



Affordability and Value Through Housing Technology

Programs and Services Guide





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PATH’s partners shape the quality and performance of America’s homes and encourage new housing technologies and approaches. This booklet is a practical guide to these activities and programs. PATH encourages you to read through and find the tools and information you can use to take advantage of the services and opportunities that PATH offers. For further details, log on to the PATH Web site at www.pathnet.org.

The PATH program is working to make building homes easier for the builder—and more energy efficient and stronger for homebuyers. Through my work with the PATH program, I am able to determine which expenses are the most worthwhile for building high-quality, affordable homes.

—Buddy Hughes, President, Hughes Construction
Lexington, North Carolina



PATH

Joining Forces To Build the Next Generation of American Homes

The ideal home has been redefined. Today's ideal home is a well-designed, affordable, durable, and efficient home that serves as a solid, long-term investment. The new generation of homeowners and buyers want more from their homes. They want homes that are more energy efficient, affordable, and environmentally safe. Innovative housing technologies are key components in the redefined home, and the Partnership for Advancing Technology in Housing (PATH) is at the forefront of these new technologies.

PATH, administered by the U.S. Department of Housing and Urban Development, is a partnership of federal agencies and innovative housing industry leaders that focuses on emerging housing technologies to improve the affordability

and value of new and existing homes.

Despite the importance of the housing industry to the American economy, not enough investment is being made in new residential technology.

Why?

The housing industry consists of homebuilders, consumers,

product manufacturers, researchers, financial institutions, and government agencies, all of which are responsible

for only one part of the technology development process. For example, homebuilders may hesitate to apply a specific technology to their new development because of the risks and regulatory barriers. Consumers may not have access to information that

could help them make educated choices for their families' needs. Product manufacturers may not have the resources to develop innovative new ideas. Researchers may not have the connections with industry leaders necessary to help them apply the latest research in the field. And financial institutions may not know the full potential effect of a new technology on home appraisals or mortgage rates.

PATH brings these diverse groups together to research new products, provide information and outreach, and help industry innovators overcome hurdles in building the next generation of American homes.

PATH Partners: At the Forefront of Housing Technology

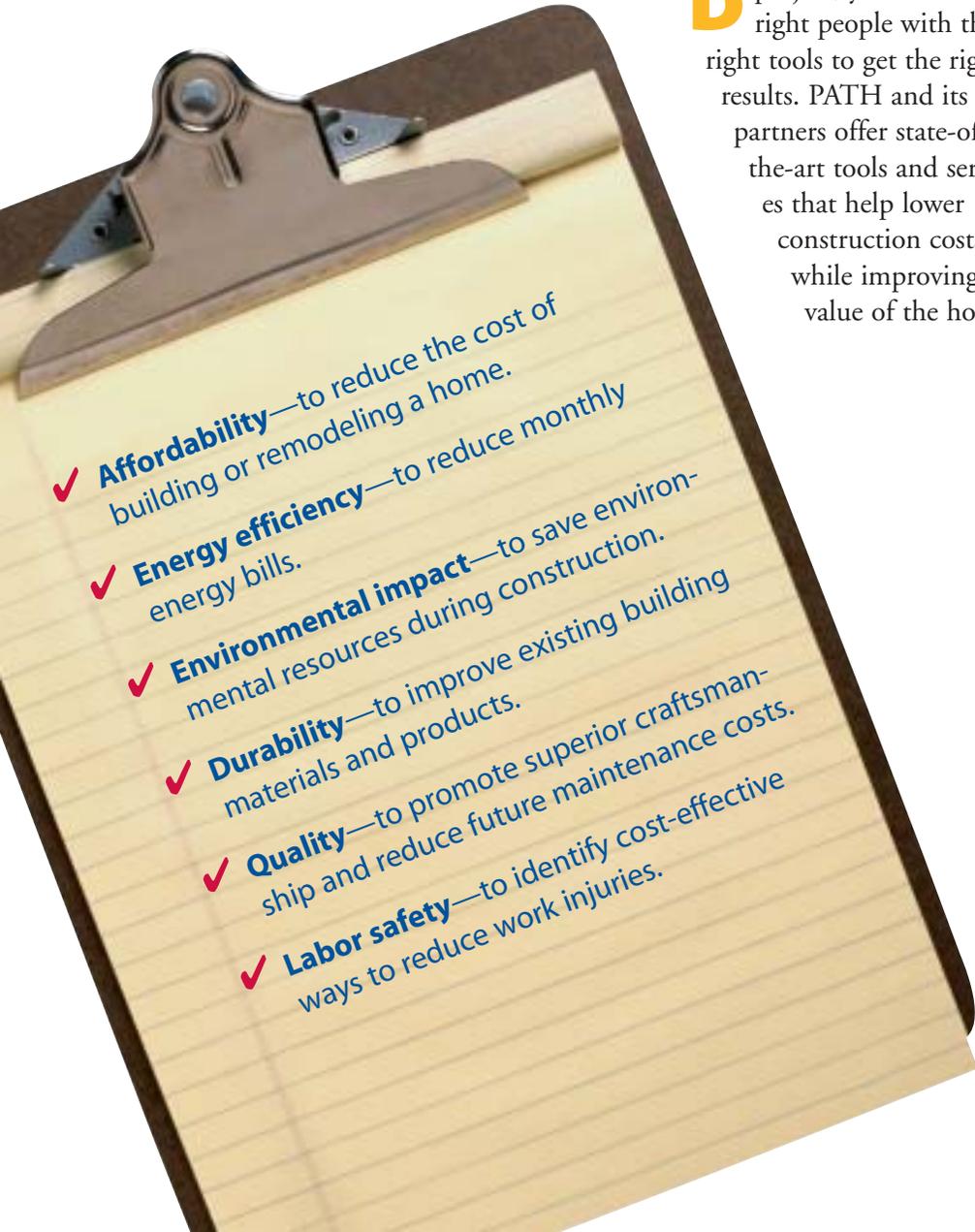
PATH partners are at the forefront of the housing industry every day. They include:

- Homeowners.
- Homebuilders.
- Researchers.
- Product innovators.
- Housing developers.
- Housing and financial institutions.

PATH at Work

The Right Tools for the Right Results

Before you begin your project, you need the right people with the right tools to get the right results. PATH and its partners offer state-of-the-art tools and services that help lower construction costs while improving the value of the home.

- 
- ✓ **Affordability**—to reduce the cost of building or remodeling a home.
 - ✓ **Energy efficiency**—to reduce monthly energy bills.
 - ✓ **Environmental impact**—to save environmental resources during construction.
 - ✓ **Durability**—to improve existing building materials and products.
 - ✓ **Quality**—to promote superior craftsmanship and reduce future maintenance costs.
 - ✓ **Labor safety**—to identify cost-effective ways to reduce work injuries.

ToolBaseSM—PATH's Technical Information Resource for the Homebuilding Industry

ToolBase is PATH's noncommercial Web site dedicated to residential construction information. It provides free and easy access to the most accurate technical construction information available. Users can search by subject, keyword, or subsystem. ToolBase services also include an information hotline (**800-898-2842**) staffed by housing experts who can answer questions and identify industry resources. The same housing experts can be reached via e-mail at toolbase@nahbrc.org.

All ToolBase services are made possible by financial support from both government and industry sponsors including the U.S. Department of Housing and Urban Development (HUD). Other sponsors are the CertainTeed Corporation, the National Association of Home Builders (NAHB), the Steel Framing Alliance, and the Wood Truss Council of America.

TOOLBASE
SERVICES

PATH Technology Inventory—Tools To Build a Better Tomorrow

Also included in ToolBase (www.toolbase.org) is PATH's Technology Inventory, listing more than 150 emerging technologies that demonstrate great potential for improving housing performance.

PATH's Technology Inventory provides information on new products, construction processes, and manufacturer contact information for emerging technologies (technologies with a market share of 5 percent or less). The Technology Inventory covers a wide range of categories—from new materials, components, and systems to complete homes. Each entry contains specific details about the product, installation features, benefits, costs, limitations, code and regulatory restrictions, and manufacturer information.

Looking for an alternative to copper plumbing? Look no further than PATH's Technology Inventory.

PATH and its partners across the country have evaluated the latest plumbing alternatives for durability, cost effectiveness, and ease of use.

One of the technologies included in PATH's Technology Inventory is the plastic

plumbing manifold, a new system for residential water distribution.

The developers at Oakwood Homes wanted the latest plumbing technology installed in their new development, The Bungalows. They planned to use cross-linked polyethylene (PEX) piping with the plastic plumbing manifold system as an alternative to copper plumbing. PATH partnered with Oakwood Homes to evaluate the technology's performance—from the builder's installation to the homeowner's daily use.

Compared with copper piping, the PEX pipes and plastic plumbing manifold:

- Reduced installation time by several hours per home.
- Cost 15 percent less to install.
- Had fewer joints to install than a standard copper system.
- Passed a pressure test without leaking.

Have Questions? Contact ToolBase

- Log on to www.toolbase.org.
- Call the Ask-an-Expert Hotline at 800-898-2842.
- E-mail queries to toolbase@nahbrc.org.

You can also:

- Sign up for *PATH E-News*, a biweekly newsletter about residential construction.
- Subscribe to *TechNotes* to receive information on the latest industry trends and issues.



Vanguard Piping Systems, Inc.

The plastic plumbing manifold system.

PATH is designed to provide durable and affordable homes for the future, reduce construction costs, and increase energy efficiency. At Green Valley Ranch, we are a proud partner with PATH and the NAHB Research Center. It has been very successful.

—Pat Hamill, President, Oakwood Homes
Denver, Colorado

NEST—Construction Software That Saves Time and Money

The National Institute of Standards and Technology (NIST) is developing several cutting-edge home product evaluation tools for PATH and for all homebuilders and homeowners. These software tools, collectively called NEST, or National Economic Service-Life Tools, will provide information to help make economic decisions about the service life or durability of homes. So far, NEST includes the Building for Environmental and Economic Sustainability (BEES) software, which compares the environmental effects of various standard building products.

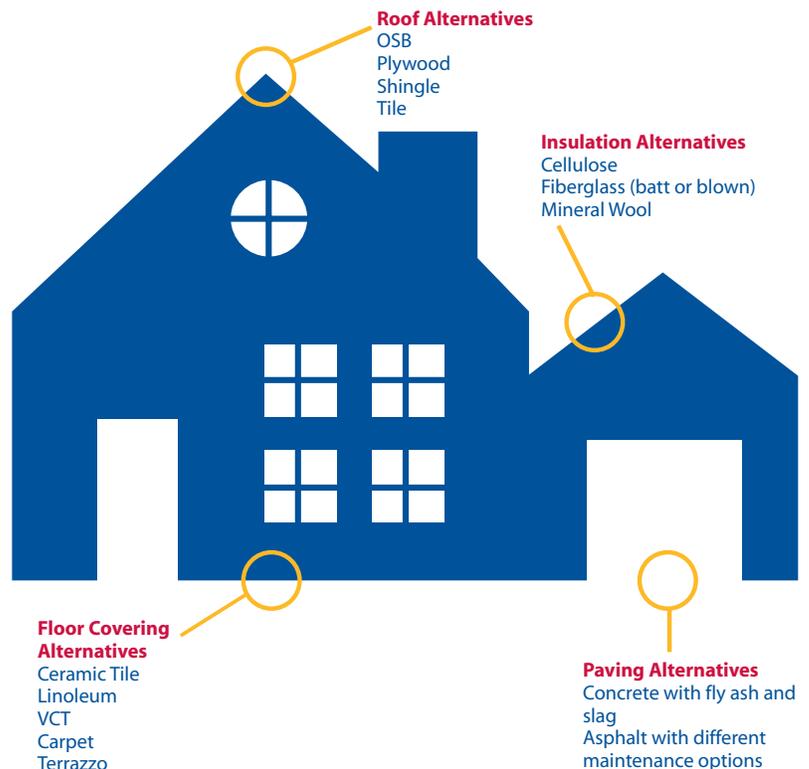
Other NEST tools are on the way. The Durability Doctor is a Web-based System designed to assist in the decision-making process that affects the durability of major

housing components, including tips on how to install, inspect, and maintain those components, and Web links to other reliable information. The Replacement Planner Tool will help homeowners budget for the replacement of major housing systems. The Durability Evaluator Tool will estimate the life-cycle benefit of increased durability. The Service-Life Predictor Tool (which includes the Sealant Selector Tool) will estimate the expected service life of all the components in a home.

The U.S. Environmental Protection Agency specifies BEES as a tool that purchasers, builders, and manufacturers can use when purchasing environmentally friendly building products.

BEES is available as a free download from the NIST Web site (www.bfrel.nist.gov/oae/software/bas/model.html).

National Economic Service-Life Tools (NEST) Software



This is one sample of the product alternatives that NEST offers.



PATH Services

Solutions for the Homebuilding Industry

PATH has not only the right tools for the right results now but also the ongoing services the housing industry needs to get the job done. PATH and its partners are researching barriers in residential construction, streamlining code approvals, and scanning the horizon for the latest housing technologies.

Overcoming Hurdles in Housing Construction

To develop successful practices and products for the housing industry, PATH must first understand the barriers to the products' research and implementation. These barriers can be found in the construction process; the economic, social, or political aspects of a new technology; or the technology's performance.

A primary PATH function is to review the issues involved with each technological barrier and develop potential alternatives and improvements. PATH also considers the legacy of the barriers and the ability of different industries to institute change.

PATH has developed strategies to overcome common development barriers within the housing industry, such as:

- Working with financial institutions to provide incentives to expand new housing technology.
- Encouraging the testing and validation of new housing technology that can be used to update building codes.
- Promoting insurance policies that reward the use of innovative housing technology.

PATH—Working To Streamline the Nation's Building Codes

Streamlining the national building code process can expedite residential construction without compromising the safety of the homeowner or homebuilder. Builders, contractors, and designers have all expressed a willingness to work together to solve regulatory problems. PATH and its partners have created regulatory assistance programs to help them.

Did you know that the regulatory process accounts for 20 percent of the purchase price of a new home?

PATH and the National Conference of States on Building Codes and Standards, a cooperative effort among 55 national organizations and federal, state, regional, and local governments, are working towards streamlining the current regulatory process. This streamlining project will bring better management practices to the regulation of the siting, design, and construction of all types of buildings throughout the United States.

Imagine a nationwide building regulatory system without the redundancy, complexity, and inefficiency that characterize the current system.

The new system would allow for uniform national codes and standards for state or local adoption and enforcement. Computer software would link the system into a seamless network to share information among relevant agencies, regulatory jurisdictions, builders, and the general public. Information would flow in a universal, plain-language format to reduce regulatory costs, save time, and provide an unsurpassed level of service to all parties involved in the regulatory process.

PATH—Regulatory Evaluation

PATH has also collaborated with the National Evaluation Service (NES), an independent nonprofit organization, to conduct voluntary and advisory programs to evaluate building materials, products, and systems. NES and PATH have developed the following programs:

- **PATH Technical Assistance Program**—assists product manufacturers in understanding issues related to code and product approval early in the product development cycle.

- **Protocol for Insulating Concrete Forms (ICF)**—helps manufacturers of ICF technology ensure that their technology adheres to U.S. building codes.

- **Protocol for Durability Assessment of Building Products and Systems**—provides standard guidelines for durability-related findings, products, and assemblies of products.

PATH Technology Roadmapping—Focused on the Future

PATH Technology Roadmapping pinpoints specific technological needs in the housing industry ranging from the development of new materials, products, and systems to improved methods of production and software. PATH's own Industry Roadmapping Committee, composed of more than 150 prominent industry leaders, has met over the past few years to determine the key technology needs for new home construction.

Through PATH Technology Roadmapping, the residential construction industry is able to prioritize its technology development agenda and decide which “roads” to choose for future research.

Current PATH Roadmaps include panelization, whole house systems, and information technology.

Panelized systems are factory-built homes in which panels—a whole wall with windows, doors, wiring, and exterior siding—are transported to the construction site and assembled. PATH's Technology Roadmap found that the use of advanced panelization techniques had significant benefits to builders with respect to labor skills, quality control, standards, and economical engineering.

Whole house design takes a systems-oriented view of housing construction, which could yield methods of building faster, at lower cost, and with higher quality. Lack of

Regulatory Streamlining Can:

- Reduce overlapping and unneeded regulations.
- Increase the quality of safe and affordable homes.
- Enhance a community's ability to accommodate ever-changing demographics.

a systems process is a barrier to building affordable houses as well as energy-efficient, durable homes.

Information technology has the potential to accelerate and streamline the homebuilding process just as it has enhanced the efficiency of most other manufacturing industries, particularly the automotive and aerospace industries. Yet, information technology has not yet been widely implemented in the homebuilding process, probably because of the industry's fragmentation and because most houses are constructed at a job site rather than in a factory. PATH Technology Roadmapping provides both a vision of how information technology can transform the homebuilding process and a detailed 10-year plan for achieving that vision.

PATH's Information Technology Roadmap embraces four major segments to achieve its goals:

- **Common language**—to enable people, processes, and information technology tools to communicate across the residential construction process.
- **A streamlining approach to the regulatory process**—to increase efficiency in permitting, plan review, site

inspection, and product approval.

- **Noncommercial “information portal”**—provides a source of objective, reliable technical information about homebuilding for builders, trade contractors, and consumers.
- **Production management systems from conception to closure**—link information technology tools and data within and between firms to improve the efficiency of the housing process.

Scanning the Horizon for New Housing Technology

PATH understands that technology breakthroughs in one industry can have spillover effects on another. PATH technology scanning looks for new and existing technologies in other industries that have potential future applications in the housing industry. The idea behind technology scanning is simple: Examine the similarities among different industry applications and see how they can improve new and existing construction practices. By researching technology advances in other industries, PATH can then apply the same advances to

housing. Technology scanning also draws on university research, government labs, and international research organizations as sources for new technologies.

PATH technology scanning recently identified automotive fuel cell technology as an efficient method to convert fuel energy to electrical energy in the housing industry. Imagine a new energy source that will be affordable, lower current emissions, and minimize weather-related power outages.

Did you know that you may soon be able to install a power plant in your own home?



Residential fuel cells are a prime example of PATH technology scanning that paves the way for improved housing efficiency.

PATH

Resources and Funding To Support Innovation in American Housing

Before you conduct the research or start designing the plans, you need to locate the funding. PATH and its partners can help.

PATH and the National Science Foundation—Encouraging Innovation

PATH and the National Science Foundation (NSF) created the NSF–PATH Award to encourage academic institutions to collaborate with industry and government laboratories to research emerging technology.

Introduced in 2000, the NSF–PATH Award brings together research and the “real world” to effectively develop practical housing innovations for the building industry. These research projects provide the background research needed to bring housing technologies to the market.

For more information about the NSF–PATH Award, log on to the PATH Web site at www.pathnet.org.

Technology and Funding Support

HUD and PATH encourage developers to rapidly introduce new building products designed to increase the quality, affordability, durability, energy efficiency, and environmental performance of today’s housing. In support of these goals, PATH and HUD offer financial assistance to be used with other industry funds for research projects that support PATH goals for furthering the use of new technologies in the homebuilding industry.

For more information on research assistance and HUD cooperative development projects, log on to the PATH Web site at www.pathnet.org.

There is rarely a concerted effort to fund research ideas in housing technology, especially at the university level. Through the NSF–PATH program, PATH is creating the networks and services needed to institutionalize technology research. These networks will benefit both the housing industry and the research community for years to come.

—Dr. Matt Syal, Michigan State University

PATH Onsite

Results That Last a Lifetime

Advanced technology is the driving force of change in America. From the stock market to the health-care industry, technology is making striking improvements in how we live. In the housing industry, these improvements are measured by results in the field. PATH actively works with builders, remodelers, and manufacturers to assess these results through Field Evaluations and Demonstration Sites.

Field Evaluations— Providing Feedback From the Field

Field Evaluations are the first step in introducing PATH technologies to the construction industry. Although many PATH technologies are not new, information about them is either vague or nonexistent. Data gathered by the NAHB Research Center in Field Evaluations fills this void and provides valuable feedback to

product manufacturers on needed improvements.

Shea Homes—Saving Energy in San Diego

A new PATH Evaluation Site is now under way in San Diego, California. Shea Homes, one of the largest builders in the United States, brought the “high-performance home” to the market. The Comfort-WiseSM home features innovations that increase energy efficiency, including solar photovoltaic roof panels and passive solar thermal water heating. PATH was there to evaluate energy savings.

As one of many PATH Evaluation Sites across the nation, Shea Homes is receiving technical support and performance-related information from PATH about these renewable energy systems.

Together, PATH and Shea Homes are evaluating the latest technologies at work.

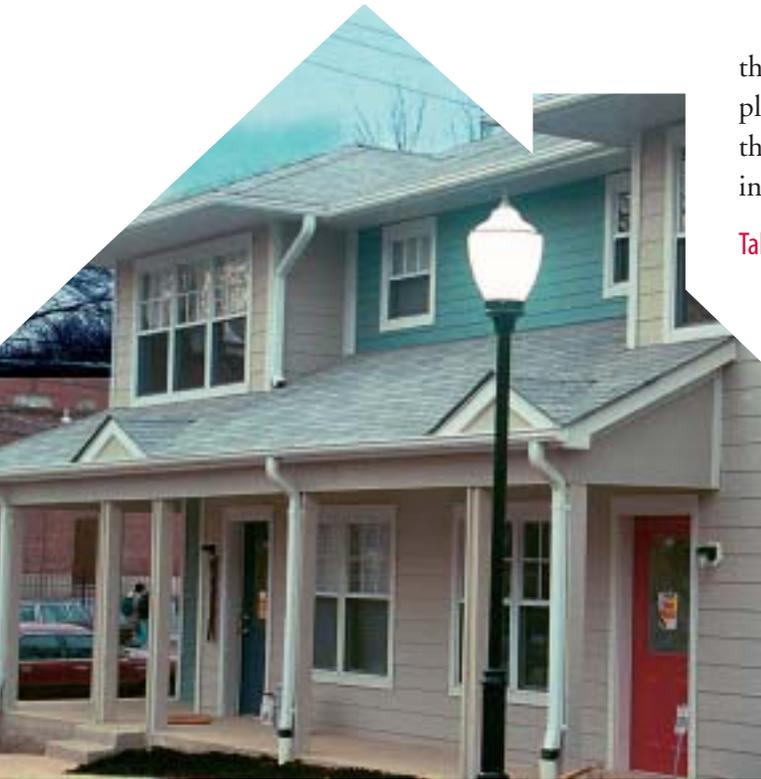


Photovoltaic roof panels are installed on a home built by Shea Homes in San Diego to increase the home's energy efficiency.

Each home's performance is being evaluated based on their overall energy consumption and heating and cooling costs.

PATH is evaluating the home's:

- Electric consumption.
- Time-of-use electric consumption.
- Peak 15-minute demand.
- Cooling electric energy.
- Heating electric energy.
- Hot water consumption and use.
- Major appliance use.
- Solar photovoltaic energy generation.
- Indoor air temperature.
- Attic air temperature.
- Outdoor climatic conditions.



Steve Winter Associates, Inc.

As a PATH Demonstration Site, Takoma Village in Washington, D.C., is using innovative housing technologies such as geothermal heating and cooling systems and renewable framing materials.

PATH Demonstration Sites—Showing Developers How It Can Be Done

PATH Demonstration Sites include 25 or more homes used to illustrate and evaluate how PATH technologies perform on a larger, community-wide scale. Demonstration Sites focus on new and emerging technologies and allow quick feedback to the building industry.

These projects serve as models for the U.S. construction and housing industry because of

their approaches to land planning and design and their incorporation of innovative technologies.

Takoma Village—Bringing Innovation to New Homes

Homes are built or renovated every day. However, introducing new technologies to improve the home is sometimes difficult. Through outreach programs like national Demonstration Sites, PATH is showcasing the latest advancements in housing technology.

Takoma Village in Washington, D.C., is a development of 22 new townhouse-style homes divided into 43 housing units. Attractive, reasonably priced, energy-efficient housing is scarce in this Washington neighborhood, and Takoma Village, the most recent PATH Demonstration Site, is showing area developers how it can be done. Through the use of innovative technologies such as geothermal heating and cooling systems along with renewable framing materials, Takoma Village was built within budget and on

Takoma Village is a prime example of a successful collaboration between a community and technical innovators.

schedule. Today, all units have been sold and occupied, and residents are enjoying lower energy bills and increased home values.

Through its Demonstration Sites, PATH proves that technology is making a difference right where Americans live.



Steve Winter Associates, Inc.

Geothermal heating and cooling system installed in a home at Takoma Village.

PATH in Practice

Applying Technology Research in the Field

PATH knows that even the best research is wasted if it can't be applied in the field. That's why PATH and its partners team up to bring the research lab into the field and deliver the results into the hands of those who need it.

Partners—Working With Industry Leaders

PATH works through groups such as the NAHB Research Center to develop real-time information for the housing industry. Affiliated with the Washington, D.C.-based NAHB, a federation of more than 800 State and local builder associations, the Research Center has extensive access to the real world of homebuilding.

NAHB's more than 200,000 members are builders, remodelers, manufacturers, and other housing industry professionals from across the country.

The NAHB Research Center tests new and emerging technologies, demonstrates how to use technologies still in development, advises on new uses of building products, and creates publications from its research.

Recently, the NAHB Research Center completed PATH-funded research on design improvements for insulating concrete forms (ICFs). ICFs are typically constructed of rigid foam plastic insulation, a composite of cement and foam insulation. The forms usually remain in place after the concrete has cured to provide added insulation.

Although ICFs have been in use in the United States for more than 20 years, they lacked efficient design guidelines and requirements. As a result, those who built ICF homes had to incur an additional cost to engineer each application.

The NAHB Research Center developed the *Prescriptive Method for Insulating Concrete Forms* manual to eliminate these costs. The manual can be downloaded from the PATH Web site and includes definitions, limitations of applicability, construction details, and thermal guidelines for application.

Did you know that one out of six new single-family housing starts were manufactured homes?

PATH Works To Improve Manufactured Housing

Manufactured housing is quickly becoming a viable source of affordable housing for first-time homebuyers. With this developing and growing market, the manufactured housing industry will need new processes and procedures to meet the demand. PATH is working with the Manufactured Housing Research Alliance (MHRA), an industrywide consortium of HUD-code manufacturers, to make manufactured housing more durable and affordable. With funds provided by PATH, MHRA is identifying better design and construction practices.

Industry growth will occur partly through the adaptation of manufactured home designs for new applications. MHRA-sponsored research will eliminate barriers to the use of HUD-code homes in urban settings; merge manufactured homes with site-built components, resulting in hybrid designs; and create designs that serve emerging niche markets, such as assisted living for seniors.

Universities Breaking New Ground With PATH

Michigan State University is one of several universities conducting research through PATH to improve manufactured housing beyond the efforts described above. Through a joint NSF–PATH Award, faculty from the university’s Housing Education and Research Center have been studying the manufactured housing production process and have identified potential major changes in the assembly process, materials inventory, and in-plant delivery systems that could, if adopted by the industry, improve efficiency, cost effectiveness, and quality.

PATH and the U.S. Department of Energy—Shedding Light on Energy Conservation

The U.S. Department of Energy (DOE) Laboratories serve as the nation’s leading energy research institute. DOE’s Office of Building Technology, State and Community Programs developed the Emerging Technology Program to research the latest energy-saving innovations and increase demand for energy-saving technologies in residential construction.

DOE and PATH are currently researching the benefits of electrochromatic (EC) windows. EC windows are “smart” windows in which an electrical signal changes the light transmittance, transparency, or shading of the unit. Through either electrically conductive films or suspended particles, the technology uses an electric current to transfer ions from one layer of EC material to

another, causing a change in tinting. A licensed electrician must install the windows because they require an electric source and switch.

EC windows block significant amounts of ultraviolet light and radiant heat. Because of the decreased heat gain from solar energy, these windows can cut energy use in a building by an estimated 50 percent. Additionally, EC windows slow the fading of interior furnishings by reducing their exposure to ultraviolet light.

The glazing is currently poised for commercialization, and PATH and DOE are evaluating field studies and market feedback to assess the opportunities, benefits, and commercialization issues related to the use of these windows in new homes. The new EC windows are expected to change the way builders, architects, and engineers design and construct homes in the near future.

PATH—Joining Forces To Build the Next Generation of American Homes

PATH and its partners are committed to finding innovation throughout the housing industry and to making these innovations work—in the lab, in the field, and in the home. To learn more about PATH’s resources, log on to the PATH Web site at www.pathnet.org. You will find detailed descriptions, up-to-date reports, and useful information about all of PATH’s programs.

Activities and Programs

The following lists all of PATH's activities and programs, including those not highlighted in this guide. To find out more about the activities or programs listed, visit the **PATH Web site at www.pathnet.org** under Activities and Programs and look for the corresponding heading.

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U.S. Department of Housing and Urban Development
Partnership for Advancing Technology in Housing
451 Seventh Street, SW, Suite B133
Washington, DC 20410-0001

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