in at least 50 million existing homes by the year 2010.

This vision places remodelers and trade contractors in the central role of delivering energy-efficient solutions to homeowners among whom a demand for these solutions has been created. Moving toward the vision requires successful implementation of the eight strategies show in Figure 5, with the following three strategies designated as top priority to be initiated:

- Enable Practitioners to Deliver Energy-Efficient Solutions
- Increase the Value Consumers Associate with Energy Efficiency
- Improve Retrofit Building Envelope Performance Technologies

These three strategies are briefly summarized below, along with the rationale for their top priority status.

Strategy 1: Enable Pratitioners to Deliver Energy-Efficient Solutions

Provide home repair and remodeling professionals with the tools, skills, and knowledge needed to guide homeowners to energy-efficient solutions and to efficiently and effectively implement these solutions.

This strategy is the top priority because of the potential impact of the professional remodelers and trade contractors who accounted for more than 75 percent of the $135 billion spent on remodeling in 1999, as stated in the Harvard Report. Clearly these professionals are in an excellent position to help homeowners make wise decisions about energy efficiency. They must be given the knowledge and skills needed to propose cost-effective, energy-efficient solutions to homeowners and to correctly install and commission those solutions.

Strategy 2: Increase the Value Consumers Associate with Energy Efficiency

Deliver a consistent, coordinated outreach message to homeowners on the value of energy-efficient improvements. Coordinate the message among federal, state, and local government agencies, utilities, manufacturers, distributors, and remodelers and trade contractors.

Because consumers must understand and value energy-efficient solutions proposed by remodelers and trade contractors, this strategy is in close harmony with the previous strategy. This strategy is especially attractive because there are already a number of active consumer outreach programs, though they are not well coordinated and, in many cases, remodelers and trade contractors have not been included. This outreach strategy should not require massive additional funds.

Strategy 3: Improve Retrofit Building Envelope Performance Technologies

Provide a continual flow of emerging and new technologies that will increase the thermal protection of the conditioned spaces of existing homes, resulting in decreased energy consumption and lower operating costs.

Windows and insulation currently on the market certainly are highly energy efficient, but most are expensive to install in existing homes. The remodeling industry urgently needs to lower these costs with more easily installed technologies and products that improve the thermal performance of existing buildings. Examples include technologies to improve the U-factor of windows in place, or to improve the R-factor of walls without removing interior plaster or gypsum board or exterior sheathing. This strategy will harness the expertise and resources of building product manufacturers to help ensure that a steady stream of new energy-saving technologies for existing homes comes online in the future.

Strategies 4 through 7 are extremely critical to achieve the vision and implementation needs of this Roadmap. They should be implemented as soon as feasible, possibly two to three years after the top-priority strategies.

Strategy 4: Develop a Single Industry Protocol for Practitioners

Develop a single protocol—a process and methodology—for analyzing the energy efficiency of existing homes and helping homeowners combine sound, energy-efficient decisions with other remodeling and renovation projects.

Strategy 5: Motivate Practitioners to Deliver Energy-Efficient Solutions

Help remodelers and trade contractors understand the economic and social benefits of delivering energy-efficient solutions to their customers.

Strategy 6: Build Credibility for Service Providers

Establish the credibility of remodelers and trade contractors by implementing a strong, effective certification program that includes training, testing, and periodic review.

Strategy 7: Provide Consumer Incentives for Implementation

Create a need, desire, and/or incentive in consumers to implement energy-efficient solutions.

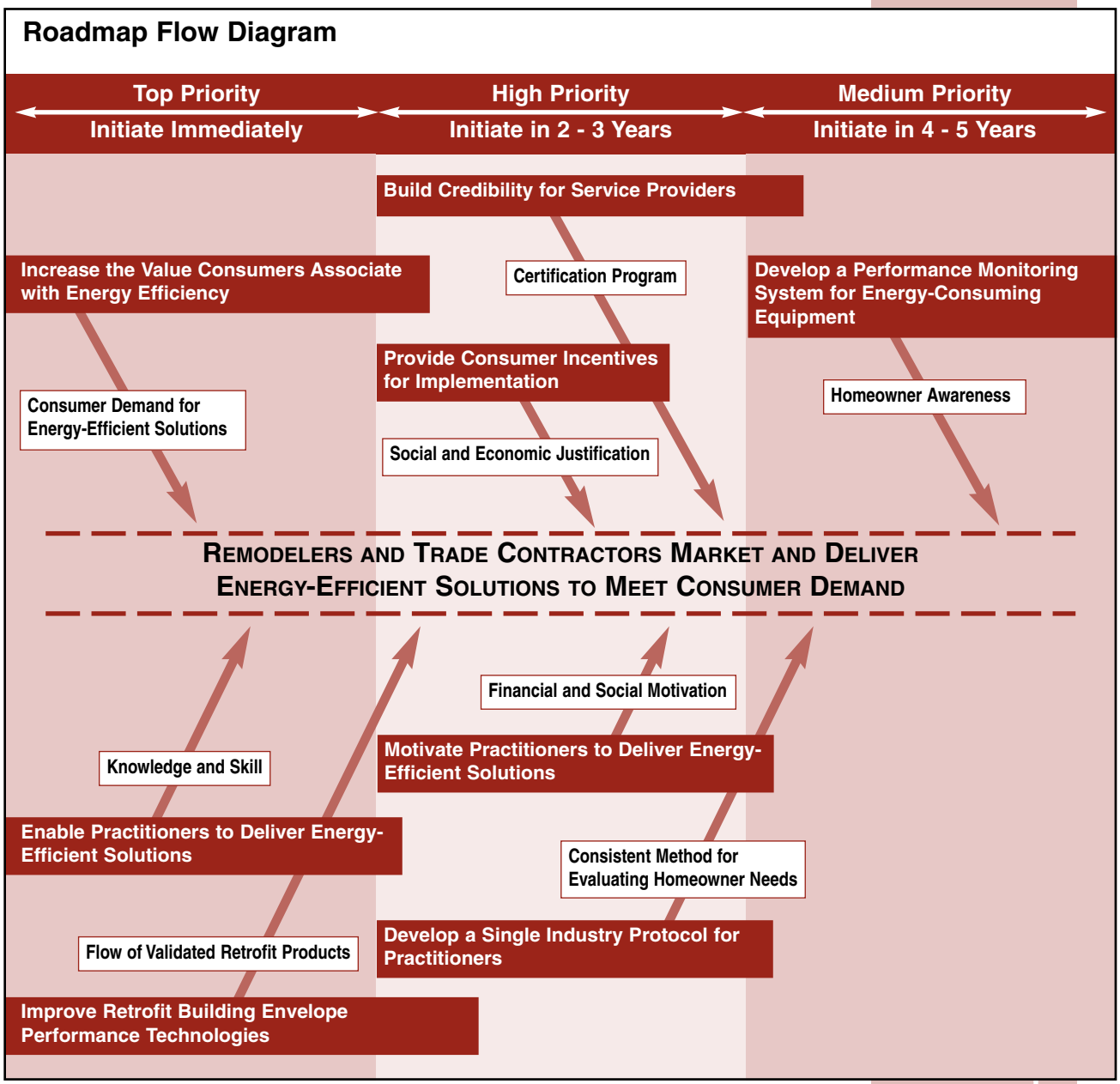
Strategy 8: Develop a Performance Monitoring System for Energy-Consuming Equipment

This strategy was ranked markedly lower than the above strategies. It should be initiated within the next four to five years.

Develop a system that gives homeowners the information they need to understand and manage their energy-consuming equipment in real time and in a consistent and easy-to-interpret form.

These eight strategies, and the actions required to implement them, are summarized in the sections that follow.

Figure 5



1 ENABLE PRACTITIONERS TO DELIVER ENERGY-EFFICIENT SOLUTIONS

Remodelers and trade contractors need more than motivation to deliver energy-efficient solutions. They need to be enabled to do so. The strategy is to provide the tools, skills, and knowledge needed to guide homeowners to energy-efficient solutions and to efficiently and effectively implement these solutions.

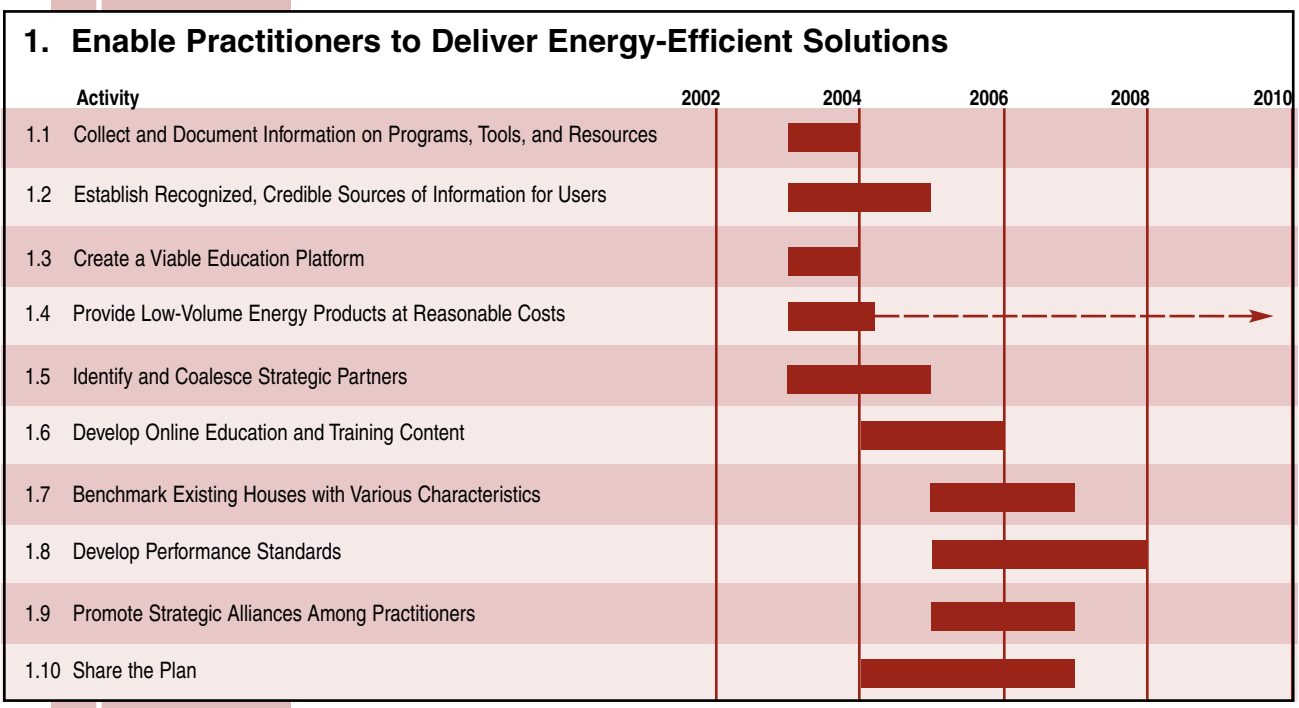
Enabling remodelers and trade contractors to provide energy-efficient solutions will result not only in more revenue and profit, but also will give the satisfaction of doing the right thing for the environment and for the nation. The skills and knowledge acquired during the enabling process will improve remodelers' and trade contractors' ability to market, sell, and install these solutions. Their businesses will grow, and their prestige as professionals will be enhanced.

At the same time, manufacturers and suppliers will benefit from a growing market for their products, and they will be encouraged to improve the availability of products and product information. Figure 6 provides a timeline for the activities required to implement this strategy. Those activities are described below.

1.1 Collect and Document Information on Programs, Tools, and Resources

The first and most essential step to enabling energy-efficient solutions providers is to determine what already has been done and what already exists. This information will provide the basis for deciding the most cost-effective and efficient approach to proceeding with remodeler and trade contractor enabling actions.

Figure 6



Programs that promote energy efficiency or educate, train, or certify remodelers, builders, and trade contractors need to be identified and documented. These programs include federal government programs, such as EPA, DOE, and HUD, and state energy programs, such as the New York State Energy Research and Development Authority (NYSERDA), and trade associations, such as the National Association of Home Builders (NAHB), the National Association of the Remodeling Industry (NARI), and a multitude of trade contractor associations.

The wide range of testing and analysis tools and protocols that already exist also need to be identified and documented. Tools include various hardware devices, such as blower door testers, infrared sensors, and airflow sensors; analysis tools predict the energy savings of various implementations or calculate payback.

The incentives currently in existence also must be identified and described. These include federal and state tax incentives, financial incentives, such as energy-efficient mortgages offered by FHA, VA, Fannie Mae, and Freddie Mac, and various utility rebate programs.

1.2 Establish Recognized, Credible Sources of Information for Users

To provide energy-efficient solutions, remodelers and trade contractors need information. Remodelers often don't know how to get a product, whether it is going to work, how to install it, or whether it is cost-effective. These practitioners also need to know about the availability of financial instruments and rebates and about tools that can help them sell energy efficiency.

In some cases, the information may not be readily available in printed form or on the Internet. In other cases, too much information is available and channels for integrating information are missing, which makes it difficult for practitioners to integrate all of the new technologies into a coherent package.

The availability of multiple tools also is confusing. For example, several tools for analyzing and predicting energy savings that might be realized by installing various products or systems currently are available on the Internet. The question remains, "Which one should providers of energy-efficient solutions use?"

A clearinghouse is needed to connect the remodeler or builder to the appropriate information source. The clearinghouse should be accessible via the Internet, include a low-bandwidth version compatible with wireless devices and the ability to print a paper version, and provide a telephone interface. Additional outlets for the information include locations, such as lumberyards, where practitioners can learn about and buy energy-efficient products.

1.3 Create a Viable Education Platform

Educating and training remodelers and trade contractors is critical to the success of this enabling strategy. It is extremely difficult for these people to find the time for education, however, because they typically run small businesses and already work more than 40 hours a week keeping their businesses going. Thus, educational opportunities must be as convenient and flexible as possible—qualities that may best be provided by Internet-based training.

An Internet-based training platform must be developed, field-tested by remodelers and trade contractors, and fine-tuned to ensure that it is delivering information effectively, that the students are acquiring the information, and that the measurement of student mastery of the materials is effective and accurate.

1.4 Provide Low-Volume Energy Products at Reasonable Costs

Remodelers and trade contractors who currently wish to use newer or underutilized energy products have a problem, especially if they aren't located in highly populated areas. Whether the products are ones they want to introduce to homeowners, or products homeowners have selected themselves, these energy-efficient solutions providers simply cannot obtain the products they want through local distribution. Or they cannot get the information, such as price, warranties, application data, installation instructions, or availability, they need in order to include one of the products in their bid.

This activity is an urgent request for producers and distributors of these products to be responsive to the needs of these remodelers and trade contractors by ensuring, to the extent feasible, that local distributors, such as lumber companies, have the necessary products and product information, including price. In addition, contact information must be made available, such as websites where practitioners can get the information they need online or via email and telephone numbers with short queue times. Manufacturers and sellers also must be willing to provide information via mail, FedEx, or UPS, and to ship small quantities of the product quickly and at a reasonable cost.

1.5 Identify and Coalesce Strategic Partners

Given that improving the energy efficiency of existing housing should be a national priority, the effort deserves the combined attention and resources of a wide array of public and private entities, including federal agencies such as HUD, EPA, and DOE, financial institutions, manufacturers, distributors and retailers, trade associations, research organizations, state energy offices, utilities, and universities.

Formal methods and processes for coalescing these entities need to be established. These processes might leverage existing strategic coalitions such as PATH, but also must include meetings that promote the exchange of information and establish linkages, as well as formal methods of communication.

A practical outcome of this activity might be a coalition of remodelers, distributors, and manufacturers that work together to get the product to the field and to get field information back to the manufacturer. This coalition might establish a networking process for facilitating the flow of information in both directions, which could serve to guide Activities 1.2 and 1.4.

1.6 Develop Online Education and Training Content

Online education and training content will enable remodelers and trade contractors to help homeowners make good energy-efficient choices, including the use of testing and analytical tools, and to select and correctly install energy-efficient products and systems. The content will be made available to remodelers and trade contractors on the education platform developed under Activity 1.3.

1.7 Benchmark Existing Houses with Various Characteristics

The existing national housing stock spans several centuries and all imaginable levels of energy efficiency, including the lack thereof. An understanding of the characteristics of these houses, and the correlation between these observable characteristics, energy efficiency, and perhaps other parameters, would be a valuable resource for enabling practitioners. The resulting information might help remodelers understand where they should direct their attention, whether they need to call in an energy analyst, or the locations of groups of houses needing energy improvements. For example, a remodeler might recognize a potentially good market for energy-efficient solutions simply by driving through a neighborhood and observing the characteristics of the houses.

Benchmarking activities could include identifying and grouping houses by characteristics, such as age, type of construction, and type of architecture. Then specific homes would be evaluated and tested to determine critical parameters, such as air infiltration, window U-value, ceiling and wall R-factors, HVAC system performance, and so forth.

1.8 Develop Performance Standards

Although the residential construction and remodeling industries traditionally have not used formal, ISO-9000-type quality processes, this is changing rapidly. General contractors and builders are beginning to implement these practices and to insist that their trade contractors conform. The NAHB Research Center, working with CertainTeed, has implemented a successful insulation contractor quality program. The PATH program, working through the NAHB Research Center, has been instrumental in developing a framing contractor quality program, piloted in Las Vegas, and now available for implementation nationwide.

The practitioner's understanding of what constitutes quality is fundamental to the implementation of quality energy solutions. Performance standards are needed that define the accepted practices for selecting, installing, and commissioning products and systems. This activity is directed at developing the performance standards for residential remodeling. The performance standard must not be limited to energy efficiency because implementation of energy-efficient solutions could have a deleterious effect on other systems, if not considered as a whole. Also, an energy-efficient remodeler whose non-energy related work is second-class, won't be effective in the marketplace.

1.9 Promote Strategic Alliances Among Practitioners

The ultimate success of energy-efficient remodeling, repair, or retrofit depends on cooperation and coordination among a diverse group, including remodelers, energy raters, trade contractors, including roofers, siding contractors, plumbers, electricians, and HVAC contractors, and others. These diverse groups of people need to be able to communicate and coordinate their efforts. Remodelers may need to know the qualified and certified HVAC contractors, roofers, or available energy raters in the area. Energy efficiency and business profitability benefits may be realized by some formal agreements for referral.

This action promotes such alliances. A promising avenue for implementation is through the various national and regional trade associations, as well as state energy offices and utilities willing to encourage and support local and regional alliances to improve coordination and communication.

1.10 Share the Plan—Promote These Actions to Remodelers and Trade Contractors

This action should be done as part of, and in coordination with, the outreach activity described under Strategy 5: Motivate Practitioners to Deliver Energy-Efficient Solutions. The basic idea is to keep remodelers and trade contractors aware of all the activities that comprise this Roadmap, to obtain their buy-in, and to derive the benefit of their feedback.

2 INCREASE THE VALUE CONSUMERS ASSOCIATE WITH ENERGY EFFICIENCY

This strategy is directed at delivering a consistent, coordinated outreach message to homeowners on the value of energy-efficient improvements, and coordinating the message among federal, state, and local government agencies, utilities, manufacturers, distributors, and remodelers and trade contractors.

Figure 7 provides a timeline for the activities required to implement this strategy. Those activities are described below.

2.1 Craft Uniform Messages for Consumers

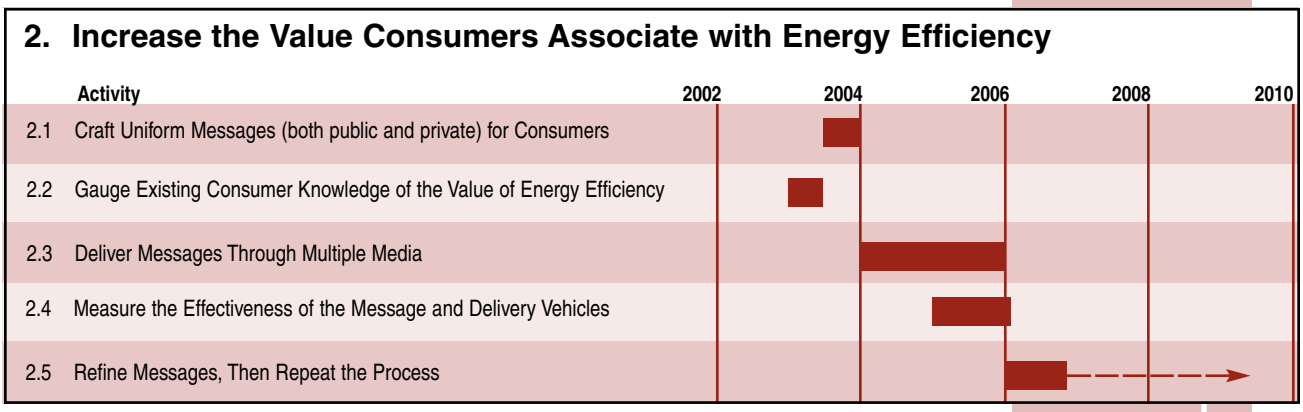
The first step to establishing or increasing, in the consumer's eye, the value of energy-efficient improvements is to make sure that there is a constant, consistent, and well-crafted message. This applies to both government and private stakeholders. As described in the Barriers/Challenges section, there are plenty of messages bombarding consumers in today's marketplace. Why add to the chaos by having a variety of different messages from federal and state government organizations, non-profits, utility companies, and manufacturers, all of which are trying to accomplish the same general goal?

Achieving message consistency requires a comprehensive review of existing messages and an assessment of the most effective messages, keeping in mind the need to appeal on both the social and economic fronts. An often-overlooked additional benefit is the significantly improved comfort of an energy-efficient home—a benefit stressed by some HVAC technicians and HVAC controls companies.

The review and agreement process needs to obtain consensus from multiple stakeholders, including DOE, EPA, HUD, NAHB's Remodelors™ Council, environmental groups, utility companies, and building product manufacturers of products such as HVAC equipment, windows, doors, insulation, photovoltaic, and so on.

EPA's Energy Star program must be included in this analysis because it has been successful in reaching consumers and its goals are aligned with PATH's goals for existing homes. The Home Energy Assistance Team (HEAT) in Colorado is another example of an apparently successful state program designed to educate

Figure 7



consumers about energy efficiency. It is sponsored by HUD, Home Depot, and Oakwood Homes.

2.2 Gauge Existing Consumer Knowledge of the Value of Energy Efficiency

Before the unified, "Energy efficiency is valuable," message is developed and delivered, participants need to be apprised of existing consumer knowledge and values related to the topic. They need to know the effective messages and delivery methods. Some participants already may have collected this consumer information for their own purposes and might be willing to share it with the group.

Consumer input is a critical part of this activity. What motivates consumers? What gets their attention? It might be necessary to do a comprehensive consumer survey and/or to conduct consumer focus groups. Town meetings in various parts of the country also might be appropriate.

2.3 Deliver Messages Through Multiple Media

Once the pool of potential messages is pared down to a workable and consistent number, the messages should be delivered through multiple media, including print, electronic, audio, visual, public, and private, to reach the maximum number of pertinent consumers. While these informational and marketing products might be produced by each of the stakeholders, above all else, the message should remain consistent.

2.4 Measure the Effectiveness of the Message and Delivery Vehicles

As with any educational or marketing effort, the message developed and delivered is only effective if it has meaning and impact for the information receiver. For this reason, it is necessary to gauge the effectiveness of both the message and the delivery channels. Such an analysis may be accomplished through consumer focus groups, individual interviews, and/or surveys. It might be necessary and prudent to look to a professional market research company to accomplish this phase of the strategy.

2.5 Refine Messages, Then Repeat the Process

Once armed with the results of the assessment noted in Activity 2.4, involved stakeholders need to amend or uphold the developed message and the delivery modes. This step might involve reassembling the stakeholders involved at the beginning of the process. Building alliances with these parties will further the goals of getting consumer buy-in for the concept of energy efficiency in their existing homes. Then it's back to the beginning—deliver the message, measure its effectiveness, refine it, and so on.

3 IMPROVE RETROFIT BUILDING ENVELOPE PERFORMANCE TECHNOLOGIES

This strategy is directed at fielding technologies that will increase the thermal performance of the conditioned spaces of existing homes, resulting in decreased energy consumption and lower operating costs. It addresses wider use of existing products in existing homes as well as development of new technologies.

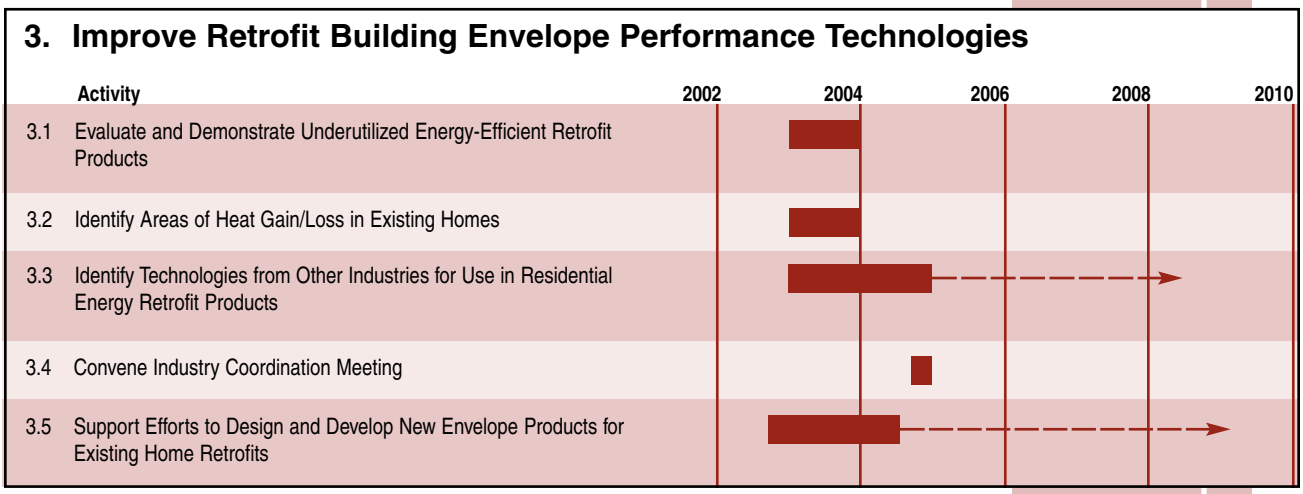
Improving the thermal envelope reduces the amount of energy used for heating and cooling, and allows the use of lower-capacity, less-expensive heating and cooling equipment and/or extends the useful life of such equipment by requiring it to run less often or less strenuously. Improving the thermal envelope of an existing home also is a key factor in improving the comfort of its occupants. The two major thrusts of this strategy are: 1) undertake activities that will speed the diffusion of existing, effective technologies; and 2) develop new, lower-cost, easier-to-install, more energy-efficient technologies. Figure 8 provides a timeline for the activities required to implement this strategy. Those activities are described below.

3.1 Evaluate and Demonstrate Underutilized Energy-Efficient Retrofit Products

Products or systems that look good on paper and in the laboratory may not be widely applied in the field for any number of reasons. Prospective users often are skeptical about performance claims and may be wary of premature failures. Remodelers and trade contractors may be unfamiliar with a technology and how and where to apply it. This activity identifies underutilized products and systems that show promise for significantly contributing to the energy efficiency of existing homes, evaluates their performance in the real world, and disseminates the results to homeowners, remodelers, and trade contractors.

The approach collects real world information about installed costs, as well as performance and other information about the product or system when it is used in various house designs in appropriate climatic regions. In some cases, the information might already exist where remodeling and trade contractors have used the product or system and maintained records. In many cases it may be

Figure 8



necessary to conduct field tests or demonstration programs that carefully document each of the steps in the retrofit process. Programs of this type already are being performed for technologies applied to new construction under the PATH Field Evaluations, and a similar approach is recommended for retrofit technologies for existing homes.

Examples of technologies that might benefit from field evaluations include conversion of ventilated crawl spaces to conditioned spaces or high-R leveling boards installed under siding.

Results of these evaluations need to be made available to consumers, remodelers, and trade contractors, and incorporated in the consumer outreach and the remodeler and trade contractor outreach activities described in Strategy 1: Enable Practitioners to Deliver Energy-Efficient Solutions.

3.2 Identify Areas of Heat Gain and Loss in Existing Homes

Manufacturers, contractors, and consumers all need to know where heat is gained in summer or lost in winter in their homes. This knowledge helps manufacturers decide where R&D makes sense, and contractors and consumers decide on the most effective areas to upgrade for energy efficiency. One important output of this activity would be a set of guidelines for appropriate energy-conserving activities that balance health and durability concerns while maximizing the cost effectiveness of energy retrofits for various climatic and geographic areas of the United States.

A great deal of work has been completed in this area and most large and small heat-gain and heat-loss areas have been identified. This area needs to be reviewed, however, to correlate currently available products and analysis tools with the actual energy consumption of existing homes in the United States. In the past, the focus has been on areas of large heat loss and heat gain in existing homes, including walls, ceiling and floor insulation, windows and doors that leak air, and smaller air leaks spread throughout the surface of the building exterior. Another area of focus is water heaters because of their continuous energy use to maintain a supply of hot water. There is a need to revisit this area of research to coordinate the current conditioned air loss data with current new construction information on durability, moisture damage, and indoor air quality research conducted in recent years.

3.3 Identify Technologies from Other Industries for Use in Residential Energy Retrofit Products

The home building industry is different from many other industries and yet the issues of energy use in buildings are not unique. The 120 million existing homes share many of the same physical requirements that affect commercial and other non-residential buildings. This activity reaches across industry lines and evaluates-energy conserving strategies and products that also could be used to retrofit existing homes. Some examples raised during the roadmapping process include:

- Insulation materials with markedly higher R-value per inch, such as thin but warm fabric from the apparel industry that permits dramatic increases in the thermal resistance of existing walls without adding perceptibly to the thickness of the inside or outside wall surface.

- Environmentally sensitive roofing materials that change thermal characteristics, such as light color to reflect or dark color to absorb radiant solar energy, when climate conditions change.
- New glazing technologies that permit windows to become radiant energy absorbers or electrical energy generators.
- Durable, flexible, and inexpensive caulking and weatherstripping materials that maintain an airtight envelope.
- Responsive window film that can be retrofitted easily and permanently onto existing residential windows.
- Enhancements that affect resistant glazing to provide reflection, absorption, or other spectrally-selective benefits.
- Air barrier membranes that can be retrofitted over the interior or exterior of existing walls or ceilings, and that shrink to fit after initial installation.
- Additional options for retrofit materials that increase the R-value of walls, floors, and ceilings.

This activity has been underway through PATH for several years. Designated as technology scanning, these technologies, which are available or under development in the United States and abroad, have been identified and described on the NAHB Research Center's ToolBase web page: http://www.toolbase.org/techscan.

Many of the identified technologies are as applicable to retrofit as to new home construction. Thus the activity described here would require only a review and possible expansion of the work already completed.

3.4 Convene Industry Coordination Meeting

Cooperation between trade associations, government laboratories, and private research entities is necessary to bring needed resources to bear on energy-conservation solutions for existing homes. This activity provides wide exposure to the information collected and analyzed in previous activities, and opportunities to develop partnerships and joint efforts to bring needed products to the marketplace. After the research effort identifies new and necessary envelope materials, a national meeting is needed to prioritize the product enhancement or product development efforts necessary to coordinate methods for bringing these products to the existing home energy retrofit marketplace.

3.5 Support Efforts to Design and Develop New Envelope Products for Existing Home Retrofits

A continuous flow of new and improved products to serve the existing home energy retrofit market is needed as part of a national effort to reduce energy use in existing homes. Beginning immediately and continuing through the abovementioned activities, public and private sector research and product development groups need to address the unique requirements encountered when retrofitting homes. With a continuous loop of research, testing, documentation of product applications, and product demonstrations, these

products will become part of the effort to implement the vision of energy usage reductions in the existing housing stock.

Examples of envelope technologies or products that could make significant improvements include:

- Economical replacement windows easily installed in openings with small dimensional differences.
- Vacuum glazing for existing sashes and frames.
- Spectrally-selective, durable, and low-e films easily applied to existing window glazing.
- Standardized weatherstripping profiles for windows and doors.
- Removable, reusable caulk.
- Improved foam sealants that expand to fill voids, but not with such force that they distort window and door frames.

4 DEVELOP A SINGLE INDUSTRY PROTOCOL FOR PRACTITIONERS

Develop a single protocol, including methodologies and procedures, for analyzing the energy efficiency of existing homes and helping homeowners combine sound, energy-efficient decisions with other remodeling and renovation projects.

Homeowners are presented with a wide array of choices when doing major home repair, home remodeling, home modification, energy-efficient improvements, home expansion, or accessibility improvements. The result often is a dilution of the effectiveness of the remodeling or renovation investment. Whether homeowners want to replace a major piece of equipment or remodel a kitchen or a bath, there is no standard process to review appropriate options for function, maintenance, energy efficiency, cost, and financing features.

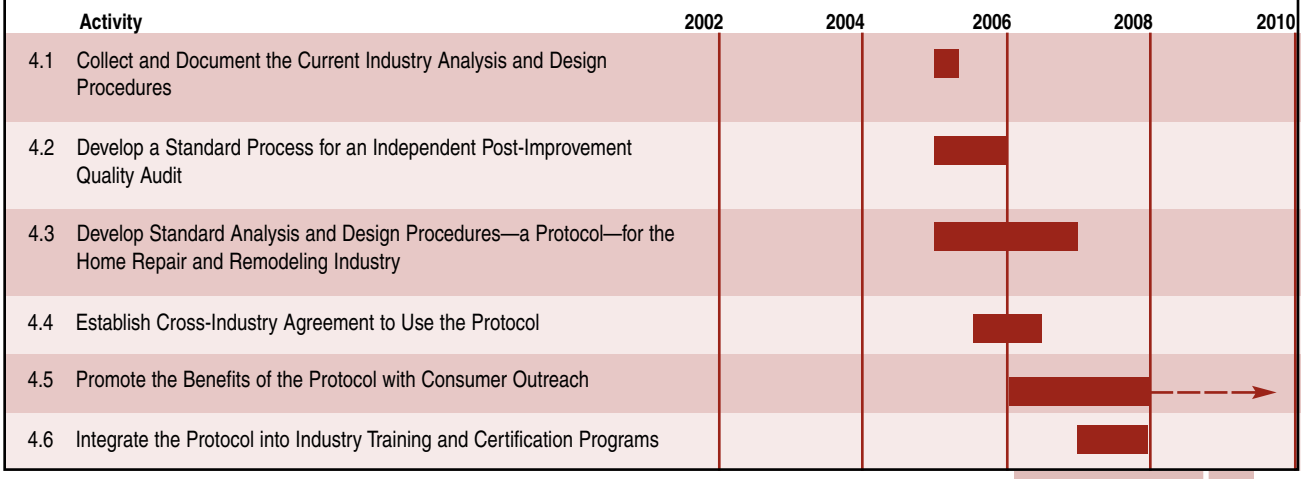
This strategy develops a unified approach, or protocol, for remodelers, trade contractors, and retail organizations to help homeowners make the best choices for home improvement projects. The protocol addresses an existing home as a complete and integrated whole. Energy improvements are viewed as natural and integral to the strategy for improving comfort, reducing monthly home operating costs, securing advantageous financing for the desired changes, and participating in a national effort to increase U.S. energy independence.

The protocol provides a consistent, high-quality, consumer-oriented approach taught to and used by all certified energy professionals and communicated in consumer outreach Strategy 2: Increase the Value Consumers Associate with Energy Efficiency. This protocol would not only increase the value of certified professionals to homeowners, but would also provide a consistent, unified approach by remodelers, HVAC contractors, energy auditors, siding contractors, and all of the other trades that obtain certification.

Figure 9 provides a timeline for the activities required to implement this strategy. Those activities are described below.

Figure 9

4. Develop a Single Protocol for Practitioners



4.1 Collect and Document Current Industry Analysis and Design Procedures

Determine how professionals currently help homeowners make decisions about home improvements. Look at how they approach remodeling and renovation, repair and replacement, energy audits, HVAC equipment upgrades, and energy-efficient upgrades in existing homes. Then document the results to serve as a basis for developing the protocol.

The study must look at the standard sales and marketing strategies currently used by remodelers to meet their customers' needs for room additions, kitchen and bath remodeling, whole-house renovations, and so on. It also must look at strategies and methodologies remodelers and trade contractors currently use to help customers select new roofing, siding, windows, and doors, and address how decisions are made to perform energy audits and the actions performed as a result of the audits. The ways that the home retail industry, especially the large home product chain stores, market and sell to homeowners for do-it-yourself projects also needs to be investigated.

This activity identifies the many ways these different companies analyze consumer needs, design solutions for consumer problems, arrange financing for desired projects, and implement those solutions.

4.2 Develop a Standard Process for an Independent Post-Improvement Quality Audit

The audit will assess the effectiveness of any energy-efficient improvements that might have been included in a home improvement project.

Energy use and utility costs in existing homes are heavily dependent on how the occupants operate their homes. When homeowners invest in energy efficiency, they need to have confidence that the energy-efficient improvements have been completed correctly. They also need to know how to operate their homes to achieve maximum comfort and utility cost savings.

This activity develops a new process for an independent third-party audit of the completed project and the delivery of a post-improvement homeowner operating manual that assures consumers that the improvements they purchased are complete, and that a new and appropriate operating regimen for their home can be implemented successfully. This task must draw on the expertise of current industry professionals to ensure that the end product is both practical and affordable. In fact, the performance standards in the quality audit should be derived from, or might be identical to, the performance standards described in Activity 1.8: Develop Performance Standards. Post-improvement quality audits might be performed by home inspectors or energy auditors not originally involved in specifying or performing the improvements.

4.3 Develop Standard Analysis and Design Procedures—a Protocol—for the Home Repair and Remodeling Industry

Develop a unified and standard protocol that allows home improvement professionals to identify the current and future needs of homeowners and offers solutions that provide the best combination of functional and energy conservation benefits. Combining energy conservation considerations with

remodeling or home expansion needs allows homeowners to make decisions that may result in lower life-cycle costs and to derive benefits from available financial incentives for using energy-efficient products or systems.

The protocol should include an energy analysis, which may range from a simple checklist to a formal energy audit depending on the home, the homeowner, and the work requested. The analysis should include a set of prioritized energy retrofit improvements, possibly customized to the climatic region in which the home is located and the age of the home. For example, if a homeowner wants to replace a failed HVAC system, the contractor should at least take a look at the ductwork for sealing and insulation. Also, a setback thermostat should be standard and the homeowner should be aware of the cost savings it offers and how to program it.

As a standard part of validating the energy retrofit process and to emphasize the importance of the intelligent operation of the improved home, the protocol also should include the post-improvement quality audit described in Activity 4.2. This protocol will apply to auditors and other energy contractors as well as remodelers and trade contractors.

The protocol must be developed by the industry, especially by remodelers, trade contractors, energy auditors, and home improvement retailers, all of whom are the ultimate users of the protocol. Technical organizations and trade associations for roofing, insulation, siding, windows, and the like also need to be involved.

4.4 Establish Cross-Industry Agreement to Use the Protocol

Agreements need to be established between professional members of the home energy efficiency industry, such as energy auditors and HVAC contractors, and the remodeling industry so that responses to homeowners, requests for major repairs, renovations, or remodeling are consistent, regardless of who responds.

Agreements might take the form of memoranda of understanding or a joint marketing program. A cooperative marketing approach can expand the market for all services offered by the various industry segments. Large retail chains also would be a valuable link to homeowners when their home improvement needs are in the initial stages of development. Retail stores routinely refer homeowners to a list of cooperating home improvement contractors to initiate the whole-house assessment, and home remodelers routinely call on energy auditors for both initial home energy assessments and post-improvement quality assessments. HVAC contractors can refer customers to remodelers or to energy auditors to initiate the process of the whole-house analysis and assessment. Remodelers can routinely and formally use home auditors and HVAC contractors as subcontractors on more comprehensive home improvement projects.

4.5 Promote the Benefits of the Protocol with Consumer Outreach

Widespread acceptance and use of the protocol will occur only if consumers understand the benefits of looking at home improvement options in a unified and organized manner. The protocol needs to be an important element in the consumer outreach described in Strategy 2: Increase the Value Consumers Associate with Energy Efficiency. Use of a unified analysis and design protocol

also will increase the credibility of, and provide benefits to, the home improvement industry. It also might potentially reduce the level of concern felt by homeowners that they are being pressured into including more in their home improvement project than they originally intended.

4.6 Integrate the Protocol into Industry Training and Certification Programs

The protocol is an important element of the remodeler and trade contractor training and credentialing program discussed under Strategy 6: Build Credibility for Service Providers. With a standard approach as a baseline for training, the additional aspects of financing programs and utility industry rebate programs could be presented to homeowners in a favorable context. A new certification program, such as one for energy improvement contractors or remodelers, could utilize this unified protocol to build value into the analysis and design phase of the interactive contractor-homeowner process.

5 MOTIVATE PRACTITIONERS TO DELIVER ENERGY-EFFICIENT SOLUTIONS

Help remodelers and trade contractors understand the economic and social benefits of delivering energy-efficient solutions to their customers.

Hundreds of thousands of remodelers and trade contractors who interact with homeowners daily are in ideal positions to guide customers toward energy-efficient decisions. These remodelers and trade contractors must be motivated to push energy efficient technologies. They need to be convinced that energy-efficiency is a good new market opportunity. Just as consumers currently make energy-efficient decisions for a variety of reasons, remodelers and trade contractors may decide to push energy-efficient solutions for a variety of reasons, ranging from pragmatic financial analyses to very subjective feelings of social consciousness.

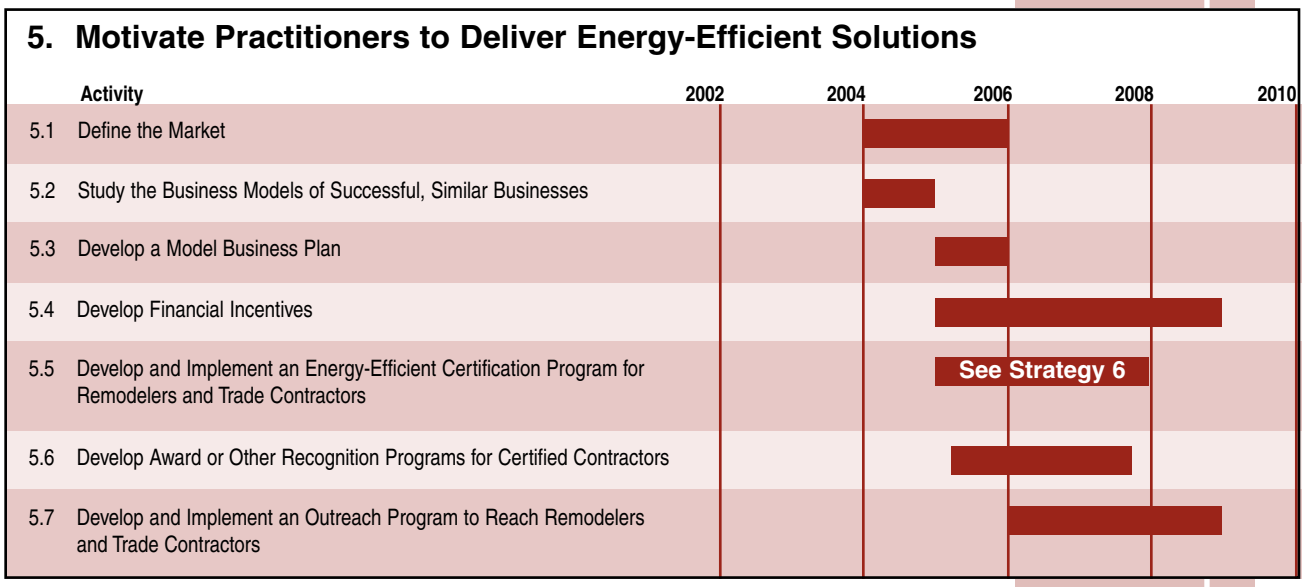
Remodelers and trade contractors already have long lists of important parameters that they review with customers—costs, reliability, quality, aesthetics, safety, comfort, and warranty. They need to be apprised of the massive energy-efficient market that is developing, and the business niche energy efficiency can provide. In addition to the potential for profit, contractors need to see how energy-efficient remodeling can improve their credibility and enhance their business image. The actions described below are directed toward two fundamental goals: 1) develop the information and tools necessary to demonstrate the financial benefits of energy-efficient solutions; and 2) provide differentiation for contractors who are providers of energy-efficient solutions.

Figure 10 provides a timeline for the activities required to implement this strategy. Those activities are described below.

5.1 Define the Market

Although many subjective reasons might influence a remodeler's or trade contractor's decision about whether to become a deliverer of energy-efficient

Figure 10



solutions, the bottom line is that they are all business people. Therefore they must be satisfied that energy efficiency is a viable market, and that they receive the information they need to make sound business decisions.

This market definition includes regional as well as national survey data. In most cases it entails the analysis of existing data. Supplementing existing survey data with additional data collection and/or the use of private survey data also may be necessary.

In addition to quantitative data from surveys, qualitative consumer results obtained from focus groups or other sources must be made available.

5.2 Study the Business Models of Successful, Similar Service Businesses

Look for examples of successful, profitable service businesses that have developed where formerly there were none. Analyze the businesses to determine the characteristics and actions that made them successful and document the results. Service businesses that may be appropriate models include exterior insulating finish systems (EIFS) mitigation, duct cleaning, and lawn care, especially lawn fertilizing. Successful home remodeling, renovation, and repair businesses also should be studied.

A model that may be directly applicable is the "Shared Energy Savings" approach to financing energy-related replacements or upgrades offered by service maintenance contractors and utility companies in the commercial service business. In this approach, the service contractor participates in the funding of the project, and then recovers the investment by sharing in the energy savings realized by the building owner.

5.3 Develop a Model Business Plan

The model business plan provides a template that remodelers and trade contractors could use to quickly and easily analyze the financial aspects of their businesses, such as revenues, operating expenses, margins, and ROIs. The template would be available in paper form and also exist in electronic form, probably as a spreadsheet. Remodelers and trade contractors then could simply plug into the form the numbers for their region (from Activity 5.1), along with the numbers that uniquely represent their business, with the results provided by the program.

5.4 Develop Financial Incentives

Financial incentives are critically important to consumers as well as trade contractors and remodelers who are expected to market energy-efficient solutions to consumers. Consumer-oriented Strategy 7: Provide Consumer Incentives for Implementation describes what needs to be done to give consumers incentives. The activity described here provides financial incentives to remodelers and trade contractors that will help them incorporate energy-efficient solutions into their businesses.

Incentives might include low-interest or interest-free loans to purchase necessary equipment or training for themselves or their employees. Incentives also might include reductions in taxes and outright grants to qualifying remodeling or contracting businesses. NYSERDA is an example of a state

energy organization that provides financial assistance for purchasing energy testing equipment. Another possibility is to provide up-front funds for professionals to implement a shared energy savings program and/or for utilities to extend their energy savings programs to include residential homes.

5.5 Develop and Implement an Energy-Efficient Certification Program for Remodelers and Trade Contractors

Refer to Strategy 6: Build Credibility for Service Providers, which focuses on developing and implementing a certification program.

5.6 Develop Award or Other Recognition Programs for Certified Contractors

Award programs that acknowledge high-quality, energy-efficient remodeling can effectively motivate remodelers. An award program must be fair and evenly administered, with well-defined criteria for winning.

Although award-recognition programs need to be consistent across the country, they must have a strong local content. To ensure that consumers find and select outstanding providers of energy-efficient solutions to do their remodeling, renovation, or repair work, effective outreach must be a key element of award programs.

5.7 Develop and Implement an Outreach Program to Reach Remodelers and Trade Contractors

Activities 5.1 through 5.6, in combination, provide tangible evidence of the desirability of energy-efficient solutions. The business-financial viability analysis, certification programs, and award programs differentiate energy-efficient solutions providers from other remodelers and trade contractors. Furthermore, implementation of the consumer outreach strategies will provide a market pull for energy-efficient solutions.

One additional motivation step is needed—an outreach program that is derived from, connected to, and coordinated with the consumer outreach program. Remodelers and trade contractors must be made aware of the consumer pull that is being created; of the fact that consumers know about the certification and award recognition programs; and of the economic and social benefits of energy-efficient solutions. Remodelers and trade contractors also need to be aware of the social benefits, which generally are the same benefits as those for consumers, but with a different slant for providers and implementers of energy-efficient solutions.

6 BUILD CREDIBILITY FOR SERVICE PROVIDERS

Establishing the credibility of remodelers and trade contractors is key to their success in helping homeowners make energy-efficient decisions for repair, remodeling, or replacement projects. A strong, effective certification program that includes training, testing, and periodic review is required.

As discussed in the Barriers/Challenges section, consumer mistrust of the building and remodeling industry is widespread. Although many of these feelings may be based on misconceptions and negative generalizations, a proactive approach to assuring credibility is likely to be far more effective than simply trying to change the image. A strong, effective certification program that ensures the competency and integrity of remodelers and trade contractors is fundamental to this strategy. Certification also will be a strong motivator for remodelers and trade contractors, providing a way to differentiate themselves as energy-efficient solutions providers (see Strategy 5: Motivate Practitioners to Deliver Energy-Efficient Solutions).

Figure 11 provides a timeline for the activities required to implement this strategy. Those activities are described below.

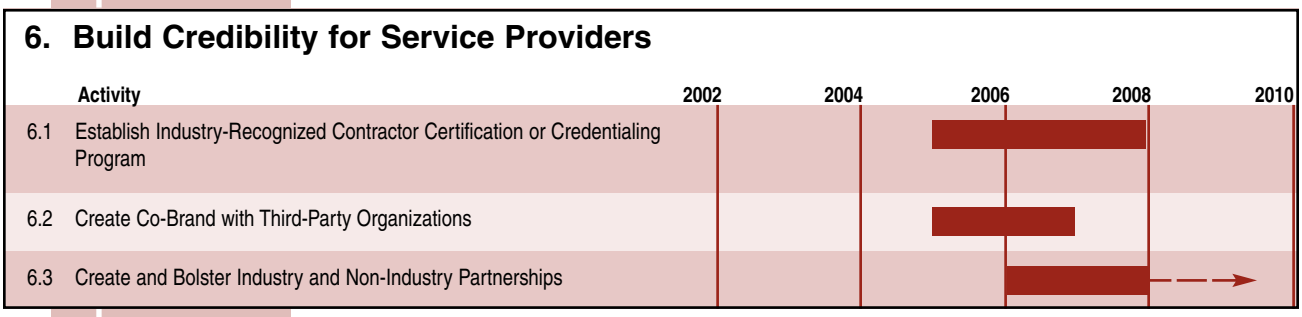
6.1 Establish an Industry-Recognized Contractor Certification or Credentialing Program

Develop a program that includes training and testing for all aspects of the profession, including analysis, design, installation, product selection, use of tools, quality management, and ethics. The topics should not be limited to energy, but must encompass all elements of remodeling to ensure that completed jobs are not just energy efficient, but are of high quality and meet consumers' needs.

Certification that is recognized within the building industry and among consumers will help brand this remodeling specialty and lend credibility to their work. The possibility of tying the program to existing programs needs to be considered. For example, the well-established and consumer-recognized Energy Star program might be expanded so that a remodeler who goes through the agreed-upon curriculum and evaluation becomes an Energy Star Certified Remodeler or Energy Star Energy Specialist. It may be desirable to connect this certification to an award program, such as the one described in Strategy 5: Motivate Practitioners to Deliver Energy-Efficient Solutions.

Figure 11

6. Build Credibility for Service Providers



The NAHB Remodelors™ Council already has in place a Certified Graduate Remodeler (CGR) program and another recently initiated Certified Aging-in-Place Specialist (CAPS) program that could serve as models from which this certification program could be developed.

6.2 Create Co-Brand with Third-Party Organizations

This part of the strategy is linked closely with the certification discussed in Activity 3.1: Evaluate and Demonstrate Underutilized Energy-Efficient Retrofit Products. Without buy-in from non-vested consumer organizations and others, the certification would have very little meaning to the average consumer. After all, any group can create its own standards and offer certification. The validity of a certification is more apparent when other organizations that already have consumer support convey their confidence in that designation by providing their seal of approval. While the selection of groups that might help forge this co-branded identification could vary from market to market and region to region, depending on the influence of those groups, possibilities include Energy Star, better business bureaus, environmental groups, and others. The CAPS program offered by NAHB and endorsed by AARP is a good example of co-branding that has significantly improved the credibility of CAPS-certified contractors.

6.3 Create and Bolster Industry and Non-Industry Partnerships

Industry and non-industry partnerships can effectively provide credibility to remodelers and the remodeling industry, especially when coupled with certification programs. Many established partnerships already are helping to increase consumer confidence in the remodeling industry and in the value of energy efficiency. The partnerships that currently exist need to be identified and the network of both industry and non-industry (consumer, government) alliances needs to be enlarged.

7 PROVIDE CONSUMER INCENTIVES FOR IMPLEMENTATION

After creating a consistent, unified message about the value attached to energy-efficient improvements for existing homes, the next critical element is to create a need, desire, and/or incentive in consumers to implement these valuable home improvements.

Part of these incentives needs to be incorporated into the messages delivered, and part needs to be built into remodelers' and trade contractors' follow-up and personal contact with consumers. Working on the knowledge that different motivators, which can be broadly identified as social and economic, drive every consumer, the most universal and applicable drivers for this part of the initiative are fear, greed, and guilt.

Figure 12 provides a timeline for the activities required to implement this strategy. Those activities are described below.

7.1 Quantify and Define the Economic Value of Energy Efficiency

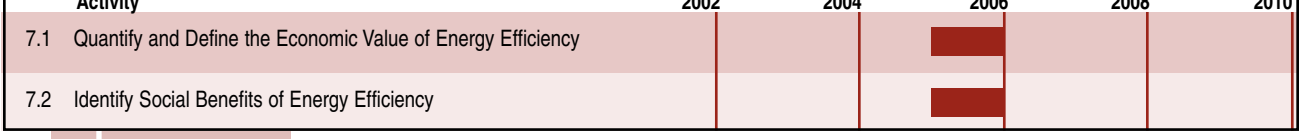
Consumers need to understand the various economic benefits that contribute to the value of energy efficiency in order to be convinced to implement retrofit energy solutions. Factors that help to quantify this value include ROI, tax incentives and/or penalties, increased curb appeal, and the potential for the increased resale value of an energy-efficient home. The quantification for this task needs to come from a number of sources. Probably the best starting place is with the stakeholders mentioned in Strategy 2: Increase the Value Consumers Associate with Energy Efficiency. In fact, EPA and DOE both provide interactive software tools that predict energy amounts and costs saved as a result of implementing various energy-efficient improvements.

7.2 Identify the Social Benefits of Energy Efficiency

At the same time, this strategy requires consumer education about the benefits of energy efficiency that are not quite as tangible as the economics. These are the emotional and social "touchy-feely" reasons to be more energy conscious. Some of these reasons include improved health (indoor air quality), benefits to the environment (the green appeal), and patriotism/national pride (decrease the nation's reliance on foreign energy suppliers). An example of an effective social consciousness message is the 1970s public service announcement that featured a Native American shedding a single but meaningful tear when he looked out over the polluted and spoiled landscape all around him. That campaign had the kind of emotional (fear/guilt) triggers that need to be created for this purpose. To this end, it may be necessary to seek the services of a professional advertising firm and/or the Ad Council.

Figure 12

7. Provide Consumers Incentives for Implementation



8 DEVELOP A PERFORMANCE MONITORING SYSTEM FOR ENERGY-CONSUMING EQUIPMENT

Develop a system that gives homeowners the information they need to understand and manage their energy-consuming equipment in real time, and in a consistent, easy-to-interpret form.

This strategy is directed at collecting operating data from the various energy-consuming products and systems in a home, communicating the information to a central point, and displaying it to the home occupants in an easy-to-understand, consistent format. The information might include the current status of any operating equipment, such as the maintenance level, years of expected remaining operation, current operating efficiency compared to manufacturer's specifications, and actual energy consumption in a normal operating mode. It might even indicate to-date and projected utility costs.

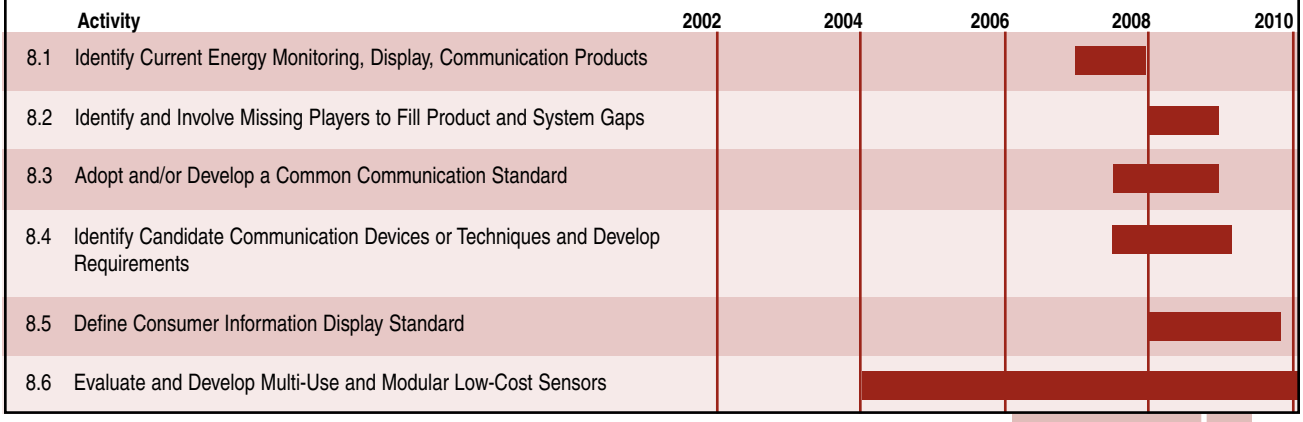
The system would provide ongoing consumer education and allow homeowners control over their homes and their energy-consuming equipment, potentially reducing the monthly operating costs of existing homes by giving homeowners a better understanding of the consequences of their behavior. The system also would improve the service life of the equipment through delivery and use of real-time maintenance and service requirements, and could improve comfort by allowing for the correction of faulty equipment operation and maximizing the opportunities to operate the energy-consuming equipment in a complementary manner.

Responsibility for the development of systems that implement this strategy ultimately lies with the manufacturers of home automation systems, energy management systems, HVAC systems, and others. A number of enabling activities, described below, will facilitate the development and diffusion of compatible products and systems.

Figure 13 provides a timeline for the activities required to implement this strategy. Those activities are described below.

Figure 13

8. Develop a Performance Monitoring System for Energy-Consuming Equipment



8.1 Identify Current Energy Monitoring, Display, and Communication Products

In the past, focus on residential energy use has resulted in a wide range of available equipment that can monitor and display equipment performance. For example, most home automation systems provide some degree of energy consumption monitoring and control, and some digital thermostats provide limited information.

Many manufacturers of HVAC equipment and controls, home automation systems, and appliances either are marketing or developing equipment that is capable of communicating status and diagnostic information.

The companies that develop and manufacture the above products need to be identified and their products need to be documented, with the results forming the basis for identifying what is available, what needs to be developed, and which companies are candidates for development.

8.2 Identify and Involve Missing Players to Fill Product and System Gaps

This activity forms connections and linkages, identifies and recruits missing players, and creates a top-level plan that facilitates development of appropriate products and systems. The plan needs to be inclusive, ensuring that no viable developers and manufacturers are excluded. It may be that cooperative public-private funding will be required to stimulate the development of certain products.

8.3 Adopt and/or Develop a Common Communication Standard

Communicating the status of energy-consuming equipment from a variety of manufacturers back to a centrally-located local display requires a standard communications protocol. Allowing various manufacturers to provide their own versions of the display further drives the need for a standard.

Unfortunately, several standards currently exist, any one of which could likely provide the communications capability needed for energy monitoring. The challenge of this activity will be to select from the available standards the one that is most appropriate and most acceptable to the manufacturers that will be using it. Organizations providing potentially applicable standards include:

- Electronic Industries Association – Consumer Electronics Bus (CEBus, EIA-600 and Home Plug and Play);
- Consumer Electronics Association – Versatile Home Network (VHN); and
- Universal Plug 'n Play Forum – UPnP.

This activity needs to evaluate the existing standards, determine if any can meet the energy monitoring needs, identify required changes, and ultimately obtain consensus, especially among the manufacturers of sensors, communication devices, and displays.

8.4 Identify Candidate Communication Devices or Techniques and Develop Requirements

Reliable, low-cost data communication from equipment to a centralized display or gateway is especially challenging in an existing home. Running wires often is labor intensive and sometimes unsightly. Wireless alternatives include radio frequency (RF) used by home security system providers; power line carriers (PLCs) used for many years for simple control applications; and infrared (IR) used for years in remote controls and wireless connections for personal computers. Depending on a variety of factors, any given energy monitoring application might use any one or a combination of these techniques.

A comprehensive assessment needs to be performed to identify the gaps and omissions. For example, development may be needed to provide a chip set for manufacturers that interfaces with equipment via the communication protocol selected in Activity 8.3 and allows communication by wires, RF, PLC, or IR at the discretion of the equipment manufacturers. The output would be a set of requirements for communications alternatives that would provide guidance to communications vendors.

8.5 Define a Consumer Information Display Standard

A sufficiently specific display standard for all manufacturers is needed so that consumers, remodelers, and trade contractors can use the displays with a minimum of training or retraining. The challenge is for the standard to provide sufficient latitude for manufacturers to provide features or functions that provide product differentiation.

Regardless of who designs and manufactures a display, every display should use the same name for the same device, the same name for each energy measurement parameter, the same units of measurement, and so on. Another element that needs to be consistent is the format for tabular and graphical data. A third element is navigation, which is a very large issue with consumers, most of whom have trouble learning to program setback thermostats or VCRs.

The standard should allow alternative implementations, such as an enhanced thermostat, an enhanced security panel, a TV set, a personal computer, or a standalone display. Handheld devices also should be considered for use by remodelers and trade contractors.

8.6 Evaluate and Develop Multi-Use and Modular Low-Cost Sensors

Affordable sensors are needed to collect real-time information on active systems and equipment, including:

- Status of indoor air quality;
- Maintenance status of mechanical systems;
- Energy consumption status of smaller system components;
- On/off status of appliances;
- Current and historical information on local weather conditions;
- Quantitative information on moisture in concealed envelope areas;

- Power requirements for whole-house systems; and
- Warnings of impending peak power needs.

The first step in this activity would require evaluating existing sensors, with the help of sensor manufacturers and the manufacturers who use sensors in their systems. Then needs and opportunities would need to be assessed and the development of required sensors initiated by the sensor manufacturers.

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