Housing in the United States comes in varied forms depending on land, climate, and available resources. Over time, changes in design, materials, building techniques, financing, and planning have changed what homes are made of, how they are built, what we can do in them, and who can afford them. As a result of these changes—referred to as innovations in this report—the quality and nature of housing have improved significantly, although not evenly for all inhabitants in all places and times.

The true value of innovation is that it is a means to an end. For example, innovations in housing provide homeowners with more for less; enable homebuilders to build more-desirable homes at lower cost; and help governments address major challenges such as making homes more affordable, improving energy efficiency, and reducing susceptibility to natural disasters.

As will be discussed in this report, the housing industry is often described as having many characteristics that challenge the development and deployment of innovations. If this description is true, then a poorly functioning housing innovation system will undoubtedly deprive homeowners, homebuilders, and society of the benefits that innovation can provide. These concerns have led to recommendations that the federal government support innovation in housing.

The Congress and federal agencies have, in fact, been involved in innovation in housing for more than three decades through investment in research and programmatic activities. Federal efforts to promote innovation have also modified strategies and tactics over time to better work with industry, and this evolution continues today.
This study examines the rationale and strategies available to the federal government for promoting and accelerating innovation in housing.\(^1\) It approaches this task by exploring how innovation might be improved or accelerated in the housing industry as it currently exists. This approach is chosen because the authors consider it more pragmatic to solving problems than approaches that emphasize barrier identification and analysis and look for solutions that call for restructuring the industry. The housing industry is so large and complex that changing any part would be difficult and changing the whole is practically impossible. This might explain why there has been little apparent success in implementing proposals from such studies.

This study begins by examining how the concept of innovation might be understood within the context of the U.S. housing industry. Next, housing industry structure and characteristics are described to better understand how they affect motives for innovation among major industry participants and to better understand the setting in which innovation occurs. Following this, past and current federal efforts to promote innovation in housing are studied to set the stage for the introduction of a conceptual framework and list of recommendations for federal consideration in selecting strategies to advance innovation in housing.

THE BENEFITS OF INNOVATION IN HOUSING

The benefits of innovation to homeowners have been significant. The professionalization of the homebuilding process, the installation of indoor plumbing, the introduction of electricity, and the development and implementation of building codes, among other innovations, have led to homes that provide a safe, secure, and comfortable environment; protect life and property; and fulfill many of our daily needs.

Innovation has also brought significant benefits to homebuilders. Standardized building products such as 2x4s, roof trusses, and

\(^1\)This report focuses on actions that the federal government can take to promote housing innovation. Although the authors believe that the report will be useful to state and local governments by providing information that could help them formulate their own strategies for promoting innovation, this is not the focus of this report.
factory-made kitchen cabinets have enabled builders to improve housing quality while lowering costs. In addition, by using innovative materials and techniques including energy-efficient design and construction, “green” building materials, and senior-friendly housing design, builders have been able to differentiate their homes from those of their competitors thereby creating market niches for their services.

The benefits of innovation also accrue to society. Most obviously, since everyone owns, rents, or seeks some form of housing, the entire nation stands to benefit from innovations that improve neighborhoods, towns, quality of life, the economy, and the environment. For example, innovation has helped keep housing affordable and the economy growing; worker productivity increased nearly 2 percent a year on average between 1972 and 2000.\(^2\) Financing innovations have also benefited society by boosting homeownership to an all-time high of 68 percent of the U.S. population in 2001.\(^3\) In addition, energy-efficiency innovations reduced residential energy consumption 27 percent between 1978 and 1997.\(^4\) Finally, regulatory innovations such as performance-based building codes\(^5\) and Internet-based permit services are helping to protect life and property at lower cost and with greater flexibility.

As these examples demonstrate, innovation affects national productivity and economic growth, homeownership rates and related socioeconomic issues,\(^6\) energy consumption, a broad range of environmental issues (e.g., air pollution, water scarcity, and solid waste), as well as society’s ability to protect life and property.

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\(^2\)Data on fixed residential investment and production workers are from U.S. Department of Commerce (2002).

\(^3\)U.S. Census Bureau, Table 5 (2002a).

\(^4\)Energy Information Administration (2002).

\(^5\)Performance-based building codes state what a material or method must achieve rather than what must be done and how to do it. This makes performance-based building codes more versatile and accommodating to both conventional and innovative technologies.

\(^6\)The affordability of housing and homeownership rates in particular are often associated with building stronger communities, strengthening families, and creating stability for children. For a discussion, see Rohe et al. (2000).
CHALLENGES TO INNOVATION IN THE HOUSING INDUSTRY

Despite the many innovations that occurred over the last century, the conventional wisdom is that innovation is slower in housing than in other industries. Two measures commonly used to support this argument are the industry’s small investments in research and development (R&D) and the long adoption/diffusion times for new technologies.\(^7\) Other challenges to innovation frequently cited by the industry include the industry’s complex and fragmented structure; its highly competitive and risky nature; the difficulty in accessing and sharing information; local variation in regulatory requirements and their implementation; the low levels of skill, training, and investment throughout much of the industry and its workforce; and the difficulty of protecting innovations and appropriating their financial returns.

Although studies disagree on the precise state of innovation in housing and on the relative importance of the contributing factors, it is more important to recognize that more innovation would be beneficial regardless of how much is occurring. However, increasing innovation is difficult for individual homeowners, homebuilders, and even significant portions of the industry, since many of the challenges to innovation are industrywide. For this reason, studies have long recommended that the federal government support housing-related R&D as well as the larger housing innovation system.

FEDERAL GOVERNMENT SUPPORT OF HOUSING INNOVATION

The legislative and executive branches of the federal government have long recognized the challenges facing innovation in housing and have supported efforts to increase innovation. These efforts have evolved over time, but one of the earliest and clearest congressional charges was in the Housing and Urban Development Act of 1970. The law states that

\(^7\)These measures will be discussed in more detail in Chapter Two.
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 . . . 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. . . .

Beyond this congressional directive, federal agencies have also invested in housing-related R&D and innovation because they were recognized as a legitimate strategy for pursuing their agency missions and goals. For example, the U.S. Department of Energy (DOE) has worked to increase energy efficiency in the home, the Department of Housing and Urban Development (HUD) has sought to make homes more affordable by lowering the cost of building materials and housing production, and the U.S. Environmental Protection Agency (EPA) has done research to reduce indoor health risks (e.g., lead poisoning, radon, air pollution).

Over the years, these and other agency efforts have had some success in supporting the early phases of the innovation process, such as conducting research and expanding the knowledge base, but they have generally been less successful at encouraging the adoption and diffusion of those innovations throughout the housing industry. Unfortunately, until new innovations are steadily developed, adopted, and diffused, their benefits will accumulate only slowly. Hence, the housing industry, government policymakers, and others continue to ask if the federal government could play a more productive role in supporting and accelerating the housing innovation system as a whole so that new technologies are not only developed but also commercialized and widely adopted throughout the industry.

OBJECTIVE OF THE STUDY

The primary objective of this study is to show how the federal government can more effectively support and accelerate innovation in housing by better understanding the industry as it exists and how it interacts with the innovation process. To this end, the study

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defines innovation and explains the innovation process,
describes the industry and explains how its characteristics influence the innovation process,
reviews federal efforts intended to promote innovation,
summarizes the tools available to the federal government to promote innovation, and
recommends federal actions to support and accelerate innovation within the current industry structure.

METHODOLOGY

To fulfill these objectives, this study combines past RAND research with an extensive literature review and meetings with representatives from throughout the housing industry.

The project team built on prior RAND analysis on housing, innovation, federal research and development, and public-private partnerships. In earlier work, RAND conducted roundtable discussions on the adoption of information technology in the construction process and within the home. RAND also studied federally sponsored R&D related to buildings and housing. Most of the team’s directly applicable knowledge resulted from RAND’s assistance with technology roadmapping efforts conducted through the Partnership for Advancing Technology in Housing (PATH). RAND publications from the team’s prior housing-related efforts include the following:


Our extensive literature review included publications on innovation, technology, housing, and homebuilding. We obtained them from the RAND library and electronic journals, via the Internet, and from libraries of the U.S. Department of Housing and Urban Development, and the National Association of Home Builders (NAHB) Research Center among others. Most of these sources were published in the United States over the past three decades. They include reports prepared by federal agencies, private firms, and nonprofit research organizations; articles from peer-reviewed journals; and meeting and workshop proceedings.

The authors interviewed industry experts, researchers, and government officials to verify and supplement insights gained from previous RAND research on housing innovation, as well as information on experiences with innovation and recent unpublished activities.9

REPORT ORGANIZATION

This report consists of six chapters. Following this introductory chapter, Chapters Two through Six address steps outlined in the study objective.

Chapter One presents the objectives, methodology, and structure of the study.

Chapter Two briefly introduces the state of innovation in U.S. housing; defines innovation, invention, and technology; presents the innovation process; and sets the stage for discussing how innovation fits within the context of the industry.

Chapter Three presents an overview of the housing industry by providing a background on how homes are designed, built, and sold, as well as the on roles and contributions of the industry’s many participants.

Chapter Four examines the characteristics and motives that affect innovation in the industry.

9Discussions were held with representatives or former representatives of the U.S. Department of Housing and Urban Development, the U.S. Department of Energy, the National Institute for Standards and Technology, the NAHB Research Center, and DuPont among others.
Chapter Five presents an overview of federal involvement in promoting innovation in general and in the housing industry in particular. The chapter describes the complementary efforts of investing in R&D, passing legislation, and creating industry-specific programs to support innovation.

Chapter Six presents, analyzes, and recommends policy options that are available to the executive and legislative branches to support and accelerate innovation in housing.