FEDERAL EFFORTS TO PROMOTE INNOVATION IN HOUSING

EVOLUTION OF THE FEDERAL APPROACH TO INNOVATION

The federal government has long recognized the importance of innovation, although the specific reasons and strategies for supporting it have evolved over time. The modern era of federal support for innovation began during World War II when, in the interests of national security, the federal government supported the development of radar and nuclear weapons. Later, during the energy crises of the 1970s, rising costs and concerns about declining supplies of fossil fuel led the government to support innovation in fossil fuel production, renewable energy, and energy efficiency. Still later, the government began to focus on promoting innovation in the health sciences to prolong and improve quality of life. Beyond these specific critical areas, the government has also promoted innovation in other industries because of its ability to increase productivity and boost prosperity and living standards.\footnote{Council of Economic Advisors (2000, p. 97).} Promoting innovation has now emerged as a major strategy for boosting economic growth and improving quality of life.

Just as the reasons for promoting innovation have evolved, so too have the strategies for pursuing it. Most notably, the strategies have shifted from supporting just one aspect of the innovation process
Building Better Homes

(for example, basic or exploratory research) to supporting many of its aspects as described in Chapter Two. These changes reflect an evolution toward a more sophisticated understanding of the subtle challenges involved in promoting innovation. This evolution reflects an implicit recognition that narrow efforts are unlikely to succeed on their own and that multiple efforts need to work in harmony to leverage each other in a more systematic approach.

This chapter presents and briefly discusses a number of federal efforts to promote innovation in housing. The purpose is not to evaluate these efforts per se but rather to identify them, explain their strategies, and discuss their effect on the innovation process.

To help put the housing industry and federal efforts to promote housing innovation in context, this chapter begins by reviewing the federal government’s general efforts to promote innovation throughout the entire economy. After this introduction, a more specific discussion of housing efforts will follow.

BROAD-BASED FEDERAL EFFORTS TO PROMOTE INNOVATION

Before World War II, most federal efforts to promote innovation were small and focused on specific public goods such as vaccine development, reducing topsoil erosion, and controlling agricultural pests. Upon entering World War II, federal spending on innovation increased sharply but fell once the war ended, since R&D was not considered to be a major government responsibility. However, the Cold War, the Korean War, and particularly the Soviet launch of the Sputnik satellite in 1957 ultimately changed this view. Following these events, federal R&D spending increased rapidly and the nation’s capacity in science and technology came to be seen as an important foundation for ensuring national security.

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2This is not an exhaustive review but rather a representative sample of past efforts to promote innovation in housing.


4Blanpied (2000).
Government thinking toward the federal role in R&D and innovation further expanded in the 1980s. Executive and legislative leadership put a high priority on strengthening the national technology and innovation system. Science and technology came to be seen as critical to both national security and national economic competitiveness as well as quality of life. Moreover, government, industry, and academia recognized that although industry had shown a remarkable ability to create new technologies and innovate, there were market failures, information barriers, and externalities beyond the purview of private enterprises to address. As a result, a consensus emerged that the government had a responsibility to increase the provision of public goods not adequately provided by private markets (e.g., basic or high-risk research) as well as to limit externalities that resulted from certain private-sector actions (e.g., environmental pollution).

**Federal Support of Research and Development**

Since World War II, federal investment in R&D has steadily grown; in 2002 the federal investment in unclassified R&D stood at roughly $100 billion. In general, these efforts were intended to contribute to the foundation of scientific knowledge. Accordingly, results were published in publicly available, peer-reviewed journals even though the results often belonged to the government. This approach was generally considered successful, since public and private investments in R&D were often complementary. For example, federal R&D funds frequently concentrated on basic research where risks were high, market funding not available, or federal investment might produce potential future high payoffs for society. This is in comparison to industry-funded R&D that generally focused on development and commercialization.

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6During the 1990s, industry R&D became increasingly focused on short-term R&D. According to the Industrial Research Institute, 70 percent of industry R&D investments were focused on projects potentially providing near-term gains, 7 percent went to basic research, and the balance went to applied research. See Larson (2002).
Expanding Support for Innovation Beyond R&D

In the 1980s, low productivity growth in the United States was believed to be a key reason why the U.S. economy was falling behind that of countries such as Japan.\(^7\) Partly in response, the federal government expanded its support of innovation beyond the funding of R&D. These efforts included the following:

- The Bayh-Dole Patent and Trademark Act of 1980 allowed the performers of federally funded research to apply for patents and obtain exclusive licenses on research results. This encouraged universities, small businesses, and private industry to invest in developing and commercializing inventions supported by public dollars.\(^8\)

- The Stevenson-Wydler Technology Innovation Act of 1980 approved the transfer (i.e., licensing) of technologies developed at public research laboratories to states, localities, and industry.

- In 1986, the Stevenson-Wydler Act was amended to allow for Cooperative Research and Development Agreements (CRADAs) that authorized federal laboratories to work with private firms and universities to develop inventions for commercial application.

Together, these and other pieces of legislation made it easier for individuals and firms to invest in, develop, and protect innovations, especially when innovations were partially or fully sponsored by government. However, even these improvements did not lead to a streamlined innovation process.

Systematic Efforts to Promote the Innovation Process

Through the sponsorship of R&D and the passage of legislation, federal agencies have launched programs to promote innovation when


\(^8\)More fully, the Bayh-Dole Act allows federal agencies to grant exclusive patent licenses to private businesses, but the government retains a nonexclusive license to use the invention and it retains “march-in” rights where the funding agency can require the grantee, contractor, or licensee to grant a license on reasonable terms to a responsible applicant. See the Technology Transfer Legislation Summary at intramural.nimh.nih.gov/techtran/legislation.htm.
doing so could help advance their mission and goals. These pro-
grams often sought to provide a more systematic and tailored ap-
proach to promoting innovation. For example, rather than funding
R&D alone, some agencies launched programs that helped explore
new concepts; disseminate information about technology and stan-
dards; and help link scientists, engineers, and other innovators
through conferences and exchanges. In short, these programs pur-
sued innovation because it was a “means to an end.”

Moreover, public-private partnerships emerged to coordinate and
leverage the respective strengths and resources of the public, private,
educational, and nonprofit sectors. In most cases, the federal gov-
ernment still supports basic, high-risk research, but it is increasingly
common to provide cost-shared funding and technical assistance for
development and demonstration activities. In most cases, industry
partners remain responsible for funding the commercial develop-
ment of technologies and innovations that emerge from these part-
nerships. Examples of these federal efforts include the following:

- The Advanced Technology Program (ATP) of the National Insti-
tute of Standards and Technology (NIST) funds high-risk inno-
vation projects.
- The Manufacturing Extension Program (MEP), also of NIST,
helps firms solve business and technical problems through a na-
tionwide network of Manufacturing Extension Centers and
manufacturing experts.
- The Industries of the Future (IOF) program of DOE promotes
collaborative R&D partnerships for energy-intensive industries
(e.g., mining, metal casting, forest products, steel) to develop
new and more efficient ways to use energy.10
- FreedomCAR, a public-private partnership between DOE and the
nation’s automobile manufacturers was launched in 2002.
Building on the work of the earlier Partnership for a New Gen-
eration of Vehicles, this partnership’s long-term goal is to per-

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10See the Industries of the Future home page at www.oit.doe.gov/industries.shtml,
form high-risk research to develop technologies for hydrogen-powered fuel cell vehicles.\textsuperscript{11}

To differing degrees, these programs have created formal and informal linkages across the innovation process in the hopes of improving communication and increasing the rate of innovation. Many regard these efforts as having contributed to increasing the rate of innovation beyond what industry would have performed on its own.

TARGETED FEDERAL EFFORTS TO PROMOTE INNOVATION IN HOUSING

As the nation struggled to define its interest in and approach to innovation in general, its efforts at promoting innovation in housing also evolved. These efforts began with direct federal funding of R&D, but they soon expanded to address other portions of the innovation process. Although the programs described in this section do not cover all that has been done or supported by the federal government, they provide a sense of the evolution in goals, scope, and strategy.

Federal Support of Housing R&D

As with the rest of the federal R&D portfolio, the portion related to housing is quite diverse, partly because housing R&D responds to a broad range of social needs and technical possibilities. For example, concerns about a housing shortage in the late 1960s led to research focused on mass production, and the energy crises of the 1970s led to a focus on energy efficiency and alternative energy research.\textsuperscript{12}

The most recent assessment of housing R&D estimated that in fiscal year (FY) 1999, the federal government invested roughly $236 million in R&D potentially relevant to housing.\textsuperscript{13} This represented only 0.6 percent of the entire 1999 federal nondefense R&D budget of roughly $40 billion.

\textsuperscript{11}U.S. Department of Energy (2002a).
\textsuperscript{12}According to Baer et al. (1976, pp. L1–L30), federal involvement in housing technology began as early as the 1940s.
\textsuperscript{13}Hassell et al. (2001).
More important than the relative or absolute size of this investment, however, is its breadth and ability to lay a foundation of knowledge and invention to increase the rate of innovation. This breadth is illustrated in part by Figure 5.1, which organizes the federal investment into 15 categories. In addition, short descriptions of these categories and the estimated funding are provided in Table 5.1.

Figure 5.1—Federal FY 1999 Investments in Housing-Related R&D
Table 5.1
Overview of Federal FY 1999 Investments in Housing-Related R&D

<table>
<thead>
<tr>
<th>R&amp;D Category</th>
<th>Investment ($ millions)</th>
<th>Sample Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building design improvements</td>
<td>4.2</td>
<td>Improving residential design. Includes sustainable and green design, affordable housing, and improved building rehabilitation/renovation.</td>
</tr>
<tr>
<td>Building process improvements and automation Building product improvement</td>
<td>3.1</td>
<td>Improving the homebuilding process. Includes traditional process improvements, IT, and how IT can be transferred to housing.</td>
</tr>
<tr>
<td>Building product improvement</td>
<td>21.0</td>
<td>Earmarking about $12 million for window-related research with balance to general R&amp;D (nearly $6 million), insulation ($1 million), alternatives to stick framing ($1 million), foundations, insulation, paint, roofing, and windows.</td>
</tr>
<tr>
<td>Concrete, cement, pavement, asphalt</td>
<td>0.6</td>
<td>Developing cement-wood composite materials.</td>
</tr>
<tr>
<td>Energy efficiency</td>
<td>49.5</td>
<td>Spending $28 million on building energy systems, building codes and standards, existing buildings, heat and moisture modeling, and weatherization; $16 million on HVAC, appliances, and motors; $5 million for lighting.</td>
</tr>
<tr>
<td>Electricity generation</td>
<td>111.0</td>
<td>Spending more than $100 million on renewable energy including photovoltaics ($90 million), general solar and solar thermal ($6 million), and geothermal ($8 million); and an additional $7 million for building-related fuel cells.</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.0078</td>
<td>Studying the effect of housing-related demand on wood markets; economic analysis of conservation tradeoffs; effect of forest and riparian forest buffers on residential development.</td>
</tr>
<tr>
<td>Land-use design improvements</td>
<td>0.3</td>
<td>Studying urban demolition, deconstruction, and redevelopment; the effect of natural resource conservation on rural subdivision development, sustainable development, and transportation issues.</td>
</tr>
<tr>
<td>Metals, composites, and advanced materials (not wood or concrete)</td>
<td>1.9</td>
<td>Investing in metals and composites R&amp;D including thermoplastic composites for structural applications, steel applications, and analysis of hybrid/composite structural walls and steel frame systems.</td>
</tr>
<tr>
<td>Other</td>
<td>3.7</td>
<td>Investing in multicategory R&amp;D and dissemination and outreach of R&amp;D results.</td>
</tr>
<tr>
<td>Pollution and waste reduction</td>
<td>3.9</td>
<td>Investing in refrigerant R&amp;D ($2 million); wood processing ($1.7 million), and studying water and multipollutant issues.</td>
</tr>
<tr>
<td>Reducing construction work illness and injuries</td>
<td>15.9</td>
<td>Researching ways to reduce residential housing-construction-related illness and injuries (other portions of the occupational safety R&amp;D likely to yield spillover benefits to housing).</td>
</tr>
<tr>
<td>Reducing occupant-related illness and injury Structural engineering and natural hazards</td>
<td>4.2</td>
<td>Studying general indoor air quality ($3.1 million), $600,000 of which focused exclusively on residential air quality; sensor development; low solvent adhesives.</td>
</tr>
<tr>
<td></td>
<td>11.5</td>
<td>Investing in multiple hazards R&amp;D ($6 million); fire research ($3.7 million); earthquake and wind-related R&amp;D (nearly $1 million each); smaller investments in structural R&amp;D, measurement, and instrumentation.</td>
</tr>
</tbody>
</table>
Table 5.1—continued

<table>
<thead>
<tr>
<th>R&amp;D Category</th>
<th>Investment ($ millions)</th>
<th>Sample Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood products and</td>
<td>5.9</td>
<td>Identifying new applications for wood and wood scrap/waste ($2.7 million);</td>
</tr>
<tr>
<td>and quality</td>
<td></td>
<td>characterizing the structural properties of wood, wood structures, and adhesives</td>
</tr>
<tr>
<td></td>
<td></td>
<td>($1 million); smaller investments in wood-containing composites, wood drying, and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>wood preservatives.</td>
</tr>
</tbody>
</table>

Additional Support for Housing Innovation

As with broader federal efforts, funding R&D alone did not lead to the widespread deployment of new housing technologies. However, perhaps unlike other industries, housing was recognized early on as requiring more than just R&D to promote innovation. This is clearly demonstrated in the language of “Title V-Research and Technology” of the Housing and Urban Development Act of 1970 that explicitly stated:

The Secretary shall require, to the greatest extent feasible, the employment of new and improved technologies, methods, and materials in housing construction, rehabilitation, and maintenance under programs administered by him with a view to reducing costs, and shall encourage and promote the acceptance and application of such advanced technology, methods, and materials by all segments of the housing industry, communities, industries, engaged in urban development activities, and the general public.14

Thus, almost from the start of the federal role in housing innovation, it was realized that promoting innovation required more than simply funding R&D. To better shed light on the additional measures that have been used to support parts of the innovation process beyond R&D, several energy-related examples are identified and described below.

State Energy Codes. California implemented the first detailed, statewide energy code in 1975 to moderate growth in energy con-

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Pushed by rising energy prices and the development of energy-related model codes, state energy codes soon followed. They spread even further in the mid-1990s when federal law required that each state consider revising its residential energy code to meet or exceed the 1992 Model Energy Code. Over the past 25 years, energy codes have varied in approach, stringency, and enforcement leading some to be more effective than others. That said, energy codes are yet another tool for boosting innovation in building materials and construction methods.

Appliance Standards. In the late 1970s, individual states began to issue their own appliance efficiency standards. As this trend continued, national manufacturers came to support the creation of a federal program to set appliance standards that would preempt state standards. This led to the 1987 passage of the National Appliance Energy Conservation Act requiring that DOE issue and periodically revise minimum energy efficiency standards for the most energy-intensive household appliances. As of 2000, DOE estimated that these standards saved consumers a total of $28 billion (1999 dollars) in energy costs. Although such estimates are fraught with difficulty, a recent study by the National Research Council (2001) found that improvements in refrigerator energy efficiency—driven by the technology push of federal R&D and the technology pull of appliance standards—reduced average refrigerator energy consumption by two-thirds since 1974 thereby reducing consumer electricity costs by $7 billion between 1981 and 1990 alone.

Energy Efficiency Mortgages. In 1979, a Presidential Executive Order directed federally sponsored secondary lenders to offer consumers incentives to purchase energy-efficient homes. This led to the creation of energy efficiency mortgages (EEMs), which traditionally increased the amount one could borrow. Today, EEMs continue to be offered by federally affiliated secondary lenders and several private lenders, but, as from the day they were initiated, they remain more

16 For a discussion and analysis of the efficacy of state building codes, see Ortiz and Bernstein (1999).
Federal Efforts to Promote Innovation in Housing

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complex to obtain. For example, as of 1998, almost 20 years after EEMs were first introduced, only 1.5 percent of the loans made by a major federal lender were EEMs.\textsuperscript{18}

Systematic Efforts to Support and Accelerate Innovation in Housing

In the case of housing, the government has long recognized that systematic efforts were needed rather than a set of narrow measures. This understanding was reflected by national and presidential commissions that were formed after the civil unrest of the mid-1960s to investigate the problems facing the nation’s cities and urban housing in particular.\textsuperscript{19} As a result of these commissions and their focus on industry characteristics that limited the production of housing, innovation was high on the national agenda, and significant pressure was placed on the new Secretary of the Department of Housing and Urban Development (itself created in 1965) to use technology to meet the nation’s housing needs.

Operation Breakthrough. In response to congressional pressure and legislation, HUD announced Operation Breakthrough in 1969. Breakthrough was presented as a "partnership of labor, consumers, private enterprise, local, state, and federal government which would seek to provide housing for all income levels through the use of modern techniques of production, marketing, and management."\textsuperscript{20}

This $72 million research and technology development program sought to industrialize housing construction while also changing people’s perceptions of manufactured housing. The main premise was that by replacing traditional, craft-based production processes with machines and precision manufacturing, mass-produced housing would be more consistent, higher quality, and more affordable.

Despite its good intentions, Operation Breakthrough is widely recognized as being unsuccessful at promoting both technical and institu-

\textsuperscript{18}Farhar (2000).
\textsuperscript{19}These included the Douglas Commission (1966) and the Kaiser Commission (1967). For additional background see Baer et al. (1976, p. L1).
\textsuperscript{20}Baer et al. (1976, p. L6).
tional change. Of the many analyses of Breakthrough’s failures, perhaps the most enduring is that Operation Breakthrough’s top-down, federal approach was incompatible with the locally regulated and highly fragmented housing industry.\textsuperscript{21} In the words of a 1976 RAND study, Operation Breakthrough’s

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\text{multi-faceted approach to increased efficiency [was] several orders of magnitude more complex than simply funding R&D projects. . . . [T]he complexity [was] due to the need to cut at the problem from both sides of the market . . . in ways that involve several levels of government responsibility and bureaucracy [and for which] the available policy levers . . . [existed] at the state and local level.}
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Thus, an important aspect of Operation Breakthrough’s downfall was that it sought to restructure the industry even though the federal government had very limited abilities to do so.

**Advanced Housing Technology Program.** In 1989, several years after the launch of DOE’s appliance standards program, DOE expanded its work on innovation in housing by helping create the Advanced Housing Technology Program (AHTP). Formed as a public-private partnership involving DOE, the National Association of Home Builders, and the NAHB Research Center, AHTP sought to identify new and emerging technologies that could cost-effectively improve the energy efficiency and quality of homes, and to develop plans to promote and accelerate the adoption of the best innovations.

In working to accomplish these goals, AHTP prepared a historical record of innovation in home building, including an inventory of 40 years of housing innovations,\textsuperscript{22} as well as studies on how innovations are diffused in homebuilding and how emerging technologies can be assessed to anticipate their likelihood of adoption.\textsuperscript{23} After these efforts, AHTP proposed six strategies to accelerate the development and diffusion of innovations. These included improving communication and the assessment of market needs, sharing the costs of technology development and commercialization, reducing the risk to

\textsuperscript{21}O’Brien et al. (2000).
\textsuperscript{22}NAHB Research Center (1989a).
\textsuperscript{23}NAHB Research Center et al. (1989); and NAHB Research Center (1989b).
buyers, and communicating the value of innovation throughout the industry.24

EnergyStar®. The Environmental Protection Agency introduced the EnergyStar label in 1992 as a voluntary labeling program to identify and promote the most energy-efficient products offered by manufacturers. The idea was to help recognize and promote manufacturers and products that could provide “the same or better performance as comparable models” while using less energy, saving money, and reducing pollution and the risk of climate change.

Beginning with computers and monitors, EnergyStar expanded into other types of office equipment and residential HVAC equipment. In 1996, EPA partnered with DOE to expand coverage of particular product categories. Today, EnergyStar evaluates and labels 30 product categories, including building materials (e.g., lighting, windows, and roofing products) and buildings themselves (e.g., homes, office buildings, schools, supermarkets, stores).25

In addition, EnergyStar created easy-to-use tools and technical information for both owners and designers to help them lower energy bills in both new and existing residential and commercial buildings. Available on the Internet, these tools include store locators to find EnergyStar products, electronic directories for information and help, and web-based diagnostic tools to help remodel and design all types of buildings.26

By simplifying the terminology and reducing the effort involved in defining and validating these improvements, EnergyStar has made it easier for individuals, firms, and the government to understand what the label means. As testament to the resulting simplicity, several national lenders have begun to offer EnergyStar mortgages, and the U.S. Army and Navy updated their housing procurement specifications in June 2000 to comply with the EnergyStar qualifications for new homes. Finally, EPA estimates that since EnergyStar’s inception, 630 million products with its label have been sold, saving $5 billion in

25For a home to qualify for the EnergyStar label, it must be at least 30 percent more efficient than one built under the Model Energy Code.
26For example, see the Home Improvement Toolbox at www.epa.gov/hhiptool/.
energy costs in 2001 and reducing pollution without reducing product quality or functionality.  

The National Construction Goals and the Residential Implementation Plan. In the mid-1990s, the federal government’s National Science and Technology Council (NSTC) formed a subcommittee on construction and building to coordinate and focus the work of 14 federal agencies in enhancing the competitiveness of the U.S. construction industry and improve public and worker safety and environmental quality through research and development. In fulfilling its charge, the subcommittee was instructed to cooperate with U.S. industry, labor, and academia.

Shortly thereafter, the subcommittee studied research priorities expressed by the construction industry in industry forums and in proposals submitted to the Department of Commerce’s ATP. After reviewing these materials, the subcommittee proposed seven goals for research, development, and demonstration for general use by the construction industry. After further discussion and backing by industry leaders, the following were presented as National Construction Goals:

- 50 percent reduction in project delivery times,
- 50 percent reduction in operations, maintenance, and energy costs,
- 30 percent increase in occupant productivity and comfort,
- 50 percent fewer facility-related illnesses and injuries,
- 50 percent less waste and pollution,
- 50 percent greater durability and flexibility, and
- 50 percent reduction in construction illnesses and injuries.

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28 NSTC is the cabinet-level council that provides the principal means for the president to coordinate science, space, and technology issues across the diverse parts of the federal research and development enterprise.
29 See National Science and Technology Council (2002).
30 National Science and Technology Council (1995a).
In December 1994, a large workshop of industry and government leaders gathered at the White House to establish priorities among the respective industry segments and to develop research agendas and action plans for achieving their highest-priority goals. Among those representing residential construction were homebuilders, product manufacturers, code officials, and insurers.

The efforts that led to the development, endorsement, and initial implementation of the National Construction Goals involved significant cooperation between the public and private sectors. This cooperation also provided a more inclusive process that helped ensure that the efforts had the support of the entire industry. As a result, this effort gave rise to other efforts including the Partnership for the Advancement of Infrastructure and its Renewal (PAIR)—an effort to streamline the nation’s building regulatory system—and the development of an implementation plan for the residential sector’s portion of the National Construction Goals. This plan was prepared with significant input throughout the residential construction industry and it placed the highest priority on two goals:\footnote{NAHB Research Center (1998).}

- reducing production cost through improved technology, and
- improving product durability.

The plan identified several strategies for achieving these goals including improving the efficiency of the housing production process; establishing and maintaining an information infrastructure that responds to the needs of builders, subcontractors, designers, manufacturers, code officials, and consumers; and fostering the development and commercialization of products and systems using input from the building community.

**Building America.** Launched in 1996, DOE’s Building America program is a voluntary public-private partnership that provides energy solutions in housing production.\footnote{O’Brien et al. (2000); and “Building America” at www.buildingamerica.gov.} Building America uses a systems engineering approach to home building to
• produce homes on a community scale that use 30 percent to 50 percent less energy,
• help builders reduce construction time and waste by as much as 50 percent,
• improve builder productivity,
• provide new product opportunities to manufacturers and suppliers, and
• implement innovative energy- and material-saving technologies.

To accomplish these goals, Building America performs research, development, and testing; education and technical assistance; and analyses of factory and site construction processes. The centerpiece of these efforts are its five Building America teams. Comprising more than 50 companies and organizations, these teams unite segments of the building industry that traditionally work independently of one another.33

Throughout the design and construction process, these teams use systems engineering to consider the interactions among the building site, envelope, and mechanical systems. This improves the understanding of how one component in a house can greatly affect others. This then allows the teams to incorporate energy-saving strategies into these homes at no extra cost. (Reinvesting these cost savings in improved energy performance and product quality is a Building America requirement.)

**Partnership for Advancing Technology in Housing.** Based on the National Construction Goals and the residential implementation plan, PATH was launched in 1998. It was created through the cooperative efforts of the Subcommittee on Construction and Building, the White House Office of Science and Technology Policy, HUD, DOE, and others as a public-private partnership involving homebuilders, federal agencies, product innovators, researchers, industry professionals and housing institutions, developers, and nonprofits. As a voluntary initiative, it seeks to foster partnerships among indus-

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try, government, and education institutions to facilitate the advancement and adoption of new and existing technologies.

Managed by HUD, PATH has three goals: (1) research and development, (2) information and outreach, and (3) planning and barriers analysis. PATH pursues these goals through a variety of activities aimed at linking technology forecasting and R&D with steps necessary to introduce innovations to the market and encourage their acceptance. Examples of PATH efforts to achieve these goals follow:

- To advance research and development of housing technologies, PATH works with a number of federal partners. Examples include leveraging PATH funds and National Science Foundation funds to conduct basic research on housing-related technologies; working with the Forest Products Laboratory of the Department of Agriculture to develop reliability-based design for housing in high wind areas; and helping the National Institute of Standards and Technology develop methods to evaluate housing technology.

- To increase information flow and outreach, PATH works with a variety of public, private, and nonprofit organizations to develop regulatory assistance programs to support new technology deployment, create an inventory of innovative technology, conduct technology evaluations and demonstrations, and disseminate information about housing technologies to industry and public audiences. PATH also cooperates with other agencies such as the Department of Energy to promote and improve awareness of pilot projects and field trials.

- To improve planning and barrier analysis, PATH sponsors technology roadmaps to help set the strategic R&D planning process for PATH and the industry as a whole. Roadmapping efforts to date have examined the use of information technology to streamline the homebuilding process; the application of advanced, panelized-type systems to housing construction; whole

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34DOE’s Office of Building, Technology, State and Community Programs has also conducted numerous technology roadmaps on such diverse areas as windows, lighting, the building envelope, and commercial buildings. These roadmaps were developed with significant and diverse involvement by government and industry. For more information, see www.eren.doe.gov/buildings/technology_roadmaps/.
house and building process design; and energy efficiency in existing buildings. PATH also funds technology reviews to better understand why some innovations succeed while others do not, as well as policy and market research to identify economic, regulatory, and institutional barriers to housing technology and innovation. This RAND study on innovation in the housing industry is one such effort.35

SUMMARY

Although this chapter has not reviewed all past federal efforts, it provides a sense of the evolution in goals, scope, and strategies used during the last 40 years. Perhaps the most important finding from this chapter is that the government has repeatedly recognized the benefits of innovation and the challenges that confront innovation in the housing industry. For this reason, the federal government has repeatedly invested in efforts to increase the rate of innovation in housing.

The next major finding is that the federal government has sought to learn from past experiences and to develop new strategies to better address the innovation process. In reviewing these past efforts, three major changes in the federal approach to promoting innovation in housing are evident.

The first is the move from a top-down to bottom-up approach. Earlier government programs frequently designated particular types of technology and directed industry to apply them. There was little consultation with stakeholders inside or outside of the industry or even across government departments and agencies. Today, instead of picking specific technologies and innovations, government programs generally seek to stimulate private and public efforts to develop technologies and innovations.

The second major change is the broadening interpretation of technology and innovation and how they are applied to housing. In the 1960s and early 1970s, technology and innovation largely meant the direct application of engineering advances to improve specific as-

35See the PATH web site at www.pathnet.org.
pects of housing production, such as industrializing home manufacturing processes. By the 1990s, thinking about technology and innovation expanded to include the application of information technology to integrate various housing production processes.

Third, perspectives on how to promote innovation in housing have increasingly focused on broader whole-house and systems approaches that integrate many aspects of the homebuilding process over narrower and more targeted efforts.

As a result of these changes, federal efforts to promote innovation in housing have evolved for the better. Even though federal approaches have become more effective, it is important to ask whether federal efforts to promote innovation in housing can be further improved. Chapter Six, the last of this report, presents a range of strategies that could improve the innovation process in the housing industry.