

## **4. Summary of FY99 Federal “Housing” R&D**

This chapter presents a quantitative profile of the housing-related R&D funded by the federal government during FY99. The data described in this chapter is a subset of the broader construction and building search presented in Chapter 3.

The chapter summary profile consists of two different aggregations of R&D projects. The first aggregation is by the R&D categories listed in Table 1. The second aggregation is by the sponsoring agency. In each case, summary data is presented in tabular and graphical format for both the number of projects and the associated funding levels. Finally, each aggregation also contains a more detailed textual description of the R&D areas and their rough funding levels.

### **4.1 Federal “Housing” R&D by Category**

#### ***4.1.1 Summary Data***

Table 4 presents the results, aggregated by category, of the housing-related subset. Figures 5 and 6 present this data graphically for the number of projects as well as for average annual funding.

Category	Number of Awards	Average Annual Funding (\$)
Building Design Improvements	11	4,194,444
Building Process Improvements & Automation	16	3,140,129
Building Product Improvement	40	21,057,473
Concrete, Cement, Pavement, Asphalt	6	571,639
Energy Efficiency	62	49,462,033
Energy Supply	60	110,515,929
Forestry	2	78,858
Land-use Design Improvements	6	326,509
Metals, Composites, & Advanced Materials (Non-wood, Non-concrete)	5	1,904,876
Other	12	3,704,480
Pollution & Waste Reduction	13	3,969,816
Reduction in Construction Work Illness & Injuries	151	15,857,039
Reduction in Occupant-related Illness & Injury	29	4,159,247
Structural Engineering & Natural Hazards	39	11,455,706
Wood Products & Quality	61	5,917,153
Total	513	236,315,331

Table 4. FY99 Federal Housing R&D by Category

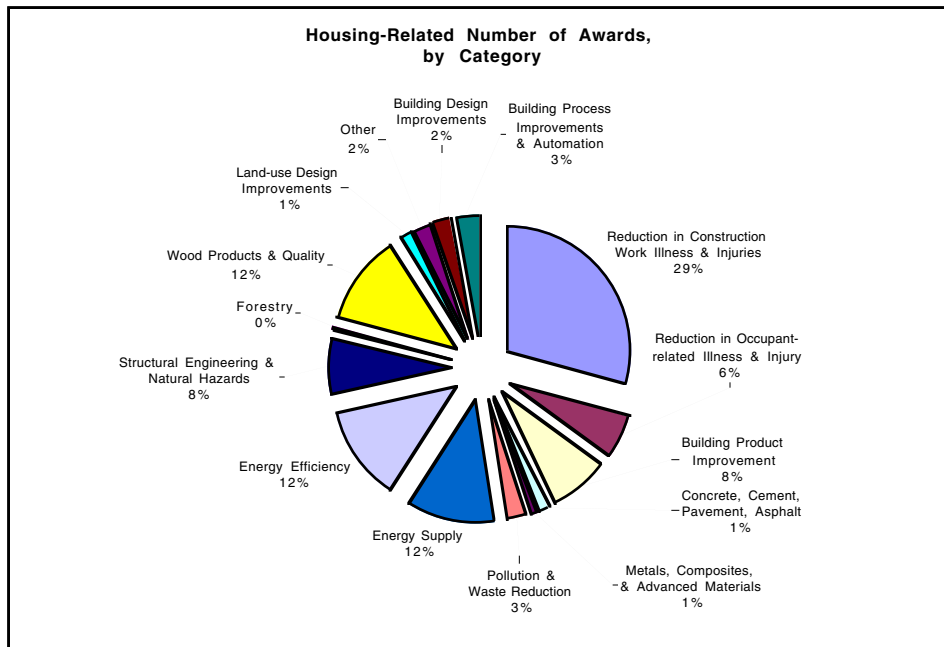


Figure 5. FY99 Federal Housing R&D Number of Project Awards by Category

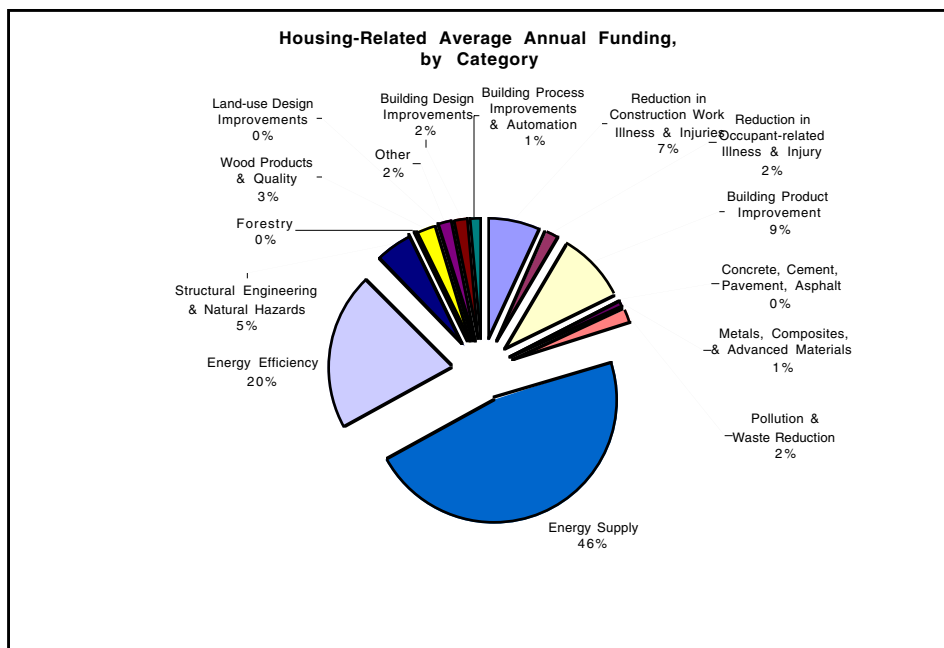


Figure 6. FY99 Federal Housing R&D Average Annual Funding by Category

### **4.1.2 Description by Category**

#### *Building Design Improvements*

Just over \$4 million was invested in efforts that could help improve residential design. This included R&D on sustainable and green design, affordable housing, and improved building rehabilitation/renovation.

#### *Building Process Improvements & Automation*

More than \$3 million was invested in R&D potentially relevant to improving the home building process. This included R&D on traditional process improvements as well as information technology developments and how those technologies can be transferred to home building industry.

#### *Building Product Improvement*

Approximately \$21 million was invested in building product improvements. Of this total, about \$12 million was for window-related research. The balance of the category was devoted to general R&D (nearly \$6 million), insulation (\$1 million), developing alternatives to stick framing (\$1 million), as well as improved foundations, insulation, paint, roofing, and windows.

#### *Concrete, Cement, Pavement, and Asphalt*

Slightly more than \$500,000 was invested in cement-wood composite materials.

#### *Energy Efficiency*

More than \$49 million in energy efficiency R&D was potentially relevant to housing. Of this total, more than \$28 million was focused on general analytical, technical, and program support. This general work addressed building energy systems, building codes and standards, existing buildings, heat and moisture modeling, and weatherization. Roughly \$16 million in R&D on HVAC, appliances, and motors was also potentially relevant. Finally, nearly \$5 million was invested in lighting.

#### *Energy Supply*

More than \$110 million of energy supply R&D is potentially relevant to housing. This includes more than \$100 million invested in renewable energy sources with photovoltaics representing \$90 million, roughly \$6 million for general solar and solar thermal technologies, and nearly \$8 million for geothermal technologies. On the non-renewable side of C&B relevant R&D, almost \$7 million was invested in fuel cells.

### *Forestry*

Roughly \$100,000 of R&D examined the role of residential housing as a major component of demand for wood, the economic trade-offs associated with conservation, and the impact of forest and riparian forest buffers on residential development.

### *Land-use Design Improvements*

Approximately \$300,000 was focused on demolition/deconstruction for redevelopment of urban areas, impact of natural resource conservation on rural subdivision developments, sustainable development, and transportation issues.

### *Metals, Composites, & Advanced Materials (Non-wood, Non-concrete)*

Nearly \$2 million was invested in metals and composites including thermoplastic composites for structural applications, steel applications, and analysis of hybrid/composite structural walls and steel frame systems.

### *Other*

Almost \$4 million in multi-category R&D and R&D results dissemination/outreach was conducted.

### *Pollution & Waste Reduction*

Nearly \$4 million was invested in reducing pollution and waste. Refrigerant R&D represented more than \$2 million of the total while wood processing represented another \$1.7 million. The balance addressed water and multi-pollutant issues.

### *Reduction in Construction Work Illness & Injuries*

Since specific project descriptions were not available for NIOSH, it was not possible to determine which portion of their construction-related illness and injury R&D was potentially relevant to housing. Out of a desire to err toward inclusion, NIOSH's full portfolio of almost \$16 million was included. However, conversations with NIOSH prior to publication determined that 10 studies representing roughly \$1 million dollars were specifically targeted at residential housing though some portions of the larger R&D portfolio were felt to have spill-over benefits to housing.

### *Reduction in Occupant-related Illness & Injury*

Just over \$4 million was invested in R&D related to the health and safety of building occupants, with the primary focus being on indoor air quality (IAQ).

Most of this research addressed IAQ generally (\$3.1 million), though \$600,000 was focused exclusively on residential air quality. Other targeted efforts addressed sensor development and low solvent adhesives.

#### *Structural Engineering & Natural Hazards*

More than \$11 million was invested in structural engineering and natural hazard R&D. R&D addressing multiple hazards amounted to almost \$6 million, with housing-related fire research representing another \$3.7 million. Both earthquake and wind-related R&D represented about \$1 million each. Smaller investments were made for structural R&D as well as measurement and instrumentation.

#### *Wood Products & Quality*

Approximately \$6 million was invested in housing-related R&D on wood products and wood quality. Slightly less than half of this was invested in finding new applications for wood and wood scrap/waste (\$2.7M). Just over \$1 million focused on the structural properties of wood and wood structures as well as adhesives. Other target areas receiving smaller investments included wood-containing composites (\$600,000), wood drying (\$350,000), and wood preservatives (\$110k).

## **4.2 Federal “Housing” R&D by Agency**

### **4.2.1 Summary Data**

Table 5 presents the results, aggregated by agency, of the housing-related R&D subset. Figures 7 and 8 present this data graphically for the number of projects as well as for average annual funding.

Category	Number of Awards	Average Annual Funding (\$)
USDA	89	8,319,175
DOC	29	27,253,127
DOD	2	0
DOE	130	167,622,313
HHS	166	17,146,260
HUD	45	11,892,694
DOI	1	57,950
DVA	1	14,011
EPA	3	606,800
NSF	47	3,403,002
Total	513	236,315,332

Table 5. FY99 Federal Housing R&D by Agency

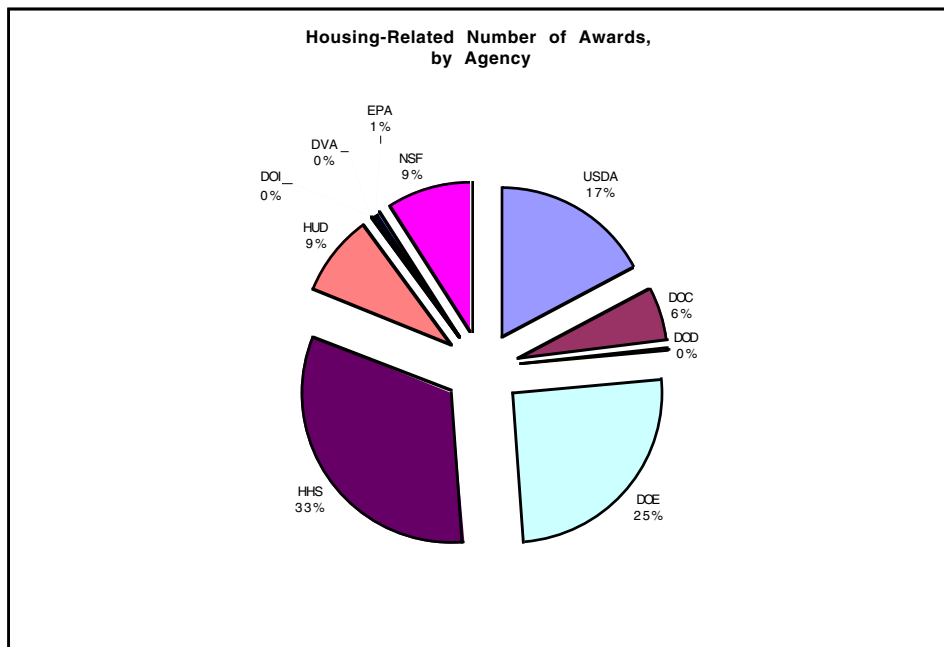


Figure 7. FY99 Federal Housing R&D Number of Project Awards by Agency

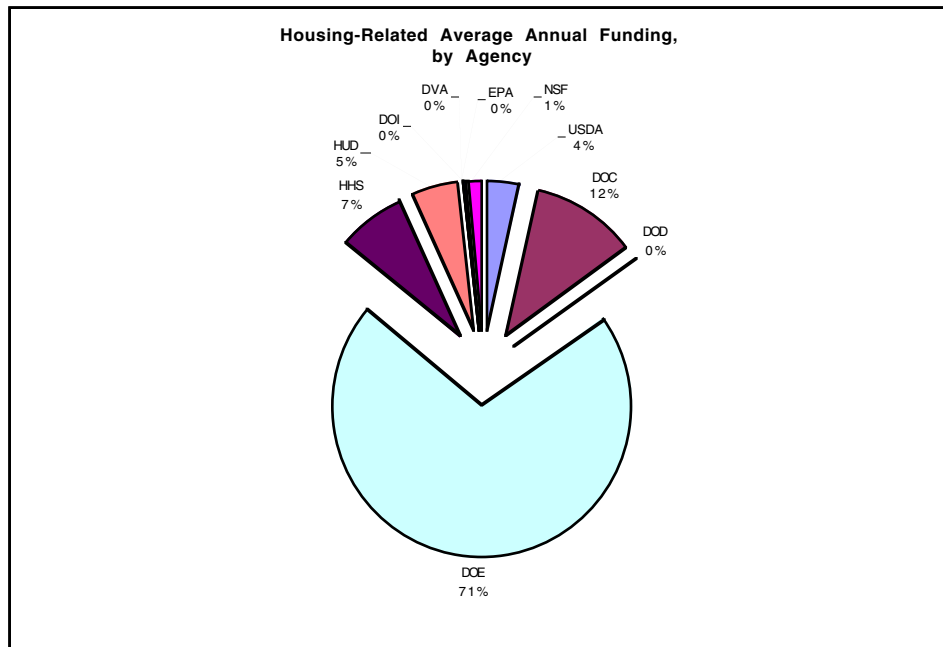


Figure 8. FY99 Federal Housing R&D Average Annual Funding by Agency

#### 4.2.2 Description by Agency

##### *Department of Agriculture*

More than \$8 million was invested by the Dept. of Agriculture with almost \$5 million for wood products and wood quality and \$2 million for pollution and waste reduction. Additional R&D addressed cement-wood composites, better building products, improved construction systems, structural engineering and natural hazards, and several other categories.

##### *Department of Commerce*

DOC invested roughly \$27 million in R&D that was potentially relevant to housing. Most focused on structural engineering and natural hazards (\$9 million), with lesser amounts for energy supply (\$5 million), energy efficiency (close to \$4 million), building design improvements (\$3 million), as well as a number of other categories.

##### *Department of Energy*

Of nearly \$170 million invested by DOE, roughly \$105 million was devoted to energy supply, nearly \$45 million to energy efficiency, and \$15 million for

building product improvements. The remainder was spread across the other categories with reducing occupant-related illness and injury and reducing pollution and waste being the largest components of the remainder.

*Department of Health & Human Services*

Of the Department's \$17 million, more than \$15 million went to reducing construction-related illnesses and injuries. The remainder focused on reducing occupant-related illness and injury, primarily due to indoor air quality issues.

*Department of Housing & Urban Development*

HUD's R&D investment was approximately \$12 million, with approximately \$10 million of this being housing-related funds. Of the total, \$4 million was used for building product improvements, \$3 million for multiple-category R&D (classified as "Other"), \$1.4 million for building process improvements and automation, and \$1 million for building design improvements. The remaining funds are spread across the remaining categories.

*Environmental Protection Agency*

EPA's investment in potentially relevant R&D amounted to \$600,000 and was focused on reducing occupant-related illness and injury, especially indoor air quality and low-solvent adhesives.

*National Science Foundation*

Roughly \$3.4 million of NSF's R&D investment was potentially relevant to housing. More than half of this was focused on structural engineering and natural hazards (\$1.7 million) with the balance spread across the full range of categories.

*Other Contributing Agencies*

Three other agencies also contributed to housing-related R&D. These included the Departments of Defense, Interior, and Veterans Affairs. DOD's contribution was focused on automated control of electricity producing distributed generation systems, however, funding information was not available for these projects. In addition, on a combined basis, the Departments of Interior and Veterans Affairs supported roughly \$72,000 of R&D addressing building codes and natural hazards and indoor air quality.

## 4.3 Federal PATH R&D by Category

### 4.3.1 *Summary Data*

Table 6 presents the results, aggregated by category, of the federal R&D funded specifically by the PATH program. Figures 7 and 8 present this data graphically for the number of projects as well as for average annual funding.

Category	Number of Awards	Average Annual Funding (\$)
Building Design Improvements	2	168,182
Building Process Improvements & Automation	6	1,237,879
Building Product Improvement	9	3,701,515
Energy Efficiency	3	716,667
Energy Supply	1	266,667
Other	6	2,765,633
Structural Engineering & Natural Hazards	5	472,727
Wood Products & Quality	3	656,364
Total	35	9,985,634

Table 6. FY99 Federal PATH R&D by Category

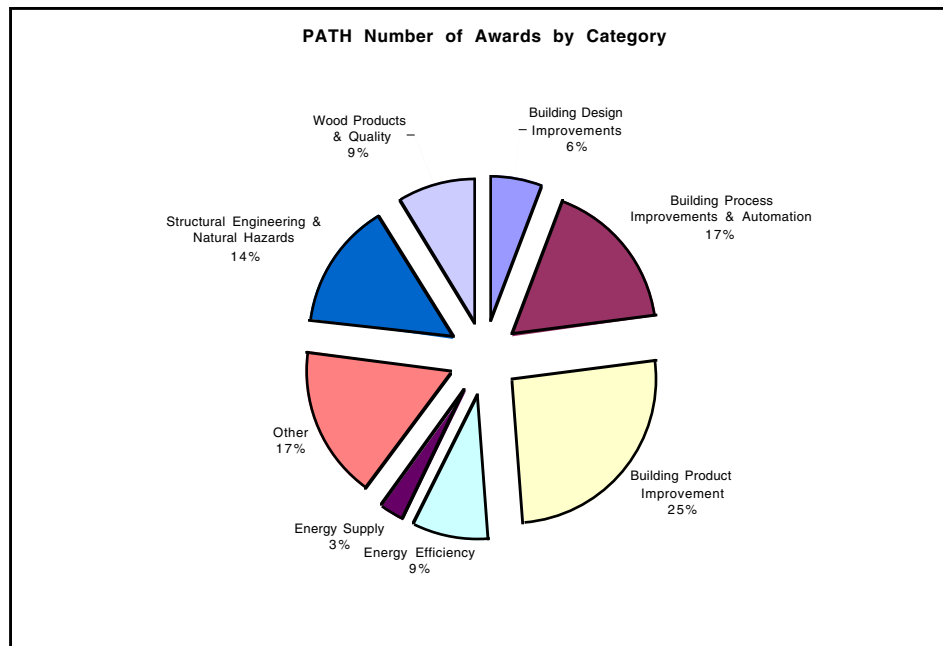
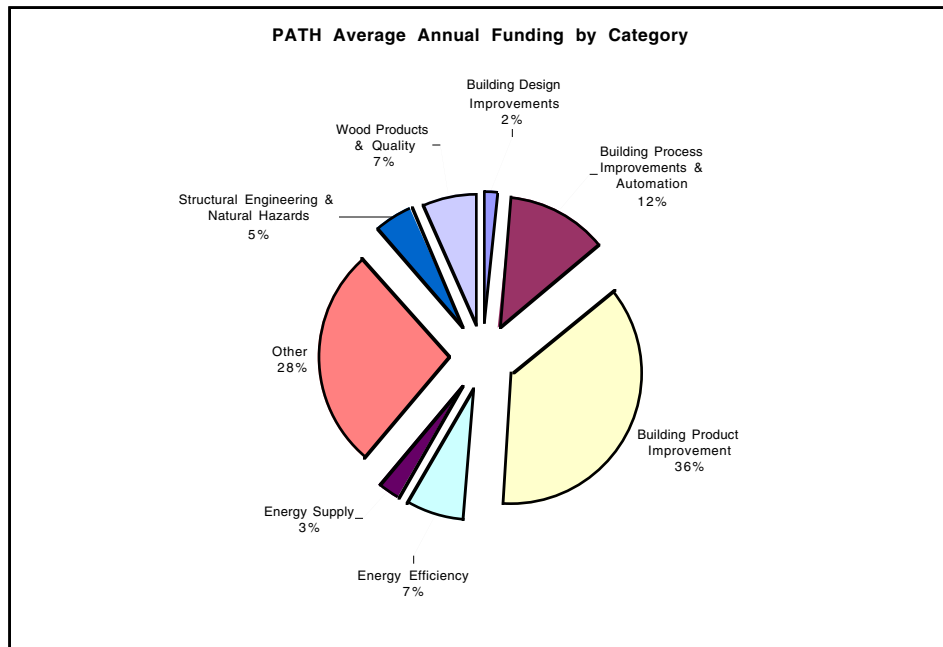


Figure 9. FY99 Federal PATH R&D Number of Project Awards by Category



**Figure 10. FY99 Federal PATH R&D Average Annual Funding by Category**

### **4.3.2 Description by Category**

#### *Building Design Improvements*

PATH invested roughly \$170,000 to develop internet-based tools to help home owners evaluate energy efficiency improvements as well as develop adaptive shading technologies for future housing.

#### *Building Process Improvements & Automation*

Roughly \$1.2 million was invested in alternative homebuilding techniques for both site-built and manufactured homes. These efforts included work on new fabrication technologies, labor-saving building systems, and new approaches to framing based on ISO 9000 practices.

#### *Building Product Improvement*

\$3.7 million was invested in improving building products. Just over \$800,000 of this was focused on developing alternatives to stick framing (e.g., clay masonry, composite structural insulated panels, insulated concrete panels, and steel framing). The roughly \$2.8 million in remaining funds addressed a broad range of building product issues including technical analysis of new products, technical

support for the PATH demonstration projects, documentation of product evaluations and best practices, as well as support in developing the PATH operating plan. The evaluation of moisture control problems and techniques for avoiding them were also addressed.

#### *Energy Efficiency*

PATH invested roughly \$700,000 in energy efficiency related R&D. Roughly one third of this funding was transferred to DOE to coordinate the PATH National Pilot sites. Another third focused on evaluating the effectiveness of advanced duct sealing technologies to increase energy efficiency as well as to assess the market potential and training requirements for wider use of these technologies. The final third of this funding focused on developing an energy saving residential thermostat that uses a variable deadband control.

#### *Energy Supply*

Roughly \$260,000 was invested by PATH in R&D on solar power roof tiles which would both generate electricity and help insulate attics and reduce cooling loads.

#### *Other*

PATH invested roughly \$2.7 million in a number of contracts that addressed multiple R&D categories and provided numerous services including analysis, technical support, coordination, and dissemination. For example, NIST initiated the development of performance standards for housing, provided support to the National Evaluation Service's Building Innovation Center, and researched or supported several topics including housing durability, environmental performance of housing components, residential fire safety, and how to streamline the nation's building regulatory process. These funds also supported technology roadmapping efforts for both new and existing homes. In addition, several contracts provided PATH with suggested management and measurement approaches. Finally, funds were also used to develop and maintain communication channels for disseminating R&D results to the broader housing community. These efforts included the Toolbase outreach program's website and telephone hotline as well as more traditional catalogues and CD-ROMs.

#### *Structural Engineering & Natural Hazards*

PATH invested almost \$500,000 in R&D addressing structural engineering and natural hazard reduction. Research addressing wind hazards, and specifically the development of in-house wind-hazard shelters, represented nearly 50 percent of the funding. The balance of the funding was spread over general structural

engineering research, the relationship between fire protection membranes and structural integrity of wood floors and ceilings, as well as the structural loads presented by eave icing during winter storms.

*Wood Products & Quality*

Wood products and wood quality received roughly \$650,000 in investment to improve reliability of homes subject to wind and severe storm conditions, to investigate the durability and disaster-resistance of new types of structural oriented strandboard (OSB), develop technical guidance for recycled lumber to increase reuse in housing construction and rehabilitation, and reduce the susceptibility of wood and wood products to water-induced decay.