TECHNOLOGY ROADMAP

- - - MOTIVATE CONSUMERS - - - ENABLE CONTRACTORS - - - DEVELOP NEW PRODUCTS - - - CREATE PROTOC

PATH
PARTNERSHIP FOR ADVANCING TECHNOLOGY IN HOUSING

ENERGY EFFICIENCY IN EXISTING HOMES

Volume Three: Prioritized Action Plan

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

PD&R U.S. Department of Housing and Urban Development
Office of Policy Development and Research

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, other 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.

To learn more about PATH, please contact

PATH
PARTNERSHIP FOR ADVANCING TECHNOLOGY IN HOUSING

451 7th Street, SW
Washington, DC 20410
202-708-4370 (phone)
202-708-5873 (fax)
e-mail: pathnet@pathnet.org
website: www.pathnet.org

PARTNERSHIP FOR ADVANCING TECHNOLOGY IN HOUSING

TECHNOLOGY ROADMAP: ENERGY EFFICIENCY IN EXISTING HOMES

Volume Three: Prioritized Action Plan

Prepared for:

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Office of Policy Development and Research
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Prepared by:

Newport Partners LLC
Davidsonville, MD

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About Newport Partners LLC

Newport Partners LLC is a small business providing analytical and technical services to clients in both the manufacturing and public sectors, with an emphasis on building technology and the introduction of innovative products.

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Disclaimer

PREFACE

The Partnership for Advancing Technology in Housing (PATH) is pleased to present the third installment of the Energy Efficiency in Existing Housing (EEEH) Roadmap. As a follow-up on the activities that have occurred since the Volume 1 *Technology Brainstorming* and Volume 2 *Strategies Defined* reports were published, we invite you to look at the progress that has been made in helping to formulate a prioritized action plan for existing housing energy efficiency.

The PATH program, administered by HUD, is focused on improving the affordability and value of new and existing homes. Through private and public cooperation, PATH is working to improve energy efficiency, environmental impact, durability and maintenance, hazard resistance, and labor safety relative to new and existing homes. To accomplish this, PATH has identified priority strategies and activities that will enable government and industry to jointly fulfill the PATH mission. We refer to this priority-setting process as roadmapping. The *Energy Efficiency in Existing Housing* Roadmap is one of five roadmaps under development to date. The other roadmaps are: 1. *Information Technology to Accelerate and Streamline Home Building*, 2. *Whole House and Building Process Redesign*, 3. *Advanced Panelized Construction*, and 4. *Technology Roadmapping for Manufactured Housing.*

This report discusses eight key strategies and associated activities for bringing about new levels of energy conservation in the nation's existing housing stock. Priorities were established by a broad cross-section of manufacturers, remodelers, trade contractors, researchers, and government program officials through the application of an innovative web-based decision making tool that was developed for this project by University for Contractors, LLC. Some of the strategies suggest ways to influence consumers to demand energy conserving products and services, while other strategies focus on developing new technologies and preparing remodeling and trade contractors to supply them into home improvement and renovation.

The three EEEH Roadmapping volumes can be read independently or as a set. This third volume expands on the concepts developed in the previous two volumes and presents them in the prioritized order determined by the web-based decision making process. Therefore, it can stand alone as the more definitive action plan for improving the energy efficiency of the nation's existing housing stock.

We invite manufacturers, builders, trade contractors, researchers, and others to examine this roadmap and encourage your participation in improving the energy performance of housing.

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PATH PROGRAM GOALS

The Partnership for Advancing Technology in Housing (PATH) encourages the use of technology 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 is adding value to seven of the nation's key housing attributes:

- affordability
- energy efficiency
- environmental impact
- quality
- durability and maintenance
- hazard mitigation
- safety

As such, four overarching goals have been established that all bear on those attributes:

● To remove barriers and facilitate technology development and adoption.

PATH will investigate the barriers, including regulatory barriers, that impede innovation, and will actively propose and develop programs to overcome those barriers. This work will guide the other goals and efforts.

● To improve technology transfer development, and adoption through information dissemination.

PATH will coordinate dissemination of innovation information directed to the housing industry and consumers.

● To advance housing technology research and speed development of new technology.

PATH will support "background" and applied research as well as technology development activities in the housing industry. This research will be complemented by short-term and long-term assessments of specific technologies that are on the market.

● To support the program through appropriate management and resource allocations.

Partners in the PATH program - U.S. Department of Housing and Urban Development, Department of Energy, Environmental Protection Agency, Department of Agriculture, Department of Commerce, Federal Emergency Management Agency, home builders, researchers, and manufacturers of building materials and products - have long recognized the importance of injecting current and emerging technologies into the home building process. The PATH program has identified many of the relevant technologies and has facilitated implementation of research, pilot, demonstration, and evaluation projects across the United States. In addition, PATH program partners recognize the importance of planning research and setting priorities for technology development that will enable the housing industry to work toward the PATH mission. This priority setting is known as "Roadmapping."

ROADMAPPING PROCESS

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

As the premier planning activity for PATH, 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. Through this process, new technologies and additional research work will be generated as the roadmaps are implemented.

The IC initiated the overall roadmapping process during early 2000. A group of 40 builders, material and product suppliers, academicians, researchers, and other stakeholders identified and prioritized technologies that hold promise in achieving PATH's goals. The IC then grouped the technologies with the greatest potential benefits into broad portfolios. These portfolios represent three initial technology roadmaps for new home construction. At about the same time, additional roadmaps were initiated by the manufactured housing industry and the remodeling industry to address PATH goals and objectives relevant to these sectors of the home building industry. The result is the following five roadmapping activities currently in different stages of development:

1. Information Technology to Accelerate and Streamline Home Building
2. Whole House and Building Process Redesign
3. Energy Efficiency in Existing Homes
4. Technology Roadmapping for Manufactured Housing, and
5. Advanced Panelized Construction

Each of the roadmaps has a separate report. This report deals specifically with the Energy Efficiency in Existing Homes Roadmap.

In late 2000, the Energy Efficiency in Existing Housing Roadmapping group met to brainstorm technology development ideas that could help the PATH program meet existing housing energy efficiency goals. Subsequently, in May 2002, the working group met to identify key strategies and activities in the existing housing area. In 2003, a process was initiated to prioritize key strategies and activities. This report summarizes the results of this Roadmapping process.

Meeting of the Technology Roadmapping Work Group

VISION

By 2010, consumers will be able to substantially improve the energy efficiency of their homes and achieve positive cash flow in the process. That is, energy savings on monthly utility bills will more than offset the monthly costs for financing the installation of the energy efficient technologies. An organized infrastructure for marketing and installing the necessary technologies will also be in place.

SITUATION TODAY

The Partnership for Advancing Technology in Housing (PATH), a public-private initiative to speed the adoption of beneficial new and existing technologies in U.S. homes, has been pursuing a broad-based effort to improve energy efficiency in the nation's housing stock on an unprecedented scale. PATH has brought together remodelers, product manufacturers, energy utilities, service providers and federal agency representatives to create a comprehensive plan designed to achieve substantial energy efficiency improvements in large numbers of houses. The planning process has led to the development of this Technology Roadmap, which presents a prioritized set of strategies and supporting research and implementation activities designed to increase consumer demand for energy efficiency upgrades to their homes at the same time as it enhances the ability of private sector firms to satisfy that demand.

Public attention to the energy efficiency of existing homes is justified by the large contribution of the residential sector to total U.S. energy consumption. The latest data, published by the Energy Information Administration (EIA) of the U.S. Department of Energy, indicates that in 2001 the residential sector consumed just under 20 quadrillion Btus (quads) of primary energy out of total national consumption of about 96 quads, with the balance used by the industrial, transportation and commercial sectors.

Long-term growth in energy consumption has outpaced domestic production and imposed cost burdens on consumers. The resulting growth in imports has led to national policy concerns about dependence on unstable foreign sources of energy. Trends in energy production and consumption have also prompted environmental concern on scales ranging from local (e.g. oil spills and smog) to regional (acid rain) to international (ozone depletion and global warming). At the same time, energy consumption has also led to major improvements in the standard of living and the convenience of everyday life throughout society. Changing patterns of use in this environment has proven controversial and difficult.

A more detailed analysis published by EIA shows that the 101 million U.S. housing units in existence as of 1997 used about 19 quads of primary energy out of a total of 93 quads of primary energy used for all purposes in that year. The 74 million existing single-family homes in 1997 accounted for about 83 percent of energy use in the residential sector. Average 1997 expenditures for energy used in the single-family houses were slightly under $1,500. Total residential use, measured at the building site, dropped slightly from 10.6 quads in 1978 to 10.25 quads in 1997. Site energy consumption (which does not include energy lost in the process of generating or transmitting electricity) dropped from 138 million Btus per

household in 1978 to 102 million Btus in 1982. This indicates some improvement in energy efficiency during a period when prices were rising and energy awareness was very high. However, per-household consumption remained essentially constant from 1982 through 1997. Total residential energy consumption measured at the building site declined less than 0.5 quad from 1978 to 1997, while primary energy consumed by the residential sector increased by about 2 quads over the same period.

The major energy end uses in the U.S. housing stock vary widely by region, year of construction and other variables. However, for the average housing unit in 1997 space heating accounted for more than one-half of site energy use, and about one-third of energy expenditures. Electricity was about one-third of site consumption and two-thirds of energy expenditures. About 13 percent of electricity was used for refrigerators, 12 percent for air conditioning, 11 percent for water heating and 11 percent for space heating (these numbers do not reflect natural gas water heating or natural gas space heating). More information and detailed breakdowns can be found in the EIA report describing results of the 1997 Residential Energy Consumption Survey.

Replacing drafty old single-pane windows and leaky doors (top photo) with low-E, argon-filled energy-efficient upgrades (lower photo) reduces heating and cooling costs, cuts down on drafts, and improves comfort.

There has, of course, been much work since the late 1970's aimed at reducing residential energy consumption. For example, the federal government has worked successfully over the last 20 years to increase the stringency of energy codes and standards, as well as to promote their adoption across the country. These code requirements generally apply only to newly constructed houses, so their effect is very slow to materialize. The government has also sponsored research into passive solar technology, improved house design procedures, and voluntary programs that call for building houses that use far less energy than houses built to minimum code requirements. Once again, these are aimed primarily or entirely at new houses. Finally, government has raised the minimum efficiency standards for furnaces, air conditioners, water heaters and many other devices, but even these standards have no impact on existing homes unless and until older appliances are replaced. This record strongly suggests that the policy focus on household energy consumption has largely overlooked existing homes. Given the longevity of housing and the very slow turnover of the housing stock, a policy aimed at new homes is destined to have very

little impact on total residential energy use for many years to come. Most of the government resources applied to energy efficiency in existing housing during recent years have gone to support low-income weatherization programs. Since federal tax credits expired over 20 years ago, the energy efficiency of existing homes has largely been left to market forces of supply and demand.

In recognition of the importance of addressing energy use in houses more broadly, PATH has adopted a goal that focuses specifically on improving energy efficiency in the existing housing stock. This goal rests on two premises. The first premise is that over the last 20 years many new and improved products that have become available can save energy in the core applications of space heating, air conditioning and water heating. Some of these products can be used equally well in new or existing homes, while others are specifically designed for retrofit application. The second premise is that the market for repair and remodeling (R&R) of existing homes is large and very healthy; in dollar volume it is around three-quarters as large as the entire new home market. There is also a large professional infrastructure to support the R&R market. Even a modest shift of R&R expenditures towards energy upgrades could have a broad and significant impact on household energy consumption in a relatively short period of time. Although much of the discussion in this report focuses on the involvement of third party professionals, do-it-yourself (DIY) jobs are commonplace in this sector. Thus, homeowners with modest skills and the right information represent another resource for improving energy efficiency through retrofit.

ROADMAP DEVELOPMENT

At the inception of the PATH program, the building industry was challenged to meet a very ambitious goal of improving the energy efficiency of 15 million homes by at least 30 percent within 10 years. Rather than counting on achieving this goal through the uncoordinated efforts of remodelers, homeowners, manufacturers, government and others, PATH chose to initiate a process of Technology Roadmapping, a systematic planning process that brings together all of these interest groups to create a strategic plan for technology development and introduction. Roadmapping typically starts by developing a short vision statement designed to give a central focus to the process. Participants then identify a comprehensive set of strategies that would, if accomplished, successfully achieve the underlying vision. Finally, the strategies are prioritized and an action plan is drawn up with specific activities, a timeframe, and an estimate of the resources required for implementation.

In order to develop the EEEH Roadmap, PATH's Technology Roadmapping Working Group has conducted two Roadmapping sessions and significant follow-up work. The first Working Group meeting, held late in 2000, was a brainstorming session during which industry experts identified nearly 40 different areas where improved technology suitable for use in existing houses could produce tangible energy-saving benefits. The technologies were classified into: (1) building envelope technologies, (2) HVAC systems and controls, (3) appliances and lighting, and (4) distributed generation. Individual ideas ranged from "high tech"

products incorporating results of the latest research to low-tech solutions to problems encountered in retrofit work or faced by homeowners who lack the resources to make significant investments in energy upgrades. The group also discussed the need for outreach strategies and tools. Results of the session were documented in the report *Volume One: Technology Brainstorming* (June 2002).

A second meeting of the EEEH Working Group was held in May 2002. That meeting was devoted to identifying high-level strategic approaches for improving energy efficiency through using the types of new technologies discussed in the earlier brainstorming session, as well as expanded use of existing technologies. The Working Group formulated eight broad strategies and identified a series of action items for implementation under each strategy. Several dozen implementation activities were described in all. While the session was successful in identifying promising strategies for achieving residential energy efficiency improvements on a large scale, there was no opportunity to systematically address priorities across the strategies. Results appeared in the Roadmapping report, *Volume Two: Strategies Defined* (April 2003), which also suggests how implementation of the strategies could be phased.

The eight strategies developed by the Working Group in the May 2002 meeting are listed below in the order presented in the Volume Two report. The first three strategies were designated for immediate implementation.

- **Enable practitioners to deliver energy-efficient solutions.**
- **Increase the value consumers associate with energy efficiency.**
- **Improve retrofit building envelope performance technologies.**
- **Develop a single industry protocol for practitioners.**
- **Motivate practitioners to deliver energy-efficient solutions.**
- **Build credibility for service providers.**
- **Provide consumer incentives for implementation.**
- **Develop a performance monitoring system for energy-consuming equipment.**

SETTING PRIORITIES

Introduction of a Web-Based Prioritization Tool

The first two published roadmapping reports (Brainstorming and Strategies Defined) were the results of in-person meetings of the EEEH Roadmapping group. To complete the Roadmapping process, it was necessary to develop a more systematic view of priorities across these strategies than was possible at the meetings. To this end, an on-line methodology was developed in the spring of 2003 with the assistance of University for Contractors, LLC. A special website was created for this purpose. Visitors to the website were provided with information about the EEEH roadmapping process and background on each of the 8 strategies. Those who provided a name and e-mail address, and classified themselves as "contractor", "supplier", "academic", "government" or "other", were invited to

rate the strategies in several respects by submitting an on-line form. The existence of the website and the rating tool was publicized by e-mail to participants in the EEEH Roadmapping meetings, by announcements to the readership of ToolBase e-news, through a link on the NAHB Remodelers Council website, www.contractor.com, and through other on-line resources.

The rating form is illustrated in Figure 1. Visitors were requested to score each strategy with respect to three criteria:

- the impact on energy efficiency if successful (1=low to 10=high)
- the likelihood of success, assuming public support of $2 million per year (1=low to 10=high), and
- the number of years needed to achieve the potential impact.

Scores for these three criteria were combined to calculate indices of the perceived long-term impact (LTI) and short-term impact (STI) for each strategy, computed as follows:

- LTI = (potential impact if successful) x (likelihood of success)
- STI = LTI ÷ (number of years needed to achieve potential impact)

Because the calculated values of LTI and STI weight potential impact on energy efficiency by probability, they are each designed to reflect the participants' views of the "expected value" of pursuing each strategy. LTI indicates potential impact without regard to how long a strategy takes to achieve results, while STI gives higher scores for strategies that deliver near-term results.

A total of 118 visitors completed and submitted rating sheets over the web between mid-March and late April, 2003. About 70 percent were self-classified as "contractors" and another 22 percent were classified as "other". There were also four suppliers, four government workers and one academic. For this analysis the rating sheets were broken into two categories: contractors/suppliers, and all others. Discussion and conclusions are based on the responses from contractor/suppliers unless otherwise indicated.

Figure 1
Web Prioritization Rating Form

Scores from all visitors classified as contractors or suppliers were assessed to determine overall rankings of the strategies. The assessment was based on the set of values of the LTI and STI for each strategy as computed in the original scoring sheets. Both means and medians of LTI and STI were considered. Using the means gave an unambiguous ranking while using the medians sometimes resulted in tied ranks, most often for long-term impact (which was the product of two integers and assumed

relatively few values). However, the results from both approaches were generally consistent. The mean values of LTI for the different strategies tended to stay within about 25 percent of each other, while STI values were within about 40 percent of each other. These facts indicate that, as viewed by the participants, the spread in expected benefits across the strategies was not especially large in the long run, and slightly greater in the short run. In other words, although some strategies rated better than others, all the strategies have considerable merit.

Rankings of the strategies based on mean ratings from contractor/supplier input are summarized below.[1] It is important to note that the classification into first, second and third priority is relative; since it is clear the participants consider all the strategies to be important and worth pursuing. Finally, the priority classification of strategies proved to be the same whether long-term or short-term savings potential was considered.

Priorities for EEEH Roadmapping Strategies based on Contractor/Supplier Scoring

Top priority:

- Provide consumer incentives for implementation
- Motivate service providers to deliver energy-efficient solutions

Second priority:

- Develop a single industry protocol for practitioners
- Improve retrofit building envelope performance technologies
- Enable practitioners to deliver energy-efficient solutions
- Develop a performance monitoring system for energy-consuming equipment

Third priority:

- Increase the value consumers associate with energy efficiency
- Build credibility for service providers

There are significant differences between these priorities and the previous list. The two top priority strategies above were much further down the earlier list, and the strategy that previously headed the list (increase the value consumers associate with energy efficiency) now ranks behind most of the others. In interpreting these results it is important to keep in mind that priorities are subjective in nature, and will naturally vary from one person to another. Priorities also may differ systematically between interest groups. Participants in the earlier Roadmapping meetings included academics, researchers and government agency representatives, while the priorities developed through the web-based process reflect input from professional remodeling contractors, specialty trade contractors, and product suppliers. The results are relevant

[1] Even though the pool of respondents in the government, researcher and "other" (GRO) categories was much smaller than the pool of contractor/supplier responses, it is interesting to compare the prioritization based on input from the two groups. The two highest priorities for the GRO respondents were "Improve Retrofit Building Envelope Technologies" and "Develop a Performance Monitoring System for Energy-Consuming Equipment", both of which are in the second-priority category above. In addition, the GRO group assigned the lowest priority to "Motivate Practitioners to Deliver Energy-Efficient Solutions", which is in the first-priority category above. These differences are consistent with a GRO orientation that places more emphasis on expanding the supply of next-generation technologies for housing, and less on affecting the behavior of consumers and industry members.

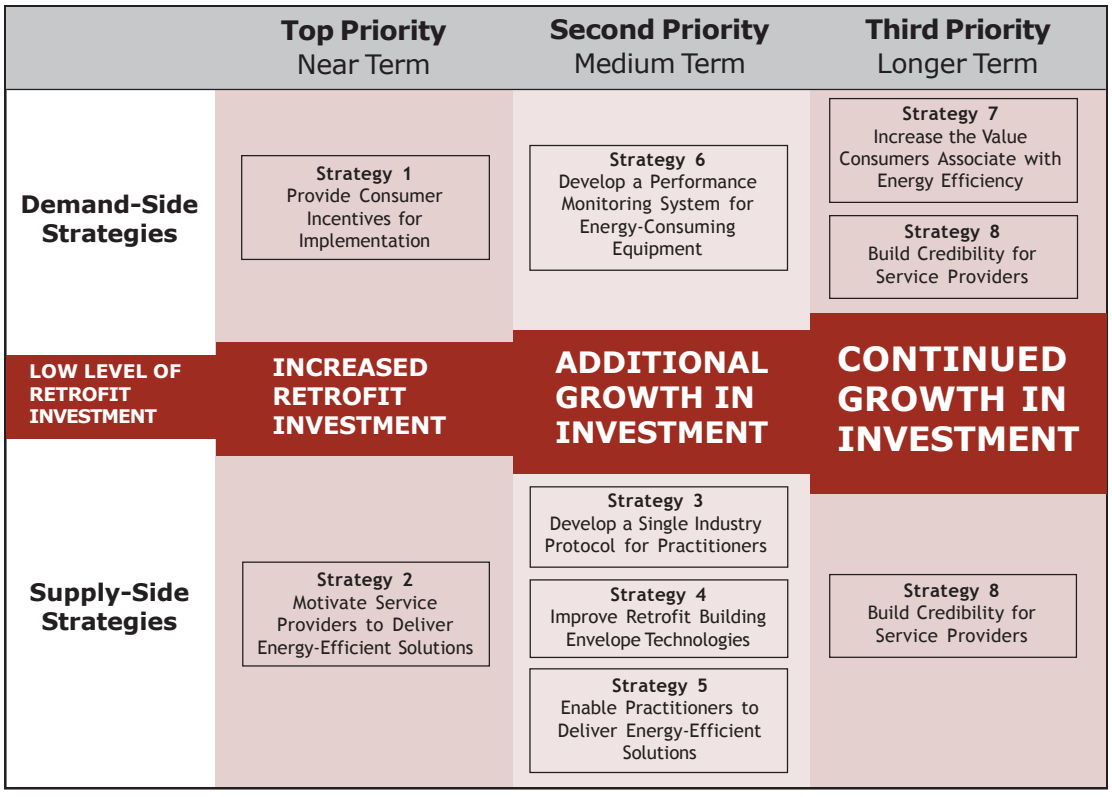
not just to the industry, but to the government agencies charged with funding programs such as outreach and research.

An overview of how implementation of the strategies should be phased, based on the industry input, and how they operate to increase the underlying level of investment in energy efficiency technologies, is in Figure 2 below.

The strategies (shown in boxes) are placed in the figure according to whether their primary impact is on the "demand" side (i.e., influencing consumers to demand more retrofit products) or on the "supply" side (i.e. expanding the size and skills of the pool of service providers available to provide and install retrofit products). Time generally proceeds from left to right across the figure, and the level of market activity is indicated in the bar extending across the center of the figure. The small bar near the left side represents the generally low level of market activity at the present time. With each step across the chart the bars grow in size, signifying continued growth in the market. The higher priority strategies and associated activities involve greater near-term work in the diagram, while the lower priority strategies and activities generally involve work further in the future.

- The two top-priority strategies call for providing consumers with incentives, and motivating service providers to participate in the retrofit market. Each of these is a direct approach that can be expected to increase the pace of retrofit investment.
- The second-priority strategies are shown near the middle of the diagram. On the

Figure 2
Impact of PATH Energy Efficiency Strategies on Retrofit Investment



demand side, the performance monitoring system would increase "energy consciousness" and provide quick feedback in a way designed to motivate and enable some consumers to take positive steps to save energy. On the supply side, a single industry protocol for practitioners would bring more order and standardization to the market. The other two strategies would expand available technology options for retrofit, and increase the pool of practitioners aiming to serve this particular market.

- The two strategies at the right side of the diagram (shown in three boxes) are of lower priority, and are less tangible and less critical to success than the others. Both strategies operate on the demand side, although one (increase credibility of service providers) is also shown on the supply side because it directly affects industry members. Increasing the value that consumers associate with energy efficiency (through means other than incentives) requires affecting perceptions and attitudes through information and persuasion. It complements the strategy that calls for creating consumer incentives. Improving the credibility of service providers responds to the perception that remodelers and trade contractors lack the competence or integrity to be entrusted with energy retrofit projects. While lack of credibility has not prevented major growth in the overall R&R market, energy-related work may raise special issues that should be addressed in this strategy.

The balance of this report reviews and discusses the eight strategies in priority order as well as the specific implementation activities included under each strategy.

Where appropriate, activities listed in the Volume 2 report have been reorganized in a more logical way, or to eliminate redundancy. Additional activities have also been added as necessary. Comments and notes under each strategy explaining the relationships between activities and documenting recent progress or existing resources are included to assist in implementation. Discussion in this report is intended to help guide decisions about what kinds of implementation work to pursue, and to show how each of the suggested lines of work relates to the more general PATH goal of improving energy efficiency in existing homes.

Note that in the interest of completeness many distinct activities have been separately described under these eight strategies. It should not be concluded that all eight of the strategies must be pursued, or every one of these activities performed, in order to produce a strong improvement in the energy efficiency of existing houses.

Finally, most of the strategies include activities that call for some type of outreach to consumers, or to remodelers and allied professionals. While these outreach efforts are described individually, they clearly should be components of an overarching communications strategy that grows in scope and content over time.

ROADMAP

OVERVIEW

This section presents the roadmap for improving the energy efficiency of the nation's existing housing stock. The roadmap is a prioritized action plan. It is not a set of directions that shows how to move from one point to another; rather, the roadmap presents a coordinated set of strategies and related activities that when collectively accomplished will bring about advances in existing housing energy efficiency. The eight strategies are identified below and listed in order, based on the prioritization process described earlier. This order helps distinguish between those activities that require near-term, intermediate term, or longer-term focus. The strategies, however, are not necessarily sequential. Many of the activities can run concurrently and should be addressed any time that sufficient resources can be applied to successfully completing the activity.

Top Priority Strategies

Strategy 1: Provide Consumer Incentives For Implementation
Create a need, desire, and/or incentive in consumers to implement energy-efficient solutions either by themselves or by engaging professional assistance.

Strategy 2: Motivate Service Providers to Deliver Energy-Efficient Solutions
Help remodelers, trade contractors, and DIY practitioners understand the economic and social benefits of delivering energy-efficient solutions.

Second Priority Strategies

Strategy 3: 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. The protocol should be usable by motivated homeowners with technical DIY skills.

Strategy 4: Improve Retrofit Building Envelope Performance Technologies
Provide a continual flow of emerging and new technologies that will reduce the energy required for heating, cooling and providing hot water to existing homes, in order to cut energy use and lower operating costs. The technologies should be designed for ease of assembly.

Strategy 5: Enable Practitioners 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. Make the same resources available to homeowners interested in performing improvements on their own behalf.

Strategy 6: 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 and easy-to-interpret form.

Third Priority Strategies

Strategy 7: 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.

Strategy 8: Build Credibility for Service Providers
Establish the credibility of remodelers and trade contractors by implementing a strong, effective contractor credentialing program that includes training, testing, and periodic review.

1 PROVIDE CONSUMER INCENTIVES FOR IMPLEMENTATION

Homeowner investments in energy efficiency upgrades are fundamentally a matter of supply and demand. Supply is governed by the availability of relevant technologies and the ability of practitioners to install them, while demand reflects the value of potential energy savings and ancillary benefits balanced against the cost of the investment. Notwithstanding the importance of energy conservation to the nation as a whole, in today's market environment the relatively low cost of energy to the end user depresses the value of energy savings and translates into a relatively low return on investment compared to other alternatives available to the homeowner. The result is inaction.

Consumer incentives are a direct and potentially simple way to change the investment equation and increase the number of households that decide to upgrade their homes without having to change underlying attitudes or perceptions. They are a fundamental tool for guiding private choice through public policy. Incentives can sometimes be very costly so they must be carefully structured, but incentives also can take many forms, not all of which require cash outlays. Approaches to creating new incentives and maximizing the impact of those that already exist are further discussed below. While the PATH program will not create or find these incentives, PATH partners can directly influence the timing and scope of incentives under consideration. Tax credits, low-interest loans and other incentives could help stimulate demand for energy-efficient technologies and ultimately improve the supply of more advanced products.

Activities 1.1 and 1.2 under this strategy are preparatory steps that, while not essential, could potentially help to shape development of specific incentives and messages for outreach.

Activities 1.3, 1.4 and 1.5 are the most important parts of this strategy. They involve establishing and promoting tangible consumer incentives of different types in order to change the economics of energy efficiency investments as perceived by the consumer. Decisions about energy retrofit are logically based on costs and benefits. Years of relatively low energy prices have kept the economic benefits of investment modest relative to the cost of retrofit. While higher energy prices or energy taxes would also create incentives, these steps may be politically unacceptable. Reducing the cost of retrofit through direct incentives also shifts the economic equation in favor of more energy retrofit, and can overcome the market imperfection resulting from externalities. Direct incentives can be very expensive, but their effect is immediate and potentially strong. Rebates and tax credits have a dollar-for-dollar impact on the cost of retrofit, while low-interest loans are helpful to consumers who lack cash to invest and also reduce carrying costs for the improvements.

1.1 Quantify and Define the Economic Benefits of Energy Efficiency

Consumers who understand the various economic benefits that result from a more energy-efficient home will be more easily convinced to implement retrofit energy solutions. The key economic benefits are direct return on investment (lower energy bills), improved "curb appeal" and the related possibility that upgrades may increase the resale value of the home, and any applicable tax incentives. Less tangible economic benefits may include lower costs of maintenance and repair, especially with modern HVAC equipment, as well as improved comfort or indoor air quality. Some of these benefits such as energy savings are well documented in the literature and can even be estimated with tools deployed on the web. Specifying or quantifying the other benefits in order to create a more complete picture may require original research.

1.2 Identify and Document the Social Benefits of Energy Efficiency

The direct economic drivers covered in Activity 1.1 are a very important part of the picture, but not the entire picture. In order to make the strongest possible case for private action, it is also important to understand the broader, societal benefits resulting from conservation. These primarily involve "external benefits," i.e., effects that are enjoyed by large numbers of people regardless of whether they invest as individuals or not. For example, reducing energy use cuts the adverse environmental impacts of power generation, including air pollution and acid rain from conventional plants, low-level radioactive waste from nuclear plants, or habitat destruction from hydroelectric plants. It will frequently cut the production of greenhouse gases and the threat they pose to the global environment. And it will directly or indirectly reduce the dependency of the U.S. on imported oil, which has left the country vulnerable to supply disruptions in politically unstable parts of the world. Different themes will resonate with different consumers, and not all consumers will respond to public benefits that have no direct link to their pocketbook, but personal philosophies and even peer pressure can turn social benefits into motivating factors.

1.3 Develop Low-Interest Loan Programs for Consumer Investments in Energy Efficiency

Incentives do not necessarily have to involve up-front cash payments. Making money available on attractive terms for financing energy upgrades defers the payment of the subsidy while addressing the lack of savings available to invest by many cash-poor homeowners. Below-market interest rates and long repayment periods can turn a large expense into a manageable one, without requiring the out-of-pocket payments that characterize other types of incentives. Many states have offered special lending programs in recent years, although not all are available at this time.

There are other lending approaches targeting energy efficiency such as "energy efficient mortgage" (EEM) programs offered by secondary mortgage lenders and the FHA. These have been available for nearly 20 years and are

directed primarily at new home purchasers but in theory can be applied to existing homes as well. EEMs do not lower the interest rate, but rather make additional money available to any given borrower based on improved ability to repay due to lower energy bills. Utilization of EEMs has historically been low; for example, FHA insure 16,000 EEMs in FY 1988 (1.5 percent of total FHA loans) 30,044EEMs in FY 1999 (2.3 percent) and 28,578 in FY 2000 (3.1 percent). The "Energy Star Mortgage" is a new approach where EPA and lenders work together to offer special loan packages to purchasers of Energy Star homes. The incentives can involve reductions or waivers of closing costs, or even reduced interest rates. Once again, the target is new home purchasers. Finally, FHA home improvement loans can be used for energy upgrades or other purchases relating to existing homes.

This activity involves extending or supplementing the available lending programs to better address improvements by homeowners who are not planning to move or refinance. These steps will help make lending incentives work in the existing home market.

1.4 Provide Rebates and Tax Incentives for Consumer Investments in Energy Efficiency

Cash incentives, whether in the form of rebate checks, income tax credits or other tax benefits, are a standard economic tool for stimulating desired investments. The use of tax credits to promote investment in energy conservation was questioned after this was tried in the 1970's, but from an economic standpoint incentives remain a viable option. Investments in energy efficiency are low in part because consumer willingness to pay for them is low relative to the cost. Consumer incentives strengthen the market because they increase consumer willingness to pay.

Federal income tax credits for the retrofit of existing homes are one recent incentive option. Several versions of this potential incentive have been recently proposed in the US Congress, with varying tax credit values assigned to homeowners for energy improvements on existing homes and to homebuilders for new home construction energy upgrades–both of which would be measured against building code and inspection criteria like the International energy Conservation Code (IECC) or Energy Star Homes ratings. One example of t his which was supported by the White House proposed a maximum of $2,000 in tax credits to homeowners for satisfying the 2000 IEC in their existing homes, and either $1,000 or $2,000 for builders of new homes who exceeded the 2000 IEC by 30% or 50%, respectively. The Roadmapping group believed that incentives that shape consumer spending habits like tax credits should be studied and monitored.

Some states have also shown a willingness to promote energy efficiency investments through state tax policy. Examples include tax credits for solar and renewable energy systems, still available in many areas, as well as waivers of sales tax on Energy Star appliances and property tax systems that prevent energy

efficiency investments from raising assessed values and increasing tax bills. A summary of state incentives for energy efficiency upgrades is available at http://www.ase.org/consumer/tax_credits.htm.

Ongoing analysis, research, and review regarding the effectiveness of all consumer incentive programs should be continued.

1.5 Publicize the Availability of Loans and Incentives for Energy Efficiency Investments

This activity is needed whether or not additional incentive programs are developed and implemented. Incentives can only affect consumer decisions if consumers know they are available. In addition to information noted above on the Alliance to Save Energy website, a DOE-funded website giving summaries of incentive programs available in each state as well as at the federal level is being operated by North Carolina State University (NCSU) at http://www.dsireusa.org. The focus of the NCSU website is on incentives for investing in renewable energy (e.g., solar water heating and PV systems), but there is also some information about incentives available for other types of energy upgrades including sales tax exemptions, property tax exemptions and financing programs. This website represents an excellent start in the right direction and should be kept up to date. In addition the site would be more useful to consumers as a way of quickly identifying incentive programs available to them if (1) its existence was widely publicized, (2) its scope was enlarged to specifically include incentives for additional types of energy efficiency investments, particularly in a retrofit context, and (3) it incorporated a motivational message to show consumers how the programs can benefit them rather than its present, purely informational tone.

Strategy 1. Provide Consumer Incentives for Implementation

Implementation Activity	Near Term (<2 Years)	Mid-Term (2-4 Years)	Long-Term (>5 Years)
1.1 Quantify and Define the Economic Benefits of Energy Efficiency	✓		
1.2 Identify and Document the Social Benefits of Energy Efficiency	✓		
1.3 Develop Low-Interest Loan Programs for Consumer Investments in Energy Efficiency		✓	✓
1.4 Provide Rebates and Tax Incentives for Consumer Investments in Energy Efficiency		✓	✓
1.5 Publicize the Availability of Loans and Incentives for Energy Efficiency Investments		✓	✓

FIGURE 3

2 MOTIVATE SERVICE PROVIDERS TO DELIVER ENERGY-EFFICIENT SOLUTIONS

In order for the private market to deliver energy retrofit services to existing homes, two basic elements are necessary: consumer demand for retrofits and available capacity to supply retrofits. This strategy speaks directly to expanding supply. Although companies specializing in energy retrofit are presently quite uncommon, there are hundreds of thousands of remodeling firms and specialty trade contractors potentially available to serve this market, if only they can be motivated to do so. The present strategy represents the most immediate method for focusing capacity on this sector.

Activities 2.1, 2.2 and 2.3 involve developing key elements of a "business case" to convince contractors that marketing energy upgrades to existing homes can be a profitable business niche, whether performed alone or in conjunction with other remodeling projects. Activity 2.4 would reduce the costs of transitioning or expanding to perform this type of work and make the business case more attractive. Activity 2.5 would provide publicity and positive reinforcement to firms that provide leadership in this market. Activity 2.6 ensures that contractor audiences learn about the opportunity so they can make informed decisions about whether and how to participate. The possibility of developing a formal certification program for energy retrofit contractors is not considered essential to contractor motivation and so is not covered here, but is discussed under a later strategy, "Build Credibility for Service Providers."

2.1 Define the Market

Simply urging remodelers to start doing "energy retrofit" for the greater good of society is unlikely to achieve much if anything at all. Making a strong case for this business move requires presenting data to describe the market opportunity in specific terms. What kinds of retrofits would such a business undertake? Presumably with current technology these would include adding insulation to underinsulated assemblies, insulating basement walls or floors above unfinished basements and crawl spaces, general building envelope air sealing, duct sealing, duct insulation, replacing old HVAC equipment or controls, replacing weatherstripping, replacing windows and doors, installing high-efficiency lighting, installing attic ventilation, and other more exotic types of improvements. In some situations retrofits might also include steps designed to preserve or improve indoor air quality through ventilation, source control or air cleaning, particularly if homes have undergone extensive air sealing or are known to be unusually tight. Defining the market would include, as a minimum, determining the extent to which existing homes of different ages in different regions would need and potentially benefit from these types of activities. Survey data from the Energy Information Administration, the American Housing Survey or other sources could be used to document the housing

characteristics, while information collected over the last twenty years in federally or regionally funded weatherization programs could give an idea of how effective different retrofit technologies can be in reducing energy bills. Additional data to document consumer attitudes and perceptions about their interest in retrofit work and the circumstances under which they would or would not be interested in it would be a useful adjunct to the housing characteristics data in establishing the potential market opportunity.

2.2 Study the Business Models of Successful, Similar Service Businesses

There may be valuable lessons to learn from identifying and studying similar service businesses to determine what has made them successful and profitable. At least two types of businesses should be studied. One type is services focused on energy efficiency; for example, firms that install and maintain upgrades to commercial and institutional buildings in exchange for a percentage of the energy savings. During the late 1970's and early 1980's there were also firms specializing in residential energy analysis and upgrades, often operating in conjunction with local utilities. Companies that provide home energy ratings or energy diagnostics and analysis to home builders are modern examples. The second type is service businesses which have arisen in response to evolving needs; for example, duct cleaning or mitigation of EIFS, lead-based paint, asbestos, and more recently, mold and mildew. Case studies focused on these or related sectors would provide a framework of similarities and differences to help today's trade contractors evaluate their own market opportunities in energy retrofit. One important element is identifying the factors that made some of these businesses economically successful.

2.3 Develop a Model Business Plan

Information developed in Activities 2.1 and 2.2 about the potential business opportunities in the retrofit market and the economics of similarly situated service businesses should next be used to develop a simple model business plan for the entrepreneur performing retrofits. The model plan would project investment for tools and equipment, revenues and operating expenses to estimate profit margins and return on invested capital. The model plan should be designed to make sense where retrofit is performed in addition to other remodeling projects or specialty contracting such as HVAC work. It would be made available electronically as a template that could readily be modified or tailored to reflect market-specific assumptions or conditions applicable to an interested business. The template could also be used to perform the types of sensitivity analysis required for sound business planning. Users could evaluate scenarios relevant to their business and assess the potential financial rewards.

2.4 Develop Financial Incentives

The need for financial incentives to expand consumer demand was discussed at length under the previous strategy. Similar types of incentives

would help to improve the economics of providing retrofit services. While there are large numbers of contractors who could theoretically fill this niche, the vast majority are small, thinly capitalized operations that may lack the ability to cover start-up or transitional costs. Supply-side incentives might include low-interest or interest-free loans to cover the purchase of diagnostic equipment or fees for training. Tax breaks or grants, while usually more expensive, would serve the same purpose. The New York State Energy Research and Development Authority (NYSERDA) is an example of a state agency that has adopted this approach, providing energy service contractors with financial assistance for purchasing testing equipment.

2.5 Develop Award or Other Recognition Programs for Energy Retrofit Contractors

Programs where successful businesses compete with their peers for awards recognizing excellence in different aspects of their work have the potential to raise interest and awareness among large numbers of companies. The awards obviously benefit the winners, who receive excellent publicity within the industry and even among consumers. They are also valuable to other firms who have the opportunity to learn by example from success stories, and they broadly publicize the existence of this specialty form of contracting to consumers. This activity involves developing and implementing award programs based on demonstrated technical and marketing success in providing energy retrofit services. Awards can be made at the national, regional and/or local levels. Results can be showcased in the trade press and promoted through a wide range of other media outlets. Key elements of a successful awards program include systematic promotion; clear, objective judging criteria; independent, qualified judges; fair and orderly administration, and recognition of the winners in a prestigious venue that justifies the cost and effort required to participate. Publicizing the results to homeowners who might benefit from retrofit work is also very important to developing a successful awards program.

At this time there are no national award programs targeting remodelers or trade contractors for their role in improving the energy efficiency of existing homes. The closest examples are the annual EPA-sponsored "Energy Star Award of Excellence in Home Improvement", presented this year to the New York State Energy Research and Development Agency (NYSERDA) for its leadership in improving the energy efficiency of existing homes. EPA also presented HUD with the "Energy Star Award for Affordable Housing" for its work in identifying ways to reduce energy consumption in all of the housing units managed or owned by the agency.

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

The results of activities 2.1 through 2.5 under this strategy are designed to motivate remodelers and trade contractors to take on energy retrofit projects. Remodelers need to know about these results as well as the steps

being taken to stimulate consumer demand. Therefore, there will be an ongoing need to communicate the availability of these resources (as well as related work performed under Strategy 1 and elsewhere) throughout the remodeling community.

Strategy 2. Motivate Service Providers to Deliver Energy-Efficient Solutions

Implementation Activity	Near Term (<2 Years)	Mid-Term (2-4 Years)	Long-Term (>5 Years)
2.1 Define the Market	✓		
2.2 Study the Business Models of Successful, Similar Service Businesses	✓		
2.3 Develop a Model Business Plan	✓		
2.4 Develop Financial Incentives		✓	
2.5 Develop Award or Other Recognition Programs for Energy Retrofit Contractors		✓	✓
2.6 Develop and Implement an Outreach Program to Reach Remodelers and Trade Contractors		✓	✓

FIGURE 4

3 DEVELOP A SINGLE INDUSTRY PROTOCOL FOR PRACTITIONERS

Homeowners face a nearly endless array of choices when doing major home repair, home remodeling, home modification, energy-efficient improvements, home expansion, or accessibility improvements. Difficulty in making the best choices can dilute the effectiveness of the remodeling or renovation investment. When homeowners decide to replace a major piece of equipment or remodel a kitchen or a bath, there is no standard process for reviewing alternatives for functionality, cost, maintenance, energy efficiency, and financing features.

This strategy involves developing a unified approach, or standard protocol, for assessing the energy efficiency of a home and identifying beneficial improvements. It would be used by remodelers, certain trade contractors, and retail outlets to help homeowners make the best choices for home improvement projects. It should also be produced in a format that a DIY homeowner can understand and use. The protocol should be designed to address an existing home as a complete and integrated whole. Users should be able to identify and evaluate potential energy improvements either as stand-alone projects that can improve comfort and reduce energy bills, or in conjunction with other work that can lower the marginal cost of improvements and help secure advantageous financing for the project as a whole. The protocol will provide a consistent, high-quality, consumer-oriented approach that can be taught to and used by those whose work impacts energy efficiency. At the same time it should be promoted to consumers as part of overall consumer outreach on energy retrofit, so they will know to ask their contractors about it or can even choose to use it themselves.

A starting point for this standardization may already exist in the Home Energy Rating Systems (HERS) guidelines, as well as in earlier protocols used for utility energy audits or weatherization programs. The question is whether the existing protocols for analyzing a house and identifying the most appropriate improvements are either too simple or too complicated for the purpose at hand. If so, they should be adapted under Activities 3.1 and 3.2 to achieve reasonable accuracy while being suitable for teaching to and implementation by home improvement contractors and other audiences. Success in this area would make it easier for more contractors to participate in this market, and give consumers more meaningful choices among service providers. Activity 3.3 calls for standardizing the process for conducting an independent post-improvement audit. Although such an audit is not necessary in all cases, it may be required by lenders that provide financing for improvements, or public authorities who subsidize particular costs. Standardizing the audit procedures would provide greater consistency when audits are used.

Activity 3.4 calls for cross-industry agreement to use the protocol. This may be informal so long as it is effective. Promoting the protocol to consumers under Activity 3.5 would create awareness and demand for its use that would drive practitioners to rely on it. Regardless of how the protocol is publicized to consumers, the training described in Activity 3.6 is critical to its ultimate success.

3.1 Collect and Document Current Industry Analysis and Design Procedures

This project would identify and document the different methods currently used by professionals to make decisions about home improvements, both with respect to major repair and remodeling, and energy-efficiency upgrades. Major home remodeling would include common activities such as kitchen and bath remodeling, whole-house renovation, room additions, roofing and siding replacement, HVAC replacements and upgrades, and window and door replacements. Documentation of the results would provide a starting point for development of an improved protocol where energy efficiency plays a larger role. The study must look at the standard sales and marketing strategies currently used by remodelers to identify and meet the needs of their customers, the ways they guide product selection, the opportunities they seek to expand the scope of any particular job, and the role they play in arranging financing. Special attention should be paid to the types of energy analysis or audits currently used in this process. The ways that building product retailers (especially the large home product chain stores) market and sell directly to homeowners for do-it-yourself projects also need to be investigated and documented.

3.2 Develop Standard Analysis and Design Procedures - a Protocol - for the Home Repair and Remodeling Process

Develop a unified and standard protocol that allows home improvement industry professionals to identify comprehensive approaches that satisfy homeowner needs with the best combination of functional and energy conservation benefits. Many homes can benefit from properly selected energy upgrades even when they are installed in isolation, and the protocol needs to be able to identify beneficial energy upgrades directly. Of equal importance, the protocol needs to address situations where energy upgrades are performed together with other remodeling work or home expansion. In those cases, homeowners may lower the cost of the upgrades and become eligible for financial incentives or loan packages.

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 provide a prioritized set of energy retrofit improvements reflecting the climate where the home is located, the type of construction and HVAC system, and other work that may also be performed. For example, if a homeowner wants to replace an old or failed heating system, the HVAC contractor should not

only identify the proper efficiency of the new equipment, but also consider whether the air distribution system would benefit from air sealing and insulation, and assess the potential benefits of setback or programmable thermostat. A separate activity calls for developing a standard protocol for a post-improvement quality audit in situations where it is desired or required.

This protocol will be available for use by energy auditors and trade contractors who do energy-related work, as well as by general remodelers and other trade contractors. Ideally, it should also be suitable for use by the skilled do-it-yourselfer. In order to be accepted and successful the protocol must be developed by the industry, including remodelers, trade contractors, energy auditors, and home improvement retailers, all of whom will be the ultimate users of the protocol. Technical organizations and trade associations for roofing, insulation, siding, windows, and other related products also need to be involved.

The EPA Energy Star Homes program, while best known for promoting energy efficiency in new homes, is already developing a component for existing homes. The standards do not presently distinguish between new and existing homes; either type must receive a HERS rating of 86 or better to earn the Energy Star label. Energy Star requires at least one on-site inspection of an existing home, including a blower door test and a duct leakage test. Results of these tests, along with other information about the house, are entered into a computer simulation program to generate the HERS score and estimate the annual energy costs. This has the makings of a protocol but falls short of providing a method for helping homeowners optimize investments in energy efficiency.

The Energy Star Homes program web site also provides "Home Energy Advisor" to help consumers understand how they can improve the energy performance of their house. The user inputs information about the construction of the house, the energy systems used in the house, the number of people in the family, and the geographic location. It then provides the consumer with a list of recommendations and estimated costs for upgrading the energy performance of the house. This also provides a starting point for developing the protocol envisioned in this strategy.

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

There are various situations where energy upgrades must pass a quality audit by an independent third party before a job is considered complete. This type of audit goes well beyond the health and safety issues addressed by code inspectors. The purpose is to provide assurance that the upgrades will perform as intended, with insulation properly installed to agreed-upon levels, caulking and sealants used where appropriate, etc. An independent audit provides an element of consumer protection at the same time as it assures lenders or organizations that provide incentives for this work that

the job has been properly done. The audit could even provide the occupants with information about how to operate their homes to achieve maximum comfort and low utility bills, although this kind of information can and should be presented in various other ways as well. Finally, availability of an audit might prove to be a selling tool that could help overcome reluctance from customers who feel unqualified to determine whether a job is properly done or not.

Like the protocol for identifying and recommending improvements, the audit protocol must draw on the expertise of current industry professionals to ensure that the resulting procedure is both usable in the field and inexpensive relative to the benefits at stake. Post-improvement quality audits might be performed by home inspectors or energy auditors who were not originally involved in specifying or performing the improvements.

3.4 Establish Broad Agreement to Use the Protocol

The protocol will have maximum impact if remodelers and professional members of the home energy efficiency industry (such as energy auditors and HVAC contractors) agree to cooperate in its use. This will make responses to homeowner requests for major repairs, renovations, or remodeling more consistent, regardless of who responds. Agreements need not be formal or written, although some participants might take this approach. A cooperative marketing approach can expand the market for all services offered by the various industry segments. Large retail chains are another potential link to homeowners whose home improvement needs are in the initial stages of development. Retail stores could routinely refer homeowners to a list of cooperating home improvement contractors to initiate the whole-house assessment, and home remodelers could 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, if they cannot perform it themselves. Remodelers would likely choose to use energy auditors and HVAC contractors as subcontractors on more comprehensive home improvement projects.

3.5 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 a subsequent strategy, "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.

3.6 Integrate the Protocol into Industry Training and Credentialing Programs

The protocol is an important element of the remodeler and trade contractor training and credentialing program discussed under a subsequent strategy, "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.

Strategy 3. Develop a Single Industry Protocol for Practitioners

Implementation Activity	Near Term (<2 Years)	Mid-Term (2-4 Years)	Long-Term (>5 Years)
3.1 Collect and Document Current Industry Analysis and Design Procedures		✓	
3.2 Develop Standard Analysis and Design Procedures--a Protocol--for the Home Repair and Remodeling Process		✓	
3.3 Develop a Standard Process for an Independent Post-Improvement Quality Audit		✓	
3.4 Establish Broad Agreement to Use the Protocol		✓	
3.5 Promote the Benefitis of the Protocol with Consumer Outreach		✓	✓
3.6 Integrate the Protocol into Industry Training and Credentialing Programs		✓	✓

FIGURE 5

4 IMPROVE RETROFIT BUILDING ENVELOPE PERFORMANCE TECHNOLOGIES

The development of technologies that can improve energy efficiency is one area that has seen considerable progress over the past two decades. Much of this success is due to collaboration between government and industry. The use of double-pane windows with low-E glazing and argon gas fill has become widespread in today's window retrofit market. Gas furnace efficiencies typically exceed 90% and central air conditioning systems rated at SEER 12 and above are widely available. These latter products are not specifically aimed at retrofit, but they have found use in that market. PATH represents an opportunity to expand the focus of this work.

Activity 4.1 is a research task designed to compile more succinct energy usage information by housing type and age in the various climatic zones of the U.S. In addition, it compiles state-of-the-art information on energy retrofit approaches and technologies throughout the U.S. Activity 4.2 has been addressed to date by PATH through an ongoing process of "Technology Scanning" which has included a wide range of industries such as automotive and aerospace. The idea is that new technologies need not be developed from scratch if they can be adapted from other applications. The PATH Scanning results are published in short topical summaries that describe products or technologies and discuss how they might be adapted for housing or home building. This kind of work is meant to help give ideas to technology developers, and should be continued.

Activity 4.3 calls for holding periodic meetings similar to the "Technology Brainstorming" held early in the EEEH roadmap development. The brainstorming session involved remodelers, trade contractors, researchers, utility representatives, and federal program officials. The output of that meeting was dozens of concepts, many never documented before, for products and systems that could be of particular value for energy retrofit. Some of these specifically address deficiencies in existing product choices, while others represented new approaches to the underlying challenges presented by existing homes. The report containing results of the brainstorming session, Volume I of the EEEH Roadmap, has been widely distributed in order to help stimulate the development of responsive technologies. It is available for download at http://www.pathnet.org. Holding similar sessions every few years would keep this essential process moving forward.

Activity 4.4 is a key follow-up item that will keep new technologies moving through the pipeline and emerging into the market. While the private sector is well-equipped to develop some products in this area, there are others that call for R&D which requires public support because the benefits would be difficult to appropriate. Suitable products or retrofit

methods can receive public support through a variety of different financial vehicles. In turn, there are clear opportunities for field testing and evaluation of retrofit technologies under Activity 4.5, and disseminating the results under Activity 4.6. Most PATH field evaluations to date have focused on new homes.

4.1 Compile Expanded Background Information

A great deal of work has been completed in identifying large and small contributors to heat loss, heat gain and energy consumption in existing houses. In the past, the focus has been on areas of large heat loss and heat gain, including walls, ceilings and floors, windows and doors that leak air, and smaller air leaks spread throughout the surface of the building exterior. The Energy Information Administration compiles extensive data on energy usage in existing housing of different age groups.

This activity calls for pulling together information on the state-of-the-art of energy retrofit in housing in the various climatic zones. DOE has the best information on low income weatherization retrofit, as its budget in this area is approximately $230 million each year. Collecting state-of-the-art energy retrofit practices in the various climatic zones would enable the PATH EEEH Roadmapping team to identify current needs for new technology development and opportunities for collaboration. The results of this task will be used as background information for the brainstorming sessions in Activity 4.3 below.

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

The PATH program has sponsored a scanning process for the past three years focused on technologies that have successfully entered other industries and may find application in the residential building industry. This scanning process utilizes PATH Roadmapping as a filter for determining whether a newly identified technology should be pursued for transfer into housing. Researchers ask such questions as "how could the thermal and structural performance of relatively thin airplane skins apply to housing systems?" or "are there lessons to be learned from the automobile manufacturing process in terms of clustering utilities that could streamline home systems design and installation?" The PATH scanning process has not categorized technologies for application to new construction versus existing housing, so a sorting process will need to occur for applications that are appropriate to existing housing. The PATH technology scanning reports are available at http://www.pathnet.org/sp.asp?mc=rd_techscan. 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 help maintain an airtight envelope.
- Reflective window film that can be retrofitted easily and firmly onto existing residential windows, or other enhancements that improve spectral performance or air leakage of windows in place.
- 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 research will also serve as background for another round of industry brainstorming meetings, discussed in the next section, where ideas and priorities for technology development will be discussed and documented.

4.3 Convene Industry Meetings to Identify Needs and Opportunities

The initial Detroit brainstorming meeting in 2000 on technology needs and opportunities for energy efficiency improvement in existing housing led to the first EEEH roadmapping report. When the EEEH Roadmapping team met again a year later in Annapolis, MD, the group re-affirmed the need to draw from the expertise that produced the brainstorming report, as well as the need to re-convene these sessions periodically to examine progress and identify new needs and opportunities for technological development. Government and private industry researchers need to meet regularly to brainstorm R&D priorities and new opportunities for energy retrofit technology development. A 2-year or 3-year cycle would be appropriate, which means that another brainstorming session is now due. Each meeting should build on ideas expressed at the earlier ones, rather than repeating previous concepts.

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

A continuous flow of new and improved products to serve the existing home energy retrofit market is needed to support an ongoing national effort to reduce energy use in existing homes. Beginning immediately and continuing through this initiative, public and private sector research and product development groups should be challenged to address the unique requirements encountered by remodelers, trade contractors, or DIY practitioners when retrofitting homes. These challenges include space and access constraints, the need to interface with dissimilar or archaic systems,

and the need to work in occupied buildings. As they emerge from an ongoing loop of research, testing, documentation of product applications, and product demonstrations, the resulting products will become part of the effort to implement the vision of energy usage reductions in the existing housing stock. Product designs should recognize the labor skill challenges in today's workforce as well as the need of DIY home energy retrofitters for products that are easy to work with.

The U.S. Department of Energy issued a $16 million per year solicitation in early 2003 to support the development of new energy-conserving retrofit products or renewable energy products designed for existing homes. A companion renewable energy development procurement was also issued in Spring 2003 by the National Renewable Energy Laboratory in Golden, CO. Each of these procurements recognizes the role of PATH Roadmapping in this area and both procurements require industry co-funding. Depending on what is funded there may need to be additional work undertaken in this area. PATH has funded existing housing energy retrofit projects to understand the cost, installation issues, technical performance, and market acceptance issues so that it can communicate these results to the industry. DOE is also funding research in this area. More work needs to be done in evaluating next generation products and systems.

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

- Highly energy-efficient, thin-skinned siding replacement systems.
- Vacuum glazing for retrofit into existing sashes and frames.
- Spectrally-selective, durable, and low-E films designed for application to existing window glazing.
- Standardized weatherstripping profiles for windows and doors.
- Removable, reusable caulk.
- Highly efficient replacement HVAC and air distribution systems for existing homes.

4.5 Evaluate and Demonstrate Underutilized and Emerging Energy Retrofit Products

Products or systems that look good on paper and in the laboratory may not be widely applied in the field for a wide variety 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 installation costs and the installation process, as well as

performance and other information about the product or system when it is used in particular house designs and climatic regions. Investigations 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 energy retrofit technologies that might benefit from field evaluations include conversion of ventilated crawl spaces to conditioned spaces, or high-R leveling boards installed under siding. Data should be analyzed and results published promptly after each evaluation.

4.6 Communicate the Results Broadly

Lessons learned from the evaluations and demonstrations of retrofit technologies help consumers understand what works and what doesn't work. It also helps to verify installed costs and identify practical issues that arise when contractors attempt to install the new technologies. HUD actively disseminates results of current evaluations to the building community as they become available, through several avenues. Both DOE and EPA also actively communicate results to consumer audiences. The three agencies need to collaborate on message content and delivery so that remodeler, trade contractor, and consumer audiences all benefit from the research that has been conducted.

Strategy 4. Improve Retrofit Building Envelope Performance Technologies

Implementation Activity	Near Term (<2 Years)	Mid-Term (2-4 Years)	Long-Term (>5 Years)
4.1 Compile Expanded Background Information	✓		
4.2 Identify Technologies from Other Industries for Use in Residential Energy Retrofit Products	✓	✓	✓
4.3 Convene Industry Meetings to Identify Needs and Opportunities	✓	✓	✓
4.4 Support Efforts to Design and Develop New Products for Existing Home Retrofits		✓	✓
4.5 Evaluate and Demonstrate Underutilized and Emerging Energy Retrofit Products		✓	✓
4.6 Communicate the Results Broadly		✓	✓

FIGURE 6

5 ENABLE PRACTITIONERS TO DELIVER ENERGY-EFFICIENT SOLUTIONS

Most remodeling companies are "home grown" businesses led by a carpenter who managed crews for a builder or another remodeling company before leaving to start a remodeling business. The company managers often acquire business and management skills after they start their company through education and training programs like the Certified Graduate Remodeler program. While their job skills are usually well developed, very few have access to education and training for specialized energy retrofit. They hire specialized crews to install various parts of the comfort system for their jobs (e.g., framers for windows, doors, and insulation, HVAC companies for the heating and cooling system, plumbers for the hot water tank, etc.). However, specialty trade contractors typically do not have the tools to develop a systematic understanding of energy performance in houses and how best to market energy upgrade packages to their customers. These trade contractors are usually called directly by consumers for product or system replacement as in the case of furnaces, air conditioning systems, and water heaters.

At nearly $170 billion per year, residential remodeling represents approximately two percent of the U.S. gross domestic product and about 40% of all investment in housing. Remodeling contractors are well versed in selling kitchen and bath upgrades and room additions. However, they miss a large opportunity by not having the tools to sell a comprehensive home energy upgrade at the time the homeowner is obtaining financing to pay for the costs of the remodeling job. By adding in the home energy upgrade, the consumer would not only lower their utility bills, but would also benefit from better comfort levels throughout the house. Most consumers wait for the furnace to break, usually during a cold spell in the winter when furnaces are most expensive to replace and financing terms are more expensive than the home equity loan or home refinance. Air conditioning systems also fail most often when the weather is exceptionally hot and the system is working the hardest to maintain comfort. The result in either case is several days of waiting in unpleasant conditions for a service technician who is fully booked replacing other systems that have failed. Proactive comfort system upgrade at the time of the remodeling project would alleviate the crisis of expensive system replacement at the time of failure.

This strategy focuses on providing the remodeling industry with the tools they need to enable them to deliver energy efficient solutions for their customers. It also provides technically oriented homeowners with the education and training necessary to efficiently and effectively implement these solutions when they do energy upgrade work themselves.

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

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

The wide range of testing and analysis tools and protocols that already exist also need to be identified and documented. Testing tools include various hardware devices, such as blower doors, infrared cameras, "duct blasters" and airflow sensors. Analysis tools predict the energy savings of specific retrofits or calculate payback. Many computer software packages provide this functionality, and information about these is compiled in various sources.

5.2 Establish Recognized, Credible Sources of Information for Users

DOE operates an online resource for consumers and the building industry called the Energy and Renewable Energy Network (EREN). Within EREN is a clearinghouse of information on a wide range of energy efficiency and renewable energy topics. EREN also maintains an online "Ask an Expert" function as well as a toll-free hotline. Some DOE national laboratories also maintain useful web based technical information sites. Lawrence Berkeley National Laboratory, for example, maintains a home energy saver web site that is designed to advise consumers about the best ways to save energy in their homes. It is accessed at http://hes.lbl.gov/. State agencies like the California Energy Commission (CEC) and NYSERDA have extensive information on energy efficiency and renewable energy. The CEC has developed a series of training videos for energy professionals that can be downloaded and viewed online. These are available at http://cec.ishow.com/. The Alliance to Save Energy provides consumers with an online Home Energy Checkup at http://www.ase.org/checkup/home/index.html designed to help homeowners understand how much they will save by investing in energy efficiency upgrades. The NAHB Research Center maintains an online portal for the PATH program called ToolBase (www.toolbase.org) and a toll-free hotline for the building trades.

There are a growing number of free information resources available to contractors and their customers regarding energy efficiency tips, techniques, and technologies. It is not clear whether contractors are using the online resources or toll-free telephone lines. Research needs to be conducted on how each of the specialty trades acquires information on new techniques

and products. Information may be available in one format that is not generally seen by a specialty trade so the information does not get picked up and put into practice.

Many of the existing resources identified above, while relevant to the professional, are actually aimed at consumers. This is logical given the large role of do-it-yourself projects in the home improvement area. As PATH sponsors development of new technical resources it should keep in mind that many items will also be of interest and value to consumers who plan to do the work themselves. As a result, these materials should be made easily available to consumers.

5.3 Create a Viable Education Platform

Current platforms for delivering educational materials to contractors usually involve taking them away from their work to a physical location where they receive training. This occurs in training facilities, local builder association meeting rooms, or at workshops and conferences. A small number of online training courses now exist relating to housing. Online education in general has been growing in recent years as the academic community has learned how to expand course offerings beyond the classroom, but the building industry does not yet have a viable online education platform for delivering information to the remodeling and contracting trades or directly to homeowners. A successful model would be one that would deliver focused information to users in a format that they understand and can put into practice. It would be affordable and flexible enough that the student would pursue coursework online at their pace and during the time they have free to "attend" class. While online training may seem like a reach for many in the industry today, the benefits and economies are numerous.

5.4 Develop Online Education and Training Content

There are a growing number of programs designed specifically for remodelers and specialized energy contractors. Home Energy magazine (www.homeenergy.org) maintains a listing of contractor training programs available in each state. The list is organized by who offers the training, a description of the program, whether there is certification, and specific areas of training. The National Association of the Remodeling Industry provides a training program entitled *Certified Green Building Professional*. That program focuses on California licensed building professionals. See http://www.stopwaste.org/naricert. The San Francisco Bay Area Chapter of NARI is the certification body for this program. The Energy and Environmental Building Association (EEBA) created the "EEBA Institute" to offer training in a broad range of areas relating to energy efficiency and indoor air quality. In addition to the training that is available through the institute, EEBA holds an annual *Excellence in Building Conference* with in-depth pre-conference sessions and specialized energy efficiency tracks led by prominent researchers and practitioners in the energy efficiency field. Information is available at http://www.eeba.org. The U.S. Green Building Council offers specialized

training in Leadership in Energy and Environmental Design (LEED) design leading to accreditation of professionals to the requirements of LEED Version 2.0. Hanley-Wood Exhibitions holds an annual Remodelers' Show with workshops and educational programs. NAHB provides educational seminars in conjunction with the annual International Builders Show. The substances of these offerings should be mined for applicability to online training courses.

A small number of vendors are now offering online training. These include Apogee Interactive, Inc., Build IQ, and University for Contractors, LLC. Current online offerings are not tailored to support a remodeler or contractor in advanced energy efficiency techniques for building retrofit. A much broader curriculum of online training needs to be developed that is targeted to each of the specialty contracting trades as well as the remodeler and even the consumer who is interested and able to make some energy efficient upgrades.

5.5 Promote Strategic Alliances Among Practitioners

The ultimate success of energy-efficient remodeling, repair, or retrofit depends on coordination of diverse groups including remodelers, energy raters, trade contractors such as roofers, siding contractors, plumbers, electricians, and HVAC contractors, and others. In order to produce effective and efficient business relationships, 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 involves promoting such alliances.

5.6 Promote These Actions to Remodelers, Trade Contractors, and Consumers

PATH can play a critical role in determining what information and educational offerings are available to each of the specialty audiences. A coordinated effort involving key federal and state agencies, utility companies, local government, and industry trade associations would be much more effective at communicating with practitioners and consumers on the availability of the technical information that has already been developed.

Strategy 5. Enable Practitioners to Deliver Energy-Efficient Solutions			
Implementation Activity	**Near Term (<2 Years)**	**Mid-Term (2-4 Years)**	**Long-Term (>5 Years)**
5.1 Collect and Document Information on Programs, Tools, and Resources	✓		
5.2 Establish Recognized, Credible Sources of Information for Users		✓	✓
5.3 Create a Viable Education Platform		✓	
5.4 Develop Online Education and Training Content		✓	
5.5 Promote Strategic Alliances Among Practitioners		✓	✓
5.6 Promote These Actions to Remodelers, Trade Contractors and Consumers		✓	✓

FIGURE 7

6 DEVELOP A PERFORMANCE MONITORING SYSTEM FOR ENERGY-CONSUMING EQUIPMENT

This strategy is directed at development of a system for 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. It is unlike the other strategies because it calls for development of a set of compatible products reminiscent of several items identified in the brainstorming report (e.g. "HVAC Monitoring and Trouble Alert System"; or "Programmable Load Monitoring and Management"). 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 not necessarily reduce energy consumption on its own. Rather, it would provide ongoing consumer education and afford homeowners greater control over their homes and the energy-consuming devices they contain. It could reduce the monthly operating costs of existing homes by giving occupants a clear understanding of the consequences of their behavior. The system also would improve the service life of equipment through delivery and use of real-time maintenance and service requirements. It could improve comfort by allowing for the correction of faulty equipment operation and maximizing opportunities to operate energy-consuming equipment in an economical way.

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.

Consumers have become familiar with set-back thermostats and generally know how to allow their HVAC system to drift when no one is in the house. Typical settings include sleep, awake, leave, and return. However, they don't know how effectively they have managed their energy consumption until the utility bill arrives. Utility meters have become more sophisticated in being able to track time-of-day energy consumption information to relay to the utility company. Marrying these two products would enable the consumer to track energy consumption on a real-time basis and provide immediate feedback on decisions that affect energy use. No such product currently is offered in residential construction.

6.1 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 a limited degree of energy consumption monitoring and control.

Many manufacturers of HVAC equipment and controls, home automation systems, and appliances either are already marketing or are developing equipment that is capable of communicating status and diagnostic information. 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 have the best platforms for further work.

6.2 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 to facilitate 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.

6.3 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 several manufacturers to provide their own versions of the display reinforces 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. Some 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.

6.4 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. More robust wireless networking standards are also coming into wide use. 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 6.3 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.

6.5 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 achieve product differentiation. Some ground rules would make this process more effective. For example, regardless of who designs and manufactures a display, it would be best if every display uses 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 through control menus, 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 display, an enhanced security system panel, a TV set, a personal computer, or a standalone display. Handheld devices also should be considered for use by remodelers and trade contractors.

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

Affordable sensors are needed to collect real-time information on active systems and equipment. Some of the basic items are:

- On/off status of appliances;
- Power requirements for whole-house systems;
- Energy consumption status of smaller system components;

- Maintenance status of mechanical systems; and
- Warnings of impending peak power needs.

Other information that could be valuable to collect and display includes:

- Current and historical information on local weather conditions;
- Status of indoor air quality; and
- Quantitative information on moisture in concealed envelope areas.

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.

Strategy 6. Develop a Performance Monitoring System for Energy-Consuming Equipment

Implementation Activity	Near Term (<2 Years)	Mid-Term (2-4 Years)	Long-Term (>5 Years)
6.1 Identify Current Energy Monitoring, Display, and Communication Products		✓	
6.2 Identify and Involve Missing Players to Fill Product and System Gaps		✓	
6.3 Adopt and/or Develop a Common Communication Standard		✓	
6.4 Identify Candidate Communication Devices or Techniques and Develop Requirements		✓	
6.5 Define a Consumer Information Display Standard			✓
6.6 Evaluate and Develop Multi-Use and Modular Low-Cost Sensors			✓

FIGURE 8

7 INCREASE THE VALUE CONSUMERS ASSOCIATE WITH ENERGY EFFICIENCY

The ranking of this strategy may reflect perceptions that much is already being done by government and the private sector to encourage consumer investment in energy efficiency, and that the PATH program need not invest scarce program resources to duplicate this effort. This should not diminish, however, the importance of continuing to motivate consumers about the value of energy efficient investments. Consumers are notoriously willing to invest in amenities like whirlpools and countertops, but are frugal when it comes to investing in higher levels of energy efficiency for their houses.

EPA's Energy Star Homes Program has devoted considerable resources to developing and delivering consumer messages of this type in recent years, and has successfully built value by associating the Energy Star "brand" with energy savings. The Energy Star label also can be found on a broad range of consumer appliances, like washers, dryers, dishwashers, and refrigerators. The appliance part of the program is managed by DOE. Capitalizing on this brand awareness has been and will likely remain highly relevant to reducing energy use in existing homes. EPA promotes a "Home Energy Advisor" developed by Lawrence Berkeley National Laboratory that presents users with specific energy efficiency upgrade suggestions tailored to the specific house configuration and location. EPA also works closely with industry partners to craft uniform messages and deliver them through multiple media vehicles. At the state level, programs like the one in New York state administered by NYSERDA deliver strong messages to residents of the state about the importance of energy efficiency, and the availability of rebates and other financing vehicles to encourage energy efficient investments. NYSERDA also informs the public on the availability of certified home auditors and repair/replacement professionals.

Activity 7.1 relates to consumer concerns about the credibility of the information they receive from product manufacturers on energy efficiency and energy savings. Uniform messages consistently delivered by credible sources that share common interests in energy efficiency would help reinforce the call to action rather than fostering confusion. The second activity recognizes that consumers have different understandings of the value of energy efficiency. Knowing how much depth of understanding consumers have helps to create messages that will be recognized and understood as part of Activity 7.3. Multiple media will be employed in delivering the messages under this activity. Activity 7.4 focuses on evaluating how well these messages are received by consumers. The messages will be refined and the process will be repeated, as described below.

7.1 Craft Uniform Messages for Consumers

Individual product manufacturers like Owens Corning and Andersen Windows spend millions of dollars each year on television advertising aimed at getting consumers to buy their products. A portion of their message is aimed at getting consumers to understand the value of improving the energy efficiency of their homes. Non-governmental organizations like the Alliance to Save Energy produce public service announcements (PSA) aimed at consumer audiences. The theme of these PSAs is that energy efficiency improvements reduce operating costs, make houses more comfortable, and improve national energy security. Government agencies, like EPA and DOE, use a variety of methods in attempting to get consumers to reduce energy consumption. EPA works through its partners to create more uniform messages.

It is important to understand the approach that each of these organizations is taking to reach consumers with targeted energy conservation messages. The first step is to conduct a comprehensive review of existing messages and an assessment of the most effective messages. Areas of overlap or common interest form the potential for collaboration by these stakeholder groups.

PATH can play an important role in bringing together key manufacturers, government agencies, and non-governmental organizations to focus on creating a more uniform message on the value of energy efficiency improvements in existing homes. The result of this task will be agreement on opportunities for collaboration as well as an understanding of the roles that each organization will play in developing new messages.

7.2 Gauge Existing Consumer Knowledge of the Value of Energy Efficiency

PATH has started the process of learning directly from housing consumers about how they make decisions with respect to new technologies. A series of focus groups at the Summerset at Frick Park project in Pittsburgh provides insight on how consumers make tradeoffs between investments in functional versus aesthetic upgrades in new home construction. More research needs to be done in this area, particularly as it relates to consumer decision making relating to their own remodeling or energy upgrade projects. What motivates consumers? Do they make decisions based on crises such as war or energy blackouts in parts of the country? Do they make decisions based on financial return? Or, simply because it makes their house less drafty and more comfortable? Understanding how these factors interact to drive decisions of individual consumers would make it easier to construct effective messages that motivate action.

7.3 Deliver Messages Through Multiple Media

It is unrealistic to expect that large corporations will invest significant resources on collaborative advertising with industry or government partners. They focus first and foremost on selling products and achieving profitability. However, there is a strong rationale for collaborating on

message content so that consumers get sufficient information to make informed decisions regarding upgrading their homes' energy efficiency. By increasing consumer awareness of the value of energy conservation upgrades, the market for energy efficient products and services will increase.

The groups that work together on message content under Activity 7.1 will identify common or uniform messages that each can use in their own advertising campaigns. They will also examine opportunities for collaboration. The PSA offers one avenue for reaching consumers. Building on the lead taken by the Alliance to Save Energy, PATH can pull together complementary sets of interests to cooperatively fund PSA development and delivery. These groups should also examine the potential for reaching a larger number of consumers through cooperatively funded paid advertising.

7.4 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. Advertising firms have sophisticated ways of measuring impact from a communications campaign. Numerically based assessment should also be balanced with consumer based qualitative research to determine if the messages are on target, if they are communicating a message that the consumer understands, and whether it will persuade them to make an energy efficiency upgrade to their homes.

7.5 Refine Messages, Then Repeat the Process

Once armed with the results of the assessment noted in Activity 7.4, involved stakeholders need to adjust 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 the entire process of message delivery, assessment and revision should be repeated.

Strategy 7. Increase The Value Consumers Associate with Energy Efficiency			
Implementation Activity	**Near Term (<2 Years)**	**Mid-Term (2-4 Years)**	**Long-Term (>5 Years)**
7.1 Craft Uniform Messages for Consumers		✓	✓
7.2 Gauge Existing Consumer Knowledge of the Value of Energy Efficiency		✓	✓
7.3 Deliver Messages Through Multiple Media		✓	✓
7.4 Measure the Effectiveness of the Message and Delivery Vehicles		✓	✓
7.5 Refine Messages, Then Repeat the Process		✓	✓

FIGURE 9

8 BUILD CREDIBILITY FOR SERVICE PROVIDERS

Consumer mistrust of the building and remodeling industry is widespread. Although many of these feelings may be based on misconceptions and negative generalizations, the remodeling industry is characterized by a large number of small firms who are not sufficiently capitalized to weather large fluctuations in cash flow. Most remodeling companies work on the "draw" system, where the customer provides a down payment on services to be performed and makes additional payments after pre-agreed stages of the construction process are completed. The discussion in Strategy 5 pointed out that many remodelers do not start their businesses with strong backgrounds in management and business. They may have supervised crews in the past but had little responsibility for bidding jobs. The draw system can turn into a nightmare for remodeler and consumer alike if the remodeler gets behind on progress and needs to keep cash flow up. Their only alternative is to start a new job so that they can generate more cash. This puts more pressure on their ability to deliver previously scheduled jobs as well as their new ones.

Another side of the credibility equation for consumers is the prospect of being held captive by specialists. Consumers know that when they have a service problem with an appliance like a central air conditioning unit, for example, they are at the mercy of the service provider who comes to give them an estimate for the repair or replacement. Since most repairmen charge for the service call, the consumer may find it difficult to get competitive bids for the work to be performed.

This strategy focuses on key steps that service providers can take to improve credibility with their customers. Activity 8.1 suggests that product manufacturers can do more to build the credibility of the remodeling trades by providing them with tools they need to succeed. Activity 8.2 encourages utility companies to help qualify and publicize the services of contractors who meet their performance criteria. Activity 8.3 explores ways to motivate contractors to upgrade their skills training. Activity 8.4 proposes that education and training programs in the area of energy efficiency and business management should be recognized by state programs requiring CEU's. New York state is investigating an industry credentialing process similar to the suggestion in Activity 8.5.

8.1 Promote Stronger Relationships Between Suppliers and the Remodeling Trades

Product manufacturers must first make a stronger effort to understand the changing demographics of those who are involved in residential remodeling and retrofit. This includes understanding the technical and business skills of their customers in the remodeling and energy retrofit trades; it also

involves understanding language requirements. The producers would also benefit by studying what types of information their customers need to build their credibility in the marketplace. Do they need more informative, less sales-oriented marketing materials? Or, do they need "leave behind" materials that showcase the benefits of the product or material the remodeling contractor is installing? Do they need more graphically oriented, language appropriate installation instructions that enables the contractor to minimize their call-backs?

Product manufacturers can also help build the credibility of their contractor client base by providing co-op advertising opportunities for their customers. Name brand products allied with a local contractor leaves the impression with the homeowner that the contractor installs quality products. Manufacturers need to support this by ensuring that the contractors know how to install their products to manufacturer specifications.

There is considerable emphasis today on systems level or whole house building performance. Contractors need to understand how to deliver comfort for their customers that reduces overall energy cost at an affordable price. The contractor needs to know what steps to take to deliver best energy efficiency at the price the customer expects. Manufacturers have a role in supporting this by not pushing their customers toward a single high performance purchase that consumes too large of a proportion of the home energy retrofit budget. They can do this by working closely with the energy performance contractors like the ones discussed in Activity 8.5 below.

Many manufacturers have in-house business skills improvement training. They should consider developing online business skills improvement training programs for their contractor customers. If they can help their contractors succeed in business, it will help them sell more product.

8.2 Recognition of Qualified Contractors by Utility Companies

Utility companies can support efforts by contractors to improve their credibility by accrediting or certifying contractors and making this information available to utility customers throughout their service region. The utility company can provide training to its program specifications or accept the certification of recognized training and certification organizations. This recognition provides assurance to homeowners that they will receive a qualified estimate and workmanship for their remodeling or energy retrofit work.

8.3 Motivate Contractors to Take Advanced Energy Efficiency Training

Despite the wealth of education and training programs available nationwide, there is still concern that an insufficient number of remodelers and trade contractors are taking advantage of this training. Most training requires attendance at a seminar facility, either for hands-on training or for a

conference workshop. Many contractors cannot afford the time away from work to take advantage of training. Online training that fits the schedules of contractors could give them better access to advanced training and help them succeed in a new market area. However, contractors are generally not yet internet savvy and would not be able to take advantage of online courses if they were available.

This activity focuses on ways to motivate the remodeling and contracting trades to appreciate the value of advanced energy efficiency training and to recognize how this training will open market opportunities for them with their customers.

8.4 Promote Statewide Acceptance of CEU Credits for Energy Efficiency and Business Management Training for Remodeling Trades

Not all states have mandatory annual continuing education requirements in order for contractors to maintain their licenses, but some states, like Florida, do require ongoing education and training. In these states, programs of education and training relating to energy retrofit need to be accredited by the state. It would be good if these programs tied into the certification process discussed in Activity 8.5 below.

8.5 Establish an Industry-Recognized Contractor Credentialing Program

EPA's Energy Star Home Improvement Program supports the development of contractor credentialing programs. The Building Performance Institute in New York State serves as a model of the type of contractor certification program the agency envisions. BPI is developing a trade-based certification process. It sets the standards and administers certification of technicians and accreditation of companies. Remodelers, inspectors, builders, insulation contractors, and heating and cooling contractors are examples of the trades that can benefit from building performance certification. The BPI-certified contractor is trained to understand the whole house and can help guide homeowners in making home improvement decisions to maximize energy savings, comfort and safety. If issues are identified that require services outside of a building performance contractor's field of expertise, the homeowner is notified of the issue and given the option to bring in a subcontractor to make the appropriate repairs. BPI currently operates in New York state but has initiated training in conjunction with the Kansas Building Science Institute in Kansas City.

Strategy 8. Build Credibility For Service Providers			
Implementation Activity	**Near Term (<2 Years)**	**Mid-Term (2-4 Years)**	**Long-Term (>5 Years)**
8.1 Promote Stronger Relationships Between Suppliers and the Remodeling Trades		✓	✓
8.2 Recognition of Qualified Contractors by Utility Companies		✓	✓
8.3 Motivate Contractors to Take Advanced Energy Efficiency Training			✓
8.4 Promote Statewide Acceptance of CEU Credits for Energy Efficiency and Business Management Training for Remodeling Trades			✓
8.5 Establish an Industry-Recognized Contractor Credentialing Program			✓

FIGURE 10

U.S. Department of Housing and Urban Development
HUD User
P.O. Box 23268
Washington, DC 20026-3268

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POSTAGE & FEES PAID
HUD
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Official Business
Penalty for Private Use $300
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