PATH Technology Inventory Review

Prepared for

The Partnership for Advancing Technology in Housing
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Written by:
NAHB Research Center

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by the NAHB Research Center

Executive Summary

This report describes the process and results of a short-term activity to identify those technologies in the 162-item PATH Technology Inventory that should be high priority candidates for a concerted PATH technology transfer or diffusion effort.

The high priority candidates were chosen as follows:

1. Five NAHB Research Center professionals who have spent most of the past several years evaluating technologies for the technology inventory and helping builders use them in the field nominated those technologies they thought showed most promise in contributing to PATH goals.

2. These five professionals, plus four additional professionals (three of them independent consultants not involved with the PATH Technology Inventory, but intimately familiar with the PATH program and goals), spent 1-1/2 days reaching consensus on:

    a) Establishing criteria for selecting the candidates;

    b) Identifying the high priority candidate technologies and the rationale for selecting these technologies;

    c) Listing barriers to the transfer/diffusion of these technologies; and

    d) Identifying preliminary strategies to implement the technology transfer/diffusion and listing the stakeholders who need to be involved.

The criteria used were the following:

- There is a demonstrated potential to significantly impact five PATH goals;
- The barriers to diffusion must be manageable; and
- There is a need for PATH involvement.

The 10 technologies identified as high priority candidates for concerted technology transfer or diffusion efforts are:

- Frost Protected Shallow Foundations
- Home Run Plumbing Systems
- HVAC Optimization
- Tankless Water Heaters
- Air Admittance Vents
- Shared (Community) Wastewater Treatment
- Low Impact Development
- Integrated Steel/Wood Combination Framing
- Pre-cast Concrete Panels (Walls & Foundation)
- Engineered Panelized Systems

Introduction

The National Academy of Sciences (NAS) report for 2002 recommends that the Partnership for Advancing Technology in Housing (PATH) “should focus on (1) identifying, understanding and removing barriers to, and (2) disseminating information for the development of new technologies, as well as (3) increasing industry investment in technology development.” The report also states that “Effective communication for the development and diffusion of technology in housing continues to be one of the major opportunities and one of the major obstacles for PATH.”

Since its inception, PATH has made significant progress in identifying emerging home building technologies, in developing roadmaps for specific types of technologies important to the industry, and in identifying technologies available or under development in other industries that could be applicable to the home building industry. It has also funded basic and applied research and development through organizations like the National Institute of Standards and Technology (NIST) and the National Science Foundation (NSF).

This body of technology knowledge developed in the PATH program needs to be effectively communicated to the industry not only to encourage and facilitate the development of new technologies and products, but also to accelerate the diffusion of existing technologies that hold the promise of making significant progress toward PATH’s goals. The technologies in the current PATH body of knowledge are in all stages of research and development, such as:

a) Concepts and ideas embodied in PATH Technology Roadmaps and Technology Scans;

b) Basic and applied research funded by PATH; and

c) Emerging and mature products embodied in the PATH Technology Inventory and Field Evaluations.

This report deals with the technologies included in the PATH Technology Inventory, many of which have been or are being evaluated in the field through PATH-sponsored field evaluations. (Visit www.toolbase.org for a complete listing and description of the Technology Inventory and Field Evaluations.)

Objective

The current PATH Technology Inventory contains more than 160 items, all of which show potential to significantly impact PATH's goals. The objective was to identify a short list of technologies upon which PATH and their partners should focus technology transfer efforts in the near future. This is not to say that these technologies are necessarily "the best," but only to say that given their current stage in the diffusion process, they are the technologies (in the Technology Inventory) that promise to provide the most benefit from PATH involvement.

Approach

The approach to identifying the high priority candidates for technology transfer was:

- Develop the criteria for evaluating the technologies;

- Ask the people who are most familiar with the technologies—those who have been working on the PATH Technology Inventory and PATH Field Evaluations—to nominate candidate technologies; and

- Assemble a panel of experts, including the above group, to discuss and evaluate the nominated technologies in relation to the selection criteria.

Participants

The NAHB Research Center staff has been significantly involved in PATH Technology Inventory and PATH Field Evaluations—with the exception of Tom Kenney. The independent consultants in addition to Tom Kenney represent in-depth knowledge of home building technologies and are also thoroughly familiar with PATH's goals.

NAHB Research Center	*Independent Consultants*
Marie Del Bianco	**Jay Crandell**
Craig Drumheller	Glenn Hause
Mike Grothe	Ross Heitzmann
Tom Kenney	
Mike Moore	
Dan Priest	

Selection Criteria

There is a demonstrated potential to significantly impact five PATH goals, which more or less in order of importance are:

1. Affordability - low initial cost and/or significant reduction in operating cost. This is the overriding priority.

2. Energy efficiency

3. Durability

4. Environment

5. Safety

It must already have been shown, by use in the field and/or laboratory testing and analysis, that the technology can contribute significantly to one or more of the goals, with an emphasis on affordability.

Significant impact on PATH's goals can be achieved in any of several ways:

1. The best result would be a significant impact per house and applicability to most or all houses built;

2. Also acceptable is a significant impact per house on a reasonable percentage of houses (e.g., regional applicability); or

3. Smaller impact per house but applicable to all houses built.

Many of the selected technologies also have promising inter-relationships that could provide a magnified effect on PATH goals. For example, tankless water heaters may be combined with manifold (home run) hot water plumbing to maximize affordability and energy efficiency. Also, the "proven to be affordable" Frost Protected Shallow Foundation technology can see reduced barriers and increased use by combining them with light-weight, insulative, pre-cast concrete systems.

The barriers to diffusion must be manageable, that is, a viable strategy for overcoming the barrier(s) must be envisioned. This exercise would require mostly subjective judgments about such barriers as:

- Regulatory acceptance
- Liability concerns
- Trade contractor acceptance
- Builder acceptance
- Consumer acceptance
- General difficulty to mainstream (straw bale construction that requires significant changes in design, construction skills, regulatory issues, distribution and many other areas is a good example)

There is a need for PATH involvement. Certain promising technologies and products will more than likely happen whether or not PATH is involved because of significant DOE, EPA or other government or private industry funding and guidance. Examples include fuel cells, electrochromic windows, and LED lighting. PATH involvement in meeting with associations and manufacturers and others on such technologies may be redundant at best, or confusing to the industry and counterproductive at worst.

However, there may be technologies that could benefit from PATH's unique connection to the home building industry, where PATH could play a stronger implementation/adoption role. For these technologies, PATH involvement in technology transfer should be considered.

High Priority Technologies

SUMMARY

The technologies listed below have been identified as those toward which PATH should direct resources in order to accelerate their diffusion into the home building industry. All of the technologies show promise of contributing significantly to the realization of PATH goals, and many have been validated in the field.

In several cases, more than one PATH Technology Inventory item is included under a single title, because the technologies are closely related, have potential synergy to make a more significant combined impact, and can effectively be implemented together under the same technology transfer effort.

The high priority technologies are:

- Frost Protected Shallow Foundations
- Home Run Plumbing Systems
- HVAC Optimization
- Tankless Water Heaters
- Air Admittance Vents
- Shared (Community) Waste Water treatment
- Low Impact Development
- Integrated Steel/Wood Combination Framing
- Pre-cast Concrete Panels (Walls & Foundation)
- Engineered Panelized Systems

The information that follows provides a description and rationale for selecting each of the above technologies, along with a summary of the barriers, preliminary strategies for overcoming the barriers, and a list of stakeholders.

Frost Protected Shallow Foundations

Description

Frost Protected Shallow Foundations (FPSF) protect foundations against frost damage without the need for excavating below the frost line. A FSPF has insulation placed strategically around the outside of a foundation to direct heat loss from the building toward the foundation, and also to use the earth's natural geothermal energy.

Traditionally, foundations have been protected from frost-heaving damage by placing the footing below the frost line. Because FPSFs are protected from freezing by thermal insulation, bottoms of footings can be just twelve to sixteen inches below grade, thereby reducing excavation costs and concrete material and labor costs.

Rationale for selection

Construction and excavation requirements, and labor and material costs are less for FPSF than for conventional foundations. In a 1993 NAHB Research Center demonstration project, the cost of an FPSF was compared to an equivalent slab-on-grade foundation with footings extending to the local design frost depth. Savings with FPSF over standard slab-on-grade foundations were found to vary between $635 and $4750. The wide range of savings reflected varying local frost depth, and builder overhead and mark-ups. A 1988 study by the NAHB Research Center showed a 15 to 21 percent savings with FPSF over conventional foundations. An insulated slab provides the additional benefits of increased energy efficiency and improved occupant comfort.

Because this technology's cost savings are dependent upon frost level, it is most cost effective in states considered to be heating climate areas or approximately two thirds of the continental U.S. The technology has been proven since at least 1993, was in the 1995 CABO and is currently in the 2003 IRC and IBC.

Under related PATH research, ground frost depth extremes were investigated and significant cost savings for all types of foundation construction could benefit from the implementation of this knowledge in the form of a national frost depth map for building foundations.

<u>Barriers</u>

The only remaining technical barrier for the Frost Protected Shallow Foundation (FPSF) is that it requires insulation around its base. The insulation is susceptible to physical damage unless it is protected and also allows a "hidden pathway" for termite infestation. New termite resistant insulation products are available and should be diffused with this technology.

In the judgment of the panel, FPSFs are not achieving rapid acceptance because:

- Most home builders and masonry contractors don't know about this technology and its benefits;
- Home buyers are not aware of the technology and are not asking builders to use it;
- Most local officials are not familiar with it, resulting in additional soft costs in the design and permitting stages;
- The cement industry is not actively promoting FPSFs, possibly because they require less concrete; and
- Since FPSF is a process—not a product—manufacturers are not promoting it.

<u>Strategies</u>

1. Meet with the stakeholders to develop strategies.
2. Revisit current users and get feedback on application and interfaces with other parts of building sequence.
3. Develop more case histories and cost comparisons in different regions and disseminate to builders, homebuyers, and affordable housing agencies.
4. Get the complete standard for FPSF out to various code bodies.
5. Make local code officials aware that complete code (2003 IRC & IBC) exists, where to look for it, and perhaps, how to use it.
6. Continue strategy of writing articles getting the word out on FPSF, promoting through ToolBase resources.
7. Disseminate architectural details and specification out to designers and architects.

8. Demonstrate and provide workshops at trade shows.

9. Video the process (e.g., on JLC Live) and make it available.

10. HVAC interface details and ductwork scenarios need to be developed in relationship to slab on grade (ductwork under slab vs. attic).

11. Link with Build America and others who are also working in this area aggressively. Jointly bring the weight of the building industry behind a solution.

12. Investigate methods to solve the termite issue. Request participation from lightweight insulative concrete and/or precast panel producers.

Stakeholders

- Builders
- Foundation Contractors
- Local code officials
- Major code bodies
- NCSBCS
- Manufacturers of insulative concrete
- Precast manufacturers
- PCI
- Portland Cement Association (is an adversary)
- Affordable housing agencies (state/local)
- Insulation manufacturers

Plumbing Manifold & Home Run Systems (PEX)

Description

This recommendation for technology transfer is for systems that include a plumbing manifold and flexible piping for hot and cold water distribution encompassing two PATH Technology Inventory items—Plastic Manifold Plumbing Systems and Aluminum-plastic Composite Water Piping. The manifold or "home run" installation method feeds piping directly to one fixture from the central manifold, eliminating interim (and sometimes hidden) connections and allowing a 1/8-inch decrease in the overall pipe size. Used together, the technologies conserve water, speed installation, and promote durability.

Rationale

For a whole-house installation, estimated installed plumbing costs based on the experimental plumbing design (accounting for hot and cold water supply to the kitchen, laundry, three fixtures in each full bath, and two fixtures in the half bath) are $999 for a PEX-plumbing manifold system and $1,463 for a similar copper system. This is congruous with a previous NAHB Research Center study that analyzed the cost of PEX versus copper piping. PEX tubing costs about $0.25 per foot; copper piping is about $0.70 per foot for 3/4 inch tubing and $0.45 per foot for 1/2 inch tubing.

Barriers

In the judgment of the panel, rapid acceptance is not occurring because:

- Negative consumer and builder perception of plastic piping because of the past failure of polybutylene piping.
- The ease of installation may mean less labor for plumbers.
- Copper producers and copper piping manufacturers see plastic piping as a threat and continue to push hard against these systems.
- Some state codes still do not allow use of plastic piping such as PEX or Kitec.

Strategies

1. Meet with stakeholders to develop strategies.
2. Emphasize introduction to states with low union profile in residential construction.
3. Make consumers and builders aware of cost benefits and help builders understand how to include these systems in their bids.
4. Educate architects on building layout and utility disentanglement through use of plumbing manifolds.

5. Disseminate the current cost study to key stakeholders (operational cost, installed cost, labor, and materials). If work to date is considered inadequate, perform additional studies.

6. Obtain and disseminate testimonials from builders, city code officials, and homeowners who have had success with the system.

Stakeholders:

- Plastics Associations - American Plastics Council, Plastic Pipe and Fittings Association
- Manufacturers -- Vanguard, Wirsbo, Kitek
- State energy commissions
- Plumbing code bodies - IAPMO
- Electric Power Research Institute
- American Society of Plumbing Engineers

HVAC OPTIMIZATION

Description

This item includes two PATH Technology Inventory items described below:

1. Rules of thumb that are often used to size HVAC equipment can result in improperly sized equipment and unsatisfied customers. This technology is a design process technology to assure that the installed air conditioning equipment is neither over- nor under-sized.

2. A second design process technology is placing HVAC equipment and ductwork fully inside the insulated and air-sealed shell of the house, known as conditioned space, and not in ventilated crawl spaces or attics. This strategy can be combined with the Frost-Protected Shallow Foundation technology to move ducts into the conditioned spaces (in slab or unventilated and insulated crawlspace) for maximizing the impact on PATH goals.

Rationale

An article published in *Home Energy Magazine*, May/June 1995 by Proctor, Katsnelson, and Wilson, reports results of a study performed by Proctor Engineering for PG&E. The article states:

> "Field studies have shown that most equipment is substantially oversized compared to Manual J specifications. In the Model Energy Communities Project, Pacific Gas and Electric Company (PG&E) found that 53 percent of the air conditioners checked were a ton (12,000 Btu/h) or more oversized and a study by Pacific Northwest Laboratories found a third of the air conditioners to be a ton or more oversized."

Equipment oversizing not only increases the first cost, but also causes frequent cycling of equipment and poor dehumidification during cooling. The article quoted in the previous paragraph reports analytical results that indicate that proper sizing could save about 10 percent of the air conditioning costs. The benefits of properly sizing HVAC systems include satisfied and comfortable customers, lower initial and operating costs, reduced callbacks, longer equipment run times and less cycling, and proper dehumidification during the cooling season. The improved dehumidification means occupants won't set the cooling temperature as low, because it is well known that reducing relative humidity makes a body comfortable at higher temperatures.

While new houses may have insulation levels of R-15 to R-30 or more, ductwork outside conditioned space is typically insulated with approximately R-4 to R-6 insulation. Ductwork and equipment cabinets are also frequently very leaky, drawing in outside air and/or blowing out air that has been heated or cooled. Research on ductwork located outside of the conditioned space indicates that between 20 and 35 percent of the energy supplied to them is lost through a combination of air leakage and conduction. Recently performed simulations at the NAHB Research Center indicate savings of between $50 and $200 per year by moving the heating equipment from the attic and/or unconditioned basement to the conditioned space.

Although the benefits of proper sizing are generally well known by energy researchers, and by organizations like the Air Conditioning Contractors of America, the majority of HVAC contractors are not implementing good sizing practices. Though the benefits of placing the equipment in the space are also well known, most houses built with ventilated crawl spaces have HVAC equipment in the crawl space or attic, and those built on slab have HVAC equipment in the attic.

Barriers

- Many contractors would rather oversize and have a larger margin of assurance that the space will be warm or cool.

- Oversizing HVAC results in increased revenues for the contractor.

- Placing the HVAC equipment in the conditioned space typically requires space that could otherwise be used for some other function.

Strategies:

1. Meet with stakeholders to develop strategies.

2. Educate builders on the benefits of an optimized system and what to require in the bid from the mechanical subcontractor.

3. Educate designers/ architects on the benefits of optimized HVAC and what is necessary for properly positioning the system.

4. Enlist the participation of power companies both to educate consumers and contractors and also to look into the possibility of incentives.

5. Enlist the participation of manufacturers to educate contractors on equipment capability and sizing guidelines.

6. Develop case studies and deliver to builders and homebuyers.

7. Design a strategy whereby an independent third party can certify that the equipment is right sized and optimal.

Stakeholders:

- Equipment manufacturers
- Air Conditioning Contractors of America
- Builders
- Power companies
- State utility associations

TANKLESS WATER HEATERS

Description

Tankless water heaters have an electric, gas, or propane heating device that is activated by the flow of water. Once activated, the heater provides a constant supply of hot water. The maximum flow rate and temperature rise will be determined by the capacity of the heater. Large units intended for whole house water heating are located centrally while, in point-of-use applications, the water heater usually sits in a closet or under a sink. Although these heaters are relatively new to the United States, they have been used in Europe and Asia for many years.

Rationale for Selection

Tankless water heaters provide hot water on demand, thereby reducing or eliminating standby loss - energy lost from warmed water sitting in a storage tank. Since water heating accounts for about 20 percent of the average U.S. household energy budget, this can be a significant loss. Through a PATH Field Evaluation in San Diego, standby and flue losses were calculated as 38 percent to 59 percent of the energy used in heating water by a tank with an energy factor of 0.49. Tankless water heaters can save water and energy while reducing operating costs. Although their initial installed cost is greater than that of conventional tank-type units, reduced energy costs and greater durability than conventional units make them a good long-term investment.

Tankless electric water heaters typically provide savings of 15 to 25 percent of an average annual electric heating bill of $400, or $60 to $100 per year savings. The estimated (mature) cost premium for a tankless electric heater is $500 ($400 equipment and $100 labor). This results in a payback period of five to eight years. However, a well-positioned tankless water heater can provide the additional benefits of saving water and roughly four square feet of floor space.

Tankless gas water heaters have a higher initial cost ($700 to $900) and about the same percent savings on an average annual water heating bill of about $200. Therefore, their payback period, compared to the tank type, is longer.

Tankless heaters become especially attractive if the potable water heating function is combined with a boiler function for hydronic heating.

Barriers

- The majority of plumbers and electricians do not know how to specify and install these heaters.
- Many local code officials don't know how to interpret installation of the temperature and pressure valve.
- The heaters are not uniformly available across the United States.
- Builders and consumers aren't aware of the advantages.

Strategies

1. Meet with stakeholders to develop strategies.
2. Provide a plumbers' and manufacturers' forum for trading experiences on product application.
3. Understand plumbers' views and perceptions of tankless water heaters.
4. Educate plumbers, electricians, and code officials.
5. Provide information and evaluations to designers, builders, plumbers, and consumers.
6. Explore the possibility of state and/or public utility energy incentives.
7. Explore hydronics industry interest in entering markets in residential tankless heaters.
8. Coordinate with EPA for Energy Star rating.
9. Educate architects on building layout and utility disentanglement through use of tankless heaters. Also, include standard architectural symbols for use in drafting building plans.

Stakeholders

- DOE
- IAPMO
- Builders and plumbing contractors
- Manufacturers - United States and global
- Local code offices
- Plumbing equipment distributors
- Plumbing Heating, Cooling Contractors Association
- Hydronic heating industry - manufacturers

SHARED (COMMUNITY) WASTEWATER TREATMENT

Description

Properly designed, installed, and maintained on-site wastewater treatment systems can cost effectively treat wastewater and protect the watershed from pollutant overloads.

In addition to standard septic and sewer systems, there are other wastewater treatment options that can address some of the performance and economic issues surrounding the two primary means of wastewater treatment used in this country. For instance, on-site community systems are a promising alternative being used in some locales. However, in order for the systems to be more widely used, local public health officials, developers, and others need to find out more about such systems' performance, benefits, costs, etc. The same is true for other alternative systems such as trickling filters, mound systems, aerobic systems, etc.

Rationale for Selection

Acquiring a permit to build is the first hurdle in the building process, and that requires the ability to get rid of sewage. It can be the stopper on the land development flow chart. Developable land is becoming increasingly scarce and treating wastewater is a big environmental issue and will only grow larger. Builders will also be required to meet more stringent rules and regulations. Soil type is the big determinant in getting approval. New innovative wastewater or community systems help turn land that is currently not developable (e.g., narrow lots, odd-shaped lots, lots with clay soils and located far away from the public) into land on which development can take place.

Barriers

- The challenge of managing a shared system that has traditionally been operated and maintained by each homeowner.
- Land use of shared system: who owns it?
- Current system of dealing with wastewater is well accepted and most stakeholders do not perceive a problem.
- Bad publicity from failed systems needs to be addressed (as the causes and prevention are through proper design and management).
- Reluctance of local officials to "trust" community based systems under private management.
- Lack of education of waste treatment engineers and appropriate design guidance on small community based systems.
- Local land use and zoning issues.

Strategies

1. Meet with stakeholders to develop strategies.

2. Educate stakeholders on types of alternative efficient systems that bring benefit and lower cost to new development or retrofit.

3. Collect and make visible to stakeholders case histories of successful implementations showing how lot costs and ongoing operational activities/costs are affected.

4. Demonstrate how it improves overall environmental quality compared to alternatives.

5. Consider the integration of EPA's small flow programs.

6. Highlight and promote specific products and technologies that make up shared wastewater systems.

7. Enlist the NAHB to draft, support, and promote a position on this subject to its builder members.

Stakeholders

- EPA
- State and county governments - public works, health department
- National Association of County Officials
- Builders and developers
- National Association of County and City Health Officials
- City and county planning officials

AIR ADMITTANCE VENTS

Description

Air admittance valves (AAVs) are pressure-activated, one-way mechanical venting ports, used in a plumbing system to eliminate the need for conventional pipe venting and roof penetrations. AAVs allow air to enter the drainage system through a one-way valve when water flows through pipes. Otherwise, the valve remains closed, preventing the escape of sewer gas and maintaining the trap seal.

Rationale for Selection

Using AAVs can significantly reduce the amount of venting materials needed for a plumbing system, increase plumbing labor efficiency, allow greater flexibility in the layout of fixtures, and reduce long-term maintenance problems where conventional vents break the roof surface. A PATH Field Evaluation in Schenectady, New York on AAVs showed $50 in material and $243 in labor savings on a small, 1300 sq ft home that used just four AAVs. Although the savings on an individual home is small, the overall impact on the affordability of housing is very large, as it is reasonable to assume that all homes built in the United States - 1,356,00 single family starts in 2002 - will eventually use these valves.

Barriers

- Many local code officials know little or nothing about these valves.
- Some plumbing contractors and plumbers resist this labor saving technology.
- The valves are not well known in the home building industry.
- AAVs are not uniformly available in plumbing supply houses across the nation.

Strategies

1. Meet with stakeholders to develop strategies.
2. Publicize benefits and potential cost savings.
3. Educate builders on how to get bids that reflect savings in roofing and plumbing.
4. Work with manufacturers and plumbing distributors to assure availability.
5. Work first in non-unionized areas and states where resistance from plumbers may be less.
6. Disseminate the message on benefits to house designers/architects, most of whom dislike roof projections and try to eliminate them
7. Get feedback and develop and disseminate testimonials from those who have successfully used the valves.

Stakeholders

- Plumbers
- Plumbing product distributors
- Builders
- Local code officials
- Manufacturers (Studor, Oatey, Durgo)

LOW IMPACT DEVELOPMENT

Description

Low Impact Development (LID) techniques can offer developers a cost effective way to address stormwater management through site design modifications and "Best Management Practices" (BMPs) when coupled with reasonable design criteria for pre- and post-development water quality and run-off volumes. These strategies allow land to be developed in an environmentally responsible manner, reduce costs, and create a more "Hydrologically Functional" landscape. Effective, proven technologies for managing stormwater are permeable surfaces/pavement and rainwater harvesting - both PATH Technology Inventory items - and also alternative stormwater infiltration systems.

Permeable pavement surfaces can be constructed from a variety of materials, including traditional asphalt and concrete, gravel or pavers. Permeable roadway or parking areas allow water to flow through, replenishing soil areas directly beneath. However, the subbase underneath permeable pavements must be engineered to accommodate temporary water storage and filtration. In many cases, permeable surfaces can reduce or eliminate the need for traditional stormwater structures. Practical methods to provide continued effective operation in the event of reduced porosity over time also need to be disseminated, as this is a major barrier to acceptance to porous traffic surfaces.

Rainwater harvesting using cistern collection systems stores rainwater for dry-period irrigation, rather than channeling it to streams. Smaller tanks that collect residential roof drainage are often called "rain barrels" and may be installed by individual homeowners. Some collection systems are designed to be installed directly under permeable pavement areas, allowing maximum water storage capacity while eliminating the need for gravel beds.

Rationale for Selection

Low Impact Development (LID) strategies strive to allow natural infiltration to occur as close as possible to the original area of rainfall. By engineering terrain, vegetation, and soil features to perform this function, costly conveyance systems can be avoided, and the landscape can retain more of its natural hydrological function. Low Impact Development practices dovetail with "Green" building practices that incorporate environmental considerations into all phases of the development process. Builders can often use Green building and LID to lower actual development costs. Although most effective when implemented on a community-wide basis, using LID practices on a smaller scale can also have an impact.

Barriers

- Designers and planners are not familiar with these technologies and/or are not aware of potential cost benefits accrued by using them.

- The cost advantages are not well documented.

- Site assessment and design protocols are often rigidly regulated or suffer from lack of reliable performance data with which to optimize a design for a particular site.

Strategies:

1. Meet with stakeholders to develop strategies.

2. Develop and disseminate a process that describes actionable steps to implement these two LID technologies.

3. Identify and disseminate resource(s) that provide information for implementation.

4. Lay out a systems strategy where technologies, policies, and practices work together to simultaneously conserve and protect natural resource systems and reduce infrastructure costs and/or reduce lot cost or land/unit cost.

5. Evaluate specific land development projects to determine cost to develop a site conventionally, identify the LID technologies appropriate for use on the site, and compare the conventional costs to the cost to develop the site using LID.

6. Identify land use regulatory issues that inhibit or prohibit the use of LID technologies.

7. Create a process to address the regulatory issues.

8. Assemble a list of resource(s) to turn to or find information such as the new HUD publication *The Practice of Low Impact Development* or the two EPA LID brochures*, Builders and Municipal Guides to Low Impact Development*.

9. Provide local LID how-to workshops for local developers and local planning officials.

10. Link with software that is used for site development and visioning by designers, planners, and engineers.

11. Create a database containing case studies of successful LID projects, examples of ordinance language that has allowed the use of, and often encouraged, an LID approach in local development projects.

12. Coordinate and link with agricultural applications and knowledge regarding non-point source pollution control and design information and strategies. Condense information in a useable format for site planners, civil engineers, and plan review officials.

Stakeholders

- Site planners, engineers, site developers

- National Association of Counties (NACo)
- Local planning officials (APA at the national level)
- National Association of Towns and Townships
- U.S. Conference of Mayors
- National Association of County Engineers
- National Fire Protection Association (for emergency response officials)
- Associated General Contractors
- American Society of Landscape Architects
- Environmental Protection Agency
- American Public Works Association
- Associations/ groups related to minimizing impact on environment (e.g., Puget Sound Water Quality Action Network)
- NAHB Land Development and Environmental Issues Committees

OPTIMUM STEEL/WOOD COMBINATION FRAMING

Description

The basic concept is to select the right material for the application—whether wood or steel—and to design the home to use the least amount of both materials. Combinations of wood and steel framing, within the overall building shell, use the best attributes and cost benefits of each material. For example, wood on the exterior framed walls, steel interior walls, and combination of wood /steel material in floor and truss systems. Optimum Value Engineering (OVE) refers to framing techniques that reduce the amount of materials used to build a home while maintaining the structural integrity of the building. These techniques include increasing width between studs, eliminating the use of headers in non-load bearing walls, designing the building modularly in 24-inch increments to reduce waste, and many others.

Rationale for Selection

Recently it has been shown that replacement of certain traditionally wood components with steel can accrue cost benefits, as well as enhance durability. For example, steel floor systems can be less expensive than the wood I-joist systems with which they compete. PATH studies conducted over the last three years indicated 15 percent savings in the material cost of steel floor assemblies. An offsetting labor increase due largely to securing sub-flooring with screws rather than nails, promotes durability and nets to a system savings in the 5 to 10 percent range in some markets. Interior framing using steel studs can be less expensive than using wood studs. Optimum value engineering techniques results in lower material and labor costs and improved energy performance for the building. In combination, these two ideas will provide many opportunities for reducing the cost and improving the energy performance of houses.

Barriers

- OVE has been around for a long time, but has not received widespread use. The technology requires that designer, plan approver, inspector, and framer have in-depth knowledge.

- Wood and steel construction each require different tools, processes, and training.

Strategies

1. Work with stakeholders to develop strategies.

2. Integrate OVE framing work with optimal material and alternate header techniques.

3. Disseminate the technology to architects and affordable housing agencies for adoption into plans.

4. Focus on panelized construction for the diffusion of combined steel/wood and OVE techniques.

5. Work to implement building code changes that allow integration of steel and wood combinations.

6. Incorporate design standard details for combining materials in the building codes.

7. Focus on panelized construction for the diffusion of OVE techniques.

8. Work with the Steel Framing Alliance to help promote this approach.

Stakeholders

- Panelizers
- Builders and framing contractors
- Plate and connector vendors
- Wood Truss Council of America
- Steel Framing Alliance
- Framing software vendors
- Local and state code officials
- Major code bodies

Pre-cast Concrete Panels (Walls & Foundation)

Description

Pre-cast concrete foundation panels consist of steel-reinforced concrete studs, reinforced top and bottom beams, and concrete facings. Insulation can be placed between the studs. A typical panelized foundation can be erected in four to five hours with no on-site concrete work (the panels sit on a compacted gravel bed in lieu of footings). The result is a tight tolerance foundation made under quality-controlled factory conditions, ready in a fraction of the time needed for a poured foundation.

Rationale for Selection

An example of savings is indicated by the NAHB Research Center's construction of the Marketable, Affordable, Durable, Entry Level (MADE) homes. A precast, simple structure with a minimum of window openings, no door openings and a partial brickledge and including a stone base or footing is $69 per lineal foot (an 8 foot section). The 2002 Means pricing shows 8-inch poured, reinforced concrete at $87 per lineal foot. The rate for poured foundations in the Maryland area where the MADE homes were built is consistent with the Means data.

As these numbers, precast indicates a 20 percent savings over a poured, conventional, foundation. But, the value isn't just the savings in materials and labor. The cycle time is shortened significantly. It takes only about a half day to install a typical precast foundation, while it can easily take a week to install a typical poured foundation. The labor and material savings may be somewhat offset by added labor/material for additional floor system bracing, but there is no question precast technology offers significant savings. It is applicable all across the country, but is still not available in all locations.

Barriers

- The equipment for placing the panels is rather large and adds another element of expense that offsets some of the cost savings.
- Foundation contractors typically have large capital investments in formwork and form-based systems.
- Uses less concrete as it eliminates a concrete footing.

Strategies

1. Local plan approvers and inspectors need to be educated.
2. Cost savings case studies need to be developed and the results disseminated.
3. Lightweight concrete versions need to be explored to reduce the size of lifting equipment needed and the transportation costs.

Stakeholders

- Current manufacturer(s)
- Builders
- PCI
- Precast manufacturers
- Foundation contractors

ENGINEERED PANELIZED SYSTEMS

Description

Manufacturers are working at reinventing the process of home construction using assembly line automation to build prefabricated panels made from a wide variety of materials. The installed panels form a structural envelope that reduces or eliminates the need for on-site framing and can be assembled swiftly by less skilled laborers.

The implementation of a performance standard for the design, fabrication, and installation of engineered panelized wall systems (much like the wood truss standard) will facilitate development of innovative and industrialized solutions for panelized wall construction. Under PATH, a model guideline intended for this purpose has already been developed and is ready for implementation as a standard. The standard would allow for innovation in fastening technologies, integration of various innovative and conventional materials (e.g., wood, steel, and plastic members in the same wall), and implementation of advanced computerized design aids. This technology may also address long-standing barriers to the acceptance and use of OVE or advanced framing methods.

Rationale for Selection

Engineered panelized wall systems represent a process innovation affecting the fundamental manner by which wall systems may be conceived and delivered to the construction market. The engineered panelized wall system technology finds many parallels with development and application of wood truss technology over the past several decades. The metal plate connected wood truss started as an innovative framing method whereby members are joined together by various means to form a light-frame truss. However, the technology has progressed through use of an industry standard that has and will continue to allow for incremental innovations in the technologies used in trusses. Most of this innovation has been in computerization of a standardized design methodology, industrialization of the fabrication process, and metal plates used to connect trusses. This same process could be applied to light-frame wall systems and would offer similar benefits to residential and commercial light-frame construction sectors.

The potential economic impact of implementing a standard for engineered panelized wall systems is staggering. For example, for housing in high hazard areas that require an engineered building solution, the delivery of a manufactured and engineered panelized wall system could easily cut structural design fees in half and also reduce material and installation costs. For housing in more normal conditions, wall solutions may be more efficiently designed resulting in either cost savings or performance benefits. The potential annual cost savings to homebuyers and building owners could easily be measured in hundreds of millions of dollars per year. The technology also has the potential to help the panelization industry to mature in a positive manner and deliver new wall system technologies that efficiently address a combination of PATH's goals including affordability, energy efficiency, durability, environment, and safety.

Barriers

There are few significant technical barriers to developing such a standard. The challenges are:

- Having this performance standard incorporated into the model codes.
- Having the standard incorporated into the local codes.
- Educating local code bodies on how to apply the standards.
- Manufacturers with proprietary panelized wall components may feel threatened by development of a standard that will allow competitors (as well as themselves) to more freely innovate.

Strategies

1. Form a stakeholder committee to review the current draft of the model wall performance standard.
2. Gain consensus on the need for a general standard.
3. Publish and bring the standard to the industry as an enabler for many other innovations to happen in panelization.

Stakeholders:

- Builders doing panelization
- Panel producers
- Wood Truss Council of America
- Design and production software companies
- Connector companies

Other Technologies Showing Potential

The technologies below show promise but were considered not quite ready for diffusion or transfer to the industry. They need further evaluation, practical application history, and demonstration of benefit.

Heat Pump Water Heater
Heat Pump Water heaters, although having a higher first cost than resistance water heaters, have an operating cost as much as 40 to 50 percent less. Because they remove heat from the house, they are much more effective in a warm, southern climate than in the north. PATH Field Evaluation of this technology would be desirable.

Electric Radiant Ceiling Panels
These panels have the potential of offering significant energy savings, especially if controlled by room occupancy sensors, because they heat objects, not space. Installation cost is significantly lower cost than forced air systems. The panels are more efficient than base board heat, but more expensive to install. The technology should be included in one or more PATH Field Evaluations to determine installed cost, energy savings, and consumer acceptance.

Phase Change Material
Phase change materials (PCMs) can smooth daily fluctuations in room temperature by lowering the peak temperatures resulting from extremes of external daily temperature changes. PCMs can reduce home heating or cooling loads, thereby producing energy saving, and ultimately reducing the need for new utility power plants. Although their potential is yet to be realized, manufacturers of heating and cooling equipment need to be exploring and developing systems applications.

Geothermal Heat Pumps- Community Level
The concept of community level geothermal heat pumps is to provide a common storage source for the heat pumps in a community. This offers the potential of significantly reducing the cost of geothermal heat exchange, especially in communities that are relatively dense. This concept should be included in a PATH Field Evaluation.

Onsite Factory Built Housing
This technology shows great promise in reducing the cost and improving the durability of homes. However, it is still in the exploratory phase - only a few houses have been built. This technology should be monitored, and perhaps a PATH Field Evaluation should be implemented, if the owners of the technology agree.

Gray Water Re-use
Using wastewater to irrigate yards for individual homes tends to be expensive and has run into code resistance and jurisdictional barriers. The technology, therefore, has seen limited use. However, as a community system, the technology may lead to lower development and site costs and should be included in a PATH Field Evaluation when a suitable situation can be found.